Watering Durham's Schools:

A Modeled Distributed Rainwater Harvesting Finance Program Using Durham Public Schools

This study investigates public and private financing options for distributed rainwater harvesting systems, using the City of Durham's water departments and Durham County Public School District properties to demonstrate how several different rainwater system finance programs could be structured. Study results suggest that a fully self-financed cistern installation will not perform well financially, but modest incentives offered through the city utility can create a financially viable program structure – for both the school property owners and the utilities.

August 2012

UNC
ENVIRONMENTAL FINANCE CENTER

About the Environmental Finance Center

The Environmental Finance Center at the University of North Carolina, Chapel Hill is part of a network of university-based centers that work on environmental issues, including water resources, solid waste management, energy, and land conservation. The EFC at UNC partners with organizations across the United States to assist communities, provide training and policy analysis services, and disseminate tools and research on a variety of environmental finance and policy topics.

The Environmental Finance Center at the University of North Carolina, Chapel Hill is dedicated to enhancing the ability of governments to provide environmental programs and services in fair, effective, and financially sustainable ways.

Acknowledgements

Written by Christine E. Boyle, Ph.D.

Research assistance was provided by Daniel Kolomeets-Darovsky. Dr. Lauren Patterson made the map. Editorial assistance was provided by Mary Tiger and Erin Weeks. This analysis would not have been possible without the time and insight of the many rainwater harvesting experts interviewed for this project. Their names and affiliations are listed in the appendix.

This report is a product of the Environmental Finance Center at the University of North Carolina, Chapel Hill. Findings, interpretations, and conclusions included in this report are those of the authors and do not necessarily reflect the views of EFC funders, the University of North Carolina, the School of Government, or those who provided review.

We are grateful to the RBC Blue Water Project via the North Carolina Water Resources Research Institute for funding this research.

Cover photo (taken by Erin Weeks) shows two cisterns located at the North Carolina Botanical Gardens in Chapel Hill, NC.

UNC ENVIRONMENTAL FINANCE CENTER

©2012 Environmental Finance Center
at the University of North Carolina, Chapel Hill
School of Government
Knapp-Sanders Building, CB# 3330
University of North Carolina at Chapel Hill
Chapel Hill, NC 27599-3330
www.efc.unc.edu
All rights reserved

TABLE OF CONTENTS

Watering Durham's Schools

A MODELED DISTRIBUTED RAINWATER HARVESTING FINANCE PROGRAM USING DURHAM PUBLIC SCHOOLS

EXECUTIVE SUMMARY

Communities in the southeastern United States face dual threats to local water supplies: increased water shortages and decreased water quality. Addressing these challenges will require additional costs for cities and utilities across the country. Despite the southeastern states' relatively humid climate, changes in climate and population pressures are bringing water resource considerations to the forefront of many local communities' growth management agendas. The solutions on the table must assist in the provision of clean water to all sectors of the community while controlling costs and without impeding economic development. Rainwater harvesting systems allow for land development while also achieving the goals of water conservation and water pollutant mitigation.

This study investigates public and private financing options for distributed rainwater harvesting systems. We use the City of Durham's water departments (water and stormwater) and Durham County Public School District properties to demonstrate how several different rainwater system finance programs could be structured. Study results suggest that a fully self-financed cistern installation will not perform well financially, but modest incentives offered through the city utility can create a financially viable program structure – for both the school property owners and the utilities. Third–party ownership, on-bill financing, and other public private partnership arrangements present alternative financing arrangements to spread risk to cistern program financing and leverage limited capital resources.

The findings of this study present a case for the viability of a utility-based incentive program for rainwater harvesting, under a few conditions.

- Integration, or at least close cooperation of stormwater and water utilities is necessary to coordinate such a program – in particular issuing stormwater credits, metering cisterns, and monitoring cistern performances.
- A viable public –private rainwater program must build upon existing "to-scale" properties to meet performance goals. Large property owners and institutions (i.e. schools, medical facilities, and universities) are strong candidates for cistern partners, as they can help the city achieve scale in stormwater mitigation and conservation efforts and also have capacity for plumbing and grounds maintenance to operate the cistern systems. Small-scale installations can be built, but won't be under the city's monitoring or performance evaluations.
- Both public and private capital are necessary to make a viable financial case for cistern installation – given the private and public benefits of cisterns tailoring of finance programs to bring both sources of capital to the table will create a viable path forward for more widespread adoption of rainwater harvesting systems.

INTRODUCTION

Communities in the southeastern United States face dual threats to local water supplies: increased water shortages and decreased water quality. Addressing these challenges will require additional costs for cities and utilities across the country. Despite the southeastern states' relatively humid climate, changes in climate and population pressures are bringing water resource considerations to the forefront of many local communities' growth management agendas. The solutions on the table must assist in the provision of clean water to all sectors of the community while controlling costs and without impeding economic development. Rainwater harvesting systems allow for land development while also achieving the goals of water conservation and water pollutant mitigation.

