BC Green Building Code
Background Research

Greywater Recycling

October 2007

Note: The following research paper on greywater recycling was prepared independently by Light House Sustainable Building Centre. The paper provides a review of current literature and background information that the province will consider during the development of Green Building requirements now and in the future. The provincial government does not necessarily endorse the information or share the views expressed in this paper.

Summary:

This paper provides information on greywater recycling. It defines the common categories of greywater, and identifies potential benefits of reuse, as well as known concerns and risks and how they may be mitigated. The paper reviews designs and technologies for collection, treatment, storage and reuse of greywater. It provides, in appendices, considerable technical information on the design and installation of greywater recycling systems. It reviews policies and regulations that have been adopted in other provinces, states and countries, and identifies barriers to greywater recycling in current BC acts and regulations.

The quality of greywater varies depending upon the source of the water and the uses to which it has been put. Light-greywater typically consists of drainage from bathroom sinks, tubs, showers, and often laundry. Dark-greywater includes both light-greywater sources plus drainage from kitchen sinks, automatic dishwashers, or other sinks involving food preparation. Reuse of greywater places the onus on householders to take moderate care over what is allowed to enter the greywater in the first place.

The term greywater throughout this paper refers to light-greywater.

Greywater recycling practices must guard against risks to public health, safety, and the environment. Different qualities of greywater require different treatment processes, depending upon the potential risks. Greywater must be treated to remove substances that might be harmful to plants, human health, and the wider environment, and substances that might clog the system. The appropriate treatment method depends upon the quality of the incoming greywater and its end use. Relatively simple treatment methods can enable most light-greywater to be reused for subsurface irrigation, and toilet or urinal flushing. Use of greywater for plant irrigation requires monitoring and some mitigating practices as greywater can affect soil pH, and may reduce the soil's ability to absorb and retain water.

In many parts of BC, small-scale or 'onsite' household water reuse projects fall under the jurisdiction of public health authorities. The BC Ministry of Health is responsible for proposed water reuse projects with flows less than 22,700 litres per day. Large-scale water reclamation

projects with flows of greater than 22,700 litres per day fall under the Municipal Sewage Regulation (1999) and associated Code of Practice for the Use of Reclaimed Water (2001). This regulation is considered to be far ahead of the rest of Canada in facilitating water reuse. Nevertheless, developers in British Columbia often face stringent regulatory challenges and other barriers. Identifying and removing these barriers and/or implementing a permitting process are key areas for future investigation and action.

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Introduction

The purpose of the following document is to provide technical research summaries that will inform the development of specific code provisions in the area of grey water recycling. The document therefore comprises literature review and excerpts from relevant technical sources, supported by commentary from Light House, in order to offer guidance and background to the Province of BC's development of a proposed Green Building code for BC.

The document was completed by Light House with technical support from Troy D. Vassos, Ph.D., P.Eng., President & Senior Environmental Engineer, NovaTec Consultants Inc.

In February of this year, a 4-day experts meeting on graywater reuse was held on the Gulf of Aqaba, Jordan. Under the auspices of the International Development Research Centre (IDRC), Canada, in conjunction with the Center for the Study of the Built Environment (CSBE), Jordan, regional experts were brought together to discuss and assess current experience and results, with a view to charting future priorities.

IDRC and other institutions have supported research on the use of graywater to combat water scarcity. The treatment and use of graywater is not limited to new techniques, but in fact has a long history in many regions of the world. In British Columbia, however, developers and residents wanting to reuse greywater often face stringent regulatory challenges and even barriers. While some jurisdictions have modified existing legislation to allow the use of greywater for specific applications, such as subsurface irrigation and toilet flushing, in much of BC, existing regulations, and the lack of an established approval process, continue to hinder the widespread implementation of greywater recycling.

Identifying and removing regulatory barriers that prohibit or unduly complicate the installation of greywater systems, and/or implementing a permitting process, are key areas for future investigation and action.

Definition, Concepts and Benefits

Residential wastewater is a mixture of all water discharges within the household including bathroom sinks, bathtubs, toilets, kitchen sinks, and laundry wash-water sources. This wastewater is characteristically divided into three sub-categories related to the organic "strength" or level of contaminants typically contained in the water: 1) light-greywater; 2) dark-greywater, and 3) blackwater.

Wastewater Defined

[This section includes excerpts from the following source: Capital Regional District. "Greywater Reuse Study Report." November 1, 2004]

Light-greywater typically consists of drainage from bathroom sinks, tubs, showers, and often laundry. All three wastewater categories contain a wide range of organic and inorganic contaminants as well as disease-causing micro-organisms; with the type of contaminants and concentrations in light-greywater depending on the specific drainage source (i.e. bathtubs versus laundry). Although light-greywater may have lower concentrations of contaminants than mixed wastewater, research shows that the concentrations can be comparable to, and at times even greater than, mixed wastewater. (1)

Dark-greywater includes both light-greywater sources plus drainage from kitchen sinks, automatic dishwashers, or other sinks involving food preparation. Food waste, grease/oils and cleaning products contribute to increased contaminant loading, including disease-causing microorganisms, even without the presence of garburators. (1)

Blackwater is drainage from toilets and urinals; containing high concentrations of bacteria and organic contaminants in addition to disease causing microorganisms and ingested chemicals (e.g., pharmaceuticals)(1)

For the purpose of this document, use of the term greywater is in reference to light-greywater, which the literature indicates is used in some jurisdictions without biological treatment for direct subsurface application for landscaping irrigation and, with provision for disinfection, for flushing toilets. With adequate biological treatment and disinfection, both light greywater and mixed wastewater can be used for a variety of other reuse water applications.

Sources of Greywater Contamination

[This section includes excerpts from the following source: Capital Regional District. "Greywater Reuse Study Report." November 1, 2004]

As previously noted, greywater may contain varying levels of disease-causing microorganisms that are washed off during bathing, and from clothes during laundering, and may also contain fats, oils, grease, hair, lint, soaps, cleansers, fabric softeners and other chemicals. Soaps and detergents are biodegradable, but they can present problems from an agronomic perspective when greywater is used for irrigation over an extended period of time. The main problem with

most cleaning agents is that they contain sodium salts which, if present in excessive amounts, can create an alkaline condition and damage the soil structure, Elevated levels of chlorides, sodium, borax, and sulfates, and high pH (alkaline) characteristics of greywater may also be harmful to some plants. Greywater should not be used to irrigate root crops, or edible parts of food crops that touch the soil without adequate treatment and disinfection.

The kinds of chemicals that may end up being flushed down sinks including: household cleaning products, washing detergents, soaps, shampoos and conditioners should be kept in mind when considering greywater reuse applications. These products can contain a vast array of potentially harmful chemical contaminants that can affect the safety of greywater reuse applications (e.g. petro-chemicals, chlorine, caustics, animal ingredients, sodium lauryl sulfate, etc.). (1)

Because greywater contains similar contaminants and contaminant concentrations, and potential disease causing microorganisms to that contained in mixed wastewater (Ottoson and Stenström, 2002), greywater reuse applications require the same public health and safety, and environmental considerations as would be the case for reuse of mixed wastewater sources.. . Even the collection and storage of rainwater for potable and even non-potable applications require consideration for treatment. That being said, and while there are exceptions, most light-greywater is expected to have a low enough concentration of contaminants and disease causing microorganisms that reuse applications can be considered without the need for biological treatment or disinfection as long as the application has a is low risk of direct public contact (e.g. subsurface irrigation, and toilet or urinal flushing), and when storage is not required. The only form of greywater treatment typically provided in these cases is sedimentation to remove coarse solids and grit, and coarse filtration to remove hair and lint. In contrast, mixed wastewater or segregated blackwater or dark-greywater sources require at least biological treatment and disinfection before they can be stored or safely used for reuse applications.

If there is a need to store reuse-water, or there is a potential for public contact, the technology needed to treat and disinfect greywater is identical to that used for mixed wastewater sources intended for water reuse applications. If biological treatment is required because of the need to, due to the level of contaminants present, or because of the desire to apply reuse water for applications in which human contact is likely, the treatment technology required is identical for both blackwater and greywater (i.e. secondary, advanced-secondary, or tertiary treatment with disinfection). If treatment and disinfection is required for the intended reuse applications, greywater segregation is not recommended and mixed wastewater treatment should be considered. The biological treatment of segregated greywater can be very difficult to achieve, often due to having inadequate nutrients present in the greywater.

Benefits of Domestic Greywater Use

[This section includes excerpts from the following source: Capital Regional District. "Greywater Reuse Study Report." November 1, 2004]

Although the primary benefit of greywater non-potable reuse applications is that it conserves water resources for potable uses, it also reduces the service demands on the potable water supply (source, treatment and transmission), reduces the demands on the downstream wastewater infrastructure (collection, treatment, and disposal), and reduces the potential for impacts on the receiving environment.

Greywater most easily offsets water demands for irrigation. In conjunction with rainwater harvesting, t can supply most, if not all, of the landscape irrigation needs of a domestic dwelling in a semiarid region. Greywater can contain nutrients (e.g. phosphorus and nitrogen from detergents) that can benefit plant growth, reduce the need for fertilizer application, and result in more vigorous vegetation. (1)

In addition to irrigation application, greywater can also be used to offset potable water demands for use in toilet and urinal flushing. As previously mentioned. If adequately treated and disinfected, greywater can also be used for a wide range of other non-potable water uses including bathing, showering, laundry, washing, etc. (1)

Removing greywater from a residential or commercial wastewater stream reduces the volume of wastewater that has to be collected and treated and enables the existing water and wastewater infrastructure to service more connections. Municipal infrastructure cost savings could potentially be realized if this delays the need for future capital expenditures to upgrade conveyance or treatment capacities. On-site treatment and reuse also offers potential energy savings over centralized sewerage alternatives, particularly where greywater reuse applications require limited or no treatment, and where the greywater would otherwise have to be pumped to a centralized treatment facility. (1)

Rainwater Harvesting

Please see Appendix J for a discussion on rainwater harvesting.

Key Issues

Greywater Quality

[This section includes excerpts from the following source: Center for the Study of the Built Environment (CSBE). "Graywater Reuse in Other Countries and its Applicability to Jordan." Funded by the Ministry of Planning, Kingdom of Jordan. 2003.]

The quality of greywater varies depending on the source of the water, and the uses to which the water has been put. Table 1 indicates the likely constituents of water from various household sources.

Table 1: Common constituents of greywater

Greywater Source	Possible Contents
Automatic Clothes Washer	Suspended solids (dirt, lint), organic material, oil and grease, sodium, nitrates and phosphates (from detergent), increased salinity and pH, bleach, heat
Bathtub and Shower	Bacteria, hair, organic material and suspended solids (skin, particles, lint), oil and grease, soap and detergent residue, heat
Sinks	Bacteria, hair, organic material and suspended solids (skin, particles, lint), oil and grease, soap and detergent residue, heat
Swimming Pool	Chlorine, organic material, suspended solids

Source: Center for the Study of the Built Environment (CSBE). "Graywater Reuse in Other Countries and its Applicability to Jordan." Funded by the Ministry of Planning, Kingdom of Jordan. 2003.

Table 2 provides an overview of the various greywater containment concentration levels, together with some guideline parameters taken from a number of published international sources.

Table 2: Greywater quality characteristics

Reference	BOD5 (mg/l)	SS (mg/l)	pH	EC µS/cm	FCC CFU/100 ml
(Jeppesen 1996)					
□ Brisbane GW	90-120	45-330	6.6-8.7	325-1140	
(Christova – Boal et al. 1995)					
□ Bathroom GW	45-330	43-380	6.4-8.1	82-250	
□ Laundry GW	10-520	26-400	6.3-9.5	83-880	
(Water CASA 2000)					20-7,640,000
□ Arizona GW					
(Jeppesen 1996)	NA	NA	5.0-8.0	0-5000	NA
Guidelines for Irrigation of Plants					

Source: Center for the Study of the Built Environment (CSBE). "Graywater Reuse in Other Countries and its Applicability to Jordan." Funded by the Ministry of Planning, Kingdom of Jordan. 2003.

Effects on Plants

[This section includes excerpts from the following source: Center for the Study of the Built Environment (CSBE). "Graywater Reuse in Other Countries and its Applicability to Jordan." Funded by the Ministry of Planning, Kingdom of Jordan. 2003.]

The main effects of greywater on plants are:

- water quality
- water distribution
- appropriate plant types

Most greywater is used to irrigate plants, so the most immediate risks of pollutant constituents in the greywater are related to plant health. It is assumed that users will avoid the disposal of inappropriate substances (paints, antifreeze, solvents, mothballs, wastewater from oily rags, chemicals from photo-labs, etc) into the greywater. However, many greywater sources themselves will contain substances, which may have harmful effects.

Most laundry soaps and detergents - including baking soda - contain sodium compounds. High levels of sodium can cause discoloration and burning of leaves, and contribute toward an alkaline soil condition. In addition, high sodium can be toxic to certain plants and can prevent calcium from reaching the plants.[1] A second possible effect of some types of sodium is a disturbance of the soil's ability to absorb water.[2] A build-up of sodium over time therefore will reduce the soil's ability to support plants. This is probably one of the most serious potential long-term consequences of irrigation with greywater.

A reduction in the amount and concentration of sodium in the greywater can be achieved on an individual household basis either by reducing the amount of detergents and soaps used or by using reduced-sodium products (liquid detergents have less sodium). Outside of a single-family residential application it is likely impractical to effect control over detergent and soap use. Flushing the soil with freshwater or rainwater from time to time will reduce the build up of sodium in the soil. Water softeners also introduce sodium-based compounds into the water, and should be avoided where greywater is to be reused.

Detergent and laundry products also contain other chemicals that are harmful to plants such as boron, chlorides, peroxides, and petroleum distillates. Boron, for example, is very toxic to most plants.[3] On the other hand, most hand and dish soaps and shampoos used in normal residential concentrations will not damage plants (Ludwig 1995-1999). In general, gentle soaps, such as soap flakes, are more suitable than those heavily laden with lanolin, perfumes, and other chemicals. Soaps are less harmful than detergents. However, the use of any soap or detergent product may present problems over periods of sustained greywater application.

[1] The UN Food and Agriculture Organization (UNFAO) indicates "no problems" at sodium levels of < 69 mg/l, "increasing problems" at levels of 69 – 207 mg/l, and "severe problems" at levels of > 207 mg/l) (Bennett et al. 2002)[1].
[2] The sodium adsorption ratio (SAR) is the parameter that measures the effect on the soil structure of sodium compounds. A high SAR (13 or above) will result in soils with reduced permeability and aeration, and a general degradation of the soil's structure.
[3] UNFAO indicates "no problems" at boron levels of < 0.75 mg/l, "increasing problems" at levels between 0.75 and 2.0 mg/l, and "severe problems" at levels > 2.0 mg/l (Bennett et al. 2002).

Many detergents also contain phosphate compounds, but these are a nutrient to plant growth, and will generally benefit the plants.

Bleaches commonly contain chlorides, which can damage plants, particularly if the bleach water actually touches the foliage.[4] One symptom of chlorine-induced damage is a tendency for new, expanding leaves to appear bleached. Bleaches carry large amounts of chlorine. Therefore, ammonia is often used as a substitute for bleach, as it also cuts grease and is preferable as a household cleaning and deodorizing agent. Ammonia itself may cause damage to plants, although it quickly oxidizes to nitrates and nitrites - themselves plant nutrients - in certain soil conditions.

Some greywater systems use disinfectants to reduce the amount of bacteria content in the storage tank (if left standing can begin to digest creating odours). Chlorine is typically used as a disinfectant, although this disinfectant agent can harm plants and soil. Human-borne bacteria does not typically survive for long periods outside the body and will soon die in the soil. Water disinfected with chlorine should be left overnight to allow chlorine to evaporate.

Monitoring and Watering

Plants irrigated with greywater should be monitored regularly for symptoms of damage. If any signs of plant injury appear, use of greywater should be discontinued or reduced.[5]

Greywater should be applied over a broad area to avoid build up of harmful ingredients in one particular location. Applying greywater to the same plants all the time should be avoided. Particular care should be taken with water containing detergents, bleach or boron, and the use of rinse water containing fabric softeners should be avoided whenever possible.

Applying the water directly to foliage or stems should be avoided, as most of the feeder roots responsible for absorbing water are located at the base of the plant. It is best to distribute the water over the whole root system, where it will be most efficiently used and reduced potential for crown rot.

If greywater is used for irrigating food plants, its application should be restricted to the soil surface around plants of which only the above ground part is eaten. Greywater should not be poured directly on plant leaves. Sprinklers should not be used in order to avoid contacting the above-ground portion of the plants. Surface irrigation should not be used for food plants, except for fruit trees. Greywater should be cool before being used since hot water can damage plant roots and stems.

[4] UNFAO indicates “no problems” at chloride levels of < 142 mg/l, “increasing problems” at levels between 142 and 355) mg/l, and “severe problems” at levels > 355 mg/l) (Bennett et al. 2002)

[5] Identification of plant injury: ‘Burning’ of leaf edges may be caused by excess salts in the water. Acid-loving plants may experience some chlorosis or yellowing of the foliage, due to the alkaline nature of the greywater.

Type of Plants

Greywater should only be used on well-established plants, not on seedlings or young plants as they are more sensitive to the impurities in the greywater. Greywater generally should not be used on potted plants because of possible build up of contaminants in the soil that can damage the restricted root systems in a confined volume of soil. In addition, greywater should never be applied to root crops or leafy vegetables that will be eaten raw, such as carrots, lettuce, or herbs, and it should not come in contact with the edible portion of fruits and vegetables (for instance, with root vegetables, such as radishes, potatoes, and beets). Use of greywater with fruit trees, and other plants where the edible portion is well away from the water, is permissible. Greywater can be used for ornamental trees and shrubs.

Effects on Soils

[This section includes excerpts from the following source: Center for the Study of the Built Environment (CSBE). "Graywater Reuse in Other Countries and its Applicability to Jordan." Funded by the Ministry of Planning, Kingdom of Jordan. 2003.]

The main effects of greywater on soils are:

- A tendency to raise soil alkalinity and salinity;
- A reduction in the ability of soil to absorb and retain water.

Soil Alkalinity and Salinity

Increases in alkalinity will arise due to the presence of sodium, potassium or calcium salts in the greywater, particularly from laundry detergents. The effects on plants of variations in the pH of soil (acidity or alkalinity) is very important because it influences several soil properties that directly affect plant growth, and also has a bearing on soil bacteria and nutrient availability.[6] Water retention also is affected by some forms of sodium – an effect measured by a parameter known as the sodium adsorption ratio – SAR. A sandy, well-drained soil will be less affected by greywater application than a poorly drained clay soil.

Greywater Irrigation Quantities

Guidance for quantities of greywater use is given in several publications. For example, it is stated that a well-drained square meter of loamy garden soil, rich in organic matter, is capable of handling 200 litres of household greywater each week. Sandy, lighter soils can absorb more water, and heavier soils with high clay content absorb less (Greenhouse People's Environmental Centre).

Reduce Sodium Levels

If a soil has been irrigated with greywater for an extended period, sodium levels may build up, resulting in poor drainage and potential damage to plants.[7] To reduce pH levels, the

[6] Most plants grow best in soils with a pH between 5 and 7. When the soil pH is 5 or below (i.e. strongly acidic), nitrates, phosphates and potassium become less available to plants, earthworms disappear and bacteria become less active. Particularly alkaline soils also lock up vital mineral nutrients needed for plant growth. When the pH is 8 or higher (i.e. moderately or strongly alkaline), iron and zinc become less available to plants.

[7] High levels of sodium may be detected by conducting a pH test of the soil. A pH of 7.5 or above may suggest that the soil has become overloaded with sodium.

Greenhouse People's Environmental Centre recommends the application of gypsum (calcium sulfate) to the soil. [8]

Fortunately, dilution of greywater by rainfall or fresh water irrigation helps flush the soil of sodium, excess salts, and other soil contaminants that might be building up. In places such as Arizona, there are two rainfall seasons that, despite the arid conditions, allow for leaching of these substances from the soil. The application of thick compost mulches is recommended by some sources to help speed up the natural decomposition of waste residues, although this will have little effect on inorganic salts.

Effects on Human Health

[This section includes excerpts from the following source: Center for the Study of the Built Environment (CSBE). "Graywater Reuse in Other Countries and its Applicability to Jordan." Funded by the Ministry of Planning, Kingdom of Jordan. 2003.]

The main potential effects of greywater water reuse applications on human health are:

- Risk of exposure to potential pathogens
- Safety hazard to children (storage tanks)

The main public health risks associated with the reuse of greywater are associated with direct physical contact with the greywater, inhalation of aerosols, or ingestion of food that may come into contact with the greywater. Some greywater may contain concentrations of human excretions that can be a mode of transmission of infectious disease. Infection theoretically could occur after contact with the eyes and nostrils, splash upon soft or open tissue, inhalation of mist from spray irrigation, or ingestion through crops contaminated by spray or surface irrigation..

The health risks associated with disease transmission through greywater applications within a single household are likely less than for applications within a community. Within a household, there are a number of ways in which disease-causing pathogens may be spread, and members of a household who are sick are likely spread communicable diseases in more direct ways. There is likely increased risk of transmission to those outside the family household where greywater produced within that household is distributed outsdie the home. There are two ways to minimize this risk – one is by extensively treating the greywater to remove pathogens and generate a reuse water quality satisfactory for unrestricted access non-potable applications. The second way of minimizing risk is simply to eliminate or minimize the potential for the greywater coming into direct contact with individuals. For this reason, most sources recommend a greywater collection, and distribution system, and reuse applications that are unlikely to come into direct contact with individuals and do not require regular user intervention. The simpler systems are more reliable and require less user intervention. Also, irrigation by sprinkler is prohibited, to avoid the danger of airborne greywater coming into contact with people, or contaminated aerosols being inhaled. Most jurisdictions prohibit surface irrigation, although

[8] A rate of 100g per square meter each month is suggested, until the pH of the soil drops to 7. (http://www.awgypsum.com/gypsum.htm).

some do allow it provided the quantity of greywater being applied are controlled, and soil saturation does not occur. Irrigation of lawns and other areas where children or animals may play, other than subsurface drip irrigation is generally prohibited. Greywater should not be used to wash down patios, walkways, or driveways or used for dust control, cooling, spray irrigation or any other use that would result in air-borne droplets or mist.

Most authorities emphasize that the introduction into the greywater of pathogens from the washing of heavily soiled laundry and diapers, or of clothes with blood or vomit should be avoided, and that where there is a particularly infectious illness in the household (e.g. diarrhea, hepatitis, measles or intestinal parasites), the greywater should be disposed of through the blackwater sewerage system and not reused.

Also, large greywater storage containers may pose a safety hazard to children. Therefore, storage containers must be tightly covered to prevent easy access, and to keep away mosquitoes, other insects, and small rodents.

Effects on the Environment

[This section includes excerpts from the following source: Center for the Study of the Built Environment (CSBE). "Graywater Reuse in Other Countries and its Applicability to Jordan." Funded by the Ministry of Planning, Kingdom of Jordan. 2003.]

The main effects of greywater on the environment are:

- Reduced demand on potable fresh-water sources
- Risk of groundwater and surface water pollution

The overriding positive environmental impact of greywater reuse is the reduction in demand for potable fresh water. Many sources argue against the use of high quality potable water for applications that do not require potable water – e.g. irrigation of plants. The reuse of greywater for non-potable water applications reduces the demand and cost for potable water and is a more sustainable means of water management.

One of the main environmental risks from greywater reuse is that of groundwater and surface water pollution. Depending on the soil and groundwater characteristics, it is possible that some of the contaminants found in greywater could either affect groundwater quality, or surface water bodies in the area of application. However, there are mitigating factors to consider that may reduce the potential for adverse impacts. The greywater should be applied to meet, and not exceed, agronomic evapotranspiration and nutrient requirements of the plants, avoiding excess irrigation. Under these conditions there is opportunity for contaminants in the greywater to be adsorbed or otherwise broken down and removed within the upper topsoil layer, preventing them from reaching the groundwater.

Additionally, one of the assumptions behind the reuse of greywater is that the householders must take moderate care over what is allowed to enter the greywater in the first place. If large doses of poisonous chemicals were being deposited into the greywater, then not only might

groundwater be at risk, but the plants also would be in danger. If the greywater is of a high enough quality for it to be suitable for plant irrigation, and it is properly applied, then it is very unlikely to be a serious threat to groundwater quality.

Many jurisdictions do take risks to groundwater into account when permitting the reuse of greywater. For example, in Arizona, greywater may only be used in locations where groundwater is greater than 1.5 m below the ground surface (Little 2001). In British Columbia wastewater (which includes greywater sources) cannot be discharged to ground within 30 metres (100 feet) of a potable well location.

Effects on Existing Infrastructure

[This section includes excerpts from the following source: Center for the Study of the Built Environment (CSBE). "Graywater Reuse in Other Countries and its Applicability to Jordan." Funded by the Ministry of Planning, Kingdom of Jordan. 2003.]

