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Rainwater Harvesting: Legal Frameworks in the United States, Singapore and Other Countries

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RAINWATER HARVESTING: LEGAL FRAMEWORKS IN THE UNITED STATES, SINGAPORE, AND OTHER COUNTRIES[1]

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ABSTRACT

With increasing climate change effects worldwide, rainwater harvesting is likely to become more and more important to ensure reliable alternative water supply and to conserve the environment. This article examines two goals to be accomplished through rainwater harvesting: (1) augmenting water supply for proposed development's use through regulations that have been formulated to make the proposed development responsible for at least a portion of the water supply needed to support the new development; and (2) managing stormwater runoff. The results show that many, perhaps most, rainwater harvesting programs, as exemplified by efforts in Singapore and elsewhere around the world, succeed in accomplishing both goals while also serving as effective climate change adaptation strategies.

KEYWORDS: rainwater harvesting, surface water runoff, stormwater, water conservation, Singapore

I. INTRODUCTION: RAINWATER HARVESTING

Water shortage is a common phenomenon in the United States and throughout the world. Often, the shortage is climate-based, either because of consistently modest annual rainfall or periodic droughts. In fact, climate change has been deemed one of the major factors in rainfall distribution, affecting water supply and demand, and likely to worsen water security. By 2050, over half of the global population is predicted to experience severe water shortages if no adaptation or

[1] This paper is an edited, updated and expanded version of Julian Conrad Juergensmeyer, "Rainwater Recapture: Development Regulations Promoting Water Conservation," 43 J. Marshall L. Rev. 359 (2010).

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mitigation actions, such as rainwater harvesting, are undertaken.[3] Rainwater harvesting entails capturing, diverting, and storing rainwater for various later uses, including landscaping, stormwater control, fire protection, plumbing, or consumption. Many countries around the world are already harvesting rainwater, with Singapore serving as a leading example, as discussed in Section III.

Whatever the cause or duration of a water shortage, one of the simplest methods many residents use to collect and conserve water is the use of rain barrels. Catching rainwater at your own home is often viewed as one of the easiest and least expensive ways to conserve water. For generations, home gardeners have put a bucket outside during a rainstorm and then later used the collected rainwater to water house plants or outdoor vegetable gardens and flower beds.

Of course, using one bucket of rainwater to water plants may not cut back water use in a dramatic way; however, the potential significance of rainwater catchment is determined by how much water can be caught. The formula for calculating the quantity of rainwater that can be caught from a building's roof is:

(1) to multiply the length of the roof by its width to get the area;

(2) to multiply the roof area by the inches of average annual rainfall; and

(3) to multiply that number by 0.623, which will provide the gallons of water that can be captured annually.[4]

The result can be surprisingly large. For example, if the roof area of a single-family residence is 2,000 square feet and the average annual rainfall is 50 inches, then approximately 62,000 gallons a year can be captured. The average domestic consumption for that living unit, consisting of an average family of four, would be approximately 400 gallons per day or 146,000 gallons per year. If one considers the extensive roofs of many public, industrial, and commercial buildings, it becomes evident that rainwater capture is not just a drop in the bucket![5]

The amount of rainwater that can be caught depends not only on how much is available (i.e., roof size and annual rainfall), but also on the equipment employed. Moving up from the bucket, rain barrels provide water on a larger scale. More meaningful quantities of rainwater can be harvested if a cistern is used. A cistern is

[3] Md Mahmudul Haque, Ataur Rahman, Bijan Samali, *Evaluation of Climate Change Impacts on Rainwater Harvesting*, 137 JOURNAL OF CLEANER PRODUCTION 60-69 (Nov 20, 2016), https://www.sciencedirect.com/science/article/pii/S095965261630926X.

[4] Doug Pushard, *Rainwater Harvesting: Frequently Asked Questions*, HARVESTH20.COM, http://www.harvesth2o.com/faq.shtml (last visited September 18, 2017).

[5] *See* AMERICAN RAINWATER CATCHMENT SYSTEMS ASSOCIATION, http://www.arcsa.org (last visited Sept. 18, 2017) (pointing out ways that the American Rainwater Catchment Systems Association promotes rainwater catchment).

a storage tank for the rainwater that is collected. In contrast to rain barrels, cisterns hold a larger amount of rainwater and allow a place for it to be stored until the water is needed. Before public water was available in rural and even suburban areas, cisterns were common substitutes or supplements to private wells. While developments in remote areas may still use them in this context, today they are used in many areas of the country to reduce the amount of public water needed. While cisterns have been a good alternative for many municipalities, they do have their problems. The main issue, other than cost, when using a cistern is how fast the water that has been collected and stored can be utilized. If the water from one rainfall fills up the cistern and that water is not quickly used, the cistern will be full during the next rainfall and no water will be collected. While the cistern conserves water and prevents wasted rainwater during the first rain, all of the rain that falls during the second storm will be completely lost. In order for a cistern to be effectively used, it should service an area capable of depleting the water supply quickly enough for the cistern to be effective during the next rainfall. An example of a land use where a cistern would be highly effective is commercial buildings.[6] Apartment buildings, office buildings, and hotels are also areas that have the capacity to deplete the water supply in the cistern very quickly. If the water in the cistern were used for toilet flushing, then any of these land uses listed above should have a high enough water demand to deplete the cistern supply. In contrast, a small business that may only have 10-15 employees would not likely have enough demand to effectively use the cistern.

Another and more innovative approach to conserving water through rainfall capture is through the use of "green roofs." A green roof in simple terms is exactly what it sounds like: a roof that has at least some vegetation rather than all impermeable roofing materials. When there is a heavy rainfall in a city that consists of buildings with traditional roofs, all of the rain that falls on the rooftops runs off into the city streets. Conversely, a green roof absorbs some of the water and stores it for later use. In addition to absorbing and storing water, it also slows down and filters the water it does not store and thereby not only provides a source of water for the building but also manages runoff.[7] The main issue developers and residents face with green roofs is cost. While lower energy bills over the life of a green roof ultimately save money, it is often difficult to convince a developer or owner of a building that the initial cost of the green roof is economically appealing.

Since water management plays a huge part in the sustainability of a development, it is no surprise that certain jurisdictions are promoting relevant goals

[6] Eric W. Strecker & Aaron Poresky, *Stormwater Retention on Site*, THE WATER REPORT, July 15, 2009, at 1, 8.
[7] Verlyn Klinkenborg, *Up on the Roof*, NAT'L GEOGRAPHIC MAG. (May 2009), http://ngm.nationalgeographic.com/2009/05/green-roofs/klinkenborg-text.

through regulation. This article examines two goals to be accomplished through rainwater harvesting: (1) augmenting water supply for proposed development's use through regulations that have been formulated to make the proposed development responsible for at least a portion of the water supply needed to support the new development; and (2) managing stormwater runoff. Many, perhaps most, rainwater harvesting programs succeed in accomplishing both goals while also serving as effective climate change adaptation strategies. With increasing climate change effects worldwide, rainwater harvesting is likely to become more and more important to ensure reliable alternative water supply and to conserve environment.

II. RAINWATER HARVESTING IN THE UNITED STATES

1. LEGAL FRAMEWORK

The traditional common law view of water rights based on reasonable use by all riparian (relating to or located on the banks of a river or stream) land owners seems to have nothing negative to say about rainwater capture.[8] However, water rights under prior appropriation laws, largely seen in the western United States, have traditionally been negative toward allowing individuals to catch and use rainwater for their own personal use.[9] In some western states, rainwater recapture is still heavily restricted, and in Nevada it is still illegal. With circumstances today such as drought, the need to be more energy-efficient, and the green movement, the idea that it is illegal to use rainwater may seem counterintuitive. However, if one looks at the problem from another perspective, it becomes clear where this idea got its force.