As green infrastructure development advocates have noted, more decentralized stormwater management systems—and more cooperation between property owners and public utilities to finance, build, and operate them—are the future of clean and vibrant urban communities. As part of a project funded by the RBC Blue Water Fund via the North Carolina Water Resources Research Institute for outreach and research in Sustainable Urban Water Use for the Southeast, the Environmental Finance Center at the University of North Carolina investigated public and private financing options for distributed rainwater harvesting systems. We use the City of Durham's water departments (water and stormwater) and Durham County Public School District properties to demonstrate how several different rainwater system finance programs could be structured.

Rainwater harvesting systems, also known as cisterns, capture rainwater from rooftop runoff and/or impervious surfaces and funnel the water into an above or below ground cistern for future use. Cistern water can be used on a property for both potable and non-potable uses. Most commonly, cistern water is used as a non-potable source for outdoor watering. However, assuming the proper plumbing equipment is installed; cistern water can also be treated to various degrees and used for toilet flushing and potable drinking water supply. In this way, rainwater harvesting reduces demand on a utility's drinking water supply (in particular when used for peak season outdoor watering) and also contributes to nutrient reduction by capturing water during storm events. In turn, reducing the runoff of water into neighboring streams, lakes, and rivers. Collection systems range from residential 40-gallon rain barrels to commercial 10,000 gallon cisterns and to large, underground systems like the 500,000 gallon installation on the campus of the University of North Carolina in Chapel Hill.

An emerging strategy for environmental protection in cities worldwide is utility-sponsored green infrastructure investments. Popular forms of such infrastructure include green roofs, rain gardens, and cisterns which utilities subsidize in order to meet the water quality goals of the locale or other regulatory jurisdictions. For water quality purposes, a city agency will provide tax credits, rebates, and building permits in sensitive areas to property owners who install green infrastructure. Specific nutrient reduction requirements, inspection requirements, and device size requirements vary per city. As recently as May 21, 2012, the use of rainwater harvesting and other green infrastructure components as a means of complying with the Clean Water Act was codified in the settlement of litigation between the Environmental Protection Agency (EPA) and the City of Seattle. The consent decree permitted the City to use green infrastructure as a cost-effective way to control and treat stormwater, thus complying with the City's National Pollutant Discharge Elimination System (NPDES) permit requirements[1].

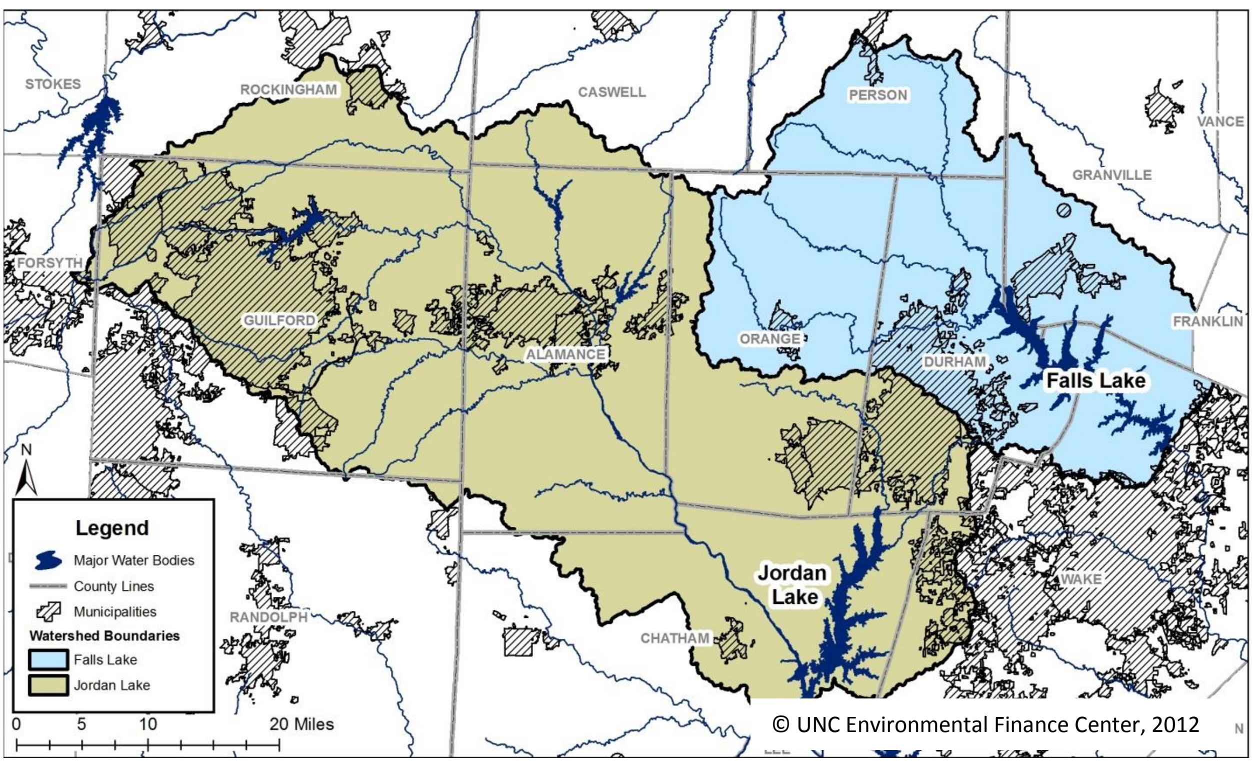
[1] http://www.seattle.gov/util/about_spu/management/strategicbusinessplan/may212012/

PROGRAM DRIVERS FOR DURHAM

Durham is North Carolina's fifth largest city, with a population of 228,330[2]. It is also a rapidly growing city, with its population growing by 22 percent between 2000 and 2010. Located in central North Carolina's Triangle Region, the city's major industries are education, health care and computer and information technology. It covers 107 square miles, making its population dispersed for an urban community and reliant on cars to move throughout the city. Median household income is $46,972, with a poverty level of 17.9 percent[3].

