This presentation premiered at WaterSmart Innovations

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Greywater in the Real World
Study of 83 Residential Greywater Systems

Conducted by Greywater Action in collaboration with City of Santa Rosa and Ecology Action

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Laura Allen
laura@greywateraction.org

Previous Greywater Studies

- Growing literature from Australia, Middle East, and Europe.
  - Studies found GW quality is lower than other sources of water, some found salinity increased in the soil, others found salinity was the same as when using fertilized water, and plants did as well or better than with other sources of irrigation water.
- Few US studies on actual systems, and those on real systems studied few sites (WERF- 5 sites, LA-8, EBMUD- 3). Other studies done in lab.

Goal for Study

- Fill information gap on greywater irrigation's effect on soil, plants, potential water savings and installation costs.
- Learn from existing systems to improve future ones.
- Identify best practices to share with public agencies and NGOs.

Study Group

- 66 households with 83 systems (in CA)
  - San Francisco Bay Area (9 cities)
  - Monterrey Bay Area (6 cities)
  - Santa Rosa Area (3 cities)
- 95% Homeowners

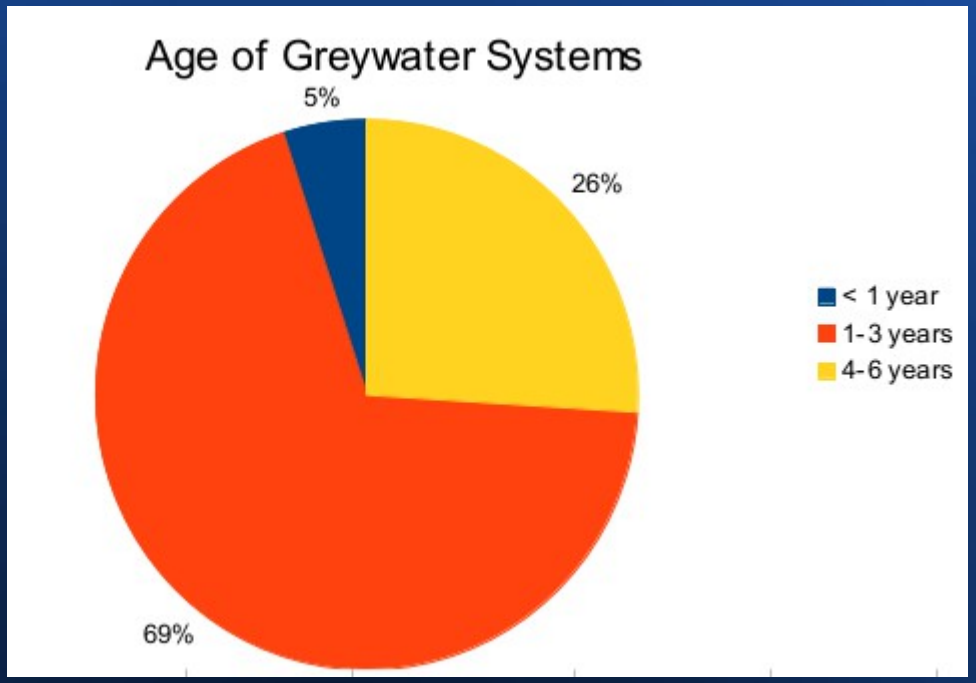
Methods

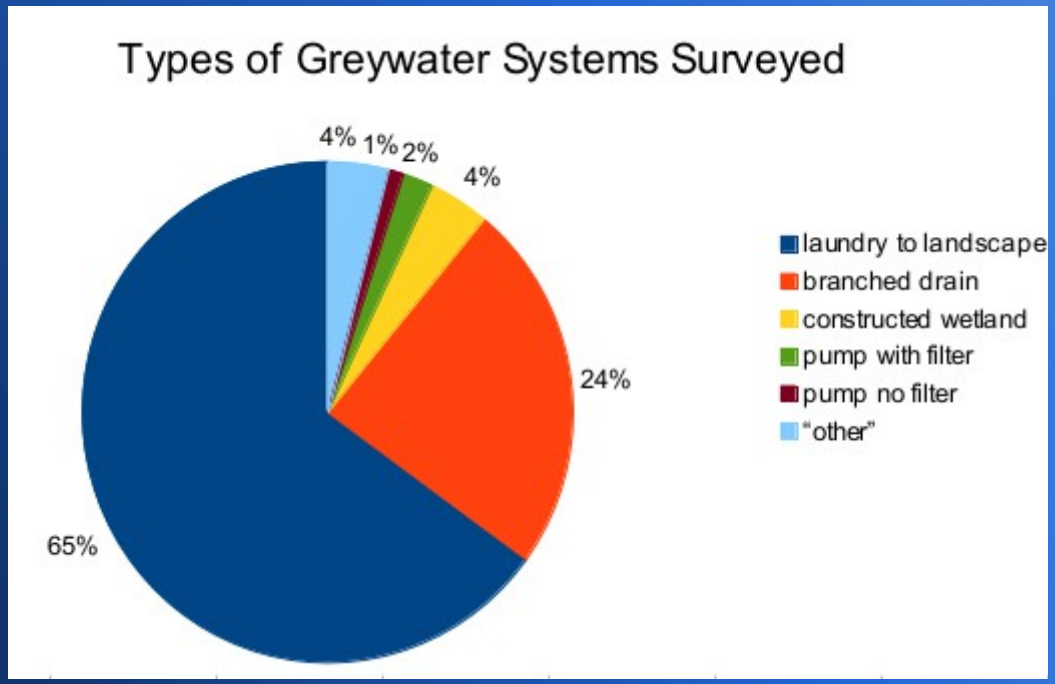
- One hour structured interview with person who maintains the system.
- Greywater testing:
  - Lab: EC (salts), TDS (salts), boron, Irrigation suitability with subset of 57 samples. On-site: pH
- Soil testing:
  - Lab: suspended salts, boron, pH, extractable nutrients. On-site: soil texture

Methods Continued

- Greywater sample collected from an outlet in the landscape for most systems
- Two soil samples collected: One from below GW outlet, one from an area of the yard not irrigated by GW
- Plant health qualitative assessment
  - 127 plants in details
  - More than 1,000 plants observed in all
- Water consumption records for 34 sites
- Installer survey to assess installation costs (20 installers for 259 systems)