Potential diminished sewer flows resulting from onsite domestic greywater extraction could potentially result in insufficient sewer flows in some circumstances to carry waste to the sewer plant (e.g. pipes with low slopes), or may result in a high strength sewage that combined with lower flows may lead to odour and corrosion problems in the centralized sewerage systems.

Types, Designs & Technologies

Technical Aspects

[This section includes excerpts from the following source: Center for the Study of the Built Environment (CSBE). "Graywater Reuse in Other Countries and its Applicability to Jordan." Funded by the Ministry of Planning, Kingdom of Jordan. 2003.]

The science behind the safe reuse of domestic greywater for irrigation is not difficult. Greywater is captured from the various household sources (sinks, hand-basins, showers, etc), and taken (possibly through a simple treatment system and maybe storage) to a distribution system. In the case of reuse for toilet flushing, often a slightly more sophisticated treatment and storage is required. The components of any type of greywater system may therefore be summarized as follows:

- Greywater source (bathroom, laundry and kitchen water)
- Collection
- Treatment
- Storage
- Greywater Use

Sources of Greywater

They include wastewater that flows from baths, bathroom sinks, bathroom showers, and wash basins. Laundry water from clothes washing machines and laundry tubs is also used in many areas. As kitchen sink water is considered more polluted than bathroom and laundry water, in many areas (e.g. Arizona, California, and New Mexico) water from the kitchen sink and automatic dishwasher are prohibited from entering the greywater stream.[9]

Other potential greywater sources include swimming pool water.

Collection of Greywater

Collection of the greywater is simple in concept, but is one of the more practically difficult aspects of reusing greywater. In the simplest case, greywater can be collected simply by placing a bucket below an open sink drain, and manually transported to the point of use.

However, a piped system requires less user intervention and is more ideal from a public health perspective since it eliminates contact between greywater and user. In this case, a plumbing network simply takes the greywater, keeping it separate from the non-greywater, and directs the greywater to a point where it can be stored, treated, or reused.

The details of such systems vary from country to country, but they are generally gravity collection systems that use ordinary plumbing components. In new houses, the installation of

[9] Kitchen waste are high in suspended solids, fats, oils, and grease, and their generally high organic content encourages the growth of bacteria. Also, the high fat and solid content cause problems for filtration and pumping.

systems to separate useable greywater from non-useable ‘blackwater’ is simple and requires little extra expense. However, retrofitting separate drainage systems into an existing building may require more difficult installation work, depending on the design of the house and the plumbing system.

Considerations for the Reuse of Greywater

A number of key issues of concern need to be taken into consideration when contemplating the reuse of greywater. The system should be as simple and easy to use and maintain as possible, while minimizing risk to human health. If storage is required, the greywater must be treated to remove biodegradable contaminants, otherwise the greywater will quickly become septic and may generate noxious odours and create other aesthetic and operational problems. For example, a greywater system installed at a housing cooperative in Ottawa that involved storage but did not provide a means of biological treatment was shut down after it's first month of operation, having becoming fould smelling and turned black in colour. However, even if treatment is not required in an immediate use application, it is necessary to minimize the potential for animals and humans to come in direct contact with the greywater. If used for irrigation, the system should also minimize the risks to plants as a result of chemicals, soaps, detergents and other contaminants (such as boron, bleach, and sodium), which could adversely affect plant health.

The following are basic, preliminary guidelines for the development of greywater irrigation schemes.

- For applications with direct (immediate) greywater reuse (i.e. subsurface irrigation, or toilet flushing), and storage is not required, a segregated greywater collection system can be considered to separate the greywater from the more contaminated blackwater or dark-greywater (i.e. kitchen sinks & dishwaher) drainage sources. Discharges from toilets, urinals, and kitchen sinks are not suitable for reuse without adequate treatment. Only water from ‘cleaner’ sources, such as baths, showers, hand basins, and floor drains should be included in direct (immediate) reuse greywater systems that do not include treatment and disinfection. If storage is desirable or required, or unrestricted public access reuse applications are desired, then there is no technical rationale for separating greywater from other sources of residential or commercial wastewater to justify the additional costs of segregating wastewater collection.
- Care should be taken to prevent or minimize the release of inappropriate substances into the greywater system, particularly where treatment and disinfection is not being provided. This includes avoiding washing heavily soiled or bloodstained clothes, diapers, waste materials, etc. in sinks that drain to the greywater system. Chemicals including bleach, cleaning agents, paints, etc. should not be disposed of into the greywater system, or any substance that may block the system or detrimentally affect plants that are irrigated with the greywater. Avoid soaps and detergents with high sodium content. If laundry wash-water is to be reused for irrigation, some degree of treatment or routine application of potable water may be required. The modest use of bleach in laundry applications may not necessarily be detrimental to biological treatment systems, but should be avoided where possible, and certainly minimized
- A greywater system must be carefully designed including determining how much greywater is produced daily, what the application demand characteristics are, whether storage is

required, and how it is to be distributed. The greywater demand should be estimated to ensure that the demand and supply are reasonably well matched.

Treatment of Greywater

[This section includes excerpts from the following source: Center for the Study of the Built Environment (CSBE). "Graywater Reuse in Other Countries and its Applicability to Jordan." Funded by the Ministry of Planning, Kingdom of Jordan. 2003.]

There are four reasons why greywater may need to be treated:

1. To remove substances which may be harmful to plants;
2. To remove substances which may be harmful to human health;
3. To remove substances which may be harmful to the wider environment;
4. To remove substances which may clog the greywater system.

A number of methods of treating greywater are available although the type of treatment required is largely determined by the following variables:

- quality of the incoming greywater;
- end use, and
- degree of care and intervention desired by the user.

No Treatment Necessary

Often, the best solution is to design, install, and maintain a system so that the greywater needs no treatment at all. The reason why greywater is being considered in the first place is due to its relatively clean nature. Many of the substances contained in greywater are not harmful to plants, and some serve as nutrients for [plant growth. Contaminants may also be treated within the layer of soil in the vicinity of the application. If human contact between the greywater and humans can be minimized (by eliminating the need for user intervention in the system, and by reducing the possibility of contact at the irrigation stage), then the risk to human health is very small.

Treatment by Filtration

A simple first level of treatment - a filter - may however be advisable in some cases to prevent solid material (hair, lint, food particles) from entering the greywater system.

A number of sources (such as Ludwig 1994 -2000) propose the use of a natural mulch basin filled with stones and organic mulch (leaves, tree bark, etc) to filter and treat the greywater. Rather than containing inert material such as sand, a mulch basin of this type provides a medium for the natural digestion of organic substances, and removes solid material from the greywater.

Similar to this are slow sand filters – which, bottom to top, include shallow layers of stone, medium gravel, and then pea gravel covered by a deep layer of sand. They also include multi-media filters, whose layers are filled with a variety of media in order of increasing size (from top to bottom). Slow sand filters are subject to clogging and very slow percolation rates, and require

regular cleaning and replacement of the top layer of media. Some authors therefore do not recommend their use in domestic contexts. Multi-media filters require cleaning less frequently.

Commercially available water filters also are sometimes used for greywater. These include activated charcoal, cellulose, or ceramic cartridges. However, these are generally designed for higher quality water and may require excessive maintenance if used with greywater. If the kitchen sink water were to be used, a grease trap – to remove fats and grease - may be necessary to prevent filter clogging, although this requires a degree of user intervention.

Treatment by Settlement and Floatation

A settling tank is sometimes recommended as a means of removing solids from the greywater. Substances denser than water will gradually fall out of suspension to the bottom of the tank. On the other hand, grease, oils, and other small particles will float to form a surface scum layer. The remaining liquid can then be reused. A settling tank also has the advantage of allowing hot water to cool before reuse.

Treatment by Disinfection

Disinfection can be achieved in a number of ways, but generally should only be done where biological treatment is carried out first. One of the most common methods of disinfection is to add chlorine, often (in the case of onsite systems) through the use of chlorine tablets. Ultraviolet (UV) disinfection may also be considered, but its effectiveness is highly dependent on the water quality and the transmission of light through the water, and is adversely affected by particulates and colloidal particles, biological treatment and filtration is often a prerequisite to UV disinfection. Ozonation is another means of disinfection that can be considered, involving the onsite generation of ozone gas, and diffusion of that gas into the liquid. Unless there is risk of human contact with the greywater there is no particular need to disinfect the greywater before use. Pathogens present in the greywater are typically removed through a relatively short distance of unsaturated soil.

Other types of systems of varied complexity have been noted in Table 3, but the evidence consistently points to simpler systems being more reliable, with most complex systems being abandoned due to high maintenance costs, and disinterest by the householder due to the amount of intervention required. The suitability of the type of system is largely determined by the quality of the incoming greywater, its end use, the need for storage, and the degree of care and intervention desired by the user. The minimal treatment system is perhaps best suited to a user who will take an active interest in controlling what goes into the greywater, and who takes a fairly active role in caring and tending for their own plants. The cleaner the greywater to begin with, the less treatment required. A more complex, catch-all system is more suited to an establishment where less attention is paid to what goes into the greywater, and how it is used. However, this relatively complex system requires more maintenance, and is more expensive.

Table 3: Summary of Greywater Technologies
Source: Capital Regional District - Greywater Reuse Study Report (2004)

Technology	Description	Pros	Cons
Diversion Valves	Probably the simplest and most common method of greywater reuse. Diversion devices direct untreated greywater typically from laundry or bathroom sinks to a subsurface garden irrigation system. Sub-surface drip irrigation systems minimize human contact with the greywater and, therefore, are one of the more common irrigation distribution methods for greywater. Rather than relying on gravity feed systems, some greywater diversion schemes drain greywater to a tank fitted with an effluent pump, which pumps the greywater to a subsurface irrigation field..	• Simple manual (hand adjust or preset) operation • Very low maintenance requirements (period manual screen cleaning). • Ability to divert greywater for immediate reuse as required or desired. • Very low capital and operating cost	• No or limited (screening) treatment provided. • Cannot store without risk of odour and other problems. • Does not kill or reduce the number of disease-causing microorganisms (pathogens) that may be present. • Reuse application typically limited to immediate sub-surface irrigation only.
Sand Filters	Sand filters usually consist of beds of sand or in some cases coarse bark or mulch, which trap and adsorb contaminants as the wastewater flows through it. "Sand filters', depending on the design, can have two treatment functions which are not necessarily inclusive: 1) physical filtration (separation) of particulate matter; and 2) biofiltration (i.e. intermittent or recirculating sand filters) which involves phsycial particlate separation, and the adsorption and biodegredation of soluble and particulate organic contaminants from the greywater. Greywater should pass through a settling tank and possibly a grease trap or screen prior to treatment through a sand filter to reduce loading to the filter and avoid clogging. Properly designed, sand filtration systems have the ability to treat greywater to a high standard, with low maintenance and cost.	• Simple operation. • Low maintenance. • Some biological treatment provided facilitating limited duration storage and application options than valve diversion alone. • Low operating cost	• Sand filters typically do not inherently provide biological treatment. Biological treatment requires either appropriately low application rates and/or recirculation. • No ability to adapt to varying greywater characteristics and must be properly designed and sized. to treat the maximum loading rate possible • Moderate capital cost. • Requires approximately one square foot of land area per gallon/day application • Reduces the number of disease-causing microorganisms (pathogens) that may be present, but does not eliminate them (i.e. does not disinfect). • High land area requirements for biological treatment in comparison to alternative mechanical-based biological treatment systems. • Subject to clogging and flooding if overloaded.

Technology	Description	Pros	Cons
Aerobic Biological Treatment Systems	Aeration of greywater characteristically results in a typically higher effluent quality than achievable with single-pass or slow sand filtration. The greywater may be discharged into a tank in which air is bubbled to transfer oxygen from the air into the liquid. Bacteria in the greywater consume the oxygen and digest the organic contaminants, reducing the concentration of these contaminants and, in turn, also producing more bacteria. The air bubbled into the tank also provides mixing energy to keep the bacteria from settling.These systems typically are followed by a clarification stage to remove the suspended bacteria, and may be preceded by a septic tank to settle solids and remove oils & grease. Depending on the reuse application, the treated effluent may also be disinfected prior to use or storage to kill bacteria, viruses and other disease causing microorganisms. Common disinfection methods include chlorine, ultraviolet light, and ozone.	• Potential for high degree of biological treatment.• Less land area required for treatment than biological sand filter systems.• High degree of operations flexibility to accommodate varying greywater strengths and flows.• Suitable for treating mixed wastewater for reuse applications if effluent is filtered and disinfected - which also allows the reuse water to be stored.	• Complex operational requirements. • High operating cost. • High capital cost. • Can be subject to process upsets due to high greywater flows or chemicals present, resulting in poor effluent quality or discharge of large quantities of solids (sludge) that may block downstream irrigation pipe or create problems for reuse applications (e.g. sludge or sediment buildup in toilet tanks, reduced disinfection effectiveness etc.) • Greater amount of operation and maintenance required than for other equivalent treatment systems.
Electro-coagulation	Electro-coagulation involves adding coagulating metal ions to the greywater using electrodes. These ions coagulate the contaminants in the water, similar to coagulating chemicals such as alum and ferric chloride, enabling them to be more easily removed by settling or floating (fine bubbles – dissolved air flotation (DAF)).	• Non-biological treatment therefore is not necessarily adversely affected by chemicals that would otherwise upset a biological process. • Typically less land area required in comparison to biological treatment.•	• Complex operational requirements. • Inefficient means or removing biodegradable organic contaminants. • High operating cost for power and replacement of electrodes. • High capital cost. • DAF may not operate efficiently. • Chemicals often required, resulting in high operations and maintenance requirements. • Typically, greater amount of operation and maintenance required than for other equivalent biological treatment systems. • May not remove organic contaminants adequately to permit significant storage, which in turn would restrict reuse applications.

Technology	Description	Pros	Cons
Disinfection - Chlorine	The most common and simplest method of disinfection is chlorination, usually achieved in greywater systems using sodium hypochlorite “pucks” similar to that used in disinfecting swimming pool water.	• Low operator skill requirement. • Highly effective if properly designed and operated. • Low capital cost. • Typically lower operating cost for chemicals and operator O&M than ozone or U.V. technologies. • Provides a residual disinfectant to ensure reuse water remains disinfected during prolonged storage.	• Chlorine reacts with residual organic contaminants to form potential carcinogens. • Chemical handling requirements. • Need for frequent chemical supply (puck addition).
Disinfection - Ozone	Ozone is another means of chemical disinfection, typically generated onsite using a device that applies a high voltage-potential to air, and bubbling the ozonated air through the treated greywater.	• Limited operator skill level required. • No chemical storage or handling requirements (ozone generated onsite). • Eliminates colour and precipitates residual contaminants .• Typically less maintenance than U.V. systems.	• Disinfection efficiency adversely affected by variations in organic content of greywater and flows.• Ozone is toxic and off-gas must be destroyed.• Results in a precipitate that must be subsequently removed. • Higher operating cost than chlorination systems for operator attention and electricity. • Higher capital cost in comparison with chlorination or U.V. systems. • No disinfection residual. • Need good ventilation, off gas control, and ozone off-gas destruct system.
Disinfection - Ultraviolet (UV)	Disinfection using ultraviolet light is becoming increasingly popular, as no chemicals are required.	• Low operator skill level required. • No chemical storage or handling requirements • No off-gas or chemicals to handle.	• Disinfection efficiency adversely affected by variations in organic content of greywater, flow and colour (UV absorbance). • Adversely affected by particulates present in the treated water. • Higher operating cost than chlorination systems (electricity & cleaning maintenance). • Higher capital cost in comparison with chlorination systems. • No disinfection residual. • U.V. lamp tubes are subject to biological growth and chemical coating phenomena that interfere with U.V. transmission and disinfection, requiring the lamp tubes to be regularly cleaned to ensure effective performance.

Storage of Greywater

[This section includes excerpts from the following source: Center for the Study of the Built Environment (CSBE). "Graywater Reuse in Other Countries and its Applicability to Jordan." Funded by the Ministry of Planning, Kingdom of Jordan. 2003.]

If intended for applications other than subsurface irrigation (e.g. toilet flushing), greywater should not be stored unless biologically treated and disinfected. Left untreated, stored greywater can quickly become septic and develop a population of anaerobic bacteria that will proliferate and create noxious odours. Odours generated by storage prior to subsurface irrigation (i.e. within a septic tank) should be properly managed and ventilated in such a way as to not become a nuisance or result in accelerated corrosion of concrete structures (e.g. concrete septic tank, pipe, or distribution boxes),

Direct reuse without storage is favored as it minimizes the problems of microorganism growth and odor. However, even if storage is not required, each greywater system should be capable of handling sudden foreseeable inputs of greywater (for example from a bath being let out, or a washing machine rinse cycle) without overloading or saturating the soil. In these cases, many authors recommend a surge tank – a small facility to allow the flow to surge, while releasing it gradually to the soil.

Even if no storage is provided, an odor problem may also arise if greywater is allowed to pool in parts of the pipe bends, tanks or other parts of the network. If a greywater system becomes unused for a period of time (for example the householders go on holiday) then there is risk that pools of greywater in the system will begin to digest anaerobically and cause unpleasant odors. Most sources recommend that all pipes be at a gradient, and that all tank bases, etc be angled, with provision for drainage, so that the entire system can be emptied of water, if necessary.

Use of Greywater

[This section includes excerpts from the following source: Center for the Study of the Built Environment (CSBE). "Graywater Reuse in Other Countries and its Applicability to Jordan." Funded by the Ministry of Planning, Kingdom of Jordan. 2003.]

Irrigation

Greywater is suitable to irrigate plants, trees, and shrubs, and should be carried out (ideally) by gravity distribution to avoid the need for pumping. Drip irrigation hoses should have holes with a diameter of at least 3 mm to reduce the potential for clogging from solids present in the greywater or from algae growing in the hose.

Greywater can be used for subsurface irrigation of ornamental plants, fruit trees, and lawns, and is best suited for use with mature plants (not saplings), which have

considerable tolerance to salinity, sodium compounds, and high pH levels. It should not be used to irrigate vegetables or fruit bearing plants if the edible portion may come in contact with the greywater.

As noted earlier, many of the potential risks to human health and other possible unfavourable side effects of greywater reuse (for example odors, encouraging breeding of mosquitoes, etc) are reduced or eliminated by eliminating storage.

It is important that the greywater be applied no faster than the soil can absorb it, to avoid saturation and pooling of the greywater. Usually, plants are healthier when the soil is allowed to dry out between irrigations. Therefore, for best results, one should wait until the soil in the root zone is half dried out before re-irrigating.

One important potential issue in using greywater for irrigation is the danger of clogging the irrigation network from particles in the greywater. This can be eliminated by either removing solid particles from the water (by filtering or settlement) and by increasing the diameter of the holes in the irrigation pipe. It is recommended that drip irrigation hoses (with small outlets) are not used for greywater irrigation unless the solid particulates have been removed. Some sources have reported a build up of algal growth in the irrigation pipe work – the natural result of the presence of nutrients in the greywater. This does not pose a risk to either plants or humans, but should be taken into account in the design of the system. Algae may be removed by periodic chlorination of the greywater, although care should be taken in such circumstances to avoid harm to the plants.

Toilet Flushing

Greywater can be used for toilet flushing to offset potable water demands. Issues concerning greywater use for toilet flushing include fixture staining, water discolouration, water quality, safety hazard for children and pets and odour. It is recommended that greywater be treated to prevent odours, flush toilet fixture discoloration, and to address any health realted concerns (i.e. splash back onto sensitive tissues).

Overview of Greywater Recycling Standards and Building Rating Systems

Greywater Recycling in Green Building Rating Systems

Summaries of international green building rating systems where greywater is an acceptable water conservation strategy are described in the following pages.

RATING SYSTEM	JURISDICTION	CREDIT REQUIREMENTS	STRATEGIES	WEBSITE
The Building Research Environmental Assessment Method (BREEAM)	U.K.	Wat 1: Internal Water Use	Focuses on water saving fixtures, but allows consideration for stormwater/**greywater**	http://www.breeam.org/pdf/EcoHomes2005DevSheetsV1.pdf
		Wat 2: External Water Use	Focuses on rainwater collection but allows consideration for **greywater**	
Leadership in Energy and Environmental Design (LEED)	Canada, US	WE Credit 1.1: Water Efficient Landscaping: Reduce potable water consumption for irrigation by 50%	Perform a soil/climate analysis to determine appropriate landscape types…Use high-efficiency irrigation systems and consider using stormwater and/or **greywater** for irrigation	http://www.cagbc.org/uploads/FINAL_LEED%20CANADA-NC%201.0_Green%20Building%20Rating%20System.pdf
		WE Credit 1.2: Water Efficient Landscaping: No Potable Water Use or No Irrigation	Perform a soil/climate analysis to determine appropriate landscape types and design the landscape with indigenous plants to reduce or eliminate irrigation requirements. Consider using stormwater, **greywater** for irrigation.	

RATING SYSTEM	JURISDICTION	CREDIT REQUIREMENTS	STRATEGIES	WEBSITE
		WE Credit 2: Innovative Wastewater Technologies	OPTION 1 Reduce potable water use for building sewage conveyance by 50% through the use of water conserving fixtures (water closets, urinals) or non-potable water (captured rainwater, recycled greywater, and on-site or municipally treated wastewater). OR OPTION 2 Treat 50% of wastewater on-site to tertiary standards. Treated water must be infiltrated or used on-site. Consider reusing stormwater or greywater for sewage conveyance or on-site wastewater treatment systems (mechanical and/or natural). Options for on-site wastewater treatment include packaged biological nutrient removal systems, constructed wetlands, and high-efficiency filtration systems	

RATING SYSTEM	JURISDICTION	CREDIT REQUIREMENTS	STRATEGIES	WEBSITE
		WE Credit 3.1: Water Use Reduction: 20% Reduction	Use high-efficiency fixtures, dry fixtures such as composting toilet systems and non-water using urinals, and occupant sensors to reduce the potable water demand. Consider reuse of stormwater and **greywater** for non-potable applications such as toilet and urinal flushing and custodial uses.	
		WE Credit 3.2: Water Use Reduction: 30% Reduction	Use high-efficiency fixtures, dry fixtures such as composting toilet systems and non-water using urinals, and occupant sensors to reduce the potable water demand. Consider reuse of stormwater and **greywater** for non-potable applications such as toilet and urinal flushing and custodial uses.	
Green Star	Australia	Potable Water Reduction Credits awarded for reducing water consumption. Greywater reuse is not necessary but is listed as an option. GreenStar design guide includes a greywater calculator to determine points awarded.	Use of greywater for toilet/urinal flushing	http://www.gbcaus.org/
The Comprehensive Assessment System of Building Environmental Efficiency (CASBEE)	Japan	Resources & Materials Credits awarded for Greywater Reuse System	strategies not specified	http://www.ibec.or.jp/CASBEE/english/method2E.htm

RATING SYSTEM	JURISDICTION	CREDIT REQUIREMENTS	STRATEGIES	WEBSITE
Built Green	US Canada: Currently the program is only available in British Columbia and Alberta	Credits awarded for reducing potable water consumption	(no specific mention of greywater)	http://www.chbabc.org/content.php?id=505
NAHB Model Green Home Building Guidelines	US	Innovation credit for separating and re-use greywater	As permitted by local code	http://www.nahb.org/publication_details.aspx?publicationID=1994&sectionID=155
Residential Environmental Assessment Program (REAP)	University of British Columbia	REAP is based on the LEED™ rating system with a number of credits made mandatory	Similar to LEED.	http://www.planning.ubc.ca/corebus/reap.html

Policies & Regulations

Other Jurisdictions

[This section includes excerpts from the following sources:

Capital Regional District. "Greywater Reuse Study Report." November 1, 2004. http://www.crd.bc.ca/reports/water_/2004_/crdgreywaterreusestu/CRDGreywaterReuseStudyFinalReport.pdf

Center for the Study of the Built Environment (CSBE). "Graywater Reuse in Other Countries and its Applicability to Jordan." Funded by the Ministry of Planning, Kingdom of Jordan. 2003. http://www.csbe.org/graywater/report/report_final.pdf

Oasis Design. "Greywater Policy Packet." 2005. http://www.oasisdesign.net/downloads/GWPolicyPacket.pdf]

Washington

Washington State issues permits and guidelines for the use of greywater for subsurface irrigation (drain-field or drip irrigation) of ornamental plants, provided certain design requirements are fulfilled (Washington State, Department of Health, Wastewater Management Section, http://www.doh.wa.gov/ehp/ts/waste.htm. (2)

Oregon

HB3320- 1995- Requires Department of Environmental Quality to establish guidelines for use of greywater and to seek approval of United States Environmental Protection Agency for guidelines.

A visitor from Corvalis, Oregon shared the following perspective:
Current law allows such minimal and restricted greywater use that changes should be made legislatively. Past attempts have failed, but have been only loosely organized.

