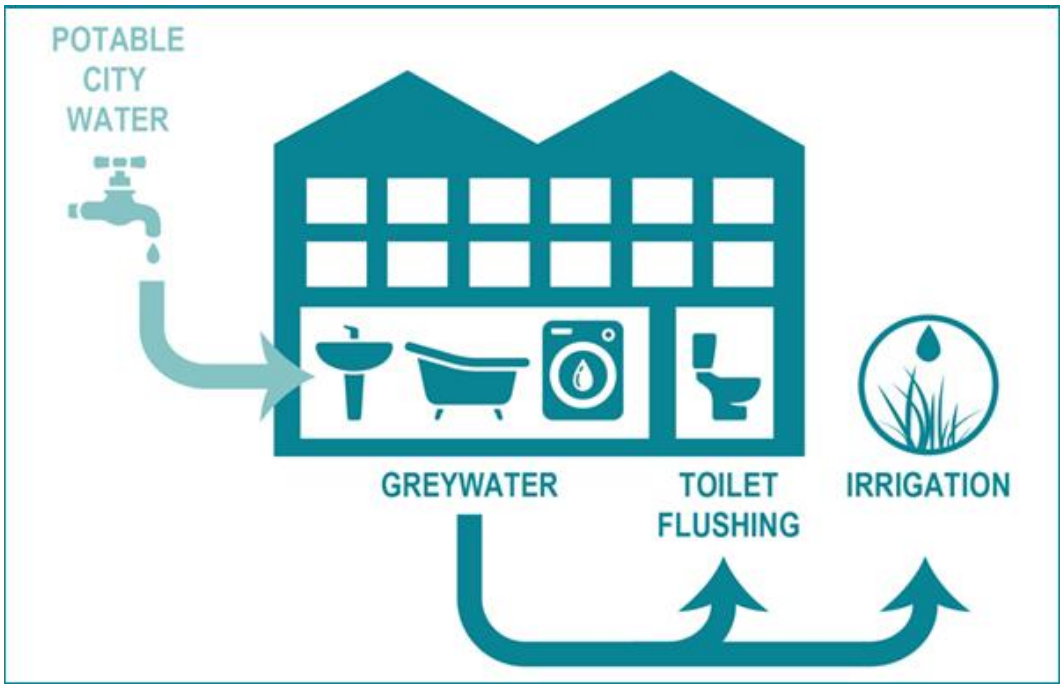
HOW CAN THE IMPLEMENTATION OF GREY WATER PRACTICES BE USED TO CREATE A MORE SUSTAINABLE COMMUNITY?

by

Joseph Woodland



(Illustration by: Sofya Karash, BioHabitats, Inc. 2018)

Signature Page

A Design Capstone submitted to the
Department of Urban Horticulture and Design
of the State University of New York,
Farmingdale State College

By Joseph Woodland

in partial fulfillment of the requirements
for the Bachelor's in Landscape development and Design
May 2018 Long Island, NY

Professor Stevie Famulari _____

Permission Rights Page

I, Joseph Woodland, grant permission for the State University of New York, Farmingdale State College, and the Department of Urban Horticulture and Design to reproduce any portion of this capstone for any purpose they deem proper.

Signature_____ Date_____

Table of Contents

Abstract

While some people in other parts of the world experience problems with water quality and quantity, we in the United States do not face the extreme water scarcity that other parts of the world experience. This lack of extreme water scarcity makes it harder for us to be conscious of the amount of water we use in our daily household routines and in our landscapes. The clean, potable water we use every day in our washing machines, irrigation systems, sinks, baths, and showers gets put back into the sewage systems with chemicals that can be harmful to our bodies of water. Grey water is the water created from household appliances that can be recycled and reused. The greywater produced can be harvested, recycled, and reused on site, indoors and outdoors. Through researching databases and other forms of literature I am aiming to show that the implementation of grey water conservation methods will save homeowners money in the long-term, create a more sustainable landscape, and to focus on my site as an example for a more sustainable community.