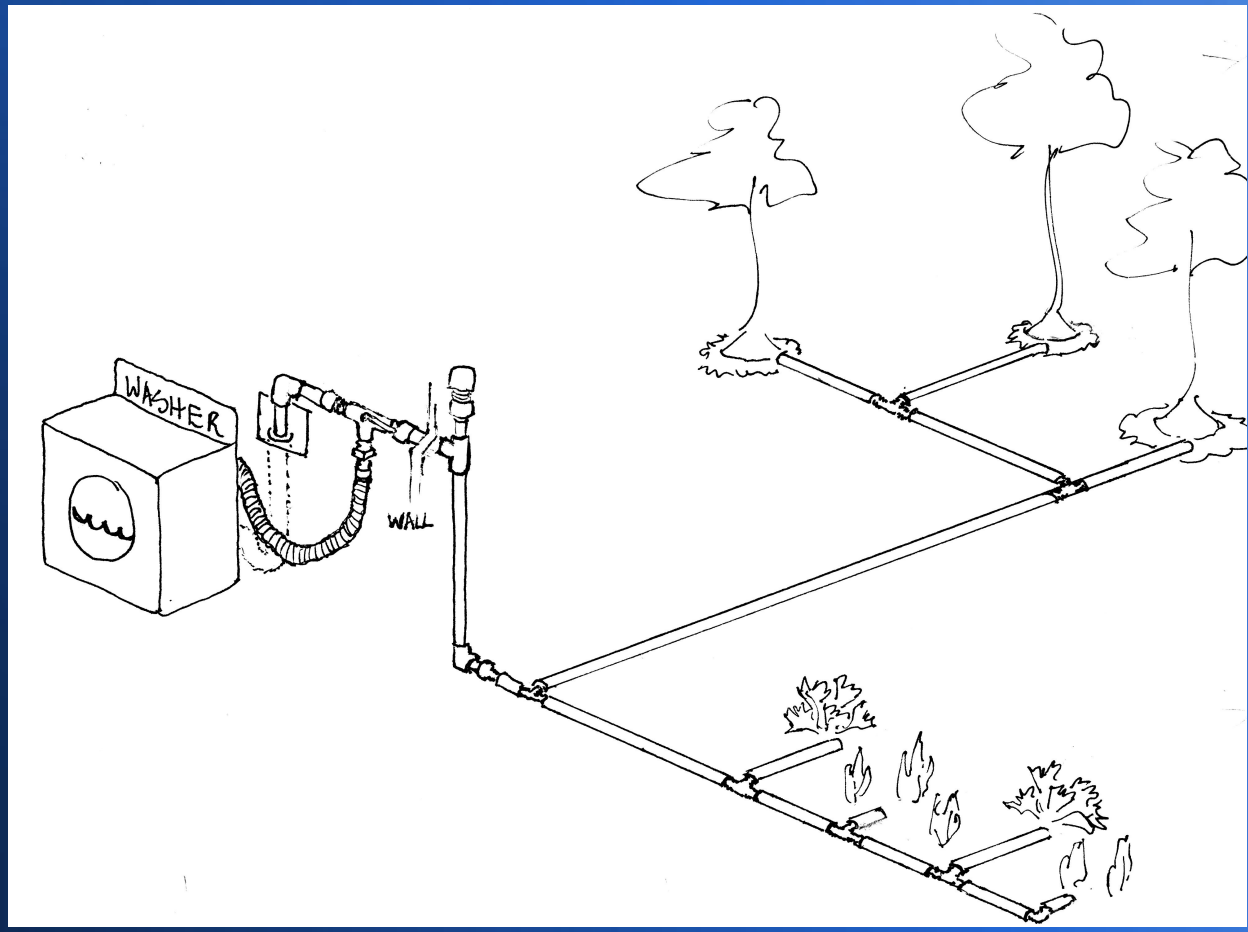
83 Residential Systems





“Laundry to Landscape” System

- Does not alter existing plumbing
- No permit needed in CA
- Easy for a handy person to install



User Satisfaction

- 99% of users were satisfied or very satisfied with their system