The hostility toward rainwater capture is firmly grounded in the prior appropriations water law theory of "first in time, first in right."[10] Water is a finite resource. When one landowner decides to take advantage of the rain falling at his house, he is preventing this rain from entering streams that flow downstream to other landowners. Downstream landowners are left with less and less water. In essence, if the downstream owners have a superior right to a certain quantity of water which would be decreased by upstream capture, the upstream rainwater harvester is effectively taking water that does not belong to him. Put another way,

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[8] *See generally* A. Dan Tarlock, LAW OF WATER RIGHTS AND RESOURCES § 3.11-3.13 (2009) (summarizing water rights of riparian owners).

[9] *See generally* Lincoln L. Davies, *East Going West? The Promise of Assured Supply Laws in Modern Real Estate Development*, 42 J. MARSHALL L. REV. 319 (2010) (discussing prior appropriations law as it relates to rainwater catchment).

[10] *See, e.g.*, *Nevada Water Law 101*, NEV. DEP'T OF CONSERVATION & NATURAL RES., http://dcnr.nv.gov/documents/documents/nevada-water-law-101/ (last visited Sept. 25, 2017) (Nevada's explanation of its "first in time, first in right" system in the context of its Prior Appropriation System).

rain does not belong to a particular person; it belongs to the watershed in which it falls.

In Nevada, the driest state in the country, and a prior appropriations state, it is illegal for an individual to collect rainwater without a water right permit.[11] In 2017, Senate Bill 74 was introduced which stated that "precipitation may be collected without a water right . . . from the rooftop of a single-family dwelling for domestic use."[12] However, this provision regarding rainwater recapture was stripped from the final version of the bill that was eventually signed into law.[13] Although technically illegal, a spokesperson for the Nevada Department of Conservation & Natural Resources recently stated that "the Division of Water Resources has not, and does not plan to police rain barrels."[14]

Several western states, with water laws based on prior appropriation concepts as previously discussed, have various restrictions on rainwater recapture. For example, until 2009, all forms of rainwater harvesting in Colorado were illegal, based on the state's strict application of the prior appropriation doctrine.[15] In 2009, Colorado enacted two statutes that allowed individuals to implement rainwater catchment systems.[16] While this has been a step forward, the statutes include significant limitations. For one, if an individual has access to city water, then he or she cannot legally catch rainwater. Only those not serviced by a domestic water system that services at least three domestic dwellings qualify for a permit to install a rainwater catchment system.[17] Moreover, Colorado only allows permits to be issued for buildings used "primarily as a residence."[18] If a Colorado resident plans on using the collected water for irrigation purposes, he or she can only do so on up to a one-acre parcel of land.[19] In 2016, Colorado enacted a third statute that supplements the two rainwater harvesting laws from 2009 and relaxes the residential rainwater harvesting restrictions.[20] Still, the 2016 statute limits the collection systems to two rain barrels with a maximum combined storage capacity of 110 gallons; rainwater can only be collected via the gutters and downspouts attached to the roof of a single-family residence or multi-family residence with not

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[11] *See* NEV. REV. STAT. § 533.030 (2017).
[12] S.B. 74, as introduced, 79th Leg. (Nev. 2017).
[13] S.B. 74, as enrolled, 79th Leg. (Nev. 2017).
[14] Mark Robison, *Update 2: Can Nevadans collect rain in barrels? No*, RENO GAZETTE-J., May 26, 2015, http://www.rgj.com/story/news/2015/05/26/ask-rgj-can-nevadans-collect-rain-barrels/27983037/
[15] *See* COLO. REV. STAT. § 37-90-105 (2008), *see also* Stephen N. Bretsen, *Rainwater Harvesting in Colorado and the Quandary of a Taking*, 4 TEX. A&M J. PROP. L. 165, 172.
[16] *See* COLO. REV. STAT. § 37-90-105(1)(f), § 37-60-115(6) (2017).
[17] COLO. REV. STAT. § 37-90-105(f)(I).
[18] *Id.*
[19] *Id.* § 37-90-105(f)(I)(D).
[20] COLO. REV. STAT. § 37-96.5-103(1) (2016); *see also*, STEPHEN N. BRETSEN, *supra*, at 176.

more than four units; lastly, the collected water can only be used for outdoor purposes on the property where it was collected.[21] The State Engineer has authority to curtail rain barrel usage and must monitor and report to the General Assembly on the impact of rainwater harvesting on downstream water rights.[22]

In 2010, Utah followed suit by passing Senate Bill 32, which legalized rainwater recapture.[23] Like Colorado, Utah imposes restrictions on rainwater harvesting. In Utah, an individual is limited to installing two rainwater tanks with a maximum capacity of 100 gallons each.[24] Alternatively, an individual can register for the capture and storage of rainwater with the State Engineer, whereby the limit is increased to 2,500 gallons combined.[25] As a prior appropriation state, Utah seeks to keep rainwater recapture small in scale in order to limit its impact on the state's existing water rights regime.

One might ask what has brought on this change in thinking from the traditional water rights view to the current rainwater harvesting view. A common theme in many of the jurisdictions that have implemented such programs and embraced change is drought. When water supply is down, conservation becomes the most important method of maintaining the amount of water available. Another reason why water conservation has become more acceptable is the "green movement." People today are more aware of the toll their actions take on the environment. As people have become more environmentally conscious, they have started to change their thinking. Conserving natural resources is a major tenet of the green movement, and water conservation is one key area everyone can implement in order to lessen his or her burden on the environment.

The last factor that may bring about more water conservation is today's overall economic environment. Individuals who can cut down on their water bill will be more inclined to do so. Just as more individuals are trying to save money, so too are municipalities. Municipalities maintain stormwater and sewer systems at a cost. By promoting individual water conservation and decreasing the load of stormwater runoff, the cost of maintaining these systems is reduced. Although all of these ideas may have contributed to a change in thinking regarding water conservation, each jurisdiction may have more individualized reasons for enacting water conservation regulations.

2. INNOVATIVE PROGRAMS

[21] COLO. REV. STAT. § 37-96.5-103(1) (2016); *see also*, STEPHEN N. BRETSEN, *supra*, at 178-79.
[22] *Id.*
[23] S.B. 32, 58th Gen. Sess. (Utah 2010).
[24] UTAH CODE ANN. § 73-3-1.5(4) (2017).
[25] *Id.* § 73-3-1.5(3).

