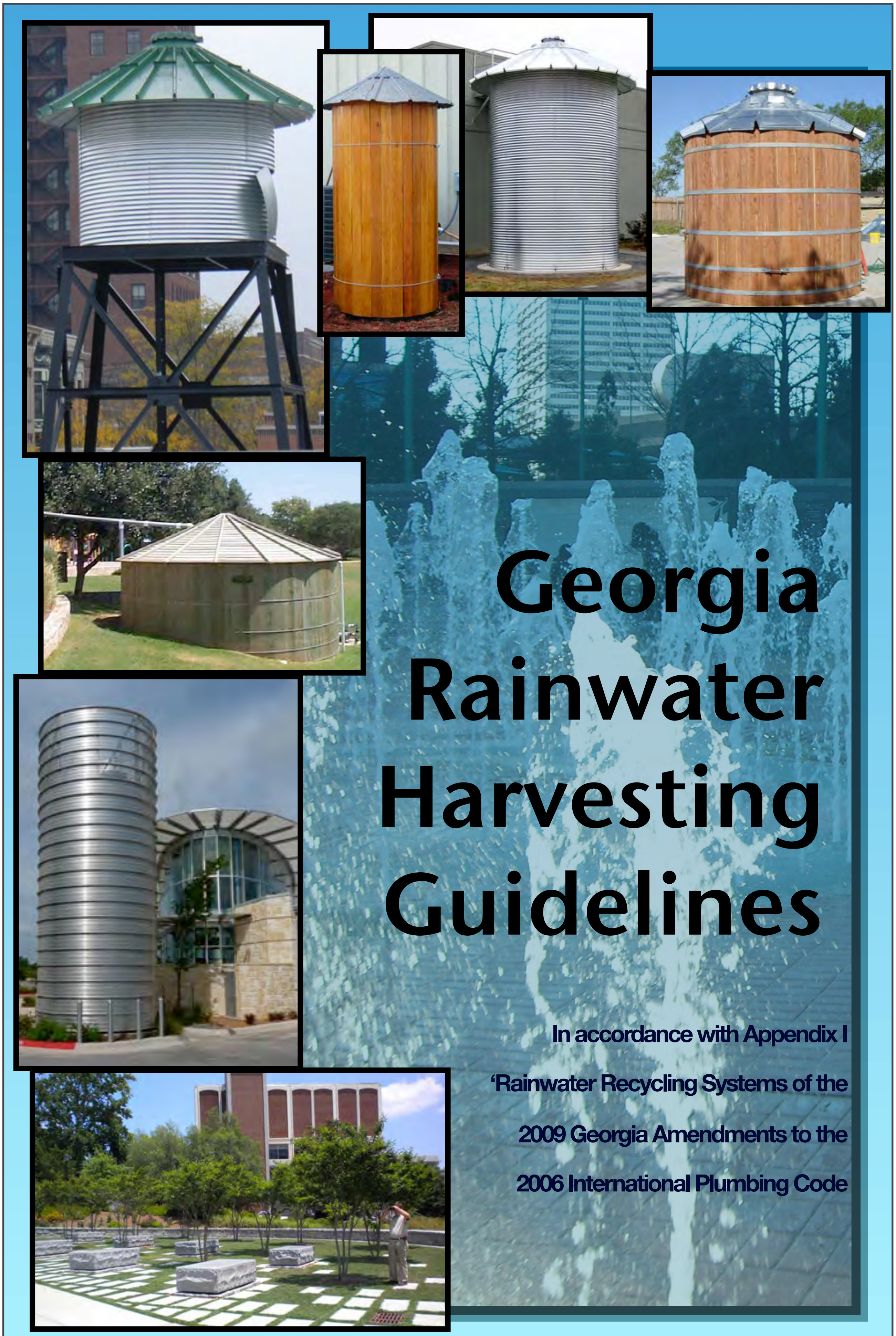

Georgia Rainwater Harvesting Guidelines

In accordance with Appendix I
'Rainwater Recycling Systems of the
2009 Georgia Amendments to the
2006 International Plumbing Code

PREFACE

The ***Georgia Rainwater Harvesting Guidelines*** are intended to assist all parties involved in the design, construction, inspection and maintenance of rainwater harvesting systems and to help successfully comply with Appendix I-'Rainwater Recycling Systems' of the 2009 Georgia Amendments to the 2006 International Plumbing Code (IPC). The parties mentioned above include owners, building officials, design professionals and contractors. This consensus document is the product of the parties listed below:

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The ***Guidelines Committee*** wishes to take this opportunity to express our sincere appreciation to those individuals who donated their time and effort to the development and production of this document. Special thanks goes out to Eddie Van Giesen and Frances Carpenter for their efforts as principal authors and editors of this document. Lay-out and design by Viviane Van Giesen.

Disclaimer and Notice:

While the information presented in these guidelines is believed to be correct, the parties involved assume no responsibility for its accuracy or for the opinions expressed herein. The material presented in this publication is not considered "Code" and should only be used for reference and guidance in complying with the requirements of Appendix I 'Rain Water Recycling Systems.' All rainwater harvesting systems shall comply with the Georgia State Minimum Standard Plumbing Code (2006 IPC with Georgia Amendments) and all other applicable State Minimum Standard Codes for construction. Users of information from this publication assume all liability arising from such use.

The 2009 Georgia Amendments to the International Plumbing Code which contain Appendix I 'Rain Water Recycling Systems' can be downloaded from the Department of Community Affairs website at the following link: http://www.dca.ga.gov/development/ConstructionCodes/programs/codeAmendments.asp

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CHAPTER 1

GENERAL INFORMATION

1.1 Purpose

Rainwater, for purposes of this document, is water collected from roof surfaces during rain events. This water is then stored in tanks or cisterns for later use. Potential uses include indoor non-potable applications (toilet flushing, cooling tower make-up) and outdoor non-potable applications (irrigation systems, hose bibs, etc). Rainwater Harvesting (RWH) in its essence is the collection, conveyance and storage of rainwater. Rainwater collected from roofs is not “recycled water”, nor is it “gray water”. It is fresh water that is in abundant supply, and is generally undervalued in the United States.