Keywords

Aeration treatment, biological treatment, built-in overflow, drip irrigation, energy efficient, fully automated, grey water, irrigation, keeping water onsite, landscape, landscape design, landscape development, potable water, pump, recycle, recycled water, reusing water, sub-grade drip irrigation, sustainability, sustainable landscape, sustainable practices, UV treatment, water

Problem Statement

How can the implementation of grey water practices be used to create a more sustainable community? How can greywater be recycled and reused on site; indoors and outdoors?

Project Typology

- Landscape
- Suburban landscape design
- Residential landscape design
- Residential site work
- Sustainable landscape
- Greywater design

The Claim

The implementation of grey water practices will help to create a more sustainable community.

The actors	Homeowner	Contractor	Designer
The action	Harvesting, recycling, and reusing greywater.	Education on greywater and its laws, and experience building greywater systems.	Implementing greywater into designs.
Object acted upon	Residential site	Residential site	Residential site
What happens when you use grey water methods?	Conserve potable water, be sustainable, save money (long-term), and educating community on greywater.	Gain knowledge and experience with greywater systems.	Make contractors and homeowners aware of greywater and its uses and benefits.

Theoretical Premise/ Unifying Idea

Presently, homeowners are more accepting to the implementations of eco-friendly, sustainable practices, especially if it will save them money in the long-run. The harvesting, recycling, and reusing of grey water can be a cost-effective, impactful way for homeowners to partake in creating more sustainable landscapes.

Project Justification

Currently, sustainability is a popular trend in landscape development and design.[1] Long Island homeowners generally tend to take pride in their landscapes, and put a lot of time, energy, and money into them. The downfall of having a traditional landscape is that they are typically not very sustainable, such as requiring high amounts of water, chemicals, and labor. I am focusing my Capstone project on water, and more specifically greywater. There are inexpensive, yet impactful ways of harvesting the water we use on a daily basis in our homes and recycling and reusing the water, and putting it back into our landscapes, as well as our toilets or other tasks that require water. This research allows for the implementation of a fairly cost-effective practice, and use the result of that practice (clean water) to provide water for indoor and outdoor appliances and irrigation for a landscape that I will design.

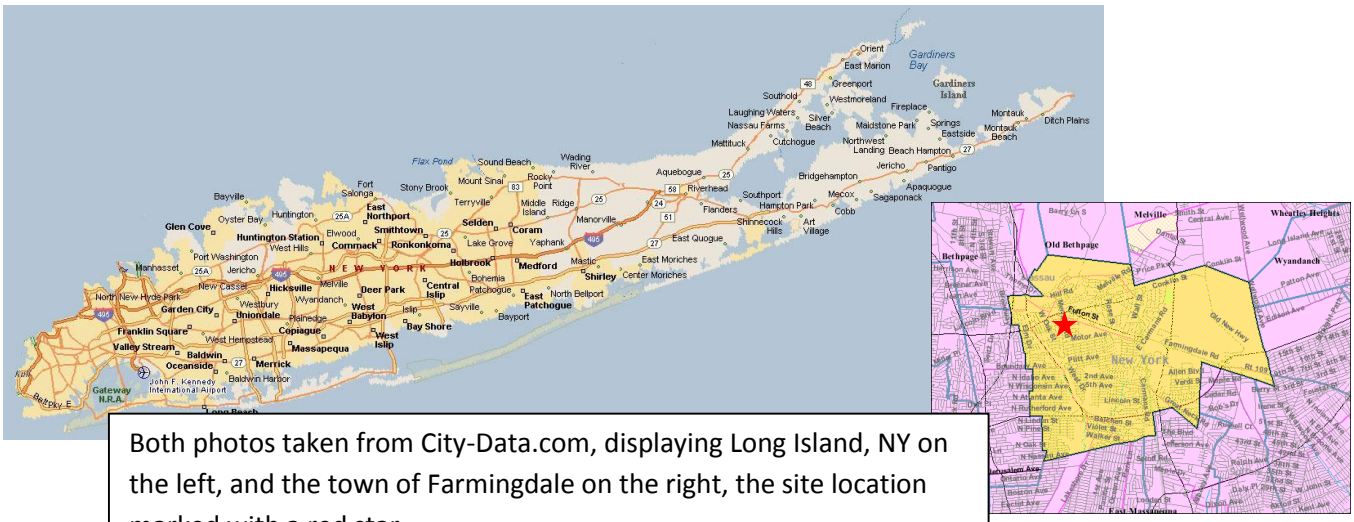
The practice of harvesting, recycling, and reusing grey water is sustainable and impactful; however on a small scale (one residential landscape) it can be hard to convince homeowners of its impact. My project focuses on the implementation of this practice to a small community in

