A DECENTRALIZED WATER SYSTEM:

Complimenting the Centralized System with Rain Harvesting

The Elevated Tank

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INTRODUCTION

The idea of a decentralized system came to me in stages after I realized the potential that rainwater harvesting could bring to our area. I witnessed landscaping trucks watering plants, people washing sidewalks and urban gardens trying to supplement irrigation with rain barrels. All were using potable water. If rainwater harvesting systems (RHS) were placed through out the city to supply clean non-potable water, much of our water needs could be supplied directly from the rain. The problem to large scale implementation of RHS in the private sector is without a 2-3 year payback and the large upfront cost there is no interest. Many irrigation RHS will take 10 years or more to payback, because they have seasonal use and the erratic climate patterns we have witnessed do not allow the need for continuous use. During a drought, water is priceless. A RHS should have a life cycle of 20-30 years or more giving them a positive return on investment. If the utilities had a revenue source from rain harvesting they would embrace the practice. Through my investigation in this project, the lower energy requirements discovered and stormwater management benefits in RHS are the key to making them economical.

Murphy Avenue Tank

Water in Atlanta is plentiful with an average 50 inches of rain a year falling on the city. Metro Atlanta uses approximately 560,000,000 gallons of water each day (gpd) according to the Metro North Georgia Water District (MNGWD) and 20% of this water goes towards non-potable use. The metro area covers 4832 square miles. If 1 inch of rain was evenly distributed over the 14 counties and could be captured, rainwater could supply the metropolitan area's water for 140 days.[1] This same concept can be applied to RHS, but not quite to the same level. Rain harvesting allows the capture of 0.625 gallons of water per square foot of roof per 1 inch of rain. In reality just over 0.5 gallons of water per square foot is captured. Rain harvesting loses approximately 15-20% during catchment depending on the roof design and weather conditions. A 100,000 square foot building can produce 2,750,000 gallons of water per year in Atlanta.

Monthly Averages of Rainwater													
Month	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**June**	**July**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**	**Total**
1981-2010 30 yr ave	4.20	4.67	4.81	3.36	3.66	3.95	5.27	3.90	4.47	3.41	4.10	3.90	49.70

[1] Paving Our Way to Water Shortages: How Sprawl Aggravates the Effects of Drought by: Betsy Otto, Katherine Ransel, and Jason Todd, American Rivers, Deron Lovaas and Hannah Stutzman, Natural Resources Defense Council, John Bailey, Smart Growth America

Rainwater can be stored, delivered and treated very efficiently using very little energy. The efficiency of storage is something not mentioned when designing reservoirs or comparing rain harvesting to reservoirs. Evaporation from Lake Lanier is about 40 inches per year with an annual average precipitation of 54.8 inches, which calculates to a 73% loss of water according to a US Department of Commerce Technical Paper.[12]

Another factor is the quality of water. Rainwater contains virtually no minerals or chemicals. When captured properly the water is of potable quality in the tank. Domestic water from the utility contains chlorine, fluoride and wide range of minerals and sometimes prescription drugs. Water with minerals and chemicals retards plants growth sometimes as much as 20-30 percent and require more water to quench the plant's thirst. Well water also retards plants growth and diminishes the quality of the soil over time. For more information download Irrigation Water Quality for Agriculture through the UGA Extension Service.

This plan will explain how the City of Atlanta's Department of Watershed Management (DWM) and other utilities in moderate to wet climates can use rainwater to supply their non-potable water needs and keep more of the revenues generated from the sale of this water. With the new Urban Farming Code and the hiring of Mario Cambardella, Urban Agriculture Director for the Mayor's Office of Sustainability City of Atlanta a discussion about where the water will come from is now and now is the time to implement this plan before we have another drought.

EXECUTIVE SUMMARY

The plan is to develop a decentralized water system through out the city by selling rainwater from thanks through fire hydrants and leasing above ground tanks to individuals and businesses. The plan consists of identifying customers needing non-potable water and place RHS's on their sites. DWM can install and maintain the tanks allowing a revenue stream to offset the potable water loss. The rainwater harvesting systems can be leased at a monthly fee based on the cost of the system and provide more revenue. By implementing this program the DWM may be able to reduce the time projected to complete the decent decree while increasing revenue.

