Issues, Perceptions, Regulations, and Legislation Associated with Cleaning Product Ingredients in Graywater

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ISSUES, PERCEPTIONS, REGULATIONS, AND LEGISLATION ASSOCIATED WITH CLEANING PRODUCT INGREDIENTS IN GRAYWATER

FINAL REPORT

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EXECUTIVE SUMMARY

The objectives of the *Issues, Perceptions, Regulations, and Legislation Associated with Cleaning Product Ingredients in Graywater Reuse* project are as follows:

1. To identify public perceptions and issues associated with cleaning products and residential graywater reuse.

2. Summarize historical, current, and projected legislation, regulation, use, and application of residential graywater.

Graywater is the wastewater from showers, tubs, clothes washing machines, or bathroom sinks. Graywater typically goes down the drain and is treated through a septic system or the municipal wastewater system. Graywater reuse is associated with the private household collection and distribution limited to the landowner's property. Wastewater reclamation also refers to wastewater from showers, tubs, clothes washing machines, or bathroom sinks that usually is cycled through a municipal wastewater collection treatment and reuse system. Wastewater reclamation projects are government operated to service the entire community for recreation, construction, and even drinking water purposes.

Findings show that there currently are no major public perceptions that cleaning products need to be reformulated for graywater reuse. Although public concerns exist regarding boron, chlorine bleach, sodium, pH, and biodegradability, there is information available to homeowners on how to minimize potential impacts. Opportunities exist to reinforce the compatibility of cleaning product ingredients with graywater reuse.

Other findings of the review of the literature focus on the legalities of graywater reuse. Most state governments prohibit the reuse of graywater. A few state governments (e.g., California, Florida, Massachusetts, and Hawaii) take an active role in graywater reuse. Generally, graywater reuse is acted allowed through local government agencies to meet the needs of specific areas.

In general, graywater reuse is increasing and the public will accept graywater reuse or water reclamation programs that avoid human contact. Individual homeowners have initiated their own graywater reuse during times of drought, regardless of applicable regulation.

The review of the literature provides the following conclusions:

- Presently, there appears to be no public perception that soaps and detergents need to be reformulated for graywater uses. Persons that use graywater have learned to work with or around the specific soap and detergent ingredients that are perceived harmful to plants, soil, and health.

- Cleaning product ingredient concerns to homeowners include boron, chlorine bleach, sodium, pH, and biodegradation.

- Information is available to homeowners that discusses the impact of cleaning products ingredients in graywater reuse. Graywater users are informed of how to apply graywater containing cleaning product ingredients to maximize irrigation use and minimize perceived harmful effects.

- In general, graywater reuse is increasing and the public will accept graywater use or wastewater reclamation programs that avoid human contact.

- While public concerns over health impacts from graywater appears to be diminishing, many of the state regulations have not yet responded proactively to encourage graywater reuse.

- State health departments are generally named as the agency to enforce graywater uses. Although a state may permit the use of graywater, provisions to the state law allow a community to deny its residents graywater uses. More often the health departments defer or delegate authority to local jurisdictions. Inconsistencies may exist between neighboring communities regarding graywater uses.

- Additional information and education programs about graywater reuse and cleaning products ingredients could be organized and conducted. A small-scale education or information pilot program could be established in a neighborhood or community based on a profile for success (e.g., drought, laws and regulations permit graywater use, and homeowners' concern and need for water resources.) Towns that are (1) located in arid regions, (2) have limited water supplies/resources, (3) have expensive means to obtain water, or (4) have experienced several years of drought conditions are best suited for a pilot graywater use program.

- An extensive public information and education program is required to implement a wastewater reclamation program. The public should be informed of sources of the wastewater, treatment, uses and distribution of the reclaimed wastewater.

SECTION 1
INTRODUCTION

1.1 PURPOSE AND ORGANIZATION OF THE REPORT

This report discusses the issues and perceptions associated with cleaning product ingredients in graywater that is subject to reuse. The purpose of the project is as follows:

1. To identify public perceptions and issues associated with cleaning products and residential graywater usage.

2. To summarize historical, current, and projected legislation, regulation, use and application of residential graywater.

Graywater is the wastewater from showers, tubs, clothes washing machines, or bathroom sinks that usually is allowed to go down the drain and is then treated through a septic system or the municipal wastewater system. Graywater reuse is associated with residential household collection and distribution limited to the landowner's property. Wastewater reclamation also refers to wastewater from showers, tubs, clothes washing machines, or bathroom sinks that usually is allowed to go down the drain and through a municipal wastewater treatment and reuse system. Wastewater reclamation projects are government operated to service the entire community for recreation, construction, and even drinking water purposes.

WESTON's Information Services obtained, via electronically and inter-library loan, general print media articles, technical documents, state and U.S. laws and regulations, and trade and environmental media articles. WESTON solicited information by mail from approximately 90 State Extension Water Quality Coordinators in each of the 50 states and 400 home economists. The Soap and Detergent Association (SDA) also provided numerous newspaper clippings and technical documents and summaries for this report.

The report consists of the following nine sections:

Executive Summary
1 Introduction
2 Early Recommendations for Water Conservation and Graywater Reuse
3 Current Information
4 Legislation and Regulation
5 Public Perception

6 International

7 Conclusions

8 References

Approximately 1800 pages have been assembled and reviewed in the Appendices. The Appendices provide a wide variety of information that is summarized in the following sections. The report identifies specific articles or resources throughout the text by author and year of publication, and also cites the source's appendix page number in brackets [ ].

It is important to note that several terms were used to generate the information presented in the Appendices. The term wastewater reclamation is used primarily for municipal wastewater collection, and recycle systems. The term graywater most often refers to residential use of recycled water.

1.2 BACKGROUND INFORMATION

Because of rising water costs and limited water resources, people are learning to conserve water, especially in the western and southwestern United States. Even with conservation measures, western water reserves are being used at a rate 22% higher than that at which they are being replenished (Carter, 1995)[B-335]. The Ogallala Aquifer, located under the Great Plains from Texas to South Dakota, is North America's largest aquifer containing a quadrillion gallons of water. The average level of its water table fell 10 feet between 1940 and 1980. Countless irrigation wells each pump out more than a thousand gallons a minute (Carter, 1995)[B-335]. So much water has been pumped from an aquifer (Basin Fill aquifer) under Las Vegas, Nevada, that the downtown area has sunk five feet in the last 60 years. In Florida, large sinkholes caused by groundwater depletion have swallowed entire houses (Carter, 1995)[B-335].

Local governments and individual homeowners have begun to seriously explore and implement methods to off-set the demand on water supply sources. Reuse of residential graywater is one of these conservation measures. Household graywater is the wastewater from showers, tubs, clothes washing machines or bathroom sinks that usually is allowed to go down the drain and through a septic system or the municipal wastewater system. Graywater is not for drinking but for other uses, for example, drive-way and car washing, lawn care, garden and crop irrigation, and even toilet flushing (Hypes, 1978)[A-409, 418].

While an inexpensive retrofit to reroute graywater is not yet available, interested and motivated homeowners can still obtain graywater before it goes down the drain. If local plumbing laws allow, a graywater system can be designed into new home construction for about $300 and a complete system, with filters and subsurface emitters, can run $1,500 (Mayer, 1994)[B-316]. This system can reduce

water-use substantially. New homes that are plumbed to use all available graywater can save from 25 to 40 gallons per person per day (Mayer, 1994)[B-315]. In homes that are retrofitted the savings is estimated at 15 to 40 gallons per person per day (Mayer, 1994)[B-315].

The California drought has inspired several new companies. Automated Gray Water Apparatus was formed in 1991 and devised a system with sand filters and automatic backwashes. The company donated prototypes to the City of Los Angeles for a pilot project and have since sold about 12 systems in communities where graywater has been legal (Mayer, 1994)[B-315]. Depending on the level of automation, the system runs from $2,100 to $3,200 (Mayer, 1994)[B-316].

In 1993, Automated Gray Water Apparatus installed a system at the Post Ranch Inn in Big Sur, California. The hotel wanted to do its own laundry to save money, but could not expand its leach system to dispose of the wastewater. The graywater system solved that problem, as well as reducing the inn's fresh water needs, by reusing 2,500 gallons a day (Mayer, 1994)[B-316].

SECTION 2
EARLY RECOMMENDATIONS FOR WATER CONSERVATION AND GRAYWATER REUSE

2.1 SDA SETS THE STAGE

A newspaper article published on 19 June 1965 regarding graywater reuse was the earliest piece of literature obtained for this report. The article in the Springfield, MA, *Union* [B-1] quoted an SDA press release suggesting methods of saving water during a drought. The article included general information about repairing leaking faucets, Navy-type showers that use only half as much water, turning the water off when brushing teeth, and laundry and dishwashing tips.

SDA also suggested that during local watering prohibition periods residents collect rinse water from the laundry and save it for washing hands, scrubbing floors, watering house plants and gardens. The SDA suggested following the recommendations of the horticulture and soil specialists at Rutgers College of Agriculture in New Jersey, and noted that there is little or no risk in using kitchen, laundry, and bathroom rinse water on plants (Springfield, MA, *Union*, 1965)[B-1]. The specialists said that the water temperature should not be excessive and that the soap and detergent residues will not interfere with normal plant growth.

2.2 ASSESSING PUBLIC ATTITUDES

Of the 16 technical studies reviewed, only two studies were limited to graywater reuse. The other

studies pertained to wastewater reclamation. All of the studies were conducted by universities or local governments and agencies. Some of the wastewater reclamation technical studies contain specific data assessing public attitudes, whereas, the graywater studies do not. Throughout the review of the general literature (e.g., newspaper articles and pamphlets) for graywater, public attitudes for graywater reuse generally correspond to the public attitudes for wastewater reclamation. Public attitudes for both graywater reuse and wastewater reclamation are favorable with two concerns: health protection and cost benefits. Therefore, this report includes discussions of the wastewater reclamation studies.