[1] SURVEY REVEALS TOP TEN DESIGN TRENDS FOR RESIDENTIAL LANDSCAPE ARCHITECTURE. (n.d.). Retrieved February 13, 2018, from https://www.asla.org/NewsReleaseDetails.aspx?id=48055

Farmingdale, Long Island, New York. The amount of water that can be conserved, and the amount of money that can be saved may shed light on the idea of investing in a fairly inexpensive practice to ultimately help in the creation of a more sustainable community.

Narrative of Design Research

Grey water harvesting, recycling, and reusing is not a new practice by any means, however it is relatively new to a place such as Long Island. It is a fairly cost-effective way for a homeowner, to take a step towards being more sustainable.



Both photos taken from City-Data.com, displaying Long Island, NY on the left, and the town of Farmingdale on the right, the site location marked with a red star.

In Long Island, NY, there are not extreme problems with water quality or quantity, however there are some details which are important to note. Water quantity in parts of Long Island are becoming an issue in some towns, such as Great Neck and Port Washington, where water districts are restricting the amount of irrigating a homeowner can do by limiting the number of days per week, and the duration they can irrigate. A homeowner's landscape should not suffer from these newly enforced codes, and the greywater system can ensure that they will

not. The use of a grey water system is one solution for a home in one of these towns, but the use of the system should not stop there. In Farmingdale, there is no major water quality or quantity problems, but that does not mean that a homeowner cannot implement a grey water system for the sole purpose of living a more sustainable lifestyle. Greywater systems are an interesting part of sustainable landscapes for several reasons: they are cost-effective, can be hidden or be visible and made into a focal point of the landscape, they allow the homeowner to conserve potable water by getting double use from the water that they use for some appliances in their homes, and they will save money in the long-term.

When implementing a grey water system into a home, it can be a filter that is hidden from view, or in the case of this capstone, a water feature that will be the greywater system that becomes the focal point of the landscape design. A simple water feature such as a fountain, or something more complex, such as a waterfall into a pond with reed beds for filtration, or anything in between can be used as a focal point for the landscape. The water feature uses grey water and will serve as a reservoir for water for irrigation. Although this project focuses on grey water, the landscape design will be sustainable throughout, including elements such as native plants and permeable pavers.

User/Client Description

The clients for this greywater system landscape design based around the greywater system are homeowners that would like to become more sustainable. Whether homeowners need to conserve potable water as required by their water district, or if they choose to do it for the sole purpose of living a more sustainable lifestyle, a greywater system with a sustainable landscape

designed around it is a step in the right direction for them to achieve their goal of water conservation.

Major Project Elements

- A **grey water filter system** is vital to this project because it cleans the greywater for irrigation of plants and other outdoor uses.
- A **water feature** makes use of the grey water system as the main project element for this design. It acts as the reservoir to hold the grey water until it is ready for use in the irrigation system or other outdoor water use, as well as be and appealing focal to the overall design.

Photo by Premium Aquascapes depicting a pondless waterfall similar to the water feature I will use in my landscape design.

- **Native plants** are essential in the planting design of this landscape. The use of native plants calls for less overall irrigation since they are adapted to the climate of Long Island.
- **Rain barrels** to harvest water are raised and placed near the household for collection of rain water. Raising the rain barrels and installing a hose spigot at the base of them allows for gravity to "pump" the water, rather than using an electric pump. This water can be harvested and used for hose spigots and manual watering of potted plants, vegetables, etc.
- **Permeable pavers/surfaces** are utilized in the design for storm water management. Although they have no effect on greywater, it is an element that contributes to a sustainable landscape since it allows water to permeate into the ground, instead of going into the sewage system.

- **Drip irrigation** is an important element of this design because they use less water than typical sprinkler heads. The drip irrigation pipes are installed in planting beds underneath mulch at the width of the root ball of each plant. Drip irrigation uses less water because it only provides water for the roots, and does not waste any water on the foliage, stems, or trunks of the plants.