Water Quality: Many of Durham's streams and other water bodies fail to meet federal water quality standards and are considered impaired according to EPA definition[4]. This impairment affects the ability of Durham citizens to use these resources for fishing, swimming, and boating activities, or as sources of drinking water. Recently adopted state requirements, namely the Falls and Jordan Lake Rules, aim to encourage the City of Durham to reduce nutrient loads reaching these drinking water supplies through a range of pollutant mitigation strategies. The Falls Lake Rules were adopted in November 2010 and became effective in January 2011. The Jordan Lake Rules have been in place since 2009. The City of Durham must demonstrate a comprehensive stormwater management strategy to qualify for its NPDES permit from North Carolina's Department of Environment and Natural Resources (NC DENR) and comply with the US Clean Water Act.

FIGURE 1 FALLS LAKE AND JORDAN LAKE WATERSHEDS



---

[2] US Census 2010

[3] *ibid*

[4] Part 130 of Title 40 of the Code of Federal Regulations, section 130.7, contains the regulations currently governing the Total Maximum Daily Load program, which were issued in 1992.

Because of these rules, all new construction—including shopping centers, office buildings, and neighborhoods—must minimize the levels of water from rain events (i.e. stormwater) that run off their property and into nearby water bodies. Existing development must also participate in stormwater management programs by retrofitting properties with stormwater reduction equipment.

Water Quantity: The City of Durham's water demand is also growing, driven primarily by the growing population and expansion of water intensive facilities in the Research Triangle Park[5]. Recurring droughts in the 2000s brought attention to the need to conserve water in Durham, which led to a 12% decrease in average water use throughout the city between 1999 and 2010[6]. Despite an average decrease in water demand, the City of Durham's total water demand is projected to increase by 16% by 2020 and by 29% by 2030, necessitating supply expansion to increase the system's capacity by the year 2040[7]. A cost-effective strategy to delay capital intensive supply expansion is to continue to reduce per capita water-use across sectors, slow demand growth, and reduce peak demand. Rainwater harvesting presents one such conservation measure and one that is spurred by a strong financial incentive for the water provider.

Due to these multiple drivers of water quality protection and conservation, we identified the City of Durham as a strong case study city for assessing a distributed green asset model in the form of a utility-led rainwater harvesting program. The aim of this research project is to investigate innovative program design and funding strategies for a distributed water conservation assets in the form of rainwater harvesting systems. More specifically, we chose to model a program between the City of Durham and Durham County Schools because the public schools represent a large-scale, property owner to help the program reach necessary scale for impact. This study uses several data sources including: interviews with professionals[8], current water, wastewater, and stormwater rates, property information on Durham Public Schools, and cost and benefit estimates from the literature where such calculations did not exist specific to the Triangle Region,.

---

[5] Triangle Regional Water Supply Plan (2012
[6] *ibid*
[7] *ibid*
[8] See Table 5 in the Appendix for a list of interviewees.

A NEW MODEL FOR WATER SUPPLY PROTECTION

Financing mechanisms and funding sources for stormwater mitigation practices are developing quickly throughout the state of North Carolina as water management has come to the forefront of local and regional growth planning. At the state level, the North Carolina Department of Agriculture's Division of Water and Soil has implemented a Community Conservation Assistance Program (CCAP), wherein landowners may be reimbursed up to 75% of the pre-established cost of purchasing and installing a rainwater harvesting system, along with other water quality best management practices (BMPs). This program operates in 57 counties across the state including Durham County where it subsidized twenty-four projects in fiscal year 2012[9].

A pending program, House Bill NC 1385, was introduced in the 2009-10 legislative session with the purpose of providing a tax credit equal to 35% of the cost of buying and installing a cistern on one's property[10], but, as of this publication, has not passed. The North Carolina Division of Water Quality (DWQ) has a stormwater treatment credit that allots stormwater credits by removing the captured roof area from the percent impervious surface. The credit allows for greater 'built upon area' on newly developed land[11]. With a fairly limited state-level CCAP budget, incentives for rainwater harvesting throughout North Carolina remain minimal with a few utility-specific exceptions.

