Santa Barbara County

GREYWATER HANDBOOK

Integrated Water and Home Resource Management

Santa Barbara County

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The Community Environmental Council applauds Santa Barbara County for providing residents with step-by-step instructions for adding integrated greywater systems to their homes. This handbook showcases the region's historical environmental leadership in greywater systems, and highlights their importance not only in conserving water, but in conserving energy, saving money on utility bills, and providing actionable solutions to climate change.

—Community Environmental Council

TORB/AKHOPPER

Let's Save Together waterWise IN SANTA BARBARA COUNTY www.WaterWiseSB.org

For more information on water conservation in Santa Barbara County, visit www.WaterWiseSB.org.

Quick Action Summary

- **Every landscape benefits from mulch cover.**
- **Every greywater- or rainwater-using landscape** benefits from mulch basins formed with these water sources in mind.
- **If you want a cheap, quick greywater system** to save water and money, and/ or are a renter, Movable Laundry to Landscape is the system for you.
- **Want to irrigate but not move a hose?** Consider a Fixed, Multi-Outlet Laundry to Landscape system.
- **On septic?** A laundry greywater system would likely pay for itself by less frequent leachfield replacement alone. If your septic is struggling, a Branched Drain system would likely pay for itself, too.
- **Greywater enthusiast?** And/ or doing new construction/ remodeling? Consider a Branched Drain system as well as a laundry system.

About Printing and Paper

If you can, please read the electronic version of this book.

If you are reading the electronic version, links are clickable. If you are reading the printed version, check WaterWiseSB.org/greywater/refs for Resources and References with clickable links.

If this is a copy printed by the County, it is printed on 100% post-consumer recycled paper. Recycled paper uses 64% less energy, 50% less water, and 100% less trees. It creates 74% less air pollution and five times more jobs than paper from virgin pulp.

If you print at home or at work, why not use 100% post-consumer recycled paper for all your printing, including this handbook? It is available locally.

To save you expensive color ink, this handbook is designed to print legibly in black and white.

You can print double-sided on 8.5 x 11" paper, and staple it close to the left edge. This way it will open like a book, with certain pages facing each other as they are designed to.

After you are done reading, please pass it on to a neighbor for their use.

Harvesting hundreds of pounds a year of tangerines from a greywatered tree.

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This handbook focuses on material that is most relevant to County greywater users, but not readily available elsewhere.

The Resources and References section links to additional information that *is* readily available elsewhere.

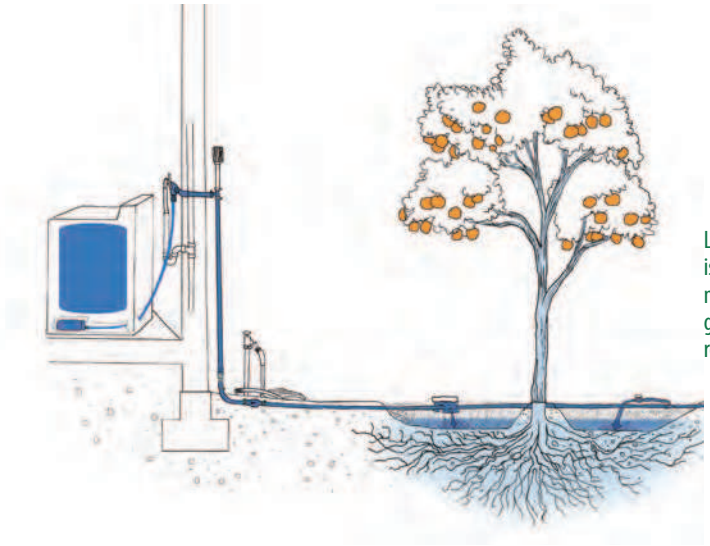
What Is Greywater?

Any wash water that has been used in the home, except water from toilets, is called greywater. Shower, bathroom sink, and laundry water comprise 50–80% of residential "waste" water. Greywater may be reused for other purposes, especially landscape irrigation. (In California, kitchen sink water is not considered greywater and its use for irrigation is not allowed.)

About this Handbook

Santa Barbara County is a national leader in greywater policy, innovation, education, and reuse. Recurring drought as well as heightened concerns about rising water and energy costs, water security, and climate safety have further spurred interest in greywater irrigation.

Greywater is uniquely connected to many home and landscape elements, including efficient fixtures, conserving habits, irrigation, stormwater infiltration, green waste processing, and multifunction trees (shade, fruit, privacy, etc.). In state-of-the-art practice, greywater is the central hub from which to manage this whole web of systems. This broad approach enables much greater improvements—for example, over ten times more water savings than by managing greywater in isolation. Similar increases in community benefits such as climate safety and groundwater recharge can also be realized.



Laundry greywater is the easiest and most common greywater source to reuse for irrigation.

This handbook was produced by a team with extensive Santa Barbara County greywater experience. It focuses on filling the County's most critical greywater knowledge and practice gaps. It covers:

- Simple, easy, resident-installed systems.
- Hiring out greywater work.
- Conformance with applicable regulations.
- Optimizing all greywater-connected elements for a more sustainable household and landscape.
- References to additional greywater information for installation details, etc. (Superscript numbers refer to endnotes in the Resources and References section. To facilitate skimming, nonessential information is in grey text like this.)

Greywater is the ideal gateway to integrated, optimized resource management at home. This handbook explains not only how to get greywater out of your septic tank and into the landscape, but how to follow the greywater thread to a more sustainable water supply, healthy soil, climate safety, and community resiliency.

History of Greywater in the County

Santa Barbara is a world center for innovation in greywater best practices and a statewide leader in greywater regulations. In fact, the majority of the technical advances in simple home greywater systems since the late 1980s have occurred here in Santa Barbara County. (See sidebar, below.)

The Mission Lavanderias at La Pursima (Lompoc), Santa Inés, and Santa Barbara (shown) are among the oldest and most famous greywater sources in the County.

Greywater Innovations and Regulatory Advances

Early history—**Greywater is near-universally reused, then universally disallowed.** With the advent of indoor plumbing, greywater irrigation continues until it is pooled in with blackwater and banned by plumbing codes.

1989—**Santa Barbara County legalizes greywater irrigation**, the first U.S. jurisdiction to do so.[1]

1990—**World's first plant and soil biocompatible laundry detergent** is launched in Santa Barbara.[2]

1991—***Create an Oasis with Greywater*** is published in Santa Barbara County, a leading reference worldwide to the present day.[2]

1992—**California and then all western states allow greywater irrigation**, following Santa Barbara County's lead.[1]

1995—**Branched Drain system** is developed in Santa Barbara County. [2]

1997—**California greywater code is revised to allow multi-family, commercial, and institutional greywater systems**, with major input from Santa Barbara.[1]

2000—**Green Septic system** is developed in Santa Barbara County.[2]

2001—**Arizona grants one blanket permit for every greywater system** that complies with 13 commonsense standards, later followed by New Mexico and several other states.[3] This forms the impetus for another round of regulatory changes in California (2009-2017 below).

2008—**Laundry to Landscape (L2L) system** is developed in Santa Barbara County.[2]

2009—**California exempts laundry-only systems** from permit if they follow guidelines sponsored by the City of Santa Barbara. The L2L system is rapidly adopted statewide, as dozens of water agencies offer classes and rebates.[4]

2015—**Santa Barbara County allows permit-exempt shower greywater systems**, the first jurisdiction in California to do so.[5]

2017—**Santa Barbara County publishes best practices for permit-exempt, movable greywater outlets** in this handbook.[5]

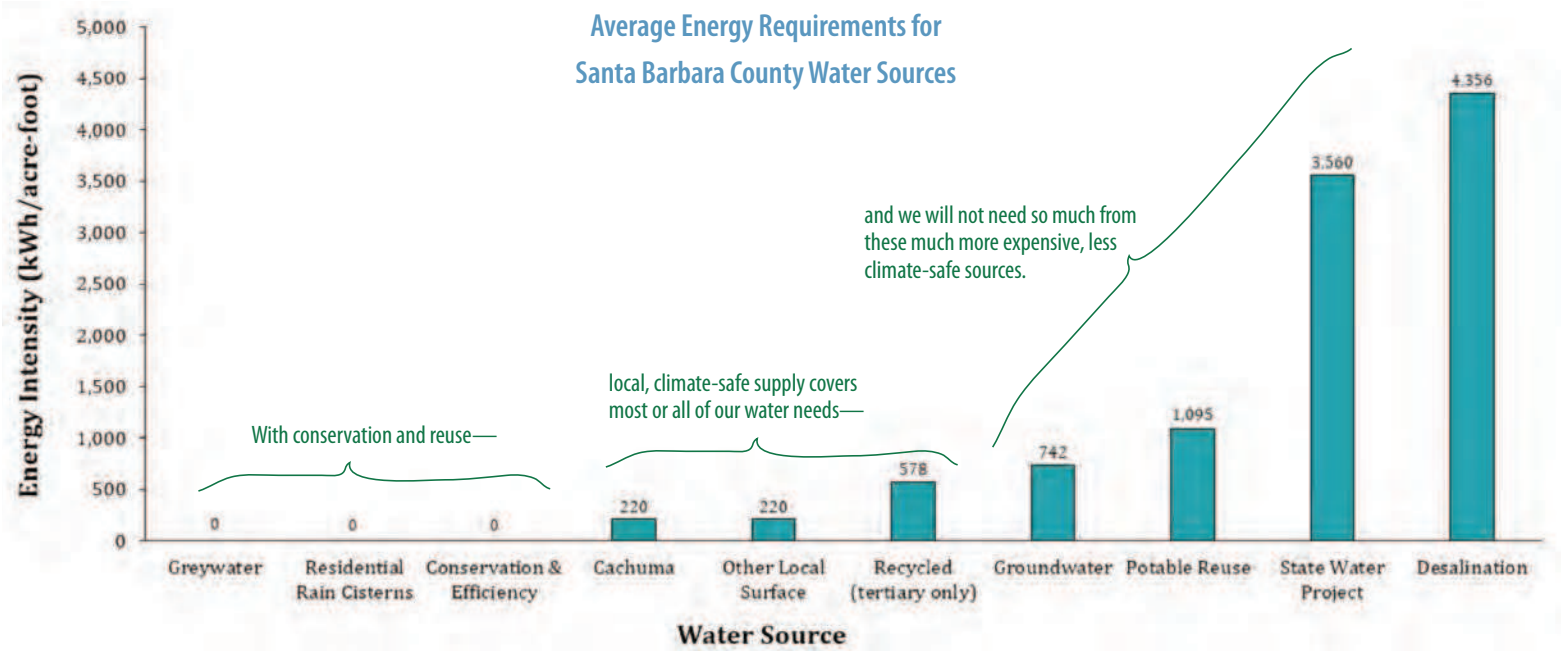
Keys to Our Climate-Friendly Water Supply

We enjoy a uniquely climate-safe water supply in Santa Barbara County. Its climate cost per gallon is about a sixth of the Southern California average, thanks to our commitment to conservation, reuse, and local supply.

How is this accomplished? Our County is blessed with a diverse portfolio of supply options. These vary widely in dollar, energy, and climate cost. Local water agencies use the low-cost, climate-safe water first, only resorting to higher-cost water sources as needed. This makes our individual choices about water use and conservation extremely consequential: *If we conserve enough to meet our needs with low-cost water alone, we completely avoid the need for sources that cost dozens of times more.* Reusing greywater can lower your water use by 30%, and that can lower the carbon footprint of your water use by a factor ranging from 2 to 50.

CHRIS HENRY PHOTOGRAPHY

North County rivers are a supply of a large amount of water that is the least expensive in dollars, energy, and climate impact.



Energy cost of Santa Barbara County water sources.[6]
(Dollar cost and climate safety cost track closely with energy cost.)

Why Reuse Greywater?

In Keys to Our Climate-Friendly Water Supply, we learned that the extreme differences in cost and climate safety between first- and last-resort water make water conservation and reuse especially consequential. Using greywater has many other benefits as well. These are the goals that greywater reuse (and this handbook) can help you achieve:

- **Extend the life of septic leachfields and reduce pumping costs**—Often even a failing septic can be restored to safe function by diverting all greywater, which is most of the total wastewater flow.
- **Conserve water and lower water bills**—by reuse of greywater for irrigation. In a drought emergency, reusing greywater can enable you to save your landscape while staying within your fair share of limited water resources.
- **Provide better purification than a septic or sewer**—Greywater reuse protects the quality of natural surface waters and groundwater, as it is purified to a very high degree in the upper, most biologically active region of the soil.[7] Reducing the wastewater flow increases the treatment effectiveness of the remaining flow in septic and municipal treatment systems as well.
- **Improve climate safety and lower energy use**—through reduced freshwater pumping and wastewater treatment; reduced methane emissions from septic systems, sewers, and landfills; and increased sequestering of carbon as soil organic matter and plant growth.
- **Lessen use of toxic chemicals**—by reducing the amount of freshwater and wastewater that needs treatment. Moreover, on-site reuse encourages the purchase of nontoxic cleaners, which eliminates toxic waste all the way up the supply chain.
- **Increase soil tilth and fertility**—Irrigating with greywater reduces nutrient loss through wastewater disposal in rivers and oceans, which is a subtle but significant form of erosion.

Greywater reuse nourishes soil and plants, and provides safe irrigation for fruit trees.

When Not to Use Greywater

There are a number of possible reasons *not* to use greywater, or to use it only at certain times:

- **Inaccessible drainpipes**—If all of the home's plumbing is entombed under a concrete slab, accessing most of the greywater will not be economical. But you can almost always get at the laundry water, or possibly use a Green Septic.[8]
- **Unstable geology**—If you have a potentially unstable slope, consult a geotechnical engineer before infiltrating stormwater, or in the least stable slopes, even greywater. Irrigating such areas when dry could promote stabilizing root growth, but over saturation could contribute to slope failure.
- **Overly wet weather**—During very wet winters, irrigating with greywater is of little benefit. It may be better to disperse it elsewhere to avoid waterlogging plants.
- **Insufficient space**—In some situations, neighbors are too close, or the yard is too small. Aside from apartments, this is rare in Santa Barbara County; even a tiny suburban lot can reuse at least some greywater.
- **Unsuitable soil**—Soil that is extremely impermeable may preclude the use of a greywater system, or at least require special adaptations. However, years of mulching dramatically improve even the worst clay soils in the County.
- **Poor cost-benefit ratio**—In some situations, especially with a complex system for a small flow of greywater, the economic and ecological costs may outweigh the benefits. This is common with professionally installed systems, which are generally much more expensive than owner-installed ones. Also, Branched Drain systems in large houses with low water use require a lot of plumbing and yield little greywater.

- **Reduce landfill**—The mulch basins described in this handbook save precious County landfill space by on-site processing of wood chips, yard waste, and compost.
- **Support flourishing landscapes where irrigation might otherwise not be feasible**—Keeping plants around wildland homes hydrated increases wildfire safety; nourishing shade trees mitigates the "heat island effect." Greywater application in excess of plant needs also recharges aquifers, and abundant groundwater keeps springs and creeks flowing between rains.
- **Encourage other resource-conserving practices**—By following the causal chains between greywater and the rest of your household systems, integrating and optimizing them, you can make your home more sustainable. Homes in the County could feature, for example, a super-efficient washing machine that fills with rooftop-harvested rainwater and launders with a tiny amount of nontoxic detergent, which biodegrades into plant food as it irrigates strategically located trees, which in turn provide fruit and sheltered, shaded, private outdoor living space as well as lower home cooling bills.

Greywater systems are a key part of resource custodianship now and for our long-term future. Greywater reuse is one of those old-time thrift actions that, in sum with many other such actions, helps to create prosperity and community resiliency.

JEFF NIGHMAN/ SANTA BARBARA NATIVES NURSERY

Bathtub and laundry greywater outlets to mulch basins behind banana trees are unobtrusive enough to get married next to.

Which of these Scenarios Apply to You?

What motivates your interest in greywater? You probably fall into one (or more) of these common Santa Barbara County scenarios. Depending on which one(s), your path forward is quite different. Do you want to:

- **Save water and money now?**—In this scenario, drought, high water bills, and/ or ecological consciousness spurs action to connect greywater to thirsty plants, ideally in a day, for a modest cost in parts. The Movable Laundry to Landscape system, newly green-lit for Santa Barbara County residents, is the best fit for immediate action (and also the most practical for renters).
- **Extend the life of your septic system?**—The greatest financial return from a greywater system is saving a septic system. If you have a septic system, it is likely worth diverting greywater out of it to reduce pumping frequency and extend the life of the leachfield. The easiest way to divert some greywater is with a laundry system. A Branched Drain system is more complicated to design and install, but it can divert more of your household greywater for irrigation purposes, further reducing septic strain.
- **Optimize resource use?**—Using greywater can deepen your connection with natural resource flows. A shower feels better when you know the wash water is being used to nourish plants. This often inspires the question: What else can I do to get more of this good feeling? Many County households have followed the gateway of greywater reuse onward to nontoxic cleaners; efficient fixtures and appliances; conserving habits; multifunction, climate-appropriate landscaping; mulch basins that turn green "waste" into rich soil; rainwater harvesting, and so on. This integrated approach can save *many* times more resources than greywater reuse alone. It is referred to throughout this handbook, especially in the section How to Make the Most of Greywater.

Greywater reuse reduces septic tank pumping frequency and extends leachfield life.

Greywater is at the center of the web of a home's connected systems. The more connected threads you pursue, the more individual and community benefit can result. By integrating and optimizing greywater-connected systems, it is possible to do most or all of these (see figure on next page):

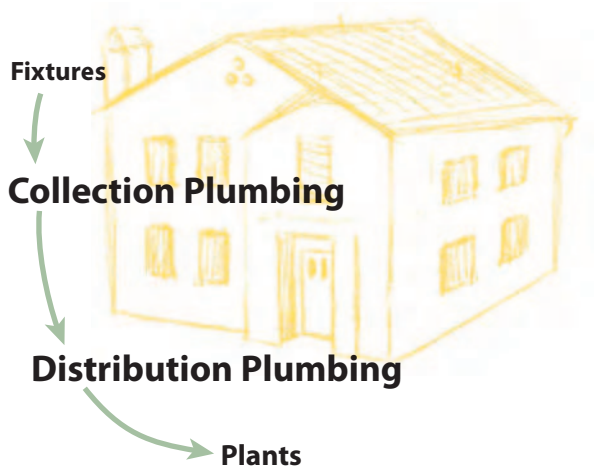
- **Reduce runoff from your property.**
- **Grow a substantial amount of fruit and create beneficial shade.**
- **Greatly reduce your climate footprint.**
- **Redirect all yard waste from landfill to creation of more fertile soil.**

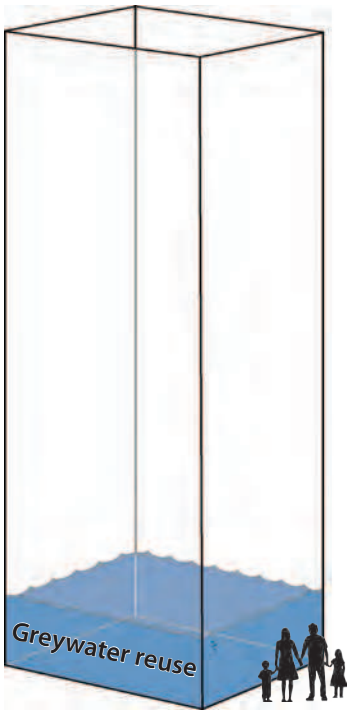
This handbook gives you a running start in achieving all of these ends and more. It also provides a Resources and References section for further details and inspiration.

Benefits of Systems Approach vs Narrow Approach to Greywater Work

Narrow Approach

Working on just the piping between fixtures and plants can achieve modest water savings up to 15%.





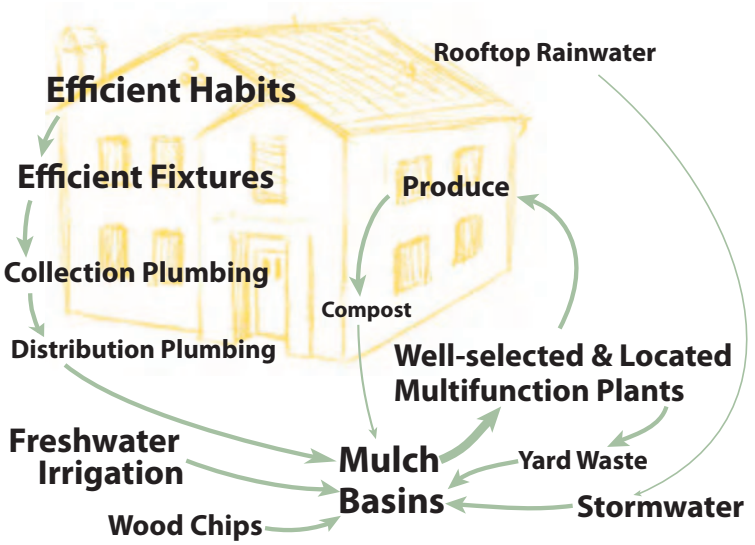
7.5 tons of water a year

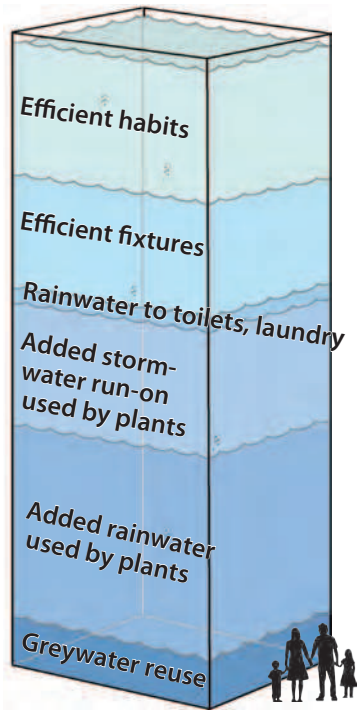
6% Water Savings

Looking at greywater narrowly, it is easy to miss the point. For example, some people hesitate to switch to a high-efficiency washer because "I will have less water for my garden," even though the high-efficiency machine conserves more water with 100% certainty all year, and the freshwater not used for laundry could more easily be managed for irrigation.