Rainwater Harvesting Systems (RWHS) for purposes of this document, are defined as systems that collect, store and use precipitation collected from rooftops or other man made, above ground collection surfaces.

The use of rainwater harvesting systems in Georgia can serve to supplement non-potable water demands while maintaining and enhancing the quality of the environment. These guidelines are intended to be consistent with, and complimentary to, the requirements of the Georgia’s 2009 Amendments to the 2006 International Plumbing Code, National Institute of Health, and local Boards of Health. Installers and the general public are advised to comply with local and state codes.

On January 1, 2009, Appendix I ‘Rainwater Recycling Systems’ of the Georgia 2009 Amendments to the 2006 International Plumbing Code took effect allowing rainwater harvesting in certain applications throughout the state. The guidelines presented in this document (Georgia Rainwater Harvesting Guidelines) will assist regulators, rainwater systems designers and end users in implementing rainwater harvesting best management practices. The water available

An amendment to allow clothes washing is currently under consideration and could be part of the Georgia Amendments to the State Plumbing Code as early as January 2010.

from such systems will offer high quality water to supplement utility-provided water for approved non-potable end uses.

Nothing in the plumbing code or this guideline should be construed to restrict the use of rainwater for outdoor irrigation.

1.2 ARCSA

The ***American Rainwater Catchment Systems Association (ARCSA)*** is one of the best sources of information about rainwater harvesting. ARCSA (www.arcsa.org), an affiliate of the International Rainwater Catchment Systems Association (IRCSA, www.ircsa.org) is an organization formed in 1994 by Dr. Hari J. Krishna in Austin, Texas. ARCSA's primary mission is to promote rainwater catchment systems in the Americas through educational opportunities, the exchange of information at the ARCSA website and regularly scheduled workshops and courses.

ARCSA has published guidelines for rainwater harvesting systems, and is currently writing national standards for the rainwater harvesting industry, both of which are available on their website. Currently Rainwater Catchment Design and Installation Standards are being developed by a joint effort of ARCSA and the American Society of Plumbing Engineers (ASPE). The purpose of these standards is to assist engineers, designers, plumbers, builders/developers, local government, and end users in successfully implementing rainwater catchment systems. These standards are intended to apply to new rainwater catchment installations, as well as alterations, additions, maintenance and repairs to existing systems.

Rainwater harvesting systems can range from a simple 55-gallon rain barrel to a complex multimillion-gallon cistern with electronic pumps and controls. It is important to evaluate existing site conditions of the project to ensure compliance with state and local requirements during the planning phase.

To assist in understanding the terminology of RWH, a glossary of commonly used terms is provided at the end of this document.

CHAPTER 2

INTRODUCTION TO RAINWATER HARVESTING

2.1 The Big Picture

The Earth's surface is 75 percent covered by water; only 3 percent of this water is suitable for human consumption. Of that 3 percent most is either locked in polar ice caps or hidden beyond the practical reach of commercial technologies. Less than 1 percent of our water is found in lakes, rivers, and approachable underground aquifers. In addition, all freshwater sources are derived from either rainfall or snowmelt. This water then makes its way into the ground, or it flows into inland freshwater bodies or the ocean. Fresh water is a diminishing limited resource, and though we cannot increase the Earth's supply of water, we can manage what supplies we have more effectively.

Global consumption of water has been doubling every 20 years, more than twice the rate of human population growth. We are using water as if it is an infinite resource, but it's not. We are in fact depleting our planet's usable water supply. Shrinking fresh water supplies present the most urgent and potentially catastrophic environmental problem today worldwide (Barlow, 2002).

> **"The city of Tucson, Arizona, on Tuesday became the first municipality in the country to require developers of commercial properties to harvest rainwater for landscaping. The new water-saving measure - approved by a unanimous vote by the City Council -- mandates that new developments meet 50 percent of their landscaping water requirements by capturing rainwater. The new rule goes into effect June 1, 2010." http://www.biologicaldiversity.org/news/center/articles/2008/land-letter-10-16-2008.html.**

The United States population more than tripled from 76 million people in 1900 to 281 million people in 2000. The population growth of 32.7 million people in the 1990s was the largest