Several municipal stormwater utilities offer incentives to landowners to install stormwater mitigation BMPs, which include rainwater harvesting systems. Utilities located within the Jordan and Falls Lake watersheds are mandated under the legislated rules to reduce the pollutants discharged into these water bodies, in particular from non-point sources such as stormwater runoff. As such, the Raleigh Stormwater Utility Division runs a Water Quality Cost Share Program for property owners to improve the quality of stormwater runoff on their land. In March 2012, the City of Durham launched its Rain Catchers project providing free rain gardens, trees, and cisterns on properties in particularly environmental sensitive sections of the city. This project is funded through grants from the North Carolina Division of Water Quality and the Clean Water Management Trust Fund. As of yet, no large-scale rainwater harvesting finance or incentive programs are in place for Durham or the Triangle region.

A school district case study

Based on the background of water supply issues in North Carolina, we develop two financial models examining the financial viability of a school district-wide rainwater harvesting system from the perspective of the utility and the property owner. We evaluate which funding mechanisms would best suit this type of green infrastructure project from different vantage points and what incentives would be necessary to drive participation. A ten-year planning horizon was used to assess the program and funding options.

To simulate a rainwater harvesting public finance program for a medium-sized city, we begin by considering the program finance options for the Durham Public School System. Durham Public Schools (DPS) are owned and run by the county, a separate jurisdictional entity from the City of Durham, and therefore are considered an independent public property owner. DPS pays the City monthly stormwater fees and a commercial rate for water and wastewater service.

[9] Phone Interview with Mike Dupree, Community Conservation Assistance Program Administrator for Durham County. June 21, 2012

[10] http://www.ncleg.net/Applications/BillLookUp/LoadBillDocument.aspx?SessionCode=2009&DocNum=1055&SeqNum=0

[11] Technical Guidance: Stormwater Treatment Credit for Rainwater Harvesting Systems Revised September 22, 2008. NC DWQ

DPS owns 77 properties throughout the city. The smallest parcel is 2,300 square feet in size, with 1,900 feet of impervious surface, and the largest is an elementary school property that is over four million square feet, with about one million square feet of impervious surface. The median DPS property is roughly 700,000 square feet in size, with 158,000 square feet of impervious surface—16 percent of the total area. Thirty-eight of the properties have over 100,000 square feet of impervious surface (see Table 1).

Table 1 Impervious Surface Area of Durham County Public School Properties

	Number	Average parcel area / property (sq. ft.)	Total area (sq. ft.)	Average impervious area / property (sq. ft.)	Total impervious area (sq. ft.)	Average Imperv/Perv. Ratio (%)
All properties	76	705,037	53,582,837	158,205	12,023,573	26.4%
Small properties (0-60,693 sq. ft.)	17	17,266	293,518	5,013	85,224	32.4%
Mid-size properties (60,694-310,887 sq. ft.)	21	186,412	3,914,655	49,558	1,040,719	25.5%
Large properties (310,888-1 mill.sq. ft.)	19	715,433	13,593,216	198,542	3,772,290	28.0%
Very-large properties (over 1 mill. sq. ft)	19	1,883,234	35,781,445	375,018	7,125,341	20.5%

Data source: City of Durham

Creating these financial models required a number of assumptions about rainwater system capacity, supply, demand, runoff, and associated costs and benefits. In reality, the costs and revenues for any stormwater retrofit will depend on the existing location and conditions of the property, making each property's cashflow scenario unique. For comparison's sake, we utilize a "typical school property" in the City of Durham, and run a number of financial scenarios based on an average Durham public school. The full list of assumptions is detailed in Table 2. Stormwater retrofits of any type are highly site-specific, and various factors can affect the costs, benefits, and payback period for a given project. A few such factors include[12]:

- Property size;
- Proximity of impervious surface to green areas or rain garden;
- Elevation and slope of green areas;
- Absorptive capacity of green areas;
- Location within sensitive watershed area

To estimate the benefits of the cistern, the amount of cistern water used must be estimated. To do so, we calculate water demand-supply balance based on (1) the supply capacity of a 10,000 gallon aboveground metal cistern installed to meet the state Division of Water Quality (DWQ) technical requirements for rainwater harvesting system credit, and (2) the potential demand to supply peak season outdoor water. Due to the rainy climate in the southeast's winter and early spring, cisterns make little to no contributions to supply or runoff deductions in the "off peak season" (Nov-April). Under the North

[12] Some of these factors include those identified in a recent Natural Resource Defense Council report, "Financing Stormwater Retrofits in Philadelphia and Beyond" (2012) by Alisa Valderrama and Larry Levine.

Carolina DWQ system, rainwater harvesting does not receive stormwater credit in the winter, as the cisterns typically exceed capacity and discharge into the stormwater system.

Financing options

To evaluate the financial feasibility of various rainwater harvest financing options, two financial models were developed to generate output indicators by which to compare program options. The basic model inputs include information to evaluate an average school in the Durham County Public School system, cost information on all related rainwater harvesting components (including capital, O&M, and avoided fees), and estimates of environmental benefits of protecting water supplies through stormwater mitigation. The model can be scaled up to evaluate the feasibility for larger numbers of participating schools. The sources and exact parameters used can be found in Table 2. We use the same basic parameters in all three financial models in order to compare the financial outputs across the models. The model outputs include both financial and environmental indicators, including net present value (NPV), internal rate of return (IRR), annual cost, annual water savings, and others.