Systems Approach

Optimizing the whole web of greywater-connected systems enables dramatically greater water savings, along with energy savings, climate safety, soil health, and other benefits.





75.0 tons of water a year[2]

60% Water Savings

Greywater is the central hub from which the management of all these connected elements can best be optimized. Most of the water, energy, climate, soil, and community benefits occur outside of the hub. So for best results, consider all these elements, whether working on your own home or for clients.

Water volumes, people, and houses are all depicted at the **same scale**. *We are fortunate to have all these tons of water flow where we want without having to carry any of it.*

ART LUDWIG/ OASIS DESIGN

What Makes a Greywater System?

A *basic* greywater system collects greywater, then divides and disperses the flow to plants. Even greywater systems designed primarily to get rid of greywater rather than irrigate still need to disperse greywater so the areas around the outlets do not get swampy. These systems are quite simple.

An *optimized* greywater system tunes fixture flow rates, user habits, plant selection and location, and stormwater and green waste management all together for the specific site and soil conditions.

These are the core elements of a greywater system:

1. **Greywater source(s)**—can be the washing machine, shower(s), bathtub(s), and/ or sink(s).
2. **Collection plumbing**—transports greywater from the house to one or more points right outside the house.
3. **Irrigation piping**—transports greywater through the yard and divides it among plants; includes tubing or pipe, and outlet chambers or mulch shields.
4. **Mulch basins**—contain the greywater, mulch that covers it, and soil and roots that purify it.
5. **Well-selected and appropriately positioned plants**—transpire the greywater and provide shade, privacy, windbreak, habitat, fruit, and/ or beauty.
6. **People**—design, make, and maintain the system, generate the greywater, tend the garden, and eat the fruit. People are a key component; when the people or their habits change, the system should ideally be able to accommodate them.

Greywater filter, left; tank and filter, right.

REGENERATIVE LANDSCAPE ALLIANCE

What about Pumps, Tanks, and Filters?

Surge tanks, filters, and pumps add cost and complexity. They are not needed in the types of systems that have been most successful for residents of Santa Barbara County to date. For more information, see Common Santa Barbara County Greywater Questions and Answers. Innovators have been trying for decades to make a system that pretreats and pressurizes greywater to enable its distribution by drip irrigation. So far, this has not proven worthwhile for residential-sized flows and has found little application in the County. Check WaterWiseSB.org/greywater for updates.

Greywater Safety and Design Basics

Although irrigation with greywater provides wide-ranging benefits, greywater does contain nutrients and bacteria. While there is not a single documented case of greywater getting anyone sick in the United States, mishandled greywater can create bad odors and at least the potential for transmitting illness. This handbook is intended to assist the user to install simple, robust, safe systems that will comply with applicable standards.

Greywater is different in many ways from purified, filtered, and pressurized freshwater. It is intermittently available at very low or no pressure, and comes mixed with soap, compost, and a trace of pathogens. It is also totally different from septic tank effluent, which has less solids, more consistent characteristics, and hundreds or thousands of times more pathogens.

Many common greywater errors arise from applying freshwater or blackwater designs to greywater. Greywater has its own safety and design principles:

- **Do not drink greywater**—This is unlikely to happen on purpose; design your system so it will not happen by accident either. For example, if you use garden hoses to distribute greywater, dedicate those hoses only to greywater, label the ends, and use a different kind of connection so they cannot be connected back to the potable water system by mistake.
- **Minimize human and animal contact**—California greywater code requires outlets to be covered with 2" (minimum) of mulch or an outlet shield;[33] 4" is preferred. Wood chips are perfect for covering greywater; they are more durable and more permeable than other kinds of mulch.
- **Contain and infiltrate greywater**—Contain it within a shallow, flat-bottomed basin. Promote infiltration by forking compost or mulch into the soil in the original installation and maintaining a continuous mulch cover. You will need much more infiltration area if you have a clay soil. Again, wood chips are perfect for promoting long-term infiltration of greywater. Over time, mulch can increase the infiltration rate ten times or more.
- **Do not store greywater**—Disperse it as it is generated. Greywater that remains in a tank or basin more than 24 hours can go septic. Any water that stands open for more than several days can breed mosquitoes.
- **Make it easy to switch greywater flow from the landscape to the septic/ sewer**—California code requires a means to switch greywater away from the garden when the weather is too wet for infiltration or in case someone is using toxic cleaners. This is generally accomplished with a three-way diverter valve.
- **Match the quantity of greywater to plant needs**—In Santa Barbara County, it is best to design your system so that greywater will meet roughly half the peak summer irrigation need of the landscape area selected. This ratio makes the best use of available greywater while minimizing the amount of plumbing needed. To realize the most water savings, you need to calculate both your greywater volume and the irrigation needs of your landscape.[10]
- **Design your system to be as simple as possible, then build it as well as possible**—Mechanically simple systems with top-notch execution have the lowest long-term cost, least maintenance, and longest service life. *Let nature handle as much of the complexity as possible.*

A three-way diverter valve makes it easy to switch greywater from the landscape to the septic/ sewer.

How to Make the Most of Greywater

If you only want to get greywater out of your septic system, or install a Movable Laundry to Landscape system, you can skip this entire section and go straight to Designing and Building Your Greywater System.

On the other hand, if you want to take steps to optimize your home and landscape both ecologically and economically, then this section is for you.

Sequence of Operations

To make it further along the sustainable resource management path, with the least cost and effort, there is an optimum sequence to your actions. For example, if you intend to (1) eliminate water-greedy plants, (2) switch to a high-efficiency washer, and (3) reuse laundry wash water, that is the most efficient order in which to do the work. If you do it in the reverse order, you will end up designing and building the greywater system *three times* instead of once.

To make the most of greywater's keystone position in sustainable household resource management:

1. **Get clear on your goals**—For example, are you simply dispersing the greywater to save your septic system, or do you want to save freshwater that is now used for irrigation?
2. **Assess your context**—Consider water sources, greywater sources, soil characteristics and percolation rate, basin area needed for infiltration, and plant area needed for efficient irrigation needs; also anticipate changes over time, and prepare for a changing climate.
3. **Remove/ reduce lawn and water-intensive and/ or unproductive plants**—Take a critical look at every plant in your landscape and remove anything that is not carrying its weight. If you have an ornamental lawn, reducing or replacing it is almost certainly your first and best water sustainability measure.[11]
4. **Make your habits and fixtures more water efficient**—These measures affect your amount of available greywater tremendously, more than enough to change the design of the system.
5. **Coordinate greywater infiltration areas with rainwater/ stormwater infiltration areas**—to make the most of all categories of water and avoid waterlogging.
6. **Check levels**—Of greywater sources, of future outlets at mulch basins, and along the paths of collection and distribution plumbing.
7. **Connect water sources and uses with the most appropriate system(s).**
8. **Check regulations**—Get a permit if needed.
9. **Install, use, and maintain the system**—Having checked that the levels will work for the system type, build the system, following the flow from fixtures to receiving landscape, and re-checking levels as needed.
10. **Share what you have learned.**

Over the course of the next sections we will consider each of these operations in turn.

FRED HUNTER/ REGENERATIVE LANDSCAPE ALLIANCE

CORNERSTONE LANDSCAPES/ DOUG ELLIS PHOTOGRAPHY

Lawn replacement saves more water than almost anything else you can do. Turf-free landscapes can be beautiful.

Get Clear on Your Goals

The foundation of ecological design is to **get clear on your goals and context**; these affect every aspect of the design. In ecological design, whether for yourself or a client, it is useful and necessary to examine your assumptions each time. Start by asking:

- **Are you willing to change your lifestyle, and if so, how?**—Changing your habits is by far the most cost-effective way to conserve resources. For example, if you decide you do not really need long high-flow showers and a vast ornamental lawn, that decision will save lots of water and energy right off the bat. Then you can install a simpler, cheaper system to capture and reuse the greywater that is left after conservation. Whenever you can choose between reducing and reusing, reducing is the priority.[12]
- **Is it important to reuse your greywater, or merely dispose of it safely?**—Responsible dispersal and reuse are both beneficial.
- **How much effort do you want to put into reuse efficiency?**—It is quite a bit more effort to ensure that greywater reuse will actually lower your freshwater use than it is to simply get greywater out into the yard.
- **Are you trying to improve a marginal septic system?**—Greywater diversion is so effective for improving the performance, economy, lifespan, and safety of septic systems that most septics in the County would benefit from a means of greywater diversion to dispersal or reuse.
- **Is saving money a priority?**—Greywater system economics are best when you save septic pumping/ replacement, for do-it-yourself systems, and in drought when water is most valuable.
- **What are your landscape goals?**—Beauty? Food production? Erosion control? Slope stabilization? Firebreak? Privacy screen? Outdoor living oasis?

Give these questions some thought, and write down your goals. If you are working with other people on any aspect of the greywater system or landscape, be sure they also understand your goals.

Water Pop Quiz

Q: How much rain falls on the average quarter-acre Santa Barbara lot, relative to the amount of water delivered through the meter?

A: About the same.

Surprised? Most people guess that the rain is much less. That is because most of the rainwater is usually wasted runoff. But it can be infiltrated and stored in the soil to meet plant needs, or infiltrated to groundwater for potable or habitat use, reducing potable water needs and increasing supply as well.

Assess Your Context

Now we will turn to your specific context: greywater sources, irrigation need, soil and percolation rate, climate, etc.

Water Sources

The reliability of our water supply in Santa Barbara County can dull our awareness that water is the most important factor for any human settlement. Do you know where your water comes from? If not, it is worth finding out.[13]

Greywater Sources

To estimate the amount of greywater you have available, see the formula in the sidebar, below. If you prefer a more thorough approach, you can measure and calculate.[14]

These days, a much cheaper alternative to hiring someone to measure and draw a site plan is a printout from Google Earth (example on next page) or a drone photo taken straight downward. For a Google Earth base photo, zoom in on your property, then scroll through the historical imagery. Pick the image that is current enough and has the best light. Save it, then open it in an image editor. If you make it much lighter, you can more easily draw over it and see your notes, even in pencil.

Estimating Greywater Quantities

Here is the formula from the California greywater code for estimating the amount of greywater generated by a dwelling:

First bedroom—two occupants
Each additional bedroom—one occupant
Estimated greywater flows of each occupant:
Showers, bathtubs, and lavatories = 25 gallons per day (gpd) per occupant
Laundry = 15 gpd per occupant
= 40 gpd total per occupant[33]

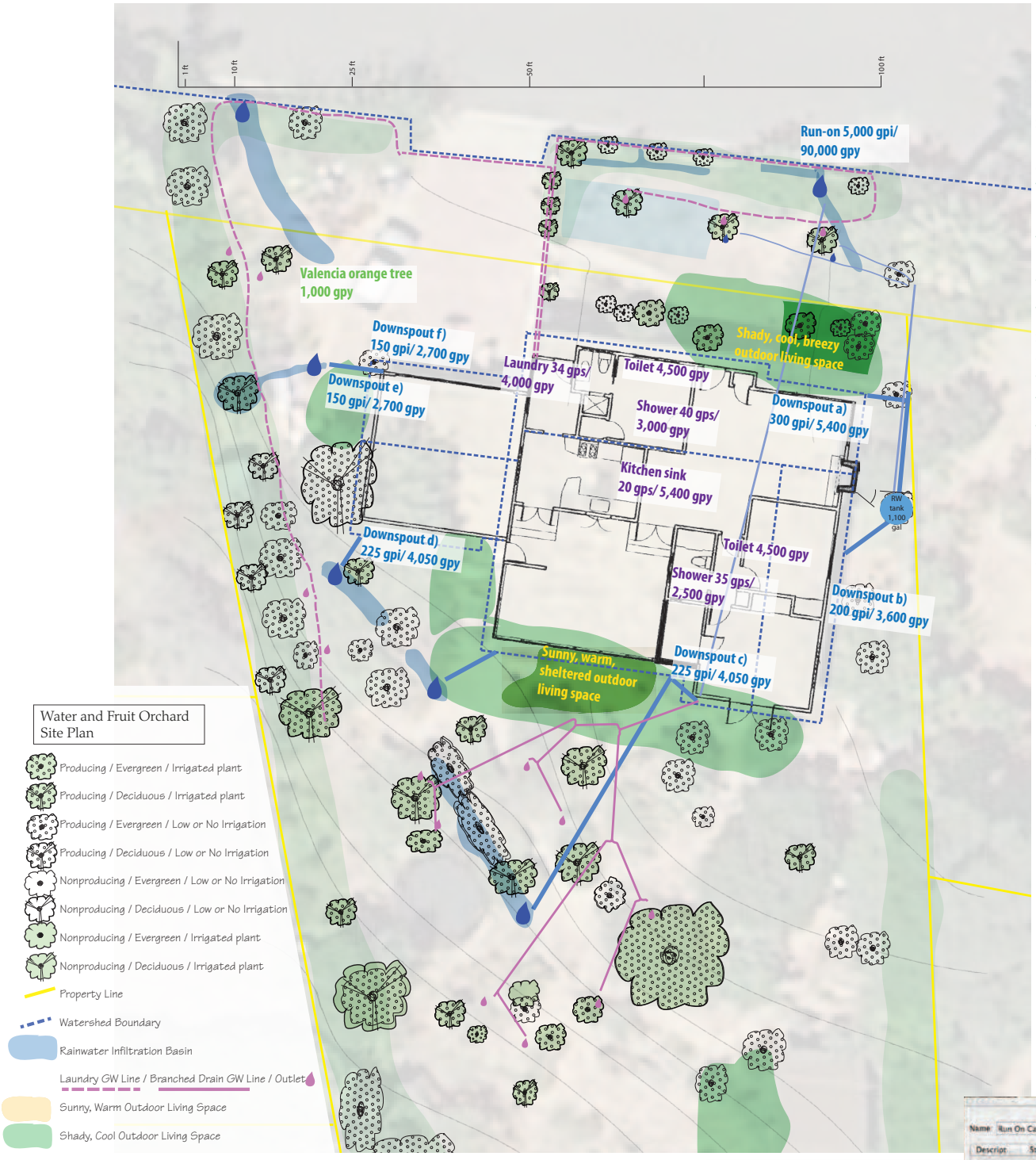
Example (based on the above formula):

Three-bedroom house = four occupants =
100 gpd from showers, bathtubs, and lavatories
+ 60 gpd from laundry
= 160 gpd total for the whole house

The California greywater code is concerned with having enough system capacity to process greywater. The above numbers correspond to overall indoor use of 50 gpd/ person (when toilet and kitchen sink water is included), which is average.
However, most greywater-using households have more-efficient-than-average fixtures and habits. Actual flow from ultra-high-efficiency fixtures may be as little as half these values, and highly conservative habits can cut that water use in half again. Total indoor use (including toilets) in the range of 10–15 gpd/ person is common at the most conservative end of the spectrum, which suggests a greywater flow more like this for a three-bedroom house with super-efficient fixtures and four occupants with super-efficient habits:

25 gpd from showers, bathtubs, and lavatories
+ 15 gpd from laundry
= 40 gpd total for the whole house

Plants cannot survive on theoretical water, so if your goal is irrigation, it is better to be realistic about your actual greywater amounts. You can get a record of your historical monthly water use from your water provider. In wet months when you do not irrigate, the water bill should reflect only indoor use.
Too much water is usually only a problem for your plants if you have heavy clay soil, an improperly designed/ used system, or leaks. As we will see below, to irrigate efficiently, you want to spread greywater over more area anyway. If you can estimate your available greywater within a factor of two, that is accurate enough.
To make the math easy, let us assume that the typical greywater-reusing household has moderately efficient fixtures and habits and generates 100 gpd of greywater.

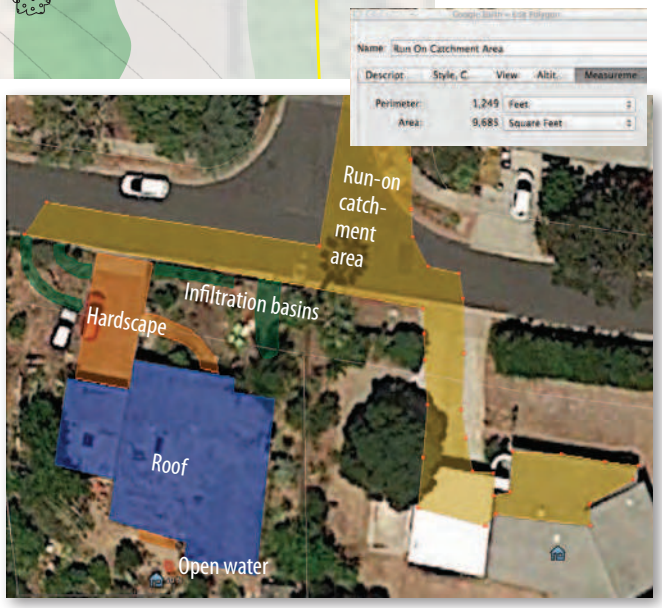


Sample Site Plan, based on a lightened Google Earth image, showing greywater sources and quantities, rooftop rainwater sources and quantities, and irrigation need.

If you have all this information noted on a site plan, it is often self-evident which water to send where.

This particular site plan shows water quantities in gallons per year, which fits with storing stormwater in the soil on an annual cycle.

The flows from downspouts are in gallons per inch as well, which is helpful for sizing basins for rainwater surges. For Santa Barbara County, a simple, conservative formula is to include enough volume below the spill point to hold a surge of 1" of water in an hour.



In Google Earth Pro, you can outline regions of your property (colored areas at right) and calculate their areas. This is handy for estimating irrigation need and infiltration area, and calculating rainwater volume.

Soil Characteristics and Percolation Rate

Soil is the main engine of every greywater system. It provides purification and storage, and converts bits of compost and soap into nutrients for plants. A great way to get to know your soil is to dig around in it (see sidebar below).

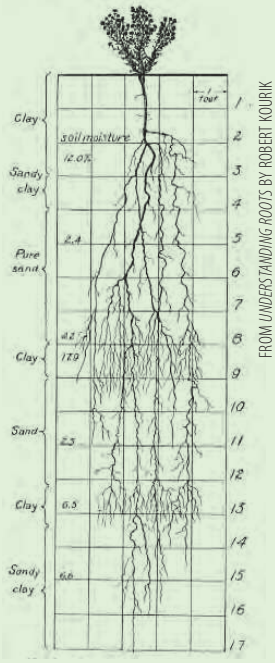
Dig Holes, Look, and Learn What Is Happening Underground

For a much more informed mental map of what is below the surface, dig holes. You may not know what you are seeing at first, but you will soon get a sense of how water and roots behave underground if you keep digging and visualizing:

1. **Check the mulch and soil surface with your fingers—**Is there a gradual transition from mulch to rich, fluffy soil that you can work your fingers into, or is there a hard surface? Years of mulching will open the soil for infiltration.
2. **Check the soil moisture—**If there was recent rain or irrigation, how far down did it infiltrate? Sodden soil is getting too much water. Soil that is hard and dry under the surface must be watered more deeply.
3. **Check the roots—**Is there new root growth? How far down? Are there deep roots? If not, something that roots need is missing; probably water, but possibly air or nutrients.
4. **Check the soil texture—**Rub soil between your fingers. Does it roll into a ribbon or snake that bends with little cracking? That indicates high clay content. The most common soil issue in Santa Barbara County is heavy clay soil.
5. **Check the initial water percolation rate (perc) in several holes—**After grading for a house, subsoil is often left exposed in some areas, making the rate that rainwater percolates into the soil extremely variable from place to place. Choose representative areas where you want to put the greywater system, and dig holes 1 ft wide and 1 ft deep using a post-hole digger or shovel. Fill them with water and observe. If it takes hours for the water to drop at all, or if a hole fills with water by itself, that area is not suited for greywater infiltration. If the perc is slow, more than 30 min/ in, loosen the top few inches of soil with a shovel or digging fork and add compost and mulch on top. If the perc is super fast, add compost, mulch, and plants that will develop a dense network of roots.
6. **Check the sustained perc—**Refill from a hose, then turn the volume down until the flow barely keeps the hole full (usually something between a drip and a steady trickle; if it takes a gush, you probably hit a gopher hole). Leave the hose running like this until the soil is saturated: 15 min for sand, possibly overnight for clay; the soil is saturated when the perc rate levels off and successive measurements give the same value. Turn the water off. Push a stick into the side of the hole at the initial water level, and start a timer. Measure how far the water drops in 15 min. If it drops ½" or more, your soil is fine. If it drops less, you will need more extensive basins—and to amend the soil with dug in compost and mulch.

