Incorporating Latest Technologies in a Cost-Effective Design of Rainfall Catchment and Filtration Systems for Coastal Rhode Island Communities

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Abstract

With this project, methods and materials for rainfall collection, storage, and treatment are tested and evaluated in order to design a system that would be adequate to meet average household water usage requirements. The system must be cost-effective, easy to install and maintain, and provide a significant benefit to the user. The system's components will include a catchment system and storage unit. In addition, because the water quality can decrease as the water is stored, filtration systems are evaluated to improve water quality. Rainfall catchment systems provide a sustainable water supply and can be installed for use as the main water supply for a household or for limited use such as landscaping needs.

Community water supplies are frequently unable to meet the demand of a growing population. In many coastal Rhode Island communities, salt water intrusion has limited the capacity of groundwater to completely provide adequate water supply for household use. In areas that are not served by a public water system, inadequate groundwater supplies can mean that households must curtail water use during the summer months when groundwater levels are at their lowest. While the ancient practice of rainwater collection could alleviate the strain on water supplies during the peak months, few households have the knowledge necessary to choose the best system to meet their needs. The available options are many due to significant advancements in materials and filtration; too many for the average person to evaluate. The product of this research is a design for a system that will best meet the needs of Rhode Islanders and will be an improvement to the traditional technology.

Statement of problem

This project addresses the problem of continuing tightening of water supplies concurrent with growing population. Water supplies are decreasing all over: locally, because their own water supplies are unreliable, communities in the East Bay of Rhode Island, including Bristol, Warren, and Barrington, must purchase relatively expensive water from the Providence Water Company. Further, many coastal areas not serviced by public water systems have suffered diminished groundwater supplies due to salt-water intrusion. Regionally, tightening of water supplies has caused numerous problems, including limiting development of land. World-wide, there is an increasing realization that our current water supplies are increasingly inadequate and that something must be done to augment the current supply.

Catching, storing, and using rainwater at the household level can help alleviate the demand on water supplies. World-wide, there is great interest in using rainfall to augment existing water supplies, but the practice is not so common in the U.S. The basic technology of catching and storing rainwater leads to concerns about water quality and insect breeding. Much work on rainfall catchment and filtration has been done in other areas of the world, but this project specifically considers the unique characteristics of precipitation quality and climatic conditions of Rhode Island. One of the reasons that U.S. households do not employ rainfall catchment systems is because of the homeowners' uncertainty about choosing the components of the systems In addition, the design for the systems will be specific for meeting the needs of Rhode Islanders.

In addition to the water supply benefits, rainfall catchment systems lead to improved storm water management. A significant amount of storm runoff would be captured, rather than cause flooding, overload to sewer systems, or washout.

Storage Tank Material Evaluation

The goal of this project is to test materials for a cost- effective, easy to install and maintain, beneficial to user water storage unit. Limited household usage and landscaping are the uses of the stored water. On the coast of Rhode Island, saltwater intrusion has depleted the supply of groundwater for household use. Many households do not recognize the fact that they can store their own rainwater. Or if they do understand water storage, they still do not know what method and materials is most beneficial to them.

In order to make a rainwater storage unit, many options must be considered. This wide array of choices is somewhat intimidating to a consumer. The material used on the tank itself is the first major choice that needs to be made. Some of the most common choices for tank materials are steel, concrete, fiberglass, plastic, brick or block tanks, and wood. The main factors to consider are availability of materials, durability, cost and contamination of water. The most important characteristics for each material are listed in the following table.

	Galvanized Steel	Plastic	Concrete
Cost	Average	More than average	Less than average
Availability of Materials	Commercially made. Needs to be shipped. Self assembly not recommended.	Commercially made, light weight, easily transportable.	Should be readily available at any hardware store, do-it-yourself or call company.
Contamination	After corrosion, rust flakes into water unless it has a polymer coating. Will leach zinc and/or iron, however, neither is toxic to humans. Initial flush is important	If food grade polymer is recommended, use as little PVC as possible depending on type of plastic, contamination will occur.	Will leach lime. Lime gathers on top of water; little contamination, but needs initial flush.
Effort	Initial installation, no building (pre-assembled), but must be cleaned yearly.	Very low maintenance after initial installation. Clean when needed, (if out of sun should not be often.)	If building yourself, make sure to allot 2-3 days of labor after built; check yearly for leaks and clean yearly.

	Fiberglass	Wood	Brick/Rock Tanks
Cost	Reasonably priced and can make at home or buy commercially.	High cost unless already made and found used.	Low cost if a local material; otherwise do not consider.
Durability	Very strong, (20+) years. Higher quality than plastic.	Wood expands when wet and contracts when dry, need to be careful about water level. Redwood: 50+ years oak & cedar: 20+ years.	Twenty (20+) years. If larger than 18.5 m^2 then reinforcement needed.
Availability of materials	Can easily be bought at hardware store or boat supplier.	Large old trees are in high demand and most likely will not be easily available. Entire tanks will be hard to find unless by chance.	Material available but much SKILLED labor is needed.
Contamination	When making, take ALL safety precautions. An initial flush is necessary since solvents from resin are highly toxic, be sure to rinse completely and flush thoroughly.	Cedar oils are toxic to humans.	After initial curing process (30 days), not much to worry about.

Effort	Several days are needed for construction since needs time to cure and dry after initial construction. Not much maintenance.	Monitoring of water levels is important to eliminate leaks. Cracks are common, but can be patched.	Skilled labor is needed to build tank. Can be hard to find and leaks are common.

This is just a brief overview of the materials available. More information is available on specific types of steel, plastic and concrete. Many of the tanks can be lined with a polymer coating which would negate the contamination of the material of the tank. This lining is not easy to apply and not very cheap. It is mostly used for the purpose of drinking water. Considering the purpose of our water storage is not for drinking water, we did not opt to use this method.
There are also other materials that are not as common as the ones mentioned. These include plastic or rubber bladders, leather/ animal hides, copper, brass, glass, and others. But these were not considered because of extremely high cost and/or low durability. Many factors determine the contamination of water inside a storage tank. The materials used for a tank can be controlled in order to prevent contamination. This project is to decide which material will be most accommodating to this issue. Our decision on which materials to use was based on which ones were most beneficial to each location, and use.

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