The aim of these models is to evaluate two program finance options: 1) property owner self-financed and 2) a utility-incentive finance program. We run models for both property owner and utility perspectives for the utility-incentive model. In the last scenario, we discuss alternative financing options under the utility-sponsored financed scenario including third-party ownership and on-bill financing.

<u>Scenario 1: Full property-owner financed rainwater harvesting model</u>

The property owner-financed model assumes the property owner (DPS in this scenario) has sufficient cash on hand or access to capital to fully finance a rainwater harvesting system. Under this model, DPS would self-finance, install, and operate a rainwater harvesting system on its property. This option is expensive for the property owner and results in a low internal rate of return (IRR) of 3.09%, a payback of eight years, and a negative NPV over a ten-year planning horizon (see Table 3). Under this model, the cistern is not metered, and the school therefore does not have to pay wastewater charges for the cistern water each year. The cash-on-hand option assumes the water utility has not yet developed the policies or capacity to meter cistern flow. The financial picture for this option is weak for a financially prudent property owner.

Although the educational and environmental benefits of a rainwater harvesting project may be compelling enough to install such a system, without additional incentives for the school system, the financial analysis suggests a rather poor use of already scarce capital improvement funds.

<u>Scenario 2: Utility-financed rainwater harvesting model</u>

As the public benefits of stormwater control become more valuable to cities and communities and Clean Water Act compliance becomes more stringent, municipal utilities are growing more involved in providing monetary incentives for stormwater control to private and other public land owners. Incentives aim to minimize stormwater runoff on private and non-municipal public land, with the added benefit of rainwater harvesting being to conserve water in high peak seasons. Currently, water supply and stormwater utilities (if a stormwater utility exists at all) in most cities remain separate entities under the municipal government. Cooperation between the two divisions is therefore necessary to understand impacts and implement successful programs.

Relationship with utility and utility impacts

> ***"Cisterns aren't free water" –Sally Hoyt, UNC Energy Services***

While rainwater harvesting helps conserve drinking water supply, reduce demand on reservoirs, increase overall supply capacity, and reduce the rate and volume of stormwater flows, there are also associated costs for the utility. Rainwater harvesting systems and other types of non-potable water supply systems have the potential to discharge into a utility's stormwater drainage or combined sewer overflow systems, incurring costs for treatment and disposal of that water to the utility. As such, utilities' rainwater harvesting policies often include charges for wastewater treatment. In North Carolina, Orange Water and Sewer Authority (OWASA) operates on a cost-of-service charge model and charges customers' sewer rates for all cisterns by metering the cisterns with the potential discharge volume of over 3,000 gallons per month. In most cities in North Carolina, including Durham, utilities have yet to develop rainwater harvesting policies around how to monitor and charge for utility-incurred costs. We can expect wastewater utilities to adopt rainwater system policies soon to avoid losing revenue from large-scale rainwater harvesting systems that flow into the wastewater treatment system.

A utility-financed rainwater harvesting program

The ownership arrangement of the rainwater harvesting equipment and distribution system between the builder, the property owner, and the utility depends on a number of factors[13], the first of which is the rainwater system size. Small systems, typically under 5,000 gallons, are not of the scale to impact utility capacity and are too minor to make financial sense for a utility to own or maintain. Larger systems however, have greater impacts on both water supply and stormwater runoff potential and fall in line with the core expertise of the utility. This leads to the second consideration—the operation and maintenance capacity of the property owner, and the utility staff. In cases where the land owner is a large institution with plumbing and grounds maintenance capacity to maintain and repair cisterns, the property owner may prefer to retain ownership of the system. In the case of the University of North Carolina's Chapel Hill campus, the university decided to transfer ownership of the equipment to OWASA, but the university's Energy Services Department retained responsibility for maintaining the equipment[14]. In other cases, the utility may not have staff capacity to take on additional maintenance responsibilities. This arrangement is decided between the property owner and the water utility and is key to long-term program success.

The Durham County Public School system falls within the institutional sector, with large areas of property and existing operational staff that could receive training to maintain a rainwater harvesting system. School systems, large medical facilities, universities and other institutions present a viable partner for utilities to pilot rainwater harvesting and other stormwater management practices as institutions seek cost effective ground-maintenance strategies, while also valuing environmental stewardship and good relations with municipalities as they look to expand facilities.

---

[13] Interviews with Sally Hoyt, Kathy DeBusk and Mitch Woodward contributed to these findings.
[14] Water Environment Research Foundation (2010) "When to Consider Distributed Systems in an Urban and Suburban Context"

Incentives

As demonstrated by the no-incentive financial model above, assisting private and non-municipal public property owners in paying for expensive rainwater harvesting systems is helpful to spur land owners to install these systems, allowing the city to realize the environmental benefits of this type of distributed green infrastructure. Financing for stormwater retrofits in general, and rainwater harvesting systems specifically, has only recently begun to gain traction as a necessary strategy to bring green infrastructure stormwater mitigation plans to scale in the nation's cities[15]. Popular forms of incentives include rebates on portions of the costs of installation (i.e., Philadelphia, Portland, and Chicago) and property tax credits (i.e., New York City).