You can easily convert the perc rate to minutes per inch by dividing minutes by inches. For example, if it takes water 30 min to drop 3", that is 10 min/ in.

GARDENS BY ALISON JORDAN



FROM *UNDERSTANDING ROOTS* BY ROBERT KOURIK

Above: Roots reach to 17 ft, and you can see how the roots proliferate in the clay layers.[15]

Center: With years of compost and mulch, clay aggregates into pellets and allows water and air to perc rapidly through the soil.

Left: With a soil probe you can make many more holes much faster and get a good idea of what is going on in the soil.
If you are doing this work professionally, checking soil and perc is so fundamental that it is worth doing on the first visit to a client.

Basin Area Needed for Infiltration

The table below from the California greywater code[33] is a good guide for how much absorption area you need to safely infiltrate greywater:

To satisfy code for a house with three bedrooms, 160 gpd of theoretical greywater requires 32 ft² of infiltration area on sandy soil or 200 ft² on clay soil. If you have clay soil, you will need four mulch basins 9 ft in diameter, or whatever other dimensions add up to the required area. (You only count the wetted area of the basins, at a depth of 2" or more below the mulch surface.) If your only goal is to keep greywater out of your septic system, then you can calculate the necessary infiltration area by using this table. If you want to save irrigation water, however, you also need to consider plant area and irrigation needs. (Note: It is true that the lesser amount of actual greywater generated by a conservative house could infiltrate in less basin area; however, it is necessary to spread it over more area for irrigation value, as we will see in the next section.)

Greywater Loading Rates by Soil Type

Type of Soil	Minimum square feet of irrigation/ leaching area per 100 gal of estimated gray water discharge per day	Maximum absorption capacity in gallons per square foot of irrigation/ leaching area for a 24-hour period
Coarse sand or gravel	20	5.0
Fine sand	25	4.0
Sandy loam	40	2.5
Sandy clay	60	1.7
Clay with considerable sand or gravel	90	1.1
Clay with small amounts of sand or gravel	120	0.8

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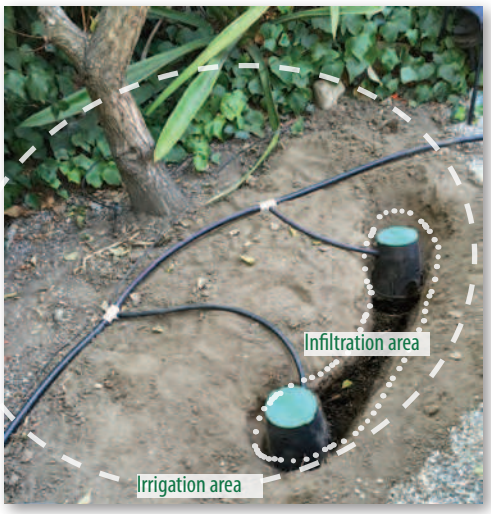
Plant Area Needed for Efficient Irrigation

For efficient irrigation use, you want to spread greywater around quite a bit more than the minimum area for disposal. You can infiltrate 5 gpd/ ft² in sandy soil. But even in the month of highest water use in the driest northeast portion of the County, plants would only transpire a tiny fraction of the water infiltrated. So if you apply greywater at the maximum rate allowed by the greywater code, the vast majority of that water will slip below the roots (getting nicely purified on the way). If you are over a groundwater basin, the greywater will recharge it. Recharge is a fine goal, but it is not going to save you as much irrigation water.

When calculating irrigation needs, count the square footage under the drip line of trees and shrubs, which can add up a lot faster than basin area. For example, a full-sized orange tree might cover more than 150 ft² of ground, even if it is irrigated by a 50 ft² mulch basin. A reasonable aim is applying 1" per week of greywater to the target vegetation. For the aforementioned standard house in the County with 100 gpd of greywater, this works out to a bit over 1,000 ft² of irrigated plants, or about a dozen medium-sized fruit trees.

Here, a small infiltration area feeds a large irrigation area. This will often be the case when retrofitting greywater irrigation to mature trees.



SWEETWATER COLLABORATIVE

An inch per week of greywater will amply supply the entire irrigation requirement of Santa Barbara County fruit trees in the winter and spring, and about half the water they need in the summer and fall. The balance must be made up with freshwater. If you put all your greywater-irrigated plants on a separate irrigation zone, you can easily adjust the watering frequency to actualize water savings. (If you apply greywater but do not change your drip system settings, *you will not realize any water or money savings.*)

Water Use by Irrigated Plants in Santa Barbara County

If it rains 6" in February, half the water runs off, and some more evaporates, that leaves about 2" stored in the soil—enough to meet all of your plants' February needs through rain alone, without supplemental greywater or freshwater irrigation.

If it rains 1" in April, and you concentrate all the rainwater from your roof and hardscape into infiltration basins so they get 6" and none of it runs off, your irrigation bill could be zero for all of April and you would still have water banked in the soil for May.

Zone	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1	0.93	1.40	2.48	3.30	4.03	4.50	4.65	4.03	3.30	2.48	1.20	0.62	32.9
3	1.86	2.24	3.72	4.80	5.27	5.70	5.58	5.27	4.20	3.41	2.40	1.86	46.3
4	1.86	2.24	3.41	4.50	5.27	5.70	5.89	5.58	4.50	3.41	2.40	1.86	46.6
6	1.86	2.24	3.41	4.80	5.58	6.30	6.51	6.20	4.80	3.72	2.40	1.86	49.7
10	0.93	1.68	3.10	4.50	5.89	7.20	8.06	7.13	5.10	3.10	1.50	0.93	49.1

Monthly average evapotranspiration (plant water needs) by zone (inches/ month).[17]

IMAGE AND TABLE FROM CALIFORNIA DEPARTMENT OF WATER RESOURCES, IRRIGATION MANAGEMENT UNIT

Anticipate Changes over Time

Children grow up and leave the nest, a garage gets converted to an accessory dwelling unit, trees grow and water use grows with them—all these changes ripple through the web of greywater-connected factors.

Planting natives and dwarf fruit trees will help maintain the fit between irrigation need and greywater generation, and also the fit between fruit production and consumption (as well as your ability to reach the fruit).

Laundry systems are fairly easy to change; Movable Laundry to Landscape systems are completely flexible—but for Branched Drain systems, you really need to think ahead. To ensure functional longevity, make a drawing of how your landscape might look in 20 years. One trick: Situate flow splitters far from the tree trunk so when trees grow you only need to reconfigure the very end of the pipe branches, where change is easiest. Build in flexibility to the degree you can.[14]

Prepare for a Changing Climate

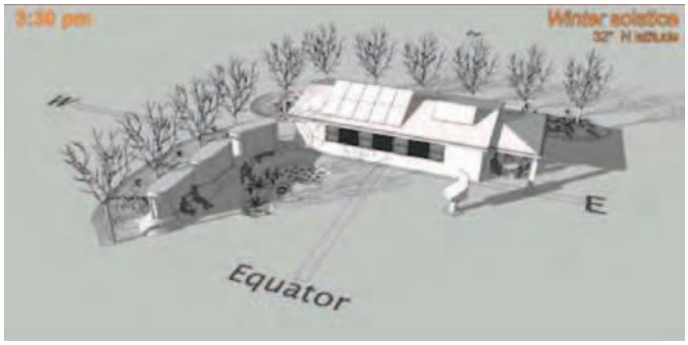
Santa Barbara communities are ahead of the curve in planning for climate change.[18] However, at the community level, there are major challenges both in reducing emissions and in responding to the effects of a changing climate. For example, for differing reasons, climate change clouds the future of every one of our County water supplies—except conservation and reuse.[19] Although the

scale of the problem can seem insurmountable, we can do many things at the community and individual levels that will have tangible short-term benefits. The integrated approach to greywater advocated in this handbook addresses the effects of climate change while simultaneously reducing the causes.

Greywater-connected measures that respond to the effects of climate change:

- **Plan for more frequent and severe droughts, floods, and wildfires—** Design for resiliency; shift toward climate-appropriate, low water use, high-water-infiltration, and wildfire-resistant landscaping.[20] Cover all soil with mulch to reduce evaporation. Design so plants either do not need irrigation other than rain, or do receive greywater, your most assured water supply.
- **Plan for rising water and energy costs—**Design for water and energy efficiency. Build systems and structures that, as much as possible, passively cool, heat, and light themselves and process water and wastewater without using energy.
- **Regrade your yard to capture stormwater—**Instead of draining rainwater down a slight slope from roof over lawn to walkway to street, use slight slopes to guide it to infiltration basins. This can add significant resiliency to your water budget, significantly benefit groundwater recharge, and reduce flooding from more intense rainfall.
- **Plant trees that provide shade for your house and outdoor living space—** especially to the west and east of the area you want shaded, where they will not interfere with winter sun (which rises more in the south). Select varieties that can weather extremes of drought and heat. The premier low-water shade trees in the County are oaks. Oaks should not get summer irrigation except for infrequent, emergency deep watering in extreme drought, and well away from the trunk.[21] Take good care of any oaks on your property by pruning dead wood and channeling stormwater into their root zone. Charging the living soil sponge with stormwater will supply your oaks with a natural water source through the dry season.[22]
- **Plant fruit trees that require fewer winter chill hours—**Most temperate-zone fruit trees such as apples, peaches, and plums require a certain number of hours of cold weather in the winter in order to flower and bear a crop the next summer. Overnight lows have gone up more than daytime highs, which directly impacts chill hours. Our changing climate means that fruit varieties that have historically produced well in Santa Barbara may no longer do so. For new plantings, select fruit trees that require fewer chill hours.[23]

The most ecological formula for landscaping is native/low water use plants fed by rainwater, and fruit trees fed by greywater and rainwater.



RAINWATER HARVESTING FOR DRYLANDS AND BEYOND, VOL. 1, BY BRAD LANCASTER, HARVESTINGRAINWATER.COM

Hot summer afternoon sun can be blocked with shade plantings to the west, without blocking desired winter sun.

Greywater-connected measures that reduce climate change:

- **Divert greywater from the septic/ sewer—**The simple act of diverting greywater from the sewer saves considerable energy by reducing mechanized water and wastewater treatment. Diversion from the septic or sewer also reduces emissions of methane—a greenhouse gas dozens of times more potent than CO_2.[24]
- **Conserve water—**Water costs energy, which drives climate change.
- **Use less hot water—**Heating water accounts for most of the carbon footprint of domestic water.
- **Compost green waste on site and apply mulch everywhere—**Processing green waste on site saves fuel from transport and reduces methane emissions from landfills.
- **Support local, regional, and national government to mount an effective response—**Prevention and adaptation require big changes, which are politically and institutionally challenging; public support is key to get response up to speed.

All the efficiency measures in the next section are climate safety measures as well.

MEG WEST DESIGN/ CORNERSTONE LANDSCAPES/ DOUG ELLIS PHOTOGRAPHY

A low water use, wildfire-safe, high resiliency landscape.

Address Greywater-Connected Factors

Connected factors are the main course of greywater design. They dramatically affect how much greywater you have, where you need it, and what good it does in the landscape. Addressing connected factors greatly increases the benefits realized. For example, removing unproductive plants and pruning others can change where greywater is needed, as well as directly saving water. We will now consider them in turn:

Remove/ Reduce Lawn and Water-Intensive and/ or Unproductive Plants

If you have a lawn, reducing or removing it is probably your best water management measure. If you can make the area into stormwater infiltration basins, even better. This increases water savings, adds valuable groundwater recharge, and enables you to position greywater basins knowing that stormwater is taken care of elsewhere in the landscape.

WWW.WATERWISESB.ORG

An ornamental lawn is remade as an attractive low water use, lower maintenance garden.[11] Turning turf into stormwater infiltration basins transforms a water liability into a water asset.

Each irrigated plant costs water. Is it giving you something in return? If the answer is no, consider removing it. If the upper half of a fruit tree is too high to reach, why not prune it off? The tree will then use significantly less water for each fruit you pick.

Most County landscapes would benefit from a phased transition to low water use and multi-benefit plants that provide fruit as well as shade, wind protection, wildlife habitat, and privacy to homes and outdoor living space.

Make Your Habits and Fixtures More Water-Efficient

You are probably familiar with these water savings measures:

- ***Reduce before reuse***—Investment in efficient fixtures and appliances typically has a high cost-benefit ratio. Changing to a low-flow showerhead or a high-efficiency washing machine will also have a huge effect on greywater flow, so this should be done before matching greywater sources to plant needs with permanent plumbing.
- ***Conserving habits***—Since they usually cost little or nothing and can save the most water, lifestyle habits that conserve water top the list of water savings measures when sorted by cost-benefit ratio.

Some recommendations you may not have heard before:

- **Shut off the hot water to your washer**—Modern laundry detergents work fine with cold water. This measure alone can reduce the carbon footprint of your water by 15% without your even noticing (water conservation can save energy more effectively than energy conservation).[25]

Modern laundry detergents work fine in cold water. Turn off the hot water supply to your washer and reduce your water carbon footprint significantly. With a wye supplying cold water to both the hot and cold inlets, the washer will not stall if someone selects hot water.

Get Your Irrigation Controller Under Control

More water is wasted by irrigation controllers in Santa Barbara County than in any other category of water use, and most of this is due to incorrect programming.

HYDRAWISE.COM

The user interface of Web-based smart irrigation controllers is much more understandable. Get one that can submeter water flow.

To achieve water savings from greywater reuse, freshwater irrigation must be reduced.

Ideally, greywater-irrigated trees would be on their own zone if there is an irrigation controller, so freshwater irrigation can be turned off when greywater supply is adequate, and turned up if residents are on extended vacation.

Check to be sure that all irrigation zones are correctly programmed. Getting your controller under control can dwarf the water savings achieved from any other measure.

Many water agencies in Santa Barbara County offer free water audits that include checking irrigation controller settings. These same folks can advise you on fixing leaks, lawn removal, and selecting efficient fixtures. If your water provider cannot help you, perhaps a certified green gardener can.[26]

- **Shut off the hot water to any sink that it takes a long time to reach**—This prevents water from being wasted while you wait for it to heat up, and energy from being wasted as unused hot water cools down in the pipes.
- **Get rid of your white clothes or dye them colors**—Non-white clothes require less frequent laundering, which saves laundry water and chemicals.
- **Make your shower stall efficient**—Seal it as if it were a steam shower, and you will save a lot of water and energy, as well as reduce moisture damage from hot water vapor infiltrating your home.
- **Put submeters for the house and landscape over the kitchen sink**—Building a new home? Run the water through a meter where everyone can see it spin: right over the kitchen sink. This is analogous to the very visible fuel usage panel on a Prius, which has been found to be one of the major fuel-reducing features of hybrid vehicles.
- **Fix leaks**—Leaks add an unceasing flow that is hard on septic and greywater systems. Leaks, if present, can easily constitute most of the water running into the system. With leaks, it can more easily go anaerobic or become overloaded. However, leaks come out at such low flow that gravity greywater systems cannot split them, likely overloading one single outlet. You can ask your water provider how to locate and fix leaks or check online for guidance.

For many more efficiency suggestions, see www.WaterWiseSB.org.

Coordinate Greywater Infiltration Areas with Rainwater/ Stormwater Infiltration Areas

To make the most water-efficient home, rainwater and greywater management should be designed and managed together. For many properties, harvesting rainwater can decrease consumption of metered water as much as or more than greywater reuse. Greywater and rainwater complement each other. Stormwater infiltration flushes accumulated salts from the soil, making irrigation sustainable in the long term. Even our County's freshwater contains traces of salt. Cleaners and perspiration make greywater saltier still. There usually is not enough salt in greywater to damage plants in the short term, but over time the salt can build up to toxic levels in the soil if not periodically flushed out by large flows of freshwater.

REGENERATIVE LANDSCAPE ALLIANCE

A swale infiltrates rooftop rainwater from the downspout at right and the walkway. Rainwater infiltration should be sited at least 8 ft from the foundation.

The Eight Principles of Successful Water Harvesting

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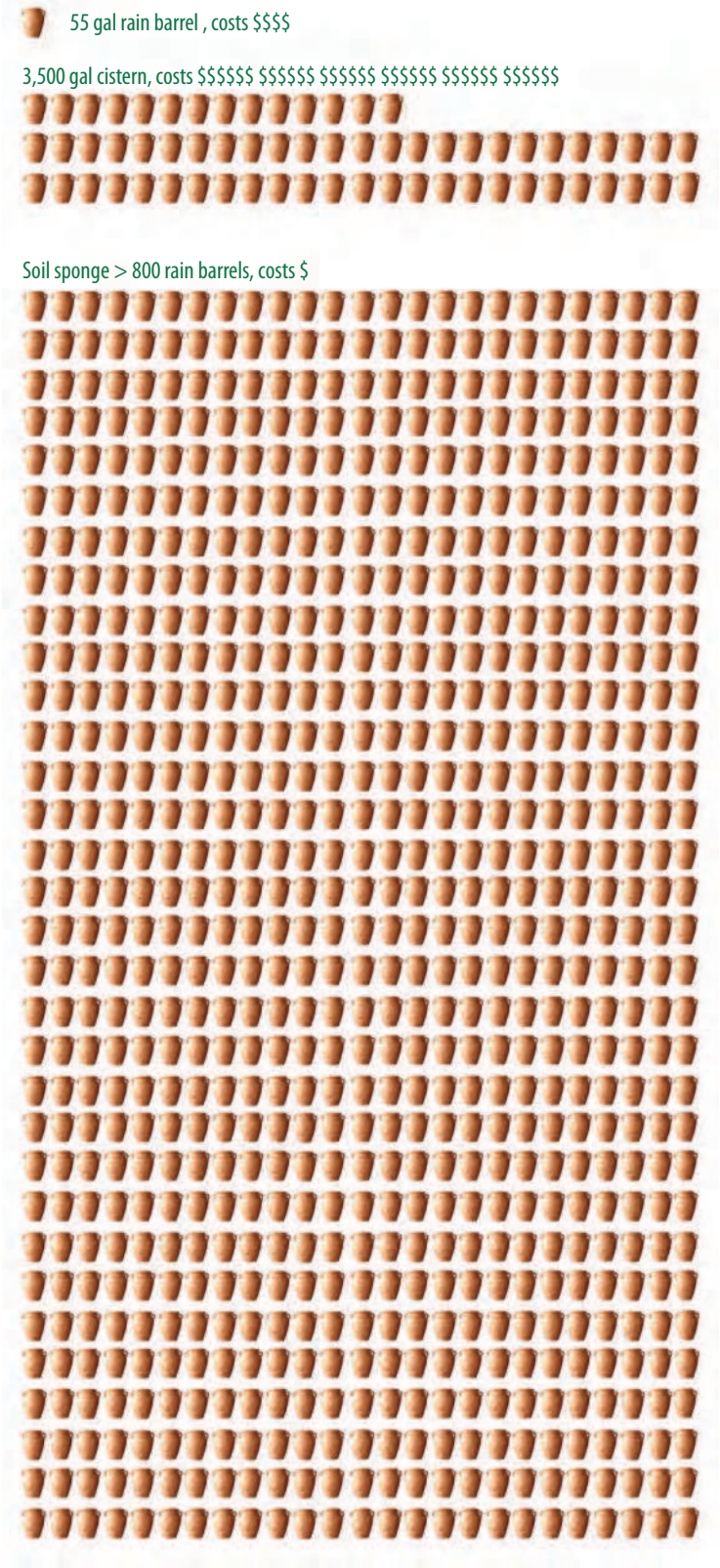
1. **Begin with long and thoughtful observation.** Use all your senses to see where the water flows and how. What is working, what is not? Build on what works.
2. **Start at the top (high point) of your watershed and work your way down.** Water travels downhill, so collect water at your high points for more immediate infiltration and easy gravity-fed distribution. Start at the top where there is less volume and velocity of water.
3. **Start small and simple.** Work at the human scale so you can build and repair everything. Many small strategies are far more effective than one big one when you are trying to infiltrate water into the soil.
4. **Slow, spread, and infiltrate the flow of water.** Rather than having water run erosively off the land's surface, encourage it to stick around, "walk" around, and infiltrate into the soil. Slow it, spread it, sink it.
5. **Always plan an overflow route, and manage that overflow as a resource.** Always have an overflow route for the water in times of extra-heavy rains, and where possible, use the overflow as a resource.
6. **Maximize living and organic groundcover.** Create a living sponge so the harvested water is used to create more resources, while the soil's ability to infiltrate and hold water steadily improves.
7. **Maximize beneficial relationships and efficiency by "stacking functions."** Get your water harvesting strategies to do more than hold water. Berms can double as high-and-dry raised paths. Plantings can be placed to cool buildings in summer. Vegetation can be selected to provide food.
8. **Continually reassess your system: the "feedback loop."** Observe how your work affects the site, beginning again with the first principle. Make any needed changes, using the principles to guide you.