Several studies were conducted in the 1970s that addressed public attitudes on both wastewater and graywater reclamation and reuse. In 1972, the University of California-Berkeley conducted a study to assess public attitudes toward reuse of reclaimed water (Bruvold, 1972)[A-1]. The study discussed the critical importance of public attitudes regarding uses of reclaimed water based on the earlier controversy surrounding fluoridation. The study groups consisted of residents in five California communities with a municipal wastewater reclamation and reuse program and five communities without a municipal wastewater reclamation and reuse program. Bruvold's study concluded that the California public did not oppose the use of graywater for commercial purposes but did not want direct contact with it (Bruvold, 1992, p. 33)[A-37]. Table 1 provides the list of reclaimed water uses in order of public acceptance (Bruvold, 1972, p.20)[A-24].

The study was optimistic regarding the public acceptance of reclaimed water use even in light of the need to address problems with dual water systems, health protection, and further cost-benefit analysis (Bruvold, 1972, p. 33)[A-37]. The study recommended a public information and educational program to address the adequacy of technical methods for water purification and psychological repugnance of using reclaimed water - freedom from undesirable conditions, including taste and odor (Bruvold, 1972, p. 33)[A-37].

Subsequent studies noted that males had more positive attitudes toward reclaimed water for drinking than females. The individual most accepting of drinking reclaimed water would be male, young, well-educated, hold a high-level job and earn a high salary, have lived only a short time at the present place of residence, and would know a good deal about reclaimed water (Bruvold, 1984, p. 124)[A-497]. Individuals with negative attitudes about drinking reclaimed water would not be well educated, have a poor paying and lower status job, older, female, would have lived at current address for many years, and would not have heard of reclaimed water.

Table 1

California Public Acceptance of Reclaimed Water Uses*

1	Road Construction
2	Irrigation of Freeway Greenbelts
3	Golf Course Construction
4	Irrigation of Recreation Parks
5	Residential Lawn Irrigation
6	Golf Course Hazard Lakes
7	Home Toilet Flushing
8	Electronic Plant Process Water
9	Commercial Air Conditioning
10	Pleasure Boating
11	Hay or Alfalfa Irrigation
12	Orchard Irrigation
13	Vineyard Irrigation
14	Spreading on Sandy Areas
15	Irrigation of Vegetable Crops
16	Irrigation of Dairy Pasture
17	Commercial Laundry
18	Home Laundry
19	Pumping Down Special Wells
20	Swimming
21	Bathing in the Home
22	Preparation of Canned Vegetables
23	Cooking in the Home
24	Food Preparation in Restaurants
25	Drinking Water

* Number 1 equals most acceptable and number 25 is least acceptable.

It is important to note that studies identified a barrier to widespread use of wastewater reclamation and reuse in light of general public acceptance. In 1974, a study reported that water managers know little of consumer responses concerning wastewater reclamation and reuse. Water managers thought that the consumers would disapprove of recycled water (Baumann, 1974, p. 667)[A-66]. The study argued that the primary impediment for wastewater renovation lie in the minds of the engineers and water management officials, who for whatever reasons, are reluctant to implement wastewater reclamation.

It was suggested that there is little contact between water supply and wastewater officials in government and consulting firms (Baumann, 1974, p. 669)[A-68]. Baumann surveyed 300 municipal water management officials in the U.S. Forty percent were opposed to wastewater reuse even if it was the most inexpensive alternative and could produce safe potable water (Baumann, 1974, p. 672)[A-71]. Basically, the water managers questioned the "practicability of using renovated waste water" Bauman, 1974, p.672)[A-71]. In Massachusetts, water managers were unanimous in rejecting reclaimed wastewater as an alternative water resource.

Other research studies agree that water management officials are a hinderance to the widespread use of reclaimed wastewater. For example, a study of the New England region noted that some localities have or will have severe water problems (Johnson, 1979, p. 1329)[A-437]. [Note: The report text did not cite the nature of the water problems nor the localities.] The study surveyed water managers and learned that graywater reuse was not a serious alternative water resource. Water managers believed that potable water supplies should be obtained from protected sources. Managers viewed health problems as the greatest obstacle to reuse alternatives. Managers believed that health officials would not endorse use of reclaimed wastewater. Without the endorsement of health officials, consideration of wastewater reclamation would fail (Johnson, 1979, p. 1332)[A-440].

Water has been treated as a "free good" (Kasperson, 1974, p. 208)[A-290]. A free good is available to all users without scarcity. The cost is for diversion, regulation, and transmission. Unfortunately, water is not a free good in some areas of the country. This report stated that the potential of reclaimed wastewater as a new source of water supply is significant since most cities discharge over two-thirds of the water withdrawn from their present source (Kasperson, 1974, p. 234)[A-317].

A graywater reuse study in Hawaii was presented in 1983 (Hirano, 1983)[A-448]. The study looked at graywater reuse options for rural or suburban households with failing cesspools, irrigation in larger land area, and the rising cost of water. The graywater would be used for toilet flushing and lawn irrigation. The study noted that graywater can pose a potential health hazard and nuisance if not handled and managed properly (Hirano, 1983, p. 32)[A-485]. The study noted that the graywater should be treated to prevent problems of clogging, odors, and transmission of disease. It suggested a treatment system that included sedimentation, disinfection, and filtration, followed by a pump and pressurized tank

for distribution (Hirano, 1983, p.32)[A-485]. The study determined that graywater was a source (for toilet flushing and lawn irrigation) if managed properly, however, the cost of the system outweighed the benefits or savings achieved (Hirano, 1983, p. 32)[A-485].

The City of Denver, Colorado, conducted an extensive study in the mid-1980s to measure degrees of public awareness, understanding, and acceptance about potable wastewater reuse (Lohman, 1985, p. *xi*)[A-524]. Denver constructed a wastewater reclamation plant designed to demonstrate and test, through continuous operation for a minimum of five years, reclaimed wastewater to potable quality. The objectives of the study were to 1) determine public attitudes, 2) select educational approaches and demonstration procedures, and 3) prepare a program guide (Lohman, 1985, p. 3)[A-528].

This study concluded that the Denver public was more skeptical than previously suggested in a 1974 study, and that any effective public education program would not be as easy to implement as researchers previously thought. Respondents identified five concerns: 1) Who regulates the water department and sets and maintains minimal standards? 2) Not enough proof or safety. 3) Concern about removing viruses and carcinogens, overall healthfulness. 4) Concern about the cost. 5) Wastewater reuse might not be accepted by the public or might not be ready to use soon enough (Lohman, 1985, p. 63)[A-588]. Denver water department officials expected the local media to automatically give the construction of the wastewater reclamation plant extensive coverage as a major portion of their information/education program. The media did not take an interest in the project; however, major interest was exhibited by water professionals from around the world (Lohman, 1985, p. 65)[A-590].

In summary, the water professionals were not convinced during the late 1980s that potable wastewater reuse could win public support. Water professionals would set a standard of quality for reuse water far stricter than "fresh" water and still find it difficult to knowingly use reuse water (Lohman, 1987, p.1029)[A-672]. Water industry professionals tend to place an almost mythical reliance on the hydrologic cycle and tend to see wastewater reclamation as a perversion of that natural cycle rather than as a parallel and complementary activity (Lohman, 1987, p. 1038)[A-681]. The water professional is still concerned about health effects and has not been convinced of the efficacy of scientific methods for wastewater treatment. They support these beliefs although water reuse projects are frequently cheaper than developing new alternative freshwater supplies (Lohman, 1987, p. 1040)[A-683]. In addition, the inability to sell reuse water makes such a project economically infeasible.

2.3 LABORATORY AND FAMILY LIVE-IN EXPERIENCES

A National Aeronautics and Space Administration study focused on laboratory and family live-in experiences with domestic graywater reuse systems (Hypes, 1979, p. 209)[A-407]. Graywater was limited to laundry and bathing wastewater. The study first simulated graywater use in the laboratory.

The graywater was used as toilet flush water. Later the NASA Technology Utilization House was used as the setting for a family live-in experience. Both the laboratory and live-in experiences demonstrated the feasibility of using reclaimed bath and laundry wastewaters as a source of water for flushing toilets (Hypes, 1979, p. 228)[A-426]. It was noted that it was necessary to implement a particle removing process step to improve the appearance of the water and a disinfection process step to eliminate microbiological contamination. The study claimed that a reuse system by homeowners appears likely because water savings could vary from 25-40% of the total requirement, and maintenance and repair needs were not too demanding of time or funds (Hypes, 1979, p. 228)[A-426].

During 1985, the University of Arizona designed and retrofitted a graywater system in an experimental and demonstration home called *Casa del Agua*. In addition to the graywater reuse system, rainwater was stored in an underground cistern and pumped to supply an evaporative cooler, toilets, hose bibs, and drip irrigation lines. The graywater was processed through two aquacells containing water hyacinth plants and a sand/garden filter and was stored in an underground cistern. The graywater was used for landscape irrigation and toilet flushing (Rose, 1985)[A-507]. The study determined a 40% less usage of municipal groundwater which represented a significant savings (Rose, 1985)[A-509]. Based on surveys from tours conducted at *Casa del Agua*, public acceptance was high. It showed water conservation measures could be implemented without disrupting family life-style. The study also demonstrated that graywater contains significant numbers of bacteria and additional treatment was required to reduce the microbial population in the graywater to reduce health risks. The study focused on fecal contamination of graywater and did not include or mention cleaning products ingredients. The study concluded that public acceptance will be influenced by dependability of the system, ease of maintenance, and efficiency of treatment (Rose, 1985)[A-510].

2.4 PUBLIC VIEWS GRAYWATER AS A RESOURCE

While researchers conducted their studies and many regulators and water professionals looked the other way, members of the public instituted their own graywater reuse program. Newspaper and magazine articles have reported the individual crusades to reuse graywater.