Effective May 12, 2008

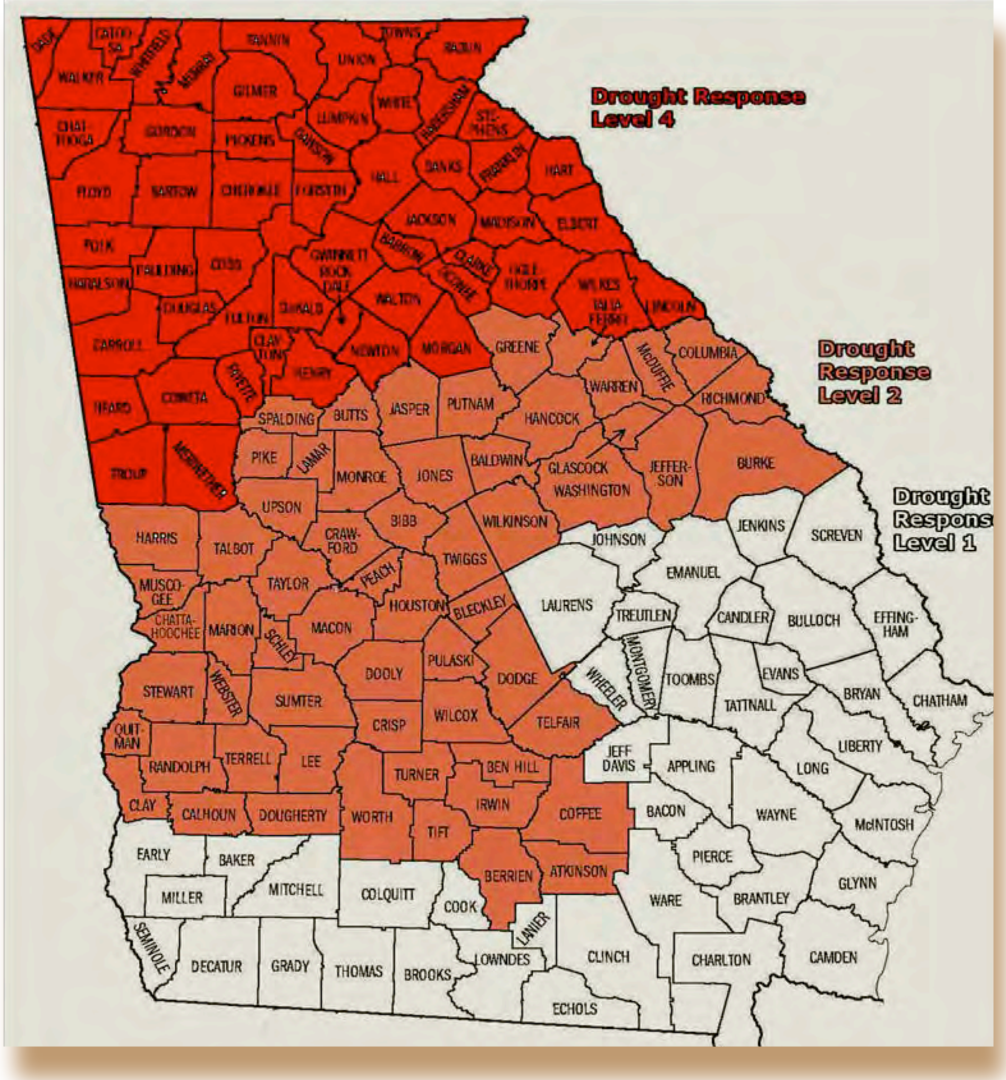

Figure 2.1 Statewide Water Level Restrictions in May, 2008

numerical increase of any decade in U.S. history (Hobbs, Frank and Nicole Stoops, U.S. Census Bureau, Census 2000 Special Reports, Series CENSR-4, Demographic Trends in the 20th Century, U.S. Government Printing Office, Washington, DC, 2002).

Statewide (Georgia) public-supply water use has increased steadily since 1980, corresponding to an increase in population during the same period. "Water use for public supply likely will continue to increase as the State's population grows."(http://ga.water.usgs.gov/pubs/other/ggs-ic106/pdf/ggs-ic106.pdf).

Excluding agriculture, one estimate for Georgia's average daily per-capita water consumption is estimated at 168 gallons compared with a national average of 153 gallons. Steps need to be taken to ensure that Georgia's water supply continues to meet the needs of the economy (Dodd, http://

www.gppf.org/article.asp?RT=20&p=pub/Water/envwateruse040528.htm). Georgia's economy cannot prosper and grow without a steady, secure supply of fresh water.

Georgia currently has approximately 7500 miles of streams and rivers not meeting water quality standards, with nearly 94% of those impairments due to nonpoint source pollution and urban stormwater runoff.

Rainwater harvesting systems address many water issues associated with population growth and urban expansion, such as reduced public water consumption, improved stormwater quality and increased soil infiltration.

We all use rainwater either directly or indirectly. Water from a municipal source, an example of an indirect use of rainwater, comes from a spring or reservoir fed by rainfall and snowmelt, the ultimate suppliers of these sources. Because the water runs across parking lots and highways, through fields that may have been treated by pesticides, down storm gutters, and into the lakes and streams, the municipal water authority has to treat the water with chemicals to kill pathogens and correct for pH. Harvested rainwater, an example of a direct use of rainwater, is not exposed to the same pollutants and therefore does not require the same level of treatment as water which flows overland and underground before it's collected. Public utilities have the added burden of maintaining existing supply and stormwater infrastructure as well as designing and building new pipelines and associated technologies (Texas Manual, 2006).

Rainwater harvesting can be envisioned as relieving, not replacing, some of the burden placed on the existing public utilities especially during times of drought and high demand.

During a Level 4 drought, virtually all outdoor water use is prohibited. A Level 4 drought is an "extreme drought," with lake levels, stream flows and rainfall at or approaching the lowest levels in 100 years. In Georgia, a Level 4 drought was declared in 2007 for the northern third of the state, including the metropolitan Atlanta area. The declaration was made because rainfall in this portion of the state was more than 20 inches below normal (see http://www.caes.uga.edu/topics/disasters/drought/totalrainfallmap .html) in 2007 and 2008, and stream flows were far below normal across the state.