Water use for this project falls into two categories listed below:

- Non-Potable Water Use: This includes a better quality of water used, stored and sold for irrigation, port-a-potties, street sweepers and utility trucks.
- Stormwater Management – Managing the quantity and quality of stormwater. The stormwater that runs off roofs will be directed to tanks and during the off season can be released slowly over time to minimize flooding. This will help keep contaminants out streams clean, reduce flooding and erosion.

[2] US Department of Commerce Technical Paper NO. 37, M. A. Kohler, T. J. Nordenson and D. R. Baker Hydrological Service Division, 1959 Evapotranspiration and Droughts by Ronald L. Hanson, U. S. Geological Survey 1991

THE PLAN

With the concern over water quantity and quality, this proposal provides a solution for a water source to help fill the non-potable water needs of Atlanta and similar climate environments. It will also provide a model and training facility for Best Management Practice (BMP) to reduce stormwater run off that pollutes our streams. The location at 1150 Murphy Ave. Atlanta, GA 30310 is located in SW Atlanta. This is a state owned warehouse with an abandoned firewater tank and was chosen to be the site to launch the first decentralized water system that provides a source of clean non-potable water for the area. The water customers will be charged as is currently practiced when using fire hydrants and 3" meters provided by the city. The water will be delivered through violet fire hydrants on Avon Ave. allowing easy access. Other tanks can be set up on both public and private property throughout the city. The system could supply water for irrigation trucks, port-a-potties, street sweepers, utility trucks and other non-potable needs.

Return on Investment Based on Use & Capacity							
Gallons Stored Yearly - 175,000	**CCF**	**Cost /CCF**	**Money Per Year**	**Cost of Project**	**Maintenance Tank /Year**	**ROI/Years**	**5.6% Cost Increase ROI/20 Years**
2,100,000	2,804	**$6.16**	$17,271.03	$1,018,895.99	$8,200.00	112.3	26.2
2,100,000	2,804	**$7.47**	$20,943.93	$1,018,895.99	$8,200.00	80.0	22.5
2,100,000	2,804	**$13.14**	$36,841.12	$1,018,895.99	$8,200.00	35.6	16.1
2,100,000	2,804	**$21.85**	$61,261.68	$1,018,895.99	$8,200.00	19.2	11.3
Gallons Stored 7 Month Growing Season - 175,000	**CCF**	**Cost /CCF**	**Money Per Year**	**Cost of Project**	**Maintenance Tank /Year**	**ROI/Years**	**5.6% Cost Increase ROI/20 Years**
1,225,000	1,636	**$6.16**	$10,074.77	$1,018,895.99	$8,200.00	543.5	
1,225,000	1,636	**$7.47**	$12,217.29	$1,018,895.99	$8,200.00	253.6	
1,225,000	1,636	**$13.14**	$21,490.65	$1,018,895.99	$8,200.00	76.7	22.3
1,225,000	1,636	**$21.85**	$35,735.98	$1,018,895.99	$8,200.00	37.0	16.6

The Murphy Ave. site can hold approximately **2,100,000** gallons per year. The table above shows the breakdown if all of the captured water is used. If the 20 year average of a 5.6% yearly increase of water pricing based on the 50 Largest Cities Water and Wastewater Report by Black & Veatch[3] is included the return drops from **112.3** to **26.2** years based on the city's current rate of **$6.16** per CCF. The original irrigation rate, which was lowered in 2012 of **$7.47** per CCF increases the ROI by **21.3%**. If we include the cost of sewer which includes money to cover stormwater issues as well as sewage the water rate is **$21.58**[4] per CCF we could reduce the rate of **13.9** years based on the original rate and **9.1** years based on the Black & Veach rate. The rate of **$13.14** was added based on the cost of water/sewer for Gwinnett County's rate who uses a stormwater utility to fund their needs. Their irrigation rate is **$7.28** when converted to CCF's. The stored table has the return calculated based on the storage capacity. Even though the return is longer more water is produced allowing for stormwater management and an emergency source of water viable. Other tables are provided break down scenarios using different storage capacities. The more water used allows a more attractive return. Now is the time to implement this plan before we have another drought.