A. Prescott and Tucson, Arizona

Prescott, Arizona, has an extremely comprehensive ordinance regarding water conservation. The ordinance has both mandatory and incentive characteristics. The mandatory portion requires all new construction to conform to specific water conservation requirements. When a homeowner in an existing home replaces fixtures in his or her home, these replacements must comply with certain water conservation requirements. The ordinance specifies the type of urinals, showerheads, and faucets to be installed within a building. In addition, bathrooms in commercial buildings used by the general public must meet strict water conservation guidelines.[26]

The incentive portion of the program is quite innovative. The ordinance provides a list of options that homeowners can implement to improve water efficiency. The homeowner then gets to pick and choose which ideas he or she would like to employ. The options include everything from relatively minor installations to large projects. Minor changes include installing low flow toilets and showerheads that do not exceed 2.4 gallons of water per minute. Larger options include converting to an automatic drip system for landscaping and installing rainwater cisterns.[27] Each option allows for a maximum award. Homeowners know exactly how much money they are entitled to receive for implementing an option. Homeowners receive the award through their water companies; when the water bill arrives, there is a credit for the amount of money due in incentives.[28]

Tucson, Arizona's ordinance employs a mandatory water conservation program. The ordinance was implemented on June 1, 2010.[29] The ordinance requires a developer to create a rainwater harvesting program. When submitting commercial development plans, the rainwater harvesting plan must also be submitted. The rainwater harvesting plan must include a budget and an implementation process.[30] The implementation process must specify the process by which water used for on-site landscaping will be metered. Within three years of the issuance of a certificate of occupancy by the City of Tucson, the commercial development must account for fifty percent of its landscape water demand with rainwater that is harvested on-site.[31]

B. Albuquerque, New Mexico

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[26] PRESCOTT, ARIZ., CODE § 3-10-3 (2017).
[27] *Id.* § 3-10-8.
[28] *Id.* § 3-10-8(F).
[29] TUCSON, ARIZ., CODE § 6-188 (2017).
[30] *Id.* § 6-182(A).
[31] *Id.* § 6-183(B).

Albuquerque began its comprehensive water conservation program in 1995, when studies showed its underground water supply was being depleted.[32] As part of its plan, the Albuquerque Bernalillo County Water Utility Authority (ABCWUA) offers rebates for rainwater harvesting, installation of low-flow appliances, planting trees, and xeriscaping, or replacing grass with a more natural desert landscape.[33] For rainwater harvesting, these rebates range from fifty dollars for the installation of a 150 gallon tank, to 150 dollars for a 1500 gallon tank.[34] Since the program's inception, Albuquerque has seen a decrease from 251 gallons per person per day to 135 in 2013.[35] The ABCWUA is currently seeking to "develop a program to encourage installation of rainwater harvesting systems beyond the current rain barrel rebate program."[36]

C. Austin and San Antonio, Texas

In 2012, Texas passed a law encouraging municipalities to promote rainwater harvesting through incentive programs.[37] It also established the Texas Water Development Board to ensure that members on the staffs of municipalities were trained on rainwater harvesting.[38] The City of San Antonio offers both subsidies on the cost of rain barrels and a rebate program for cisterns.[39] The City of Austin offers rebates of up to five-thousand dollars for the installation of rainwater recapture systems.[40]

D. Yankeetown, Florida

One community that has really confronted the issue of water conservation and has already implemented a variety of measures to preserve water is Yankeetown, Florida. The Town of Yankeetown Comprehensive Plan contains a policy that all new planned unit developments, subdivisions, and commercial development in every land use district must utilize "low impact development"

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[32] Steve Miller, *Albuquerque's Aggressive Water Programs Make a Difference*, HARVESTH20, http://www.harvesth2o.com/alb.shtml (last visited Sept. 21, 2017).
[33] *Conservation & Rebates*, ALBUQUERQUE BERNALILLO CNTY. WATER UTIL. AUTH., http://www.abcwua.org/Outdoor_Rebates.aspx (last visited Sept. 21, 2017).
[34] *Id.*
[35] ALBUQUERQUE BERNALILLO CNTY. WATER UTIL. AUTH., 2024 WATER CONSERVATION PLAN GOAL AND PROGRAM UPDATE (2013), http://www.abcwua.org/uploads/files/2024_Water_Conservation_Plan_Update.pdf.
[36] *Id.*
[37] TEX. LOC. GOV'T CODE § 580.004 (2017).
[38] *Id.*
[39] *Outdoor Programs & Rebates*, SAN ANTONIO WATER SYS., http://www.saws.org/Conservation/Outdoor/RainHarvesting.cfm# (last visited Sept. 21, 2017).
[40] AUSTIN WATER, RAINWATER HARVESTING RESIDENTIAL/ COMMERCIAL REBATE, http://www.austintexas.gov/sites/default/files/files/Water/Conservation/Rebates_and_Programs/Rainwater_Harvesting_Rebate_Guidelines_and_Application.pdf (last updated May 17, 2017).

("LID") practices.[41] There are many water conservation methods included in these practices. One practice is to use green roofs and rain barrels where feasible. Another method is to utilize porous pavement. It is also suggested that water be conserved by utilizing stormwater that has accumulated in ponds to irrigate the landscape. Under the policy, each of these methods must be connected in a treatment "train" with effluent from one process entering as influent into the next management practice to achieve even greater nutrient reduction.[42]

Yankeetown also created what is known as commercial water-dependent land use districts.[43] Only certain types of low-to medium-intensity commercial development are allowed in these districts. These districts are used to promote "water-dependent" uses such as commercial and recreational fishing. Hotels, motels, and resorts are allowed, but are required to include additional features as "water-enhanced" uses, including perpendicular and parallel walkways providing public access to the waterfront, or a rebuttable presumption is created that such hotel, motel, or resort can be located elsewhere on upland non-waterfront parcels and still meet its basic purpose.[44] These districts promote water conservation by requiring that any commercial development in the district may not have more than fifty percent of impervious surface on its parcel of land.[45] By requiring that most of the land be free of impervious surface, the law allows for less rainwater runoff because more stormwater can be absorbed by the pervious surface of the land while stormwater falling on impervious surfaces is captured and treated by other LID mechanisms such as a rain barrel or a green roof.

E. LEED Guidelines

The U.S. Green Building Council developed Leadership in Energy and Environmental Design (LEED) Guidelines in 2000.[46] Since then, LEED guidelines have helped jurisdictions set up their own water conservation ordinances. LEED is a third-party certification program and a tool that can be used for all types of buildings. LEED guidelines cover new construction as well as major renovations. It also covers buildings such as schools, homes, commercial interiors, and existing buildings. A building will be LEED-certified if the building receives sufficient points.[47] One hundred possible points are available. There are seven categories in

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[41] TOWN OF YANKEETOWN COMPREHENSIVE PLAN, Policy 1.1.1.3.
[42] *Id.*
[43] *Id.* at Policy 1.1.2.8.
[44] *Id.* at Policy 1.1.2.8.7.
[45] *Id.* at Policy 1.1.2.8.2.
[46] Cecilia Shutters & Robb Tuft, *LEED by the Numbers: 16 Years of Steady Growth*, U.S. GREEN BLDG. COUNCIL, May 27, 2016, https://www.usgbc.org/articles/leed-numbers-16-years-steady-growth.
[47] *LEED*, U.S. GREEN BLDG. COUNCIL, https://new.usgbc.org/leed (last visited Sept. 21, 2017).

which buildings can receive points. Once a building has received its points, it is either certified or not. The four certifications a building may receive are Platinum, Gold, Silver, and Certified.[48] The buildings that receive the highest points will earn a Platinum certification.

Water Efficiency is one category in which a building may receive points. Out of the one hundred points, a building may receive up to ten points in this category. As a prerequisite, the building must reduce water use in the aggregate by twenty percent.[49] If this prerequisite is met, there are three ways to earn points. The first way in which a building may earn points under the water efficiency category is to employ water-efficient landscaping. This can be worth one to two points. Option one allows one point to be gained if a building decreases the amount of potable water used for irrigation by fifty percent. Option two allows for a building to gain two points. This option first requires that option one be met and, in addition, that no potable water be used for irrigation.[50] One suggestion for achieving this goal is to use only captured rainwater for irrigation. The second way to earn points is to reduce water use by a certain percentage. A building will receive two points for a thirty percent reduction, four points for a forty percent reduction, and six points for a fifty percent reduction.[51]

Completed in 2017, Mercedes-Benz Stadium in Atlanta Georgia, home to the Atlanta Falcons of the National Football League, became the first NFL stadium to achieve LEED Platinum certification.[52] As part of its Platinum level certification, the stadium installed a 680,000 gallon (2,574,080 liters) rainwater cistern.[53] The cistern is used to recapture and reuse rainwater for landscape irrigation; it also helps to prevent flooding in the surrounding neighborhoods.[54]

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[48] *Id.*

[49] U.S. GREEN BLDG. COUNCIL, LEED v4 FOR BUILDING DESIGN AND CONSTRUCTION 51 (2013), https://www.usgbc.org/sites/default/files/LEED%20v4%20ballot%20version%20(BDC)%20-%2013%2011%2013.pdf.