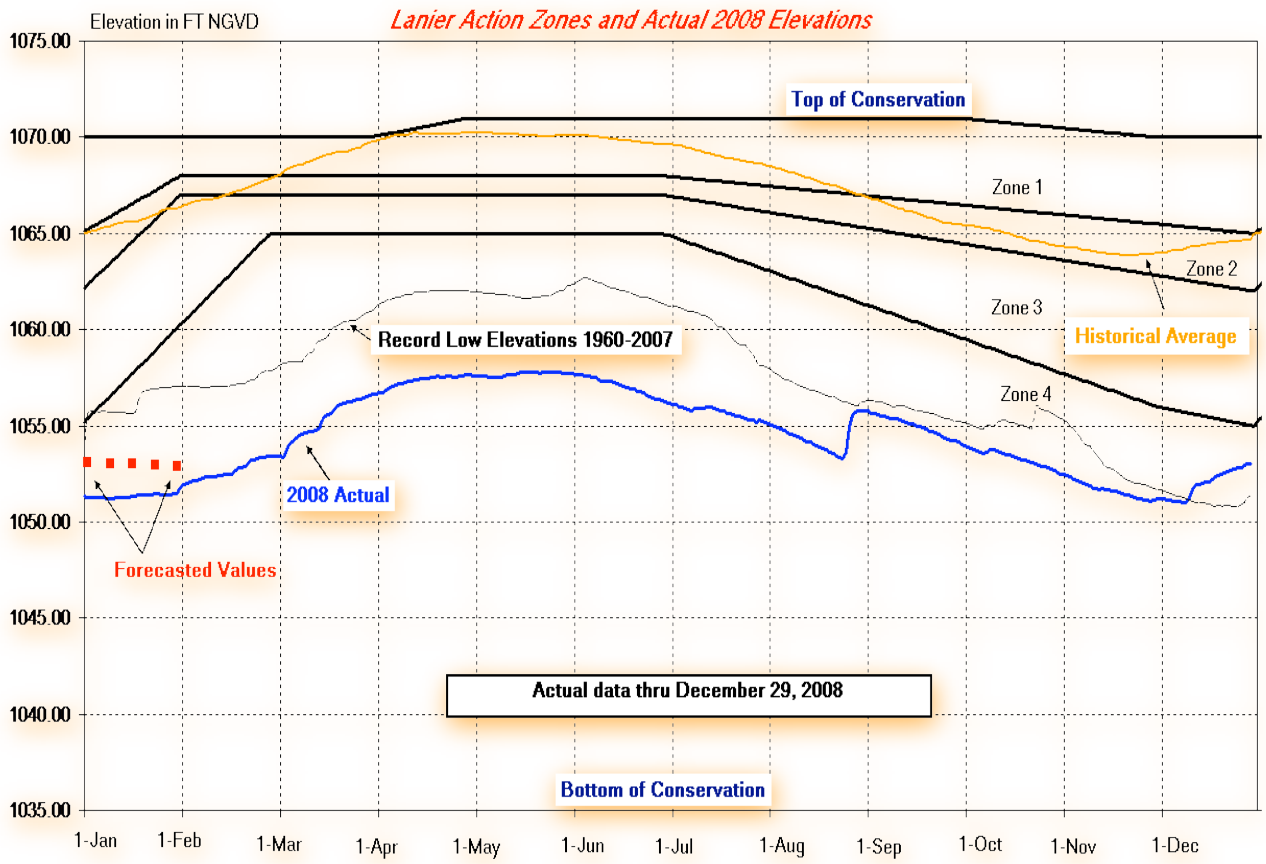

Figure 2.2 Lake Lanier Level Diagram for 2008

2.2 History

The collection and use of rainwater is not new. Long before centralized water delivery and treatment systems were built, our ancestors knew that access to water was a basic necessity for survival. Archeological evidence of RWH techniques dates back at least 4,000 years. Ruins of cisterns have been found in Israel, believed to be from 2,000 BCE. The concept of rainwater harvesting may date back 6,000 years (Gould and Nissen-Peterson 1999).

In the 20th century, large-scale public water systems were developed in industrialized countries and RWH became restricted to specialized applications and regions, such as on small islands and in semi-arid rural areas of the world. Law in the U.S. Virgin Islands and many other Caribbean Islands requires RWH due to limited fresh water sources. Interest in RWH in the United States and around the globe has grown significantly in recent years due to droughts and water shortages. RWH associations are forming in countries all over the world and many are now joining together in IRCSA to promote and advance rainwater catchment systems technology.

2.3 Current Usage of Rainwater

There may be as many as 250,000 RWH systems in use in the United States (Kincade, 2007). Texas, Virginia, Oregon, the state of Washington, and other states have developed guidelines for designing and installing rainwater harvesting systems. In Hawaii, up to 60,000 people depend on RWH systems for their water needs (Macomber, 2001). In India, since June 2001, the Ministry of Urban affairs and Poverty Alleviation has made rainwater harvesting mandatory in all new buildings with a roof area of more than 100 square meters and in all plots with an area of more than 1,000 square meters, that are being developed (http://www.rainwaterharvesting.org/Urban/Legislation.htm). In the United States some municipalities require RWH systems in new developments. Tucson, Arizona recently passed the nation's first rainwater harvesting ordinance for commercial properties. Currently more than 10 percent of New Zealanders rely on rainwater for their drinking needs (Abbott, 2008). In Australia 17 percent of households now source their water from rainwater tanks. Countries such as Germany, Australia, New Zealand, Great Britain, Sri Lanka, India, Pakistan and others are considerably farther along in their understanding and regulation of the use of rainwater. In some instances both local and national authorities insist on designed and installed rainwater catchment systems integrated into new developments.

Figure 2.3 Aerial Photo of Lake Lanier 2007

2.4 Response to Drought

By August 2000, 36 percent of the United States was in severe to extreme drought, leading to widespread wildfires and other drought-related damages (Natl Oceanic and Atmospheric Administration Climate of 2000 - September, U.S. Drought National Climatic Data Center).

According to Dr. David Stooksbury, state climatologist for the state of Georgia, the period between WWII and the late 1970s was an abnormally benign climatic period. Since the late 1970s we returned to a more normal climate pattern that involves greater year-to-year variability in temperature and rainfall. For city planners, public water authorities and the agriculture industry, this means increased difficulty in planning.

It has generally been taken for granted that there will always be a supply of clean water in Georgia and in our region as a whole. Recent drought conditions in the Southeast and in Georgia in particular have triggered many municipalities and governing bodies to place water restrictions on the use of municipal water (Figure 2.1, Statewide Water Level Restrictions). In some instances outdoor watering has been banned completely. Even more alarming is the possibility of implementing contingency plans for prioritized use of municipal water supplies. RWH has great potential for supplying water for various uses in the midst of these restrictions.