[3] 50 Largest Cities Water and Wastewater Report by Black & Veatch
[4] City of Atlanta DWM -Approved FY 2008-09 through FY 2011-12 Water and Sewer Rates

A pilot program implemented by the DWM can start this system at 1150 Murphy Ave, a state owned property and be used to develop an expansion into other areas in their service district. Different products can be tested at the pilot site and utility workers and the public can be trained. A rain garden and swales can be designed and tested to study and train inspectors on green infrastructure practices, a program promoted by the city for new development. This site was chosen because of the existing tank and large roof area of 103,250 sq. ft., which can collect 56,787 gallons of water per 1 inch of rain (gpi). The tank has been abandon and can be refurbished for 50-65% of the cost of a new tank. When the tank is restored it can be labeled RAINWATER with a message *When it Rains ... We Store...* coined by the Southeastern Rainwater Harvesting Systems Association, to promote this practice.

1150 Murphy Avenue site provides:

- State property with abandoned and unused water tank.
- Refurbishing tank less expensive then building a new one.
- Industrial I-1 zoning.
- Easily accessible location for water delivery.
- Supply water for Trees Atlanta's west side needs.
- Supply water for downtown watering needs.
- Back up water supply for Beltline Farms and other farms in SW Atlanta.
    - Beltline Farm is about 3000 feet from the tank and water could be piped using no energy to distribute.
- Water Tank could be used as a public relations device to promote Atlanta as a sustainable leader. MARTA riders and visitors coming into the city would see tank.

Components of the Plan Include:

- Increase the rate for irrigation and price the water at the conservation rate that was originally approved.
- Energy costs can be eliminated through the use of energy through PV panels
- Revenue can be generated by selling rainwater
- The DWM sets up rain tanks to sell rainwater to customers through out the city.
- An emergency water reserve will be available through out the city
- Stormwater management reducing CSO's
- Possible funding sources from GEFA for utilities
- Possible funding sources from diverting decent decree funds to reduce stormwater overflows similar to the Historic Fourth Ward Park
- New jobs for engineers, contractors, plumbers and maintenance personnel.

RATES & COST

Water rates were set in 2011 in response to raising capital to finance the federal consent degree to eliminate the sewer over flows due to growth and an aging infrastructure. Because the problems with the aging sewer and stormwater system, sewer rates increased dramatically and a tiered system was used to incentivize efficiency. Irrigation rates were tiered for the same reason and, because the high sewer rates were set at a higher rate then domestic rates, which is commonly used. This practiced is supported by the North Ga Metro Water District, which establishes strategies for water supply and conservation, watershed and wastewater management through out the region.

City of Atlanta Department of Watershed Management New Rates Effective 07/01/2011						
MONTHLY WATER RATES AND MONTHLY IRRIGATION RATES						
CONSUMPTION RANGE FROM-TO	INSIDE CITY RATE	BASE RATE	ORIGINAL IRRIGATION RATE	CHANGE IN RATES	OUTSIDE CITY RATE	BASE CHARGE
1-3	$2.58	$6.56	$3.51	36.0%	$3.51	$6.56
4-6	$5.34		$6.48	21.3%	$6.48	
7 & UP	$6.16		$7.47	21.3%	$7.47	
MONTHLY SEWER RATE						
CONSUMPTION RANGE FROM-TO	INSIDE CITY RATE	BASE RATE	COMBINED per CCF	COMBINED per 1000	OUTSIDE CITY RATE*	BASE CHARGE
1-3	$9.74	$6.56	$12.32	$16.43		$3.45
4-6	$13.64		$18.98	$25.31		
7 & UP	$15.69		$21.85	$29.13		
SENIOR MONTHLY WATER DISCOUNT RATES						
CONSUMPTION RANGE FROM-TO	INSIDE CITY RATE	BASE RATE			OUTSIDE CITY RATE	BASE CHARGE
1-3	$1.81	$4.59			$2.46	$4.59
4-6	$3.74				$4.54	
7 & UP	$4.31				$5.23	
SENIOR MONTHLY SEWER DISCOUNT RATES						
CONSUMPTION RANGE FROM-TO	INSIDE CITY RATE	BASE RATE			OUTSIDE CITY RATE*	BASE CHARGE
1-3	$6.82	$4.59				$3.45
4-6	$9.55					
7 & UP	$10.98					
Wholesale Rate effective: $3.70 per ccf, July 1, 2011						
* Effective since 2/1/2013: Outside City Sewer Rate is $4.12 per ccfs. Fulton County Rate is $3.45						

In 2012 the irrigation rate was dropped to the domestic rate with no reason or notification to the public. While many would be happy to see a drop, this reduces the revenue for the city and reduces the incentive to conserve. This plan proposes to raise the irrigation rate to its original amount above in yellow.

