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The Use of Reclaimed Rain Water in U.S. Cities and USACE Installations

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Abstract

Currently many locations in the United States and throughout the world are facing significant water shortages resulting from climate change, drought, reduced surface aquifer levels, and competing regional requirements for agriculture, municipal consumption, energy production, and environmental requirements. For the U.S. military and the U.S. Army Corp of Engineer (USACE) installations, potential mission shifting or increased growth may be strongly impacted by water restrictions or water unavailability. In many ways, water sustainment at military installations is both a security and sustainability issue. Rainwater harvesting is specifically called out as an approach to meet Army requirements for Low Impact Development as related to storm water. On February 19, 2015, President Obama issued Executive Order 13514 on *Federal Leadership in Environmental, Energy, and Economic Performance*, which sets sustainability goals for Federal agencies and focuses on making improvements in their environmental, energy and economic performance. This paper describes several rainwater collection systems used in various communities. In addition, brief case studies are presented describing rainwater harvesting use at several USACE installations.

Keywords: rainwater harvesting, reclaimed rainwater, USACE.

1. Introduction

Currently many locations in the United States and throughout the world are facing significant water shortages resulting from climate change, drought, reduced surface streams and aquifer levels, and competing regional requirements for agriculture, municipal consumption, energy production, and environmental requirements. For the military, potential mission shifting or increased growth may be strongly impacted by water restrictions or water unavailability [1]. In many ways, water sustainments at military installations are both a security and sustainability issue. Many Department of Defense (DoD) installations are located in water stressed locations. Rainwater capture and harvesting is also currently in uses in various cities and municipalities in the United States and has proven to be an excellent means of increasing water supply. Harvested rain water is also very useful for areas that rely on groundwater with high solids content or with natural contaminants like arsenic or fluoride. It also provides a lower energy cost than other water sources. The idea of harvesting rain water is not a new concept. History teaches us that ancient civilization like Negev desert in Israel, the Mediterranean, India, Greece, Italy, Egypt, Turkey, and Mexico used reclaimed water by building structures to facilitate the process.

1.1. *Rainwater Capture and Harvesting and the benefits*

The use of harvesting rainwater in areas with water stress in which substantial water is lost due to storm runoff, evaporation, or subsurface leaching. The main challenge in harvesting rainwater is the treatment of the water, which includes high solids or contains natural contaminants arsenic and fluoride are common issues or surface water that is prone to degradation from eutrophication, resulting algal issues like taste, odor or toxic compound which can be challenging to treat. Rainwater can be harvested for various uses which include potable water uses, including drinking water, food preparation, showering and washing. These applications would likely require treatment to insure that the water meets state and federal requirements for potable uses. Some beneficial non-potable uses for rainwater are toilet and urinal flushing and vehicle washing. Harvested rainwater use has been proven safe for the following types of applications throughout the U.S. and is approved for use by the Texas Commission on Environmental Qualities (TCEQ) [2].

School Playgrounds and Sport Fields

Landscape Nurseries

Sports Complexes

Golf Courses

Street Median Landscaping

Construction Projects

Street Sweeping

Fire Protection

Residential Landscape

Apartment Landscape

Industrial Cooling Towers

Industrial Processes

In the city of El Paso reclaimed water is being used to maintain golf courses, city parks, school grounds, apartment landscapes, construction, and industrial sites with over 5.83 million gallons per day of reclaimed water.

2. Meeting Communities Needs by Using Rainwater Harvesting

Rainwater can provide 100% of water needs for communities that rely strictly on this resource. The needs on military installations however are greater than what is supplied by rain water. Reasonable goals for rooftop collection for a custom building might be reduce domestic water supply by 40 to 50% for a building that would then the building to meet LEED goals for sewage reduction. Military installations are in most instances small cities estimate that maximized rooftop collection approach could supply about 32% needs. However, they also estimated a 10% goal would be reasonable from an economic standpoint, yielding a 3.2% displacement [3].

2.1. *Rain Water Concerns*

Rainwater harvesting can be used in a wide range of climates. In hot, arid climates, the focus is on efficient collection from big, infrequent weather events. In order to salvage rain water from these events large, underground storage tanks provide water between storms and reduce water losses from evaporation. A concern in wetter environments is the possibility of contaminates, so a system like first flush or rain diverters may be required. These systems flush off the first water from a storm before it enters the storage tank. These systems dispose of water that is mostly contaminated by particulates, bird droppings, and other materials on the roof. Eliminating these contaminants before they enter into your storage and conveyance system is critical to keeping rainwater clean [4]. Another concern are for environments that experience cold temperatures and frequent freezing conditions is that the weather may cause underground rainwater storage tank to freeze.