California

Greywater use was legalized in California in 1992, and the California Department of Water Resources (CDWR) adopted standards for the installation of greywater systems and greywater reuse applications. CDWR defines greywater as untreated single-family residential wastewater from all sources, excluding toilets, kitchen sinks, and dishwashers, and the application is limited to subsurface drip and mini-leachfield irrigation systems. (1)

Unlike Arizona, which defines subsurface irrigation as below two feet, CDWR's minimal soil depths for subsurface irrigation range from eight inches for sandy soils to twelve inches for clay soils. Irrigation above this soil depth is considered to be a surface application, and stricter rules apply. The CDWR approved subsurface drip irrigation systems must include a surge tank (50 to 100 gallons), and filtration, before the effluent can be pumped through to the drip irrigation system. A surge tank isn't required for a

mini-leachfield irrigation system. California does not require the greywater sampling, monitoring and treatment required by Arizona, and municipalities can adopt the State regulations as a base, or ban greywater applications altogether.
http://ag.arizona.edu/AZWATER/arroyo/071rain.html

Although the California Greywater Code – CAC (Title 24, Part 5, Appendix J, Graywater Systems for Single Family Dwellings) was regarded as groundbreaking in its time, it takes a very different approach from that of Arizona and is regarded as only partially successful. This code prescribes greywater system designs, and has been criticized for not allowing flexibility and innovation on the part of the user. The code defines greywater as untreated wastewater that has not come into contact with toilet waste. This includes wastewater from bathtubs, showers, bathroom wash basins, clothes washing machines, and laundry tubs, or an equivalent discharge as approved by the local authority. The code does not allow wastewater from kitchen sinks, photo lab sinks, dishwashers, or laundry water from soiled diapers to be considered as greywater. (2)

The CAC mandates that all greywater systems must discharge into subsurface irrigation fields, and sets procedures for estimating greywater discharge volumes and for determining the irrigation capacity of the soil. The code requires soil percolation tests and/or soil analyses as the basis for determining the required area of 'disposal'. This code also sets standards for greywater subsurface drip irrigation systems. The householder therefore must provide significant information to the local authorities before a permit is issued. This acts as a disincentive to greywater reuse and contrasts unfavorably with Arizona's blanket permit.

To reduce possible health risks that can result from the reuse of greywater, residents in California are prohibited from applying greywater above the land surface or discharging it directly into storm sewers or any body of water. In addition, humans must not contact greywater, except as required to maintain the greywater treatment and distribution system, and greywater must not be used for irrigating vegetable gardens. (2)

A detailed analysis of the code and a number of suggested improvements are outlined in the 'Builder's Greywater Guide' (Ludwig 1995-1999), and on the Oasis Design web site (www.oasisdesign.net). (2)

Arizona

In Arizona "Greywater reuse" refers to the capturing water from sink sinks, showers and washing machines for reuse in landscape irrigation and sometimes toilet flushing. The Arizona Department of Environmental Quality (ADEQ) regulates domestic greywater systems and, in some instances, specific counties are involved. In 2001, the ADEQ published regulations for residential greywater reuse. Regulations permit single and multi-family residences to use greywater for surface irrigation under certain conditions, including ADEQ approval of the design and construction of the system. The system must

include a settling or holding tank to settle out the grit and heavier material from the greywater, and a filtration device is also required. If the greywater is to be applied to the surface, disinfection is also required. Greywater used for surface irrigation must meet allowable water quality and monitoring specifications. Allowable limits are set for fecal coliform and chlorine residuals (3)

Arizona takes a three-tiered approach to scrutinizing greywater systems (3):

1. Systems for less than 400 gallons per day that meet a list of reasonable requirements are all covered under a general permit without the builder having to apply for anything.

   With this one stroke, Arizona has raised their compliance rate from near zero to perhaps 50%.And, homeowners are more likely to work towards compliance for the informal systems that still fall short. What's more, the door is now open for professionals to install simple systems.

2. Second tier systems process over 400 gallons a day, or don't meet the list of requirements, as well as commercial, multi-family, and institutional systems.

   They require a standard permit.

3. Third tier systems are over 3000 gallons a day. Regulators consider each of them on an individual basis.

   In Arizona, regulators apply oversight to greywater systems in rational proportion to their possible impacts. (3)

It does not prescribe design specifics. Instead, regulators require that systems meet performance goals. They don't care how the system is built. They just want it to function well. This is the preferred approach. It creates a favorable climate for innovation. Technical progress is not likely to quickly outdate the law. (3)

They have a short, simply worded law and a longer explanatory booklet. The booklet can be more easily updated than the law.

The Doney Park Timberline Fernwood Area Plan is an example of the changes that have occurred since 2002. That plan states, “The reuse of treated wastewater/greywater shall be encouraged wherever possible for both residential and commercial irrigation and for commercial/industrial purposes”. Under the plan, to use greywater for outdoor landscape watering, homeowners obtain a permit from the county Health Department, and in new homes additional piping can be added to use greywater to flush toilets.

About 90 percent of people calling the ADEQ about greywater use are reported to be interested in draining their washing machine directly onto backyard vegetation – which is defined as greywater surface irrigation. The ADEQ rules require the washing machine

discharge to first drain into a holding tank and be filtered before it can be discharged through the irrigation system. Daily fecal coliform sampling is required to be done by a state certified laboratory, at a cost of about $100 per sample. This cost is reported to have the effect of deterring people from further considering using washing machine water for irrigation – at least legally.[10]

The ADEQ regulations are widely regarded as the most progressive anywhere. The tiered approach makes reuse easy for the ordinary householder and allows for innovation and flexibility of design. They do not prescribe particular design specifics and follow a performance-based approach. The blanket prohibitions ensure the protection of human and plant health. A booklet containing the text of Arizona's Title 18 Reuse Rules, and some explanatory notes and guidelines are available for download from www.watercasa.org. (2)

New Mexico

New Mexico's greywater law was originally part of their septic system law. They recently passed (signed March 11th 2003) a greywater bill "HB114 Facilitating Greywater Use in New Mexico Landscapes" that is similar in approach to that of Arizona. Bill HB114 allows householders to install legal greywater systems without applying for a special permit. It is permissible to install a greywater system under one blanket permit for the whole state, provided the system meets a short list of reasonable requirements (similar to Arizona). (2) (3)

HB114 simplifies state code so that greywater can be used safely in the landscape. Currently state code does not differentiate between black and greywater. This makes greywater re-use prohibitively expensive. HB114 does not undermine any local ordinances, because it allows for towns, cities, and counties to be more restrictive when it comes to greywater reuse.

What does HB114 require?
In New Mexico greywater is defined as "untreated household wastewater that has not come in contact with toilet waste and includes wastewater from bathtubs, showers, washbasins, clothes washing machines and laundry tubs, but does not include wastewater from kitchen sinks or dishwashers or laundry water from the washing of material soiled with human excreta, such as diapers." Regulation HB114 allows up to 250 gallons per day of residential greywater to be used for household gardening, composting or landscaping irrigation without a permit if the following conditions are met (1):

[10] http://ag.arizona.edu/azwater/arroyo/071rain.html

1. The greywater distribution system must be constructed so that overflow from the system drains into the sanitary sewer or septic system. In some cases, a liquid waste permit may be necessary if an on site septic system is modified.
2. A greywater storage tank must be covered to restrict access and to eliminate habitat for mosquitoes or other vectors. Standing water left in place for more than seven days has the potential to allow mosquitoes to breed and hatch.
3. The greywater system must not be located in a floodway.
4. Greywater is discharged only in areas where there is vertical separation of at least five feet between the point of discharge and the ground water table to protect ground water resources from possible contamination. Current Liquid
5. Waste Disposal Regulations require that greywater is not applied within 100 feet of a domestic well or within 200 feet of a public water supply.
6. Greywater pressure piping is clearly identified as carrying non-potable water.
7. Greywater is used on the site where it is generated and may not run off the property.
8. Greywater is applied in a manner that minimizes the potential for contact with people or domestic pets. Greywater application methods that reduce contact include drip irrigation, shallow piping systems, or mulch trenches.
9. Ponding of greywater is prohibited and application of greywater must be managed to minimize standing water and to prevent saturation of the soil.
10. Greywater must not be sprayed. Low-pressure drip irrigation or bubblers located under mulch help to prevent misting and exposure to greywater.
11. Greywater must not be discharged to a watercourse. Current Liquid Waste Disposal Regulations require that discharges of greywater be at least 100 feet from streams or lakes or 25 feet (plus the depth of the arroyo) from an arroyo. Greywater use shall comply with all applicable municipal or county ordinances and local building codes. [11]

HB114 includes best management practices developed to protect public health and water quality. Arizona and Texas already have greywater regulations similar to HB114. Many of the rules in Arizona are based on an extensive study conducted in Tuscon and can be found at http://ag.arizona.edu/AZWATER.

Australia

[This section includes excerpts from: Capital Regional District. "Greywater Reuse Study Report." November 1, 2004]

Australia appears to be at the forefront to implement greywater reuse as one of the key methods of residential water conservation.

In June 2004, Queensland State Cabinet endorsed the use of recycled water from showers and washing machines for use in garden irrigation following "extensive tests to ensure the untreated greywater will not pose a health hazard" (ABC News Online: Friday, June 4, 2004. 7:35pm (AEST)). Queensland also commissioned a study to determine if existing funding arrangements in use in Queensland are hindering the

[11] http://www.nmenv.state.nm.us/OOTS/GRAY%20WATER%20IRRIGATION%20GUIDE1.pdf)
http://www.legis.state.nm.us/Sessions/03%20Regular/FinalVersions/house/HB0114.htm

advancement of water recycling (PriceWaterhouseCoopers, 2000). The study notes that local governments implement a large portion of the water recycling schemes, many of which are funded up to 50% by the State government, and recommends effluent charges at the discharge end of the water cycle as means of encouraging water recycling.

New South Wales (NSW) in Australia has initiated an ambitious Building Sustainability Index project called "BASIX", which is a web-based planning tool that assesses residential development proposals for a range of sustainability indices including landscape, stormwater, water, thermal comfort and energy. Building applicants are responsible for completing a BASIX assessment for each residential development proposal as part of the development approval process. The applicant enters information about a proposed development, such as site location, dwelling size, floor area, landscaped area and services, and the development is scored according to its potential to consume less water or energy than average existing dwellings.[12]

The first stage of BASIX compares the proposed residential development with average existing homes with respect to reducing water and energy consumption. Effective July 1, 2004, all new single and dual occupancy dwellings are required to complete a BASIX assessment as part of the building application process. In 2005 the program included multi-unit residential and all renovations.[13] Residential development must be designed and built to use 40% less drinking-quality water and produce 25% less greenhouse gas emissions than average NSW homes of the same type. This is accomplished by electing to implement various water conservation measures including the use of greywater reuse technologies.

With respect to water conservation, a typical development is expected to meet the target for water conservation if it includes the following elements:

- showerheads and tap fittings with at least a "3A"[14] rating;
- dual flush toilets; and
- a rainwater tank or equivalent communal system of a minimum specified volume, or a connection to an appropriate recycled water supply for outdoor garden water use and toilet flushing and/or laundry.

This includes treated and diverted greywater use with optional applications for toilet flushing, laundry, and garden irrigation. It is estimated that greywater (bathroom tub/sink shower, and laundry sources) accounts for 40% of all water used by domestic dwellings

[12] http://203.110.153.11/information/about.jsp
[13] Same as reference above.
[14] The designation '3A' refers to a water consumption efficiency rating for a specific fixture as defined in the BASIX Calculation Manual (http://www.basix.nsw.gov.au/information/common/pdf/method_full.pdf) with the higher index number (i.e. 1A, 2A or 3A) indicating a greater water conservation efficiency. For example, a toilet
with a water consumption of 4 Litres per flush has a 3A rating, whereas one using 5.5 L/flush has a 2A rating, and one using 6.5 L/flush has a 1A rating.

and about 70% of all of the wastewater created in Australia.15 (See estimated water savings due to greywater reuse in table below).

Table 1 Potable water savings associated with various greywater reuse case studies in Australia (from Australian Water Association, April 2004)

Reference	*Location*	*End use*	*Tank description and size (kL)*	*% potable water reduction*
McAlister, 1999	Canberra, ACT	Irrigation & toilet flushing	Not stated	20%
Smith, 1999	Sydney, NSW	Irrigation & toilet flushing	Storage guttering (30 L of water/m)	27%
www.unisa.edu.au/water/prototypes/Regent_Gardens.html	Adelaide, SA	Hot water system & kitchen[1]	2 kL	30%[2]
Gardner et al., 2001	Gold Coast, Queensland	All household uses (with potable back-up)	22kL	32%
Apostolidis, 2003	Brisbane, Queensland	Laundry, toilet flushing and hot water supply	20kL	50%
Coombes, 2003(correct year?)	Newcastle, NSW	Irrigation, hot water system and toilet flushing	0.91kL	52%

[1] Ultra-violet disinfection system installed for kitchen uses
[2] Predicted value in combination with greywater

The BASIX process[16]:
An applicant for a development completes an online web-based BASIX assessment of the project and obtains a BASIX Certificate, which is then submitted with the development application. The development certificate issued by the authority includes a prescribed condition imposing the commitments listed in the BASIX Certificate, and these commitments must also be included in all construction certificate plans and specifications, and the development must be carried out in accordance with the commitments.

[15] http://www.ecologicalhomes.com.au/econewsFeb04.htm#Story#2
[16] http://www.iplan.nsw.gov.au/basix/pdf/basixdatainputchecklist.pdf
http://www.iplan.nsw.gov.au/basix/pdf/designguidelines/w01_what_water_source.pdf

BC Transferability

[This section includes excerpts from the following sources:

Capital Regional District. "Greywater Reuse Study Report." November 1, 2004.

Center for the Study of the Built Environment (CSBE). "Graywater Reuse in Other Countries and its Applicability to Jordan." Funded by the Ministry of Planning, Kingdom of Jordan. 2003.]

Technical Barriers of Greywater Recycling

British Columbia has two primary regulations that address residential wastewater issues: 1) Ministry of Health - Health Act - Sewerage System Regulation (SSR); and 2) the Ministry of Environment - Waste Management Act - Municipal Sewage Regulation (MSR). Only the MSR has provision for reclaimed water quality standards and reuse applications. The SSR has some provision for shallow sub-surface irrigation applications, but not specifically in reference to reclaimed water applications, and generally applies to conventional or alternative wastewater ground disposal systems.

Drinking Water Protection Act

The Drinking Water Protection Act and Regulation sets out requirements pertaining to potable water supply and distribution systems, but does not necessarily applu to non-potable water systems. Section 3.1 of the Regulation states "a small system is exempt from section 6 of the Act if the system does not provide water for human consumption or food preparation purposes, and is not connected to a water supply system that provides water for human consumption and food preparation purposes. A small system is defined by the Regulation to mean "a water supply system that serves up to 500 individuals during any 24 hour period".

A non-potable greywater system that is considered to be a health hazard to the potable water system may be shut down or prohibited under the Health Act. Refer to Appendix H.

Health Act – Sewerage System Regulation

The Health Act Sewerage System Regulation (B.C. Reg. 326/2004 - O.C. 701/2004), effective on May 31, 2005, addresses treatment and disposal criteria for sewage originating from single family dwellings to subdivisions, including non-single family and duplex structures with flows less than 22,700 litres per day discharging to ground. The Regulation is silent on the issue of greywater systems or water reuse, but does define "the discharge of domestic sewage or effluent onto land" as a "health hazard" unless "authorized under another enactment" {Section 3(2)}. The Regulation also defines "sewage" as being both greywater and blackwater combined. The Sewerage System Regulation (SSR) does not specifically define black water and greywater separately. (2)

The SSR does not address the practice of water reuse, or more specifically greywater reuse within a residence. However, greywater reuse systems that would affect a number of residences (e.g. Quayside Village, North Vancouver, CMHC Water conservation report17) would be of concern to the Ministry. (2) The ministry does have concerns with reuse and wants to make sure they have the information before developing regulations around water reuse. Their concerns vary depending upon the reuse intentions; subsurface disposal into good soil presents little concerns, whereas internal reuse plumbing presents many concerns, concerns with regard to protection of human contact, possible need for disinfection, internal plumbing cross-connection control, and protection of cross-connection outside the building envelope to the overall water supply system or source - as an example.

The SSR regulates wastewater discharge location and vertical distance to ground water table, or distance to well or public water supply through the Standard Practice Manual (SPM) (Table 5.4) referencing a minimum required standard from the edge of a distribution system to a source of drinking water, well, or water suction lines of 30 metres (100 ft). The minimum vertical separation from the infiltrative surface to the seasonal high water table or limiting layer (Table 5-2) is 36 inches if no treatment is provided, which is less than those specified in New Mexico's greywater bill HB114. .

SSR systems do not require Ministry of Health, or Health Authority "approval". The entire approval process is left up to the authorized person. Health authorities do not issue operating permits for single-family greywater reuse systems.

British Columbia Building Code – Non-Potable Water Systems

The Canada Mortgage and Housing report titled "Regulatory Barriers to Onsite Water Reuse" notes that while the "National Plumbing Code provides for alternative systems such as dual water distribution within sites" it also "prohibits the discharge of non-potable water through outlets such as faucets or toilets".

The BC Building Code also provides for non-potable water systems, and restricts outlets where they can discharge into "a sink or sink" (toilet).

[17] Quayside Village is a 20-unit apartment building in which greywater is reused for toilet flushing. A 40% reduction in water demand, and associated water supply costs were estimated. Treatment includes a settling tank, filtration tank, biofilter, pre-ozonation, multi-stage sand filtration, and ozonation. Capital cost of the equipment was approximately $115,000. Estimated maintenance cost is $100 per month.

Environmental Management Act – Municipal Sewage Regulation (MSR)

The only regulation in BC that does address the issue of reclaimed water, and inherently greywater reuse, is the Waste Management Act - Municipal Sewage Regulation (MSR). The MSR describe the conditions to allow reclaimed water to be used for a range of application. The conditions include a minimum effluent quality criteria, the completion of an environmental impact assessment and operations plan, treatment system component redundancy, and the posting of financial security for operations and a capital replacement fund. (1)

The following table illustrates the effluent quality requirements as they are related to reclaimed water applications for treated wastewater. Parameters of concern are pH, BOD, TSS, turbidity and fecal coliform.

Class	Reuse Application	Effluent Quality Requirements				
		Median FC (CFU/100ml)	BOD (mg/L)	TSS (mg/L)	pH (90%)	Turbidity (NTU)
Unrestricted public access	**Urban:**	≤ 2.2	<10	≤ 5	6-9	≤ 2
	Parks, playgrounds, cemeteries, golf courses, road right of ways, school grounds, residential lawns, green belts, vehicle and driveway washing, landscaping, toilet flushing, outside fire protection, street cleaning					
	Agricultural:					
	Aquaculture, food crops eaten raw, orchards and vineyards, pasture, frost protection, seed crops					
	Recreational:					
	Stream augmentation, impoundments for boating and fishing, snow making					
Restricted Public Access	• Urban/Recreational: • Landscape Impoundments • Landscape Waterfalls • Snow Making (not for skiing and snowboarding)	≤ 200	≤ 45	≤ 45	6-9	-
	Monitoring Requirements (unrestricted access)	daily (1)	weekly	daily	weekly	continuous

British Columbia Ministry of Environment, Lands and Parks. (1999). "*Regulation 129/99. Waste Management Act Municipal Sewage Regulation*."

With respect to reclaimed water use, the MSR applies only to sewage or reuse water applications for clusters of two or more dwellings, (although if the combined system is less than 22,700 liters per day it is still under the SSR filing process). The MSR includes specific requirements for environmental impact assessment, operations plans, security (100% capital replacement & operations security funds) and technology (system redundancy and chemical flocculation & filtration) and operations specifications (operator certification, sampling, monitoring & reporting) that may be onerous for small private systems and make greywater reuse impractical. Furthermore, Section 10 (7) states that "No person may provide for the use of reclaimed water unless specifically authorized (a)

in writing by the local health authority having jurisdiction, or (b) under a local service area bylaw under which the municipality or a private corporation under contract to the municipality assumes the responsibility for ensuring compliance with this regulation and that proper operation and maintenance will be carried out".

With respect individual residential (onsite) applications, and with the possible exception of a shallow subsurface irrigation application under the SSR, the current regulatory environment in British Columbia is a barrier for greywater reuse. Because individual dwellings are exempt from the MSR, they fall under the jurisdiction of the Ministry of Health through the Sewerage System Regulation, and discharges from individual residences must conform to the ground disposal requirements of the Regulation (the Regulation does not specifically address the issue of greywater or water reuse). The restrictions within the B.C. Building Code for Non-Potable Water Systems prohibit the location of an outlet for a non-potable water system where it can discharge into “a sink or sink” (toilet). (2)

What Experts Think – POLIS Project

[This section includes excerpts from: Maas, Tony. “What the Experts Think: Understanding Urban Water Demand Management in Canada.” The POLIS Project on Ecological Governance, University of Victoria. 2003.]

In BC the Municipal Sewage Regulation (1999) and associated Code of Practice for the Use of Reclaimed Water (2001) allows large-scale water reclamation projects. The regulation is applicable to projects dealing with flows greater than 22,700 liters (4,993 gallons) per day. According to Vassos (2003:PC) “this regulation is far ahead of the rest of Canada in facilitating water reuse.”

The regulation takes a ‘performance-based’ approach by prescribing outcomes (e.g. water quality criteria) rather than specific processes or techniques to achieve those outcomes. The regulatory framework includes water quality standards and detailed guidelines on appropriate end-uses for reclaimed water.

Water quality standards and allowable end-uses are founded on the basic principle of public health protection (BC MELP, 2001: 3; CCME, 2002: 9). Examples of allowable end-uses include (but are not limited to): irrigation of agricultural and recreational lands, fire fighting, toilet and urinal flushing, snow and ice making, and a variety of industrial applications (BC MELP, 2001).

In many areas, water reuse projects fall under the jurisdiction of public health authorities. This is particularly true of smaller-scale or ‘onsite’ household and institutional systems, the majority of which are still in experimental phases. For example, the BC Ministry of Health is responsible for proposed water reuse projects with flows less than 22,700 litres

per day. In most cases, onsite reuse projects are filed by authorized persons as there is no permitting process.

West Coast Environmental Law Suggestions

[*This section referenced Sewage Disposal Regulation and does not represent current regulations. Information is only for historical reference. The Sewage Disposal Regulation is superseded by the Health Act- Sewerage System Regulation.*

This following is an excerpt from the West Coast Environmental Law. "Cutting Green Tape: An Action Plan for Removing Regulatory Barriers to Green Innovations." April 2002.]

CMHC has identified that health concerns and health officials are the prime barriers to onsite water reuse. While there is not a specific prohibition on on-site water reuse, the Public Health officials' act as a de facto prohibition against widespread adoption of greywater reuse systems. While toilet flushing and subsoil irrigation are the only greywater reuses that are likely to gain acceptance in the current regulatory and health protection climate, over time treated greywater is likely to be considered for more widespread applications.

We understand the Ministry of Health and Ministry of Environment are currently considering amendments to their respective wastewater regulations. Amendments to the regulation could lead to substantial water and costs savings while still protecting public health. Instead of requiring potable water for flushing of toilets and watering of lawns, water from washing vegetables or doing the laundry, greywater could be reused. [Although some form of treatment may be required by the DWPA for toilet flushing water.]

Barriers Mitigated

- Restrictions on greywater reuse.
- Restrictions on innovative local wastewater treatment systems.

Appendix A: Greywater Collection Plumbing and Stub Outs

[This section includes excerpts and figures from: Oasis Design. "Greywater Policy Packet." 2005.]

In states that follow the Arizona greywater regulatory model, the collection plumbing may be the only part of the system, which needs inspection; however there isn't much guidance on how this should be done.

Stub outs are 'greywater collection' plumbing which dead ends at a cap. They provide for easy diversion to a future greywater system that can be installed at a later date. Stubbing out the graywater collection part of the system without the graywater distribution part of system installed has several advantages:

- Foremost, the greywater distribution system **mus**t be installed concurrently with the landscaping for best results. Often, the landscaping won't happen until months or years after the structure is completed and inspected.

- Deferring the construction of most of the system until after occupancy lowers the economic hurdle, which must be cleared to attain occupancy.

- Greywater systems are rapidly evolving. Even if no currently available greywater system meets the owners requirements, it makes sense to stub out greywater lines in anticipation that new system types will become available over the long life of the house. Lines entombed under a slab without stub outs are lost to reuse forever.

For Regulators: How to inspect greywater collection plumbing/ stub outs

The Arizona Greywater Law has only this to say about collection plumbing:

> The greywater system is constructed so that if blockage, plugging, or backup of the system occurs, greywater can be directed into the sewage collection system or onsite wastewater treatment and disposal system, as applicable.

