

WaterSmart: A “ClearWater” Revival: A Novel Method for Recycling Residential Waste Water



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The Opportunity

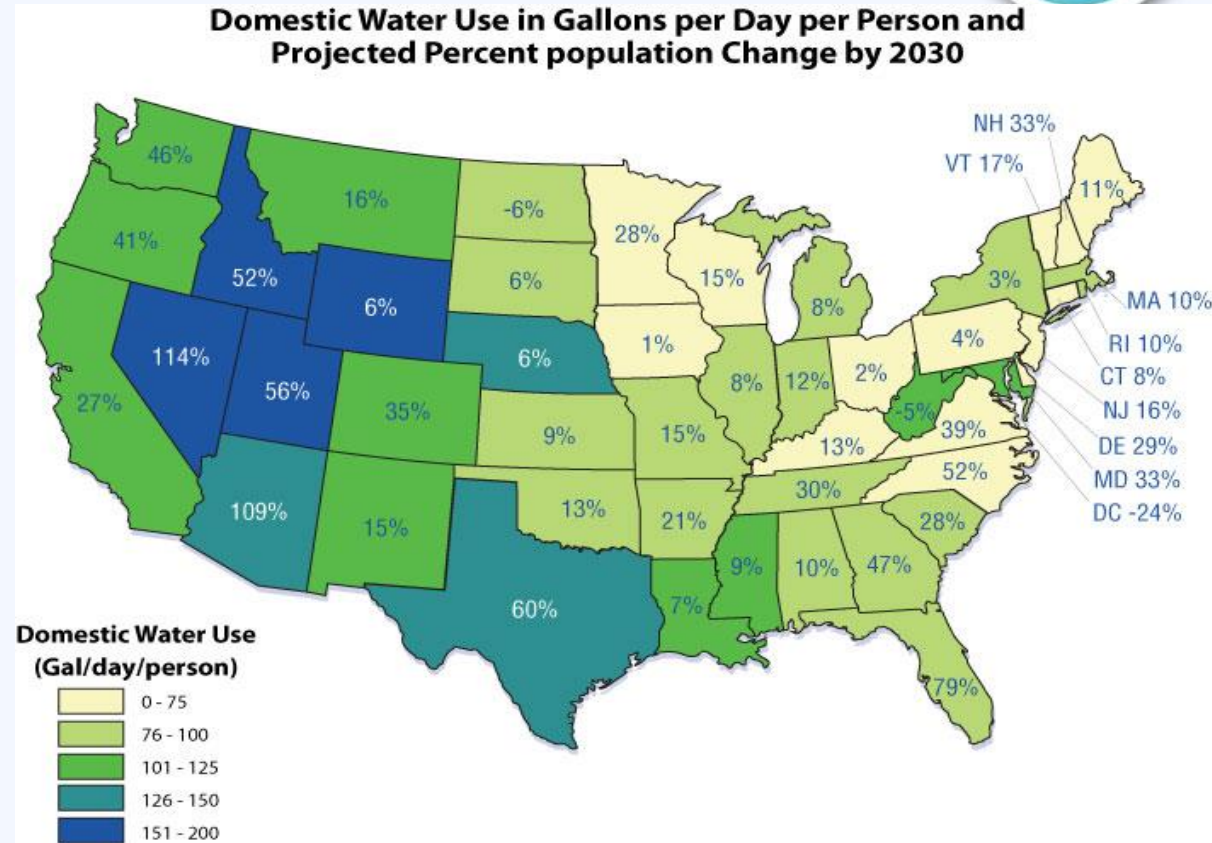


- Water is a precious resource.
- Water recycling is a socially, environmentally and economically viable solution to help utilize our water resource more efficiently.
- Across the US, household water bills are increasing continuously.
- Of 29 billion gallons of water used daily by households in the United States, nearly 30-70 percent is used outdoors.

Water Use Across the U.S.



- The average family spends \$1,100 per year in water costs.
- Considerable amount of energy is consumed to deliver and treat the water you use every day.