The city of Atlanta derives most of its water from Lake Lanier. In December 2008, lake

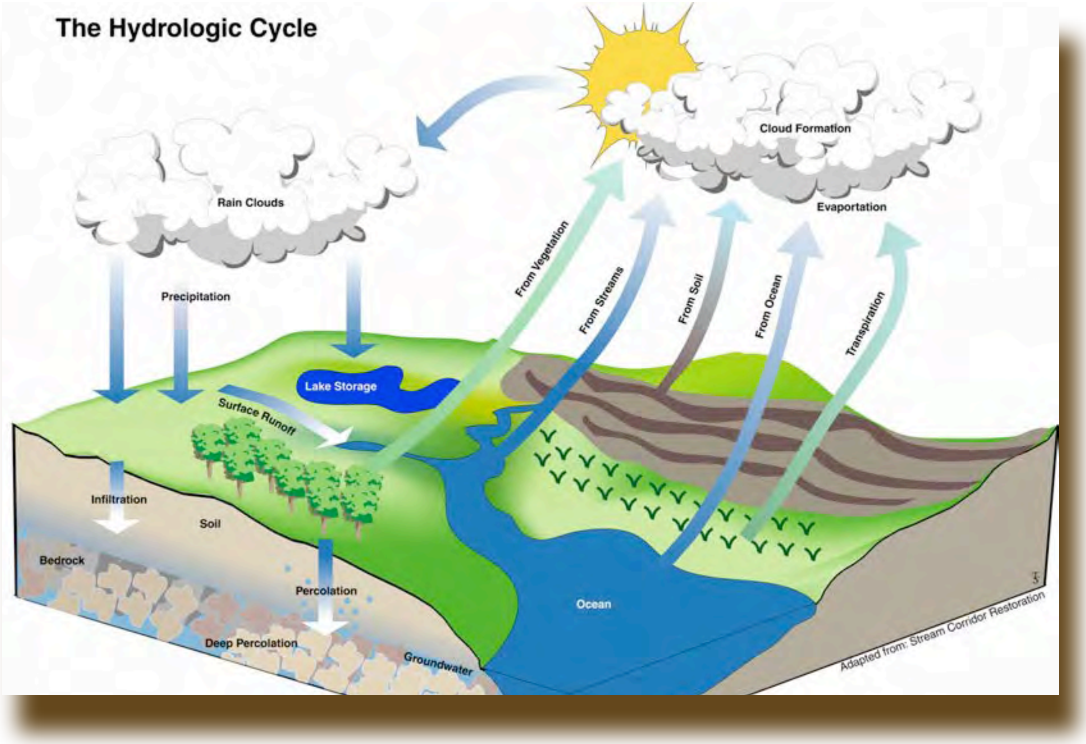

Figure 2.4 Basic Hydrological Cycle

levels were near the all time low (Figure 2.2, Lake Lanier Level Diagram). As difficult as this is to imagine, there is a finite amount of water in the lake. Once the water level goes below the level of the intakes, there is no way to extract any more water until the lake is replenished by additional rains, or until the intake is lowered, which could require dredging and large capital outlays.

Water rights and water availability are important and relevant topics today. Politics, industrial interests, and environmental concerns all play into this picture. The state boundary between Georgia and Tennessee has been recently disputed over water rights in the Tennessee River. The aerial view of drought-stricken Lake Lanier (Figure 2.3, Aerial Photo of Lake Lanier, 2007) makes it clear that actions must be taken to address water supplies in our State.

Water conservation is in the minds of many of our citizens and policy makers. Unlike other natural disasters, drought does not have a clearly defined beginning and end. As a result, our reaction to drought traditionally has not been timely. It is human nature to think that just because it rained yesterday that the drought is over. This is largely due to widespread lack

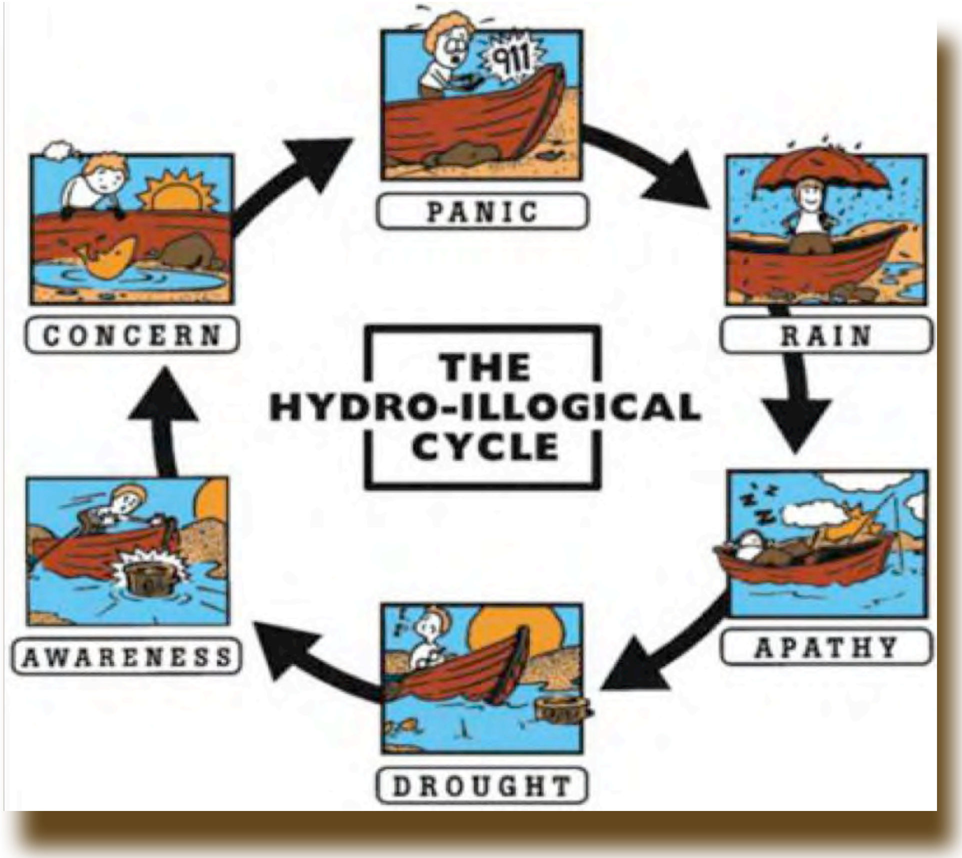

Figure 2.5 The Hydro-Illogical Cycle

of understanding of the basic hydrological cycle (Figure 2.4, Basic Hydrological Cycle). Public attention tends to wane after significant rain events and sometimes after small ones. The cartoon in Figure 2.5, The Hydro-Illogical Cycle, cleverly illustrates the point that appearances can be deceiving.