These principles are the core of successful water harvesting. They apply equally to the conceptualization, design, and implementation of all water-harvesting landscapes. You must integrate all principles, not just your favorites, to realize a site's full potential. Used together, these principles greatly enhance success, dramatically reduce mistakes, and enable you to adapt and integrate a range of strategies to meet site needs. While the principles remain constant, the strategies you use to achieve them will vary with each unique site.

Principles above and drawings in this section are from Rainwater Harvesting for Drylands and Beyond, *volume 1,*[27] *courtesy of author Brad Lancaster.*

Relative Costs and Volumes of Rainwater Storage in Rain Barrels, Cisterns, and the Living Soil Sponge



Rain barrel

A 3,500 gal cistern. The 10 ft diameter, 7 ft tall tank holds 64 large rain barrels of water. Yet, at 600 gal/in of rain per 1,000 ft^2 of roof, just 4" of rainfall will fill it.[29]

Meanwhile, the top 4 ft of soil sponge on a quarter-acre lot can hold approximately 45,000 gal of useful water in storage. That is over 800 rain barrels, almost a whole year's rainfall. It costs nothing, and it is already connected to roots.

Infiltration basins and mulch can dramatically improve the capacity and utilization of the living soil sponge.

Better than barrels: Slow it, spread it, sink it into the soil sponge for storage.

In the popular imagination, rainwater harvesting means a barrel placed under a gutter downspout to store captured rainwater. However, rain barrels fill up very quickly and do not hold enough water to be very useful (see previous page). Their greatest value may be to illuminate just how much water comes from the sky, and inspire people to try other practices.[28] Bigger water storage tanks are quite costly and surprisingly difficult to get real utility from.[29] In most instances, by far the more effective practice is to infiltrate rainwater into the soil, using the living soil sponge as the tank (except see Rainwater Cautions at right).

The beauty of soil as water storage:

a) **Its dollar and ecological costs could not be lower**.

b) **It is already plumbed for plants to access the water**—with their roots.

The reason that this practice is not more widely embraced may be that the action is underground, out of sight and mind. Cultivate x-ray vision, informed by some digging, and you will likely warm to the advantages of managing the living sponge.

Before implementing rainwater best practices, a landscape typically sheds half of its received rainfall as runoff. After a rain, the surface looks soaked but the sponge is dry a mere few inches down. Shortly after the rain stops, the surface will dry out and the plants will need irrigation.

After implementing rainwater best practices, most properties in Santa Barbara County could capture 100% of the rain that falls on them, and even infiltrate storm run-on from adjoining land (if site conditions are appropriate; see Rainwater Cautions at right). During a storm, the soil sponge would fill deep down with water, with any water in excess of the sponge capacity percolating farther down to recharge groundwater. Then, roots would gradually suck it out of the sponge. Each gallon from this added soil storage is a gallon you do not have to buy. Besides substituting for purchased water on site, capturing and infiltrating rainwater produces community benefit by recharging aquifers and reducing peak flood flows.[22]

Rainwater Cautions

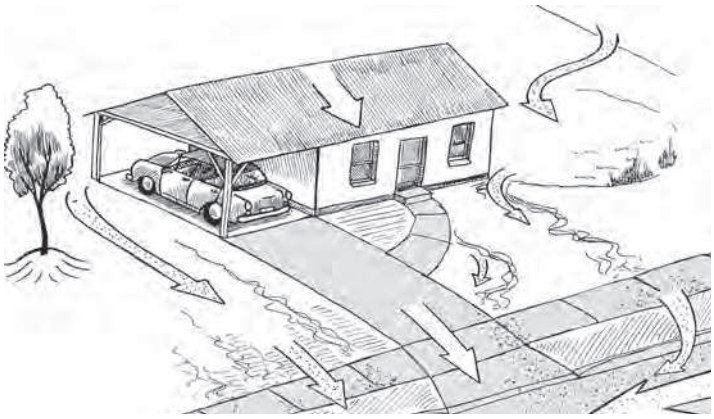
If you are on a steep slope or have clay soil, get an opinion from a soils engineer before infiltrating stormwater.

If you are in an area known for slope failure potential, it is better to let most of your rain run off, especially in wet years, to be infiltrated somewhere downstream.

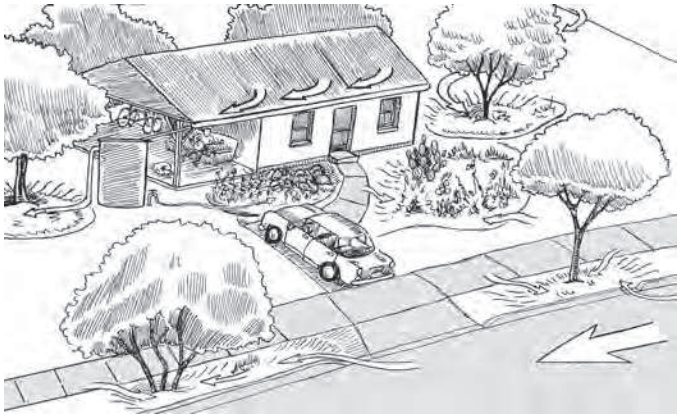
If you have a basement or expansive clay soil, it is best not to infiltrate rainwater near the house.

If you are in a lowland, avoid creating deep depressions in the soil, as these could hold water long enough to hatch mosquitoes. If water does not quickly infiltrate your basins, enhance their absorptive quality:

- Make their bottoms wide and level to maximize soil-water contact and even infiltration.
- Pump water out of the basins using vigorous plants and roots.
- Mulch the soil.
- And if needed, decrease the stormwater draining into an overloaded basin by directing some of it to other basins.



A landscape draining resources. Arrows denote runoff flow.



A landscape harvesting resources. Arrows denote runoff flow.

RAINWATER HARVESTING FOR DRYLANDS AND BEYOND, VOL. 1, BY BRAD LANCASTER, HARVESTINGRAINWATER.COM

Here is how water savings are actualized: For native or other low water use plants, rainwater harvesting can provide all their water needs year-round with *zero* supplemental irrigation, once plants are established. For fruit trees and other plants that require supplemental irrigation, you may not need to irrigate for a month or two after it rains, instead of a week. About a third of County irrigation water use occurs in the "wet" season—all of which could be met with rain instead of the potable water supply.

The main thing you need to know about rainwater when designing your greywater system is that rainwater should never be allowed to cause a greywater mulch basin to overflow.[30] The most foolproof setup is to divert greywater to the septic/ sewer when it is really wet, or to run rainwater into its own separate infiltration areas. These can be rainwater-dedicated mulch basins, or—if you must have one—a lawn. A lawn that gently slopes away from the house is a great place to direct a downspout. The water should ideally be applied 8 ft or more from the house to reduce the chance of foundation leaks or excessive soil saturation near the house. Ideally there would also be a way to direct rainwater into the greywater basins once a year to flush out salts.

ANN SHAW/ HAIK HAKOBIAN

The ideal shape for infiltration: shallow, flat-bottomed basins below the grade of the surroundings, with low berms surrounding each basin, like dry rice paddies that fill only in storms. The basin above is in well-draining soil above a groundwater recharge zone. Minutes after this downpour stopped, the standing water had infiltrated.

Is It Helpful to Save Water in the Wet Season?

It may seem counterintuitve, but:

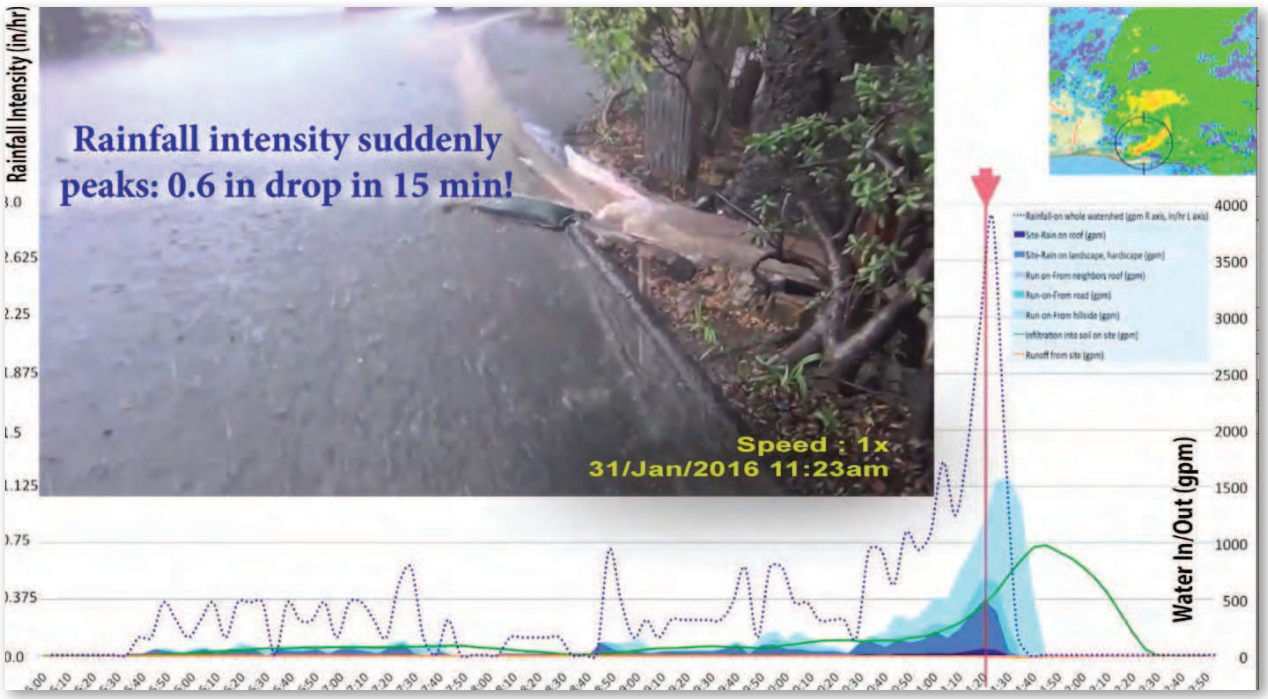
A gallon of water saved during a January flood is virtually as helpful as a gallon saved during a July heat wave.

Almost all County residents receive at least part of their water supply from multi-year storage in reservoirs or groundwater. Except in those rare cases when the reservoir is spilling over, any gallon you save will be 1 gal more "in the bank" in the dry season, minus a few percent lost to evaporation or seepage.

The wasteful path to scarcity. This site rapidly dehydrates itself by erosively *draining the rain* and runoff away. Greywater is lost to the sewer. Costly municipal or well water is pumped in to replace the free water that was drained away. Leaf drop/ mulch is also drained away, further depleting fertility and water-holding capacity. Puddles form on compacted, bare earth and evaporate slowly. This all leads to a depletion of resources.

FROM *RAINWATER HARVESTING FOR DRYLANDS AND BEYOND,* VOL. 1, BY BRAD LANCASTER, HARVESTINGRAINWATER.COM

The stewardship path to abundance. This site passively hydrates itself by productively *planting the rain* with the on-site harvest and infiltration of rainwater and runoff. Greywater is directed to plants in times of no rain. The need to pump water in is greatly reduced or eliminated. Wells, creeks, and rivers are recharged. Leaf drop/ mulch is also harvested and cycled back into the soil and plants, further increasing fertility and water-holding capacity. This all leads to an enhancement of resources and abundance.[27]



Look at all that free water. Tens of thousands of gallons of stormwater fill a series of terraces/ basins in this landscape during storms, to be banked in the soil sponge for a sunny day. This *really* complements the long, steady trickle of greywater for meeting plant needs.[22]

Designing and Building Your Greywater System

The conservation measures described in the previous section will reduce both the amount of greywater your home generates and the amount of irrigation your landscape requires. Once you have adopted these changes and have thoroughly considered the overall goals for your greywater system, including those factors mentioned in the previous section, it is time to design your system and receiving landscape.

This section contains details on mulch basins, the outdoor portion of a Movable Laundry to Landscape system, and an overview of the types of systems and their installation. The Resources and References section has links to more installation information.[7, 35, 40]

This section starts with guidance for finding the right kind of professional if you are looking to hire out your greywater work. Even if you want to make your own system, this short section is worth reading, as the same considerations about required skills apply.

Get Professional Help

Historically, most of the thousands of greywater systems in Santa Barbara County were do-it-yourself affairs. Only since the changes in State greywater codes in 2009 have professionals been installing greywater systems in any number. Because effective greywater reuse is so interconnected with the user's goals and habits, even an installer who has a firm grasp of the state of the art will need to ask you quite a few questions. It is not possible to simply write a check and await delivery of the perfect greywater system for your household; you must be involved.

Hiring suggestions by job and system type:

- **Mulch basins and tree planting**—Any skilled gardener or landscaper should be able to plant trees and form basins. Make sure they read and understand the information on greywater mulch basins and planting in this handbook, and the applicable information in the Resources and References section.
- **Movable Laundry to Landscape system**—Any handy person should be able to install this system. The hole for the pipe to get laundry water through the house wall is the only tricky part; make sure the installer is looking out for wires and gas and water lines, and have a plan to weatherize the hole. Moving the outlet to the right spot(s) to make best use of the greywater is up to you. If you make a map that shows washer users the best sequence of moving the outlet (hose) between the irrigation points in the yard, that will increase the water reuse efficiency.

WWW.WATERWISESB.ORG

Check with your water provider to see whether they offer free water checkups.

- **Fixed, Multi-Outlet Laundry to Landscape system—** Installing this fixed-outlet system requires the same skills as the movable laundry system above, plus plumbing greywater flow through relatively immutable piping to plants. This is most likely work for a landscaper or a greywater professional.
- **Branched Drain system—**Installing this system requires a landscaper with the requisite license and drain plumbing skills, or a professional plumber, for the gravity-flow collection plumbing indoors. Outdoors, it is a job for a landscaper with gravity-flow greywater plumbing experience and good landscape design skills. You may need a permit if you do not meet the permit exemption requirement in Appendix B. These systems are not easy to modify, and they last for decades. Next thing you know, the kids are gone, the trees are so big they require 20 times as much water, and no one can find the concealed outlets. A good greywater or landscape designer can anticipate these developments and plan accordingly. A map of the system that includes the location of all outlets can be helpful for years to come, especially if there is a change in tenancy or ownership.[40]

Check for Rebates and Free Mulch

Many water purveyors offer free mulch and/ or rebates on greywater system components.

CITY OF SANTA BARBARA WATER CONSERVATION PROGRAM

Things to Consider When Hiring Out Greywater Work

Landscapers—Look for a landscaper with experience in ecological landscaping, greywater, rainwater, edible landscaping, and native plants.[26, 41] You will likely still need to manage a learning curve; planting trees in the fashion recommended in this handbook is new, for example. If you do not communicate clearly what is required and why, you are likely to end up with trees too low and basins too small. If your landscaper engages intellectually and tries to figure out how these recommendations apply in your particular soil conditions, that is a great sign that they have the innovation capacity for this work.

Plumbers—Do not use a plumber for the distribution plumbing; once you get outdoors, you need a landscaper. If your landscaper has the right license and the experience, you are probably best off with them doing the collection plumbing as well. Plumbers are susceptible to the common error of translating decades of experience with freshwater or blackwater systems to greywater. They are excellent for greywater collection plumbing if the objectives are very clearly defined and understood, especially with respect to the height at which the greywater needs to exit the house.

Greening Gardeners

Gardeners often remove all loose organic matter—and the fertility it contains. Bare earth exposes the living sponge, so it evaporates much more water. Let your gardener know that you would like as much of this material as possible to be spread under plants, hidden with a uniform layer of attractive mulch if you prefer. Peel back the nice-looking redwood chips, tuck pruned branches under, and cover back up. It looks good, and the integrity of the nutrient and water cycles is good too.

Request that your gardener not change the irrigation controller settings without checking with you first. There are lots of theories about how to set irrigation controllers. A frequent error is to water for too short a time, wetting only the visible surface of the soil. This is especially common with bare, compacted soil, because it is much less permeable than mulched soil, so ponding and runoff may occur before enough water has been applied. With short watering, an excessive percentage of the water is lost to evaporation, and root development is overly superficial. It is easy to waste a fortune in water with bad programming. For this reason, many Santa Barbara County water agencies have a free water checkup service that includes adjusting controller settings; contact your water provider for information.

CORNERSTONE LANDSCAPES/ DOUG ELLIS PHOTOGRAPHY

Returning kitchen compost to the soil adds tilth and fertility to the living sponge.

Installing Your Own System

An overview and general guidelines for installation follow. For additional installation details and information on other, less commonly used system types, see the Resources and References section.

The best results are obtained if you:

- **Get oriented**—Read up,[31] take a class,[32] and/ or have a landscaper experienced with greywater systems, or a greywater professional, help to design your system and check permit requirements.[7,33]
- **Start out easy**—A Movable Laundry to Landscape system is one of the simplest systems to install. You could get someone to help you with the wall pass-through for the laundry water. Once you see where greywater is consistently needed and grow tired of moving lines, you could change it to a Fixed, Multi-Outlet Laundry to Landscape system. Later, if you are up for it, you could add a Branched Drain system as well (these are easiest to install at the same time that the trees are planted).
- **Design a simple system, construct it as well as possible, and adjust—** Often the route to the best system is to test a temporary mock-up first, adjust the design based on how it works, then install the permanent system, which may itself need to be refined over time.
- **Build from top to bottom**—Follow the flow from fixtures to collection plumbing to distribution plumbing to receiving landscape, checking and rechecking levels as you go.

A quarter bubble = ¼" per foot on most levels, the optimum slope for wastewater flow.

REGENERATIVE LANDSCAPE ALLIANCE

Check and Re-Check Levels

Levels and slopes are critical. At its heart, this work is adjusting the micro-grading of the landscape to precisely guide greywater and stormwater from where it is not wanted to where it is beneficial. To accomplish this, there are a number of standard slopes and level separations:

- **Laundry greywater systems**—perform best if they slope downhill continuously from the washing machine to the receiving landscape, but they do not have to, because they are pressurized by the washer pump.
- **Branched Drain systems**—flow by gravity and must slope downhill at a 2% slope, minimum.
- **Piped greywater falling out of a free-flow outlet**—requires a minimum 2" vertical gap to minimize the potential for clogging.
- **Rain gutters**—typically slope at 0.5%.
- **Stormwater channels**—typically slope at 1%.
- **Stormwater carrying leaves**—should have a 4" gap between, for example, a pipe outlet and the mulch in a basin.

Downhill slope helps to efficiently distribute greywater. On a flat site, or on a lot where no outdoors area is available downhill of the house, the options are very limited.

Small slopes are challenging to gauge, but can add up to big differences in height. Especially for complicated sites with many water-related elements and flows, it is eye-opening to draw a schematic section through all the elements. Such a drawing accurately reveals height relationships between elements indoors and outdoors, and on different sides of buildings, walls, or hedges. These are otherwise difficult to visualize. This step can make critical issues and opportunities obvious. Doing a survey and drawing an accurate section is not easy; it is a great help to have someone with experience and the tools necessary for accurate surveying.[34]

Before You Dig

Most greywater plumbing is shallow, but it is still a good idea to call DigAlert at 811 for a free check to avoid encountering underground utility lines.

A laser transit is a very helpful tool. If you can borrow one or hire someone who comes with one, it makes conducting an accurate survey much faster. Note the heights on a site plan, and from there you can check levels or make a schematic section through the elevation of all the system elements.

CORNERSTONE LANDSCAPES

Section Showing Irrigation Need and Greywater and Rainwater Elevations

Example of how a section shows what is happening at various levels. This drawing revealed that a stormwater cascade through basins would work, with just barely enough slope. However, installing a greywater line following normal plumbing practices would result in shower water coming out more than 1 ft underground at the back of the lot (left), which is too deep (purple line). Solutions? Use the greywater closer to the house, or ask for a variance to run the distribution plumbing aboveground along the property line wall.

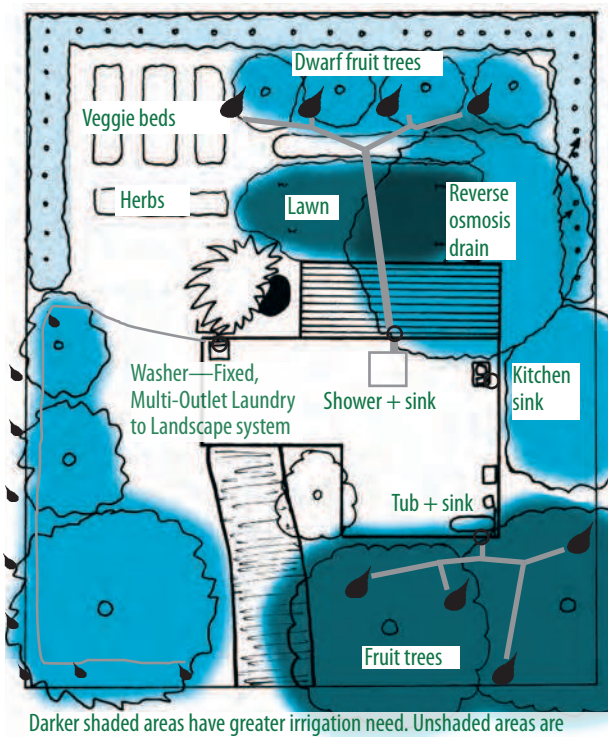
Connect Water Sources and Uses with the Most Appropriate System(s)

If you make a site plan that includes all your greywater and rainwater sources with approximate quantities, plus all your irrigation needs, the supply and demand will practically connect themselves. Be sure to label stormwater runoff channels and downspouts (see examples on p. 13 and at right).