[50] *Id.* at 55.

[51] *Id.* at 56.

[52] Jessica Lyons Hardcastle, *Mercedes-Benz Stadium Set to Achieve LEED Platinum, an NFL, MLS Stadium First*, ENVIRONMENTAL LEADER, Feb. 23, 2017, https://www.environmentalleader.com/2017/02/mercedes-benz-stadium-set-achieve-leed-platinum-nfl-mls-stadium-first/.

[53] *Id.*

[54] *Id.* In another recent major redevelopment project in Atlanta, Ponce City Market, that has achieved LEED Gold status, the renovation of a large 2,100,000 sq. ft (200,000 sq. meters) former warehouse into a mixed-use development includes a green roof that filters stormwater runoff, combats Atlanta's heat island effect, and provides greenery for the enjoyment of residents and surrounding offices. Ponce City Market's stormwater management system includes underground detention vaults together with water quality improvement devices and groundwater recharge infiltration systems that reduce that total runoff and runoff rates. *See* Ponce City Market:

Since its inception, numerous U.S. cities have enacted ordinances requiring or incentivizing LEED certification.[55] In 2017, thirty-two major cities have LEED-related ordinances. Some examples of these ordinances include requiring LEED silver certifications for all new commercial buildings, expediting permits and offering rebates for those seeking LEED certification, and even reimbursing the total cost of LEED certification.[56] The advent of the LEED certification system has provided a major incentive for implementing rainwater recapture systems. As discussed previously, the LEED guidelines offer a number of points for implementing water conservation.

III. RAINWATER HARVESTING IN SINGAPORE

Like a sponge, Singapore uses two-thirds of its entire land area as a water catchment. The tropical country's small size limits the amount of rain that can be captured and stored, but Singapore is working on expanding the catchment area to 90% of its land by 2060,[57] making the country one of the few in the world to harvest urban stormwater for potable consumption on such a large scale.[58] The city-state manages its plentiful rainwater (up to 98 inches of rain a year, while the U.S., for instance, gets an annual average of 28 inches)[59] through the Active, Beautiful, Clean (ABC) Waters program.[60]

Launched in 2007, the ABC Waters program is an ambitious holistic master plan that aims to reduce, collect, and recycle stormwater runoff. The master plan is devised to transform Singapore's utilitarian drains, canals, and reservoirs into aesthetically pleasing water features that are integrated with the environment for everyone to enjoy.[61] Such a holistic approach is consistent with

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Sustainability Facts, http://poncecitymarket.com/wp-content/uploads/Sustainability-Facts.pdf; *see also Repurposing Ponce City Market: A Look from Ground Level*, EBERLY & ASSOCIATES, https://www.eberly.net/repurposing-ponce-city-market/.

[55] *Cities Requiring or Supporting LEED*, EVERBLUE, http://www.everbluetraining.com/blog/cities-requiring-or-supporting-leed-2015-edition (last updated Sept. 21, 2017).

[56] *Id.*

[57] Cecilia Tortajada, *Singapore's Water Success and Lessons for the Region*, GLOBAL-*IS*-ASIAN, Jun 29, 2017, https://lkyspp.nus.edu.sg/gia/article/singapore-s-water-success-and-lessons-for-the-region.

[58] Water from Local Catchment, PUBLIC UTILITIES BOARD (PUB), https://www.pub.gov.sg/watersupply/fournationaltaps/localcatchmentwater (last visited Dec 17, 2018).

[59] Average Precipitation in depth (mm per year) (Singapore, 2014), THE WORLD BANK GROUP, https://data.worldbank.org/indicator/AG.LND.PRCP.MM.

[60] Active, Beautiful, Clean Waters Programme, PUBLIC UTILITIES BOARD (PUB), https://www.pub.gov.sg/abcwaters/about (last visited Dec 20, 2018).

[61] Active, Beautiful, Clean Waters: Design Guidelines (4th ed.), PUBLIC UTILITIES BOARD (PUB), https://www.pub.gov.sg/Documents/ABC_Waters_Design_Guidelines.pdf (last accessed Dec 20, 2018).

Singapore's on-going practice of incorporating landscape design within an urban planning framework to soften the harsh concrete effects of high-rise housing.[62] Consequently, ABC Waters promotes natural cleansing systems with selected plants and special soil to treat rainwater runoff before it reaches waterways and reservoirs. These systems are collectively called "ABC Waters design features."[63]

The runoff reduction obligation using the ABC Waters design features has been codified in the Code of Practice on Surface Water Drainage, prepared by the Public Utilities Board (PUB, Singaporean national water agency).[64] The Code of Practice on Surface Water drainage sets out mandatory minimum engineering requirements for surface water drainage for new developments. Clause 7.1.5 sets maximum allowable peak runoff levels by requiring that all industrial, commercial, institutional, and residential developments equal to or greater than 0.5 acres in size (any new construction, as well as any additions, extensions, or reconstructions of the mentioned size) control the peak runoff discharged from the development sites. The Code advises that the peak runoff can be reduced through implementation of such ABC Waters design features as porous pavements, green roofs, planter boxes, bioretention swales, detention tanks/ponds, sedimentation basins, wetlands, cleansing biotopes, or bioretention basins (rain gardens).[65] Each of these features have been craftily designed to complement the country's complex water management system, which integrates 17 reservoirs with close to 5,000 miles of drains, canals, and rivers with the surrounding environment.[66]

A prevalent ABC Waters design feature, green roof water collection systems, has been installed in many commercial and government-built high-rise public housing buildings, where roughly 80% of Singaporeans live,[67] to act as

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[62] Adrienne Lyles-Chockley, *Building Livable Places: The Importance of Landscape in Urban Land Use, Planning, and Development*, 16 BUFF. ENVT'L. L.J. 95, 104.
[63] World Cities Summit 2018: Livable & Sustainable Cities: Embracing the Future through Innovation and Collaboration, 6 Program Book, http://www.worldcitiessummit.com.sg/sites/default/files/WCS2018-Programme-Booklet-FA-LowRes.pdf.
[64] Code of Practice on Surface Water Drainage, 7th ed. Dec 2018, PUBLIC UTILITIES BOARD (PUB), https://www.pub.gov.sg/Documents/PUB_COP_7th_Edition.pdf.
[65] *Id.*
[66] Active, Beautiful, Clean Waters: Design Guidelines (4th ed.), PUBLIC UTILITIES BOARD (PUB), https://www.pub.gov.sg/Documents/ABC_Waters_Design_Guidelines.pdf (last accessed Dec 20, 2018).
[67] Sarah Keating, *Can Singapore's Social Housing Keep Up with Changing Times?* BBC, Dec 14, 2018, http://www.bbc.com/capital/story/20181210-can-singapores-social-housing-keep-up-with-changing-times.