Photo by Leichman, A.K. displaying drip irrigation.

Site Analysis

Located at 19 Country Ct, South Farmingdale, NY 11735, the home built in 1999 is in walking distance of two supermarkets, multiple restaurants, a large town park that is currently being expanded, the Farmingdale Public Library, and a pharmacy. It is a site of interest for my capstone project because it is a typical suburban Long Island home, with an average sized property. Since the site is an average suburban Long Island home, it serves as a general template for installing a greywater system accompanied by a water feature and sustainable landscape. The landscape design of the site is currently simple and lacks color and creativity, allowing for many opportunities for me to be creative with a design and not have to worry about working around any pre-existing planting beds, hardscapes, or water features.

Aerial view of site (Google Maps, 2017)

The site is a 9,520 square foot, fairly flat property with a small front yard consisting of turf grass and small foundation planting beds, and a larger back yard consisting of some simple arborvitae screening and mostly turf grass. The house faces west, allowing for morning sun in the back yard and afternoon sun in

the front yard. There are two adults and three children living in the household, collectively generating approximately 120 gallons of greywater per day.

While visiting the site at different times throughout the day, I was able to feel and see different aspects of the space. The western facing house allows for full sun to fill the entire space of the backyard in the morning, and in the front yard during the afternoon. In the spring and summer, the full sun and warmer temperature allows for the spaces to be enjoyed to the fullest, during their respective times of day, without worrying about being shaded out by trees or the house. While visiting the site after a rain storm, there was no evidence of areas that need to be addressed with storm water management practices.

Site Summary

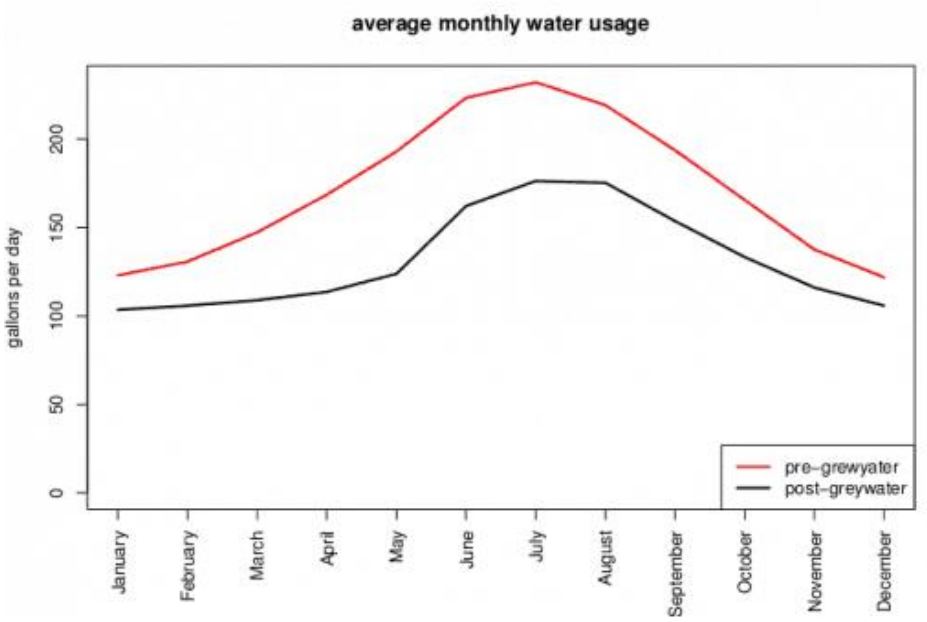
The site receives a lot of sun in the backyard during the morning, and in the afternoon in the front yard. It is located in a cul-de-sac within walking distance of multiple restaurants, supermarkets, a library, a pharmacy, and a large town park. It is a flat, simple landscape design with the potential to be a beautiful, and sustainable landscape incorporating greywater.