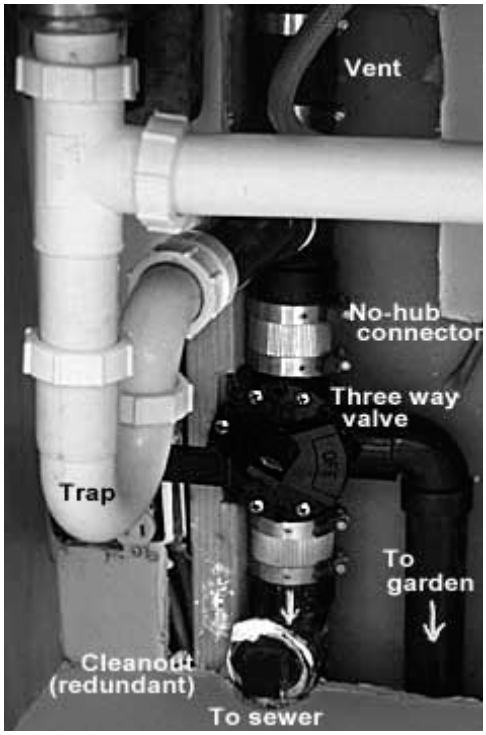
In the California Plumbing Code there is only one sentence on stub outs, reproduced here in context (it's in bold at the end):

> G-5 Inspection and Testing.
> (a) Inspection
> 1. All applicable provisions of this Appendix and of Section 103.5 of the UPC shall be complied with.
> 2. System components shall be properly identified as to manufacturer.
> 3. Surge tanks shall be installed on dry, level, well-compacted soil if in a drywell, or on a level, three inch concrete slab or equivalent, if above ground.
> 4. Surge tanks shall be anchored against overturning.
> 5. If the irrigation design is predicated on soil tests, the irrigation field shall be installed at the same location and depth as the tested area.

6. Installation shall conform with the equipment and installation methods identified in the approved plans.
7. Graywater stub-out plumbing may be allowed for future connection prior to the installation of irrigation lines and landscaping. Stub-out shall be permanently marked "GRAYWATER STUB-OUT, DANGER - UNSAFE WATER."

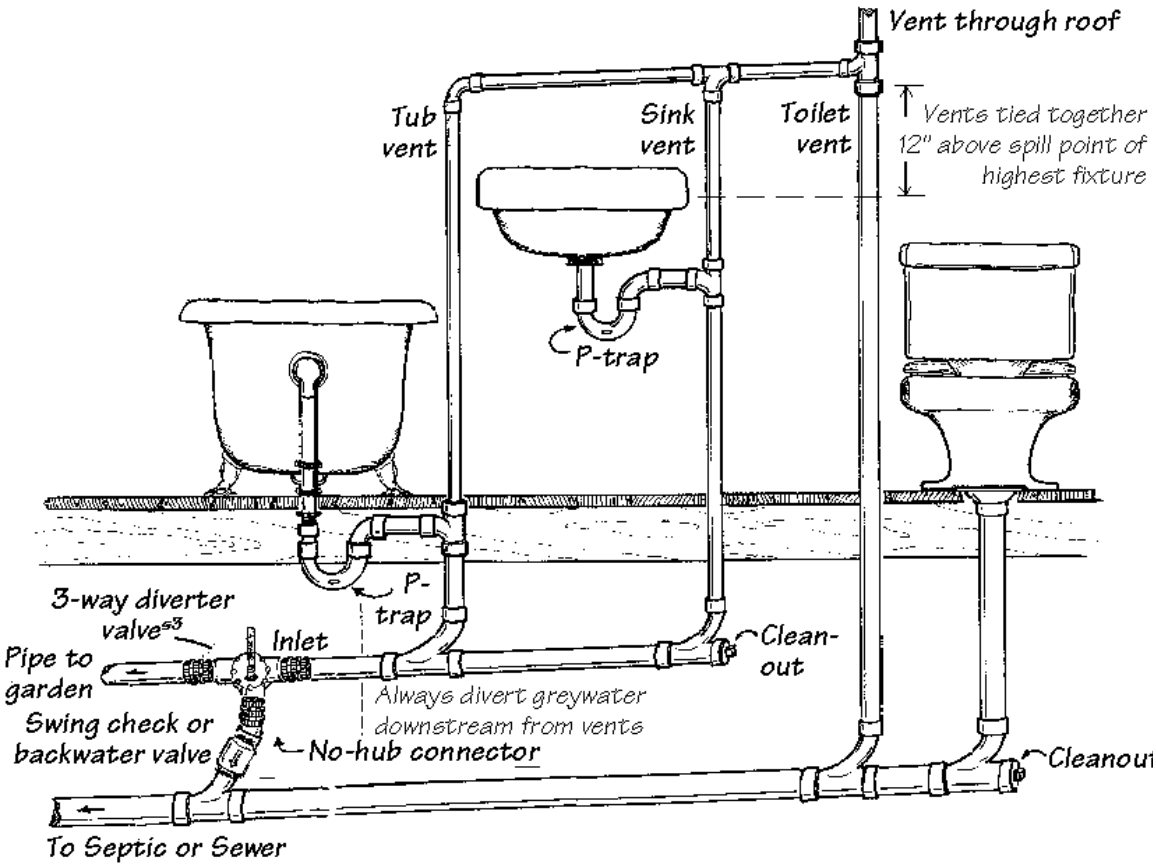
Oasis checklist for inspection of collection plumbing/stub outs:

1. Stout is permanently marked as per appendix G, section G-5 (a)-7 (above) - “GRAYWATER STUB-OUT, DANGER - UNSAFE WATER"
2. Pipes slope 1/4" per foot minimum in all flow directions entering and leaving the diversion (the only way to do this with currently available 3 way valves is to tweak the pipes in the hubs, which do not provide for slope).
3. Cleanouts are present every 270° of aggregate bend.
4. Diversion is downstream from vents and traps, so they will perform their function in either graywater or septic/sewer modes.
5. In the case of a stub out, valve is in sewer position and stub out pipe to future graywater distribution system is securely capped.



Other considerations

1. Three way valves, which have a removable cover plate, can function as cleanouts in all three directions.
2. "Jandy" three way valves, the most common type, can work equally well in all orientations, however check that the builder has positioned the movable "inlet" designation on the valve cover to the port which is receiving the inlet water.
3. Confirm that no toilet is connected upstream of the greywater diversion (downstream is OK, upstream connection through vent pipe is best connected 12" above spill point of highest fixture).
4. Check valve could be added with stub out or (more commonly) later with greywater system. *Note: check valves are not required for any other type of waste plumbing, are a source of clogging, and they form an effective trap to prevent plumbing snakes from being retracted. In practice, the check valve requirement is widely ignored by inspectors of full graywater systems for these reasons, and is rarely if ever called for during inspection of stub outs.*
5. One main diversion valve -or- multiple diversion valves to multiple outlets are both valid approaches. If your system includes kitchen sink water, this should be separately divertible.


Vent through roof
Tub vent
Sink vent
Toilet vent
Vents tied together 12" above spill point of highest fixture
P-trap
P-trap
3-way diverter valve
Inlet
Pipe to garden
Swing check or backwater valve
No-hub connector
Always divert greywater downstream from vents
Clean-out
Cleanout
To Septic or Sewer

Examples of Dual Waste Collection Plumbing for New Slab

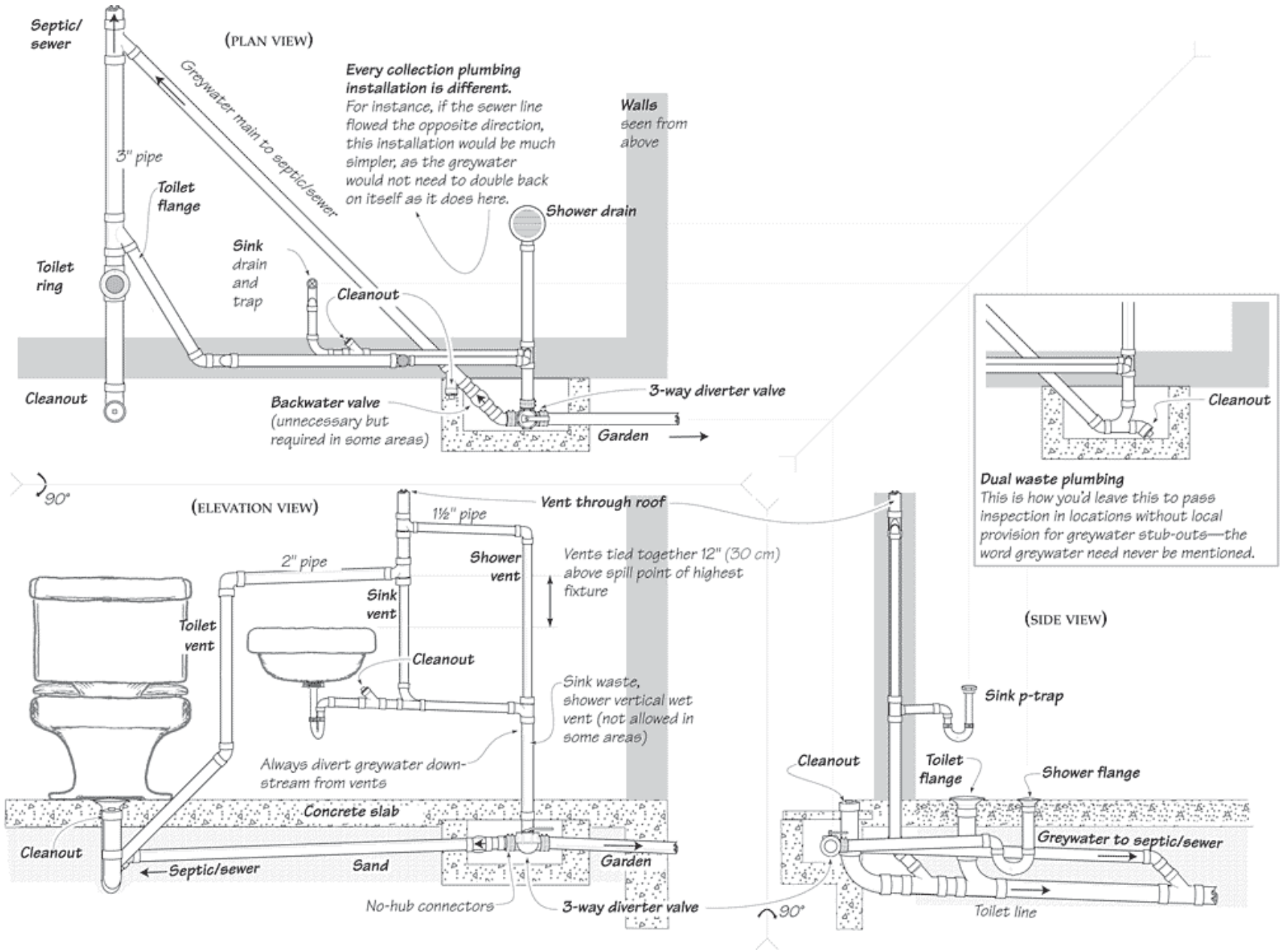
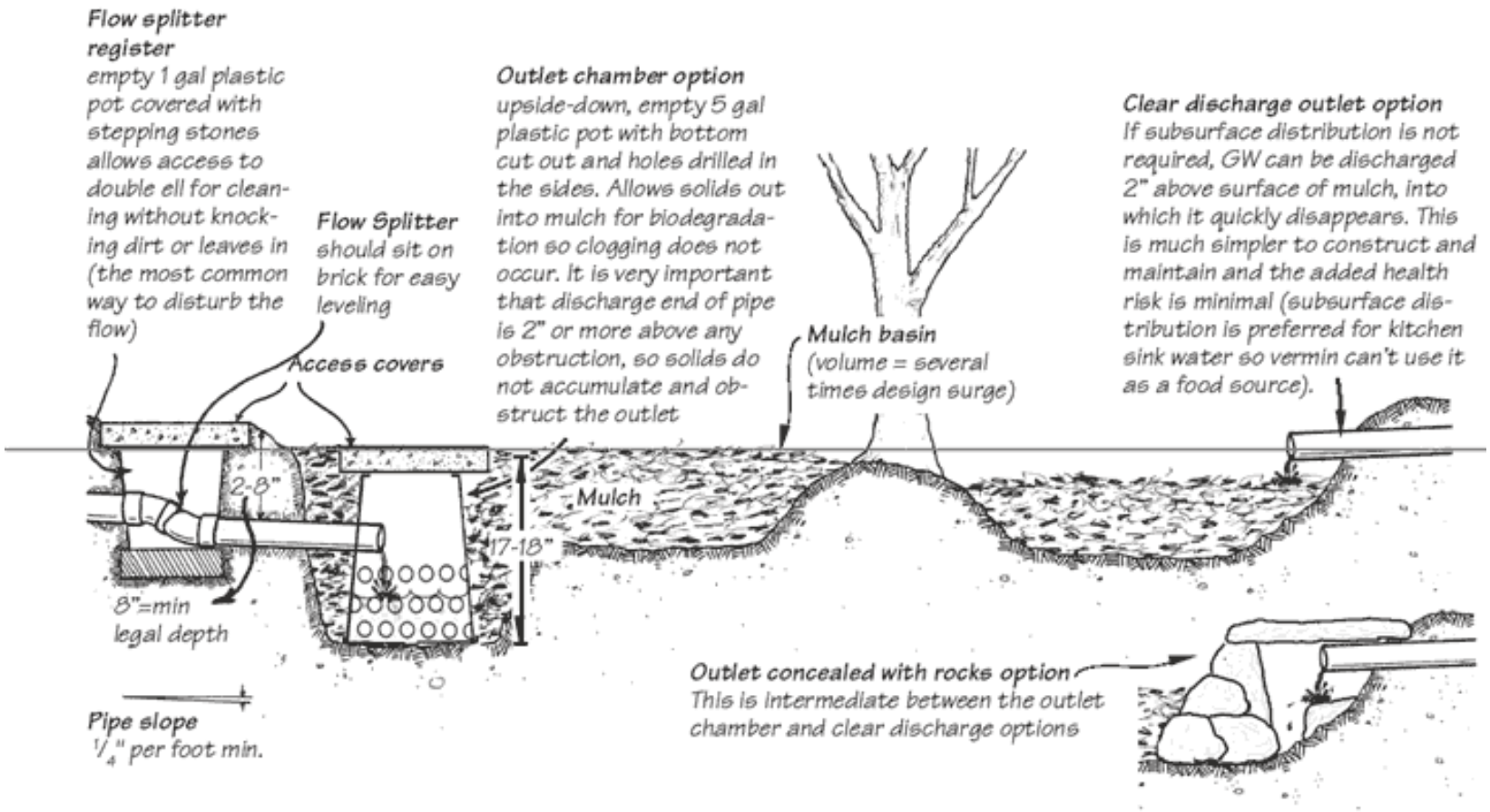


FIGURE 2: GREYWATER CONTAINED AND COVERED IN A BRANCHED DRAIN-FED MULCH BASIN
(ELEVATION VIEW)

Enclosed chamber option shown at left, clear discharge option shown at right (you can skip the rest of the details for now, we'll refer back to this figure later).



For Builders: How to design & construct collection plumbing and graywater stub outs

One outlet or many?

Your first critical decision is to bring all the graywater together to one point, then divert it through one valve and distribute it from there, OR, divert greywater at multiple points with multiple valves and start with it already somewhat distributed. Once you plumb it one way or the other, you are committed.

Outlet(s) as high as possible

The next critical design issue is to get the outlet(s) from the house as high as possible; this can involve extra work, although the value of having the outlets high can't be stressed enough.

Valve handle(s) accessible

Ideally the position of a diversion valve can be seen while using or on the way to use a fixture, its position can be changed while using the fixture or without going far from the fixture, and it's position can be locked against meddling by children and curious guests. Sometimes this can be achieved with valve handle extensions, but often there isn't any alternative to slithering through a crawl space to change the position.

Valves serviceable

Suggest installing the valves with no-hub connectors (which use removable clamps instead of glue) so that you can remove the entire valve for service or replacement without sawing up any pipes. If there is no space (e.g., street angles plugging right into the valve), you can use silicone sealer in place of ABS glue. This makes a watertight seal, but the fitting can easily be removed.

Valve sources

Jandy three way diverter valves, allows the inlet to be moved to any of the three ports. Ortega and other three way valves also work fine. Using a tee with two ball valves is commonly done, but less advisable. If the valves are seldom operated, crud can accumulate in the short dead end before the shut valve and congeal the passage shut. If you must do two ball valves, provide access for cleaning out the dead ends.

Appendix B: State Regulations (US), Compiled in 1999 for Greywater Systems

[The following is an excerpt from: Oasis Design. "Greywater Policy Packet." 2005]

Notes:
Although many states do not have formal design standards or regulations concerning greywater systems, as they pertain to on-site sewage management for residences, many of the rules and regulations do contain a section allowing "experimental" and/or "alternative" systems which may be permitted by individual application to the regulating agency.

In some cases (as noted in the document) information from other sources is provided on current regulations (to 2007).

Alabama: REGULATION(S): Chapter 420-3-1: Onsite Sewage Disposal and Subdivision-Onsite Sewage Systems, Water Supplies and Solid Waste Management (23 December 1998). Ch. 420-3-1-.03. Defined, greywater is that portion of sewage generated by a water-using fixture or appliance, excluding the toilet and possibly the garbage disposal.[3] References to greywater can be found under 402-3-1-.27 Effluent from Clothes Washing Machine and Residential Spa. Water from these systems can circumvent a septic tank and go into a separate effluent disposal field (EDF). In the current regulations, in the absence of water under pressure, greywater shall be disposed of by an effluent distribution line of 50 linear feet per dwelling. Greywater is also covered under the proposed draft of Ch. 420-3-1-.59. No new recommendations besides the EDF system are proposed.

Alaska: GREYWATER: 18 AAC 72.990. Greywater means wastewater a) from a laundry, kitchen, sink, shower, bath, or other domestic sources; and wastewater b) that does not contain excrement, urine, or combined stormwater. No existing regulations.

Arizona: For more details refer to Arizona Appendices REGULATION(S): Arizona Department of Environmental Quality (ADEQ) Bulletin No. 12, Minimum Requirements for the Design and Installation of Septic Tank Systems and Alternative On-site Disposal Systems (June 1989); Arizona Administrative Code Title 18, Ch. 9, Article 7: Regulations for the Reuse of Wastewater (30 September 1998);. Defined under R18-9-701. Greywater means wastewater that originates from clothes washers, dishwashers, bathtubs, showers and sinks, except kitchen sinks and toilets. Under R18-9-703, section C6, greywater from single and multi-family residences may be used for surface irrigation. The design and construction of the system must be approved by the Department. Irrigation sites must be designed to contain a 10-year, 24-hour (i.e., maximum possible) rainfall event and the greywater must fall under the allowable limits of less than 25 colony forming units per 100 milliliters (CFU/ml) fecal coliform and less than 2.0 mg/l chlorine for surface irrigation. Under section 7, formation of a wetlands marsh is allowable reuse of reclaimed wastewater.[7] Bulletin 12 describes onsite alternatives to septic tank and drainfield disposal systems. The first general requirement of Bulletin No. 12 is that alternative onsite disposal systems are intended and will be approved for individual lots only where conventional septic tank systems are not suitable and cannot be approved.[8] The bulletin points out several benefits of segregating blackwater and greywater: 1) conservation of water resources; 2) potential of recycling valuable nutrients to the soil; 3) reuse potential of recycled greywater; and 4) prolonged life of the septic tank soil absorption system.[10] However, until further field data becomes available and is evaluated, greywater treatment and disposal systems shall be designed similarly for typical residential wastewater septic tank soil absorption systems. Under this scenario, it may be possible to reduce the septic tank system capacities, sometimes by one-third.[11]

Arkansas: REGULATION(S): Alternate Systems Manual published by Environmental Program Services, Division of Environmental Health Protection (April 1993). According to the Alternate Systems Manual, the Arkansas Department of Health encourages studies and submission of plans for alternative methods of treating and disposing of wastes generated by individual residences.[12] However, if site and soil conditions

indicate that a standard septic tank and soil absorption system is feasible, no alternative or experimental system will be considered.[13] : Essentially, greywater is treated the same as blackwater. The preferred method of handling greywater is through a conventional septic tank and absorption field. A 35% reduction in the absorption field size will be granted. Other methods of treating and/or disposing of greywater will be reviewed on a case by case basis.[18]

California: REGULATION(S): Appendix G. Greywater Systems. Uniform Plumbing Code, Title 24, Part 5, California Administrative Code (18 March 1997).
G-1. General. (b) The type of system shall be determined on the basis of location, soil type, and ground water level and shall be designed to accept all greywater connected to the system from the building. The system shall discharge into subsurface irrigation fields and may include surge tanks and appurtenances, as required by the Administrative Authority. (d) No permit for any greywater system shall be issued until a plot plan with appropriate data satisfactory to the Administrative Authority has been submitted and approved. When there is insufficient lot area or inappropriate soil conditions for adequate absorption of the greywater, as determined by the Administrative Authority, no greywater system shall be permitted. G2. Greywater is untreated wastewater which has not come into contact with toilet waste. Greywater includes used water from bathtubs, showers, bathroom wash basins, clothes washing machines and laundry tubs or an equivalent discharge as approved by the Administrative Authority. It does not include wastewater from kitchen sinks, photo lab sinks, dishwashers, or laundry water from soiled diapers. Surfacing of greywater means the ponding, running off, or other release of greywater from the land surface. G13 Health and Safety. (a) Greywater may contain fecal matter as a result of bathing and/or washing of diapers and undergarments. Water containing fecal matter, if swallowed, can cause illness in a susceptible person. (b) Greywater shall not include laundry water from soiled diapers. (c) Greywater shall not be applied above the land surface or allowed to surface and shall not be discharged directly into or reach any storm sewer system or any water of the United States. (d) Greywater shall not be contacted by humans, except as required to maintain the greywater treatment and distribution system. (e) Greywater shall not be used for vegetable gardens.[20]

Colorado: REGULATION(S): Guidelines on Individual Sewage Disposal Systems, Chapter 25, Article 10 (1994). Greywater systems collect, treat, and dispose of liquid wastes from sinks, sinks, tubs, showers, and laundry or other approved plumbing fixtures, excluding toilet fixtures.[24] Greywater systems shall meet at least all minimum design and construction standards for septic tank systems based on the amount and character of wastes for the fixtures and the number of persons served.[25]

Connecticut: REGULATION(S): Connecticut Public Health Code: Regulations and Technical Standards for Subsurface Sewage Disposal Systems, Section 19-13-B100 (Conversions, Changes in Use, Additions) (25 October 1976); Section 19-13-B103 (Discharges 5,000 Gallons Per Day or Less) (16 August 1982); and Technical Standards (Pursuant to Section 19-13-B103) (1 January 1997). Greywater means domestic sewage containing no fecal material or toilet wastes. Sec. 19-13-B103d. Minimum Requirements. (f) Gray Water Systems. Disposal systems for sinks, tubs, showers, laundries, and other greywater from residential buildings, where no water flush toilet fixtures are connected, shall be constructed with a septic tank and leaching system at least one-half the capacity specified for the required residential sewage disposal system.[30] Sec. 19-13-B103f. Non-discharging Sewage Disposal Systems (a) All non-discharging sewage disposal systems shall be designed, installed, and operated in accordance with the Technical Standards and the requirements of this section, unless an exception is granted by the Commissioner upon a determination that system shall provide for the proper and complete disposal and treatment of toilet wastes or greywater.[31]

Delaware: REGULATION(S): Regulations Governing the Design, Installation and Operation of On-Site Wastewater Treatment and Disposal Systems (4 January 1984).
No existing regulations. However, a substantial portion of Delaware's population lives where centralized water supply or wastewater treatment services are limited. The Department's mission is to aid and assist the public in the installation of on-site sewage disposal systems, where possible, by utilizing the best information, techniques, and soil evaluations for the most suitable system that site and soil conditions permit. In the past, inadequately renovated wastewater has contaminated Delaware's groundwater and presented a threat to the public health, safety, and welfare. Corrective measures required the

replacement of water supply and wastewater systems at a very high cost which was sometimes borne by the general public. In developing these Regulations, the Department operated under the philosophy that where soil and site conditions permit, the least complex, easy to maintain, and most economical system should be used. The Department's policy is to encourage development of systems, processes, and techniques which may benefit significant numbers of people in Delaware.[32]

Florida: REGULATION(S): 381.0065 Florida Statutes Regulations: Chapter 64E-6, Florida Administrative Code, Standards for Onsite Sewage Treatment and Disposal Systems (3 March 1998). As defined under Title XXIX, Public Health Chapter 381.0065 Onsite Sewage treatment and disposal systems, means that part of domestic sewage that is not blackwater, including the waste from the bath, sink, laundry, and sink, except kitchen sink waste.[36] Greywater systems are described in Rule 64E-6.013(4).[37] When a separate system is installed to dispose of greywater, the retention tank for such systems shall meet certain design standards as specified in Rule 64E-6.008(3): The minimum effective capacity of the greywater retention tank shall be 250 gallons, with such system receiving not more than 75 gallons of flow per day. Where separate greywater and blackwater systems are used, the size of the blackwater system can be reduced by not more than 25%. 10D-6.046 Location and Installation. (7) Onsite greywater tank and drainfield systems may, at the homeowner's discretion, be utilized in conjunction with an onsite blackwater system where a sewerage system is not available for blackwater disposal.[38] 10D-6.048 System Size Determination (4) A separate laundry waste tank and drainfield system may be utilized for residences and may be required by the county public health unit where building codes allow for separation of discharge pipes of the residence to separate stubouts and where lot sizes and setback allow system construction. (a) The minimum laundry waste trench drainfield absorption area for slightly limited soil shall be 75 square feet for a one or two bedroom residence with an additional 25 square feet for each additional bedroom. 10D-6.055 (k) All greywater tanks distributed by the state shall be approved for use by the department prior to being installed. Such approval shall be obtained only after the manufacturer of a specific model has submitted engineering designs of the tank. (4) Greywater retention tanks - when a separate system is installed to dispose of greywater, the retention tank for such system shall meet the following minimum design standards: a) the minimum effective capacity shall be as specified in Rule 10D-6.048(3). Liquid depth shall be at least 30 inches; and b) retention tanks shall be baffled and vented as specified in the septic tank construction standards found elsewhere in the section provided that an inlet tee, ell, or baffle shall be provided for greywater tanks.