Sketch several different scenarios for connecting greywater to irrigation need, and compare the advantages of each scenario. It is common in the County to have a separate system for laundry water because it is cheaper and more flexible for greywater distribution. (Because the washer pump pressurizes it, slope is not so critical.) Shower systems can be combined or split; there are advantages and disadvantages either way.[35]

It is tempting to draw in a laundry system first on your site plan because it is the easiest. Instead, start with one or more Branched Drain systems that disperse greywater from your sinks and showers. These systems are less flexible and more difficult to install. When you have figured out which trees can be irrigated with a Branched Drain, then run the laundry water to whatever plants are most important that the Branched Drain cannot reach.

Example of How Water Sources and Irrigation Need Could Be Connected



Darker shaded areas have greater irrigation need. Unshaded areas are irrigated occasionally or not at all.

2" Greywater distribution pipe
1½" Greywater distribution pipe
1" flexible HDPE greywater tubing
3-way diverter valve
Greywater outlet

Check Regulations

State and Santa Barbara County officials are making it easier for residents to install simple, commonsense greywater systems. However, you will still need to familiarize yourself with certain requirements to ensure that your system meets applicable standards, even if a permit is not required. The full text of these standards can be found in the appendices of this handbook.

Here are the standards you need to meet to install a greywater system without a permit:

- **Movable Laundry to Landscape systems**—County movable laundry standards in the Movable Laundry to Landscape section and Appendix A: State Laundry-Only System Exemption Standards
- **Fixed, Multi-Outlet Laundry to Landscape systems**—Appendix A: State Laundry-Only System Exemption Standards
- **Shower/ bathroom sink systems**—Appendix B: County Shower System Exemption Standards

If you do not meet all of the standards and/ or exemption standards for your system type as noted above, but do still meet the California greywater code requirements, you can get a permit from your local building department. How do you know whether you meet the code? You can read the code,[33] but the interpretation is not always obvious. The Santa Barbara County Department of Environmental Health (SBDEH) can help you to interpret the code, or you can refer to a book that provides interpretations.[7] If your system cannot be adjusted to meet the code, it is not allowed.

Your local building official has jurisdiction over greywater systems. The Santa Barbara County Department of Environmental Health consults on greywater systems and has authority over septic systems, and is supportive of relieving septic strain to improve system performance.

Install, Use, and Maintain the System

The next section presents some information on recommended systems; the sources in the Resources and References section include all details.

For Branched Drain systems, the design of the greywater collection plumbing, irrigation piping, and receiving landscape should be done all together, and the levels checked before plumbing or planting anything. Once it is clear that the levels will work, you can build the system from top to bottom—following the flow from fixtures to receiving landscape. If you are at all unsure, try temporary mock-ups or dry fitting the configuration you think will work, before you invest in anything permanent.

It is a nice touch to label the system clearly so all users know, for example, that the bathroom sink water goes to the fig tree. With this information, they are less likely to dump toxins like nail polish remover down the sink.

The information in the Resources and References section includes troubleshooting and maintaining the system.

Share What You Have Learned

This whole body of knowledge has been developed primarily by citizens sharing what works for their conditions and what does not. Please share with your neighbors, family, friends, gardener, and landscaper to add to the common knowledge.

Recommended Systems

This section has some information on recommended systems; there is more listed in the Resources and References section.

Constructing Mulch Basins and Planting Trees

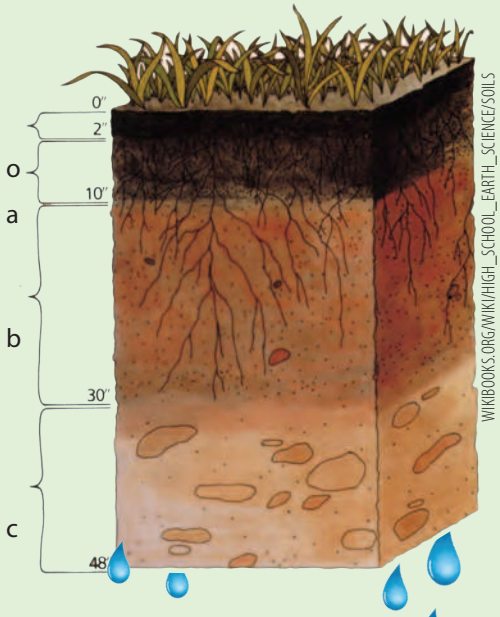
If you only remember two words from this handbook, "**mulch basins**" would be the most useful. Greywater and its interconnected resource flows all meet in mulch basins (see figure, on p. 7). Often referred to as "resource basins" due to their multiple functions and benefits, mulch basins are at the heart of a greywater system:

- **Basins**—contain greywater for sanitation and better infiltration.
- **Mulch**—covers greywater for sanitation and reduces evaporation from the soil while increasing the speed of water infiltration.
- **The living soil sponge**—is the main water storage for plants, and a bioreactor that transforms wood chips, yard clippings, and compost into fertile soil with improved tilth and infiltration.[36] Mulch basins support healthy, productive plants that better resist pests and disease.
- **Trees/ shrubs**—pump water and nutrients out of the living sponge and turn them into shade, a means of evaporative cooling, fruit, biomass, and beauty.

With experience over the past few decades, greywater mulch basins and planting techniques have evolved to differ in important ways from standard horticultural basins and planting. For example, greywater basins should be wider and flatter-bottomed, with a more dramatic raised island in the middle, and/ or planting terraces on the sides, and stouter berms. Here are key points for making greywater- and stormwater-ready tree basins:

- **Divide greywater flow among enough outlets that no single outlet is overloaded**—to prevent oversaturating the area around the outlets.

Living Soil Sponge Fun Facts



A cubic foot of rich, healthy topsoil:

- can hold 3 gal of water,
- contains a length of root hairs sufficient to encircle the continental United States,
- contains trillions of beneficial bacteria, fungi, and
- can remove 90% of the pathogens in wastewater that passes through it.

Typical layers: (o) organic layer, (a) topsoil, (b) subsoil, (c) rock.

WILSON ENVIRONMENTAL CONTRACTING

A mulch basin on a slope with a rock retaining wall, retrofitted around a mature tree which is ideally situated for a Branched Brain greywater system.

- **Include enough area**—to comfortably infiltrate greywater without the soil ever staying saturated more than 24 hrs. The slower your soil infiltration, the bigger basin (or the greater number of outlets) you will need for a given volume of water.
- **Include enough volume to contain surges without overflowing or exceeding 4" water depth**—The top of the basin walls should be another 4" above the high-water line. A greywater basin should never overflow. But consider where the water should go if it did, and make the wall lower on that side. Water deeper than 4" can lead to saturation and increase the likelihood of berm collapse or runaway drainage through a gopher hole. You can calculate the basin volume by multiplying the area by the wetted depth.[37] For greywater surges, calculate or check a table.[35] A single-outlet Movable Laundry to Landscape system will require more surge space than one of the several outlets from a Fixed, Multi-Outlet Laundry to Landscape system.
- **Flatten the basin bottoms**—To spread water for even infiltration. This is better for roots and increases capacity by engaging more infiltration area.[38]
- **Attend to micro-grading**—Ideally, all hardscape and paths should funnel rainwater and fallen leaves to "resource basins" for use (see drawings on pp. 23 and 25). Check the catchment area to make sure your greywater basins are not overloaded with rain, or use separate basins for greywater and stormwater.
- **Add wood chips**—Basins need wood chips (best), fallen leaves, or cut-up on-site prunings added each year or two. Put coarser material—even large (but cut and pressed flat) woody clippings—on the bottom to help water spread.
- **Watch for waterlogging**—If you can see or smell that a basin is waterlogged, widen the basin; or divert greywater to the septic/ sewer in high-use or rainy conditions; or add more basins and/ or outlets so the greywater in the basin never takes more than 24 hours to infiltrate. Do not flood basins deeper than 4"—that tends to make waterlogging worse by forcing more inches of water into each square foot of basin bottom.
- **Periodically re-form the basins**—Restore the berms and center island, widen the basin as needed for tree growth, and add new, free-draining wood chips. When basins eventually clog with fine-composted material, rake the rough material off the top for reuse; dig out excess fine compost to spread elsewhere; and reshape and resize the basin. Oversizing the basin minimizes later damage to tree roots: For a new tree, make a basin big enough for a five-year-old tree. In five years, resize it for a 10-year-old tree. If you are working for a client, just size the basin for the eventual mature tree. Add amendments if you like, including scratched in gypsum if you are worried about salt. Fill the basin with fresh wood chips.

How Much Mulch and Where to Get It

The optimum thickness for mulch in our climate is 2–4" for areas that receive rain only from the sky, and 3–6" for basins that receive concentrated rooftop rainwater, stormwater, or greywater. Leave a 2" gap between the top of the mulch and the bottom of the greywater outlets. If too thick, mulch intercepts too much rain before it reaches the soil, and can be a wildfire hazard; if too thin, it is not as effective at slowing evaporation. It must cover 2" above the greywater surface to meet code. Mulch sources:

Chop and drop—Leave as much as possible of your yard's production of organic matter on site. Mulch basins are very effective for magically disappearing yard clippings.

Tree trimmers—If you hear a chipper, ask whether the operator would be willing to drop the chips in your yard. Or, call companies and ask.

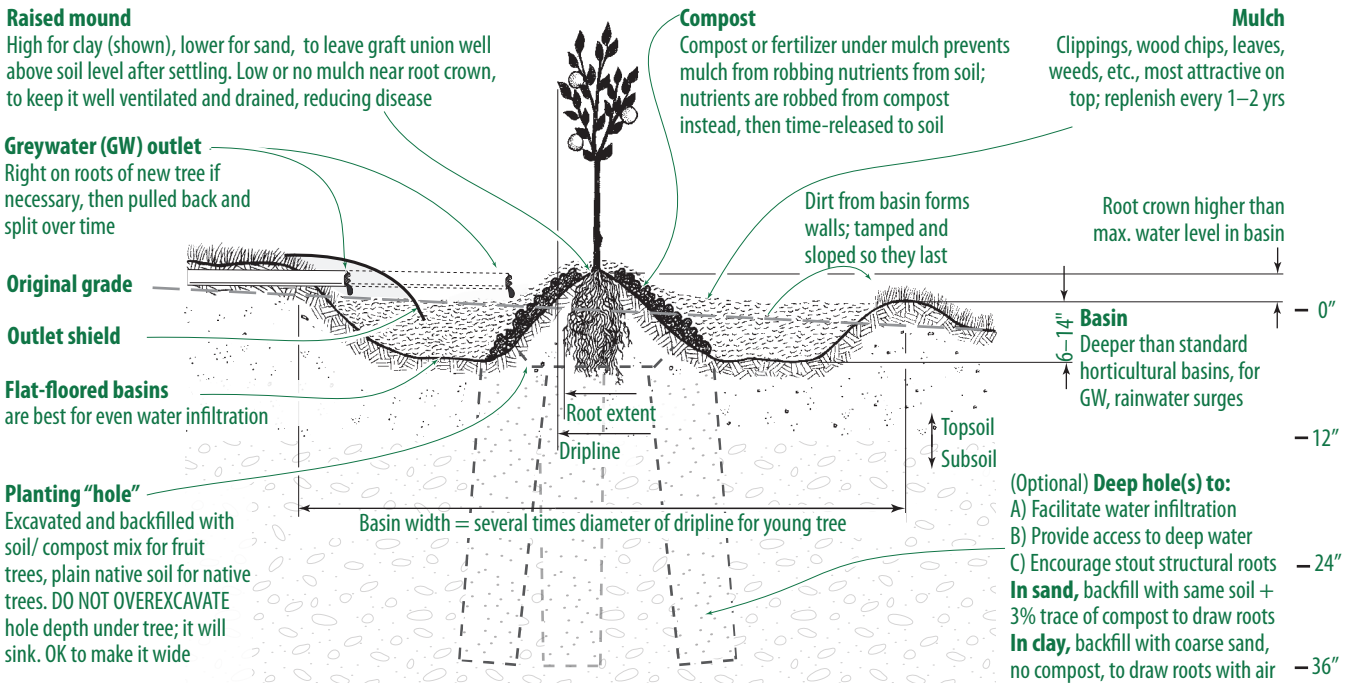
Transfer stations—Many offer free mulch for pickup.

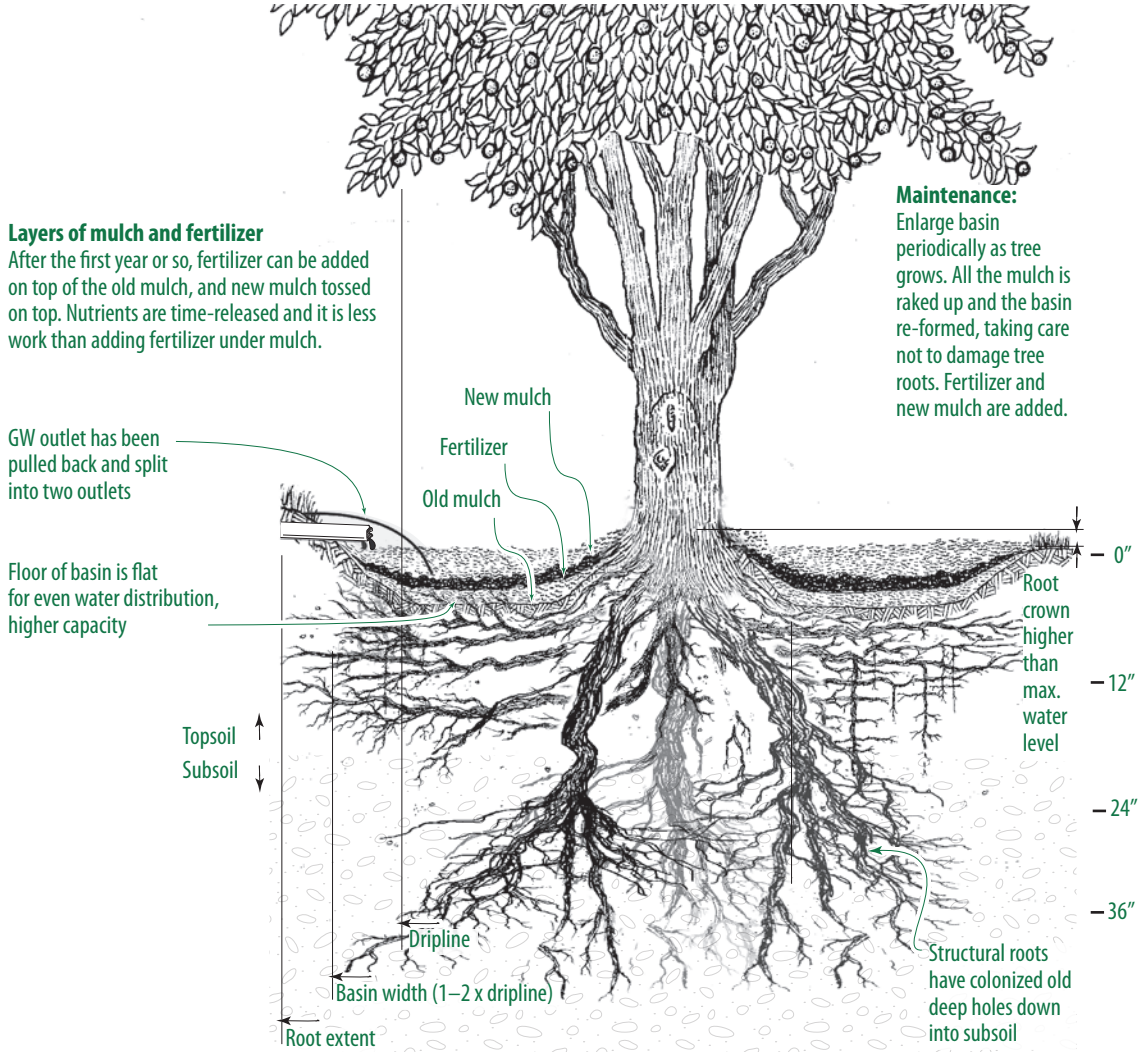
County mulch—You can get dump truck loads of sifted County mulch delivered by the County for a bargain price. See WaterWiseSB.org/mulch.

Stormwater basins can have an armored overflow that directs excess water into a cascade through a series of basins; greywater, however, must infiltrate into the basin that its outlet supplies, without overflow.

REGENERATIVE LANDSCAPE ALLIANCE

Greywater, Stormwater, Drought, Flood and Wind-Ready Tree Planting





This planting technique is significantly more work, and the tree is at greater risk of drying for the first few months, but then the tree is greywater and rainwater ready and highly resilient to climate vagaries:
Drought—Roots can more easily access deeper regions of the living soil sponge for more water.
Flood—The root crown is high and dry above the overflow line of high water from a storm or high water use in the house. Water drains more quickly into the deeper portion of the soil sponge through permeable soil and large surface area in postholes.
Fire—Better-hydrated foliage resists burning.
Storm—The tree resists overturning in high wind and saturated soil thanks to a deep tripod of structural roots, in concert with roots that extend well beyond the basin to the surrounding mulched area and/ or nearby basins (not shown).[15]

ADAPTED FROM *CREATE AN OATSIS WITH GREYWATER*

- **Avoid gopher damage—**Thick mulch in the basin slows the movement of water, reducing flow through gopher holes. Mulch outside the walls can infiltrate incidental leakage. For a definitive leak solution, and/ or to protect sensitive trees such as figs from gnawing gophers, bury a ring of stainless steel gopher screen in the basin walls down 24" or more, in an L shape with the leg facing out.

Using thick, woody clippings or coarse wood chips as the bottom layer of mulch promotes good water flow. Even inch-thick branches are turned to compost within a few years.

For best results, trees in greywater basins should be planted differently from historical planting practice in the County. These recommendations are a synthesis of several master landscaper's best practices. The aims are basins that will require minimal maintenance for decades, trees that thrive on greywater, stormwater, and heavy mulch, and are resilient to drought, flood, and high wind:

- **Plant water-sensitive trees with the root crowns in earth higher than the basin overflow, and *instead of over-excavating, leave undisturbed soil immediately under the root ball—***The consequence of a tree being set too low relative to the surrounding soil is that the root crown can easily become too damp and the tree can more easily get sick. Because greywater and rainwater arrive in surges that do not match irrigation need, it is extra important to keep the root crown high and aerated. Everything conspires to make the root crown sink: Loose dirt under the tree settles. The light potting mix that comes with the tree composts to nothing. As soil tilth in the mulch basin improves, it gets less dense and puffs up. Adding mulch for decades raises the soil level, and every new application of wood chips immediately raises the effective surface by several inches.
- **Dig post- or auger holes a few to several feet deep surrounding and just outside the root ball—**These will infiltrate air and water deep into the soil, and draw roots quickly to large reserves of water in the subsoil sponge. Visualize how the roots will appear in the future, and arrange the holes so they promote a stout root structure as well. (Many mature trees with trunks 4–6" thick are largely root-bound in their original planting holes; grab the trunk and rock it, and you may see a surprising amount of movement, indicating poor root structure.) What goes in these holes? The same soil, loosened, is a simple, safe bet. In clay soil, the best fill would be coarse sand, because *lack of air* is what limits deep root growth. In sandy soil, you could backfill with loosened soil plus 3% mature compost: Too much organic matter deep down will use up the oxygen and fester. Such holes could be retrofit around existing trees as well, a bit farther from the trunk, between existing major roots.
- **If you succumb to habit and dig a hole deeper than the root ball—**it will settle too low after watering in. Dig it up and replant it higher. Then, a month later when it has resettled, dig it up and replant it again. Plant trees high on firm ground initially, so they will end up just right, instead of being too low forever.

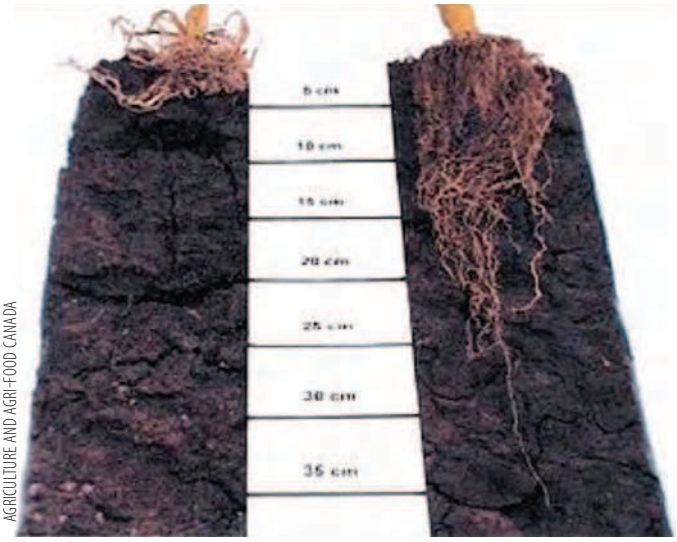
Oops—dug under the root ball. The root crown was almost a foot higher originally. But the tree settled several inches and now needs the mulch pulled back multiple times a year, and the root crown is still more vulnerable to rot. (The graft union below the trunk fork should be well above the mulch, not buried in it.)