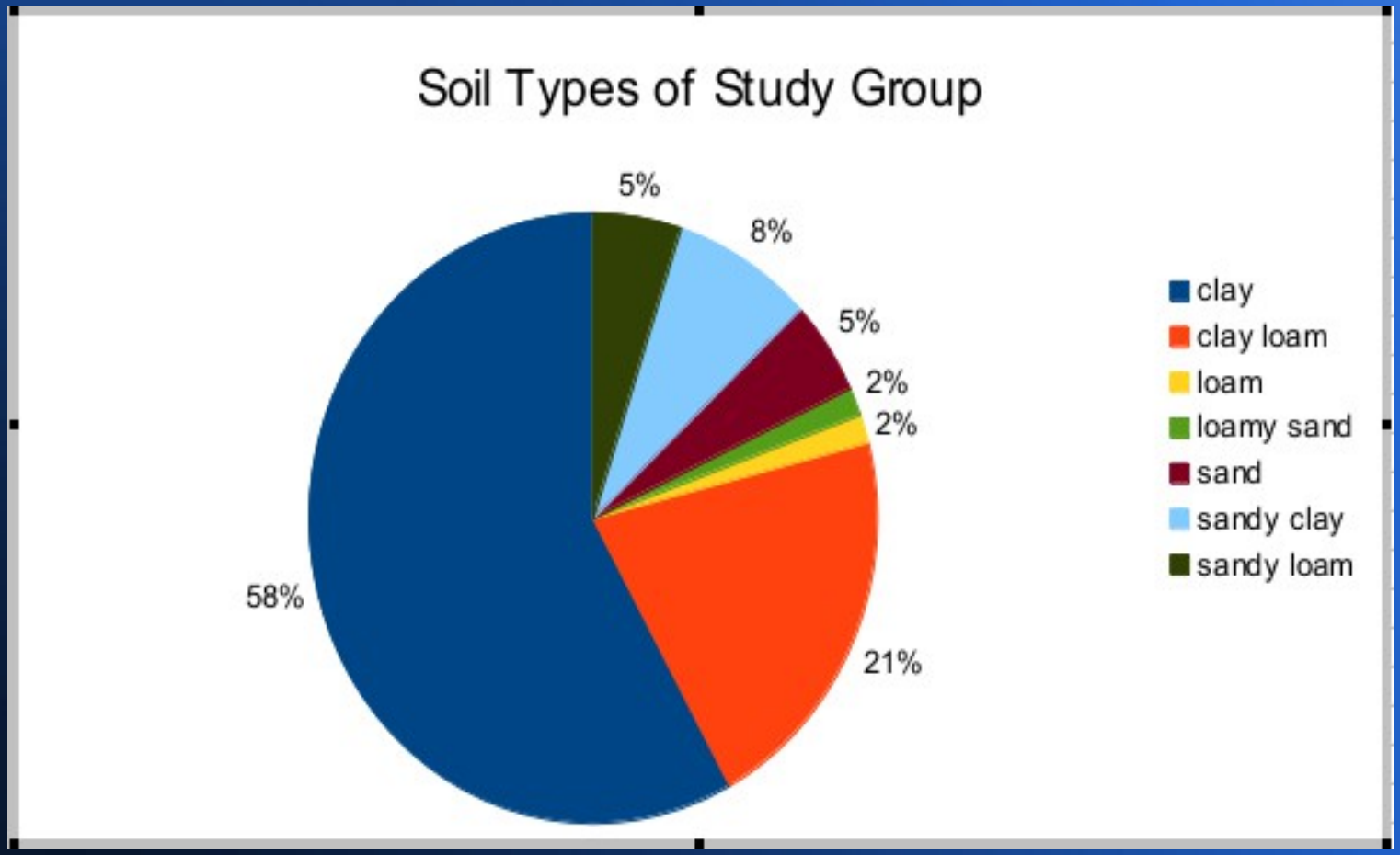
User Satisfaction with Greywater System					
	% Very satisfied	**% Satisfied**	% Neutral	% Dissatisfied	% Very dissatisfied
Overall satisfaction	**75**	**24**	1	0	0
Reliability (need for maintenance)	**69**	**23**	7	1	0
Irrigation performance	**55**	**40**	5	0	0