The cost for an irrigation meter is $1800 + $85 right of way fee and takes 15 weeks to install. Rainwater tanks could be installed in less time. Wells are priced at $12 per foot, cost $5000-$20,000 and give the false comfort of an unlimited resource.

ENERGY

The key component to RHS that may not be realized is the energy savings. Satisfying the Nation's water needs requires energy for distribution and treatment of water. Electricity costs represents approximately 75 percent of the cost of municipal water processing and distribution (Powicki, 2002) according to the ENERGY DEMANDS ON WATER RESOURCES by the US Department of Energy.[5] The cost of treatment for RHS will only include maintenance of the filters, maintenance of the tanks and the cost of distribution will be the electricity needed to pump the water from underground tanks to the above ground tanks. This cost can be offset with photovoltaic panels as illustrated in the Energy section below.

[5] ENERGY DEMANDS ON WATER RESOURCES - REPORT TO CONGRESS ON THE INTERDEPENDENCY OF ENERGY AND WATER Chapter III conducted by the U.S. Department of Energy - 12/2006

Energy reduction is a known benefit in water efficiency, but there is little public discussion about the how much energy is used related to water treatment and distribution. As mentioned above the key component is energy savings. Satisfying the Nation's water needs requires energy for distribution and treatment of water. The cost of treatment for RHS will only include maintenance of the filters, maintenance of the tanks. The cost of electricity is only needed for pumping water from the underground tanks to the elevated tanks on Murphy Ave. This distribution is offset with photovoltaic panels (PV) producing energy to be used to power a pump. Based on current estimated rate from Georgia Power of **$.16** per kWh. **1591** hours of pumping will be required to fill the **2,100,000** gallons the catchment area will produce through out the year at the Murphy Ave. site. The electricity that is offset by PV panels on the roof will cost **$11,320.00** and have a payback of **37.81** years depending on incentives and rates at the time of implementation.[6]

PV ROI to Pump Water to Elevated Tank								
Watts	Amps	kW	Hours	kWh	Price/kWh	Cost/KW	Total	ROI
140	8.4	1.2	1591	1,871.0	$0.16	$299.36	$11,320.00	37.81

The water will be delivered to the hydrants by gravity. The tank is 100 feet high and will provide a consistent pressure of 43 psi with no energy required. Another benefit to this design is the ability to acquire water during emergencies. No energy is required to treat the water collected, because gravity is used to clean the water as it is piped into the tank as described below in the rainwater filtration section.

If the water was pumped to the fire hydrants using traditional AC pumps the cost would be approximately $101.93 if all the water was pumped. This is only .83% of the revenue generated. Not only will this system reduce potable water use, but will save a great deal of energy.

Electricity Consumption w/175,000 gallons of storage								
Volts	**Amps**	**kW**	**Hours**	**kWh**	**Price/kWh**	**Total**	**Yearly Revenue**	**% of Use**
230	17.6	4.05	340.3	1,377.4	$0.074	$101.93	$12,217.29	0.83%

Data is based on full potential use for the system. Climate variations will vary ROI.

USE

One use observed in this area was a port-o-potty business that used the fire hydrants on Avon Ave. to fill their trucks. Each truck held 1500 gallons of water. The trucks would fill up once per day and the location had 5 trucks. If they fill up 200 days per year the water use would total 1,500,000 gallons. They are no longer in the area, but it gives a quantity of potential use. Trees Atlanta is also using potable water to water their plantings on the west side. They are currently using 5,120 gallons per week for 24 weeks each year or 122,880 gallons per year. As the Beltline progresses more water will be needed. Gibbs Landscaping is currently watering downtown plantings for the Central Atlanta Progress. They use approximately 11,000 gallons each month from April through September. Which is

[6] Price based on information supplied by Creative Solar USA

transported from their facility in Smyrna. More data is needed water needs will increase as the area grows.