- **Form a stout berm around the downslope side of the basin**—or all the way around a basin on flat ground, with 30° sides and curved transitions so it does not immediately fall apart. Thoroughly water in the tree after planting. This will settle the disturbed soil so you can adjust the grades before adding mulch, and provide some reserve moisture to help keep the young tree from drying out.
- **After planting, surround the mound with mulch**—so the basin looks flat, with a few inches of mulch over the top of the island and the berm. If you have enough mulch, cover the *entire* surface of your soil, not just the basins, protecting the whole sponge.
- **Make a small well at the top and keep the root ball well watered until roots grow into the surrounding soil**—The tree is at risk of drying until its roots have grown into the soil. If conditions are at all dry when you plant the tree, put an irrigation dripper right over the root ball and a greywater outlet at the edge of the root ball until it is well wetted with rain and the danger of drying is past. The moment it is rooted into the soil, you should move the freshwater dripper and greywater outlet away from the trunk to avoid rotting it. Irrigation right at the trunk is *only* for this initial period when the roots are only as extensive as the pot the tree came in; forever after, water should be applied some distance from the trunk. As soon as your tree is rooted deep, it is prepared for drought, flood, and wind. Be sure to leave a few inches with little or no mulch right around the trunk, to reduce the likelihood of mold or rodents damaging the tree bark.

Planting in a compost-filled, bowl-shaped hole in bad soil can lead to roots that just circle in the hole, provide little access to water or nutrients, and possibly girdle or topple the tree.

AMY FULCHER, UNIVERSITY OF KENTUCKY

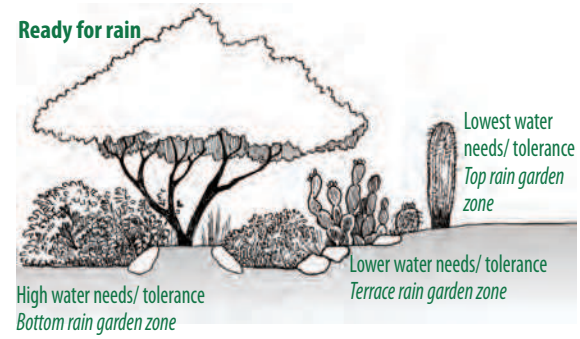
Avocados are particularly susceptible to root rot and need to be planted even higher than other fruit trees. If you have clay soil, it is probably best to reduce the fraction of irrigation from greywater and to apply it extra far from avocado trunks.
This avocado tree is planted high, with undisturbed soil under it. The mini-doughnut on top of the "volcano" keeps the root ball from drying right after planting. The large basins are correctly sized for greywater and/ or rainwater.

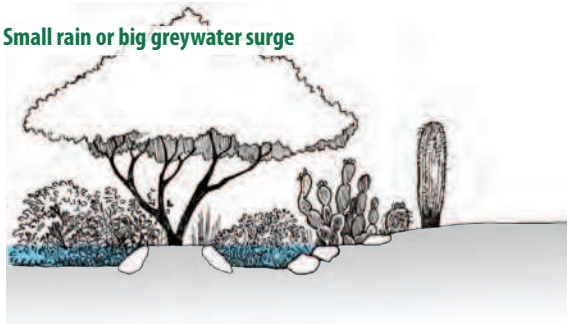


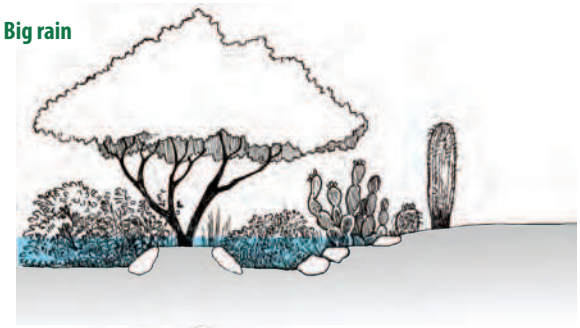
AGRICULTURE AND AGRI-FOOD CANADA

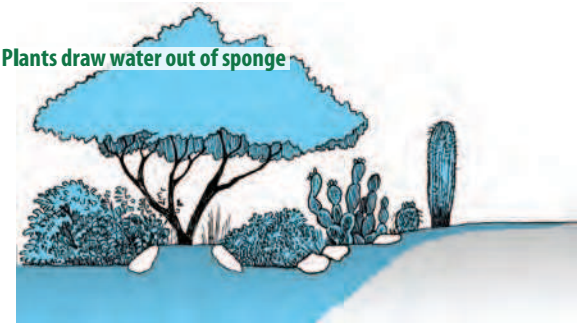
Corn root development in compacted vs uncompacted soil. Roots need air and water, which moves freely through the space in uncompacted soil. After decades of mulching, greywater basins can infiltrate water and air dozens of times faster than the original soil. [36]

Planting Zones for Stormwater Harvesting Basins









RAINWATER HARVESTING FOR DRYLANDS AND BEYOND, VOL. 1, BY BRAD LANCASTER, HARVESTINGRAINWATER.COM

Soils, plants, water sources, and climate vary, as does the culture of how to best plant for them. This sequence shows contributor Brad Lancaster's highly evolved take on how to capture monsoon rains in Tucson, Arizona, from his authoritative books, *Rainwater Harvesting for Drylands,* volumes 1 and 2. These images help visualize how water moves from the surface into the soil sponge and thence to plants. One can easily imagine what later images would look like as the plants pump the sponge dry.

The planting shelves of varying heights that experience different degrees of inundation are stabilized with rock work. In coastal Santa Barbara County, mulch seems to be more abundant, and unreinforced, mulch-protected basin walls seem to hold adequately. The approach shown would be ideally suited to the arid northeast of our County or where traffic or slopes call for more stabilization.

Some of these tree planting suggestions differ from common practice; check www.WaterWiseSB.org/greywater/handbook for possible updates.

Movable Laundry to Landscape System

This system only works with a high-efficiency washer.

A recurring theme we have heard in the County is the desire to have a movable line coming from the washer that can direct the water wherever the user wants it to go. This system works with a high-efficiency washer, because the flow is too low to divide easily, and the volume per load is also so low that it is unlikely to overwhelm one outlet.

Laundry systems with one or more movable lines that meet the California greywater code and the local compliance guidelines, detailed below, can be installed without a permit where Santa Barbara County is the permitting agency. If your permitting agency is an entity other than Santa Barbara County, please check with them to confirm the compliance status of this system.

The drawing on pp. 40-41 shows this movable line system. This system and its compliance guidelines are new for 2017, so check for updates.[39] The numbers in the following guidelines correspond to the numbers in the drawing. Only the underlined elements are required for compliance; the non-underlined sections are suggestions:

Basins can be any shape; there just needs to be sufficient area that the greywater is all contained under the mulch and within the basin.

1) REQUIRED: **High-efficiency washing machine**—If the flow is greater than 20 gpd, a minimum of two outlets and two hoses is required. This system only works for low-flow, low-volume machines, i.e., most horizontal axis washing machines. Check your user's manual, call the washer's manufacturer, or measure if you are not sure of the water use per load.

2) Biocompatible cleaners—are highly recommended to avoid long-term harm to plants or soil. Sodium, chlorine, and boron are the most common materials of concern in non-biocompatible cleaners.

3) REQUIRED: **Means of diversion**—"The design shall allow the user to direct the flow to the irrigation or disposal field or the building sewer. The direction control of the greywater shall be clearly labeled and readily accessible to the user." A three-way valve is an easy way to do this. Direct the laundry water to the sewer when you are using non-biocompatible cleaners or when greywater mulch basins are waterlogged from rain or high use.

4) REQUIRED: **Signage**—to inform the user how to redirect the flow of greywater from the septic/ sewer to irrigation, and a map showing the locations and suggested sequence for moving the outlet hose, with the words "Please move laundry hose with each load" or equivalent.

5) Irrigation zone diverter—to direct wash water from a hose on one side of the house to another. This is optional, for convenience, and can also make it easier to use the irrigation water more effectively.

6) Transition to outdoors—this is the step in which help from a handyperson or greywater installer is most useful; you do not want to drill through an electrical wire or water line by mistake.

7) Air admittance—to prevent the hose from siphoning water out of the washer as the washer tries to refill.

8) Breather tube version of air admittance

9) Backflow prevention—to prevent water in the hose from going back into the washing machine. This is only needed if the line runs uphill.

10) REQUIRED: **¾" minimum dedicated greywater hose**—marked "Do Not Drink—Greywater" at the downstream end. If the hose is tightly affixed to

an outlet shield marked with this warning, the warning on the hose can be omitted. It is best to use hose clamps or pipe threads ends rather than hose threads so the greywater hoses and potable water hoses are less likely to be connected together. The minimum required ¾" hose diameter is sufficient for 6 gpm flow, which is typical of horizontal axis machines. For higher flow, a 1" hose is recommended to avoid strain on the washer pump. The hose should not be less than 2 ft below the top of the washer at any point, and should not be longer than 50 ft if running uphill, or 75 ft if flat.

11) REQUIRED: **Shielded outlets**—to prevent contact with greywater. The outlet hose must be moved for each load, or as necessary to prevent surfacing of greywater or nuisance conditions. Outlets must be marked "Do Not Drink—Greywater."

The minimum required number of locations to which the outlet can be moved is one per load per week. These locations must be a minimum of 5 ft from each other. Several of the numerous possible outlet shield options[35, 40] are shown in the drawing on the following pages.

12) REQUIRED: **Mulch basins**—to contain the greywater where it is wanted, with a minimum cover of 2" of mulch over the greywater, or an outlet shield. Basins must be sized such that overflow or daylighting of effluent, or septic conditions, do not occur. Suggested basin area:

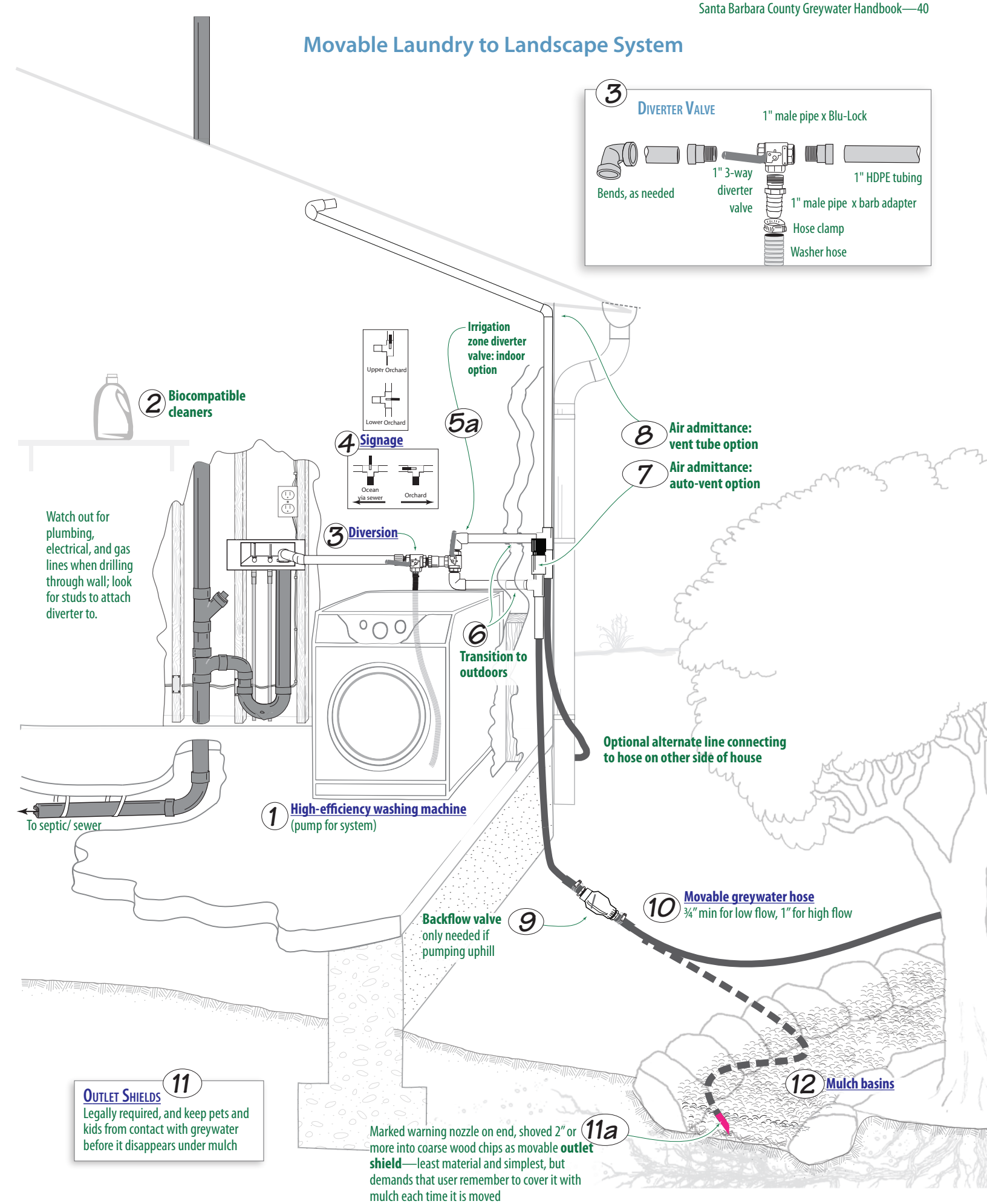
20 ft² per load per week for regular soil (e.g., 5 loads/ week = 100 ft²)
40 ft² per load per week for clay soil (e.g., 5 loads/ week = 200 ft²)

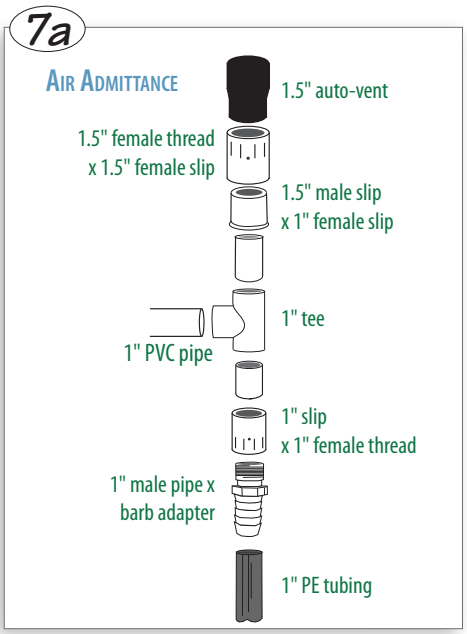
For times when irrigation is less critical and you might forget to move the hose, it is suggested that you designate one "home" basin that is big enough to prevent any chance of the greywater overflowing or daylighting. The ideal mulch is coarse wood chips, for rapid infiltration below the surface.

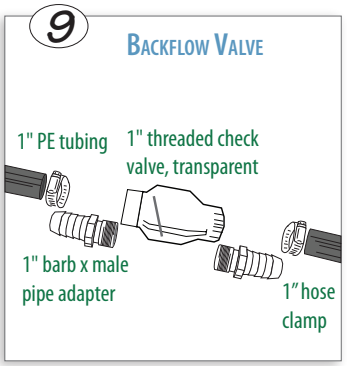
13) Productive/ appropriate plants—such as fruit trees, for reuse, or bananas or blackberries, for dispersal. Note: Irrigation of lawn by this means is not allowed (by code, greywater may not be applied to a surface where humans could easily come into contact with it).

Sample map of outlet moving sequence to post by the washing machine. When you start a load, you move the hose to the next spot; from 1 to 2 to 3, etc.

Movable Laundry to Landscape System







13 **Productive trees/ plants**
Turf irrigation not allowed

Movable **outlet shield**, ornamental version—a plastic turtle shell replica, artificial rock, etc.

11c

11b
Movable **outlet shield** clamped to end of hose-sends clear signal that water is non-potable, and automatically follows outlet wherever it is placed

11d
Stationary **outlet shield**—with hole to receive hose, which is inserted in a different shield at each location

11e
Subsoil infiltration chamber as **outlet shield**—difficult to service, only recommended in special cases, e.g., to bear traffic load under path, or where it is necessary to have system hidden

Fixed, Multi-Outlet Laundry to Landscape System

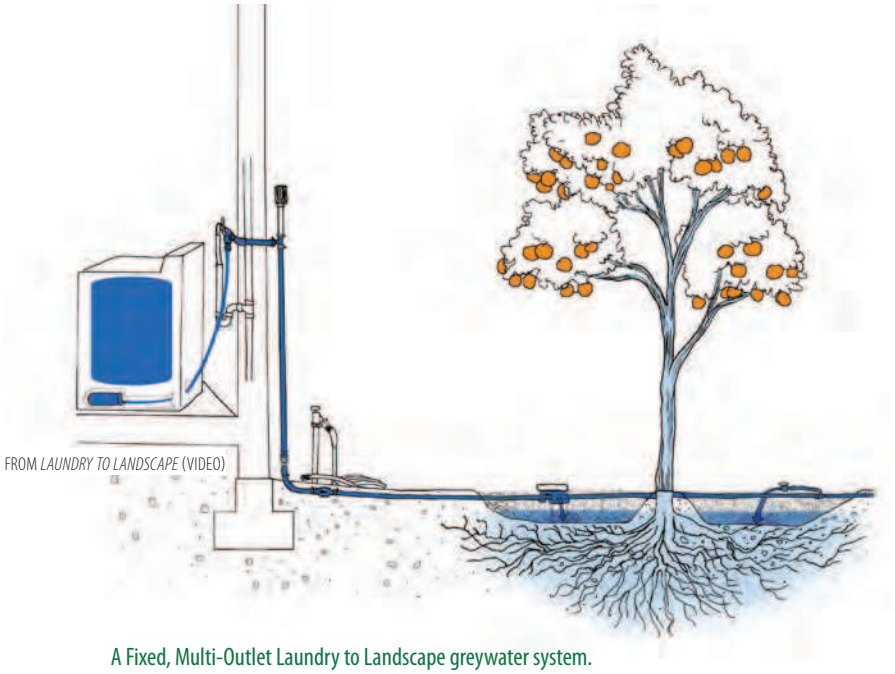
The original Laundry to Landscape system with several fixed outlets is currently the most popular for new installations in Santa Barbara County. It has an advantage over the preceding system in that there is no need to move a hose; the water comes out of the outlets by itself. If you have an old, high-flow washer, this system is more suitable; the flow can more readily be divided, is too much for one outlet, and is too much for a ¾" hose.

Note: This and the previous system can be hybridized. Multiple outlets can be movable. Or a bank of valves with an octopus of ¾" single-outlet lines could enable greywater from a low-flow, high-efficiency machine to be sent to various fixed outlets one at a time, by switching valves inside rather than moving lines outside.

Since the Laundry to Landscape system was invented in Santa Barbara County in 2009, this system has become popular throughout California. The procedures to design and install these systems can be found in the Resources and References section.[40]

ML2L vs FL2L Which is for You?

Movable L2L	Fixed Outlet L2L
Best with high-efficiency washer	Best with old-style washer
Need to move hose	Do not need to move hose
1 or 2 movable outlets	4–16 fixed outlets
Know exactly where water is going and how much	Hard to tell how much water is going to each outlet
Quick, cheap, and flexible to set up	Harder to set up, easier to use



FROM *LAUNDRY TO LANDSCAPE* (VIDEO)

A Fixed, Multi-Outlet Laundry to Landscape greywater system.

Branched Drain System (Shower to Flowers)

The best way to send shower water automatically to trees over decades is though a Branched Drain system. These flow by gravity, need no filtration, and only need service once a year or so.

Branched Drain systems can be quite challenging to design and install well, more on par with building a shower than fixing a leaky faucet. Unlike cheap, small-diameter, flexible hoses for freshwater drip irrigation or laundry-only greywater systems, the expensive, large-diameter, stiff, buried piping for gravity-flow greywater irrigation must be supported by straps or soil. Moreover, it must slope continuously downhill at a precise minimum of 2%. It is not easy to get it exactly where you want it, and even harder to move it later. It is simpler to install if the trees to be irrigated are chosen and planted in conjunction with the design of a Branched Drain system (fruit trees are generally the best plants to irrigate with gravity-flow greywater). On the other hand, once this effort is made, the system can last for decades, and it is a great feeling to know that thirsty fruit trees are benefitting from your shower.