Some communities encouraged commercial and industrial water users to recycle. For example, officials in Hagerstown, Maryland, rescinded a favorable sewage treatment rate it was extending to its largest single customer, the Mack Truck Company. The company looked at recycling graywater to cut its daily waste water from one million gallons to 250,000 (Bache, 1977)[B-2]. Fairfax County, Virginia requires recycling in car washes and other operations with continuously running equipment using more than five gallons of water per minute. Few other commercial and industrial recycling uses were cited in the literature reviewed.

Few community-based graywater reuse projects were identified, indicating that community graywater reuse projects are uncommon. Under an Appalachian Regional Commission project, a number of homes in Boyd County, Kentucky, have both on-lot waste disposal plants and recycling equipment. The graywater is filtered, disinfected, and pumped back inside for toilet flushing (Bache, 1977)[B-3]. Conservation attitudes of the 1970s had influenced commercial manufacturer to build water-saving washing machines, low-water dishwashers, and conservation shower heads (Bache, 1977)[B-3].

Installation of water-saving appliances would save fresh water and money (per the water bill). The water-saving devices would decrease the volume of graywater a homeowner may recycle to make a graywater reuse system cost effective. The output of graywater may not be enough to meet the needs of a homeowner (e.g., toilet flushing, gardening, lawn irrigation), specially in a drought situation. A homeowner may be satisfied with the water-saving devices and not pursue the option of graywater reuse.

While residential graywater reuse was illegal in many areas, citizens chose to ignore the prohibition during drought conditions. In the 1970s, 1980s, and 1990s, newspaper and magazine accounts informed readers of simple home graywater procedures, even though health officials considered graywater reuse "a step backward in community sanitation" (e.g., *Sunset*, July 1977, p. 150)[B-4]. Through the print media they shared their graywater practices with the public. The print media has always been positive when presenting individual stories. In each case the individual was using graywater because of drought conditions.

2.5 SOAP AND DETERGENT RESIDUES

Many articles discussing graywater reuse also discussed soap and detergent residues. These articles discussed the content of the soaps and detergents and recommended avoiding using graywater that could contain sodium, chorine bleach, and boron (*Sunset*, July 1977, p. 150)[B-4](Sartore, 1978)[B-9](Rose, 1981)[B-21]. Others recommended that the pH of the graywater should be taken into account when watering plants (Tonge, 1981)[B-25]. Table 2 summaries these concerns.

Table 2

Summary of Graywater Reuse Concerns and Mitigation Measures

Graywater Reuse	Reuse Concern	Mitigation Measure
Irrigation	pH (alkalinity)	Gypsum soil amendments; avoid acid-loving plants.
	bleach	Avoid direct application of graywater to leaves; dilute washwater with rinsewater; minimize use of washwater.
	sodium	Minimize high-sodium content detergent use; increase reliance on soaps.
	grease	Avoid use for irrigation.
	pathogenic bacteria	Increase soil cultivation; mulch; limit use to ornamental plantings.
	elevated temperature	Let water cool before application.
	boron	Avoid direct application of graywater to leaves; dilute washwater with rinsewater; minimize use of washwater.
Toilet Flushing	No concerns	N/A

A wide range of mitigative measures were identified to address some of the graywater concerns. For example, if consistent use of graywater raises the soil's pH (alkalinity) above acceptable levels, incorporate gypsum (sodium sulfate) over the soil (Tonge, 1981)[B-25]. Gardeners should avoid applying graywater directly on plant leaves and root crops. The Farallones Institute in Berkeley, California, suggested to use soap instead of detergent because soap is lower in sodium content (*Sunset*, July 1977, p. 150)[B-4](Tonge, 1981)[B-25]. It was suggested to cultivate around the plants an hour or two after applying graywater to permit the sun and air to attack any bacteria the graywater may contain (Eden, 1988)[B-50]. The soil's rich range of bacteria and fungi do an effective job of purifying the graywater and destroying unwanted pathogens (Tonge, 1988)[B-53]. There was some disagreement among graywater users. For example, one resident said to mix washwater with the rinse water and with the dilution there is no danger to plants from detergent or bleach (Abraham, 1988)[B-45]. On the other hand, another source said to use the rinsewater but not the water from the initial washing cycle (Eden, 1988)[B-49].

Most of these measures are not scientifically based. There is a need to develop a scientifically sound, data-based approach to address graywater concerns and disseminate through a summary article for state extension agents.

2.6 LEGALITY OF RESIDENTIAL GRAYWATER USE

The legality of residential reuse of graywater had been reevaluated over time. In 1988, when drought plagued California, graywater gardening was permissible in most areas of the state. In fact, the California Department of Water Resources prepared and distributed a pamphlet for local authorities to adopt modification of the code to meet the needs of local conditions (Tonge, 1988)[B-53]. It was at this time that Californian Robert Kourick became known as the expert on installing graywater systems and its use. Mr. Kourick, a landscaper by trade, wrote a booklet, *Gray Water Use in the Landscape*. The booklet covers both the benefits and pitfalls of graywater uses, plumbing systems, and methods of irrigating the landscape. A photocopy of the booklet is available in Appendix M (page 24).

The long-term drought conditions and Mr. Kourick's defiance of the law and popular booklet may have gotten the attention of the Santa Barbara County, California, Board of Supervisors. In July 1989, the Board of Supervisors began considering to approve the use of graywater on outdoor plants (Yoshitake, 1988)[B-70]. In October 1989, Santa Barbara County was the first to approve graywater. A newspaper account stated that the county supervisors acted at the request of the area water district.

This was a beginning, but did not turn the graywater tide in California. In April 1990, a Ventura County, California, landscaper was warned by the County Building and Planning Department to stop using graywater from washing machines to irrigate plants. The Ventura County Environmental Health Department stood by the standard statement that graywater could transmit bacterial and viral disease that can cause serious and sometimes fatal illness (Pascual, 1990)[B-80]. At the same time, Los Angeles County, California, Department of Health went on record stating the use of graywater violates the county plumbing and health codes (Ball, 1990)[B-93].

In spite of the Los Angeles County Department of Health's warning that graywater usage violates the county plumbing and health codes, and in light of the water shortage in the area, the Los Angeles City Council considered approving graywater usage (Murphy, 1990)[B-98]. The newspaper report stated that with graywater usage, Santa Barbara County was saving 25 to 40 gallons of water per day per person. Los Angeles hired a director of water reclamation whose tasks included encouraging home graywater usage (Levine, 1991)[B-107]. In 1991, the California Department of Health Services issued guidelines to water agencies on the proper way homeowners can use graywater systems for gardening purposes (Woo, 1991)[B-110]. The San Diego County Environmental Health Services recorded approximately 200 calls per day from residents curious about how to use graywater (Wallace,

1991)[B-123].

In May 1991, Los Angeles County, California, Supervisors ordered the drafting of ordinance that would allow the use of household graywater for irrigating trees and shrubs (*Los Angeles Times*, 1991)[B-145]. On the other hand, Glendale, California, City Council voted down graywater usage (*Los Angeles Times*, 1991)[B-166]. In 1993, the State of California authorized homeowners to install graywater systems (Gilliam, 1993)[B-267].

The State of New York included graywater in a set of environmental laws that were passed by the State Legislature and signed by Governor Cuomo (Kass, 1991)[B-167]. The New York law established state regulations and standards for the household reuse and disposal of graywater.

2.7 SUMMARY

Graywater reuse has been identified as one aspect of water conservation during periods of drought. Based on the literature reviewed, state and local governments have been polarized and have acted independently on the issue of graywater reuse. Despite evidence of the achievement of water conservation goals through graywater reuse, graywater reuse and wastewater reclamation programs have been impeded by numerous barriers, including public perception and public policy concerns over health risks. These health risks can be minimized by limiting direct human contact with the water. There is a need to develop a scientifically sound, data-based approach to address graywater concerns, such as potential impacts to irrigated plants.

SECTION 3
CURRENT INFORMATION

This section provides an overview of the literature published between 1993 and 1995. It provides a perspective of recent governmental actions, violations, and uses of graywater.

3.1 GOVERNMENT ACCEPTANCE OF GRAYWATER AND WASTEWATER RECLAMATION

In February 1993, a Texas legislator filed to extend standards for graywater regulations to include sinks that do not have garbage disposal devices and are used for food preparation and to the underground distribution of graywater (*Texas Industry Environment Alert*, 1993)[B-284]. The City of Wichita, Kansas, began reviewing conventional and non-conventional solutions to assure enough water will be available to meet expected demands (Seba, 1993)[B-286]. Among the Wichita solutions examined were developing new or existing sources of water, recycling graywater, and pumping water from flood

flows back into the groundwater aquifer.

The Los Angeles Office of Water Reclamation completed the first quantitative field study of the actual public health threat from graywater reuse and found it to be of little consequence (Ludwig, 1993)[[B-290]. The graywater-irrigated soil contained indicator microorganisms, but so did the freshwater-irrigated soil. The conclusion was to advise against eating dirt, with or without graywater! The report challenged "eco-entrepreneurs" to take note that no one has yet figured out an inexpensive, hands-off retrofit system for reusing graywater efficiently, and noted that there are about 30 million potential customers for a system.

The Arizona Department of Environmental Quality (ADEQ) released a concept paper that outlined a major revision of rules on reuse of reclaimed water by integrating their reuse program and the Aquifer Protection Permit program (*BNA State Environment Daily*, 1993)[B-297]. The ADEQ also planned to repeal the existing permit rules applying to graywater, and proposed to regulate graywater systems under revised Sewage System Rules.

The New York City Department of Sanitation worked with a newspaper recycling mill to incorporate the use of graywater from a sewage plant in Harlem (Murray, 1993)[B-298]. Graywater was defined as wastewater that had been processed and discharged.

Municipal graywater from the Wallkill's, Maryland, Wastewater Treatment Plant will be used by a power plant for its cooling needs (*Business Wire*, 1993)[B-307]. The initiative will recycle up to 1.8 million gallons of graywater per day. The graywater purchase will provide the Town of Wallkill with more than $125,000 per year in revenues.