- 86% said they'd recommend their system to others, 13% said they'd recommend it with modifications, 1 person was unsure

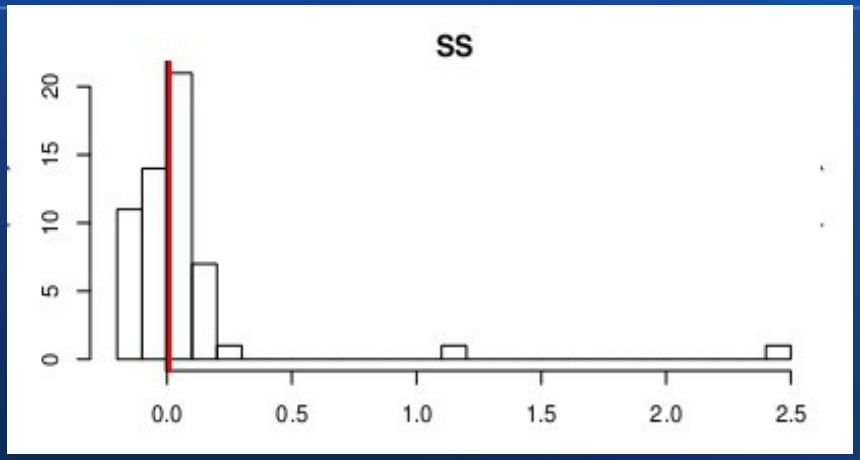
Maintenance and Repairs

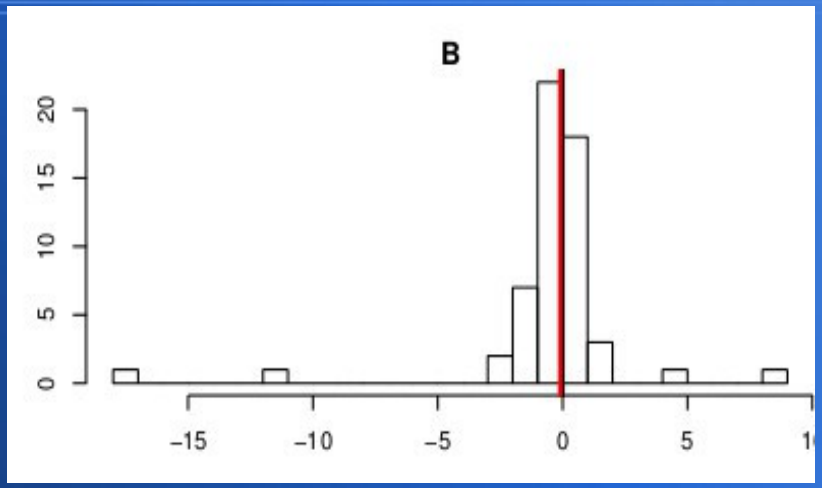
- Most people reported no problems
  - 12% reported clogging, for most it occurred once at GW outlet. One system with filter had monthly clogging.
  - 8% reported irrigation problems, most due to clog in outlet or detached valve.
  - A few reports of pests: 1 gopher, slugs in mulch shields
  - 84% no broken parts
    - Broken parts included 9 tubing breaks, 1 filter, 1 valve. (Tubing broke from damage with shovel)
    - Mulch shields made from polyethylene pots often broke.
- Most did very little maintenance

Soil Test Results

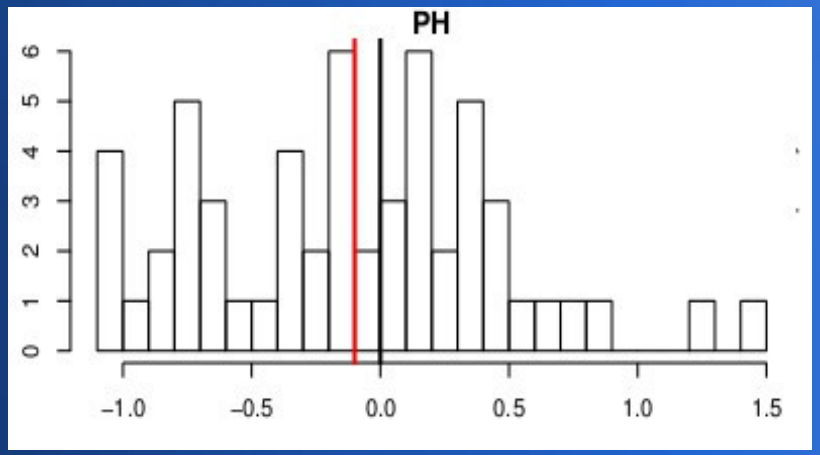


Soil Test Results Cont.





No statistically significant difference for any variable by soil type, quantity of greywater, or age of system, except: systems older than 4 years had lower pH.



Soil Test Results Cont.