Case Study 1

In a 2013 case study, 20 greywater system installers were surveyed and 83 greywater systems were studied in California (the San Francisco Bay Area, Monterrey Bay Area, and the Santa Rosa Area). The grey water systems in the study received 99% customer approval/satisfaction since they required little to no maintenance, had few problems, and they saved homeowners water and money. This study mainly focused on the Greywater Diversion Devices that only diverts greywater to irrigation systems, and soil testing proved that the "greywater did not negatively affect wither soil or plant health," and that "the quality of grey water was typically suitable for long-term irrigation of plants, so long as the household used products without sodium or boron compounds."[2]

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



[2] Allen, L. (n.d.). Residential Greywater System Study. Retrieved February 06, 2018, from https://greywateraction.org/residential-greywater-system-study/

Water consumption before and after the installation of a greywater system was a large part of the study. The results of the study can be very helpful to a person considering implementing a greywater system for their household. Overall the consumption part of the study concluded that, "Per capita water consumption decreased by an average of 17 gallons per day…average household savings of 14,565 gallons per year." [2]

Case Study 2

A study beginning in May 2008 examined the effects of long-term irrigation utilizing grey water. Although greywater systems offer many benefits, the use of them at that time had not yet become widespread because of safety concerns. Some states began to legalize and regulate greywater systems and the reuse of the water in landscape irrigation, however little information was available as to the safe operation of the grey water systems. "Limited scientific data [was] available on the fate of graywater chemical and microbiological constituents and the effect of these constituents on plant health after greywater is applied for irrigation. The objective of this research project was to elucidate information on the fate and occurrence of graywater constituents and their potential impacts on soil quality, groundwater quality, and plant and human health as a result of its application for residential landscape irrigation. This project began in May 2008 and included a series of experimental studies [that were] conducted in three parts: existing household systems, new household systems, and greenhouse studies."[3]

[3] Sharvelle, S., Roesner, L. A., Qian, Y., Stromberger, M., & Azar, M. N. (2012). LONG-TERM STUDY ON LANDSCAPE IRRIGATION USING HOUSEHOLD GRAYWATER - EXPERIMENTAL STUDY. Retrieved February 6, 2018, from https://greywateraction.org/wp-content/uploads/2014/12/Long-term-Study-on-Landscape-Irrigation-Using-Household-Graywater.pdf

Ultimately the research team studied the effects of long term grey water irrigation on 22 plants, and found nearly all 22 were healthy compared to fresh-water irrigation. Only 3 plants tested (avocado, lemon tree, and Scotch pine) had experienced reduced growth, leaf scarring, and reduced fruiting under the long term grey water irrigation. As a result of the study, it was discovered that there was an accumulation of antimicrobials and surfactants, and increased sodium levels in the soil. "However, after 5 or more years the levels of sodium in the soils that were tested were not high enough to raise any concern about the soil quality or plant health."[3]

Case Study 3

Through critical analysis and data from existing greywater applications, a 2007 study in the United Kingdom compared and contrasted the strengths and weaknesses of different types of greywater treatment systems. "Simple technologies and sand filters have been shown to have a limited effect on greywater; membranes are reported to provide good solids removal but cannot efficiently tackle the organic fraction. Alternatively, biological and extensive schemes achieve a good general treatment of greywater with particularly effective removal of organics. The best overall performances were observed within schemes that combine different types of methods to ensure effective treatment of all the fractions."[4] Some of these extensive schemes include ultraviolet and biological treatments.

[4] Pidou, M., Memon, F., Stephenson, T., Jefferson, B., & Jeffrey, P. (2007, September 01). Greywater recycling: treatment options and applications. Retrieved February 26, 2018, from https://espace.library.uq.edu.au/view/UQ:258410

The study also breaks down the domestic water usage percentage (determining the percentage of water that is labeled grey water), as well as the application percentage of grey water.

Use	Fraction of total water demand: %
Toilet flushing	35
Wash basin	8
Shower	5
Bath	15
Laundry	12
Dishwasher	4
Outside use	6
Kitchen sink	15

Table 1. Domestic water usage[11]

According to these statistics, 65% of the domestic water usage can be labeled grey water, can be harvested, treated, and reused. (35% toilet water usage is considered black water)

Application	%
Toilet flushing	54
Irrigation and garden watering	36
Outdoor use and cleaning	5
Laundry	2·5
Infiltration	2·5

Table 3. Distribution of applications for greywater reuse in reviewed systems

According to these statistics, 90% of the grey water is used for toilet flushing and irrigation.