In evaluating the financial feasibility of an incentive-based program, we present two financial models. The models present the perspectives of the utility and the property owner in order to see how investments in a rainwater harvesting system over a ten-year planning horizon would look for different stakeholders. We assume a one-time cash rebate covering 15% of project cost, fully distributed within the first year of installation (see Table 4). At this relatively low incentive amount, the project financials have strong returns for both the utility and the property owner, with an internal rate of return of 21% and 6.5% respectively. Net present values are positive for both parties as well. Using these project parameters, any incentive amount higher than 15% results in a negative financial outcome for the utility.

Alternative utility financing options

Aside from the amount of funds provided, innovative financing mechanisms can be used to leverage capital sources and minimize financial risks to the stakeholders.

On-bill financing and repayment are two alternative financing mechanisms to provide a capital pool through which a utility could loan money to property owners. Based on the on-bill energy retrofit program models utilized throughout the state and the country, a similar program could be applied to finance rainwater harvesting systems. Initially, this program would require a pool of startup funds from a grant, private investor, bond, or reserves to be lent to utility customers and repaid as part their water or stormwater bill.

Several options exist for forming the repayment amounts. The utility could calculate the difference in the customers' water charges and stormwater fees and charge them an average of this monthly amount in order to avoid a higher bill than the pre-rainwater harvest system. The payment could also be simply based on a typical loan repayment schedule for a specified number of years, in which case the customer would separately receive stormwater credits and the reduced water bills.

Similar to on-bill energy efficiency programs, the rainwater harvesting loan can be fixed to the property and thus transfer to future property owners, reducing a disincentive price signal to the current owner. To stimulate demand for the program, more attractive terms can be targeted to the cities' most environmentally sensitive areas to make such private investment on property a more financially attractive option to land owners.

Under the on-bill finance option, another version of such a program involves third-party ownership of the cistern system, wherein the private third party investor provides the initial capital for the system and enters a contractual agreement with the utility to receive a predetermined amount from each

[15] City of Seattle / EPA consent case

participating customer's bill in order to recover the capital costs[16]. To make this program attractive for private investors, the recovered costs must at least cover the upfront costs of capital for the rainwater harvest system, and they must also cover the administrative costs incurred to the utility plus a return on investment through the on-bill fees.

As seen in the experiences of energy efficiency retrofit finance programs, a lack of clear regulatory requirements over the loans or stormwater directives leaves utilities unclear about administering such programs and what risks may be incurred. As such, some cities (Honolulu and Charleston) have outsourced similar financing programs for energy to local community lending institutions whose core expertise lies in lending and underwriting criteria.

The options for structuring public-private financing to support rainwater harvesting and other forms of distributed stormwater infrastructure are currently in a nascent stage in the United States. From the utility perspective, partnering with both financial institutions and large-scale property owners to provide creative financing mechanisms for rainwater harvesting appears to make both financial and environmental sense for utilities. Whether the financing mechanism is a traditional loan or made via a third party investor, utility participation can form a bridge between lenders and property owners to drive up investment in rainwater harvesting systems.

THE VIABILITY OF A UTILITY SPONSORED RAINWATER HARVESTING PROGRAM

Capturing rainwater in underground or above ground cisterns allow for irrigation without using more expensive potable drinking water, while also decreasing polluting stormwater runoff from entering nearby waterways. There is little doubt that rainwater harvesting systems contribute to environmental quality in a number of ways, however the costs and maintenance associated with installing and using cistern have limited their widespread adoption. The low cost of water in the southeast also minimizes the potential cost savings. This paper uses Durham Public School System and City of Durham water and stormwater utilities to introduce a number of innovative program structures and finance mechanisms. Although a fully self-financed cistern installation does not perform well financially, modest incentives offered through the city utility can create a financially viable program structure – for both the school property owners and the utilities. Third – party ownership, on-bill financing and other public private partnership arrangements present alternative financing arrangements to spread risk to cistern program financing and leverage limited capital resources.

The findings of this study present a case for the viability of a utility-based incentive program for rainwater harvesting, under a few conditions.

- Integration, or at least close cooperation of stormwater and water utilities is necessary to coordinate such a program – in particular issuing stormwater credits, metering cisterns, and monitoring cistern performance.
- A viable public –private rainwater program must build upon existing "to-scale" properties to meet performance goals. Large property owners and institutions (i.e. schools, medical facilities, and universities) are strong candidates for cistern partners as they can help the city achieve scale in stormwater mitigation and conservation efforts and also have capacity for plumbing and

[16] For more information on this option, see the NRDC report, "Financing Stormwater Retrofits in Philadelphia and Beyond" (2012) by Alisa Valderrama and Larry Levine. Natural Resources Defense Council

grounds maintenance to operate the cistern systems. Small-scale installations can be built, but won't be under the city's monitoring or performance evaluations.

- Both public and private capital are necessary to make a viable financial case for cistern installation – given the both private and public benefits of cisterns tailoring of finance programs to bring both sources of capital to the table will create a viable path forward for more widespread adoption of rainwater harvesting systems.