		Median	Samples in "generally safe" range	Samples in "slight to medium" risk	Samples in "severe" risk	Median difference btw. GW and non-GW samples
Soluble salts (mmhos/cm) or dS/m	greywater	0.17	97%	3%	0%	0.01
	non-GW	0.16	100%	0%	0%	
pH	greywater	6.5				-0.1
	non-GW	6.5				
Boron (ppm)	greywater	1	55%	42%	3%	0
	non-GW	0.8	65%	32%	3%	

Guidelines for Interpreting Soil Test Results

	Generally safe	Slight to moderate risk	Severe risk
Soluble salts (EC) mmhos/cm	0.5-2.0	2.0-4.0	>4.0
Boron (ppm)	0.1-0.5	1 – 5	>5

Greywater Test Results

		Median	Samples in "**generally safe**" range	Samples in "**slight to medium**" risk range	Samples in "**severe**" risk range
EC (mmhos/cm)	greywater	0.31	85%	14%[2]	1%
	municipal water[1]	0.38			
TDS (ppm)	greywater	193	84%	15%[2]	1%
	municipal water[1]	240			
SAR[3]	greywater	1.8	80%	18%[2]	2%
	municipal water[1]	no data available			
pH	greywater	6.5			
	municipal water[1]	8.3			
Boron (ppm)	greywater	0.04	92%	5%[2]	3%
	municipal water[1]	0.31			
Chlorine (ppm)	greywater	24	94%	6%[2]	0%
	municipal water[1]	24			
Sodium (ppm)	greywater	32	85%	13%[2]	2%
	municipal water[1]	23			