2.2. *Army Requirements*

Rainwater harvesting is specifically called out as an approach to meet Army requirements for Low Impact Development as related to storm water [5]. On February 19, 2015, President Obama issued Executive Order 13514 on "Federal Leadership in Environmental, Energy, and Economic Performance", which sets sustainability goals for Federal agencies and focuses on making improvements in their environmental, energy and economic performance. Other regulations that govern the use of Rain Water are the Army memorandum on Sustainable Design and Development Policy Update (10/27/2010), OSD EISA 438. Maintaining or reducing predevelopment runoff and the Army's Net Zero Water and Energy. AR 200-1 also states that all Army organizations and activities will comply with applicable Federal, state, and local environmental laws, regulations, and Eos. Therefore, it is essential that the local Army counsel be consulted on the applicability of all laws, regulations, and initiatives in the specific state where the facility resides, and of course all Eos [6].

2.3. *Green Building Council LEED BD+C: Water Efficiency (WE)*

In the U.S., buildings account for 13.6% of potable water use, the third-largest category, behind thermoelectric power and irrigation. Designers and builders can construct green buildings that use significantly less water than conventional construction by incorporating native landscapes that eliminate the need for irrigation, installing water-efficient fixtures, and reusing wastewater for non-potable water needs. The Green Building Market Impact Report 2009 found that LEED projects were responsible for saving an aggregate 1.2 trillion gallons (4.54 trillion liters) of water. LEED's WE credits encourage project teams to take advantage of every opportunity to significantly reduce total water use. The WE category comprises three major components: indoor water (used by fixtures, appliances, and processes, such as cooling), irrigation water, and water metering. Several kinds of documentation span these components, depending on the project's specific water-saving strategies [7].

3. Case Studies

The Army is familiar with the water reuse process on several installations many installations have been practicing water reuse at vehicle wash racks and for irrigation purposes for many years. The wash rack systems typically consist of sedimentation basins and oil-water separators, with additional technologies applied as needed to meet water quality for a given washing application and environmental protection. Wastewater reclamation is being used to irrigate golf courses and other large parcels have been achieved by providing a higher level of wastewater treatment. With the new Net Zero guidance being implemented across the Army, additional reuse opportunities will be pursued. Some representative examples of recent advancements are provided herein, but there are many other installations considering or practicing water reuse at various scales.

Fort Carson in Colorado has used this process to irrigating its golf course with treated wastewater since the 1970s. The reclamation system has recently been updated to expand the fraction of irrigation that is accomplished using treated wastewater to include other recreational areas. The goal is to use treated wastewater to offset approximately 200 million gallons of water demand each watering season.

Aberdeen Proving Ground has also recently started a project to reuse effluent water from a groundwater remediation effort to offset water demand at a boiler facility, which provides heating to buildings. The effluent water was previously being discharged to a local creek. The reuse project is expected to result in substantial cost savings compared to the previous local discharge practice. Tobyhanna Army Depot has implemented a water reuse process in its wastewater treatment plant. The process reused treated wastewater to support foam reduction processes that were previously supported with potable water. This saves 300,000 gallons per month and had a payback period of just over one month. The depot also implemented a re-circulating water chiller to save an additional 2,000,000 gallons per month.

One of the challenges with water reuse projects is the cost of retrofitting the associated infrastructure. At the building scale, for instance, re-plumbing the sink, laundry, and shower sanitary drain lines to a dedicated gray water collector and then re-plumbing distribution lines to supply low tier activities such as toilet flushing and irrigation is not very cost-effective in many cases. For centralized water systems, similar challenges can manifest when designing and installing a new purple pipe distribution network to support reuse activities such as flushing toilets in buildings. While there are certainly many scenarios where water reclamation or gray water reuse can pay back in an acceptable time period, there are ongoing efforts within the R&D community and even some cases that may help alleviate retrofit costs such that a greater fraction of water can be reused in an equally economical manner.

Several municipalities in the US have implemented more progressive water reuse systems that recycle wastewater for potable use. These Direct Potable Reuse (DPR) systems include advanced tertiary treatment technologies positioned downstream of the wastewater treatment plant for the control of pathogens and trace contaminants like personal care products. Component technologies can include reverse osmosis membranes for screening out the smallest of contaminants and advanced oxidation processes for destroying any organic contaminants. Coupled with frequent water quality monitoring and other quality control measures, these systems then return the purified wastewater to the head works of the drinking water plant or directly inject into a potable supply reservoir. Examples of DPR systems include Big Spring and Wichita Falls in Texas and Cloudcroft in New

Mexico. At the building scale, facilities with showers and laundry could potentially explore high tier reuse, or more appropriately, recycling of shower and laundry water to allow a greater fraction of the gray water to be recovered. While this requires a higher level of purification prior to reuse, the Army has developed gray water recycling systems for field use that could potentially support building scale recycling activities should regulations allow so in the future.

3.1. *Fixture scale reuse*

To alleviate the costs of retrofitting the plumbing system of an entire building, fixture scale reuse systems are also being developed. By reusing water within the fixture or bathroom itself, the retrofit costs may be potentially reduced. Shower stall products that recycle shower water and recover waste heat are being developed by several corporations around the globe. A demonstration at ERDC CERL is looking at a commercial scale under-sink water reuse system that uses sink water effluent to offset some of the toilet flushing demand. A residential model of such a technology was previously commercialized.