If you find installing a laundry system easy, then you may be up for the challenge of a Branched Drain system.[35] If not, professionals can help you.[41]

Here are some tips for a successful installation:

- **Plan well—**The system can last for decades and is not easy to modify, so the design will ideally account for factors such as tree growth, kids leaving for college (and then coming back to live with you—together with your grandkids), changes in ownership of the house, etc. This is not an easy task, but the reward is decades of free water and happy trees.
- **Pay particular attention to outlet elevations—**Gravity-flow greywater outlets usually perform best when situated as high as possible, ideally 6" above the soil at the bottom of the basin, to leave clearance for mulch without clogging. Note that it takes either a steep slope or *much* more design effort, installation skill, and expense to get the outlets this high in the landscape. But the height and location of outlets will determine the performance, maintenance interval, installation challenge, and cost of your system. Where possible, the extra effort and expense to position the collection plumbing high enough for unimpeded flow of solids from the outlets is well worth it. ***Shielded, free-flow outlets*** need 6" of clearance and are essentially clog free and easily serviced, whereas ***sub-mulch outlets*** require 2" and involve perhaps four times the maintenance, forever. ***Subsoil outlets*** can be several inches below the surface, but cost many times more to install, with service 10–100 times as difficult and costly. Also, it is surprisingly easy for buried outlets to get "lost" or forgotten.
- **Involve a professional in the collection plumbing—**That is, the plumbing from the home's greywater sources to the exit point and elevation specified by the landscaper. It is legal to do your own drain plumbing. However, involving a professional will ensure that traps and vents are positioned properly and upstream of the required diverter valve, cleanouts are where they need to be, pipes are and will stay sloped correctly, and the proper fittings are used to ensure the long-term smooth flow of solids through pipes in both greywater and septic/ sewer modes. Properly designed collection plumbing should last the life of the house. Having a professional eye on it from the start will save money and grief compared to hiring someone later to repeatedly unclog or rebuild it.

A flow-splitter retrofitted with inspection access. The access is sealed with a threaded plug.

FROM *CREATE AN OASIS WITH GREYWATER*

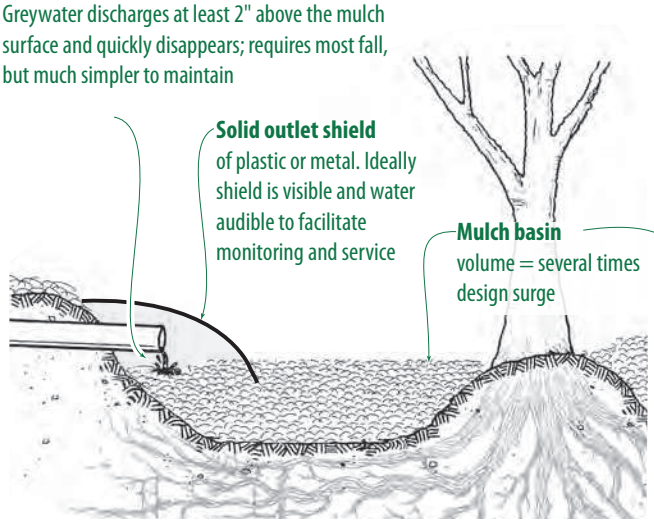
Cutaway view of flow-splitter; a fitting that is largely self-cleaning with no filtration.

Gravity-Flow Branched Drain Greywater Outlet Options (elevation view)

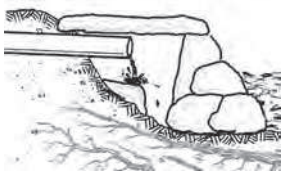
A: Shielded free-flow outlet (preferred option)

Shielded above-grade, above-mulch outlets are preferred whenever possible. They are far less clog prone and ar easier to find, inspect, and maintain. These can go for years without maintenance.

Greywater discharges at least 2" above the mulch surface and quickly disappears; requires most fall, but much simpler to maintain

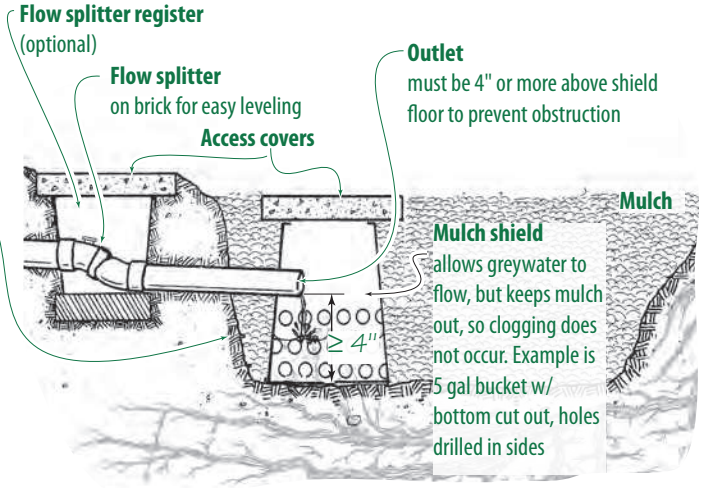


Outlet shielded with rocks



B: Sub-mulch outlet with mulch shield

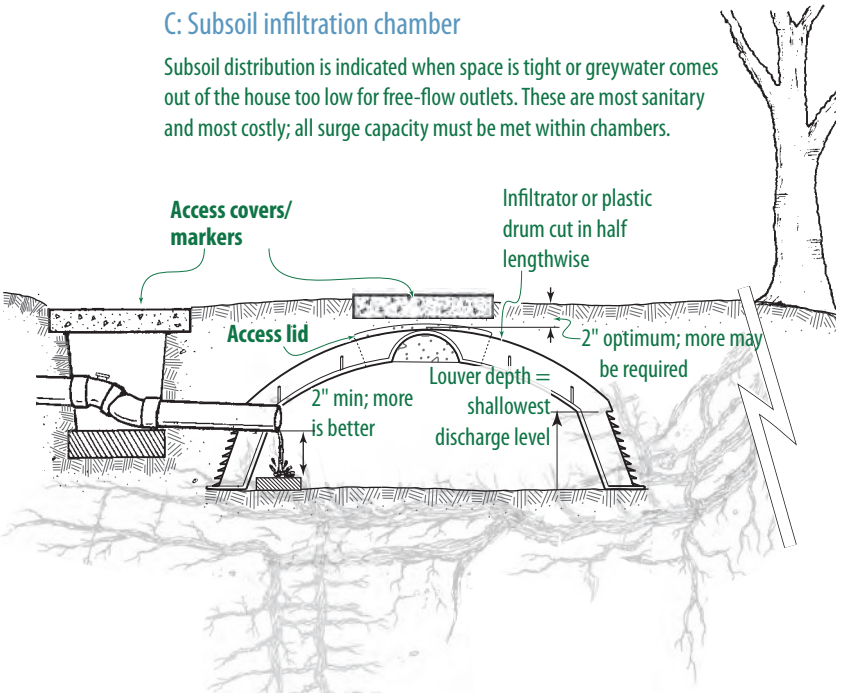
Sub-mulch outlet shields are necessary when pipes are not high enough for shielded free-flow outlets. These require removal of material from inside the shields at least annually.



Avoid these common mistakes:
Do not make the outlet chamber too small. 3 gal is the minimum size.
Do not surround them with soil; they require the rapid infiltration of mulch.

C: Subsoil infiltration chamber

Subsoil distribution is indicated when space is tight or greywater comes out of the house too low for free-flow outlets. These are most sanitary and most costly; all surge capacity must be met within chambers.



Subsoil infiltration chambers are the last resort, and are usually used in tight quarters, where they can be placed under pathways or outdoor living surfaces. They are by far the most costly as the entire infiltration capacity must be in the chamber (expensive) vs in an open basin (cheap). This is compounded by the fact that the infiltration rate will be lower, as they cannot easily be mulched inside to keep the soil open. Be sure to make them big enough, avoid overloading them, put wire mesh under them so gophers do not backfill them with dirt, place them where they can be dug up for service if needed, and mark/ map them well.

Finding Parts

Local plumbing and irrigation suppliers have all the parts you require, though you may need to go to more than one store. The parts are also available on the Internet; search on greywater parts, greywater valves, etc.

The detailed procedures to design and install Branched Drain systems are available; see the Resources and References section.[35]

MEG WEST DESIGN/ CORNERSTONE LANDSCAPES/ DOUG ELLIS PHOTOGRAPHY

Water efficient landscape in Santa Barbara County.

Common Santa Barbara County Greywater Questions and Answers

These are responses to common questions posed by Santa Barbara County residents.

Can I Save My Lawn with Greywater?

No. It is not legal to apply greywater to grass. If your lawn has people playing on it, that would not "minimize human contact with greywater" as required by code. If your lawn is ornamental, without people playing on it, so it would make more sense to replace the grass with something else that is nice to look at but does not need so much water and maintenance.

Preferred practice: Apply greywater to your most essential irrigation-requiring trees and shrubs around the house; these are often fruit trees. Most niches in the landscape for plants that do not provide edible fruit—e.g., privacy hedge in a shaded area, a big shade tree, flowers—can be filled by low water use plants that require little or no irrigation once established.

FRED HUNTER/ REGENERATIVE LANDSCAPE ALLIANCE

Replacing lawn with low water use alternatives is the preferred solution.

Exceptions: A lawn shower could provide irrigation for a very small lawn (a large lawn takes many, many times more water than is generated by showering).

A subsurface drip system fed by a greywater filtration system or by treated septic effluent can irrigate turf. This can be economical for institutional-scale flows.

However, even for a single-family residence, the proven versions of these systems cost as much as a midrange new car, and require a maintenance contract that costs as much each year as the parts for a simple greywater system. The more cut-rate systems have disappointing longevity. So, they are not currently recommended for Santa Barbara County at a residential scale. If you are one of the rare County residents who needs an advanced treatment unit due to soil conditions too poor for a regular leachfield—at least you can irrigate your lawn with the treated effluent. Even in this case, irrigation of more climate-appropriate landscaping would likely be a better use of the water.

Finally, in order to install subsurface irrigation, you would need to take out your present lawn and put in a new one after the irrigation has been done. It makes more sense financially to install a water-wise meadow or other lawn alternative if you are going to go to all that trouble.

Can I Water My Drought-Tolerant Garden with Greywater?

Generally, no. Drought-tolerant plants may suffer and get sick with the daily greywatering that citrus or other water-loving plants thrive on.

Exceptions: Occasional greywatering—especially during drought—and continued greywatering of low water use plants that have been greywatered for decades are generally okay. The farther the application from the trunk and the faster percolating the soil, the less likelihood of harm.

Having low water use plants near high water use plants that are greywatered is probably okay—if the outlet is as far as possible from the root crown of the drought-tolerant plant or tree. For example, a small lot may have fruit trees on the south edge of the canopy of an oak far above, with oak roots everywhere;

the oak will likely take some nutrients and water from the fruit trees, but if the greywater outlets are 20 ft or more from the trunk, the oak will not likely be harmed.

Preferred practice: Apply greywater to fruit trees.

Can I Water My Veggie Garden with Greywater?

No. It is not recommended to put water that may contain a trace of pathogens on lettuce, carrots, etc. that may be eaten after inadequate washing. Moreover, the varying water requirements of annual vegetables from the time of planting to maturity, and then the bare ground after harvest, make it difficult to get the right amounts of greywater to these gardens.

Preferred practice: Chances are that you have more irrigation demand than greywater supply. Use greywater on ornamentals and fruit trees, and use the freshwater you saved on your veggie garden.

Can I Just Run a Hose from My Washer to Trees?

Yes. This handbook includes brand new best practice information on how to run laundry water to a movable outlet safely and in compliance with California's greywater rules—with no permit required (see Movable Laundry to Landscape System).

Can I Put Greywater into My Freshwater Drip Irrigation?

No. Everybody wants to do this, but greywater contains solids that would quickly clog your drip system. Innovators are working on greywater-to-drip-irrigation systems, but 1) all entries to date require special drip hardware that resists clogging, so your existing drip tubing will not work anyway; 2) the outlets must all be under 2" of mulch to meet California greywater code, which necessitates drippers with provision against root intrusion; and 3) the cost-benefit ratio and system longevity have a way to go before these systems will make sense for use on residential properties.

Exceptions: Sites with problematic conditions for a conventional septic may find it economical to use more elaborate means of greywater treatment, or combined greywater and blackwater advanced treatment systems, which do work with subsurface drip irrigation. This class of systems is rare in our area because our soils and climate are generally good for treating blackwater on their own without the extra expense.

Can I Irrigate with Greywater If I Have a Water Softener?

Short answer: Remove the water softener. Water softeners add salt to the water, which is toxic to plants and soil over time.

Preferred practice: Remove the water softener, or if you can not bring yourself to do that, switch to potassium chloride (see exception, below). Even if you do not use your greywater for irrigation, you may live in a sewer district that already is or someday will be reclaiming water to use on crops. Sodium in the sewer stream creates serious problems for this beneficial reuse of water. Also, water softeners use a lot of water for flushing. In a very water-conserving household, softener recharge can be the single biggest water use. If you must soften your water, you can reduce the problem and still get most of the benefit by only supplying soft water to the hot water heater. For a washer—which only needs cold water—you can soften the water in the machine by adding a tablespoon of potassium tripolyphosphate to each load.[43] This is a great solution: a

DONALD SUAREZ, USDA SALINITY LABORATORY

"Salting the fields" was a tactic of war used in ancient times to destroy an enemy's food supply. An average family using softened water sheds almost 500 lbs of salt a year in their wastewater.

rare case where the most effective solution is also the most ecological and economical.

Exception: If you switch your softener from sodium to potassium chloride and do not have much clay in your soil, reusing softened greywater should be fine. The softener flush drain water, however, is still too concentrated to run into the landscape.

What Cleaners Should I Use?

Cleaners without sodium, chlorine, or boron. These cleaners will not accumulate to damage plants over time. Such products are available from local retailers.[44] Coconut or palm oil surfactants nearly always contain sodium unless otherwise specified.

Can I Access Greywater If My House Is on a Slab Foundation?

Yes and no: yes for laundry, maybe for a bathtub on an exterior wall, probably no for everything else. Check with a greywater professional to be sure. If you are on septic, a Green Septic may be an option.[45]

Can Diverting Greywater Save My Septic System?

Yes. Get the greywater out of your septic. This can extend the life of your leachfield and reduce pumping frequency. If you have a failing septic, it is possible that diverting all the greywater—which is up to 80% of the total flow—could restore it to function. The laundry water is especially helpful to divert, as synthetic fibers can float through the septic tank and papier-mâché shut the soil in the leachfield. Also consider using ultra-high-efficiency toilets (less than 1 gal per flush) and implementing a "flush only when necessary" policy.

Edible and low water use plants alongside fire-safe architecture in the foothills of Santa Barbara County.

Systems Thinkers Needed

Hundreds of thousands of skilled systems thinkers are needed to help actualize the untapped benefits of integration in all fields.

Greywater is the residential gateway to systems thinking. Taking the systems approach produces markedly better results all the way around. Ideally what "greywater installers" would do is actually "integrated landscape and resource management. "

On one local job, the initial client request was to run greywater to their extensive, Maui-like landscape. But with 90% percent of the astronomical water bill for irrigation, their maximum theoretical water savings from greywater irrigation was merely 5%, and their actual savings probably more like 2%. Taking the systems approach, the focus was shifted to efficient freshwater irrigation.

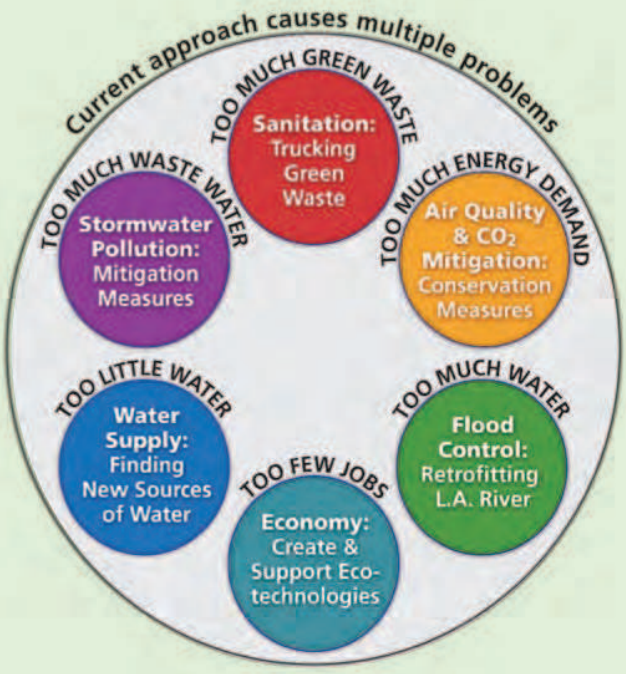
Turned out the irrigation controller was over-irrigating by double the intended amount. With a minute of pushing buttons, the site's water consumption was reduced by half.

Submetering the freshwater irrigation was the top hardware suggestion, followed by a phased transition from water-guzzling to water-sipping plants. Greywater reuse was actually near the bottom of the list of suggestions.

Since greywater systems depend on so many other house systems, every greywater job can and should be approached with a wide scope of work.

Much as greywater is the gateway for residential systems thinking, stormwater is the gateway to systems thinking for public agencies, as shown in this lovely graphic from TreePeople:

Past



Dis-integrated approach wastes resources, duplicates efforts, and imposes unsustainable practices.

Future

Integrated approach also creates jobs and liberates funds for emerging green technologies.

When someone asks me to install a greywater system I always look at the bigger picture: fixing the irrigation schedule, reducing lawn—half the time the idea they had for their greywater doesn't make sense—greywatering lawn, for example—and what we end up doing for them doesn't include the original idea at all, but saves far more water and money.
—Santa Barbara County Landscape Contractor

Appendix A: State Laundry-Only System Exemption Standards

Text from the 2016 California Plumbing Code, Chapter 16 (greywater systems):

1603A.1.1 Clothes Washer System and/ or Single Fixture System.

A clothes washer system and/ or a single fixture system in compliance with all of the following is exempt from the construction permit specified in Section 1.8.4.1 and may be installed or altered without a construction permit:

1. If required, notification has been provided to the Enforcing Agency regarding the proposed location and installation of a graywater irrigation or disposal system. Note: A city, County, or city and County or other local government may, after a public hearing and enactment of an ordinance or resolution, further restrict or prohibit the use of graywater systems. For additional information, see Health and Safety Code Section 18941.7.
2. The design shall allow the user to direct the flow to the irrigation or disposal field or the building sewer. The direction control 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.
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.[46] 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.

BARBARA WISHINGRAD/ SWEETWATER COLLABORATIVE

Take photos of all pipes before you bury them, name the photos something searchable, and save them with your house files.

Appendix B: County Shower System Exemption Standards

Simple greywater systems that meet commonsense guidelines may now be installed without a permit in participating water service areas in Santa Barbara County; this section explains how.

What Requirements Must Be Met for a Simple Greywater System to Be Permit Exempt?

An exempted system must meet all the following requirements, which are based on the greywater chapter in the 2016 California Plumbing code. Notes in italic are not part of the requirements:

1. **You are within unincorporated Santa Barbara County and provide your own water or are supplied by a participating water purveyor—**Participating purveyors include Goleta Water District, Carpinteria Valley Water District, Montecito Water District, and San Marcos Mutual Water Company as of June 2016. Other districts may choose to participate; check www.WaterWiseSB.org for the current list. If your property is in any city other than Buellton, you need to contact your local building department regarding gray water system permitting.
2. **The greywater originates from a single-family dwelling with 4 bedrooms or fewer.**
3. **The system receives less than 250 gallons per day of greywater—**This will be true for most conserving households with fewer than 10 people.
4. **The system does not include a pump—**excepting the pump in a clothes-washer.
5. **The mulch basins or infiltration chambers receiving the greywater in the landscaped area are properly sized and designed so that there is no visible ponding, runoff, or septic odor—**The required area depends on the perc rate of the soil, and can be found in Table 1602-10, reproduced here for your reference.
6. **The greywater is contained in basins and covered by a minimum of 2 inches of mulch, solid outlet shield, or another method that provides equivalent separation.**
7. **The highest known seasonal groundwater level needs to be at least 3 feet below the surface—**This can be determined by digging or in consultation with the Environmental Health Department.
8. **The system does not include a potable water connection and does not adversely affect other building, electrical, or mechanical components—**for example, structural features, egress, fire/ life safety, potable water supply piping, or accessibility.
9. **The greywater is contained on the site where it is generated.**
10. **Greywater contact with humans and domestic pets is minimized—**for example, by covering with mulch, and outlet shields.
11. **Greywater is used to irrigate plants such as trees or shrubs, not vegetables or surface irrigation of lawn.**
12. **Hazardous chemicals are not introduced into the greywater system—**for example, those derived from activities such as cleaning car parts, washing greasy or oily rags, or disposing of waste solutions from art studios or similar hobbyist or home occupational activities. Ideally the possibility of contamination is minimized by reducing or eliminating such substances from the site; though they can also be diverted to the septic/ sewer, hazardous chemicals are not good for groundwater or the ocean, either.

Greywater-irrigated edible and rain-fed native flower landscape.