APPENDICES – TABLES AND MODELS

Table 2. Model Assumptions & Sources

	Median	Unit	Source & notes
Property size	327,659	sq. ft	City of Durham
Impermeable surface area	104,035	sq. ft	City of Durham
Rooftop area (20% of total area)	65,000	sq. ft	
Discount rate	5%	per anum	OMB
Installed tank capacity (above ground)	10	thousand gallons	
Target water supply % (peak season)	83%	percent of outdoor demand	NC Climate Office & Mike Ruck. For the peak season (May - Oct.)
Water supply (based on cistern size, rooftop drainage, and rainfall)	32,500	gallons per month	
Capital cost (above ground tank) - equipment & installation	$ 2.50	$ / stored gallon	Bobby Feller (Green Horizon Developers)
Incentive Amount	15%	percent of capital cost	
Water Charge (@target water supply point)	$ 330	per month	commerical irrigation rate for 3" meter
Sewer charge (@target water supply point)	$ 258	per month	commerical irrigation rate for 3" meter
Delayed capacity expansion	10	years	CUWCC Model
Utility avoided capacity costs: peak season	$ 200	$ / acre foot	based on San Antonio Program manual
O & M costs	$ 2.75	$ / thousand stored gallons	Source: Sally Hoyt UNC Energy Services
Stormwater fee rate	$ 9.68	$ / 2400 feet of impermeable surface per year	City of Durham; median is actual 2012 rate
Cost of capital (interest rate)	3%	per annum	
Environmental benefits of water left in rivers	$ 1.25	per kgal saved	California Urban Water Conservation Council
Estimated Public Stormwater Savings (avoided stormwater penalties at the property level)	$ 500	per property per month	This number is an estimate of avoided stormwater penalties from the NCDENR and EPA based on actual stormwater penalties assesed to NC properties in 2010 and 2011. Source: NC DENR DWQ.
Escalation rates (water, wastewater, energy)	5%		
Rate of inflation	2.05%	per year	Bureau of Labor and Statistics

Table 3. Scenario A- Property Owner - Self Financed Model

Modeling of Distributed Rainwater Harvesting Program Scenarios											
Scenario 1: Outdoor Water Use Only - Small Scale - 1 Above Ground Tank											
Property Owner Perspective:	for 1 school		10,000 gallon tank								
						Year					
	0	1	2	3	4	5	6	7	8	9	10
Cash in											
Avoided water costs (water charge * volume per month *6*escalation rate)	$ 1,980	$ 2,079	$ 2,183	$ 2,292	$ 2,407	$ 2,527	$ 2,654	$ 2,786	$ 2,926	$ 3,072	$ 3,226
Avoided Stormwater fee payments (rate per 2400 sq feet * impervious surface * escalation rate)	$ 420	$ 441	$ 463	$ 486	$ 510	$ 536	$ 563	$ 591	$ 620	$ 651	$ 684
Annual cash in:	**$ 2,400**	**$ 2,520**	**$ 2,646**	**$ 2,778**	**$ 2,917**	**$ 3,063**	**$ 3,216**	**$ 3,377**	**$ 3,546**	**$ 3,723**	**$ 3,909**
Running cash in:	**$ 2,400**	**$ 4,920**	**$ 7,566**	**$ 10,345**	**$ 13,262**	**$ 16,325**	**$19,541**	**$22,918**	**$26,464**	**$30,188**	**$34,097**
Cash out											
Initial Capital Costs	$ 25,000	-	-	-	-	-	-	-	-	-	-
O&M (with escalation rate)	$ 330	$ 347	$ 364	$ 382	$ 401	$ 421	$ 442	$ 464	$ 488	$ 512	$ 538
Annual cah out:	**$ 25,330**	**$ 347**	**$ 364**	**$ 382**	**$ 401**	**$ 421**	**$ 442**	**$ 464**	**$ 488**	**$ 512**	**$ 538**
Running cash out:	**$ 25,330**	**$ 25,677**	**$ 26,040**	**$ 26,422**	**$ 26,823**	**$ 27,245**	**$27,687**	**$28,151**	**$28,639**	**$29,151**	**$29,688**
Cumulative cash flow:	**($22,930)**	**($20,756)**	**($18,474)**	**($16,078)**	**($13,562)**	**($10,920)**	**($8,146)**	**($5,233)**	**($2,174)**	**$1,037**	**$4,409**
Annual net cash flow:	**($22,930)**	**$2,174**	**$2,282**	**$2,396**	**$2,516**	**$2,642**	**$2,774**	**$2,913**	**$3,058**	**$3,211**	**$3,372**

IRR:	3.09%	**Annual Monetary savings ($ / year)**	$ 401
NPV:	($2,123)	**Payback (years)**	9
Capital Cost:	$ 25,000	**Total Water savings (gallons)**	1,950,000

Note: Assumed lack of utility meter & sewer charge for cisterns.