Georgia: REGULATION(S): Rules of Department of Human Resources, Public Health, Chapter 290-5-26: Onsite Sewage Disposal Management Systems (20 February 1998). Greywater means wastewater generated by water-using fixtures and appliances, excluding water closets, urinals, bidets, kitchen sinks, and garbage disposals. Chapter 290-5-59, Special Onsite Sewage Management Systems, defines sewage as human excreta, all water-carried wastes, and/or liquid household waste including greywater from residences or similar wastes or by-products from commercial and industrial establishments.[42] Where a separate greywater system is to be used, the minimum effective capacity of the greywater retention tank shall be 500 gallons. The minimum absorption area for greywater or blackwater absorption systems serving residential properties shall be based on the number of bedrooms and the percolation rate. The blackwater portion of the total daily sewage flow shall be 35%; the greywater portion shall be 65%.[43]

Hawaii: REGULATION(S): Hawaii Administrative Rules, Chapter 11-62 (30 August 1991). GREYWATER: means liquid waste from a dwelling or other establishment produced by bathing, washdown, minor laundry, and minor culinary operations, and specifically excluding toilet waste.[48] Chapter 11-62-31.1 states that individual wastewater systems may be used as a temporary on-site means of wastewater disposal in lieu of wastewater treatment works in residential developments when there is 10,000 square feet or more of land area for each individual wastewater system.[49] Section G covers greywater systems and their respective design characteristics.[50] Greywater conveyance systems include: sand filters, absorption trenches and beds, mounds or seepage pits, or when disinfected in accordance with 11-62-26(b) (which governs total coliform levels), used for irrigation.[51] 11-62-31.1 gives the general requirements for proposed individual wastewater systems. (g) A greywater system shall be designed in accordance with the following criteria: (1) design of greywater systems for dwelling units shall be based on a minimum greywater flow of 150 gallons per day per bedroom; and (2) greywater tanks, when required, shall be sized with no less than a 600 gallon capacity and shall conform to the requirements of

section 11-62-33-1(a).[52]

Idaho: REGULATION(S): IDAPA 16, Title 01, Chapter 03, Rules for Individual/Subsurface Sewage Disposal Systems (7 May 1993) and the Technical Guidance Manual (TGM) for Individual Subsurface Sewage Disposal Systems. The TGM can be viewed at http://www.state.id.us/phd1/tgm/tgm_toc.html Section 10 of the Idaho code covers Alternative Systems. If a standard system as described in the rules cannot be installed on a parcel of land, an alternative system may be permitted if that system is in accordance with the recommendations of the Technical Guidance Committee and is approved by the Director. : The Technical Guidance Manual contains a draft for greywater system guidelines and design requirements, but current Idaho rules permit greywater systems only as experimental systems.[56] The draft proposal describes greywater as untreated household wastewater that has not come into contact with toilet waste. Greywater includes used water from bathtubs, showers, bathroom wash basins, and water from clothes washing machines and laundry tubs. It shall not include wastewater from kitchen sinks, dishwashers, or laundry water from soiled diapers. A greywater system consists of a separate plumbing system from the blackwaste and kitchen plumbing, a surge tank to temporarily hold large drain flows, a filter to remove particles that could clog the irrigation system, a pump to move the greywater from the surge tank to the irrigation field, and an irrigation system to distribute the greywater. Greywater may not be used to irrigate vegetable gardens. Greywater systems may only be permitted for individual dwellings. The capacity of the septic tank and size of the blackwaste drainfield and replacement area shall not be reduced by the existence or proposed installation of a greywater system servicing the dwelling. Greywater shall not be applied on the land surface or be allowed to reach the land surface.[57]

Illinois: REGULATION(S): Title 77: Public Health, Chapter I: Department of Public Health, Subchapter r: Water and Sewage, Part 905: Private Sewage Disposal Code, Section 905.30, Approved Private Sewage Disposal Systems (15 March 1996). No existing regulations for greywater systems (governed under experimental systems).

Indiana: REGULATION(S): Regulations, if they existed, would most likely be found under 401 Indiana Administrative Code 6-8.1. No existing regulations for greywater systems

Iowa: REGULATION(S): Chapter 69: On-Site Wastewater Treatment and Disposal Systems 567-69.11(455B). No existing regulations for greywater systems

Kansas: REGULATION(S): No existing regulations. If regulations existed, they should fall under the Kansas Administrative Regulations (KAR) Chapter 25, Article 5, Sewage and Excreta Disposal. No existing regulations for greywater systems

Kentucky: REGULATION(S): 902 Kentucky Administrative Regulations 10:085 Kentucky Onsite Sewage Disposal Systems (September 1989). Greywater, in Section 2(13), means wastewater generated by water-using fixtures and appliances, excluding the toilet and the garbage disposal.[67] Greywater standards are mentioned under 13a-c, 8. When improved performance (of a septic system) may be attained by separating laundry greywater waste flows from other residential waste flow for new system installations, or as repair for existing systems, such separation shall be accomplished in the following manner: a) Greywater sewer for the washing machine shall be separated from the main house sewer; b) laundry greywater shall discharge into a lateral bed or trench(es) of a minimum of 100 square feet of bottom surface soil absorption area for a two bedroom residence and an additional 50 square feet for each additional bedroom; c) new system installations where laundry wasteflow separation exists are permitted a 15% reduction in the primary system lateral field requirements shall be allowed only for sites with soils in Soil Groups I-III. On sites with soils in Soil Group IV, such separation may be required, but no system size reduction will be granted.[68]

Louisiana: No existing regulations for greywater systems

Maine: REGULATION(S): Maine Subsurface Wastewater Disposal Rules 144A CMR 241(20 January 1998). Greywater covered 1509.0 Separated Laundry Disposal Systems. The plumbing inspector may approve a separate laundry system for single-family dwelling units. A separated laundry field requires an

application for subsurface wastewater disposal system completed by a licensed site evaluator and a permit to install the system. Only wastewater from a washing machine may be discharged to the separate laundry disposal field designed for that purpose. Separate laundry disposal fields may be designed and used for hot tubs or backwash water. A separated laundry disposal field does not require a septic tank. **Maryland**: REGULATION(S): Regulations may be discussed under Chapter 9, Subtitle 14A. Waterless Toilets (1993). Innovative greywater designs are currently allowed on a case-by-case basis under the Innovative and Alternative Program.[74]

Massachusetts: REGULATION(S): 310 CMR 15.000, Title 5: Innovative and Alternative Subsurface Sewage Disposal Technologies Approved for Use in Massachusetts (4 March 1998). If the facility generates greywater (i.e, wastewater from sinks, showers, washing machines, etc.) a disposal system is still needed for the greywater. Title 5 has different requirements for remedial use and for new construction. Remedial use is for facilities which have a design flow of less than 10,000 gallons per day, are served by an existing system, and where there is no proposed increase in the design flow. An existing cesspool may be used as a leaching pit, provided that the cesspool is pumped and cleaned and is not located in groundwater, and meets the design criteria of 310 CMR 15.253 with respect to effective depth, separation between units, and inspection access. The cesspool may be replaced by a precast concrete leaching pit meeting those requirements, and the effluent loading requirements of Title 5. A septic tank should also be installed. Pertaining to greywater, a filter system specifically approved by the Department can be used instead of a septic tank.[76] Non-traditional greywater systems, such as those which use constructed wetlands or evapotranspiration beds, are approved on a piloting, site-specific basis.[77]

Michigan: REGULATION(S): Michigan has one of the oldest existing guidelines for greywater systems. However, as there is no statewide sanitary code, the 46 local health departments define the criteria for onsite sewage disposal and "each county runs its own show."[79] The Michigan Department of Health publishes Guidelines for Acceptable Innovative or Alternative Waste Treatment Systems and Acceptable Alternative Greywater Systems under authority of Act 421, P.A. 1981 (1986). Under Act 421, an owner of a structure using an acceptable an innovative or alternative waste treatment system (heretoafter referred to as "alternative systems") in combination with an acceptable alternative greywater system (heretoafter referred to as "greywater systems") shall not be required to connect to an available public sanitary sewer system.[80] Alternative system means a decentralized or individual waste system which has been approved for use by a local health department and which is properly operated and maintained so as to not cause a health hazard or nuisance. Alternative systems do not include septic tank-drainfield systems or any other systems which are determined by the department to pose a similar threat to the public health, safety and welfare, and the quality of surface and subsurface waters of this state.[81] A person may install and use in a structure an alternative system or an alternative system in combination with an greywater system. The installation and use of an alternative system or an alternative system in combination with a greywater system in a structure shall be subject to regulations by the local health department in accordance with the ordinances and regulations of the local units of government in which the structure lies. A local health department may inspect each alternative system within its jurisdiction at least once each year to determine if it being properly operated and maintained. 1) A local health department may charge the owner of an alternative system a reasonable fee for such an inspection and for the plan review and installation inspection. 2) The department shall maintain a record of approved alternative systems and their maintenance and adoption. The department, after consultation with the state plumbing board, shall adopt guidelines to assist local health departments in determining what are greywater systems and what are alternative systems. The department shall advise local health departments regarding the appropriate installation and use of alternative systems and alternative systems in combination with greywater systems. 3) A person who installs and uses an alternative system or an alternative system in combination with a greywater system shall not be exempt from any special assessments levied by a local unit of government for the purpose of financing the construction of an available public sanitary sewer system. 4) An owner of a structure using an alternative in combination with a greywater system shall not be required to connect to an available public sanitary sewer system.[82] A greywater system means a system for the treatment and disposal of wastewater which does not receive human body wastes or industrial waste which has been approved for use by a local health department and which is properly operated and maintained so as not to cause a health hazard or nuisance.[83] Structures which utilize alternative systems and greywater systems which are self-contained systems that do not have an on-site discharge should

not be required to connect to an available public sanitary sewer system.[84] Alternative systems must meet the requirements of Sections 5 (6) and 21 of the Michigan Construction Code, act 230, Public Acts of 1972 as amended. Structures using alternative systems must also meet the requirements of the Michigan Plumbing Code.[85] Alternative systems and greywater systems should be tested by the National Sanitation Foundation (NSF) under Standard 41 testing protocol or by an equivalent independent testing agency and procedure. Lacking this testing procedure, the local health department should require performance data prior to approval. When requested, the Michigan Department of Public Health will assist local health departments in evaluating performance data from the NSF and other sources. Each local health department should require appropriate methods for disposal of stored liquid or solid end products from alternative systems.[86] To the extent that funds are available, the department will provide training and technical field assistance to local health departments regarding the appropriate installation and use of alternative systems and greywater systems.[87] A person may petition, in writing, the commission to approve the use of a particular material, product, method of manufacture or method or manner of construction or installation. On receipt of the petition, the commission shall cause to be conducted testing and evaluation it deem desirable. After testing and evaluation, and an open public hearing, the commission may reject the petition in whole or in part, may amend the code in such matter as the commission deems appropriate, or may grant a certificate of acceptability.[88]

Minnesota: REGULATION(S): Chapter 7080.9010, Alternative and Experimental Systems [Regulation Repealed as of 02/28/00] Use of alternative systems is allowed only in areas where a standard system cannot be installed or is not the most suitable treatment. Subpart 3E of Ch. 7080.9010 states that a toilet waste treatment device must be used in conjunction with a greywater system. Accordingly, toilets wastes shall be discharged only to toilet waste treatment devices. Greywater or garbage shall not be discharged to the device, except as specifically recommended by a manufacturer. Septic systems are required for greywater systems. The drainage system in new dwellings or other establishments shall be based on a pipe diameter of two inches to prevent installation of a water flush toilet. There shall be no openings or connections to the drainage system, including floor drains, larger than two inches in diameter. For repair or replacement of an existing system, the existing drainage system may be used. Toilets or urinals of any kind shall not be connected to the drainage system. Toilet waste or garbage shall not be discharged to the drainage system. Garbage grinders shall not be connected to the drainage system. The building sewer shall meet all requirements for part 7080.0120, except that the building sewer for a greywater system shall be no greater than two inches in diameter. Greywater septic tanks shall meet all requirements of 7080.0130, subpart 1, except that the liquid capacity of a greywater septic tank serving a dwelling shall be based on the number of bedrooms existing and anticipated in the dwelling served and shall be at least as large as the following given capacities: 2 bedrooms, 300 gallon capacity; 3 or 4 rooms, 500 gallons; 5 or 6 rooms, 750 gallons; 7, 8 or 9 rooms, 1000 gallons. 4) Sizing for the system can be 60% of the amount calculated for a standard septic system. For ten or more bedrooms or other establishments, the greywater septic tank shall be sized as for any other establishment, except the minimum liquid capacity shall be at least 300 gallons. Greywater aerobic tanks shall meet all requirements of part 7080.0130. 6) Distribution and dosing of greywater shall meet all requirements of parts 7000.0150 and 7080.0160. 7) A standard greywater system shall meet all requirements of part 7080.0170. Experimental systems are discussed in subpart 3a. They may be used in areas where a standard systems cannot be installed or if a system is considered new technology with limited data on reliability.[93]

Mississippi: REGULATION(S): Mississippi Individual On-Site Wastewater Disposal System Law, Chapter 41-67 (1996). No existing regulations for greywater systems

Missouri: REGULATION(S): Missouri Laws for On-Site Disposal Systems, Chapter 701, Section 701.025 (28 August 1998). Under 701.025,12(b), greywater includes bath, sink, laundry, and sink waste, excepting human excreta, toilet waste, residential kitchen waste and other similar waste from household or establishment appurtenances.[98] Title 19, Division 20, Chapter 3, General Sanitation, defines greywater as liquid waste, specifically excluding toilet, hazardous, culinary and oily wastes, from a dwelling or other establishment which is produced by bathing, laundry, or discharges from floor drains.[99] There are no design recommendations or regulations governing greywater systems.

Montana: REGULATION(S): Circular WQB 5. Minimum Design Standards for On-Site Alternative Sewage Treatment and Disposal Systems (1992). No existing regulations for greywater systems Greywater must be disposed of through a septic tank and drainfield system.

Nebraska: REGULATION(S): If they existed, regulations would probably be found in Title 124, Rules and Regulations for Design, Operation and Maintenance of Onsite Wastewater Treatment Systems. No existing regulations for greywater systems. Greywater is defined, but no systems are necessarily allowed under Title 124.

Nevada: REGULATION(S): R129-98. Sewage disposal is regulated under Nevada Administrative Code 444.750 (February 1998). Greywater systems are governed under Regulation R129-98, Section 78. 1. Greywater may be used for underground irrigation if approved by the administrative authority. A homeowner must obtain a permit to construct, alter or install a system that uses greywater for underground irrigation from the administrative authority before such a system may be constructed, altered or installed. 2. A system that uses greywater for underground irrigation: a) may be used only for a single family dwelling; b) must not be used in soils which have a percolation rate that is greater than 120 minutes per inch; c) must consist of a three-way diversion valve, a holding tank for the greywater and an irrigation system; d) may be equipped with a pump or siphon, or may rely on gravity to cause the water to flow to the irrigation system; e) must not be connected to a system for potable water; and f) must not result in the surfacing of any greywater. 3. A system that uses greywater for underground irrigation, or any part thereof, must not be located on a lot other than the lot which is the site of the single-family dwelling that discharges the greywater to be used in the system. Section 79. 1. An application to construct, alter or install a system that uses greywater for underground irrigation must include: a) detailed plans of the system to be constructed, altered or installed; b) detailed plans of the existing and proposed sewage disposal system; and c) data from percolation tests conducted in accordance with NAC 444.796 and sections 40 to 43, inclusive, of this regulation. 2. A holding tank for greywater must: a) be watertight and constructed of solid, durable materials that are not subject to excessive corrosion or decay; b) have a minimum capacity of 50 gallons; c) have an overflow and an emergency drain. The overflow and emergency drain must not be equipped with a shutoff valve. 3. A three-way diversion valve, emergency drain and overflow must be permanently connected to the building drain or building sewer and must be located upstream from any septic tanks. The required size of an individual sewage disposal system must not be reduced solely because a system that uses greywater for underground irrigation is being used in conjunction with the individual sewage disposal system. 4. The piping for a system that uses greywater for underground irrigation which discharges into the holding tank or is directly connected to the building sewer must be downstream of any vented trap to protect the building from possible sewer gases. 5. The estimated discharge of a system that uses greywater for underground irrigation must be calculated based on the number of bedrooms in the building, as follows: a) for the first bedroom, the estimated discharge of greywater is 80 gallons per day; and b) for each additional bedroom, the estimated discharge of greywater is 40 gallons per day. 6. The absorption area for an irrigation system that includes a system that uses greywater for underground irrigation must be calculated in accordance with the following parameters: percolation rate of 0-20 minutes per inch, 20 square feet (minimum square feet per 100 gallons discharged per day); 21-40 minutes/inch, 40 gallons/day; 41-60 minutes/inch, 60 gallons/day.

New Hampshire: REGULATION(S): Chapter Env-Ws 1000 Subdivision and Individual Sewage Disposal System Design Rules. Env-Ws 1022 deals with Alternate Systems.
No existing regulations for greywater systems. New Hampshire, does, however, have extensive regulations pertaining to Alternate Systems, as follows. Part Env-Ws 1024 Innovative/Alternative Technology. The purpose of this part is to provide the methodology and review process for the approval of innovative/alternative individual sewage disposal systems, in compliance with RSA 485-A:29, I. b.This part shall apply to any proposed individual sewage disposal system technology not described elsewhere in Env-Ws 1000. a."Conventional system" means an individual sewage disposal system regulated under Env-Ws 1000 other than Env-Ws 1024. b."Innovative/Alternative waste treatment" as defined in RSA 485-A:2, XXI, includes individual sewage disposal systems. c."ITA" means innovative/alternative technology approval. Env-Ws 1024.03 a.If the system will require ongoing professional maintenance, a service contract for such maintenance shall be executed before operational approval is granted. b.In exchange for obtaining the benefit of an operational approval based on innovative/alternative technology, the owner

shall covenant to replace the innovative/alternative system with a conventional system should the innovative/alternative system fail to operate lawfully. The covenant shall be recorded by the owner at the registry of deeds where the property is located. Env-Ws 1024.04 ITA Applications. a.Before an innovative/alternative waste treatment system may be used the technology shall be evaluated and approved in an ITA. b.To obtain an ITA, an owner, designer, or other person shall submit a letter of application that includes the following: 1).A written description of the proposed system; 2) All operational reports, patent information, technical reports, and laboratory reports published on the proposed system, even if the information might in whole or in part reflect negatively on the system; 3) A description of any advantages of the proposed system over conventional systems in the prevention of health hazards, surface and groundwater pollution, and any other environmental benefits; 4).A description of the possible risks to public health, surface or groundwaters, or other aspects of the environment of using the proposed system; 5).The names, addresses, and phone numbers of at least three individuals who have experience in the design operation of the same type of system; 6).The proposed system's effect on the area of land required for operation; 7).A list of any rules under Env-Ws 1000 for which waivers will be required; and 8).A list of site locations where the system has been used, whether successfully or not.[104]

New Jersey: REGULATION(S): New .Jersey Administrative Code 7:9A Standards for Individual Subsurface Sewage Disposal Systems. Under Section 7:9A-2.1 "Greywater" means that portion of the sanitary sewage generated within a residential, commercial or institutional facility which does not include discharges from water closets or urinals.[105] 7:9A-1.8 (c) In cases where the actual volume of sanitary sewage discharged from a facility will be reduced by use of water-saving plumbing fixtures, recycling of renovated wastewater, incineration or composting of wastes, evaporation of sewage effluent or any other process, the requirement for obtaining a treatment works approval and a NJPDES permit shall be based upon the design volume of sanitary sewage, calculated as prescribed in N.J.A.C. 7:9A-7.4, rather than the actual discharge volume as modified by water conservation or special treatment processes.7:9A-7.3 (a) The system(s) shall be designed to receive all sanitary sewage from the building served except in the following cases: 1. Separate systems may be designed to receive only greywater, or only blackwater, as allowed in N.J.A.C. 7:9A-7.5. 7:9A-7.5 A greywater system may be approved by the administrative authority provided that all of the requirements of these standards are satisfied and provided that an acceptable means for disposal of the blackwater from the building served is indicated in the system design. When the blackwater from the building served by a greywater system is to be disposed of into a waterless toilet, a variance from the Uniform Construction Code, Plumbing sub-code, N.J.A.C. 5:23-3.5, must be obtained by the applicant prior to approval of the greywater system by the administrative authority and the volume of sanitary sewage to be used in the design of the greywater system shall be determined as prescribed in N.J.A.C. 7:9A-7.4. When the blackwater from the building served by a greywater system is to be disposed of into a separate subsurface sewage disposal system, the blackwater system shall meet all the requirements of this chapter and the volume of sanitary sewage used in the design of both the greywater system and the blackwater system shall be a minimum of 75 % of the volume of sanitary sewage determined as prescribed in N.J.A.C. 7:9A-7.4.[106] 7:9A-7.6 Each system approved by the administrative authority pursuant to this chapter shall consist of a septic tank which discharges effluent through a gravity flow, gravity dosing or pressure dosing network to a disposal field as hereafter described. Seepage pits shall not be approved for new installations except in the case of a greywater system as provided by in N.J.A.C. 7:9A-7.5. Installation of a seepage pit may be approved as an alteration for an existing system subject to the requirements of N.J.A.C. 7:9A-3.3.[107]

New Mexico: REGULATION(S): 20 NMAC 7.3, Liquid Waste Disposal Regulations (10 October 1997). Under subpart I, Part 107. AF. "greywater" means water carried waste from kitchen (excluding garbage disposal) and bathroom sinks, wet bar sinks, showers, bathtubs and washing machines. Greywater does not include water carried wastes from kitchen sinks equipped with a garbage disposal, utility sinks, any hazardous materials, or laundry water from the washing of material soiled with human excreta.[111] Revised regulations will have a separate section allowing greywater systems. However, the system will still have to run through a septic tank. Greywater can then be used for subsurface irrigation.

New York: REGULATION(S): Appendix 75-A, Wastewater Treatment Standards - Individual Household Systems, Statutory Authority: Public Health Law 201(1)(1) (1 December 1990). Greywater systems shall be designed upon a flow of 75 gpd/bedroom and meet all the criteria for treatment of household

wastewater.[120] The treatment of household wastewater is regulated by 75-A.8. Subsurface Treatment. (a) General Information. All effluent from septic tanks or aerobic tanks shall be discharged to a subsurface treatment system. Surface discharge of septic tank or aerobic effluent shall not be approved by the Department of Health or a local health department acting as its agent.[121]

North Carolina: REGULATION(S): Sewage Treatment and Disposal Systems, Section .1900 (April 1993). No existing regulations for greywater systems

North Dakota: REGULATION(S): Chapter 62-03-16. Individual Sewage Treatment Systems for Homes and Other Establishments Where Public Sewage Systems are not Available (1996). Water-carried sewage from bathrooms, kitchens, laundry fixtures, and other household plumbing shall pass through a septic or other approved sedimentation tank prior to its discharge into the soil or into an alternative system. Where underground disposal for treatment is not feasible, consideration will be given to special methods of collection and disposal.[126]

Ohio: REGULATION(S): O.A.C. Chapter 3701-29 Household Sewage Disposal Rules (1977). No existing regulations for greywater systems. Chapter 3701-29-20. Variance. (C). Household sewage disposal system components or household sewage disposal systems differing in design or principle of operation from those set forth in rules 3701-29-01 to 3701-29-21, may qualify for approval as a special device or system provided, comprehensive tests and investigations show any such component or system produces results equivalent to those obtained by sewage disposal components or systems complying with such regulations. Such approval shall be obtained in writing from the director of health.[127]

Oklahoma : REGULATION(S): Chapter 640. Individual and Small Public Sewage Disposal (1998). No existing regulations for greywater systems. Chapter 640-1-12 governs alternative/experimental disposal systems. Where unusual conditions exist, special systems of treatment and disposal, other than individual sewage disposal systems mentioned may be employed, provided that: 1) reasonable assurance is presented to the Department that the system will work properly; 2) the design of the system is approved by the Department prior to installation; 3) there is no discharge to the waters of the state; 4) treatment and disposal of waste are in such a manner as to protect public health and the environment; 5) such systems comply with all local codes and ordinances. (b) Special alternative systems or experimental systems shall be considered on a case-by-case basis, weighing heavily in the approval process. The plans for alternative systems shall be reviewed by the Department and approved or disapproved by the Area or Regional Supervisor. After construction, the installation of the alternative system shall be approved or disapproved by the local DEQ representative. (c) To apply for approval of such systems an applicant shall file two copies of test results based on OAC 252:640-1-9 and two copies of the design plan for the proposed system with the local representative of the Department for the area in which the property is located.[128]

Oregon: REGULATION(S): Oregon Administrative Rules, Oregon Revised Statutes 447.115 (1997); OAR Chapter 340, Divison 71 (1997). GREYWATER: 447.140 (1) All wastewater and sewage from plumbing fixtures shall be discharged into a sewer system or alternate sewage disposal system approved by the Environmental Quality Commission or department of Environmental Quality under ORS chapters 468, 468A and 468B. Greywater is technically defined as sewage and still requires a septic tank and drainfield, although the septic system can be reduced in size.[132] Chapter 340, Divisions 71 and 73: Under the "split-waste method," blackwater sewage and greywater sewage from the same dwelling or building are disposed of by separate systems.[133] 340-71-320. Split Waste Method. In a split waste method, wastes may be disposed of as follows: (1) Black wastes may be disposed of by the use of State Building Codes Division approved non-water carried plumbing units such as recirculating oil flush toilets or compost toilets. (2) Greywater may be disposed of by discharge to: a) an existing on-site system which is not failing; or b) a new on-site system with a soil absorption facility 2/3 normal size. A full size initial disposal area and replacement disposal area of equal size are required; or c) a public sewerage system.[134]

Pennsylvania: REGULATION(S): Title 25. Environmental Protection, Chapter 73. Standards for Sewage Disposal Facilities, Current through 28 Pa.B. 348 (17 January 1998). 73.11. (c) Liquid wastes, including kitchen and laundry wastes and water softener backwash, shall be discharged to a treatment tank.[138]

Rhode Island: REGULATION(S): Chapter 12-120-002, Individual Sewage Disposal Systems (September 1998). The term, "greywater," shall be held to mean any wastewater discharge from a structure excluding the waste discharges from water closets and waste discharges containing human or animal excrement. The term, "sanitary sewage," shall be held to mean any human or animal excremental liquid or substance, any putrescible animal or vegetable matter and/or any garbage and filth, including, but not limited to, any greywater or blackwater discharged from toilets, laundry tubs, washing machines, sinks, and dishwashers as well as the content of septic tanks, cesspools, or privies.[141]

South Carolina: REGULATION(S): Chapter 61-56, Individual Waste Disposal Systems (27 June 1986). No existing regulations for greywater systems. Greywater is included within the Department's definition of sewage and must be managed appropriately. A permit applicant could elect to install separate systems to handle blackwater and greywater, but the same site and soil requirements apply for both systems.