13. **Exemption from construction permit requirements does not grant authorization for any greywater system to be installed in a manner that violates other provisions of applicable codes or any other laws or ordinances of the enforcing agency—**In other words, you still have to follow all codes even though you do not need a permit.
14. **An operation and maintenance manual is provided to the owner—**Directions indicate that the manual is to remain with the building throughout the life of the system and upon change of ownership or occupancy.
15. **Greywater piping conforms to the plumbing code and greywater best practices, including, for example:**
    a) **Professional involved in the collection plumbing—**the plumbing from the greywater sources to a point or points just outside the building—to ensure that traps and vents are positioned properly above the required diverter valve; that cleanouts are properly positioned; that pipes are sloped properly and will stay sloped properly; and that the proper fittings are used in the proper orientation to ensure the long-term smooth flow of solids through pipes in both greywater and septic/ sewer modes. The landscaper/ greywater designer can help specify the point(s) and elevation just outside the house that collection plumbing should be routed to.
    b) **Diverter valve(s) for switching between irrigation and septic/ sewer, clearly labeled and as accessible to the user as is feasible—**This allows greywater to be diverted to septic/ sewer as needed if use is high and/ or weather is wet, or if toxic cleaners are used.
    c) **A backwater valve on all drain connections to the sanitary drain or sewer piping that are subject to backflow—**This prevents sewage from backing up into the greywater system.
    d) **Greywater plumbing clearly marked as non-potable where any possibility of confusion exists—**for example, any greywater not in 1.25" or larger ABS pipe should be marked with the words "CAUTION: NON-POTABLE WATER, DO NOT DRINK."
    e) **Greywater collection plumbing to a stub-out just outside the house is also permit exempt, provided the stub-out is permanently marked as non-potable—**for example, with the words "Greywater STUB-OUT, CAUTION: NON-POTABLE WATER, DO NOT DRINK." (Stub-out plumbing collection plumbing to a point just outside the house, where future distribution plumbing can be connected.)

TEXT FROM SANTA BARBARA COUNTY BUILDING AND SAFETY, AND SANTA BARBARA COUNTY ENVIRONMENTAL HEALTH, IN CONFORMANCE WITH CALIFORNIA PLUMBING CODE

Greywater Loading Rates by Soil Type

Type of Soil	Minimum Square feet of irrigation/*leaching* area per 100g of estimated gray water discharge per day	Maximum absorption capacity in gallons per square foot of irrigation/leaching area for a 24-hour period
Coarse sand or gravel	20	5.0
Fine sand	25	4.0
Sandy loam	40	2.5
Sandy clay	60	1.7
Clay with considerable sand or gravel	90	1.1
Clay with small amounts of sand or gravel	120	0.8

2016 CALIFORNIA PLUMBING CODE

What If My System Does Not Meet All these Requirements?

Your system will not be exempt, but you can still get a permit for your system from your building department if it meets the rest of the California greywater code. If the system is for a bigger house or greater water flow, if it includes a pump, or if you want to do the collection plumbing yourself, the pathway to system success is a little trickier. In these instances, the permitting process will help to ensure that your system works satisfactorily for the long term.

Edible and low water use landscape uses less resources and offers more than lawn.

Resources and References

Note to print copy readers: Most of these references include Web links. You can go to the Web page WaterWiseSB.org/greywater/handbook/refs to see updated, clickable references as well. WaterWiseSB.org is the information hub for Santa Barbara County water provider's conservation and education.

WWW.WATERWISESB.ORG

Contacts

For more information about greywater systems, call the Environmental Health Services Division of the Santa Barbara County Public Health Department at (805) 681-4900 in Santa Barbara or (805) 346-8460 in Santa Maria.

For plumbing permit requirements, contact your local Building Department. If you live in a city, contact the city offices. In the County, call the Building and Safety Division of the Santa Barbara County Planning and Development Department at (805) 568-3030 for the South County Office or (805) 934-6230 for the North County Office.

Resources

Copies of the current California Plumbing Code (CPC) Greywater Regulations Chapter 16 are available from Public Resource. org. Check with your local building department to see whether this 2016 plumbing code has been superseded by a later code.

The Web offers a wealth of information on greywater, though care must be taken to assess the quality of the information. Sample searches: "Laundry to Landscape," "Branched Drain," "Common Greywater Mistakes."

Funding Assistance

The Santa Barbara County EmPower program offers property owners the opportunity to finance energy- and water-efficient property improvements through the property tax system: https://empowersbc.org

Endnotes

[1] Larry Farwell was the main force behind the Santa Barbara County and California state legalization that started the modern greywater movement.

[2] Oasis Design/ Art Ludwig was largely responsible for items 2, 3, 5, 7, 9, 11, and 12.

[3] Val Little and Chuck Graf were the architects of Arizona's blanket statewide allowance of all greywater systems that met a short list of reasonable requirements. This approach was later followed by several other states and is arguably the best embodiment of the "proportional regulation" principle (more regulation for more dangerous practices). There still has not been one documented case of greywater-transmitted illness in the United States, and the Arizona approach saves compliance resources for other applications.

[4] California's 2009 improvements were a group effort with dozens playing key roles, ranging from government staff to Governor Arnold Schwarzenegger. Foremost were Doug Henzel at CAHCD, and Oasis Design/ Art Ludwig, contracted by Alison Jordan at the City of Santa Barbara Water Conservation Program to represent Santa Barbara in the stakeholder code development process.

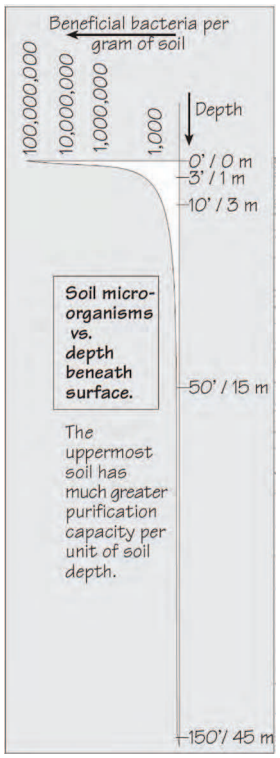
[5] For Santa Barbara County greywater standards improvements, Larry Fay and Massoud Abolhoda were instrumental, in collaboration with Oasis Design/ Art Ludwig.

[6] The graph is from *Not a Drop to Spare: Sustainable Water Management for the South Coast of Santa Barbara County*, a report from the UCSB Bren School. For information on County water supply, climate, rainfall, creek flows, reservoir levels, etc., see the Santa Barbara County Water Agency. For particulars on your water supply see your water provider or where your water comes from.

[7] *Builder's Greywater Guide* by Art Ludwig. Greywater treatment effectiveness in topsoil pp. 40–46.

[8] Green Septic, a fusion of modern passive septic system technology with Oasis's Branched Drain flow splitting, and landscape/ orchard irrigation.

[9] Relative water savings numbers for a narrow vs systems approach to greywater are based on the analysis of our own house, with and without best practices. A graph of this comparison can be seen on the inside back cover of the 6th edition of *Create an Oasis with Greywater.* The left-hand greywater slice here is thicker, because there is more greywater available prior to conservation.
High savings for greywater alone are unlikely, because so much can and does go awry in the field, more so when the spotlight of study is not on: Greywater may not be distributed to plant roots evenly; redundant freshwater irrigation is often applied; and greywater may not be needed (roughly a third of Santa Barbara County greywater generation occurs during that portion of the season when plant needs are met by rain). A narrow approach to greywater can cause water consumption to *increase*. From *Residential Greywater Irrigation Systems in California: An Evaluation of Soil and Water Quality, User Satisfaction, and Installation Costs*, Greywater Action in collaboration with City of Santa Rosa and Ecology Action of Santa



BUILDER'S GREYWATER GUIDE

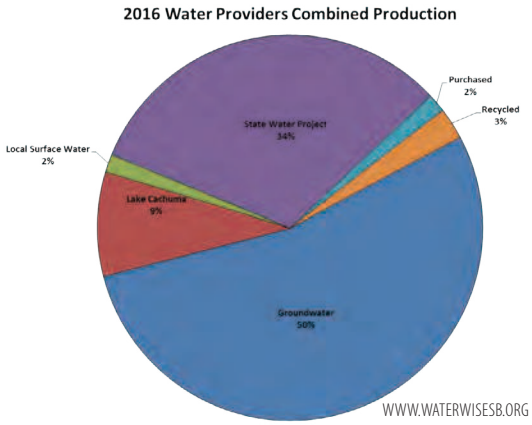
Cruz: *Of the households that did not make any water saving changes, those that planted new plants when they installed their greywater system used an average of 4 more gallons per person per day, while households that did not plant new plants saved an average of 11.*

[10] Calculating theoretical water consumption and measuring/ calculating actual water applied is an eye-opening exercise. While it is not unusual for a whole landscape to be over- or underwatered by half, looking plant by plant can reveal that the watering is off by an even wider margin. Trying to account for the "missing" water from this exercise can reveal the surprisingly large role played by stored rainwater in the living soil sponge.

[11] WaterWiseSB.org/rebate.wwsb Landscape rebate info, including lawn replacement. Informative lawn vs sustainable landscape cost study from the Santa Monica Office of Sustainability: a 9-year case study documenting the resource consumption at the two gardens showed that the Native Garden used 83% less water, generated 56% less green waste, and requires 68% less maintenance than the Traditional Garden.

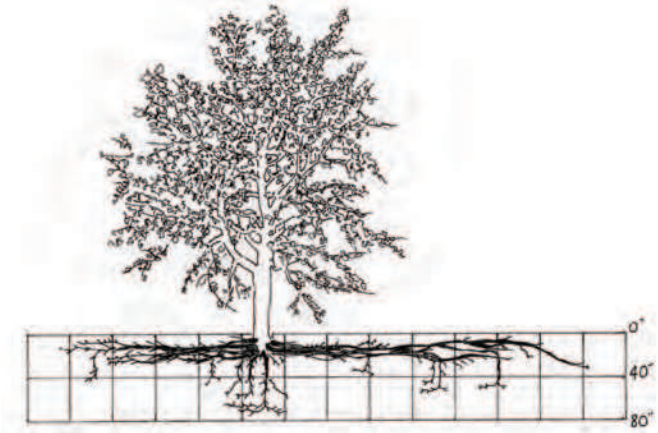
[12] *Principles of Ecological Design* by Art Ludwig—information on systemic, fundamental shifts toward ecological, economical living.

[13] Where does your water come from? Santa Barbara County water sources by purveyor.



[14] Greywater quantities and irrigation need are described in the book *Create an Oasis with Greywater*. The Water Makeover Checklist has procedures for accurately measuring water use in your home.

[15] *Understanding Roots* by Robert Kourik: excellent window into what is happening underground. Sample:



A 30-year-old apricot tree with roots growing to a depth of nearly 7 ft in sandy soil. The roots on the right extend more than 39 ft beyond the dripline. 82% of its roots are growing in the top 8–24" inches of soil.

[17] California Irrigation Management Information System (CIMIS) has plant water use measurement stations throughout the state; some smart irrigation controllers are informed by this system.

[18] County of Santa Barbara Energy and Climate Action Plan, City of Santa Barbara Climate Action Plan

[19] Challenges to Santa Barbara County water supplies, by source: **Surface water, e.g., Santa Ynez River**—Issues are increased severity of drought, which lowers inflows; increased rainfall intensity, which increases the rate of siltation of reservoirs; and increased evaporation, which directly takes water out of reservoirs. **Groundwater**—The issue is reduced recharge. To recharge groundwater, rain must exceed evaporation and transpiration (both are higher with higher temperature) and yet not run off. The runoff coefficient is exponentially higher with higher rainfall intensity. Thus, the needle to thread for recharge is much narrower with climate change. **Desalination**—This has the highest climate impact per gallon of any local water source, so it should be used very sparingly. **State water**—This supply depends on Sierra snow pack, the biggest reservoir in the state, which is already depleted due to melting and is expected to be severely depleted in the future.

[20] Optimal Integrated Design for Fire Safety—a host of designs for making your home more wildfire-resistant. For example, irrigated trees and mulch that are close to but not touching your home (say, 10 ft away) may be safer for wildfire than bare earth, or bare earth under trees. How? According to personal communication with Don Oaks, fire safety consultant and former fire marshal of Santa Barbara County, trees serve as windbreaks that slow the velocity of embers pushing into crevices of structures. Since embers are the primary threat to structures, your home may be safer with trees around it than nakedly exposed to blasts of wind.
On an equally counterintuitve note, Ernie Wisner, experienced wildland firefighter, observed that in wild areas where mulch was removed, fires were more intense than in adjoining areas where mulch was in place. He theorizes that the effect of higher evaporation from bare soil, which reduces moisture in living plants and makes them easier to burn, may be larger than the effect of dry mulch burning under relatively hydrated trees. In any case, County fire guidelines support irrigated trees and mulch no more than 4" thick with separation from structures.

[21] From Even California's Mighty Oaks Are Dying From Drought: *If an oak produces dwarf or no leaves, it may be under such water stress that occasional deep watering in summer is indicated.*

[22] Stormwater Information Central includes a video of a stormwater infiltration system capturing 60,000 gallons in 6 hours on a quarter acre lot. This system concentrates runoff. We investigated after a storm that wet the soil 2" down elsewhere, and found that it wet the soil 40" down under the infiltration basins.

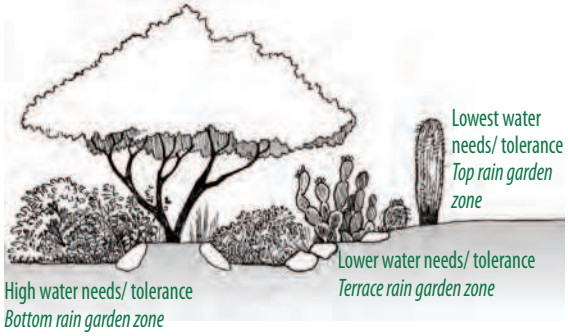
[23] Low chill fruit trees: Locally owned nurseries typically have fruit trees more adapted to our climate than those at chain stores. Read the tags and ask questions. This variety selection tool is helpful for identifying low chill, high quality cultivars.

[24] *Methane is a potent greenhouse gas that contributes to atmospheric warming, and is approximately 25 times more potent per molecule than carbon dioxide over a 100-year period*—climate.nasa.gov

[25] Carbon footprint of water—oCoCarbon: *89% of the footprint of domestic water use is caused by heating it.* River Network, 2009: *the carbon footprint currently associated with moving, treating and heating water in the U.S. is at least 290 million metric tons a year. The CO_2 embedded in the nation's water represents 5% of all U.S. carbon emissions and is equivalent to the emissions of over 62 coal fired power plants. Most significantly, the carbon footprint of our water use is likely growing for several reasons. Climate change is predicted to have numerous adverse affects on freshwater resources, rendering many available water supplies far less reliable. With water demand growing and many local, low-energy supplies already tapped, water providers are increasingly looking to more remote or alternative water sources that often carry a far greater energy and carbon cost than existing supplies. Water conservation, efficiency, reuse and Low Impact Development (LID) strategies should be targeted to achieve energy and greenhouse gas emissions reductions. Research from the California Energy Commission suggests that programs focusing on these kinds of water management strategies can achieve energy savings comparable to traditional energy conservation measures at almost half the cost. If every household in the United States installed efficient fixtures and appliances, residential hot water use could be reduced by approximately 4.4 billion gallons per year, [resulting in] CO_2 reductions of about 38.3 million metric tons. If LID techniques [rainwater harvesting] were applied in Southern California and the San Francisco Bay area, between 40,400 MG and 72,700 MG per year in additional water supplies would become available by 2020. The creation of these local water supplies would result in electricity savings of up to 637 million kWh per year and annual carbon emissions reductions would amount to approximately 202,000 metric tons by offsetting the need for inter-basin transfers and desalinated seawater.*

[26] The Green Gardener Program for Santa Barbara County educates local gardeners in resource efficient and pollution prevention landscape maintenance practices. The Green Gardener Program is a regional program designed to offer education, training, and promotion of participating gardeners and landscape maintenance contractors. Since Fall 2000, over 1,400 students have completed the certification program. It is offered through the Santa Barbara City College's School of Extended Learning in Santa Barbara and Allan Hancock College in Santa Maria.

[27] *Rainwater Harvesting for Drylands,* volumes 1 and 2, Brad Lancaster, Rainsource Press. Includes hundreds of informative drawings explaining all aspects of rainwater harvesting science and implementation;



how to conceptualize, design, and implement life-enhancing water-, sun-, wind-, and shade-harvesting systems for your home, landscape, and community. This book enables you to assess your on-site resources, gives you a diverse array of strategies to maximize their potential, and empowers you with guiding principles to create an integrated, multifunction plan specific to your site and needs.

[28] Rain barrels: pointless waste, or useful gateway to other, more significant practices? Probably both. See, for example, Roll Out the Rain Barrels? by noted local landscaper Owen Dell: *A typical 1,500 square foot front yard on the South Coast with a lawn and some foundation plantings requires around 43,000 gallons of water per year…[and] typical water use is 2 to 3 times what is needed, with actual applied water often clocking in at over 100,000 gallons for the same small front yard. So here's a question: Which is better, to save 60 gallons of rain water by installing a rain barrel or to save over 1,000 times that amount simply by dialing back the watering to a reasonable level? …Saving 60,000 gallons of water will reduce the water bill by $393 per year. By comparison, that smidgen of water in the rain barrel is worth just over 39 cents.*

[29] *Water Storage* by Art Ludwig—detailed explanation of issues with rainwater cisterns, all storage alternatives, and how to make the most of a multi-use rainwater cistern in Santa Barbara conditions. If you put in a cistern, be sure to run the overflow to a mulch basin for storage in the soil.

[30] Rainwater quantities: Rooftop rainwater from typical residential downspouts may be okay to add to generously sized greywater basins in good (non-clay) soil. An acceptable rainwater amount can be calculated easily enough: Measure the area of roof that feeds each downspout and multiply it by 0.6; that is the number of gallons the downspout would generate with 1″ of rain—about the biggest surge expected. If that amount could fit comfortably in the basin together with a greywater surge, then this harvesting practice is probably okay.

[31] The books mentioned here are available from local libraries and independent bookstores, or online. The Laundry to Landscape instructional DVD is available for free from some County water purveyors.

[32] Greywater 101 classes are currently being taught by Sweetwater Collaborative every month or every other month at various locations in south Santa Barbara County.

[33] The California greywater code (Chapter 16 of the California Plumbing Code) is available from Public Resource. Org. Check with your local building department to see whether this 2016 plumbing code has been superseded by a later code.

[34] Making landscape site plans, including contour lines, is a common skill among County professionals. Landscape contractors who do drainage plumbing should understand the importance of heights, and their skill set should be adaptable to most greywater work. Schematic sections for greywater are a more exotic skill, for which you may find yourself providing guidance as your mapmaker does something new. A table of elements and elevations is a good place

to start, as it puts the focus on the points that matter: floor height under greywater sources, heights of greywater drainage pipes where they exit the house, soil level at trunks of target trees, bottoms of greywater basins, gutter heights at downspouts, heights of surfaces for rainwater tank installation, stormwater channel grade lines, etc.

[35] *Create an Oasis with Greywater*—detailed design, construction, use, and troubleshooting details for Laundry to Landscape, Branched Drain, and 15 other greywater systems. Includes table of surge volumes, estimating or calculating irrigation need.

[36] Greywater LTAR—In septic system leachfields, Long Term Acceptance Rate (LTAR) or infiltration rate plummets over time; the value generally heard is by a factor of 100. For greywater mulch basins, through application of mulch, the infiltration rate *increases* over time, by as much as a factor of 30, due to increased tilth. This benefit has profound implications that warrant further investigation.

[37] Basin volume calculation example: For a basin that has an 8 ft diameter inside the berm with a 3 ft diameter island, there are 43 ft^2 of floor area (area of big circle minus area of small circle).With water 4″ deep at 0.6 gal/in, that is 107 gal. Take off a third for volume of mulch, = 70 gal.

[38] Thanks to Brad Lancaster of harvestingrainwater.com for this tip, which moved us to redo dozens of drawings in our books.

[39] waterwisesb.org/greywater/handbook or oasisdesign.net/sbgreywater.

[40] *Laundry to Landscape* instructional video.

Oasis Design wrote most of the text of the State's laundry exemption standards. When it became apparent that these would be adopted, we made an intensive effort to develop a laundry design that would be more ready for prime time than the old-style laundry drum of the 1990s drought. The resulting Fixed, Multi-Outlet Laundry to Landscape system was then published unpatented into the public domain. Dozens of water agencies in California now offer rebates on this system, including many agencies in Santa Barbara County.

[41] Directory of Santa Barbara County greywater professionals. Greywater Action provides training for greywater installers, and has a nationwide directory of graduates.

[42] Directory of Santa Barbara County greywater parts vendors.

[43] Potassium tripolyphosphate (KTPP), sold as fertilizer, works to soften water in a washing machine and improve cleaning.

[44] Isla Vista Food Cooperative is the most reliable source for plant and soil biocompatible cleaners.

[45] Green Septic.

[46] Users manuals for greywater systems.

JEFF SHELTON ARCHITECTURE

Low water use/ low maintenance landscape.

Notes

Notes

What you will learn:

* Answers to common greywater questions
* How to make a simple greywater system
* How your context affects design
* Why greywater matters

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COUNTY OF SANTA BARBARA CALIFORNIA

Santa Barbara County
PUBLIC Health
DEPARTMENT

SANTA BARBARA COUNTY WATER AGENCY