Case Study 1 Summary

This information can be relevant, and a great source for my capstone project because it provides data on the amount of water consumed before and after the installation of the greywater systems, giving solid evidence of the benefits of the systems. It also shows how satisfied customers are with their systems, which will help to further convince consumers to implement a greywater system in their homes.

Case Study 2 Summary

The information in this case study can be relevant, and useful for my capstone project because the information provided is on the use of greywater in irrigation. The main use of the greywater in my design is irrigation, so this study shows that it is acceptable and not detrimental to the health of plants to use greywater for irrigation.

Case Study 3 Summary

The information in this case study can be relevant and useful and my capstone project because it provides information on the percentage of household water used that becomes labeled as greywater, and what percentage of it is used for irrigation and other outdoor tasks. It also provides information on the best methods for filtering the greywater, which I can implement into the water feature greywater filter I am using in my landscape design.

Itstorical Context

Investigations into the treatment and recycling of grey water have been reported since the 1970's. The first technologies studied were mainly physical treatments paired with disinfection. In the 1980's and 1990's biological-based studies were investigated. During that same period, simple physical separators such as sand filters or membranes, were being installed in individual homes. In the late 1990's, more advanced technologies such as membrane bio-reactors came to the surface, as well as cheaper technologies such as reed beds and ponds.[5]

The use of grey water in New York is relatively new in comparison to states such as California and Arizona. In the early 1990's greywater practices began gaining ground with citizens in New York City, primarily in office buildings and multifamily housing. With more recent understandings of greywater and its uses, an updated 2010 plumbing code for grey water subsurface irrigation has been created allowing property owners to incorporate greywater irrigation systems in all properties, including residential sites.

The following codes are enforced for the proper installation and use of grey water for subsurface irrigation on a residential site:

Section C103 Subsurface Landscape Irrigation Systems:

C103.1 Collection Resevoir	*Reservoirs shall be sized to limit the retention time of gray water to a maximum of 24 hours.*
C103.2 Valves Required	*A check valve and a full-open valve located on the discharge side of the check valve shall be installed on the effluent pipe of the collection reservoir.*

[5] [5] Pidou, M., Memon, F., Stephenson, T., Jefferson, B., & Jeffrey, P. (2007, September 01). Greywater recycling: treatment options and applications. Retrieved February 26, 2018, from https://espace.library.uq.edu.au/view/UQ:258410

C103.3 Makeup Water	*Makeup water shall not be required for subsurface landscape irrigation systems.*
C103.4 Disinfection	*Disinfection shall not be required for gray water used for subsurface landscape irrigation systems.*
C103.5 Coloring	*Gray water used for subsurface landscape irrigation systems shall not be required to be dyed.*
C103.6 Estimating Greywater Discharge	*25 gal/day/person for showers, bathtubs, lavatories, and 15 gal/day/person for washing machines; 40 gal/day/person*

C103.8 Location of Greywater System

	MINIMUM HORIZONTAL DISTANCE	
ELEMENT	*HOLDING TANK (feet)*	*IRRIGATION DISPOSAL FIELD (feet)*
Buildings	*5*	*2*
Property line adjoining private property	*5*	*5*
Water wells	*50*	*100*
Streams and lakes	*50*	*50*
Seepage pits	*5*	*5*
Septic tanks	*0*	*5*
Water service	*5*	*5*
Public water main	*10*	*10*

Greywater Subsurface Irrigation codes from:

Searchable platform for building codes. (n.d.). Retrieved March 13, 2018, from https://up.codes/viewer/new_york/ny-plumbing-code-2010/chapter/C/gray-water-recycling-systems#C103

Programmatic Requirements

The landscape design utilizes all 9,520 square feet, and the water feature-greywater system requires about 100 square feet (not including the underground plumbing/piping). The greywater system to be used is a Flotender ™ Greywater Irrigation System that filters greywater to ensure that the drip irrigation emitters will not be clogged with any sediment or particles. This greywater-to-irrigation system is a multiple zone, programmed system that will irrigate at the times the homeowner chooses. The reservoir on the system will be connected to the reservoir for the water feature, allowing for larger amounts of water to be reserved, and also allow for irrigation water to be drawn from the water feature's reservoir if needed. The plumbing pipes for the greywater system will be 1.5"- 2" PVC pipes, and the irrigation pipes will be 1" and ¾" polypropylene pipes and Netafim™ drip irrigation pipe. The cost estimate of the water feature ($2,000-3,000), greywater system and irrigation system ($3,000-5,000), including installation would be about $8,000.