4. The City of El Paso and the Use of Purple Pipe

El Paso Water Utilities (EPWU), one of the nation's most progressive water agencies, has been delivering reclaimed water to the community since 1963. As a pioneer in water reclamation, EPWU has attained international recognition for its innovative and extensive use of recycled water. EPWU now operates one of the most extensive and advanced reclaimed water systems in Texas for industrial use and landscape irrigation [8]. Purple pipe can reduce the demand on the potable water treatment and distribution system. It also reduces the demand on water supplies such as surface or ground water sources and recharges diminishing groundwater supplies and may reduce saltwater intrusion into aquifers. Additional benefits are the reducing the volume on a wastewater treatment plant and its collection system and it reduces the volume of water discharged from the WWTP to the environment. It also provides a drought-resistant irrigation water supply.

The city of El Paso Texas has become a leader in the use of purple pipe because of necessity. The El Paso Water Utilities (EPWU) has established themselves as one of the nation's most progressive water agencies. EPWU has been a leader in water reclamation since 1963 and has been recognized international for its innovation and extensive use of recycled water. EPWU operates one of the extensive and advanced reclaimed water systems in Texas for industrial use and landscape irrigation.

EPWU has several currently under construction in the city will assist the city in harvesting rain water, the distribution, and will safe much needed water resources. One current project is a multi-phase project that provides over 520 million gallons of reclaimed water per year through 26 miles of pipeline to various locations throughout the city. The system is fully automated dispensing station, which operates continuously and provides uninterrupted service to contractors for construction, street sweeping, etc. This project is valued at $23 million paid for by grants from the U.S. Bureau of Reclamation, the Texas Water Development Board and through City of El Paso Water and Sewer revenue bonds from EPWU. Other projects that provided reclaimed water service to 3 schools, parks, cemeteries, municipal golf courses, and the city zoo for irrigation. In phase one of this project reclaimed water is distributed thru 19,200 linear feet of the purple pipeline infrastructure developed by EPWU to locations throughout Central El Paso. This purple pipe system also supplies water to five major cemeteries, three parks, a storm drain station, street parkways and medians. EPWU has constructed stations that dispense reclaimed water into water trucks for construction sites, street sweeping, car washing, and other non-potable uses. This project is valued at $13.4 million, which was also funded by the U.S. Bureau of Reclamation and through the City of El Paso Water and Sewer revenue bonds from EPWU and provides approximately 325 MG of reclaimed water per year.

Wastewater within the EPWU service area is collected and treated at one of four EPWU wastewater reclamation plants using advanced secondary or tertiary treatment. The result is high water quality that earned EPWU the reputation of operating the first wastewater treatment plant in the world to meet drinking water standards for its reclaimed water. The other three plants meet the highest possible quality rating of Type I reclaimed water as described in Texas state regulations and monitored by the Texas Commission on Environmental Quality (TCEQ).

4.1. *Current Projects*

One current project under construction is the Northwest Reclaimed Water Project. This multi-phase project provides over 520 million gallons of reclaimed water per year through 26 miles of pipeline to various locations in northwest El Paso. A fully automated dispensing station operates continuously to provide uninterrupted service to contractors and others for construction, street sweeping, etc. The project value is $23 million paid for by grants from the U.S. Bureau of Reclamation, the Texas Water Development Board and through City of El Paso Water and Sewer revenue bonds from EPWU. The city is planning extensions to service to serve new schools, parks, and commercial properties in more areas of the city.

Phase I of the Central Reclaimed Water Project was completed in 2003 and provides reclaimed water service to 3 schools, parks, cemetery's, municipal golf courses, and the city zoo for irrigation. The first phase of this project provides reclaimed water through 19,200 linear feet of pipeline to various locations in Central El Paso. The second phase extends as far as areas north of the city and services 3 parks, a storm drain station, street parkways and medians. This phase incorporates two automated dispensing stations into the system to provide continuous service for construction activities. These stations dispense reclaimed water into water trucks for construction sites, street sweeping, car washing, and other non-potable uses. The projects are valued at $13.4 million, which was funded through grants from the U.S. Bureau of Reclamation and through the City of El Paso Water and Sewer revenue bonds from EPWU and provides approximately 325 MG of reclaimed water per year [8].

5. Conclusion

Harvesting rainwater for irrigation of trees, grass, gardens and landscapes is a practice that assist in water conservation, mosquito prevention, and protection of water sources, reduces water runoff and pollution, and helps in sustainability. Harvesting and reclaiming rain water helps cities, military installations in the United States are conserving millions of gallons of potable water each year for domestic uses. When not filtered rainwater is non-potable and may contain high levels of salts and nutrients than potable water. The water has a higher contents of salts than potable water and these salts can accumulate in the soil with time if not managed properly. In communities like El Paso Texas the use of purple pipe to distributed harvested rainwater has become part of the city's infrastructure planning [8]. The city has devoted millions of dollars to collect and recycle water out of necessity. As a result El Paso has become a leader in the use of purple pipe to water city parks, golf courses, and various other municipal facilities.

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