The Massachusetts Department of Environmental Protection began considering the Ruck System for addressing private sewage disposal systems (*The Boston Globe*, 1995)[B-357]. The Ruck System reclaims nitrates by separating blackwater from toilets and the kitchen sink from graywater. Blackwater flows into a tank, through a Ruck filter, then it is piped into a graywater tank. Once in the graywater tank, carbon from the soapy water helps the bacteria break down the nitrates into a gas which is discharged through vents (*The Boston Globe*, 1995)[B-357-8]. This newspaper article focuses on sewage disposal and mentions graywater but does not address graywater reuse as part of the Ruck System.

3.2 GRAYWATER VIOLATIONS

An Idaho County health department official took issue with members of Earth First!, an environmental group, camping in the area to protest building and logging in the Cove-Mallard portion of the Nez Perce

National Forest. The official cited the members for noncompliance with health district regulations regarding the disposal of human waste and graywater (Hedberg, 1993)[B-299]. The official provided the group with information about digging pit privies and graywater sumps to dispose of wastes. He required the group to purchase permits for the waste disposal pits.

The CNN cable news network broadcasted a story about a U.S. sailor accusing the Navy of dumping trash and sewage at sea. The Navy admitted to dumping graywater under the Golden Gate Bridge and explained that was legal (Knapp, 1993)[B295].

3.3 COMMERCIAL USES OF GRAYWATER

Wal-Mart Stores began using graywater from restroom sinks, drinking fountains, mixed with parking lots and roof storm runoffs, for landscape irrigation (*Discount Store News,* 1993)[B-304]. The graywater is collected, stored, and treated in a retention pond. The graywater reuse system is one of several environmental measure taken at "Wal-Mart's environmental demonstration store" built in 1993 in Lawrence, Kansas (*Discount Store News*, 1993)[B-302]. Wal-Mart will track and evaluate the costs of the store's environmental technologies and plans to incorporate the most cost-efficient technologies into new stores (*Discount Store News*, 1993)[B-303].

The Arizona Public Service Co. began construction of a home designed to use 60% less energy and between 50 and 70% less water than a standard energy-efficient home (*Electrical World*, 1994)[B-326]. Graywater will be collected from baths, showers, and the washing machine and applied to trees and shrubs.

A home show exhibit featured a system for washing hands with the clean water from a toilet tank (Archer, 1994)[B-333]. The system saves water by using the clean water that fills a toilet tank to wash hands. The graywater from the handwashing process is recycled back into the toilet bowl. The concept has been used in Japan and Australia.

Plans to build a new office park in Santa Monica, California, include a graywater system to be used for landscape irrigation and toilet flushing (Sullivan, 1995)[B-360]. In the same article, the Arizona-Sonora Desert Museum in Tucson implemented a graywater system to extend the museum's environmental stewardship. The museum uses the graywater for toilet flushing.

3.4 RESIDENTIAL USES OF GRAYWATER

A family of three living between Los Angeles and San Diego maintain a home in which the drains from all the sinks and showers have automatic sensors that direct "lightly soiled" graywater to a storage

system in the basement and heavily soiled water to the municipal sewage system (*Sacramento Bee*, 1995)[B-363]. The graywater supplies the toilets and outdoor irrigation system, which includes a wide variety of native drought-resistant plants and a small area of lawn.

Two California residents recently built a solar-powered home that is also piped for graywater reuse (*Los Angeles Times*, 1995)[B-349]. However, the City of Laguna Beach, where the home is located, does not yet permit graywater reuse.

3.5 WASTEWATER RECLAMATION

More U.S. cities incorporate reclaimed wastewater, now referred to as "purified water" into municipal drinking systems (Tomsho, 1994)[B-331]. El Paso, Texas, Tampa, Florida, and San Diego, California, boost their drinking water supplies with purified water. The super-treated water is not pumped directly into water intake lines. Instead it is pumped into reservoirs and aquifers, where it mixes with water from other sources.

The Miller Brewing Co., filed a lawsuit to stop the San Gabriel Valley, California, water reclamation project that will make drinking water out of effluent (Clifford, 1994)[B-337]. Miller claimed that the project will pollute the area and the treated water will contain harmful bacteria and industrial chemicals. Like San Diego, San Gabriel Valley was trying to reduce its dependence on its dwindling local water supplies and the more costly water imported from Northern California and the Colorado River. Miller wants to guarantee that its ingredients are pure.

3.6 SUMMARY

Local governments have been to study graywater reuse. Several have scaled back their concerns over public health risks from exposure to graywater. One area has even proposed to authorize graywater reuse systems. Public concerns appear to be diminishing in recognition of the many other factors and the widespread incorporation of reclaimed wastewater into municipal systems.

SECTION 4
LEGISLATION AND REGULATION

4.1 CURRENT STATE LAWS

Information obtained through the literature search identified 18 states with the term "graywater" included in the law. Some of the laws, for example in California and Florida, refer directly to household graywater. Other laws define graywater or incorporate it with septic system or sewage laws. The level

of information contained in the laws varies greatly from state to state and that is reflected in the summaries below. The listing includes the following states:

1. California - Graywater systems for single family residents [D-1]. Graywater has been defined as untreated household wastewater which has not been contaminated by any toilet discharge, has not been affected by infectious, contaminated, or unhealthy bodily wastes, and which does not present a threat from contamination by unhealthful processing, manufacturing, or operating wastes. The state definition includes wastewater from bathtubs, showers, bathroom washbasins, clothes washing machines, and laundry tubs, but does not include wastewater from kitchen sinks or dishwashers. A graywater system is defined as a system and devices, attached to the plumbing system for the sanitary distribution or use of graywater.

   California law includes that a graywater system may be installed in a residential building if the city or county having jurisdiction over the building determines that the system complies with standards adopted by the Department of Health Services. The law also includes that a city or county may adopt, by ordinance, more stringent criteria for approval of graywater systems or may prohibit graywater systems [D-2].

2. Delaware - Defines graywater to mean galley, bath and shower water [D-6].

3. Florida - Encourages development of graywater systems to existing sewerage capacity [D-10]. Florida urges all public-owned or investor-owned water and sewerage systems to reduce connection fees and regular service charges for customers who utilize water or sewer-saving devices, including, but not limited to, individual graywater disposal systems [D-11]. Florida defines graywater to mean that part of domestic sewage that is not blackwater, including waste from the bath, lavatory, laundry, sink, except kitchen sink waste [D-12].

4. Georgia - Graywater is included in the state's definition of "sewage": human excreta, all water carried wastes, and liquid waste, including graywater or similar waste by-products [D-20].

5. Hawaii - Use of graywater from residential units for irrigation purposes [D-21]. The state authorizes any county to implement a graywater reuse program that is limited to the use of graywater from residential units for the purpose of irrigating lawns and gardens. The county is required to submit a plan that includes the rules and procedures for the proposed program. The plan should address the appropriateness of the program for the geographic area, the environmental impact of the program on the geographic area, the cost of the program, and any other factors deemed relevant by the Department of Health. The department may revoke the authorization at any time.

Hawaii defines graywater to mean any water from the domestic plumbing system of a residence except toilets; provided that the discharged graywater is not contaminated with any household hazardous waste or any other contaminant the department deems inappropriate [D-21]. Examples of household hazardous wastes are drain cleaners, floor and furniture polish, dry cleaning fluid/spot removers, waste auto oil, paint and stain, turpentine, pesticides, herbicides, and poisons.

6. Idaho - The state includes graywater in its Marine Sewage Disposal Act [D-22]. The state finds that the streams, rivers, and lakes are threatened with pollution from discharge of marine sewage and other wastes and that it is necessary to provide a uniform system for control and treatment of such marine sewage, graywater, and other wastes. Violators should be penalized.

7. Kentucky - The state includes the term graywater in its definition of "sewage": domestic blackwater and graywater wastes, but does not include waste from industrial or commercial processes [D-23].

8. Massachusetts - Grants are available for construction of collection systems [D-25]. The Commonwealth has made $2.5 million available for such grants that include graywater reuse for nonpotable uses.

9. Michigan - The state defines "acceptable alternative graywater system" to mean a system for the treatment and disposal of wastewater which normally does not receive human body wastes or industrial waste and is approved for use by a local health department [D-27]. The systems are subject to regulation and inspection by the local health department [D-28]. The Michigan Department of Health is required to assist the local health department in determining acceptable graywater systems.

10. Missouri - The state defines graywater as all domestic wastewater from a state building except wastewater from urinals, toilets, laboratory sinks, and garbage disposals [D-29]. The state also defines graywater as all domestic waste not covered in the blackwater definition. Bath, lavatory, laundry, and sink wastes are included in the graywater definition [D-31].

11. New Hampshire - Includes graywater in its sewage definition for control of marine pollution and aquatic growth regarding marine toilets and disposal of sewage from boats [D-32].

12. New Jersey - The state defines "acceptable alternative graywater systems" as a system for the treatment and disposal of wastewater which normally does not receive human body wastes or

industrial waste and is approved for use by a local health department. The state permits persons to install such systems [D-33].

13. New York - Graywater is defined in the state's environmental conservation law as that portion of the sanitary sewage generated in a residential, commercial, or institutional facility which does not include discharges from water closets or urinals [D-35]. Graywater shall include water discharged from lavatory sinks, tubs, showers, automatic dishwashers, and washing machines, but not industrial discharges or discharges containing toxic or hazardous materials. New York navigational law defines graywater as wastewater generated by water using fixtures other than toilets; including but not limited to baths, sinks, and laundry facilities used on residential vessels.

14. Oregon - The state defines graywater as any household sewage other than toilet and garbage wastes, including shower and bath wastewater, kitchen wastewater, and laundry wastes [D-36]. The law includes that soil and site conditions for graywater conform to the rules of the Department of Environmental Quality regarding standard subsurface sewage disposal systems except that graywater systems may use two-thirds the normal size surface area for a drainfield and should be preceded by a pretreatment facility such as, but not limited to, a septic tank.