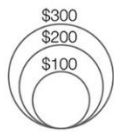
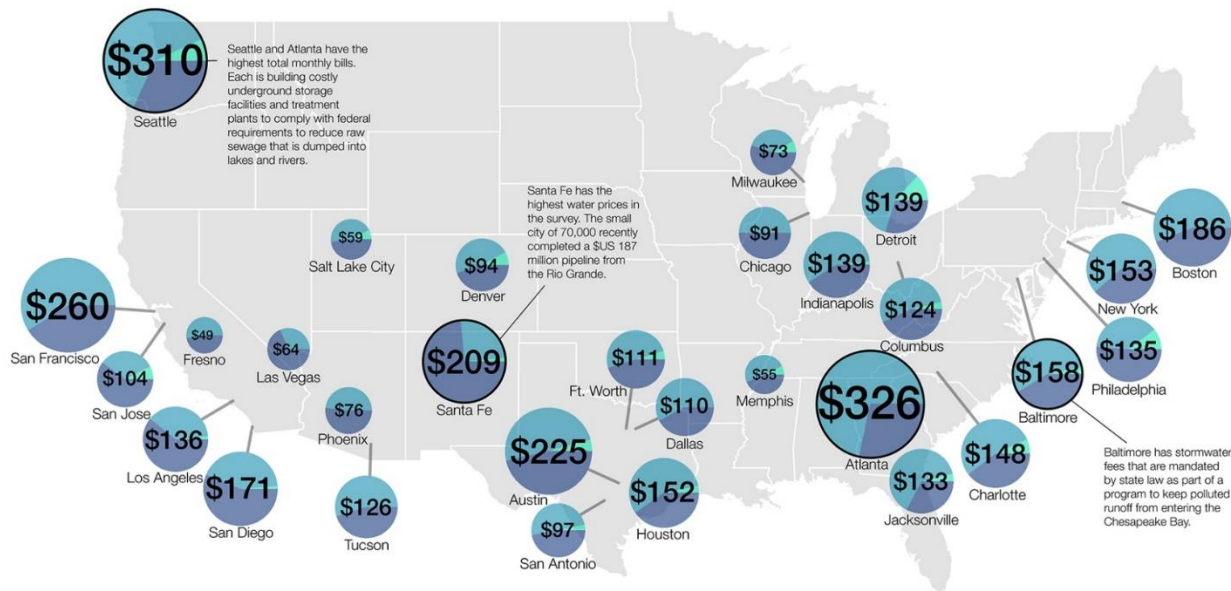


Cost of Water in the US



THE PRICE OF WATER: 2015

Combined water, sewer and stormwater prices for households in 30 major U.S. cities.



Water prices pay for treating, pumping, and delivering water, while sewer prices cover the cost of cleansing the water that goes down the drain.



Sewer prices are often higher than water prices because more energy and chemicals are required for treatment. Following the Clean Water Act, the federal government gave grants for new treatment plants during the 1970s and 1980s. Over the past three decades, however, new spending has been cut for local sewer infrastructure.



Stormwater fees are not included in every city's monthly bill. Some cities use general tax revenues to pay for projects to reduce polluted runoff from streets and parking lots. However, these projects must then compete for funds with other departments like police and schools.

Rates current as of April 1, 2015.
Monthly bill calculated for a family of four using 100 gallons per person per day.
Source: Circle of Blue research, based on utility water rates.

 circle of blue

Outdoor Water Use



- Of the estimated 29 billion gallons of water used daily by households in the United States, nearly 9 billion gallons, or 30 percent, is devoted to outdoor water use. In the hot summer months, or in dry climates, a household's outdoor water use can be as high as 70 percent.

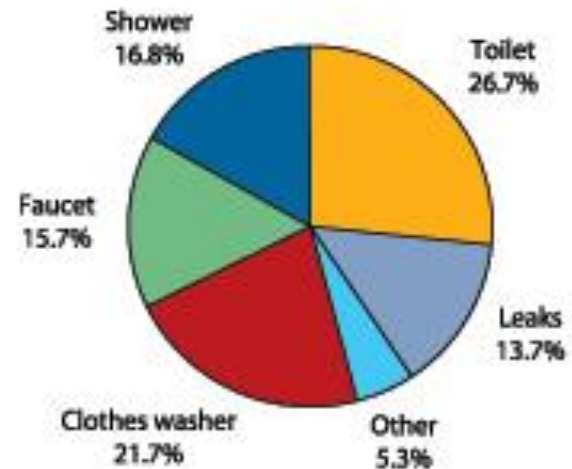


Household Water Use



- The average American family of four uses 400 gallons of water per day. On average, approximately 70 percent of that water is used indoors, with the bathroom being the largest consumer (a toilet alone can use 27 percent!).
- Much of the water used is clean enough to easily be treated and reused for non-potable (non-human consumption) purposes, such as gardening.
- Approximately 50 percent of the water households use annually (73,000 gallons per year) can be recycled and reused.