1. Average of 7 water districts' data. 2. Most samples at low end, see report for details.
3. We used adjusted Rna data

Guidelines for Interpreting Greywater Test Results

	Generally safe	Slight to moderate risk	Severe risk
EC (mmhos/cm)	<.7	0.7-3.0	>3.0
TDS (ppm)	<450	450-2,000	>2,000
SAR	<3	3 – 9	>9
Boron (ppm)	<0.5	0.5-1.0	>1.0
Chloride (ppm)	<140	140-300	>300
Sodium (ppm)	<70	70-200	>200

Types of Plants Analyzed

127 plants of 68 different species

- Fruit trees (almond, apple, apricot, asian pear, avocado, cherry, fig, lemon, lime, mandarin, olive, orange, peach, pear, persimmon, pineapple guava, plum, pluot, pomegranate)
- Edibles (artichoke, arugula, blue berry, chard, grape, kiwi, herbs, raspberry, sugar snap pea)
- Ornamentals (bamboo, bougainvillea, willow, box wood, buddah's hand, butterfly bush, many flower species, camellia, maples, red oak, silverberry, spice bush, umbrella tree)
- CA natives (ceonothes, flowering currant, mimulus, rushes, salvias)

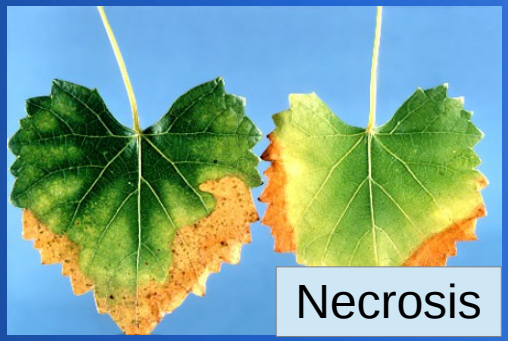
Plant Health Results

Almost all plants were healthy.

	No signs	Some signs	Severe signs
Leaf necrosis	95%	5%	0%
Leaf chlorosis	94%	5%	1%
	Fully healthy	**Mostly healthy**	**Unhealthy[1]**
Overall health	95%	2%	3%

1- Of the unhealthy plants, half were identified to be unhealthy before greywater irrigation began.