South Dakota: REGULATION(S): Chapter 74:53:01:10 (1 July 1996). Under Chapter 74:03: 01:38, greywater systems are wastewater systems designed to recycle or treat wastes from sinks, sinks, tubs, showers, washers, or other devices which do not discharge garbage or urinary or fecal wastes. In areas where they will not create a public nuisance or enter any water of the state, greywater systems are exempt from the requirement that normally states that wastewater is not allowed to surface on, around, or enter state waters. 74-03:01:75. A greywater system shall be designed in accordance with the following criteria: 1) All greywater treatment and recycle systems shall be located in accordance of the distances specified in 74:03.01:56, Table 1; 2) Design of greywater systems shall be based on a minimum greywater flow of 25 gallons per day per person. Three days retention time shall be provided for each greywater tank; 3) Greywater tanks are septic tanks and shall conform to the requirements for septic tanks; and 4) Effluent from greywater systems may be recycled for toilet use, conveyed to absorption fields, mounds or seepage pits, or used for irrigation of lawns and areas not intended for food production. Percolation tests shall be conducted and the minimum size of absorption area shall be determined in accordance with 74:03:01:66 to 74:03:01:69, inclusive.[145]

Tennessee: REGULATIONS Rules of Department of Environment and Conservation, Division of Ground Water Protection, Chapter 1200-1-6: Regulations to Govern Subsurface Sewage Disposal Systems (1997). No existing regulations for greywater systems.
Texas: REGULATION(S): Chapter 285: On-Site Sewage Facilities (1999). Greywater is defined as wastewater from clothes washing machines, showers, bathtubs, handwashing sinks, and sinks not used for the disposal of hazardous or toxic ingredients or waste from food preparations. Subchapter H: 285.80. Treatment and Disposal of Greywater. New construction or modification to an existing greywater conveyance, treatment, storage or disposal system outside of a structure or building must be carried out in accordance with provisions of this chapter and any established requirements of the permitting authority. Any new construction or modification to an existing greywater reuse or reuse conveyance system associated with a structure or building must be carried out in accordance with the requirements of the State Board of Plumbing Examiners.[148] Greywater must be treated through a septic system first.[149]

Utah: REGULATION(S): If they existed, they may be covered under R317-502-3, Individual Wastewater Disposal Systems (1993). R317-502-3. does speak to alternative systems. The drainage system of each dwelling, building or premises covered herein shall receive all wastewater (including but not limited to bathroom, kitchen, and laundry wastes) as required by the Uniform Plumbing Code and shall have a connection to a public sewer except when such sewer is not available or practicable for use, in which case connection shall be made as follows: 3.1 To an individual wastewater disposal system found to be adequate and constructed in accordance with requirements stated herein. 3.2 To any other type of wastewater disposal system acceptable under R317-1, R317-3, R317-5, or R317-560. R317-502-20. Experimental and Alternate Disposal Methods. 20.1 Where unusual conditions exist, experimental methods of wastewater disposal may be employed provided they are acceptable to the Division and to the local health department having jurisdiction. 20.2 When considering proposals for experimental individual wastewater disposal systems, the Division shall not be restricted by this rule provided that: A. The experimental system proposed is attempting to resolve an existing pollution or public health hazard, or when the experimental system proposal is for new construction, it has been predetermined that an

acceptable back-up disposal system will be installed in event of failure of the experiment; B. The proposal for an experimental individual wastewater disposal system must be in the name of and bear the signature of the person who will own the system; and C. The person proposing to utilize an experimental system has the responsibility to maintain, correct, or replace the system in event of failure of the experiment. 20.3 When sufficient, successful experience is established with experimental individual wastewater disposal systems, the Division may designate them as approved alternate individual wastewater disposal systems. Following this approval of alternate individual wastewater disposal systems, the Division will adopt rules governing their use.[151]

Vermont: REGULATION(S): If they existed, they would most likely be found under Environmental Protection Rules, Chapter 1, Small Scale Wastewater Treatment and Disposal Rules (8 August 1996). Innovative systems are regulated under Chapter 1, Small Scale Wastewater Treatment and Disposal Rules. Innovative Systems are governed under subchapter 2, 1-203. Alternative systems are allowed in Vermont only if a back-up, in ground conventional (septic) system is installed.[152] Constructed wetlands as treatment units could be approved if the design was sufficiently reliable given the extended winter season in Vermont. However, for all practical purposes, the discharge from a constructed wetland unit could not be discharged directly into surface waters under these regulations but would have to be discharged to a subsurface leachfield or possibly a sprayfield system.[153]

Virginia: REGULATION(S): 12 VAC 5-610-980. No existing regulations for greywater systems.

Washington: REGULATION(S): Recommended Standards and Guidance for Water Conserving On-Site Wastewater Treatment Systems (1999). Section B. Greywater systems are virtually the same as combined-wastewater on-site sewage systems. Gravity flow greywater systems consist of a septic tank and subsurface drainfield. Pressurized greywater systems consist of a septic tank, a pump chamber or vault, and a subsurface drainfield. Other types of alternative systems, pre-treatment methods and drainfield design and materials options may also be incorporated in greywater systems. The primary distinction between a greywater system and a combined wastewater system is the lower volume of wastewater. As a result, the size of the septic tank and subsurface drainfield is smaller compared to a system that treats and disposes all the household wastewater (combined) through a septic tank and drainfield. In addition to the water conserving nature of waterless toilets/greywater systems, the greywater system drainfield can be designed and located to reuse greywater for subsurface irrigation. Drainfield designs (methods and materials) which place the distributed wastewater in close proximity to the root zone of turf grasses, plants, shrubs, and trees may be used to enhance the reuse potential of greywater as it is treated in the soil, assuring public health protection. When greywater systems are designed, installed, operated and maintained to maximize their potential as a greywater reuse irrigation system, various items should be considered. Among these are plant water and nutrient needs and limits, salt tolerances, depths of root zones, etc. The development of a landscape plan is recommended. Greywater treatment and disposal/reuse systems must provide treatment and disposal at least equal to that provided by on-site system. Greywater on-site systems may be used with new residential construction and existing dwellings. Internal household plumbing may be modified (consistent with local plumbing code) to route any portion of the household greywater to the greywater on-site sewage system. Greywater on-site sewage systems may be located anywhere conventional or alternative on-site sewage systems are allowed. Site conditions, vertical separation, pretreatment requirements, setbacks and other location requirements are the same as described in Chapter 246-272 WAC. 2.4 Greywater on-sites sewage systems must provide permanent, year-round treatment and disposal of greywater unless this is already provided by an approved on-site system or connection to public sewer. Greywater on-site systems must be installed with an approved waterless toilet or other means of sewage treatment for blackwater approved by the local health officer. Greywater systems are intended to treat and dispose "residential strength" greywater. Greywater exceeding residential strength must receive pre-treatment to at least residential strength levels. Design requirements for greywater on-site sewage systems, unless otherwise noted, are the same as requirements for combined wastewater systems presented in Chapter WAC 246-272. Greywater may be used for subsurface irrigation of trees (including fruit trees) shrubs, flowers, lawns and other ground covers but must not be used for watering of food crops of vegetable gardens, any type of surface or spray irrigation, to flush toilets/urinals or to wash wall, sidewalks or driveways. The disposal component of a greywater treatment system may be designed to enhance the potential for subsurface irrigation. The efficiency of greywater reuse via subsurface irrigation depends upon the proximity of the

drainfield to the root-zone of plants, shrubs, trees or turf and the method of distribution. This may be enhanced by: Installing narrower-than-normal trenches shallow in the soil profile (state rules do not have a minimum trench width; minimum trench depth is six inches). Gravel and pipe size may limit how narrow a "conventional" trench may be. It is recommended that at least two inches of gravel be provided between the sides of the distribution pipe and trench sidewalls. Small gravel size (no less that 3/4 inch) is recommended for narrow trenches; using pressure distribution to reduce the height of the trench cross section to enable shallow trench placement and to assure even distribution; and using subsurface drip irrigation (SDS) technology for shallow system placement and equal distribution in close proximity to plant, shrub, turf and trees roots. Some agronomic issues that should be considered with greywater reuse are the water needs and salt tolerances of plants to be irrigated. In many cases, the volume of greywater generated may not meet the needs of the landscape plantings. If potable water is used to augment greywater for irrigation within the same distribution network, a method of backflow prevention approved by the local health officer is required. In some geographical and climatic areas, the frost-protection needs of an SDS or a conventional drainfield trench system may be counter-productive to effective greywater reuse via subsurface irrigation (distribution piping may be too deep for plant root systems). In these areas, local health officers may permit seasonal systems where year-round treatment and disposal is provided by an approved sewage system and seasonal subsurface irrigation with greywater is provided by a separate system with a shallow drainfield or SDS. Where seasonal systems are allowed, various administrative and design issues must be addressed. Both drainfields must meet state and local rule requirements, including soil application rates, to assure treatment and disposal at least equal to that provided by conventional gravity or pressure on-site sewage systems according to Chapter 246-272 WAC. 3.4.2 Municipal sewer systems may provide year-round sewage disposal in conjunction with seasonal greywater treatment and disposal systems designed to enhance greywater reuse via subsurface irrigation. Seasonal greywater treatment and disposal/reuse systems must include a three-way diverter valve to easily divert greywater to the year-round disposal field or sewer when needed (when freezing is a problem). Local health officers may permit "laundry wastewater only" greywater disposal or reuse systems for single family residences for either year-round or seasonal use. Greywater systems limited only to laundry wastewater (including laundry sinks) may differ from other greywater systems according to the following: A single compartment retention/pump tank, with a minimum liquid capacity of 40 gallons may be used in lieu of the tank recommendations. The tank must be warranted by the manufacturer for use with wastewater and meet requirements listed in Appendix G of the 1997 edition of the Uniform Plumbing Code (UPC). Minimum design flow for "laundry wastewater only" systems (for the purpose of drainfield sizing) must be based on the number of bedrooms in the residence and must be no less than 30% of the minimum greywater system design flows. A wastewater filter or screen (with a maximum size opening of 1/16 inch) must be provided in an accessible location conducive to routine maintenance. Homeowners are responsible for proper operation and maintenance of their greywater systems. Specific requirements will vary according to the county where the system is located and the specific type of system. See your local health jurisdiction for local system O & M requirements.[161]

West Virginia: REGULATION(S): Title 64, Interpretive Rules Board of Health, Series 47, Sewage Treatment and Collection System Design Standards (1983). Those houses served by a greywater disposal system must have a house sewer of not more than two inches in diameter. 12.2. Houses served by greywater disposal systems shall not have garbage disposal units. 12.3 Manufactured greywater disposal systems must be approved by the director. 12.4. Non-commercial greywater disposal systems shall consist of the following: 12.4.1. A soil absorption field designed on the basis of a 30% reduction in water usage, and constructed in accordance with the design requirements for the standard soil absorption fields. 12.4.2. A septic tank sized according to the following room sizes and minimum capacities: 2 rooms, 500 gallons; 3 to 4 rooms, 750 gallons; 5 or more rooms, add 210 gallons for each additional bedroom.[162]

Wisconsin: REGULATION(S): If they existed, they may be found in Wisconsin Comm083.

Wyoming: REGULATION(S): If they existed, regulations would most likely be found in Chapter XI, Part D, Septic Tank and/or Soil Absorption System, Water Quality Rules and Regulations in the Innovative and Alternative section.

Appendix C: Arizona Greywater Law

[This section includes excerpts from: Oasis Design. "Greywater Policy Packet." 2005]

TITLE 18. ENVIRONMENTAL QUALITY
CHAPTER 9. DEPARTMENT OF ENVIRONMENTAL QUALITY

WATER POLLUTION CONTROL
ARTICLE 7. DIRECT REUSE OF RECLAIMED WATER

Article 4 consisting of Sections R9-20-401 through R9-20-407 renumbered as Article 7, Sections R18-9-701 through R18-9-707 (Supp. 87-3).

Article 4 consisting of Sections R9-20-401 through R9-20-407 adopted effective May 24, 1985.

Former Article 4 consisting of Sections R9-20-401 through R9-20-408 repealed effective May 24, 1985.

Section:

Tier 1 Arizona Greywater Law – Applies to systems under 400 gpd which meet requirements below

R18-9-711. Type 1 Reclaimed Water General Permit for Greywater

A. A Type 1 Reclaimed Water General Permit allows private residential direct reuse of greywater for a flow of less than 400 gallons per day if all the following conditions are met:

1. Human contact with greywater and soil irrigated by greywater is avoided;
2. Greywater originating from the residence is used and contained within the property boundary for household gardening, composting, lawn watering, or landscape irrigation;
3. Surface application of greywater is not used for irrigation of food plants, except for citrus and nut trees;

4. The greywater does 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;
5. The application of greywater is managed to minimize standing water on the surface;
6. The greywater system is constructed so that if blockage, plugging, or backup of the system occurs, greywater can be directed into the sewage collection system or onsite wastewater treatment and disposal system, as applicable. The greywater system may include a means of filtration to reduce plugging and extend system lifetime;
7. Any greywater storage tank is covered to restrict access and to eliminate habitat for mosquitoes or other vectors;
8. The greywater system is sited outside of a floodway;
9. The greywater system is operated to maintain a minimum vertical separation distance of at least five feet from the point of greywater application to the top of the seasonally high groundwater table;
10. For residences using an onsite wastewater treatment facility for black water treatment and disposal, the use of a greywater system does not change the design, capacity, or reserve area requirements for the onsite wastewater treatment facility at the residence, and ensures that the facility can handle the combined black water and greywater flow if the greywater system fails or is not fully used;
11. Any pressure piping used in a greywater system that may be susceptible to cross connection with a potable water system clearly indicates that the piping does not carry potable water;
12. Greywater applied by surface irrigation does not contain water used to wash diapers or similarly soiled or infectious garments unless the greywater is disinfected before irrigation; and
13. Surface irrigation by greywater is only by flood or drip irrigation.

B. Prohibitions. The following are prohibited:

1. Greywater use for purposes other than irrigation, and
2. Spray irrigation.

C. Towns, cities, or counties may further limit the use of greywater described in this Section by rule or ordinance.

Tier 2 Arizona Greywater Law–Systems of 400 to 3000 gpd, or which don't meet conditions for Tier 1 general permit

A. A Type 2 Reclaimed Water General Permit allows a greywater irrigation system if:

1. The general permit described in R18-9-711 does not apply,
2. The flow is not more than 3000 gallons per day, and
3. The greywater system satisfies the notification, design, and installation requirements specified in subsection (C).

B. A person shall file a Notice of Intent to Operate a Greywater Irrigation System with the Department at least 90 days before the date the proposed activity will start. The Notice of Intent to Operate shall include:

1. The name, address, and telephone number of the applicant;
2. The social security number of the applicant, if the applicant is an individual;
3. A legal description of the direct reuse site, including latitude and longitude coordinates;
4. The design plans for the greywater irrigation system;
5. A signature on the Notice of Intent to Operate certifying that the applicant agrees to comply with the requirements of this Article and the terms of this Reclaimed Water General Permit; and
6. The applicable permit fee specified under 18 A.A.C. 14.

C. The following technical requirements apply to the design and installation of a greywater irrigation system allowed under this Reclaimed Water General Permit:

1. Design of the greywater irrigation system shall meet the onsite wastewater treatment facility requirements under R18-9-A312(C), (D)(1), (D)(2), (E)(1), (G), and R18-9-E302(C)(1), except the septic tank specified in R18-9-E302(C)(1) is not required if pretreatment of greywater is not necessary for the intended application;
2. Design of the dispersal trenches for the greywater irrigation system shall meet the onsite wastewater treatment facility requirements for shallow trenches specified in R18-9-E302(C)(2);
3. The depth of the greywater dispersal trenches shall be appropriate for the intended irrigation use but not more than 5 feet below the finished grade of the native soil; and
4. The void space volume of the aggregate fill in the greywater dispersal trench below the bottom of the distribution pipe shall have enough capacity to contain two days of greywater at the design flow.

D. The Department may review design plans and details and accept a greywater irrigation system that differs from the requirements specified in subsection (C) if the system provides equivalent performance and protection of human health and water quality.

Tier 3 Arizona Greywater Law–Systems Over 3000 gallons a day

Applies to large facilities.

Water Quality Division
RULE CLARIFICATION

RC#: 012A	Title: 18	Chapter: 9	Article: 3	Rule Citation: A.A.C. R18-9-701(4); R18-9-E303
Date Issued: 4/27/05			Supersedes Rule Clarification # 12, dated 5/11/01	

Topic of Rule Needing Clarification:

Kitchen sink wastewater disposal for a single family dwelling using composting toilet technology for managing all human excreta generated on the property.

Text of Rule Needing Clarification:

A.A.C. R18-9-701(4) "Gray water" means wastewater collected separately from a sewage flow that originates from a clothes washer, bathtub, shower, and sink, but does not include wastewater from a kitchen sink, dishwasher, or toilet."

Questions Needing Clarification:

If a composting toilet and gray water system is proposed for installation to serve a single family dwelling, how can the discharge from the dishwasher and/or kitchen sink be handled?

Clarification of Rule:

In some instances, a single family dwelling may be proposed for use with a composting toilet and a gray water system. Since the definition of gray water does not include the wastewater from a dishwasher and/or kitchen sink, additional treatment of this wastewater is required. However, the current general permit rule for composting toilets, A.A.C. R18-9-E303, does not address the management of wastewater containing flows from a dishwasher and/or a kitchen sink. One method of acceptable treatment is to route dishwasher and/or kitchen sink wastewater through an interceptor to trap grease and solids, followed by routing to a subsurface disposal works. This rule clarification provides criteria for two situations in which dishwasher and/or kitchen sink wastewater is routed through an interceptor into a subsurface disposal works: 1) Gray water is used at the property in accordance with the Type 1 Reclaimed Water General Permit for gray water (A.A.C. R18-9-711), therefore only dishwasher and/or kitchen sink flows are routed through the interceptor to subsurface disposal and 2) all non-toilet wastewater is combined and routed through the interceptor to subsurface disposal (that is, gray water is not separately collected and reused under A.A.C. R18-9-711). Review of the treatment and disposal works for the dishwasher and/or kitchen sink wastewater will be done as part of the overall review of the Notice of Intent to Discharge for the 4.03 composting toilet general permit. The following applies.

A. Notice of Intent to Discharge. In addition to the Notice of Intent to Discharge requirements specified in A.A.C. R18-9-A301(B), R18-9-A309(B), and R18-9-E303(D), the applicant shall submit the following information:
   1. The number of bedrooms in the dwelling or persons served on a daily basis, as applicable, and the corresponding design flow of the disposal works for the wastewater;
   2. The results from soil evaluation or percolation testing that adequately characterize the soils into which the wastewater will be dispersed and the locations of soil evaluation and percolation testing on the site plan; and
   3. The design for the disposal works per subsection (B) of this rule clarification including the location of the interceptor, the location and configuration of the trench or bed used for wastewater dispersal, the location of connecting wastewater pipelines, and the location of the reserve area.

B. Design requirements for the wastewater disposal works.

1. Interceptor. An applicant shall ensure that the design complies with the following:
   a. Wastewater passes into an interceptor before it is conducted to the subsurface for dispersal;
   b. The interceptor is designed to remove grease, oil, fibers, and solids to ensure long-term performance of the trench or bed used for subsurface dispersal;
   c. The interceptor is covered to restrict access and eliminate habitat for mosquitoes and other vectors; and
   d. Minimum interceptor size is based on design flow.
      i. For a dwelling, the following apply:

No. of Bedrooms	Design Flow (gallons Per day)	Minimum Interceptor Size (gallons)	
		Kitchen Wastewater Only (All gray water sources are collected and reused)	Combined Non-Toilet Wastewater (Gray water is not separated and reused)
1 (7 fixture units or less)	90	42	200
1-2 (greater than 7 fixture units)	180	84	400
3	270	125	600
4	330	150	700
5	380	175	800
6	420	200	900
7	460	225	1000

      ii. For other than a dwelling, minimum interceptor size in gallons is 2.1 times the design flow from *Table 1, Unit Design Flows*.

2. Dispersal of wastewater. An applicant shall ensure that the design complies with the following:
   a. Wastewater is disposed into the subsurface to prevent any wastewater from surfacing.
   b. A trench or bed is used to disperse the wastewater into the subsurface;
   c. Sizing of the trench or bed is based on the design flow of wastewater as determined in subsection (B)(1)(d) and an SAR determined under A.A.C. R18-9-A312(D);
   d. The minimum vertical separation from the bottom of the trench or bed to a limiting subsurface condition is at least 5 feet; and
   e. Other aspects of trench or bed design follow A.A.C. R18-9-E302, as applicable.
3. Setback distances. Setback distances are no less than 1/4 of the setback distances specified in A.A.C. R18-9-A312(C), but not less than 5 feet, except the setback distance from wells is 100 feet.

C. Operation and maintenance requirements. For a wastewater disposal works, a permittee shall:

1. Ensure that the interceptor is maintained regularly according to manufacturer's instructions to prevent grease and solid wastes from impairing performance of the trench or bed used for dispersal of wastewater, and
2. Protect the area of the trench or bed from soil compaction or other activity that will impair dispersal performance.

D. Information submittal, design, and operation and maintenance requirements for the composting toilet portion of the facility are as specified in A.A.C. R18-9-E303.

E. If a flush toilet is installed on the property, a new Notice of Intent must be submitted per the provisions of A.A.C. R18-9-A305(B).

Appendix C: Arizona Greywater Law – Comments & Improvements

[This section includes excerpts from: Oasis Design. "Greywater Policy Packet." 2005]

Greywater regulation in Arizona has the following brilliant aspects:

- Regulators apply oversight to greywater systems in rational proportion to their possible impacts, using a three-tiered system
- People with low-volume, low-risk systems don't have to apply for a permit to comply with the law
- The law gives performance goals, not proscribed design specifics
- They have a short, simply worded law and a longer explanatory booklet

This is *the* model to emulate—the Arizona method makes so much sense it is hard to justify regulating greywater any other way. New Mexico has passed a similar law, Texas a somewhat similar one, and other states are considering it.

The three tiers:

1. **Systems for less than 400 gpd that meet a list of reasonable requirements** are all covered under a general permit without the builder having to apply for anything. With this one stroke, Arizona has raised its compliance rate from near zero to perhaps 50%. And, homeowners are more likely to work toward compliance for the informal systems that still fall short of the low bar for this first regulatory tier. What's more, the door is now open for *professionals* to install simple systems.
2. **Systems that process over 400 gpd, don't meet the list of requirements, and/or commercial, multi-family, and institutional systems** require a standard permit under the second tier.
3. **Systems over 3,000 gpd**—the third tier—are given attention by regulators on an individual basis.