Table 4. Scenario 2. Utility - Incentive based program

Model for Utility - led Distributed Rainwater Harvesting Program
Outdoor Water Use Only - Small Scale - 1 Above Ground Tank 10,000 gallon storage capacity

Utility Perspective	**for 1 school**										
						Year					
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Costs											
PEAK: Lost Water Revenue (water charge * volume per month *6*escalation rate)	$1,980	$2,079	$2,183	$2,292	$2,407	$2,527	$2,654	$2,786	$2,926	$3,072	$3,226
Stormwater fee reductions (rate per 2400 sq feet * impervious surface * escalation rate)	$420	$441	$463	$486	$510	$536	$563	$591	$620	$651	$684
Incentive to cover Capital Costs	$5,250	-	-	-	-	-	-	-	-	-	-
Cost of capital	$0	$158	$158	$158	$158	$158	$158	$158	$158	$158	$158
Annual Costs:	**$7,650**	**$2,678**	**$2,804**	**$2,936**	**$3,075**	**$3,221**	**$3,374**	**$3,535**	**$3,703**	**$3,881**	**$4,067**
Benefits											
Direct Avoided Costs from conservation ($200 / acre feet saved per month* 6 * escalation rate)	1,197	1,257	1,320	1,386	1,455	1,528	1,604	1,684	1,768	1,857	1,950
Environmental Benefits of Conserved Water	244	244	244	244	244	244	244	244	244	244	244
Public Stormwater Savings (avoided penalties * 3 *escalation rate)	2,000	2,100	2,205	2,315	2,431	2,553	2,680	2,814	2,955	3,103	3,258
Annual Benefits:	**3,441**	**3,600**	**3,768**	**3,945**	**4,130**	**4,324**	**4,528**	**4,742**	**4,967**	**5,203**	**5,451**
Cumulative NPV:	**(4,209)**	**(3,331)**	**(2,455)**	**(1,584)**	**(716)**	**148**	**1,009**	**1,867**	**2,722**	**3,575**	**4,425**
Cumulative Cash flow:	**(4,209)**	**923**	**965**	**1,009**	**1,055**	**1,103**	**1,154**	**1,207**	**1,263**	**1,322**	**1,384**

IRR:	21.7%	**Benefit Cost Ratio:**	1.18
NPV:	$ 4,425	**Payback (years):**	5
Annualized Cost ($ / year):	$ 3,720	**Annualized Water savings (MG / yr)**	1.95
Annualized Benefit ($ / year):	$ 4,373		

Property Owner Perspective	**for 1 school**										
Cash in											
Avoided water charge (water charge * volume per month *6*escalation rate)	$1,980	$2,079	$2,183	$2,292	$2,407	$2,527	$2,654	$2,786	$2,926	$3,072	$3,226
Avoided Stormwater fee payments (rate per 2400 sq feet * impervious surface * escalation rate)	$420	$441	$463	$486	$510	$536	$563	$591	$620	$651	$684
Incentive (15% * capital amount)	$3,750	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Annual Cash in:	**$6,150**	**$2,520**	**$2,646**	**$2,778**	**$2,917**	**$3,063**	**$3,216**	**$3,377**	**$3,546**	**$3,723**	**$3,909**
Cumulative Cash in:	**$6,150**	**$8,670**	**$11,316**	**$14,095**	**$17,012**	**$20,075**	**$23,291**	**$26,668**	**$30,214**	**$33,938**	**$37,847**
Cash out											
Initial Capital Costs	$25,000	-	-	-	-	-	-	-	-	-	-
O&M (with escalation rate)	$330	$347	$364	$382	$401	$421	$442	$464	$488	$512	$538
Annual cash out:	**$25,330**	**$347**	**$364**	**$382**	**$401**	**$421**	**$442**	**$464**	**$488**	**$512**	**$538**
Cumulative cash out:	**$25,330**	**$25,677**	**$26,040**	**$26,422**	**$26,823**	**$27,245**	**$27,687**	**$28,151**	**$28,639**	**$29,151**	**$29,688**
Annual net cash flow:	**($19,180)**	**$2,174**	**$2,282**	**$2,396**	**$2,516**	**$2,642**	**$2,774**	**$2,913**	**$3,058**	**$3,211**	**$3,372**
Cumulative cash flow:	**($19,180)**	**($17,006)**	**($14,724)**	**($12,328)**	**($9,812)**	**($7,170)**	**($4,396)**	**($1,483)**	**$1,576**	**$4,787**	**$8,159**

IRR:	6.5%	**Annual Monetary savings ($ / year)**	$2,734
NPV:	$1,448	**Payback (years)**	8
Capital Cost:	$21,250	**Total Water savings (gallons)**	1,950,000

Table 5 Experts Interviewed

Last name	First name	Organization
Patterson	Robert	NC DENR
Henshaw	Julie	NC Division of Soil and Water Conservation
Dupree	Mike	Durham County Division of Soil and Water Conservation
Ruck	Mike	Rainwater Solutions
Hoyt	Sally	UNC Energy Services
Kandis	Danny	Centrex Properties, inc
Ortosky	Mike	Earthwise Company
Woodward	Mitch	State Agricultural Extension Offices
DeBusk	Kathy	North Carolina State University
Ferrell	Bobby	Green Horizon Developers
Buzun	Jennifer	City of Durham Stormwater Division