2.5 Benefits

Given the variability in the amounts and timing of rainfall received, collecting water when it comes in abundance for use at a later time is logical and sustainable. Integrating rainwater harvesting concepts into new construction design generally does not present overwhelming problems. Retrofitting most buildings to collect the rainwater that is ordinarily piped away is a relatively simple procedure. In many cases, the gutters, downspouts and pipes are already present on the building.

The numerous benefits and advantages in harvesting rainwater include the following:

- Rainwater is free. Although its initial equipment installation costs can be significant, long-term costs are workable, given our circumstances.
- Stored rainwater gives its owner more independence from the effects of irregularities of rain events.
- RWH is by nature decentralized and relatively less vulnerable to natural disasters than public water supplies.
- Harvested rainwater is low in minerals and it is ideal for activities such as car washing. Since it contains no chlorine, rainwater is also ideal for filling garden ponds and irrigating sensitive plants.
- Widespread adoption of rainwater harvesting can increase the efficiency of expensive water supply and stormwater conveyance infrastructure.
- Rainwater harvesting decreases the harmful volume of stormwater runoff as well as the nonpoint source pollutant load that enters streams, lakes and rivers.

2.6 Economics and Feasibility

Municipal water is generally purchased at relatively low rates throughout the state. According to EPA Region 4 Environmental Finance Center, the median monthly amount charged for minimum usage of water is $10.00, $20.50 for 6,000 gallons, and $29.50 for 10,000 gallons. As a point of comparison, a gallon of potable water at a major grocery retailer is $1.20 per gallon while the median bill for 6,000 gallons is $0.0034 per gallon which is approximately 350 times cheaper (http://www.efc.unc.edu/publications/pdfs/GA2007WaterSewerRatesReport.pdf).

For most Georgians, spending significant amounts of money on a RWH system is low on the priority list. When calculating the "payback" for a residential or commercial rain harvesting system, costing in the thousands of dollars, often the investment cannot be justified based only on the relatively cheap cost of municipal water. Perhaps it makes more sense to think in terms of the overall ecological benefit gained from reducing demands on public fresh water supplies.

For some individuals the satisfaction of catching the rain is motivation enough. Fresh water demands from ground sources (wells), both public and private can also be reduced by using rainwater. It is worth pointing out that in some instances, the only thing preventing the loss of an established landscape during periods of outdoor watering restrictions is a RWH system. For some residents, having the peace of mind that their new or existing landscape will survive and thrive is the only motivation needed to install a RWH system. In the case of some businesses in some municipalities in the Southeastern US, the ability to remain in business has depended on a functioning RWH system.

2.7 In Conclusion

Worldwide freshwater shortages clearly indicate that immediate action must be taken to implement RWH technologies. Rainwater Harvesting has been practiced since ancient times. We know from history that local and regional droughts occur on a regular basis throughout the world. We also know that many thousands of RWH systems exist throughout the US and that when they are properly designed and installed they are able to provide many benefits, most immediately to alleviate pressure on municipal and private water supplies. Understanding how to implement these technologies is key in rainwater harvesting as a viable safe supplement to a shrinking water supply.

CHAPTER 3

SYSTEM SIZING AND WATER BALANCING

RWH systems can range from the very simple to the very complex. It is absolutely fundamental to determine the reasons for collecting rainwater prior to designing any system. There are many reasons for wanting to have a RWH system; however, three of the most important reasons are:

- Water conservation and supplemental water supply;
- Stormwater retention and runoff reduction; and
- Achieving Green building goals.

Examining these three areas (water conservation, stormwater retention and runoff reduction, and Green building) helps focus on the benefits of collecting rainwater and establishes specific parameters in designing a rainwater system. Rainwater harvesting may assist a project in meeting specific goals or regulatory requirements related to water efficiency or stormwater runoff.

3.1 Water Conservation

Conservation practices are those that help us extend the usefulness of a specific resource. Water conservation makes good economic sense and is sometimes law for private and public commercial buildings, educational facilities and homes. For example, the Energy Policy Act of 1992 requires that from January 1994 onward all toilets sold in the United States use no more than 1.6 gallons of water per flush, well below the 3.5 gallons per flush used by most American toilets (Energy Policy Act of 1992. Public Law 102486, 102nd Congress. Washington, D.C. Oct. 24, 1992 http://www.cepis.ops-oms.org/muwww/fulltext/repind48/energy/energy.html).

Georgia's average daily per-capita water consumption, excluding agriculture, is estimated at 168 gallons compared with a national average of 153 gallons. Only one percent of this water is used for drinking purposes (Benita Dodd, Georgia Public Policy Foundation (May 28, 2004), http://www.gppf.org/default.asp?pt=news&RT=20).

Even during times of drought there is plenty of rainfall in Georgia that can be harvested and used to supplement the demands for non-potable purposes such as landscape watering, toilet and urinal flushing, and cooling tower makeup.

Water used for non-potable purposes does not require the same level of treatment as water that must meet EPA drinking water quality standards. In order to safely serve these needs, this water must have, however, appropriate quality. See Chapter 5 for more information on water quality.