The following diagram shows Arizona's law for tier-one systems with suggested improvements in underline.

Annotated Arizona Greywater Law
R18-9-711. Type 1 Reclaimed Water General Permit for Gray Water

(~~Strike through~~ denotes Oasis-suggested deletions, underline denotes additions)

[From definitions:] "Graywater" means wastewater that originates from residential clothes washers, bathtubs, showers, and sinks, but does not include wastewater from ~~kitchen sinks, dishwashers and~~ toilets.

A. A Type 1 Reclaimed Water General Permit allows private residential direct reuse of gray water for a flow of less than 400 gallons per day if all the following conditions are met:

1. Human contact with gray water and soil irrigated by gray water is avoided;
2. Gray water originating from the residence is used and contained within the property boundary for household gardening, composting, lawn watering, or landscape irrigation;
3. Surface application of gray water is not used for irrigation of food plants~~, except for citrus and nut trees;~~ which have an edible portion that comes in direct contact with greywater;
4. The gray water does 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;
5. The application of gray water is managed to minimize standing water on the surface, for example, by splitting the flow, moderate application rates, and generous mulching;
6. The gray water system is constructed so that if blockage, plugging, or backup of the system occurs, gray water can be directed into the sewage collection system or onsite wastewater treatment and disposal system, as applicable (except as provided for under 10, below). The gray water system may include a means of filtration to reduce plugging and extend system lifetime;
7. Any gray water storage tank is covered to restrict access and to eliminate habitat for mosquitoes or other vectors;
8. The gray water system is sited outside of a floodway;
9. The gray water system is operated to maintain a minimum vertical separation distance of at least five feet from the point of gray water application to the top of the seasonally high groundwater table;
10. For residences using an onsite wastewater treatment facility for black water treatment and disposal, the use of a gray water system does not change the design, capacity, or reserve area requirements for the onsite wastewater treatment facility at the residence, and ensures that the facility can handle the combined black water and gray water flow if the gray water system fails or is not fully used. Alternatively, the greywater system shall be designed with two valved zones, each of which can accommodate the full expected greywater volume. Providing the greywater system passes a flow test in each zone, the capacity of the on-site system may be reduced, or in the instance that an approved composting toilet system is present, eliminated;
11. Any pressure piping used in a gray water system that may be susceptible to cross connection with a potable water system clearly indicates that the piping does not carry potable water;
12. Gray water applied by surface irrigation does not contain water used to wash diapers or similarly soiled or infectious garments unless the gray water is disinfected before irrigation; and
13. Surface irrigation by gray water is only by flood or drip irrigation. Containment within horticultural basins or swales is encouraged for flood irrigation;
14. It is required that kitchen sink water be applied subsoil or contained within a rat-proof outlet shield;
15. Greywater diverter valves should be downstream from traps and vents in plumbing that leads to septic or sewer.

B. Prohibitions. The following are prohibited:

1. Gray water use for purposes other than irrigation, and
2. Spray irrigation.

C. Towns, cities, or counties may further limit the use of gray water described in this Section by rule or ordinance.

Appendix D: California Greywater Law

[The following is an excerpt from: Oasis Design. "Greywater Policy Packet." 2005]

APPENDIX G
GRAYWATER SYSTEMS

Title 24, Part 5, California Administrative Code

G 1 Graywater Systems (General)

(a) The provisions of this Appendix shall apply to the construction, installation, alteration and repair of graywater systems for subsurface landscape irrigation. The graywater system shall not be connected to any potable water system without an air gap (a space or other physical device which prevents backflow) and shall not result in any surfacing of the graywater. Except as otherwise provided for in this Appendix, the provisions of the Uniform Plumbing Code (UPC) shall be applicable to graywater installations.

(b) The type of system shall be determined on the basis of location, soil type, an ground water level and shall be designed to accept all graywater connected to the system from the building. The system shall discharge into subsurface irrigation fields and may include surge tank(s) and appurtenances, as required by the Administrative Authority.

(c) No graywater system, or part thereof, shall be located on any lot other than the lot which is the site of the building or structure which discharges the graywater; nor shall any graywater system or part thereof be located at any point having less than the minimum distances indicated in Table G-1.

(d) No permit for any graywater system shall be issued until a plot plan with appropriate data satisfactory to the Administrative Authority has been submitted and approved. When there is insufficient lot area or inappropriate soil conditions for adequate absorption of the graywater, as determined by the Administrative Authority, no graywater system shall be permitted. The Administrative Authority is a city or county.

(e) No permit shall be issued for a graywater system which would adversely impact a geologically sensitive area, as determined by the Administrative Authority.

(f) Private sewage disposal systems existing or to be constructed on the premises shall comply with Appendix I of this code or applicable local ordinance. When abandoning underground tanks, Section 722.0 of the UPC shall apply. Also, appropriate clearances from graywater systems shall be maintained as provided in Table G-1. The capacity of the private sewage disposal system, including required future areas, shall not be decreased by the existence or proposed installation of a graywater system servicing the premises.

(g) Installers of graywater systems shall provide an operation and maintenance manual, acceptable to the Administrative Authority, to the owner of each system. Graywater systems require regular or periodic maintenance.

(h) The Administrative Authority shall provide the applicant a copy of this Appendix.

G 2 Definitions

Graywater is untreated wastewater which has not come into contact with toilet waste. Graywater includes wastewater from bathtubs, showers, bathroom wash basins, clothes washing machines, and laundry tubs, or an equivalent discharge as approved by the Administrative Authority. It does not include wastewater from kitchen sinks, photo lab sinks, dishwashers, or laundry water from soiled diapers. Surfacing of graywater means the ponding, running off, or other release of graywater from the land surface.

G 3 Permit

It shall be unlawful for any person to construct, install or alter, or cause to be constructed, installed or altered any graywater system in a building or on premises without first obtaining a permit to do such work from the Administrative Authority.

G 4 Drawings and Specifications

The Administrative Authority may require any or all of the following information to be included with or in the plot plan before a permit is issued for a graywater system:

(a) Plot plan drawn to scale completely dimensioned, showing lot lines and structures, direction and approximate slope of surface, location of all present or proposed retaining walls, drainage channels, water supply lines, wells, paved areas and structures on the plot, number of bedrooms and plumbing fixtures in each structure, location of private sewage disposal system and 100 percent expansion area or building sewer connecting to public sewer, and location of the proposed graywater system.

(b) Details of construction necessary to ensure compliance with the requirements of this Appendix together with full description of the complete installation including installation methods, construction and materials as required by the Administrative Authority.

(c) A log of soil formations and ground water level as determined by test holes dug in close proximity to any proposed irrigation area, together with a statement of water absorption characteristics of the soil at the proposed site as determined by approved percolation tests. In lieu of percolation tests, the Administrative Authority may allow the use of Table G-2, an infiltration rate designated by the Administrative Authority, or an infiltration rate determined by a test approved by the Administrative Authority.

(d) A characterization of the graywater for commercial, industrial, or institutional systems, based on existing records or testing.

G 5 Inspections and Testing

(a) Inspection

1. All applicable provisions of this Appendix and of Section 103.5 of the UPC shall be complied with.
2. System components shall be properly identified as to manufacturer.

3. Surge tanks shall be installed on dry, level, well-compacted soil if in a drywell, or on a level, three inch concrete slab or equivalent, if above ground.
4. Surge tanks shall be anchored against overturning
5. If the irrigation design is predicated on soil tests, the irrigation field shall be installed at the same location and depth as the tested area.
6. Installation shall conform with the equipment and installation methods identified in the approved plans.
7. Graywater stub-out plumbing may be allowed for future connection prior to the installation of irrigation lines and landscaping. Stub-out shall be permanently marked "GRAYWATER STUB-OUT, DANGER UNSAFE WATER."

(b) Testing

1. Surge tanks shall be filled with water to the overflow line prior to and during inspection. All seams and joints shall be left exposed and the tank shall remain watertight.

2. A flow test shall be performed through the system to the point of graywater irrigation. All lines and components shall be watertight.

G-6 Procedure for Estimating Graywater Discharge

(a) Single Family Dwellings and Multi-Family Dwellings

The Administrative Authority may utilize the graywater discharge procedure listed below, water use records, or calculations of local daily per person interior water use:

1. The number of occupants of each dwelling unit shall be calculated as follows:

First Bedroom	2 occupants
Each additional bedroom	1 occupant

2. The estimated graywater flows of each occupant shall be calculated as follows:

Showers, bathtubs and wash basins	25 GPD/occupant
Laundry	15 GPD/occupant

3. The total number of occupants shall be multiplied be the applicable estimated graywater discharge as provided above and the type of fixtures connected to the graywater system.

(b) Commercial, Industrial, and Institutional Projects

The Administrative Authority may utilize the graywater discharge procedure listed below, water use records, or other documentation to estimate graywater discharge:

1. The square footage of the building divided by the occupant load factor from UPC Table 10-A equals the numbers of occupants.
2. The number of occupants times the flow rate per person (minus toilet water and other disallowed sources) from UPC Table I-2 equals the estimated graywater discharge per day.

The graywater system shall be designed to distribute the total amount of estimated graywater discharged daily.

G 7 Required Area of Subsurface Irrigation

Each irrigation zone shall have a minimum effective irrigation area for the type of soil and infiltration rate to distribute all graywater produced daily , pursuant to Section G-6, without surfacing. The required irrigation area shall be based on the estimated graywater discharge, pursuant to Section G-6, size of surge tank, or a method determined by the Administrative Authority.

If a mini-leachfield irrigation system is used, the required square footage shall be determined from Table G-2, or equivalent, for the type of soil found in the excavation.

The area of the irrigation field shall be equal to the aggregate length of the perforated pipe sections within the irrigation zone times the width of the proposed mini-leachfield trench.

No irrigation point shall be within five vertical feet of the highest known seasonal groundwater nor where graywater may contaminate the groundwater or ocean water.

The applicant shall supply evidence of ground water depth to the satisfaction of the Administrative Authority.

G 8 Determination of Irrigation Capacity

(a) In order to determine the absorption quantities of soils other than those listed in Table G-2, the proposed site may be subjected to percolation tests acceptable to the Administrative Authority or determined by the Administrative Authority.

(b) When a percolation test is required, no mini-leach field system or subsurface drip irrigation system shall be permitted if the test shows the absorption capacity of the soil is less than 60 minutes/inch or more rapid than 5 minutes/inch, unless otherwise permitted by the Administrative Authority.

(c) The irrigation field size may be computed from Table G-2, or determined by the Administrative Authority or a designee of the Administrative Authority.

G 9 Surge Tank Construction (Figure 1)

(a) Plans for surge tanks shall be submitted to the Administrative Authority for approval. The plans shall show the data required by the Administrative Authority and may include dimensions, structural calculations, and bracing details.

(b) Surge tanks shall be constructed of solid, durable materials, not subject to excessive corrosion or decay and shall be watertight.

(c) Surge tanks shall be vented as required by Chapter 9 of this Code and shall have a locking, gasketed access opening, or approved equivalent, to allow for inspection and cleaning.

(d) Surge tanks shall have the rated capacity permanently marked on the unit. In addition, "GRAYWATER IRRIGATION SYSTEM, DANGER - UNSAFE WATER" shall be permanently marked on the surge tank.

(e) Surge tanks installed above ground shall have an overflow, separate from the line connecting the tank with the irrigation fields. The overflow shall have a permanent connection to

a sewer or to a septic tank, and shall be protected against sewer line backflow by a backwater valve. The overflow shall not be equipped with a shut-off valve.

(f) The overflow and drain pipes shall not be less in diameter than the inlet pipe. The vent size shall be based on the total graywater fixture units, as outlined in UPC Table 7-5 or local equivalent. Unions or equally effective fittings shall be provided for all piping connected to the surge tank.

(g) Surge tanks shall be structurally designed to withstand anticipated loads. Surge tank covers shall be capable of supporting an earth load of not less than 300 pounds per square foot when the tank is designed for underground installation.

(h) Surge tanks may be installed below ground in a dry well on compacted soil, or buried if the tank design is approved by the Administrative Authority. The system shall be designed so that the tank overflow will gravity drain to a sanitary sewer line or septic tank. The tank must be protected against sewer line backflow by a backwater valve.

(i) Materials

(1) Surge tanks shall meet nationally recognized standards for non potable water and shall be approved by the Administrative Authority.
(2) Steel surge tanks shall be protected from corrosion, both externally and internally, by an approved coating or by other acceptable means.

G 10 Valves and Piping

Graywater piping discharging into a surge tank or having a direct connection to a sanitary drain or sewer piping shall be downstream of an approved waterseal type trap(s). If no such trap(s) exists, an approved vented running trap shall be installed upstream of the connection to protect the building from any possible waste or sewer gasses. Vents and venting shall meet the requirements in Chapter 9 of the UPC. All graywater piping shall be marked or shall have a continuous tape marked with the words "DANGER - UNSAFE WATER." All valves, including the three-way valve, shall be readily accessible and shall be approved by the Administrative Authority. A backwater valve, installed pursuant to this Appendix, shall be provided on all surge tank drain connections to the sanitary drain or sewer piping.

G 11 Irrigation Field Construction

The Administrative Authority may permit subsurface drip irrigation, mini-leach field or other equivalent irrigation methods which discharge graywater in a manner which ensures that the graywater does not surface. Design Standards for subsurface drip irrigation systems and mini-leach field irrigation systems follow:

(a) Standards for a subsurface drip irrigation system are:

(1) Minimum 140 mesh (115 micron) filter with a capacity of 25 gallons per minute, or equivalent, filtration, sized appropriately to maintain the filtration rate, shall be used. The filter back-wash and flush discharge shall be caught, contained and disposed of to the sewer system, septic tank, or with approval of the Administrative Authority, a separate mini-leach field sized to accept all the backwash and flush discharge water. Filter backwash water and flush water shall

not be used for any purpose. Sanitary procedures shall be followed when handling filter back-wash and flush discharge of graywater.

(2) Emitters shall have minimum flow path of 1200 microns and shall have a coefficient of manufacturing variation (Cv) of no more than seven percent. Irrigation system design shall be such that emitter flow variation shall not exceed plus or minus ten percent. Emitters shall be recommended by the manufacture for subsurface use and graywater use, and shall have demonstrated resistance to root intrusion. For emitter ratings refer to: Irrigation Equipment Performance Report, Drip Emitters and Micro-Sprinklers, Center for Irrigation Technology, California State University, 5730 N. Chestnut Avenue. Fresno, California 93740-0018.

(3) Each irrigation zone shall be designed to include no less than the number of emitters specified in Table G-3, or through a procedure designated by the Administrative Authority. Minimum spacing between emitters is 14 inches in any direction.

(4) The system design shall provide user controls, such as valves, switches,timers, and other controllers as appropriate, to rotate the distribution of graywater between irrigation zones.

(5) All drip irrigation supply lines shall be polyethylene tubing or PVC class 200 pipe or better and schedule 40 fittings. All joints shall be properly solventcemented, inspected and pressure tested at 40 psi, and shown to be drip tight for five minutes, before burial. All supply lines will be buried at least eight inches deep. Drip feeder lines can be poly or flexible PVC tubing and shall be covered to a minimum depth of nine inches.

(6) Where pressure at the discharge side of the pump exceeds 20 pounds per square inch (psi), a pressure reducing valve able to maintain downstream pressure no greater than 20 psi shall be installed downstream from the pump and before any emission device.

(7) Each irrigation zone shall include a flush valve/anti-siphon valve to prevent back siphonage of water and soil.

(b) Standards for a mini-leach field system are:

(1) Perforated sections shall be a minimum 3-inch diameter and shall be constructed of perforated high density polyethylene pipe, perforated ABS pipe, perforated PVC pipe, or other approved materials, provided that sufficient openings are available for distribution of the graywater in the trench area. Material, construction and perforation of the piping shall be in compliance with the appropriate absorption field drainage piping standards and shall be approved by the Administrative Authority.

(2) Clean stone, gravel, or similar filter material acceptable to the Administrative Authority, and varying in size between 3/4 inch to 2 inches shall be placed in the trench to the depth and grade required by this Section. Perforated sections shall be laid on the filter material in an approved manner. The perforated sections shall

then be covered with filter material to the minimum depth required by this Section. The filter material shall then be covered with landscape filter fabric or similar porous material to prevent closure of voids with earth backfill. No earth backfill shall be placed over the filter material cover until after inspections and acceptance.

(3) Irrigation fields shall be constructed as follows:

	Minimum	*Maximum*
Number of drain lines per irrigation zone	*1*	---
Length of each perforated line	---	*100 feet*
Bottom width of trench	*6 inches*	*18 inches*
Total depth of trench	*17 inches*	*18 inches*
Spacing of lines, center to center	*4 feet*	---
Depth of earth cover of lines	*9 inches*	---
Depth of filter material cover of lines	*2 inches*	---
Depth of filter material beneath lines	*3 inches*	---
Grade of perforated lines	*level*	*3 inches/100 feet*

G 12 Special Provisions

(a) Other collection and distribution systems may be approved by the Administrative Authority as allowed by Section 301 of the UPC.

(b) Nothing contained in this Appendix shall be construed to prevent the Administrative Authority from requiring compliance with stricter requirements than those contained herein, where such stricter requirements are essential in maintaining safe and sanitary conditions or from prohibiting graywater systems. The prohibition of graywater systems or more restrictive standards may be adopted by the Administrative Authoriy by ordinance after a public hearing.

G 13 Health and Safety

(a) Graywater may contain fecal matter as a result of bathing and/or washing of diapers and undergarments. Water containing fecal matter, if swallowed, can cause illness in a susceptible person. Therefore, graywater shall be not be contacted by humans, except as required to maintain the graywater treatment and distribution system.

(b) Graywater shall not include laundry water from soiled diapers.

(c) Graywater shall not be applied above the land surface or allowed to surface and shall not be discharge directly into or reach any storm sewer system or any water of the United States.

(d) Graywater shall not be used for vegetable gardens.

Table G-1 Location of Graywater System.

Minimum Horizontal Distance (in feet) From	Surge Tank (feet)	Irrigation Field (feet)
Buildings or Structures (1)	*5ft (2)*	*8ft (3)*
Property line adjoining private property	*5ft*	*5ft (4)*
Water supply wells (5)	*50ft*	*100ft*
Streams and lakes (5)	*50ft*	*50ft*
Seepage pits or cesspools	*5ft*	*5ft*
Disposal field & 100% expansion area	*5ft*	*4ft (6)*
Septic tank	*0ft*	*5ft (7)*
On-site domestic water service line	*5ft*	*5ft (8)*
Pressure public water main	*10ft*	*10ft (9)*
Water ditches	*50ft*	*50ft*

Notes: When mini-leach fields are installed in sloping ground, the minimum horizontal distance between any part of the distribution system and ground surface shall be fifteen feet.

1. Including porches and steps, whether covered or uncovered, but does not include car ports, covered walks, driveways and similar structures.
2. The distance may be reduced to zero feet for above ground tanks if approved by the Administrative Authority.
3. The distance may be reduced to two feet.
4. For subsurface drip irrigation systems, 2 feet from property line.
5. Where special hazards are involved, the distance may be increased by the Administrative Authority.
6. Applies to the mini-leach fields type system only. Plus two feet for additional foot of depth in excess of one foot below the bottom of the drain line.
7. Applies to mini-leach field only.
8. A two foot separation is required for subsurface drip systems.
9. For parallel construction or for crossings, approval by the Administrative Authority shall be required.

Table G-2 Mini-Leach Field Design Criteria of Six Typical Soils.

Type of Soil	Minimum sq. ft. of irrigation area per 100 gallon of estimated graywater discharge per day	Maximum absorption capacity, minutes per inch of irrigation area for a 24-hour period
1. Coarse sand or gravel	*20*	*5*
2. Fine sand	*25*	*12*
3. Sandy loam	*40*	*18*
4. Sandy clay	*60*	*24*
5. Clay with considerable sand or gravel	*90*	*48*
6. Clay with small amount of sand or gravel	*120*	*60*

Table G-3 Subsurface Drip Design Criteria of Six Typical Soils.

Type of Soil	Maximum emitter discharge (gal/day)	Minimum number of emitters per gpd of graywater production
1. Sand	*1.8*	*0.6*
2. Sandy loam	*1.4*	*0.7*
3. Loam	*1.2*	*0.9*
4. Clay loam	*0.9*	*1.1*
5. Silty clay	*0.6*	*1.6*
6. Clay	*0.5*	*2.0*

Use the daily graywater flow calculated in Section G-6 to determine the number of emitters per line.

Appendix E: California Greywater Law – Comments & Suggested Improvements

[The following is an excerpt from: Oasis Design. "Greywater Policy Packet." 2005]

Summary:
California's new greywater law is an important step and certainly as well done as was politically possible. However, it's a step not quite in the right direction, which is unfortunate as it is being emulated all over the US and the world.

California is about to revise their greywater law as a consequence of the recent passage of Assembly Bill 313. This is an important opportunity to update this groundbreaking legislation. The current law, by mandating design specifics which eliminate every theoretical vestige of risk in every scenario, has greatly increased the public health threat from greywater systems. Santa Barbara, for example has issued approximately 10 permits for greywater systems since greywater was legalized in 1989b12. This is in an area with 200,000 people, as many as 40% of whom were using greywater in the last drought!b13 So many requirements are obviously overkill that the entire law, including some very sensible provisions, is dismissed as a source of design guidance. A more reasonable regulatory stance would lead to greater participation and a reduction in risk from the perpetuation of unregulated systems. As California's law is being taken as a model for other states and countries this is all the more vital.

In general

Take a tiered approach to regulating greywater like Arizona and New Mexico, with no permit application required for first tier, small residential systems that meet a list of requirements.

Wherever appropriate, require achievement of goals (e.g., ecologically and biologically safe treatment of wastewater), with explicit designs as options, rather than specifying mandatory techniques to be used.

Be more realistic about the quantitative health threat from greywater systems. There is a long history of surface greywater reuse (with systems far, far less safe than those specified in the current law) which has not produced a single documented case of greywater-transmitted illness in the United States.

In Australia greywater is legally distributed through sprinklers with 6 foot throw. The City of Los Angeles Greywater Pilot Project showed that dog feces were a far greater contributor to pathogens in soil than greywater irrigation. Even the worst illegal greywater systems don't stand out among myriad sources that besiege our bodies with pathogens in the course of ordinary life. The actual health threat is small enough to include ecological and practical considerations along with public heath considerations.

Consider exposure from required maintenance in comparing the relative health risk of systems. Local jurisdictions should consider the effect of high permit fees on participation in the legal process. In our area a greywater permit costs $75, increasing the attractiveness of simple, illegal systems, which already have dramatically superior cost/benefit ratios to currently legal systems in most situations.

Change the Uniform Plumbing Code to require greywater and blackwater to be plumbed separately for all new construction of single family homes on ¼ acre or more. The lines should be joined after all the fixtures and vents and at or after a convenient future greywater diversion point.

Specific suggestions

J-1-a Allow commercial and multifamily systems (this change is already approved). This is a serious problem with the current law.

J-1-f Allow reduction in size or elimination of septic/sewer system at the discretion of the Administrative Authority, if the alternative waste disposal system(s) are capable of handling all wastes as well or better. There are sites and regions where currently mandated treatment technologies cause more ecological and health problems than proven alternatives.

J-2 Redefine kitchen sink and dishwasher effluent as "difficult to handle greywater" (rather than blackwater) and allow its use the discretion of the Administrative Authority, if the hardware is demonstrably able to handle it. This high solids water is a (solvable) hardware design problem, not a soil or public health problem.

J-7 Allow greywater systems in areas with high groundwater at the discretion of the Administrative Authority (a proper greywater system design can provide better treatment and protect groundwater better than currently mandated systems).

J-7 Eliminate the requirement for two irrigation zones which are each capable of accepting the entire greywater flow, if there is a disposal alternative. This ill-thought through requirement eliminates the possibility of meeting all the irrigation needs of an area with greywater, whether it makes sense or not. It effectively mandates the installation of a redundant freshwater irrigation system, which would severely undermine the economics of some systems, particularly commercial or multifamily systems. High end greywater systems are capable of distributing freshwater as needed for supplemental irrigation without wasteful hardware duplication. This is a serious problem with the current law.

J-7, J-8, Table J-2, Table J-3 Explicitly allow reduction in system design loads with water conserving fixtures. The current language allows local discretion in this area but the possibility is not obvious.

J-8-b Allow greywater systems across a wider range of percolation rates. Greywater systems can be safer at percolation extremes than septic systems.

J-9-e Delete the requirement for a gravity drain for surge tanks. A gravity drain is a nice convenience but it is a practical impossibility for many installations. Note that current law does not require a gravity drain for underground greywater surge tanks, septic tanks, or sewage ejector pump tanks. This is a serious problem with the current law.

J-9-h Require below grade tanks to be anchored against popping to the surface if conditions indicate this may be a problem. Unlike septic tanks, greywater surge tanks are often empty and experience tremendous buoyant lift under saturated soil conditions.

J-11-a-2 Modify the requirement that "system design shall be such that emitter flow variation shall not exceed plus or minus 10%" with the phrase "in instances where greater variation could result in flows high enough to produce per emitter ponding in the soil in question."