rainwater catchment.[68] Singaporean green roofs can be grouped into two types: intensive and extensive. Intensive green roofs are large, green, public rooftop spaces, designated for recreation, often as gardens. Rainwater runoff is first collected and cleansed on the intensive green roof, then channeled to lower levels or used to water the plants or to wash sidewalks.[69] Extensive green roofs are not designed as recreational areas; instead, they accommodate low-maintenance vegetated roof systems with a shallow drainage/storage layer to store rainwater. In addition to conserving potable water for irrigation, extensive green roofs cool buildings and reduce the heat island effect by shading the building from sunlight.[70] To adapt to climate change, Singapore's Building Construction Authority is aiming for 80% of city buildings to be Green Mark certified by 2030 – designed to use resources more efficiently through incorporation of such features as green roofs.[71]

Other ABC Waters design features on the list of requirement options for new buildings include bioretention swales, which form the edges of Singaporean roads, sloped toward either curbs or central dividers where drop inlet chambers direct the stormwater runoff into drains that then bring it to the main water canals.[72] Detention tanks and ponds, similarly to porous pavements, can also be installed to temporarily store peak runoff during intense storms that would otherwise overwhelm public drains, resulting in flash floods. The stored water from detention tanks and ponds is gradually released into the drainage system.[73] Another option is construction of sedimentation basins – ponds to temporarily detain or for a longer time retain stormwater runoff. Such ponds can turn into aesthetic water features when landscaped.[74] The list also provides for constructed wetlands – shallow and extensively vegetated waterbodies, often with a hard edge, to form a part of a streetscape or building fronts. Constructed wetlands, together with cleansing biotopes, have been designed primarily to remove suspended particles and dissolved contaminants, but also to provide wildlife

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[68] Mooyoung Han and Lisa Andrews, *Can Rainwater Harvesting Transform Cities into Water-Wise Cities?* INTERNATIONAL WATER ASSOCIATION, Mar 30, 2017, http://www.iwa-network.org/can-rainwater-harvesting-transform-cities-into-water-wise-cities/.
[69] Active, Beautiful, Clean Waters: Design Guidelines (4th ed.), PUBLIC UTILITIES BOARD (PUB), *supra*, at 25.
[70] *Id*. at 26.
[71] Derek MacKenzie, *Green Buildings, Singapore's Natural Ally in Climate Change Fight, Eco-Business*, November 2017, https://www.eco-business.com/opinion/green-buildings-singapores-natural-ally-in-climate-change-fight/.
[72] Active, Beautiful, Clean Waters: Design Guidelines (4th ed.), *supra* at 28.
[73] Active, Beautiful, Clean Waters: Design Guidelines (4th ed.), PUBLIC UTILITIES BOARD (PUB), *supra*, at 11.
[74] *Id.* at 41.

habitats.[75] Lastly, rain gardens are yet another feature new developments can install. Rain gardens are densely-planted surface areas designed to detain and treat stormwater runoff, except, unlike swales, rain gardens do not channel stormwater runoff.[76] All of the mentioned ABC Waters features are supervised and maintained to ensure safety, prolong their lifespan, and sustain the multiple functions they serve.

Since 2010, PUB has been recognizing public agencies and private developers for incorporating ABC Waters features in their developments. In 2011, PUB and the Institution of Engineers Singapore launched the ABC Water Professional Program to ensure a pool of engineers, architects, and landscape specialists, are trained to install and maintain ABC designs for developments. Furthermore, PUB regularly encourages and educates the public about taking care of the country's waterbodies. The ultimate goal is to mainstream ABC Waters concepts so that they become an essential element in urban planning. Over 100 projects embodying ABC Waters features have been identified by PUB to complete by 2030.[77]

One of the newest residential complexes to have recently received the ABC Water Certification is d'Leedon,[78] Singapore's largest residential development. Its seven 36-floor towers taper inwards to occupy only 22% of the site to free up space for landscaping and living spaces. The basement houses most of the complex's surface roads to allow for more greenery on the ground and a rainwater tank that supplies water to the automatic irrigation system. Two large bioretention basins collect and treat stormwater before it is released into public drains; signs along the bioretention basins educate residents about the ABC Waters design features.[79]

An example of a rather extensive rainwater catchment complex in Singapore is Changi Airport, where the runoff is collected from the runways, surrounding green areas, and building roofs to be sent to two reservoirs. From the first reservoir, collected rainwater is pumped to an on-site pre-treatment plant and

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[75] *Id.* at 43.
[76] *Id.* at 39.
[77] *Id.* at 4-5, 65-72.
[78] *CapitaLand's Architectural Excellence Receives Worldwide Recognition Again with CapitaGreen and d'Leedon Accorded International Accolades by the Council on Tall Buildings and Urban Habitat*, CAPITALAND, Jun 2015, https://www.capitaland.com/international/en/about-capitaland/newsroom/news-releases/international/2015/jun/nr-20150623-CapitaLands-architectural-excellence-receives-worldwide-recognition-again-with-CapitaGreen-and-dLeedon-accorded-international-accolades-by-the-Council-on-Tall-Buildings-and-Urban-Habitat.html.
[79] *The ABCs of Sustainable Surroundings*, CAPITALAND, October 2014, https://www.capitaland.com/international/en/about-capitaland/newsroom/inside/2014/oct/inside-201410-the-abcs-of-sustainable-surroundings.html.

then used for firefighting and toilet flushing. The second reservoir is used for storm relief when stormwater discharges and incoming tide from the sea coincide. The collected and treated rainwater accounts for over a third of the total water used by the airport, saving close to $300,000 a year.[80] Furthermore, the Jewel building in Terminal 1, expected to open later in 2019, will house the world's tallest indoor waterfall, fed by harvested rainwater that will also service the building and its landscape irrigation systems.[81]

Along with the elaborate rainwater management system, Singapore's government has also instituted rather strict individual rainwater collection laws. Under Section 31 of the Sewerage and Drainage Act, no person, without approval of PUB, is allowed to build any rainwater collection structures.[82] In 2004, the rainwater collection restrictions were loosened to allow residents to collect and recycle rainwater for non-potable purposes in larger containers, measuring up to about 16.4 by 6.6 feet and about 6.6 feet in depth.[83] Such rainwater collection restrictions have been put in place in part to meet the growing demand for water, but also in part to move toward independence from water imports, since about half of the Singapore's water needs are currently imported from Malaysia[84] (the two other remaining sources being desalinated seawater and reclaimed used water).

IV. RAINWATER HARVESTING IN OTHER COUNTRIES

Rainwater recapture is indeed a global phenomenon. Around the world, local and state-level governments have implemented a variety of mandatory and incentive-based laws for rainwater recapture. Recently, Uttar Pradesh, the largest state in India and home to over 200 million people created a mandatory system for new buildings. In May of 2017, Uttar Pradesh's Chief Minister ordered that construction permits only be granted for new construction if plans for rainwater

[80] *Examples of Rainwater Harvesting and Utilization Around the World: Singapore*, UNITED NATIONS ENVIRONMENT PROGRAMME, DIVISION OF TECHNOLOGY, INDUSTRY AND ECONOMICS, http://www.unep.or.jp/ietc/Publications/Urban/UrbanEnv-2/9.asp (last accessed Dec 22, 2018).
[81] Jewel Changi Airport, SAFDIEARCHITECTS, https://www.safdiearchitects.com/projects/jewel-changi-airport (last visited Dec 22, 2018).
[82] The Statutes of the Republic of Singapore, Sewerage and Drainage Act (Chapter 294), Part V, § 31, current as of Aug 16, 2018, https://sso.agc.gov.sg/Act/SDA1999.
[83] Sharmilpal Kaur, *Home Owners Can Build Tanks to Collect Rainwater*, THE STRAITS TIMES, March 16, 2004, accessed on LexisNexis on August 15, 2018.
[84] Seow Bei Yi, "Finding Ways to Increase Water Supply from Johor River," THE STRAITS TIMES, Jan 17, 2018, https://www.straitstimes.com/singapore/finding-ways-to-increase-water-supply-from-johor-river.