Capstone Goals

The goals for my capstone project are to create a sustainable landscape design focused around a greywater system, create a greywater system that will be accompanied by a water feature and be appealing to the eye, educate my peers on the benefits of a greywater system, and ultimately have a firm understanding on the installation of greywater systems so I can implement them as a selling point to clients for future landscape designs in my career.

Reference List

Allen, L. (n.d.). Residential Greywater System Study. Retrieved February 06, 2018, from https://greywateraction.org/residential-greywater-system-study/

Disappearing Pondless Waterfall Ideas - Northern New Jersey (NJ) -Bergen,Passaic,Essex, Morris. (n.d.). Retrieved March 07, 2018, from http://www.premiumaquascapes.com/disappearing-pondless-waterfall-ideas-for-your-landscape.html

Misra, R., Patel, J., & Baxi, V. (2010). Reuse potential of laundry greywater for irrigation based on growth, water and nutrient use of tomato . Retrieved February 6, 2018, from https://greywateraction.org/wp-content/uploads/2014/12/Misra_Patel_Baxi_JH_V386_2010_AV.pdf

Pidou, M., Memon, F., Stephenson, T., Jefferson, B., & Jeffrey, P. (2007, September 01). Greywater recycling: treatment options and applications. Retrieved February 26, 2018, from https://espace.library.uq.edu.au/view/UQ:258410

Searchable platform for building codes. (n.d.). Retrieved March 13, 2018, from https://up.codes/viewer/new_york/ny-plumbing-code-2010/chapter/C/gray-water-recycling-systems#C103

Sharvelle, S., Roesner, L. A., Qian, Y., Stromberger, M., & Azar, M. N. (2012). LONG-TERM STUDY ON LANDSCAPE IRRIGATION USING HOUSEHOLD GRAYWATER - EXPERIMENTAL STUDY. Retrieved February 6, 2018, from https://greywateraction.org/wp-content/uploads/2014/12/Long-term-Study-on-Landscape-Irrigation-Using-Household-Graywater.pdf

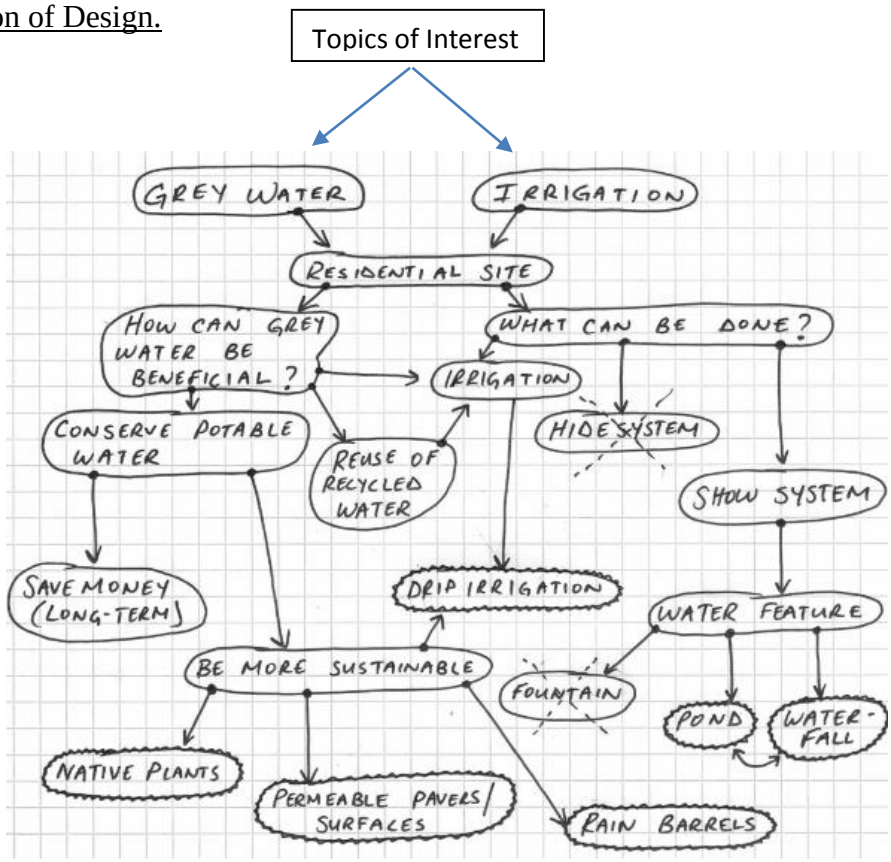
SURVEY REVEALS TOP TEN DESIGN TRENDS FOR RESIDENTIAL LANDSCAPE ARCHITECTURE. (n.d.). Retrieved February 13, 2018, from https://www.asla.org/NewsReleaseDetails.aspx?id=48055