How Much Water Do We Use?



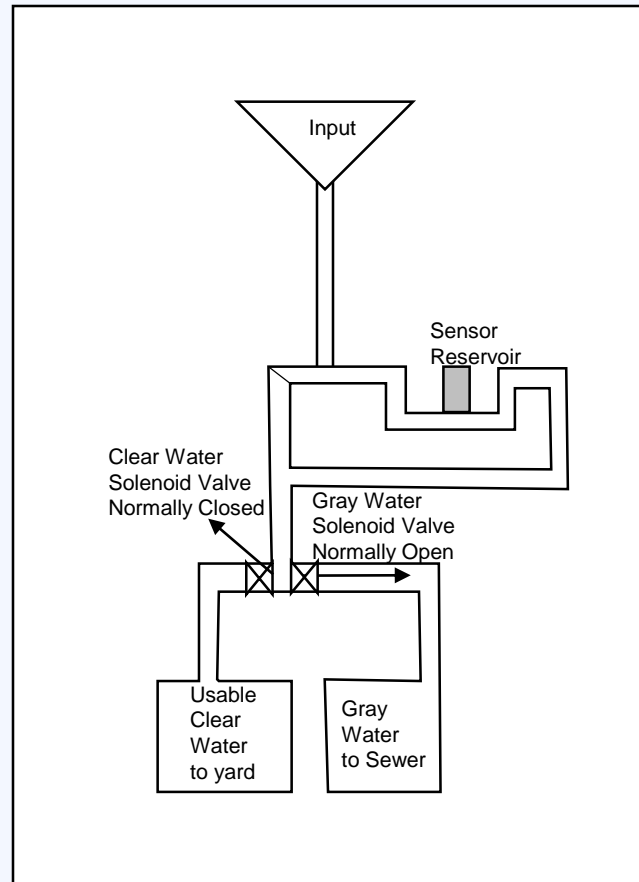
Source: American Water Works Association Research Foundation, "Residential End Uses of Water," 1999

Proposal



- While there are solutions to separate graywater (non-toilet water) and blackwater (toilet water), the graywater contains significant amount of organic matter and soap.
- The proposed solution does a fine separation of graywater to separate soap, as well as other factors that affect pH as well as turbidity. The end result is much cleaner water – “Clearwater” that can be directly used for outdoor irrigation with minimal filtration.
- The proposed solution is a system to measure the pH and the turbidity of graywater and decide whether or not it is “Clearwater” and send the water flow into either the sewer or the garden.