Chlorosis

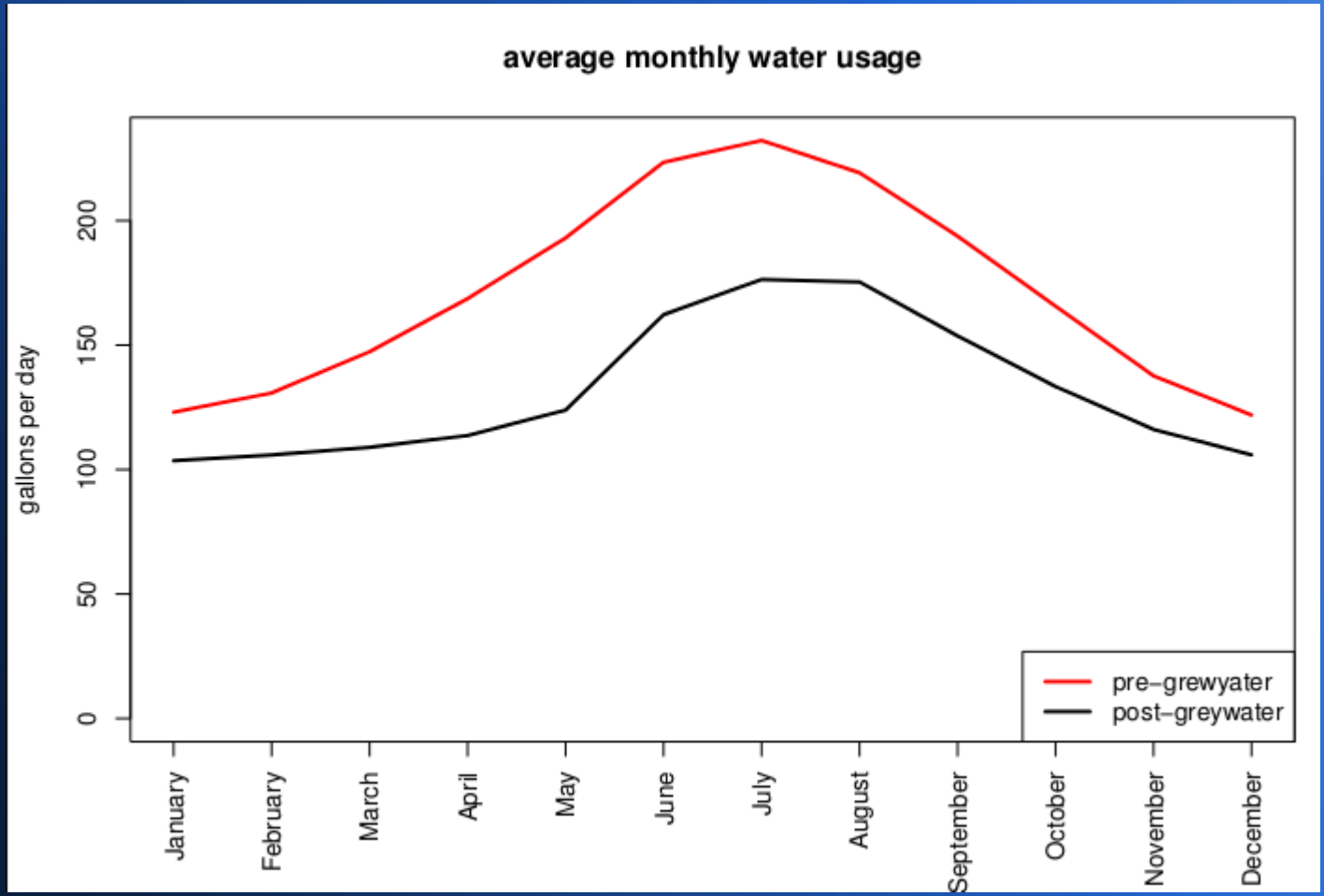

Necrosis

Plant Health Results Cont.

- Diseases we saw were common and did not appear to be related to GW irrigation. eg. peach leaf curl
- Several homeowners reported health improvements after GW use: increased flowering and fruiting.
- Some plant were over watered, some under watered, and others appropriately watered. Since all seemed healthy, this demonstrates a large range of tolerances to irrigation amounts.

Water Consumption Results

Average savings: **14,565** gallons/year (~10,000 Summer ~5,000 winter)



Water Consumption Results Cont.

Per Capita Savings Per Category (GPCD)			
	Average	Minimum	Maximum
Per capita	17	-32	122
GW + other water saving changes in home	23	-18	81
Planted new plants with GW, no other changes	-4	-19	8
No new plants, no other changes	11	-32	122

Key Conclusions

- The quality of GW we tested was much higher than in other studies, we believe due to households using “plant friendly” products.
  - Education on “plant friendly” products is important to ensure suitable irrigation water.
- Plants grew healthily with few problems.
- Our results should allay concerns for soil health with long term irrigation so long as plant friendly products are used.

Key Conclusions (cont.)

- Greywater is an important component in reducing total residential water consumption. (Average 17gpcd in this study represents a 26% reduction.)
  - GW should be used in concert with other strategies (efficient fixtures, lawn removal, rainwater harvesting, etc.)
- Assessing water savings is not always straightforward.
  - Some sites increased their landscaped area when they installed the GW system.
  - Behavior factors influence savings, such as continued irrigation of plants also irrigated with GW will negatively affect potential savings.

Key Conclusions (cont.)

- We observed a few sites with problems that could have easily been prevented with simple design changes or more frequent maintenance.
  - Two sites experienced runoff due to GW being discharged near hardscape with unmaintained mulch basins.
  - Two systems resulted in extreme over irrigation of plants.

Key Conclusions (Cont.)

- Simple laundry-to-landscape and branched drain systems should be promoted as they:
  - Are more economical, have few problems, and result in high user satisfaction.
  - Users need education on products, maintenance, and how to maximize water savings (ie. Disconnect other irrigation systems).
- Costs (See full report)

Questions?

Download report at
www.greywateraction.org