Monthly Averages of Rainwater													
Month	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
1981-2010 30 yr avg "	4.20	4.67	4.81	3.36	3.66	3.95	5.27	3.90	4.47	3.41	4.10	3.90	49.70
Trees Atlanta			20,480	20,480	20,480	20,480	20,480	20,480	20,480	20,480			163,840
Gibbs Landscaping				11,000	11,000	11,000	11,000	11,000	11,000				66,000
Port O Potty	112,500	112,500	112,500	112,500	112,500	112,500	112,500	112,500	112,500	112,500	112,500	112,500	1,350,000
Total Water Needed	112,500	112,500	132,980	143,980	143,980	143,980	143,980	143,980	143,980	132,980	112,500	112,500	1,579,840
Water Collected	238,508	265,198	273,148	190,806	207,842	224,311	299,270	221,471	253,840	193,645	232,829	221,471	2,822,339
The collection area of 103,250 will produce approximately 56,787 gallons per 1" of rain													

Water Balance

CATCHMENT AREA

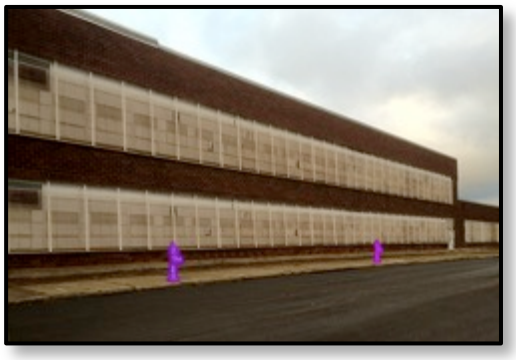
The rainwater will be collected off the north side of the building at 1150 Murphy Ave. The roof area used for collection is 103,250 sq. ft. This will produce approximately 56,787 gallons of water per 1 inch of rain (gpi)

STORAGE TANKS

This site is designed to collect and store 175,000 gallons of water, which is the amount of water that will be produced from 3 inches of rain. Two 50,000-gallon tanks will fill with 1.75 inches of rain, which will capture a 2-year storm event when empty. A submersible pump located in the underground tanks will fill the elevated tank as needed. The underground tanks will be made from fiberglass. The reason for choosing fiberglass tanks is they last for 50 years or more, can be cleaned and repaired. They will be manufactured for potable water storage.

The above ground tank will be refurbished and store 75,000 gallons of water delivering 43psi of pressure to the hydrants below. This tank can be refurbished reducing the cost of a new tank and eliminating a significant amount of energy.

DISTRIBUTION

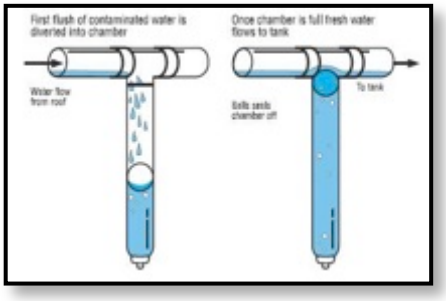


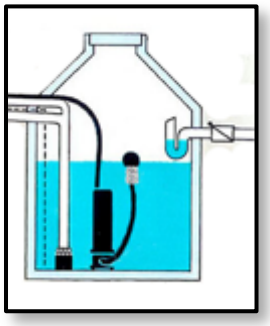
The water will flow to two fire hydrants painted violet on Avon Ave and will allow 24-hour access for filling mobile tanks. Meters provided by the city to the customer requiring a deposit are attached to the rain hydrants to measure the water use. The customers turn in their use monthly and are billed accordingly.

RAINWATER FILTRATION

Rainwater is very clean before and after it lands on the roof if collected properly. To provide clean rainwater the surface of the roof must be cleaned. This is accomplished by filtering the start of the event water first through a roof washer (fine stainless steel screen) placed at the bottom of each of the four existing downspouts to remove the particulates. There will be four different styles of roof washers installed to evaluate how they perform and educate the inspectors. (See Appendix.) The inspectors will have the opportunity to learn how the different types of products work. Suggested manufacturers are 3P Technic, Rain Harvesting, Intewa and Wisy. All of these products have been designed for commercial use and have been in production years.