Proposed System

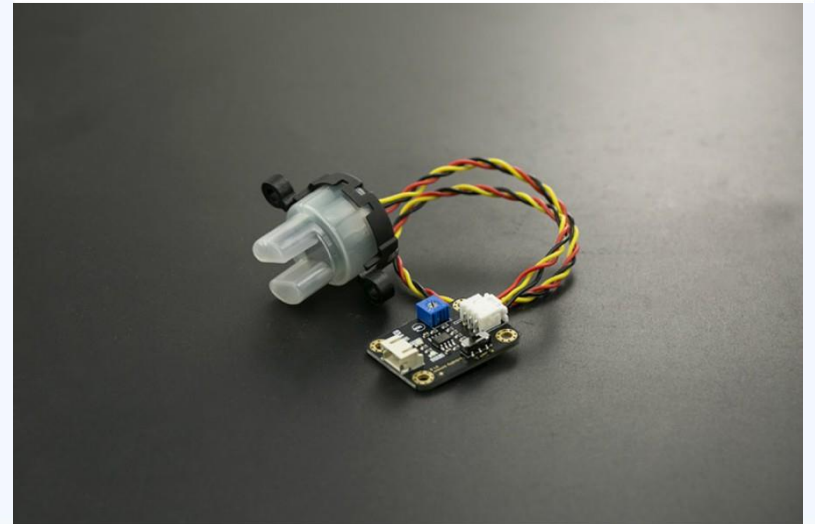


Sensor System

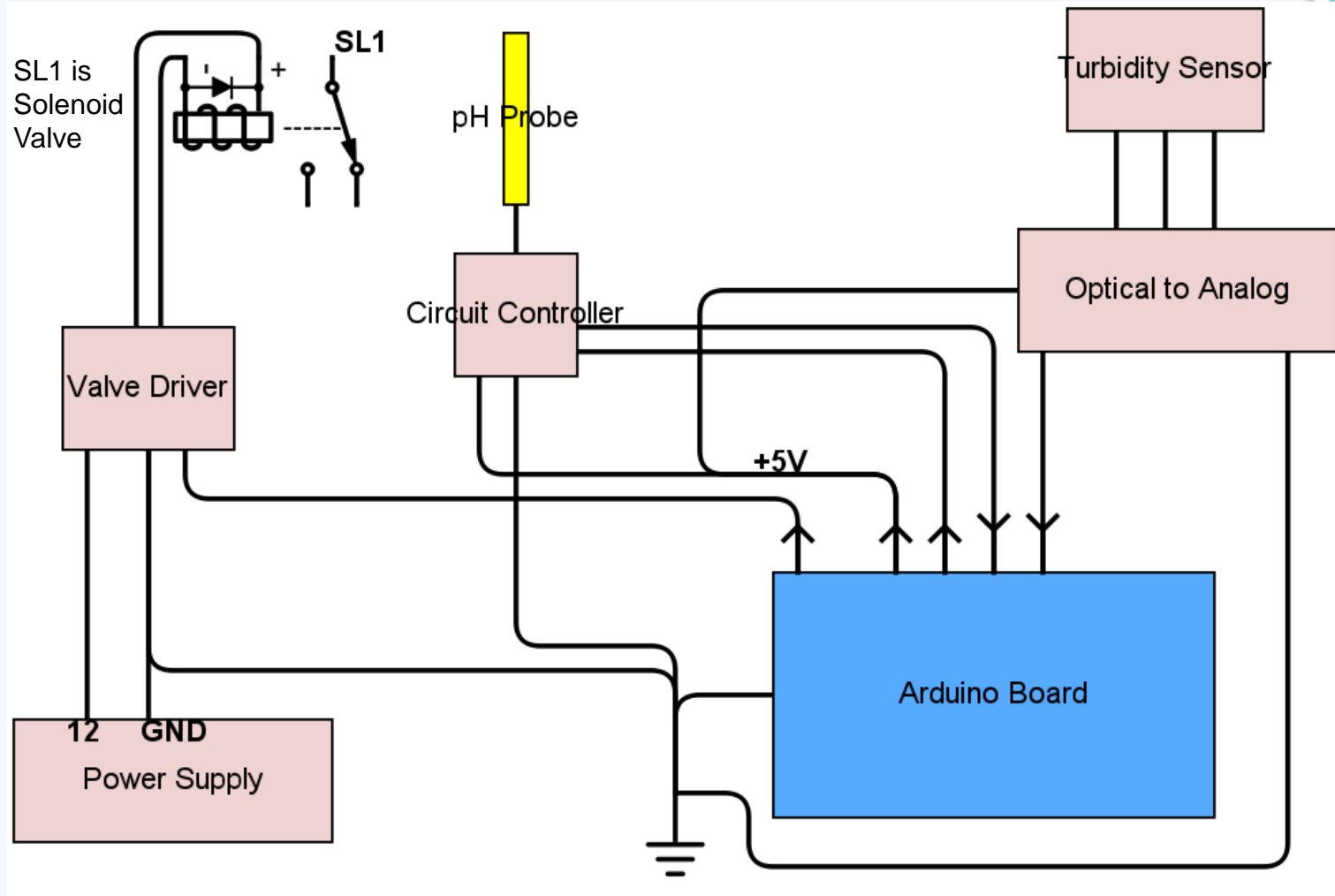


Sources of water detection

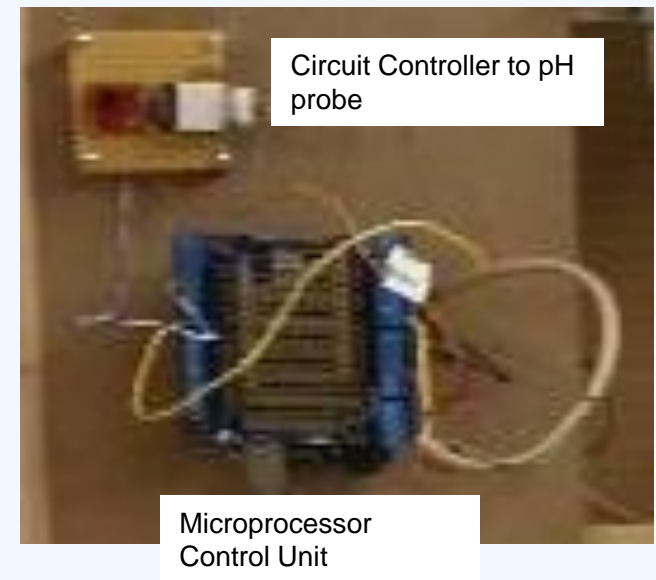
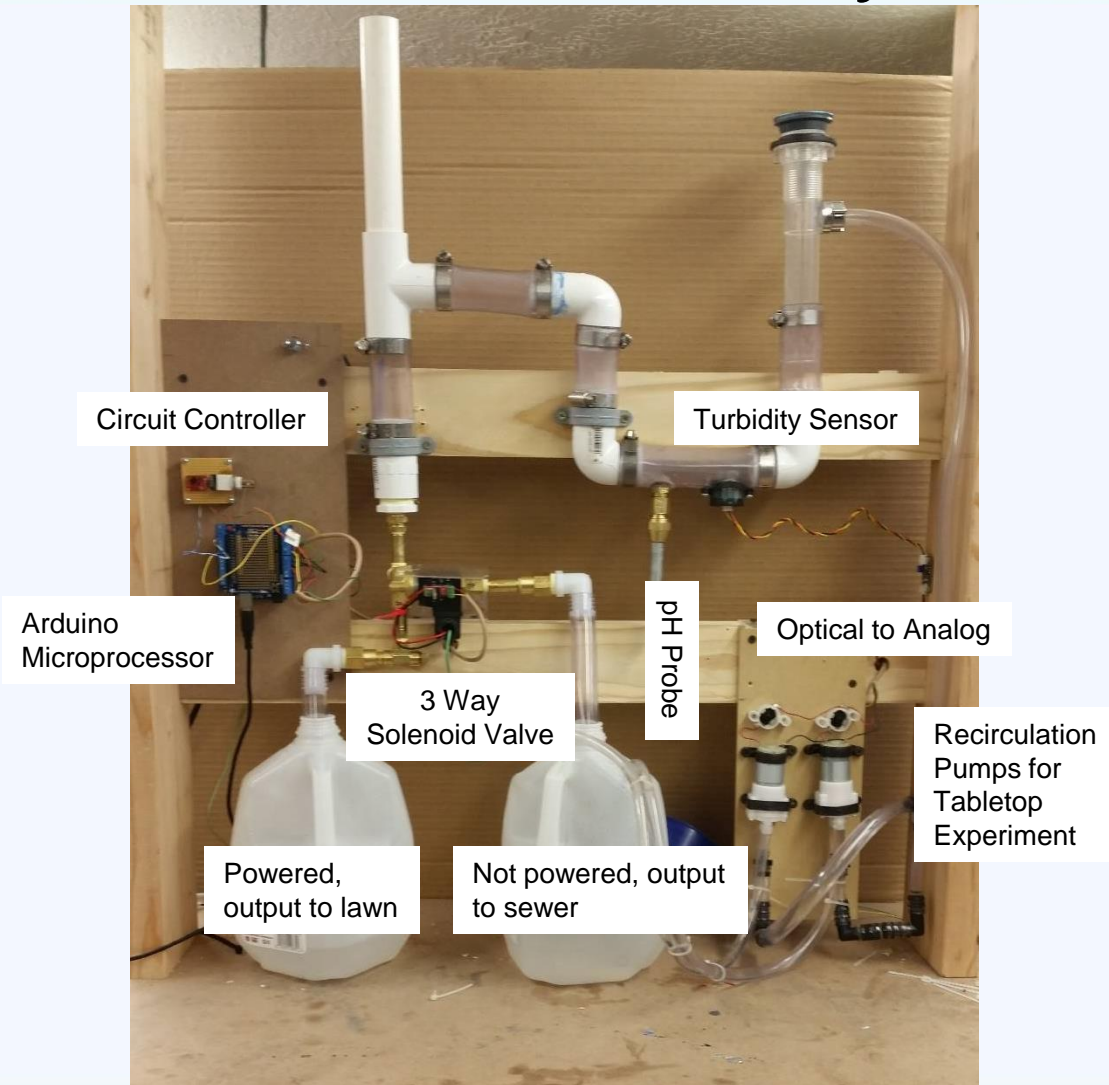
- pH Probe: A pH electrode is a passive device that detects a current generated from hydrogen ion activity. This current (which can be positive or negative) is very weak and cannot be detected with a multi-meter, or an analog to digital converter. This weak electrical signal can easily be disrupted and care should be taken to only use proper connectors and cables.
- Turbidity Sensor: To optically measure the presence of water. [recommended after test] This sensor is less likely to foul but may also be a challenge in getting predictable readings dependent on how the sensor is mounted in the pipe.