15. South Dakota - Graywater systems are included in a list of individual and small on-site wastewater disposal systems requiring certification of individuals responsible for the supervision of the alteration, repair, construction and installation of certain systems [D-37].

16. Texas - The Texas State Board of Plumbing Examiners shall adopt and implement minimum standards for the use and reuse of graywater in irrigation and for other agricultural, domestic, commercial, and industrial purposes to assure that the use of graywater is not a nuisance and does not damage the quality of surface water and groundwater [D-38]. Graywater is defined as wastewater from clothes washing machines, showers, bathtubs, hand-washing lavatories, sinks that are not used for disposal of hazardous or toxic ingredients.

17. Utah - State law referring to railroads and offensive substances on right-of-way includes the term graywater in its definition of "human waste" [D-39].

18. Washington - The state passed a water resource planning act where the Department of Ecology and Department of Health were charged with developing criteria to encourage reuse of graywater that is consistent with the protection of public health and water quality [D-40]. The state defines graywater as sewage having the consistency and strength of residential domestic type wastewater. Graywater includes wastewater from sinks, showers, and laundry fixtures, but does not include toilet or urinal waters.

4.2 PENDING LEGISLATION

Five states have bills and/or amendments pending. Each of the five states is determining uses for graywater. The primary uses are irrigation and toilet flushing. The following is a brief summary of the pending state legislation:

1. California - A bill is in the process to require the Department of Water Resources, by January 1, 1997, to adopt standards for the installation of graywater systems for subsurface irrigation and other safe uses [E-6].

2. Massachusetts - A bill is in the process that authorizes the House Committee on Natural Resources and Agriculture to make an investigation and study of the technology and feasibility of implementing graywater reuse technology [E-7].

3. Oregon - A bill is pending to require the Department of Environmental Quality to establish guidelines for the use of graywater and to seek approval of the U.S. Environmental Protection Agency for guidelines [E-8].

4. Vermont - A bill is pending to require the use of graywater for toilet flushing in State buildings [E-9].

5. Washington - The state is considering adding new sections to the act mentioned in **4.1 Current State Laws** regarding an interest in the development of facilities to provide reclaimed water to replace potable water in nonpotable applications [E-2]. Additionally, the state is considering the use of reclaimed water for domestic, agricultural, industrial, recreational, and fish and wildlife habitat creation and enhancement.

4.3 STATE REGULATIONS

In April 1994, the National Small Flows Clearinghouse issued a report entitled *Greywater Systems*, that summarized the 11 states that included graywater in its regulations [F-1]. The 11 states were Arizona, Connecticut, Florida, Hawaii, Kentucky, Minnesota, New Jersey, Oregon, South Dakota, Texas, and Wyoming. Regulations pertaining to graywater focused on design and construction of graywater reuse systems, capacity restrictions of septic/retention tanks, minimum of graywater flow, plumbing, treatment and disposal, seasonal use, sumps, and use of effluent from graywater systems.

In the electronic literature search conducted in July 1995, WESTON identified 24 states with regulations pertaining to graywater. Only Arizona and Texas specifically provide for graywater reuse. The following is a brief summary of the state regulations:

1. Alaska - Graywater regulations pertain to publicly-owned treatment works [F-84] and definitions for water, drinking water, and public water systems [F-86]. Does not address graywater reuse.

2. Arizona - Defines graywater for the reuse of wastewater for regulating activities. [F-87].

3. Colorado - Defines graywater system [F-88].

4. Connecticut - Defines graywater systems [F-89].

5. Delaware - Defines graywater for marine regulating activities [F-91].

6. Florida - Includes graywater systems as part of on-site sewage treatment and disposal system regulations [F-92]. Does not specify reuse.

7. Hawaii - Defines graywater and establishes criteria for system design [F-96]. Does not specify reuse.

8. Idaho - Defines graywater [F-97].

9. Indiana - Defines graywater [F-98].

10. Kentucky - Provisions for separating laundry graywater waste flow from other residential waste flow [F-21]. Does not refer to reuse of graywater.

11. Maine - Defines graywater [F-103] and sets criteria for graywater disposal fields for special

events [F-104]. The special events include fairs, carnivals, and similar events where people congregate. Does not refer to reuse of graywater.

12. Massachusetts - Defines graywater for the public building water conservation grant program [F-100]. The grants are for counties, cities, towns, and districts to develop water conservation projects to promote the conservation of water in public buildings.

13. Minnesota - Defines graywater and regulates the disposal of graywater, but does not refer to reuse of graywater [F-106].

14. Missouri - Defines graywater in context of individual sewage treatment systems standards and does not refer to reuse of graywater [F-108].

15. Nebraska - Defines graywater for septic tank systems [F-109].

16. New Jersey - Defines graywater in relation to sewage from vessels [F-110].

17. New Mexico - Defines graywater as used in liquid waste disposal regulations [F-111].

18. Oklahoma - The term graywater is used to define sewage [F-112].

19. Oregon - Defines graywater for the municipal wastewater treatment works construction grants [F-13]. Provides criteria for graywater waste disposal sumps [F-115], but does not refer to any reuse criteria.

20. Rhode Island - Defines graywater as it pertains to individual sewage disposal systems [F-117].

21. South Dakota - Defines graywater [F-118]. Graywater may be deposited upon the ground in locations where the graywater will not create a public nuisance or enter any waters of the state [F-119].

22. Tennessee - The term graywater is included in the definition of privately owned alternative wastewater treatment works [F-122].

23. Texas - Defines graywater in terms of employee hand-washing [F-123] and on-site wastewater treatment [F-124]. Permits on-site surface irrigation of treated wastewater in accordance with Texas Department of Health policy. The regulations include reuse and/or recycling of wastewater and/or graywater as an additional conservation strategy [F-127]. Texas regulates

the use of reclaimed water [F-129]. Texas regulates use of reclaimed water as a toilet flush water [F-131].

24. West Virginia - Graywater is regulated in terms of a disposal system, not a reuse system.

25. Wisconsin - The term graywater is included the definition of privately owned alternative wastewater treatment works [F-132].

4.4 U.S. LAW AND REGULATIONS

Only one reference to graywater in U.S. law was identified. Graywater is defined in the marine sanitation devices from the water pollution prevention and control standards and enforcement for navigation and navigable waters [G-1].

U.S. regulations incorporate four areas: commerce and foreign trade, navigation and navigable waters, environmental protection, and wildlife and fisheries. According to commerce and foreign trade regulations and pertaining to national marine sanctuaries, it is prohibited to reuse graywater generated by routine vessel operations [H-1, H-1, H-4, H-7, H-9]. Graywater is defined under navigation and navigable waters regulations pertaining to vessels containing oil, noxious liquid substances, garbage and municipal or commercial waste and ballast water.

Regulations under the U.S. Environmental Protection Agency pertaining to grants for construction of treatment works includes graywater in its definition of "individual systems" [H-21]. The systems are for the treatment and disposal of wastewater for one or more principal residences or small commercial establishments.

In the U.S. Environmental Protection Agency regulations pertaining to grants for construction of wastewater treatment works (40 CFR 35.2005) the term graywater is not used; however, it includes "alternative technology" [H-22]. Alternative technology consists of proven wastewater treatment technologies which provide for the reclaiming and reuse of water. It also includes land application of effluent and sludge; aquifer recharge; aquaculture; direct reuse (non-potable); horticulture; revegetation of disturbed land; containment ponds; sludge composting and drying prior to land application; self-sustaining incineration; and methane recovery.

A regulation (40 CFR Part 73 Appendix A to Subpart F) under the U.S. Environmental Protection Agency that pertains to energy conservation and renewable energy reserve, lists graywater systems as an approved "qualified energy conservation measure" [H-33]. Under wildlife and fisheries pertaining to geological and geophysical exploration of the coastal plain, Arctic National Wildlife Refuge in Alaska,

graywater may be discharged to the surface provided it is filtered, disinfected, and not discharged directly into lakes and rivers.

4.5 SUMMARY

Thirty-two states specifically define graywater either in statutes or regulations (the definitions and intent range from a simple definition of the term as part of household wastewater regulations through regulatory schemes for graywater reuse. Table 3 provides a summary of the 50 state's current law and regulations, pending law, and definition(s) as they pertain to each state's consideration of graywater. Most states distinguish graywater from blackwater, and three states (Hawaii, New York, and Texas) specifically prohibit household hazardous and/or toxic wastes. Five states have pending legislation to establish acceptable uses of graywater. Graywater is also regulated at the county and municipal level and it is possible for local regulations to contradict state laws and regulations. Federal oversight for graywater is limited to marine sanitation devices in navigable waters. While not specifically name, graywater reuse is implied as an acceptable alternative technology in wastewater treatment grants provided by the U.S. EPA.