J-11-a-6 Change wording from "pressure at pump shall not exceed 20 psi" to "pressure at any emission device not exceed 20 psi." The current wording effectively precludes irrigation with adequate pressure at a location significantly higher than the pump.

J-11-a-5, J-11-b-2 Explicitly allow greywater to be distributed and emitted through lines covered by mulch at the discretion of the Administrative Authority.

J-11-b-1 Allow smaller diameter pipes in mini-leachfields, allow half-pipes in mini-leachfields. Table J-1 Allow installations on steeper slopes where environmental conditions are such that the water will not surface.

Explicitly describe "Infiltration beds," "Leaching Chambers," "Box Troughs," (see Create an Oasis with Greywater"), and "hard plumbing to minileachfields" (see pages 11-14) as allowed system examples.

Figures: Show a greywater surge tank rather than a sewage ejector pump tank in figures.

Allow the use of swing check valves instead of expensive backwater valves.

Allow greywater surge tank to be vented back through the house vents (as is done with all septic tanks and sewers) as an alternative to a vent at the tank.

Appendix F: International Pluming Code – Comments and Suggested Improvements

[The following is an excerpt from: Oasis Design. "Greywater Policy Packet." 2005]

Based on 2000 IPC, appendix c, page 101:

c101.1 Differentiate between allowable uses for treated and untreated greywater. As it stands, reuse for toilet flushing is allowed with disinfection only, which may not be satisfactory if BOD remains high ° toilet tanks may become foul and anaerobic with stored, putrefying water. Treated greywater could be reused for other non-potable uses besides those listed, laundry for example. Irrigation should be specifically allowed, not just as an exception.

c101.2 Expand definition to include all domestic wastewater other than toilet water. Exclusion of kitchen sink water leaves this particular wastewater flow in awkward limbo in facilities which have a greywater system and composting toilets. Instead, give performance requirements for dealing with high SS, BOD water.

c101.4 Reservoir. The reservoir should be optional, as storing greywater is not required for all system types and is undesirable. The not less than 50 gallons and not more than 72 hours retention requirements are potentially at odds with each other. 24 hours maximum retention is a better design goal, with the tank size left up to the designer.

c101.6 Disinfection. Disinfection should not be required for irrigation reuse.

c101.7 Makeup water. Should be optional depending on reuse. Toilet flushing requires makeup water for public health, irrigation does not.

c101.8 Overflow. Overflow pipe should be the same size or greater than the influent pipe. Allow possibility of connecting to alternate overflow as an exception, in order that facilities with composting toilets and greywater systems have the option of adding redundancy and safety features to these systems instead of a sewer hookup or septic system, or that if a septic system is required it may be downsized.

Appendix G: Provisions in Municipal Sewage Regulation for Reclaimed Water Uses

Effluent disinfection

2) A person must not use chlorine to disinfect an effluent which is to be discharged to surface water unless the effluent is dechlorinated before discharge.

(3) If dechlorination is required in accordance with subsection (2) or (7), the discharger must dechlorinate the effluent to reduce the chlorine residual below 0.01 mg/L total residual chlorine before discharge.

Use of reclaimed water

10 (1) A person must not provide or use reclaimed water unless

(d) an environmental impact study has been conducted in accordance with condition 8 in Schedule 1.

(7) No person may provide for the use of reclaimed water unless specifically authorized

(a) in writing by the local health authority having jurisdiction, or

(b) under a local service area bylaw under which the municipality or a private corporation under contract to the municipality assumes the responsibility for ensuring compliance with this regulation and that proper operation and maintenance will be carried out.

(8) For the unrestricted public access category, a person must not be a provider of reclaimed water unless the person

(a) develops, to the satisfaction of a director, user information and communication materials related to the use of reclaimed water, and

(b) provides annually to all users copies of the materials required by paragraph (a).

Discharges to ground

12 A person must not introduce effluent to ground unless

(a) the effluent quality standards for discharges to ground as set out in Schedule 4 or 5 are met, and

(b) an environmental impact study has been conducted in accordance with condition 8 in Schedule 1.

General

24 Discharge of effluent or use of reclaimed water is prohibited, unless monitoring of effluent or reclaimed water and the receiving environment is undertaken by the discharger to determine compliance with this regulation.

Discharge monitoring

26 (1) In order to satisfy the requirements of section 24, the discharger must

(a) unless directed otherwise by a director in writing, install a suitable sampling facility for obtaining a sample of the effluent,

(b) unless directed otherwise by a director in writing, provide and maintain a suitable flow measuring device to record the effluent volume discharged over a 24-hour period, and

(c) monitor effluent quantity and quality as stipulated in Schedule 6, or as directed by a director in writing.

(2) The discharger must ensure that the projected monitoring dates for the next year must be outlined in the annual report required in section 28.

Table 2 — Discharges to Land

Effluent Class	Flow Category	Maximum Daily Flow Range (m^3/d)	Frequency of Data Submission to Director	Flow (4)	BOD_5, (3), TSS		Nitrogen Total, NO_3 as N		Turbidity		Fecal Coliforms	
				Freq.	Freq.	Type	Freq.	Type	Freq.	Type	Freq.	Type
D	1	<50	2X/Y	W	N	—	N	—	N	—	N	—
D	2	≥50 - <500	2X/Y	2 X/W	N	—	N	—	N	—	N	—
D	3	≥500	Q	D	N	—	N	—	N	—	N	—
C	1	<50	2X/Y	W	Q	G	N	—	N	—	N	—
C	2	≥50 - <500	2X/Y	2 X/W	M	G	N	—	N	—	N	—
C	3	≥500	Q	D	2 X/M	C3	N	—	N	—	N	—
B	1	<50	2X/Y	W	M	G	N	—	N	—	N	—
B	2	≥50 - <500	2X/Y	2X/W	2 X/M	G	N	—	N	—	N	—
B	3	≥500	Q	D	W	C3	N	—	N	—	N	—
A	1	<50	2X/Y	W	M	G	M	G	M	G	M	G
A	2	≥50 - <500	2X/Y	2 X/W	2 X/M	G	2 X/M	G	W	G	W	G

A	3	≥500	Q	D	W	C3	W	C3	D	C3	D (7)	C3

< means less than ≥ means greater than or equal to

Table 3 — Toxicity Monitoring Requirements for Discharges to Surface Waters

Flow Category	Maximum Daily Flow Range(m^3/d)	Frequency of Data Submission to Director	Toxicity (8)			
			Column 4 - Regular (9)		Column 5 - After Confirmed Failure (10)	
			Freq.	Type	Freq.	Type
0	<10	N	N	—	N	—
1	≥10 - <500	1/3Y	1/3Y	G	Q	G
2	≥500 - <5000	1/2Y	1/2Y	G	Q	G
3	≥5000 - <25000	A	A	G	6X/Y	G
3a	≥25000 - <50,000	2X/Y	Q	C3	2X/M	C3
4	≥50,000 - <200,000	Q	6X/Y	C3	W	C3
5	≥200,000	M	M	C3	W	C3

< means less than ≥ means greater than or equal to

Appendix 1 to Schedule 6
Explanatory Notes

1 All of these requirements are minimum for the first two years of discharge after which, based on the monitoring data, written recommendations of a qualified professional, or any other information related to the discharge or the receiving environment, a director may in writing alter these requirements.

2 Sampling Frequency (Freq.) and Type

N = No monitoring requirement
1/3Y = Once every three years
1/2Y = Once every two years
A = Annually
Q = Quarterly
2 X/Y = Two times per year

6 X/Y = Six times per year

M = Monthly

2 X/M = Two times per month

W = Weekly

2 X/W = Two times per week

5 X/W = Five times per week

D = Daily

C_3 = Sample composited in proportion to flow over 24 hours.

G = Grab sample

Appendix H: Provisions in the Drinking Water Protection Act

Excerpted definitions from the Drinking Water Protection Act

"domestic purposes" means the use of water for

(a) human consumption, food preparation or sanitation,

(b) household purposes not covered by paragraph (a), or

(c) other prescribed purposes;

"domestic water system" means a system by which water is provided or offered for domestic purposes, including

(a) works used to obtain intake water,

(b) equipment, works and facilities used for treatment, diversion, storage, pumping, transmission and distribution,

(c) any other equipment, works or facilities prescribed by regulation as being included,

(d) a tank truck, vehicle water tank or other prescribed means of transporting drinking water, whether or not there are any related works or facilities, and

(e) the intake water and the water in the system,

but excluding equipment, works or facilities prescribed by regulation as being excluded;

"intake water" means, in relation to a domestic water system, the water at or near the point of intake into the system;

"potable water" means water provided by a domestic water system that

(a) meets the standards prescribed by regulation, and

(b) is safe to drink and fit for domestic purposes without further treatment;

Excerpts from Drinking Water Protection Regulation

Definitions

1 In this regulation:

"Act" means the *Drinking Water Protection Act*;

"building system" means a system, within a building, to which the British Columbia Plumbing Code applies, that receives water from a water supply system operating under a valid operating permit under the Act;

"connection" means the line from the water main to a dwelling, campsite or premises;

"small system" means a water supply system that serves up to 500 individuals during any 24 hour period.

[en. B.C. Reg. 352/2005, s. 1; am. B.C. Reg. 5/2007, App. 1, s. 1.]

Standards for potable water

2 The prescribed water quality standards for potable water are set out in Schedule A.

Domestic water system

3 The following are excluded from the definition of "domestic water system" in the Act:

(a) equipment, works and facilities constructed, operated or maintained
(i) under a licence, as defined in the *Water Act*, for conservation, power or storage purposes,
(ii) under a permit issued under the *Water Act*,
(iii) for bottled water production or distribution, or
(iv) for drinking water dispensing machines;

(b) a reservoir relating to a licence or permit referred to in paragraph (a);
(c) a building system.

Health Act Excerpts

Powers of local board to enforce the termination of health hazards

59 (1) Subject to subsection (1.1), a local board may make an order under this section if any of the following apply:

(a) an order under section 63 against an owner or occupier of land or premises within its area or jurisdiction has not been complied with and the medical health officer requests the local board to act under this section;

(b) the local board has reason to believe that a health hazard exists;
(c) the medical health officer advises the local board that a health hazard exists.

(1.1) If a health hazard referred to in subsection (1) appears to be wholly or partially caused by an act or default committed outside its area of jurisdiction, the board may make an order under this section that is effective outside that area, but only on the recommendation of the Provincial health officer.

(1.2) If authorized under this section, the local board may, as applicable,
(a) order the owner or occupier of the land or premises on which the health hazard exists or from which the health hazard arises to terminate the health hazard in accordance with the order, or

(b) order the owner or occupier to comply with the order under section 63, with a view to taking action in default under subsection (3) of this section if the person does not comply.

(1.3) An order under this section
(a) must be served on the owner or occupier to whom it is directed, and
(b) must set out the reasons why it was made, what the owner or occupier is required to do and the time within which this must be done.

(1.4) If the order is directed to an occupier, a copy of the order must also be promptly served on the owner.
(2) If it appears that the health hazard does not arise or is not continued by the act or default of the owner or occupier or from the nature of the premises themselves, and it is therefore improper that the owner or occupier should be required to terminate the health hazard, the local board may terminate the health hazard at the expense of the municipality, if in a municipality, and if in a rural area, then, subject to the approval of the Minister of Finance, out of money voted by the Legislature available for the purposes of this Act.

(3) If a local board makes an order under this section, the local board may

(a) direct that, if the person fails to take the action required by the order, the action is to be done at the expense of that person, with the costs and expenses recoverable under section 74 or 75, and

(b) authorize officers, employees and agents of the local board to enter at all reasonable times on or into any property that is subject to the order for the purpose of

(i) determining whether the order is being complied with, or
(ii) taking action in default under paragraph (a).

(4) As restrictions on subsection (3),

(a) except in the case of an emergency, a person authorized under that subsection must take reasonable steps to notify the owner or occupier before entering the property, and

(b) the authority must not be used to enter a private dwelling except with the consent of the occupant or as authorized by a warrant under this or another Act.

Inspection authority

61 (1) A health officer, medical health officer or public health inspector may enter on or into any property and conduct an inspection for the purpose of determining

(a) whether a health hazard exists, or
(b) whether this Act and the regulations are being complied with.

(2) The authority under subsection (1) must not be used to enter a private dwelling except with the consent of the occupant or as authorized by a warrant under this or another Act.

Appendix J: Rainwater Harvesting

[This section includes excerpts from: Texas Water Development Board. "The Texas Manual on Rainwater Harvesting". 3rd ed. 2005.]

Definitions and Benefits

Rainwater Harvesting' refers to the collection and storage of rain. Collection is usually from rooftops, and storage in catchment tanks. Stored water can be used for non-potable purposes such as irrigating lawns, washing cars, or flushing toilets. Rainwater harvesting systems can range from a simple barrel at the bottom of a downspout to multiple tanks with pumps and controls.

Benefits of Rainwater Harvesting

- The water is free; the only cost is for collection and use.
- The end use of harvested water is located close to the source, eliminating the need for complex and costly distribution systems.
- Rainwater provides a water source when groundwater is unacceptable or unavailable, or it can augment limited groundwater supplies.
- The zero hardness of rainwater helps prevent scale on appliances, extending their use; rainwater eliminates the need for a water softener and the salts added during the softening process.
- Rainwater is superior for landscape irrigation.
- Rainwater harvesting reduces flow to stormwater drains and also reduces non-point source pollution.
- Rainwater harvesting helps utilities reduce the summer demand peak and delay expansion of existing water treatment plants.
- Rainwater harvesting can reduce consumers' utility bills.

Key Issues

Water Quality

The key to choosing building materials for all parts of a rainwater harvesting system is to select materials that are non toxic and inert (non leaching.) This is particularly true of the roof that is subject to the oxidizing affects of sun and air borne pollutants. Other sources of contamination are lead flashings around sky lights or plumbing vents. Water quality from different roof catchments is a function of the type of roof material, climate conditions, and surrounding environment. When choosing a roofing material - the smoother the better. The quantity of rainwater that can be collected is also a function of roof texture.

Types, Design, and Technologies

Rainwater harvesting systems can be as simple as a rain barrel for garden irrigation at the end of a downspout, or as complex as a domestic potable system or a multiple end-use system at a large corporate campus.

Regardless of the complexity of the system, the domestic rainwater harvesting system

comprises six basic components:

1. *Catchment surface:* the collection surface from which rainfall runs off. Due to leaching of toxins, composite shingles are not appropriate for potable systems, but can be used to collect water for irrigation. Composite roofs have an approximated 10-percent loss due to inefficient flow or evaporation (Radlet and Radlet, 2004).

2. *Gutters and downspouts*: channel water from the roof to the tank. For potable water systems, lead cannot be used as gutter solder, as is sometimes the case in older metal gutters. The slightly acidic quality of rain could dissolve lead and thus contaminate the water supply.

3. *Leaf screens, first-flush diverters, and roof washers*: components which remove debris and dust from the captured rainwater before it goes to the tank. A roof can be a natural collection surface for dust, leaves, blooms, twigs, insect bodies, animal feces, pesticides, and other airborne residues. The firstflush diverter routes the first flow of water from the catchment surface away from the storage tank. The flushed water can be routed to a planted area. While leaf screens remove the larger debris, such as leaves, twigs, and blooms that fall on the roof, the first-flush diverter gives the system a chance to rid itself of the smaller contaminants, such as dust, pollen, and bird and rodent feces. The roof washer, placed just ahead of the storage tank, filters small debris for potable systems and also for systems using drip irrigation.

4. *Storage tanks*: also called cisterns. The storage tank is the most expensive component of the rainwater harvesting system. The size of storage tank or cistern is dictated by several variables: the rainwater supply (local precipitation), the demand, the projected length of dry spells without rain, the catchment surface area, aesthetics, personal preference, and budget. Storage tank basics include:

    - Storage tanks must be opaque, either upon purchase or painted later, to washer inhibit algae growth.
    - For potable systems, storage tanks must never have been used to store toxic materials.
    - Tanks must be covered and vents screened to discourage mosquito breeding.
    - Tanks used for potable systems must be accessible for cleaning.

5. *Treatment systems (for potable use):* For potable water systems, treatment beyond the leaf screen and roof washer is necessary to remove sediment and disease-causing pathogens from stored water. Treatment generally consists of filtration and disinfection processes in series before distribution to ensure health and safety. Treatment systems can include:

    - Cartridge Filters and Ultraviolet (UV) Light
    - Ozone
    - Membrane filtration
    - Chlorination

6. *Delivery system*: gravity-fed or pumped to the end use

From a financial perspective, the installation and maintenance costs of a rainwater harvesting system for potable water cannot compete with water supplied by a central utility, but is often cost-competitive with installation of a well in rural settings.

With a very large catchment surface, such as that of big commercial building, the volume of rainwater, when captured and stored, can cost-effectively serve several end uses, such as landscape irrigation and toilet flushing. Some commercial and industrial buildings augment rainwater with condensate from air conditioning systems. During hot, humid months, warm, moisture-laden air passing over the cooling coils of a residential air conditioner can produce 10 or more gallons per day of water.

Learning from Other Jurisdictions

Many cities have adopted creative, low-cost ways to stop wasting rainwater by diverting it from their sewage systems and putting it to use where it falls. Here are some examples:

Seattle
Seattle's P-Patch Community Garden Program has created rainwater-harvesting systems and issued urban-design guidelines that promote paving with porous surfaces, landscaping planting strips and setbacks, and vertical and rooftop landscaping.

In April 2002, the city of Seattle adopted Resolution 30454 on wastewater reuse and rainwater reclamation. Seattle Public Utilities is recommending changes to the city's land use and building codes that encourage water conservation and has sponsored wildly successful sales of rain barrels to Seattle residents.

Austin
Austin, Texas, offers rebates of up to $30 for newly installed rain barrels and of up to $500 for installation of a rainwater harvesting system, following approval of its design by the City.

Portland

Permits are not needed to use collected rainwater outside the house.

To use it indoors for purposes like toilet flushing, you'll need to apply for a permit. The permit guidelines show how to plumb separate lines for rainwater and city water, and prevent contamination between them.

The city also allows residents to go a step farther and use rainwater to replace potable water by way of a permit appeal. The appeal process is used so that the Bureau of Development Services can look over your specific design and installation. It's not an adversarial appeal, more like a way to be sure an applicant has really thought through the installation. Once water pipes have been used for rainwater they can't be converted back to city water.

For commercial/multifamily applications, to use harvested rainwater to flush toilets, you are required to be treat the water with filters, UV and/or chlorinating (usually a combination of the first two and possibly all three). Portland, Oregon, has granted a permit for a household to harvest rainwater for use indoors to use it indoors for purposes like toilet flushing. The permit guidelines show how to plumb separate lines for rainwater and city water, and prevent contamination between them. The permit guide that can be downloaded from their website.

Code Requirements
The Bureau of Development Services has produced a prescriptive code guide that details how to design and build a residential rainwater harvesting system for permit approval. A permit is required to use rainwater indoors, and the details shown in the guide should ensure that rainwater stays separate from potable water. The City considers unfiltered rainwater non-potable or unsafe to drink. For commercial projects, the City reviews each system through the appeal process. See the *Portland Residential Rainwater Harvesting Code Guide.* - http://www.opdr.ci.portland.or.us/pubs/CodeGuides/Cabo/RES34%201.pdf

BC Transferability

Rainwater harvesting faces only municipal permitting hurdles. The City of Vancouver, in consultation with Vancouver Coastal Health have established guidelines for design and review for permitting these systems. There are two examples in the lower mainland (the Aquarium and the Delta worksyard building)

According the a report entitled “Guide for Regulating the Installation of Rainwater Harvesting Systems – Potable and Non-Potable Uses” the following permits may apply to system operating on the Gulf Islands:

- Plumbing permit for the system
- Building permit where cistern footings, foundations, enclosures and roof structures are included in system construction
- In some jurisdictions, the local Building Inspection office may impose specific requirements or restrictions

A key secondary issue is if the rainwater is to be treated and used as a potable water source - in which case there is a community drinking water regulation that comes into play.

Also, the Plumbing Code requirement for all water piped to any fixture to be potable and the interconnection of two water supplies and split plumbing systems prohibited by plumbing code.

Appendix J1: Flush Diverters

First-Flush Diverters

First-Flush Diverters

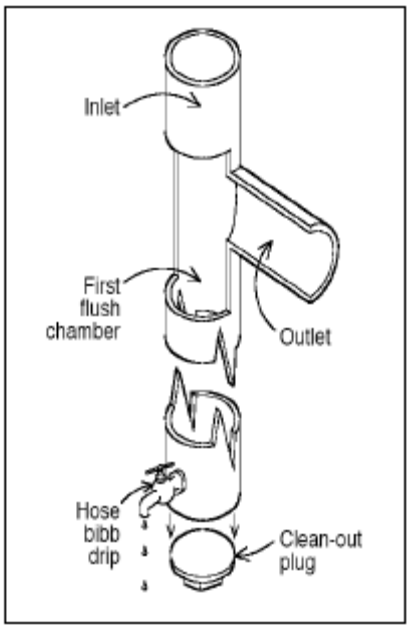


Figure 2-2. Standpipe first-flush diverter

Standpipe

The simplest first-flush diverter is a 6- or 8-inch PVC standpipe (Figure 2-2). The diverter fills with water first, backs up, and then allows water to flow into the main collection piping. These standpipes usually have a cleanout fitting at the bottom, and must be emptied and cleaned out after each rainfall event. The water from the standpipe may be routed to a planted area. A pinhole drilled at the bottom of the pipe or a hose bibb fixture left slightly open (shown) allows water to gradually leak out.

If you are using 3" diameter PVC or similar pipe, allow 33" length of pipe per gallon; 4" diameter pipe needs only 18" of length per gallon; and a little over 8" of 6" diameter pipe is needed to catch a gallon of water.

Standpipe with ball valve

The standpipe with ball valve is a variation of the standpipe filter. The cutaway drawing (Figure 2-3) shows the ball valve. As the chamber fills, the ball floats up and seals on the seat, trapping first-flush water and routing the balance of the water to the tank.

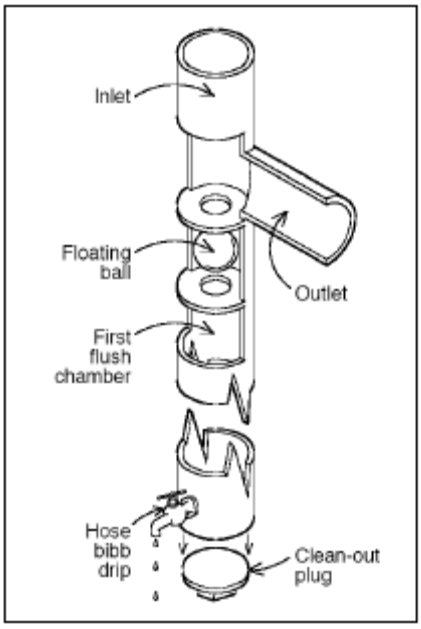


Figure 2-3. Standpipe with ball valve

Appendix J2 : Types of Storage Tanks

MATERIAL	FEATURES	CAUTION
Plastics		
Trash cans (20-50 gallon)	commercially available; inexpensive	use only new cans
Fiberglass	commercially available; alterable and moveable	must be sited on smooth, solid, level footing
Polyethylene/polypropylene	commercially available; alterable and moveable	UV-degradable, must be painted or tinted
Metals		
Steel drums (55-gallon)	commercially available; alterable and moveable	verify prior to use for toxics; prone to corrosion an rust;
Galvanized steel tanks	commercially available; alterable and moveable	possibly corrosion and rust; must be lined for potable use
Concrete and Masonry		
Ferrocement	durable and immoveable	potential to crack and fail
Stone, concrete block	durable and immoveable	difficult to maintain
Monolithic/Poured-in-place	durable and immoveable	potential to crack
Wood		
Redwood, fir, cypress	attractive, durable, can be disassembled and moved	expensive

Appendix J3: Treatment Technologies

METHOD	LOCATION	RESULT
Treatment		
Screening		
Leaf screens and strainers	gutters and downspouts	prevent leaves and other debris from entering tank
Settling		
Sedimentation	within tank	settles out particulate matter
Activated charcoal	before tap	removes chlorine*
Filtering		
Roof washer	before tank	eliminates suspended material
In-line/multi-cartridge	after pump	sieves sediment
Activated charcoal	after sediment filter	removes chlorine, improves taste
Slow sand	separate tank	traps particulate matter
Microbiological treatment /Disinfection		
Boiling/distilling	before use	kills microorganisms
Chemical treatments (Chlorine or Iodine)	within tank or at pump (liquid, tablet, or granular) before activated charcoal filter	kills microorganisms
Ultraviolet light	after activated charcoal filter, before tap	kills microorganisms
Ozonation	after activated charcoal filter, before tap	kills microorganisms
Nanofiltration	before use; polymer membrane (pores 10^{-3} to 10^{-6} inch)	removes molecules
Reverse osmosis	before use: polymer membrane (pores 10^{-9} inch)	removes ions (contaminants and microorganisms)
*Should be used if chlorine has been used as a disinfectant.		

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