Electrical Schematic



Model of GrayWater Separation System



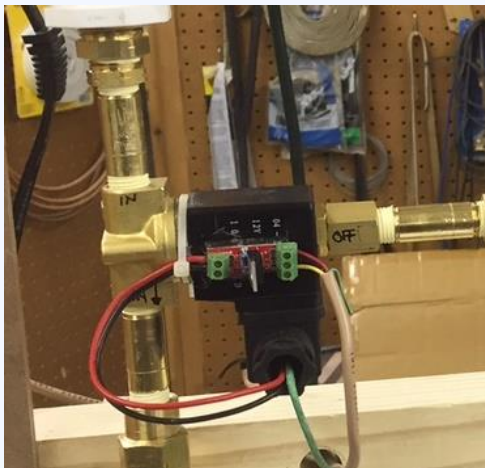
Photos of the Clearwater System



Full system
with controller



pH Probe and
turbidity sensor



Solenoid valve
to separate water



Recirculation pump
for testing purposes
only

Results – “Clearwater Revival”



- I developed an automatic working model of the system.
- The solenoid valve separates the water streams, with the turbidity sensor separating the turbid water from the clear water and pH probe deciding based on pH whether to send the base or acidic liquid to one drain or the other.
- The program is a simple algorithm and the values only have to be changed in one location to calibrate the program. This shows easy application and viability.
- With this system, I can now show that homeowners and commercial buildings can reuse clear water for yard use without needing to add cleaning chemicals before the water could be used in lawns. Hence, the name “Clearwater Revival”.

Water Savings



1	7:42	4:42
2	6:00	3:02
3	7:26	4:46
4	7:50	5:08
5	6:50	4:02
6	4:55	3:19
7	9:17	7:37
8	8:13	4:39
9	7:17	4:14
10	8:12	4:39
11	8:57	3:59
Average	7:30	4:33
Percent of time ClearWater wasted		61%
Average GPM use of shower		3.5 GPM
Average per person ClearWater		15.925 gallons
Clearwater for family of 4 per day		63.7 gallons
Amount of ClearWater per year per home		23250.5 gallons
Salt Lake County Population		1,080,000 people
Salt Lake County: ClearWater saved per year		6,277,635,000 gallons
California Population		37,000,000
Savings in one year		215,067,125,000

Conclusion



- I have developed the concept of a clear water and graywater separator. This will significantly increase the amount of water that can be recycled for yard use, as almost 60% of shower water can be recycled. This will reduce the amount of treatment chemicals added to the yard and the total water consumption in the house and the yard. The concept applies to the construction of new houses where another clear water waste line can be added with minimal cost but with great benefit to homeowner.
- I have filed a patent disclosure for this system.
- The next steps are to come up with a system to have multiple such devices hooked to a power source and the amount of water can be estimated to present an ROI to the homeowner.

Works Cited



- http://www3.epa.gov/watersense/our_water/tomorrow_beyond.html
- <http://www.circleofblue.org/waternews/2015/world/price-of-water-2015-up-6-percent-in-30-major-u-s-cities-41-percent-rise-since-2010/>
- <http://www.hgtv.com/remodel/mechanical-systems/reusing-household-water-with-graywater-systems>
- <http://www3.epa.gov/watersense/pubs/indoor.html>
- https://www.utdallas.edu/~brikowi/Teaching/Field_Methods/WaterQuality_Activities.html
- Many thanks to my mentors Dr. Ragula Bhaskar and Mr. Don Kleinschnitz in the construction of the system.