harvesting are included.[85] This order includes both residential and commercial construction. Citing depletion in the groundwater levels in parts of Uttar Pradesh, the Chief Minister issued the order to ensure that the state's population will not face a shortage of drinking water.[86]

In 2009, the Programme of 1 Million Cisterns (P1MC) was implemented in the semi-arid northeastern region of Brazil with a goal to provide "drought-secure" drinking water for millions of people in the region. The P1MC was funded both by the Brazilian government and the private sector and designed to be carried out in a decentralized fashion at the local, state, and regional levels. Within one year of its implementation, over 250,000 cisterns were installed.[87]

To address flooding and water security issues, China has recently launched the Sponge City Program (SCP), run as a three-year pilot. Under SCP, cities are to be equipped to behave like sponges (catching and storing rainwater, treating it, and then redistributing to residents via improved permeation, detention, storage, drainage, and purification systems). Out of 130 candidate city applicants, China Ministries of Finance and Water Resource chose 16 cities to participate in 2015, 14 more, including Beijing and Shanghai, were added in 2016.[88] To guide the SCP implementation, the central government has published various policy and technical information documents, including a guide of Sponge City technology and the evaluation and assessment index to measure sponge city performance.[89] Singapore companies have also offered their expertise to help Chinese cities bid and request funding for SCP projects.[90] As of 2018, the country has spent over $12 billion on

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[85] *Only Buildings with Rainwater Harvesting Facility to be Approved: CM Yogi Adiyanath*, THE INDIAN EXPRESS, May 16, 2017, http://indianexpress.com/article/india/only-buildings-with-rainwater-harvesting-facility-to-be-approved-cm-yogi-adiyanath-4658173/.

[86] *Id.*

[87] Johann Gnadlinger, *Community Water Action in Semi-Arid Brazil: Factors for Success of Rainwater Harvesting Programs* at 4, 4TH WORLD WATER FORUM, March 16, 2006 (revised May 2009).

[88] Liping Dai, Helena F. M. W. van Rijswick, Peter P. J. Driessen & Andrea M. Keessen, *Governance of the Sponge City Programme in China with Wuhan as a Case Study*, 34:4 INTERNATIONAL JOURNAL OF WATER RESOURCES DEVELOPMENT, 578-596 (2018), https://www.tandfonline.com/doi/full/10.1080/07900627.2017.1373637; see also Xiaoning Li et al., *Case Studies of the Sponge City Program in China*, World Environmental and Water Resources Congress Paper, May 2016, https://www.researchgate.net/publication/303362681_Case_Studies_of_the_Sponge_City_Program_in_China.

[89] XIAONING LI ET AL., *supra* at 7.

[90] *A Thirst for China's 'Sponge City' Projects*, ENTERPRISE SINGAPORE, https://ie.enterprisesg.gov.sg/Partner-Singapore/Singapore-Industry-Capabilities/Infrastructure-Hub/Singapore-Asia-s-Infrastructure-Hub/Technical-and-Engineering-Services/Energy/Singapore-Sector-Folder/Featured-Projects/mc/News/2016/7/A-thirst-for-China-s--sponge-city--projects (last accessed Jan 15, 2019).

all sponge city projects, with the central government covering 15-20% of the cost, and the rest of the expenses shared between local governments and the private sector.[91] China is planning to turn 80% of the country's urban areas into Sponge Cities by 2030, with each sponge city absorbing and recycling roughly 70% of stormwater.[92]

Unlike Singapore, Australia is the driest inhabited continental land in the world.[93] To alleviate drought effects on available water resources, several Australian states and cities have enacted requirements for rainwater harvesting. Since 2005, in the State of Victoria, new homes and apartments must be built with either a rainwater tank or a solar hot water system. The State of South Australia has made rainwater tanks mandatory for new homes. The State of New South Wales and the City of Sydney require buildings to reach the Building and Sustainability Index (BASIX) target of forty percent reduction in water usage. One of the ways suggested to accomplish this goal is through the use of rainwater harvesting tanks. From 2009 to 2011, under the Water for Future Initiative, Australian federal government ran a rebate scheme to assist families with rainwater harvesting system installations. Additionally, starting in 2008-2009, all six states together with Australian Capital Territory ran similar rebate programs, offering up to $1,500 on rainwater tank systems. All of the state rebate programs have ended, the last one, in the State of Victoria, having expired in 2015.[94]

To address increasingly frequent and heavy flooding, coupled with the city's sinking by almost half an inch each year, Thailand's capital Bangkok has been mapping out an extensive water-management plan. One of the largest, recently completed anti-flooding projects is an 11-acre Chulalongkorn University Centenary Park with porous-concrete walkways, artificial wetlands, and a retention pond to hold up to a million gallons of rainwater.[95] A museum in the park is topped with a green roof that filters rainwater before it is stored in tanks underground.[96] The park is Bangkok's first in many years and an important step toward resilience (the city

[91] Asit K Biswas, Kris Hartley, *China's 'Sponge Cities' Aim to Re-Use 70% of Rainwater*, CNN, Oct 15, 2018, https://www.cnn.com/2017/09/17/asia/china-sponge-cities/index.html.
[92] Thu Thuy Nguyen et al., *Implementation of a Specific Urban Water Management – Sponge City*, SCIENCE OF THE TOTAL ENVIRONMENT 652 (2019) 147-162.
[93] Chirhakarhula E. Chubaka, Harriet Whiley, John W. Edwards, Kirstin E. Ross, *A Review of Roof Harvested Rainwater in Australia*. 2018 J ENVIRON PUBLIC HEALTH, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5828256/.
[94] *Id.*
[95] Leanna Garfield, *Bangkok is Sinking, so It Built a Park that Holds a Million Gallons of Rainwater to Help Prevent Flooding*, BUSINESS INSIDER, Aug 1, 2018, https://www.businessinsider.com/bangkok-park-holds-a-million-gallons-of-rainwater-to-prevent-flooding-2018-7.
[96] Rina Chandran, *Bangkok Fights Floods with Thirsty Landscaping*, PLACE, Jan 9, 2019, http://www.thisisplace.org/i/?id=61312b24-7861-478f-86ad-e9f5e606f44b.

has one of the lowest ratios of green space: mere 35.5 sq. ft per person, compared to 66 in Singapore or 23.1 in New York City).[97]

In April 2017, the government of Kenya, partnered with the business and development communities, launched a rainwater harvesting program to construct farm ponds to increase water storage within those farms. The program is a pilot initiative, expected to be rolled out in other potential countries across the African continent.[98] Kenya's national government has been promoting rainwater harvesting through enabling legislation designed to increase rainwater storage, including the recently enacted Water Act 2016.[99] The Water Act 2016 establishes, among other new water institutions, the National Water Harvesting and Storage Authority to develop national water harvesting policy and to enforce water harvesting strategies[100] to build resilience to floods and droughts to ensure access to clean and affordable water. Kenya's Rainwater Harvesting program, together with the examples discussed above, illustrate the widespread adoption of rainwater harvesting programs worldwide, not only to promote green development and to build resilience, but also to provide a supply of drinking water for millions of people.[101]

IV. MANAGEMENT OF SURFACE WATER RUNOFF THROUGH A RAIN TAX

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[97] *Id.*

[98] Susan Onyango, Lynnea Imbai, *Kenya Launches National Program to Harvest Rainwater*, WORLD AGROFORESTRY, May 10, 2017, http://blog.worldagroforestry.org/index.php/2017/05/10/kenya-launches-national-program-to-harvest-rainwater/.