Table 3

Summary of State Legislation and Regulations

STATE	CURRENT LAW	CURRENT REGULATIONS	PENDING LAW	GRAYWATER DEFINITION
ALABAMA				
ALASKA		Pertains to public-owned treatment works, not graywater reuse		
ARIZONA		Mentions reuse potential of recycled graywater		Wastewater generated from showers, baths, wash basins, clothes washers, and miscellaneous cleaning operations
ARKANSAS				
CALIFORNIA	Specific graywater legislation		Adopting standards for installation of graywater systems	Untreated household wastewater which has not been contaminated by any toilet discharge, has not been affected by infectious, contaminated, or unhealthy bodily wastes, and which does not present a threat from contamination by unhealthful processing, manufacturing, or operating wastes. Wastewater from bathtubs, showers, bathroom washbasins, clothes washing machines, and laundry tubs, but does not include wastewater from kitchen sinks or dishwashers. System and devices attached to the plumbing system for the sanitary distribution or use of graywater.
COLORADO		Sewage discharge, not graywater reuse		System designed to collect, treat, and dispose only liquid wastes from sinks, lavatories, tubs, showers, and laundry, or other approved plumbing fixtures excluding toilet fixtures

STATE	CURRENT LAW	CURRENT REGULATIONS	PENDING LAW	GRAYWATER DEFINITION
CONNECTICUT		Sewage discharge, not graywater reuse		Domestic sewage containing no fecal material or toilet wastes
DELAWARE	Sewage treatment and discharge, not graywater reuse	Marine sanitation, not graywater reuse		Liquid and water-borne waste derived from vessel galleys, showers, bathroom sinks, and tubs, but not including sewage
FLORIDA	Sewage treatment and discharge, not graywater reuse	Sewage treatment and discharge, not graywater reuse		That part of domestic sewage that is not blackwater, including wastes from the bath, lavatory, laundry, sink, except kitchen sink waste
GEORGIA	Sewage holding tanks, not graywater reuse			Graywater is included in the state's definition of "sewage": human excreta, all water carried wastes, and liquid waste, including graywater or similar waste byproducts
HAWAII	Use of graywater from residential units for irrigation purposes	Use of graywater from residential units for irrigation purposes		Any water from the domestic plumbing system of a residence expect toilets; provided that the discharged graywater is not contaminated with any household hazardous waste (e.g., drain cleaners, floor and furniture polish, dry cleaning fluid, poisons) or any other contaminant deemed inappropriate.
IDAHO	Marine sewage disposal, not graywater reuse	Reference to wastewater, not graywater reuse		The term graywater is used in the definition of "wastewater"
ILLINOIS				
INDIANA		Marine sanitation, not graywater reuse		Galley, bath, and shower water
IOWA				
KANSAS				
KENTUCKY	Septic tank servicing, not	Separate disposal system for		Includes the term graywater in definition of

STATE	CURRENT LAW	CURRENT REGULATIONS	PENDING LAW	GRAYWATER DEFINITION
	graywater reuse	washing machine water, not graywater reuse		"sewage": domestic blackwater and graywater wastes, but does not include waste from industrial or commercial processes
LOUISIANA				
MAINE		Criteria for graywater disposal fields for special events, not reuse of graywater		Wastewater containing domestic pollutants excluding human excrement and/or urine
MARYLAND				
MASSACHUSETTS	Purpose of developing new water conservation projects	Grants for counties, cities, towns, and districts to develop water conservation projects to promote the conservation of water in public buildings	Investigate and study the technology and feasibility of implementing graywater reuse	Any putrescible wastewater discharged from domestic activities including but not limited to washing machines, sinks, showers, bathtubs, dishwashers, or other source except toilets, urinals and any drains equipped with garbage grinders
MICHIGAN	Sewage treatment and discharge, not graywater reuse			System for the treatment and disposal of wastewater which normally does not receive human body wastes or industrial waste and is approved for use by a local health department
MINNESOTA		Regulates disposal of graywater, but does not refer to graywater reuse		Liquid waste from a dwelling or other establishment produced by bathing, laundry, culinary operations, and from floor drains associated with these sources, and specifically excluding toilet waste
MISSISSIPPI				
MISSOURI	Sewage treatment and discharge, not graywater reuse			All domestic wastewater from a state building except wastewater from urinals, toilets, laboratory sinks, and garbage disposals. All domestic waste not covered in the blackwater definition. Bath, lavatory, laundry, and sink wastes are included in the graywater

STATE	CURRENT LAW	CURRENT REGULATIONS	PENDING LAW	GRAYWATER DEFINITION
				definition.
MONTANA				
NEBRASKA		Septic tank systems, not graywater reuse		All domestic waste excluding blackwater and including bath, lavatory, laundry, and sink waste except kitchen sink waste
NEVADA				
NEW HAMPSHIRE	Marine toilets and sewage disposal from boats, not graywater reuse			Includes graywater in its sewage definition for control of marine pollution and aquatic growth regarding marine toilets and disposal from boats
NEW JERSEY	Water supply and sewer systems, not graywater reuse			System for the treatment and disposal of wastewater which normally does not receive human body wastes or industrial waste and is approved for use by a local health department
NEW MEXICO				Water carried waste from kitchen (excluding garbage disposal) and bathroom sinks, showers, bathtubs, and washing machines
NEW YORK	Specific mention of graywater reuse, plus marine sewage disposal			That portion of the sanitary sewage generated in a residential, commercial, or institutional facility which does not include discharges from water closets or urinals. Includes water discharged from lavatory sinks, tubs, showers, automatic dishwashers, and washing machines, but not industrial discharges or discharges containing toxic or hazardous materials.
NORTH CAROLINA				
NORTH DAKOTA				

STATE	CURRENT LAW	CURRENT REGULATIONS	PENDING LAW	GRAYWATER DEFINITION
OHIO				
OKLAHOMA		Sewage, not graywater reuse		Household showers, dishwashing operations, etc. (Included as part of definition for "sewage")
OREGON	Sewage disposal system, not graywater reuse	Municipal wastewater treatment works construction grants, graywater waste disposal sumps, not graywater reuse	Establish guidelines for the use of graywater and seek approval from U.S. EPA for the guidelines	Any household sewage other than toilet and garbage wastes, including shower and bath wastewater, kitchen wastewater, and laundry wastes
PENNSYLVANIA				
RHODE ISLAND		Individual sewage disposal systems		Any wastewater discharge from a structure excluding the waste discharges from water closets and waste discharges containing human or animal excrement
SOUTH CAROLINA				
SOUTH DAKOTA	Violations of sewage disposal, not graywater reuse	Graywater may be deposited upon the ground in locations where the graywater will not create a public nuisance or enter any waters of the state		Wastewater generated by water-using fixtures and appliances which do not discharge garbage or urinary or fecal wastes
TENNESSEE		Private wastewater treatment systems, not graywater reuse		
TEXAS	State Board of Plumbing Examiners to adopt and implement standards for graywater reuse	Reuse and/or recycling of wastewater and/or graywater as an additional conservation strategy		Wastewater from clothes washing machines, showers, bathtubs, hand-washing lavatories, sinks that are not used for disposal of hazardous or toxic ingredients
UTAH	Offensive substances on railway right-of-way, not graywater reuse			Includes graywater in definition of "human waste"

STATE	CURRENT LAW	CURRENT REGULATIONS	PENDING LAW	GRAYWATER DEFINITION
VERMONT			Require use of graywater for toilet flushing in State buildings	
VIRGINIA				
WASHINGTON	Graywater reuse as part of water resource planning		Development of facilities to provide reclaimed water to replace potable water in nonpotable application. Considering use of reclaimed water for domestic, agricultural, industrial, recreational, and fish and wildlife habitat creation and enhancement	Sewage having the consistency and strength of residential domestic type wastewater. Includes wastewater from sinks, showers, and laundry fixtures, but does not include toilet or urinal waters.
WEST VIRGINIA		Sewage disposal systems, not graywater reuse		
WISCONSIN		Privately owned wastewater treatment works, not graywater reuse		
WYOMING				

SECTION 5

PUBLIC PERCEPTION

5.1 ACCEPTING GRAYWATER USE

Technical studies have shown that the general public is accepting of graywater use primarily when it does not come into direct contact with humans (U.S. EPA, 1992)[I-3]. The public tends to support water reclamation projects for environmental benefits such as conservation or water quality protection of water resources.

One of the first studies, in 1972, encompassed the philosophy to introduce graywater use to the public in non-contact methods and then proceed from that point to increase the variety of uses of graywater supplies (Bruvold, 1972)[A-1]. The researchers offered several non-contact uses to the respondents: road construction, irrigation, golf course construction, golf course hazard lakes, home toilet flushing, electronic plant process water, commercial air conditioning, and pleasure boating. Even swimming in reclaimed water did not horrify the respondents.

It is important to note that it was members of the public that disregarded local ordinances prohibiting graywater use (Appendix B). It was private citizens who pioneered the use of graywater when water management professionals refused to consider graywater as an alternative water resource. Homeowners chose to use graywater in times of drought to irrigate lawns and gardens. Homeowners active in the graywater movement significantly saved on freshwater supplies and their water bill. When applied carefully and correctly, graywater became a viable resource to the resident's garden and landscape.

Local governments learned from the individuals using graywater and provided ordinances approving its use. For example, in the 1970s and 1980s, residents in Santa Barbara and Los Angeles Counties, California, defied local ordinances and developed their own graywater use systems. Santa Barbara County approved graywater use in October 1989 (Yoshitake, 1988)[B-70], and the City of Los Angeles hired a director of water reclamation whose task included encouraging home graywater usage (Levine, 1991)[B-107]. Health officials protested the use of graywater because of bacteria and potential health risks. However, no disease or illness has been attributed to the use of graywater. Finally, the water management professionals opened up to graywater uses and has incorporated its practices during time of drought.

Of the 16 technical studies reviewed, only two studies were limited to graywater reuse. The other studies pertained to wastewater reclamation. All of the studies were conducted by universities or local governments and agencies. Some of the wastewater reclamation technical studies contain specific data

assessing public attitudes, whereas, the graywater studies do not. Throughout the review of the general literature (e.g., newspaper articles and pamphlets) for graywater, public attitudes for graywater reuse generally correspond to the public attitudes for wastewater reclamation. Generally, public attitudes for both graywater reuse and wastewater reclamation are favorable with the following concerns: health protection and cost benefits. Therefore, this report includes discussions of the wastewater reclamation studies.

The evidence suggests that with proper public information and education programs, a gradual exposure to wastewater reclamation uses (non-contact to ingestion), with a fellowship of support among local public health, water supply, waste treatment, and scientific personnel, the support of the community is more likely to be successful (Kasperson, 1974)[A-348].

Initial public acceptance of reclaimed water projects requires the following:

- The public's awareness of local water supply problems and perception of reclaimed water as having a place in the overall water supply allocation scheme.
- Public understanding of the quality of reclaimed water and how it would be used.
- Confidence in local management of the public utilities and in local application of modern technology.
- Assurance that the reuse applications being considered involve minimal risk of accidental personal exposure (U.S. EPA, 1992)[I-5].