The next step is to divert the first 2% of the water on the roof to a first flush device that will be buried in the ground. This will divert the roof contaminants that pass through the screen in the water from the tank. When the pipes are filled the device closes and clean water will go into the underground tanks. The contaminants will drain to stormwater pipes.





The water then enters the tank through a calming inlet so not to stir any sediment settled on the bottom of the tank. The water is filtered through another fine stainless steel screen attached to a floating filter when pumped to the elevated tank. The filter collects the water 6-8 inches below the surface. This is the cleanest and most oxygenated water. If this simple design is followed the water in the tanks should be potable. No other filtration is needed.

EVAPORATION

Water is stored more efficiently in tanks then in lakes, traditional reservoirs, because of evaporation. According to an AJC article Sun Drains .2 Inch of Water Daily from Lanier by Satavy Shelton Published on 06/19/08

> *193.9 million gallons of water evaporated from the lake, the main water source for more than 3 million in metro Atlanta. By comparison, Gwinnett County withdrew an average of 74.2 million gallons a day from the lake in May, or less than half the amount that's disappearing in the sun's rays.*

STORMWATER MANAGEMENT

The stormwater that runs off the land and driveways can be directed to swales, a rainwater garden or pervious pavers to allow it to soak into the earth and replenish ground water. Runoff from the roof will be stored in tanks and can be released during low use periods after the rain events to minimize flooding.

Ground water loss in Atlanta has been going on for decades. Tree loss in the Atlanta metro area from 1974 to 1996 resulted in a 33% increase in stormwater runoff (from each 2-year peak storm event). This translates into an estimated 4,420,987,013 gallons according to data from the Paving Our Way to Water Shortages: How Sprawl Aggravates the Effects of Drought[7]. Atlanta sites land development from1982-1997 increased by 81%. In Atlanta, for example, between 56.9 and 132.8 billion gallons of groundwater infiltration may have been lost compared to 15 years earlier.

The city has recently developed green infrastructure practices to offset water runoff with land disturbing practices. The amount of impervious surface on this property allows for the opportunity to test and teach stormwater practices. Rainwater harvesting can also control stormwater runoff. This can be accomplished through the slow release of water from the tank after a storm event to reduce flooding during large storm events. The Murphy Ave tank and property can be used as a research facility to learn more about this practice.

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[7] Paving Our Way to Water Shortages: How Sprawl Aggravates the Effects of Drought by: Betsy Otto, Katherine Ransel, and Jason Todd, American Rivers, Deron Lovaas and Hannah Stutzman, Natural Resources Defense Council, John Bailey, Smart Growth America

MAINTENANCE

Maintenance will be required for the filters and the tanks. There are four roof filters that remove the debris from the roof. They should be checked quarterly along with the first flush. The design in all four of the filters includes a self-cleaning feature, which keeps maintenance time to a minimum. Suggested frequency for cleaning is quarterly, but during the first year inspections should be made after rain events to monitor the environmental influences.

The underground tanks will need little maintenance, because the water entering the tank will be filtered by the system to eliminate contaminants. Therefore only quarterly inspections are necessary to make sure the components are working properly. A small amount of sediment will settle on the bottom, but will not affect the quality of the water.

The elevated tank needs regular maintenance and can be serviced through a maintenance program. The program will cost approximately **$8,200.00** per year.

IN CONCLUSION

By managing rainwater and stormwater efficiently there will be plenty of water for generations. Expanding the reservoir system with the cost of land, new infrastructure, energy use, environmental issues and the loss due to evaporation seems inefficient. A decentralized system can be implemented with in years instead of the decades it takes to complete a reservoir. The system will complement the centralized system and be a more profitable revenue stream. This concept may seem a bit radical, but it achievable. Now is the time to implement this plan before we have another drought.

SITE PLAN


First
Flush
300′
40′
Filter
100′
110′
Filter
103,250 sq ft
56,787 gpi
100′
Tank
Filter
100′
Tank
Filter
First Flush Swale
250′
96,000 sq ft
1150 Murphy Ave
75,000
Gallon
Tank
Outlet Line
Rain Garden
13,000 sq ft
10,000 sq ft
Water Hydrants