[99] *Billion Dollar Business Alliance for Rainwater Harvesting*, UNITED NATIONS, PARTNERSHIP FOR THE SDGS, https://sustainabledevelopment.un.org/partnership/?p=11904 (last accessed January 13, 2019).

[100] The Water Act, 2016, Section 30, WATER SERVICES REGULATORY BOARD (WASREB), https://wasreb.go.ke/downloads/Water%20Act%202016.pdf.

[101] Fog harvesting is another sustainable water collection method, practiced around the world in countries including Chile, Dominican Republic, Ecuador, Ethiopia, Guatemala, Haiti, Morocco, Namibia, Nepal, Peru, and Yemen. This method can be effectively used to collect water in locations where annual rainfall is scarce since fog harvesting does not require rain, only fog and light winds. Fog collectors (erected mesh nets that catch fog droplets and use gravity to send the harvested water down into containers underneath) work well in hilly areas with frequent cloud movement. In Yemen, for example, such devices have amassed up to 10 gallons of water per day. The fog collectors are not usually built in large cities, however, where such collectors would be unlikely to meet the high water demands. *See* FogQuest: Sustainable Water Solutions, http://www.fogquest.org/f-a-q/ (last visited May 1, 2019); *see also* United Nations Development Programme (UNDP), *Harvesting Fog in Western Yemen*, https://www.undp.org/content/undp/en/home/ourwork/ourstories/harvesting-fog-in-western-yemen.html (last visited May 1, 2019).

Implementing a rain tax encourages rainwater capture by concentrating on the need to manage surface water runoff. The rain tax, also known as a stormwater service charge, stormwater utility charge, or surface water drainage charge, requires property owners to pay for the cost of "handling" their rainwater runoff. This fee is calculated by the total impervious surface area on the property. In order to understand the rain tax, one must first examine the relationship between rainwater catchment and stormwater system management. Stormwater management can represent a huge cost to municipalities. Municipalities spend money in order to maintain the drainage system rainwater runoff and sewage flow-through. No maintenance or poor maintenance can ultimately lead to systems backing up and flooding. Municipalities also spend money to separate the storm and sewer systems.[102] It costs money to manage the excess rainwater runoff flowing into stormwater and sewage systems, and the rain tax is a way to recoup that cost. Effective stormwater management in general has many benefits related to preventing water pollution and flooding, but is not the focus of this Article.[103] Rainwater catchment is also a benefit of implementing a rain tax. When such a tax is created, it can account for conservation methods used by property owners and in turn allow them to receive a credit.[104] If property owners use rainwater catchment methods on-site, they will be able to cut down on their bills.

Perhaps the best example of an effective rain tax is in Germany. German households are charged stormwater fees based on individual parcel assessments, which determine the amount of impermeable surfaces on the property.[105] The tax encourages landowners to implement water conservation in order to shield themselves from higher water bills. One of the rainwater catchment systems discussed above, which would be most helpful in reducing one's tax, is installation of a green roof. At a residential level, the largest impermeable area on a parcel of land usually is the structure's roof. By installing a permeable green roof, that surface area would no longer be used in calculating how much tax will be levied. In Germany, the tax is seen as an incentive to install green roofs or permeable pavement in order to reduce the amount of tax assessed. The individual parcel assessment system has found great success in Germany. The proliferation of green roofs and rainwater harvesting through Germany has been accomplished through a

[102] *Bolt v. City of Lansing*, 587 N.W.2d 264 (Mich. 1998).
[103] Avi Brisman, Article, *Considerations in Establishing a Stormwater Utility*, 26 S. ILL. U. L.J. 505, 512 (2002).
[104] *Id.* at 515.
[105] Ralph Bueler et al., *How Germany Became Europe's Green Leader: A Look at Four Decades of Sustainable Policymaking*, THE SOLUTIONS J., at 51–63, Sept. 2011, https://www.thesolutionsjournal.com/article/how-germany-became-europes-green-leader-a-look-at-four-decades-of-sustainable-policymaking/.

combination of rebates and requirements, and cooperation between multiple levels of government.

Potsdamer Platz, an office, entertainment, and retail district in the center of Berlin, exemplifies the push for green roof adoption, generally ascribed to Germany's Federal Nature Conservation Act.[106] Berlin's stormwater fee is the highest in Germany, thus, works as the greatest financial incentive to promote green infrastructure, especially for industries and businesses operating large sites with impervious cover.[107] One of such sites, Potsdamer Platz, includes the Daimler-Chrysler headquarters, was completed in 1998 with an extremely complex rainwater retention system called Urban Waterscape.[108] 23,000 cubic meters of rainwater are saved each year through this system. This is accomplished mostly through green roofs, which cover over sixty percent of the buildings in the district. The rainwater then flows to five massive cisterns under the district. From there, it flows to man-made canals, lagoons and reservoirs in the district, which have become major tourist draws in their own right. It is also used to irrigate the many green spaces that line the canals in the district. Some rainwater is also used to flush toilets in the district's buildings and in sprinkler systems. As a positive side effect of this, the summertime temperature in the district has decreased by about two degrees Celsius.[109]

Promoting conservation through taxes forces results, but it can also lead to problems. In England, there has been considerable protest by churches and other non-profit entities. Churches tend to have large amounts of non-permeable areas (such as parking lots) on their property.[110] Before the new rain tax, an area was charged based on a ratable value. Churches, charities, and community sport clubs received very low ratable values under the old system and based on those values,

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[106] Working Party on Biodiversity, Water and Ecosystems: Barriers to, and Incentives for, the Adoption of Green Water Infrastructure, 29 ORGANIZATION FOR ECONOMIC COOPERATION AND DEVELOPMENT (OECD), ENVIRONMENT POLICY COMMITTEE, Nov 4, 2013, http://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?cote=ENV/EPOC/WPBWE/RD%282013%298&docLanguage=En.

[107] Darla Nickel, Wenke Schoenfelder, Dale Medearis, David P. Dolowitz, Melissa Keeley & William Shuster, *German Experience in Managing Stormwater with Green Infrastructure*, JOURNAL OF ENVIRONMENTAL PLANNING AND MANAGEMENT, 57:3, 403-423 (2014), https://doi.org/10.1080/09640568.2012.748652.

[108] *Berlin: Water Creates a Vibrant Cityscape*, DAC & CITIES, http://www.dac.dk/en/dac-cities/sustainable-cities/all-cases/water/berlin-water-creates-a-vibrant-cityscape/ (last visited Sept. 25, 2017).