End-use	Gallons per capita	% of Daily Total
POTABLE INDOOR USES:		
Showers	11.6	7%
Dishwashers	1	0.60%
Baths	1.2	0.80%
Faucets	10.9	6.60%
Other uses, leaks	11.1	6.70%
Subtotal potable indoor uses	35.8	21.70%
NON-POTABLE INDOOR USES:		
Clothes washers (Not permissable per code in GA)	15	9.10%
Toilets	18.5	11.20%
Subtotal non-potable indoor uses	33.5	20.30%
NON-POTABLE OUTDOOR USES	95.7	58%

Table 3.1 Percentage of water uses

3.2 Stormwater Retention and Runoff Reduction

Researchers at the University of Georgia have compiled data on the extent of impervious surfaces in Georgia. Statewide, impervious cover increased by 81% between 1991 and 2005, an addition of nearly 370,000 acres. While the greatest number of acres was added in the Piedmont ecoregion, increases were seen across the state (Table 3.2) (http://www.gaepd.org/Files_PDF/soe/epd_soe_2009_obj2.pdf). In urban areas across the state, rain falls on a roof surface, travels through a gutter/piping network, and eventually arrives as stormwater in a creek or river. Impervious surfaces force water to flow rapidly through stormwater systems and thus overwhelm creek and stream banks, causing ongoing ecological degradation. Rainwater harvesting reduces the volume of stormwater that enters streams and rivers, thus mitigating the adverse effects of impervious surfaces.

Unfortunately in some urban environments in Georgia, sewage and stormwater still flow in

Ecoregion	Change in acres of impervious surface	Percent change
Ridge and Valley & Southwestern Appalachians	27,783	89%
Blue Ridge	7,535	121%
Piedmont	238,532	111%
Upper Coastal Plain (Southeastern Plains)	62,344	42%
Lower Coastal	32,434	63%

Table 3.2 Changes in impervious surface cover, 1991-2005. (Natural Resources Spatial Analysis Laboratory, University of Georgia)

the same pipe networks. During particularly heavy rain events, raw untreated sewage may be carried directly into creeks and streams. Harvesting some of the rainwater before it enters the stormwater drainage system can help reduce peak flow volumes during these rain events and therefore lessen the environmental impacts of these combined systems.

Stormwater management requirements can be partially achieved by incorporating RWH as an integral part of the design (http://www.lowimpactdevelopment.org/). Low Impact Development (LID) is a design and site development methodology that allows newly developed and/or existing sites to hydrologically mimic pre-development conditions. For example, if a forested area is developed for commercial purposes, one LID goal would be to mimic some of the hydrological functions of trees and encourage

The National Green Building Standard offers the following points for rainwater collection:

801.11 Rainwater collection and distribution.

(1)Rainwater is collected and used: 6 points

(2)Rainwater is distributed using a renewable energy source or gravity: 2 points

Courtesy of NAHB 2009

(National Association of Home Builders)

www.nahbrc.org/technical/standards/gbversion1_chapter08.pdf

Harvested Water (gal) =
catchment area (sq.ft.) X depth (in.) X 0.623
(conversion factor)

A simple estimate of the number of gallons that can be harvested from a given catchment area after a rainfall event can be determined with the following formula. The total number of gallons harvested is equal to the catchment area (square feet) times the depth of a rainfall (inches) times a conversion factor of 0.623.

rainwater retention, cleansing, and infiltration of site rainwater rather than runoff. Capturing rain and encouraging it to soak into the ground close to the location where it falls, is a primary goal of LID. A RWH system can act as a large sponge, absorbing and storing water for later use. The water can then be released at a slower rate via landscape watering.

The Georgia Stormwater Management Manual (the GSWMM or "Blue Book") is a technical tool to manage post-construction stormwater, and is required to be used for new and re-development in many large and small urban areas in Georgia. The Coastal Stormwater Supplement to the GSWMM, which includes coastal-specific stormwater practices, places an emphasis on better site design and infiltration, evapotranspiration and reuse of stormwater. Both stormwater manuals discuss reduction of nonpoint source pollutant loads, which can be partially accomplished through RWH methods. (www.georgiastormwater.com).

3.3 Green Building

With the growing awareness of the need to reduce our footprint on the environment, a new movement toward a more conscious, sustainable and wise development has been dubbed green building. Many building organizations have programs with rating systems for new developments, homes and commercial buildings. These rating systems are based in sustainability standards. Rainwater harvesting can assist in achieving the desired level of green. For example, the National Association of Home Builders (**NAHB**) has a program that awards points for integrating a RWH system into the construction of new homes. **NAHB,** the International Code Council (ICC) and the **NAHB** Research Center have initiated a process for the development of an ANSI standard for Green home building construction practices, which is titled The National Green Building Standard™ (http://www.nahbrc.org/technical/standards/gbinvitation.aspx). Selecting materials for rainwater systems based

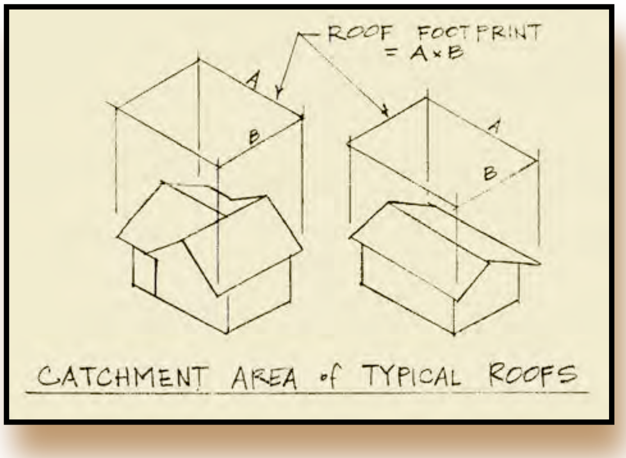

Figure 3.1 Catchment area of typical roofs

Note: It is important to understand that regardless of the pitch, the shape, or the complexity of any roof surface, it is the overall footprint of the building that determines the collection area. (see Figure 3.1)

on locally available components and equipment containing recycled content may achieve further credit.