Studios, I. M., & Karash, S. (n.d.). Connect with Biohabitats. Retrieved February 14, 2018, from http://www.biohabitats.com/projects/silver-star-apartments-greywater-treatment-reuse/

Veneman, P. L., & Stewart, B. (2012, December). GREYWATER CHARACTERIZATION AND TREATMENT EFFICIENCY. Retrieved February 6, 2018, from https://greywateraction.org/wp-content/uploads/2014/12/Mass-GW-Soil-Treatment-Study.pdf

Yu, Z. L., Rahardianto, A., DeShazo, J., Stenstrom, M. K., & Cohen, Y. (2013). Critical Review: Regulatory Incentives and Impediments for Onsite Graywater Reuse in the United States. Retrieved February 6, 2018, from https://greywateraction.org/wp-content/uploads/2014/12/Critical-Review_Regulatory-Incentives-and-Impediments-for-Onsite-Graywater-Reuse-in-US.pdf

Documentation of Design.



Plan for Proceeding

Week#	Goals
1	Complete stage 1
2	Continue to gather sources Get started on stage 2 Prepare presentation for Feb 14
3	Continue to work on stage 2 Gathering more sources
4	Continue working on stage 2 Visit the site and take pictures
5	Continue stage 2 Google Earth the site Gather more sources
6	Search for construction details of grey water management system Continue stage 2 Schedule appointment at writing center ton get feedback on paper so far
7	Create a base map of single residence on the site in Auto CAD Continue paper/finish paper
8	Sketch out rough designs on trash paper (continue paper)
9	Finalize design Create a plant list Begin design on AutoCAD
10	Continue design on AutoCAD Finish up any unfinished parts of the paper
11	Continue to work in AutoCAD
12	Finish up design in AutoCAD Create a layer of Labels Create a plant list key Begin to gather thoughts for final presentation
13	Color render final design Create presentation board for final presentation
14	Create a PowerPoint for final presentation Practice presentation
15	Make sure all materials are complete for the final presentation Practice presentation Submit Capstone Present the finished product

Previous Course Experience

1st year	Landscape Drafting I	Richard Arnedos	Fall 2015	Projects include residential designs
1st year	Landscape Drafting II	Paul Fogelberg	Spring 2016	Projects include perspective drawings
2nd year	Landscape Plans I	Dennis Flynn	Fall 2016	Projects include landscape designs focusing on composition
2nd year	Landscape Plans II	Dennis Flynn	Spring 2017	Projects include residential designs, and the design of Greenley Library, SUNY Farmingdale
2nd year	Sustainable Garden	Michael Veracka	Fall 2016	Lectures and labs on sustainable practices in the landscape
2nd year	Site Engineering	Rusty Schmitt	Spring 2017	Projects include grading, rain gardens, water management
3rd year	AutoCAD	Stevie Famulari	Spring 2018	Projects include landscape designs and learning the tools on AutoCAD
3rd year	Native Plants	Jonathan Lehrer	Spring 2017	Study of Long Island native plants
4th year	Capstone	Stevie Famulari	Spring 2018	Classwork consists of practicing research, writing, designing, and presentation techniques.

Personal Identification

woodjm5@farmingdale.edu

Hometown: Farmingdale, NY

"Ego clouds and disrupts everything." – Jocko Willink