[109] *Id.*

[110] *See, e.g.*, Lynn Monson, *Ypsilanti City Council Wary of Proposal to Charge "Pavement Fee,"* MLIVE.COM, Apr. 1, 2009, http://www.mlive.com/news/ann-arbor/index.ssf/2009/04/ypsilanti_city_council_wary_of.html (pointing out that lawmakers are reluctant to apply storm water utility fees to churches).

were not charged a high amount.[111] Under the rain tax imposed by Ofwat, the industry regulator, these groups saw a tremendous increase in their bills. Some churches, cemeteries, and community sports stadiums that previously received low stormwater bills began being assessed bills of five-thousand pounds per year. In 2010, Parliament passed a law that allowed these large community and church parcels to receive social tariffs and breaks from the rain tax, greatly reducing their bills.[112]

However, in the United States, the rain tax has not exactly been universally embraced and has even faced constitutionality questions. In 2010, the Environmental Protection Agency called on seven states to enact legislation aimed at reducing polluted runoff into the Chesapeake Bay.[113] Of the seven states, only Maryland heeded the mandate and passed HB 987 in 2012.[114] This bill was officially known as the Stormwater Management Watershed and Restoration Program, but was in effect, a rain tax. The rain tax applied to nine Maryland counties plus the City of Baltimore. The legislature tasked these jurisdictions with setting their own "stormwater remediation fees" which could be a flat rate, a rate based on the amount of impervious surface on each property, or a rate calculated in any other way by the county or municipality.[115] Frederick County chose to impose a tax of one cent per year in protest, and Carroll County refused to impose any tax at all in defiance of the law.[116] After three years and tremendous public disdain, the bill was amended by the Maryland legislature to make the imposition of the rain tax by the counties optional.[117] This amendment was passed unanimously in the Maryland Senate and with a lone dissenter in the Maryland House. However, counties are still required to complete stormwater pollution projects, and must come up with the money some other way to avoid being fined. Some counties opted to repeal the rain tax, diverting funds from other parts of their budget to pay for the required environmental projects. Some counties reduced their tax, and others have

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[111] Martin Beckford, *Churches, Scouts and Sports Clubs Win Battle Over 'Rain Tax' in Parliament's 'Wash-Up,'* THE TELEGRAPH, Apr. 9, 2010, http://www.telegraph.co.uk/news/religion/7572322/Churches-Scouts-and-sports-clubs-win-battle-over-rain-tax-in-Parliaments-wash-up.html.

[112] Nick Lester, *Groups Are Given New "Rain Tax' Assurances*, PLYMOUTH EVENING HERALD, Sept. 29, 2009, *available at* http://www.thisisplymouth.co.uk/oddnews/GROUPS-GIVEN-NEW-RAIN-TAX-ASSURANCES/article-1374615-detail/article.html.

[113] Travis H. Brown, *When It Rains, It Pours Tax Dollars in Maryland*, FORBES, Jan. 3, 2014, https://www.forbes.com/sites/travisbrown/2014/01/03/when-it-rains-it-pours-tax-dollars-in-maryland/#1724415c7c69.

[114] H.B. 987, 2010 Reg. Sess. (Md. 2010).

[115] *Id.*

[116] Jared Walczak, *Maryland's Rain Tax Mandate Washed Away*, TAX FOUNDATION, Apr. 14, 2015, https://taxfoundation.org/marylands-rain-tax-mandate-washed-away/

[117] *Id.*

opted to keep their rain tax.[118] The Maryland rain tax situation is a great illustration that a rain tax works better when it is left to up to the local jurisdiction, and does not benefit from state-level intervention.

Another issue with implementing a rain tax is that the process by which it is imposed must be constitutional. Lansing, Michigan, struggled with this problem in 1995. Lansing adopted an ordinance that created a stormwater service charge. The charge was imposed on each landowner and attempted to estimate each parcel's stormwater runoff.[119] A landowner who received a bill for $59.83 for his 5,400 square foot parcel brought suit against the city. He claimed that the charge was a tax, rather than a valid user fee, which required a vote by the electorate before it could be implemented. The Michigan Supreme Court held that the stormwater service charge was a tax, and because there was never approval by a vote of the electorate, it was unconstitutional.[120]

V. ISSUES WITH IMPLEMENTATION OF RAINWATER HARVESTING PROGRAMS

The first issue that local governments face when implementing a rainwater harvesting program is deciding what means to use in its implementation. Some of the programs discussed above are incentive-based, some are mandatory, and some are a combination of the two. The biggest problem with a strictly incentive-based program is that developers may decide not to take advantage of the incentives. This outcome tends to lead municipalities to adopt mandatory programs.

Achieving its goal is the main objective for a municipality, but it would prefer to reach this objective while avoiding problems. One issue to consider when enacting a rainwater harvesting ordinance is at what point in the development process the ordinance will be implemented. Many of the plans listed above implement the ordinance at the building permitting stage. When a developer wants approval of building and development plans, it must submit plans to harvest rainwater. This scheme makes permits and approval contingent on the developer's ability to capture rainwater once the development is completed.

The most debated issue that arises in the context of rainwater harvesting programs is the question of who should pay for the necessary infrastructure. Should developers or homeowners pay? Is the up-front cost going to be too much for the developer to absorb or pass on? Will the costs ever be recouped? Most developer funding of infrastructure programs - impact fees, for example - require the

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[118] Pamela Wood & Timothy B. Wheeler, *Repeal of 'Rain Tax' Requirement Yet to Trickle Down to Most Area Homeowners*, THE BALTIMORE SUN, Apr. 19, 2015, http://www.baltimoresun.com/news/maryland/bs-md-rain-tax-20150419-story.html

[119] *Bolt*, 587 N.W.2d at 267.

[120] Id. at 169.

developer (the person or entity who applies for the building permit) to pay. Depending on various economic factors, which vary from place to place, the buyer of the residential, commercial, or industrial property may bear all or a portion of the cost through paying a higher purchase price for the property. Or, the infrastructure costs may come out of the developer's profit. Or, some analysis indicates that those developers who know the infrastructure costs they will bear are willing to pay less for the raw land which will be the locus of the development, and therefore the cost is passed back to the owner of developable land. Most likely, all three bear some of the burden.

The equities in regards to who should bear the financial burden of water and energy conservation infrastructure are somewhat different because the homebuyer (or ultimate owner of the commercial or industrial building) may save money by paying less for water or energy because of the required conservation infrastructure. Professor Robert Freilich has pioneered an innovative and workable solution to this problem. He calls it the "monetization" idea, but a more descriptive name may be the advancement or refunding agreement approach.[121] Pursuant to many of the statutes discussed above, the developer has the initial cost of providing the rainwater harvesting system. A developer may not have the money up front to fund such an expensive conservation project, or may decide that it will be impossible to recoup the investment by passing it on to the buyer. The advancement approach would work like this: the developer would receive money advanced through a grant from some organization such as a water utility or a homeowner's association. The developer would then use this money to pay the extra cost of the water conservation infrastructure. When the developer sells the house to a homeowner, that homeowner will pay back the advancement. If the advancement was made from a water utility, the homeowner's water bill would include surcharges that ultimately go to paying off the money advanced to the developer. If the homeowners' association was the entity which initially fronted the money, then it can charge the homeowner a special fee that will be tacked on to the homeowner's dues. The money that was advanced to the developer will be paid back through these special assessments.

VI. CONCLUSION

Water conservation will continue to become more important to local governments as time progresses. Droughts and water shortages due to overdevelopment and climate change will continue to bring water conservation to the forefront of land use planning goals. As a result, rainwater harvesting programs are likely to attract support since they succeed in augmenting water supply and managing stormwater runoff while also serving as effective climate change

[121] DAVID L. CALLIES, ROBERT H. FREILICH & THOMAS E. ROBERTS, CASES AND MATERIALS ON LAND USE 682 (Thomson West 5th ed. 2008).

adaptation strategies. Assessing the impact of proposed development on water supply and drainage issues will no doubt result in frequent conditioning of development approval on compliance with regulations requiring and incentivizing rainwater catchment, as exemplified by efforts in Singapore and elsewhere around the world.