5.2 WASTEWATER RECLAMATION

Information presented in **Section 2 Early Recommendations for Water Conservation and Graywater Reuse** and **Section 3 Current Information** provided an overview of how the public received and perceived graywater issues from the mid-1960s to present day. This subsection focuses on public perceptions/acceptance and highlights specific examples of willing publics. Public acceptance of reclaimed water is not new. Santee, California, provides a success story of public acceptance (Kasperson, 1974)[A-330]. Santee is a small community (11,500 persons in 1974) about 20 miles east of San Diego. In 1959, the community decided to develop its own wastewater treatment system rather than join the San Diego metropolitan sewage disposal system. Santee also faced a water supply problem, with eventual reliance upon imported water from northern California. The community decided to reclaim and reuse its wastewater. The plan included using a mined-out canyon adjacent to the wastewater treatment plant to create an aquatic park with five lakes. The lakes were landscaped and used for recreation with spillover water used to irrigate golf courses.

An extensive public education and involvement program was implemented. Organizers gave oral presentation to a variety of community groups and briefed the media continuously. Upon completion of the lakes, the public was allowed to view the waters through a chain link fence. When the landscaping of the recreational lake was completed in the spring of 1961, the public was encouraged to use the park for picnicking, boating and scenic beauty. A fish-for-fun program was begun, but the fish could not be taken home for eating. Fishing enthusiasts were permitted to take their catch home in June 1964. In June 1965, a pool using reclaimed water was opened for swimming. By the end of that year, approximately 75,000 persons had visited the aquatic park, and that figure increased to 125,000 persons in 1966. Visitors expressed an interest in the use of reclaimed water for drinking purposes.

5.3 REJECTING WASTEWATER RECLAMATION

Information presented in **Section 2 Early Recommendations for Water Conservation and Graywater Reuse** and **Section 3 Current Information** provided an overview of how the public received and perceived graywater issues from the mid-1960s to present day. This subsection focuses on public perceptions and rejection of reclaimed wastewater practices and highlights a resisting public.

From 14 October 1956 to 14 March 1957, Chanute, Kansas, treated and reused its wastewater to augment the municipal water system (Kasperson, 1974)[A-328]. At that time, wastewater treatment technology was still in its infancy and the quality of the reclaimed wastewater product was poor, although it met public health standards. The treated water was a pale yellow color with an unpleasant musty taste and odor, and foamed when agitated.

The citizens of Chanute were not informed until after implementation of the treated water. The public was instantly negative and consumers purchased bottled water. Bottled-water sales boomed and nearly all grocery stores stocked large supplies. More than 70 private wells were drilled, but most were too mineralized for domestic use. Many people hauled water from neighboring towns and wells. Even with this behavior of resistance there was some public acceptance. Residents surveyed liked the reclaimed water for toilet flushing, washing clothes, and bathing.

5.4 EXTENSION SERVICES

In 1989, the SDA solicited the Cooperative Extension Service in each state regarding the use of graywater for home lawn and garden irrigation (Booman, 1989)[K-10]. About half of the extension services responded. Information focused on practical uses of graywater:

- Determine if graywater use is legal. If it is, laundry rinsewater, bath water, and light duty cleaning wastewater is preferred.

- Laundry washwater may be used if it is diluted with other graywater (rinsewater) or fresh water.

- The major concern is sodium but a gardener can take corrective action if plants and soil are getting too much sodium.

- Use of water containing wash additives (e.g., sodium, chlorine, boron, fabric softeners, and phosphorus) is discouraged.

- Graywater is best used for toilet flushing.

Collectively, the extension service agents were knowledgeable of harmful effects of graywater constituents on plants and soils (Booman, 1989)[K-13]: sodium, chlorine, boron, fabric softeners, phosphorus and soap. The extension service agents were also knowledgeable about the application of graywater (Booman, 1989)[K-15]:

- Let hot washwater cool before application.

- Try to use graywater for ornamental plants and shrubs and use fresh water for a vegetable garden to avoid consuming contamination. Do not apply graywater to leafy vegetables or root crops. Apply graywater between rows of fruiting vegetables such as tomatoes and beans. Be sure the graywater does not contact the plants.

- Pour the graywater on flat garden areas and avoid steep slopes were runoff into areas sensitive to graywater could be a problem.

- Avoid concentrating graywater to one area because of potential contaminants in the graywater. Cover a broad area.

- If possible, rotate graywater and fresh water applications to avoid buildup of potential contaminants in graywater.

- Spread thick compost mulches to areas where graywater is used. It will speed the natural decomposition of graywater residues.

- Use graywater on only well-established plants. Graywater impurities are harmful to seedlings.

- Do not apply graywater, which is alkaline, on acid-loving plants like rhododendrons and azaleas.

- One season of moderate graywater use should not kill a plant, but it may cause chlorosis (yellowing of the foliage). If that is the case, apply iron and/or ammonium sulfate in the spring to restore foliage color.

- Apply graywater over the root zone away from a tree or shrub base to reach feeder roots.

- Do not use graywater containing grease. Grease can plug the soil.

The cooperative extension services provided a variety of flyers, brochures, and pamphlets to the researcher. Copies of these publications are included in Appendix K (pages K-22 through K-345).

As a follow-up to the 1989 request for information, WESTON sent a mass mailing to the State Extension Water Quality Coordinators and members of the Home Economists Association in September 1995 (WESTON, 1995)[L-2]. The purpose of this mailing was to identify what information local resources are providing to their constituents. The WESTON letter requested the extension professionals to respond to the following questions:

- What questions have citizens asked about graywater uses?

- What is the frequency of public inquiries about graywater?

- How does the State (or home economist) respond to the questions posed?

- What are the State's (or home economist's) recommendation to the public about graywater uses?

- What State publications that include graywater education, uses, laws, and/or regulations are available to the public? Please send a copy of the publications to WESTON.

- Who else should one contact regarding public issues and perceptions associated with graywater uses.

Eleven states responded to the request for information. The following is a summary of the responses.

1. Alabama - Citizens ask if graywater can be used to water lawns and gardens. There is only a few phone calls per year. It was noted that average yearly rainfall in Alabama is a plentiful 55 inches. Graywater is not much of an issue at this time (Hairston, 1995)[L-6].

2. Arkansas - A representative of the Arkansas Department of Health said that the most common question is "Can I separate washing machine water from other household waste?" The state's response is yes; under Act 402 of 1977 any wastewater from the home is considered sewage and must be disposed of in a proper manner. The separation of the graywater and blackwater is done occasionally but the graywater is still disposed of in a subsurface method. Of the 9,000 septic system permits issued last year, less than one percent asked about graywater. The state responds to the questions by educating the public that graywater is not harmful to a properly constructed septic system (Brumbelow, 1995)[L-21].

3. Indiana - A representative of the Purdue University Department of Agronomy said that the Indiana State Department of Health regulations consider both graywater and blackwater as "sewage" which must be discharged to a central sewer or to an approved septic system. State officials and Purdue University specialist receive questions about composting toilets, the use of privies, and other systems that would require a graywater disposal system. The response to those questions is that graywater must be disposed of according to the state rules (Yahner, 1995)[L-35].

4. Iowa - A representative from the University Extension said that they receive few inquiries about graywater because most residents are unaware of it. The questions, about two or three per year, usually refer to septic system uses. The current version of Chafer 69 of the Iowa Administration Code (*On-site Wastewater Treatment & Disposal Systems*) gives no specific guidance or graywater. The state has not issued any recommendations to the public about graywater uses and no state publications on graywater exists (Glanville, 1995)[L-28].

5. Kentucky - A representative of the Kentucky Cooperative Extension Service said that generally receive very few questions regarding the graywater issues. Graywater issues of concern in Kentucky focus on water conservation. Sewer rates are based upon the amount of water intake, not outflow, so there is no financial incentive for homeowners to use graywater for other purposes in the home. Another issue is the current health regulations. The Kentucky Department of Health require that graywater be treated before being used for other purposes because of possible bacteria contamination. Some homeowners are interested in using

graywater in gardening, while others are interested in collecting graywater to decrease the amount of water flowing into septic systems (Cocanougher, 1995)[L-23].

The Kentucky Cooperative Extension Service produced a publication entitled *Conserving Water at Home.* The publication includes two graywater uses "during emergencies": use graywater to flush the toilet or water plants (Heaton, 1989)[L-24].

6. Louisiana - A representative of the Louisiana Cooperative Extension Service said that there are situations where individual household septage treated effluent is irrigated or surface applied to reduce discharge off property, and the state encourages public and private sector wastewater producers to irrigate agricultural or silvicultural crops instead of treating for discharge (Branch, 1995)[L-20].

7. Mississippi - The state does not allow the use of graywater but has two publications regarding household wastewater management, pertaining to septic systems (Bonner, 1995)[L-9].

8. Nebraska - A representative of the University of Nebraska Water Resources Center said that graywater questions focused on water conservation, soaps and detergents (washwater and rinsewater), and laws and regulations. Approximately 12 inquiries are received each year (Volk, 1995)[L-34].

9. New York - A representative from the New York water quality program responded to the request for information. Fewer than five questions are received per year. Questions focused on if graywater must be treated in a septic system and if wastewater from washing machines could be used to water lawns and gardens. New York State Department of Health regulations does not allow surface discharge of wastewater, including graywater; however, local (county) health departments would consider proposals to use graywater in an unconventional system on a case by case basis. New York State does not make any recommendations to the public about graywater reuses, except for the treatment regulations. There are no state publications concerning graywater (Kneen, 1995)[L-18].

10. Oklahoma - An Oklahoma State University representative said that he received only one or two questions about graywater in the past two years. The questions related to the use of washing machine or dishwater wastewater for garden irrigation. One resident asked if graywater could be disposed of without going through the septic system. District sanitarians informed the resident that all household wastewater must go to an approved on-site wastewater treatment system for rural areas (Smolen, 1995)[L-31].

11. Virginia - A representative of the Virginia Cooperative Extension Service said the frequency of graywater inquiries is very low. The questions that have been asked are: Are there plans for graywater reuse in Virginia? Is graywater reuse safe? What will it cost/save the homeowner? Where can one fine more information about graywater? The state responds that graywater issues are only applicable to metropolitan areas that are considering retrofitting for that purpose. There are no state guidelines or publications regarding graywater. (Lyons, 1995)[L-32].

5.5 SUMMARY

The general public has pioneered the use of graywater as a method to save freshwater supplies. Local governments have followed this trend, providing ordinances for such use. The Cooperative Extension Service has provided recommendations for graywater reuse, including mitigative measures where appropriate.

SECTION 6
INTERNATIONAL

6.1 INTERNATIONAL SUMMARY

The following provides a brief summary of articles about wastewater reclamation and graywater uses in countries around the world:

1. Argentina - Effluent from a primary treatment plant in Mendoza Province was used for irrigation of an agricultural canal and unrestricted irrigation of land. At the city of Ortega, stabilization pond effluent of poor quality was mixed with river water and used for unrestricted irrigation of vegetable crops. It was determined that the effluents created a relatively high health risk (U.S. EPA, 1992, p. 192)[I-17].

2. Brazil - The city of Sao Paulo, the third largest city in the world, began to address a prospect of a limited supply of water and initiated a study of the feasibility of reclaiming its secondary (activated sludge) effluent for industrial purposes (U.S. EPA, 1992, p. 192)[I-17].

3. Canada - A newspaper article reports that implementation of a graywater program/system could cut water consumption for a family of four in an average house by about 16%, according to a Canada Mortgage and Housing Corporation report on domestic water conservation (MacLean, 1993)[B-293].

4. Chile - All of Santiago's wastewater was used indirectly for crop irrigation. Seventy to 80% of

the city's raw wastewater was collected into an open drainage canal and then distributed for irrigation. The irrigated area provides almost all the salad vegetables and low-growing fruits to Santiago. A connection has been drawn between the use of raw wastewater for irrigation and the higher incidence of typhoid in Santiago than in the rest of Chile (U.S. EPA, 1992, p. 193)[I-18].

5. Cyprus - The country is challenged with a growing scarcity of water resources in the semi-arid regions and degradation of water at its beaches. The government has begun implementation of a new sewerage and wastewater treatment and reuse in two major tourist areas (U.S. EPA, 1992, p.193)[I-18].

6. France - Regulations require operators to minimize graywater sewage when washing, cleaning, and inspecting vehicles. This pertains to pretreatment of industrial waste [J-1].

7. India - Irrigation with untreated wastewater is widely practiced. The law prohibits irrigation of salad vegetables with wastewater, however, the practice is widespread and the government does not actively enforce the regulations. In many states there is no microbiological standards, therefore, no parameter to control the level of treatment. Farm workers suffer from enteric diseases, anemia, and gastrointestinal illnesses. And it is possible that consumers of salad and vegetable crops are at risk. A Ganges River program is to include treatment facilities for six cities (U.S. EPA, 1992, p. 193)[I-18].

8. Israel - Newspaper article promotes the use of graywater for gardening during time of fresh water supply shortages (Ben Shaul, 1991)[B-101].

9. Japan - Because of a dense population and limited water resources, Japan implemented programs of wastewater reclamation and reuse. Reclaimed water is used for toilet flushing in multi-family, commercial, and school buildings. Japan provides a good example for urban cities in developing countries because its historical usage has been for meeting urban water needs and not only agricultural irrigation requirements (U.S. EPA, 1992, p. 195)[I-20].

10. Mexico - Approximately 90% of Mexico City's wastewater is reused for agricultural purposes. Farmers have complained of illnesses. It is expected that both irrigation and industrial wastewater reuse will increase (U.S. EPA, 1992, p. 195)[I-20].

Basic Services for the Americas - a non-profit organization in Baton Rouge, Louisiana, addresses sanitation and water problems in Mexico. The organization designs and installs graywater filters that make water from cleaning, cooking, and bathing usable for watering gardens (*The Times-Picayune*, 1993)[B-282].

11. People's Republic of China - Two principal ports in northern China, are examples of urban centers with falling groundwater tables and increasing land subsidence. Saltwater intrusion and heavy pollution have rendered much of the region's water unusable. Studies of regional water resources concluded that the reduction of agricultural water use through more efficient irrigation practices and wastewater reclamation for nonpotable urban and industrial needs should have the highest priority in the region's water management program (U.S. EPA, 1992, p. 196)[I-21].

12. Peru - Reuse is widely practiced along the coastal desert strip. Raw sewage is used for irrigation of market vegetables that are eaten without processing (U.S. EPA, 1992, p. 197)[I-22].

13. Saudi Arabia - By 2000, Saudi Arabia expects to meet almost 10% of its water demand through reuse. Advanced treatment systems include reverse osmosis, desalination, filtration, and disinfection. Reclaimed water is used for municipal, industrial, and agricultural use (U.S. EPA, 1992, p. 198)[I-23].

14. Singapore - Because of its small size, Singapore has limited water resources. Wastewater plants discharge effluents to the sea. At one location, the effluent is withdrawn from the outfall to serve industrial needs. When a major housing development was constructed, for a population of about 25,000 in 15-story buildings, all the toilets were served with reclaimed water (U.S. EPA, 1992, p. 198)[I-23].

15. Sultanate of Oman - Reclaimed wastewater has been used to irrigate plants by drip irrigation. During the summer, all of the reclaimed water is used, and demands are not met. During the winter about 40% of the effluent from one of the three reclamation plants is discharged to the Gulf of Oman. In the future, the reclaimed wastewater network will be expanded so that all the effluent is reused (U.S. EPA, 1992, p. 199)[I-24].

16. Sweden - People are joining together to build specially designed "eco-villages" where graywater is collected separately from toilet waste, filtered in sand beds, stored in cisterns, and used for irrigation (Evans, 1993)[B-277].

17. Tunisia - Tunisia has done the most of all the countries in North Africa with water reclamation.

Considerable research has been conducted to assess the fertilizer value of reclaimed water and the sewage produced in treatment. Reclaimed water irrigation produced higher yields than groundwater irrigation. Studies of contamination of crops and groundwater when reclaimed water is used revealed little impact on soils, crops, or groundwater (U.S. EPA, 1992, p. 199)[I-24].

18. United Arab Emirates - Extensive nonpotable reuse has been practiced in Abu Dhabi since 1976. Reclaimed water is used for urban irrigation of public gardens, trees, shrubs and areas of grass long roadways (U.S. EPA, 1992, p. 199)[I-24].

6.2 SUMMARY

Literature or graywater reuse and wastewater reclamation was identified for 18 countries. In each instance, declining freshwater resources was the drilling force behind water reclamation effort.

While generally recognized as a potentially valuable resource during times of water shortages, public health concerns were frequently identified. Irrigation was the most common reuse, with toilet flushing also frequently cited. Several countries have initiated feasibility studies to investigate reclamation of graywater, blackwater and wastewater.

SECTION 7
CONCLUSIONS

Public perceptions surrounding graywater reuse are driven by the nature and extent of the exposure. Successful graywater reuse has been most frequently reported where direct human contact has been limited, thus avoiding potential health risks, as well as concerns over water color and odor. Irrigation and toilet flushing have been the most widely reported uses. The review of the literature provides the following conclusions:

- Individual homeowners will initiate their own graywater use during times of drought. In general, the public will accept graywater use or wastewater reclamation programs when the programs begin with uses that avoids human contact. Graywater use will increase in drought-stricken areas and arid regions because of governmental restrictions on water usage, rising water costs, and homeowner control over their graywater system.

- Information is available to homeowners that discusses the impact of cleaning product ingredients in graywater reuse. Most of this information is not scientifically based. Graywater users are informed how to apply graywater containing soaps and detergents

to maximize irrigation use. Presently, there appears to be no public outcry for re-formulating soaps and detergents for graywater uses.

? State health departments are generally named as the agency to enforce graywater uses. Although a state may permit the use of graywater, provisions to the state law allow a community to deny its residents graywater uses. More often the health departments defer or delegate authority to local jurisdictions. Inconsistencies may exist between neighboring communities regarding graywater uses.

? An extensive public information and education program is required to implement a wastewater reclamation program. The public should be informed of sources of the wastewater, treatment, uses and distribution of the reclaimed wastewater. Information and education is also important in graywater uses because the homeowner has direct contact with the graywater and is responsible for the collection and uses of the graywater.

? Information and education programs about graywater opportunities and uses could be organized and conducted. A small-scale education or information pilot program could be established in a neighborhood or community based on a profile for success (e.g., drought, laws and regulations permit graywater use, and homeowners' concern and need for water resources.) Towns best suited for a pilot graywater reuse program are (1) located in arid regions, (2) have limited water supplies/resources, (3) have expensive means to obtain water, or (4) have experienced several years of drought conditions.

? The most prominent citizen resource for graywater reuse is Robert Kourik, c/o Edible Publications Metamorphic Press, P.O. Box 1841, Santa Rosa, California 95402 (707)874-2606. A recommended government official is Marcia Prillwitz of the California State Department of Water Resources (916) 327-1620.

SECTION 8
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APPENDIX D - STATE LAWS

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APPENDIX G - U.S. LAW

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Title 33. Navigation and Navigable Waters, Chapter 26. Water Pollution Prevention and Control Standards and Enforcement. [G-1]

APPENDIX H - U.S. REGULATIONS

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Title 15. Commerce and Foreign Trade, Subtitle B. Regulations Relating to Commerce and Foreign Trade, Chapter IX. National Oceanic and Atmospheric Administration, Department of Commerce, Subchapter B. Ocean and Coastal Resource Managment

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APPENDIX J - INTERNATIONAL LAWS/REGULATIONS

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