3.4 System Sizing

A basic goal for sizing any rainwater harvesting system is to balance the volume of water that can be captured and stored (supply), compared to the volume of water used (demand). In order to “balance” the system, the supply must equal or exceed the demand. This is easiest to understand if broken down on a monthly basis.

In Georgia, the longest anticipated period between rain events is normally less than 30 days. However, no measurable rain fell from September 25th through November 4th, 2000 for a total of 41 consecutive dry days, a record in the state (http://www.ncdc.noaa.gov/oa/climate/extremes/2000/october/octoberext2000.html). This is clearly not the norm.

The rainfall distribution in Georgia is such that storage capacity can be smaller than in other areas of the country (arid southwestern states) where rainfall occurs more seasonally (longer periods of time between rain events). Storage capacity needs to be sufficient to store water collected during heavy rain events to last through dry periods. Some residences might be constrained by the size of the collection surfaces and/or the volume of storage capacity that can be installed due to space or costs. The following sections describe ways to determine the amount of rainfall, the estimated demand, and how much storage capacity is needed to provide enough rainwater to meet the demand. The rainfall data for selected Georgia cities is found in Table 3.3 Major Georgia Cities Annual Precipitation.

City	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
ATHENS	4.69	4.39	4.99	3.35	3.86	3.94	4.41	3.78	3.53	3.47	3.71	3.71	47.83
ATLANTA	5.03	4.68	5.38	3.62	3.95	3.63	5.12	3.67	4.09	3.11	4.10	3.82	50.20
AUGUSTA	4.95	4.11	4.61	2.94	3.07	4.09	4.07	4.48	3.59	3.20	2.68	3.14	44.58
COLUMBUS	4.78	4.48	5.75	3.84	3.62	3.51	5.04	3.78	3.07	2.33	3.97	4.40	48.57
MACON	5.00	4.55	4.90	3.14	2.98	3.54	4.32	3.79	3.26	2.37	3.22	3.93	45.00
SAVANNAH	3.95	2.92	3.64	3.32	3.61	5.49	6.04	7.20	5.08	3.12	2.40	2.81	49.58
VALDOSTA	5.79	4.47	5.30	3.61	3.15	4.91	6.30	5.24	4.11	3.11	3.24	3.83	53.06

Table 3.3 Major GA Cities Annual Precipitation 1971-2000 - 30 year average (inches)

NOAA – National Weather Service Forecast Office, www.srh.noaa.gov Weather Channel, www.weather.com

3.5 How Much Water Can Be Captured?

Approximately 0.62 gallons per square foot of collection surface per inch of rainfall can be collected during a rain event. Some rainwater is lost to first flush (see components, see glossary), evaporation, splash-out or overshoot from the gutters in hard rains, and possible leaks. Rough collection surfaces are less efficient at conveying water, as some of the water captured on porous surfaces tends to be lost to evaporation. A much more in depth analysis of how to calculate potential harvested rainwater is available through the ARCSA website (http://www.arcsa.org/resources.html) in their guidelines publication.

•Collection Surface

The collection surface is the “footprint” of the roof. In other words, regardless of the pitch or shape of the roof, the effective collection surface is the area covered by collection surface (length times width of the roof from eave to eave and front to rear). Obviously, if only one side of the structure is guttered, only the area drained by the gutters is used in the calculation. (For commercial buildings refer to the plumbing code for drain pipe sizing.)

•Rainfall Distribution

According to the Georgia State Climatology Office, average annual rainfall in Georgia varies from a low of about 40 inches in Montgomery County to a high of over 80 inches in isolated mountainous areas in the northeastern part of the state. If the rainwater harvesting system is intended to be the sole water source for a specific use, the catchment area and storage capacity must be sized to meet the water demand through the longest expected interval without rain. If additional water is required, other water sources must be considered to supplement the collected rainwater.

Some rainfall collected from high-intensity, short-duration rain events, may be lost to overflow from storage tanks or splash out from the gutters. Since these intense rainfall events are considered part of the cumulative annual rainfall, the total available volume is rarely captured.

Another consideration is that annual rainfall is not evenly distributed throughout the twelve months of the year. Statewide average monthly precipitation ranges from 3.4 inches in November to 5.3 inches in July. The monthly distribution of rainfall is an important factor to consider for sizing a system.

•Monthly Rainfall Estimation

Rainfall estimates should always be prepared for a specific locale, using the best data that apply to that area. Two different estimators of monthly rainfall are commonly used: average rainfall and median rainfall. Taking the sum of historical rainfall and dividing by the number of years of recorded data calculates average annual rainfall. Median rainfall is the amount of rainfall that occurs in the midpoint of all historic rainfall totals for any given month. In other words, historically for the month in question, half of the time the rainfall was less than the median and half of the time rainfall was more than the median.

Information on rainfall data is available from numerous public sources, including the National Climate Data Center website (NOAA, Climatography of the United States No. 85, Section 2: Precipitation. NCDC: National Climatic Data Center (NCDC).

3.6 Calculating Storage Capacity

Once the potential for rainfall capture volume is known from rainfall data and catchment area, the next step is to calculate storage capacity. The decision of whether rainwater will be used for irrigation, non-potable domestic use, or both, will factor into how much water will be used, thus dictating water demand and storage capacity.

If a rainwater harvesting system is to be the sole water supply for a set of specific uses, overbuilding ensures a safety margin. If budget constraints do not allow the user to install as much storage capacity as a sizing method indicates, it is important to provide an area where additional tanks or cisterns can be installed at a later date when finances permit (Texas Manual, 2006).

Rainfall (in.)	Area(Sq. Ft.)	X Gallons/Sq. Ft.	Total Gallons
1	2,200	0.62	1,364.00
5	2,200	0.62	6,820.00
10	2,200	0.62	13,640.00
40	2,200	0.62	54,560.00
50	2,200	0.62	68,200.00
1	3,500	0.62	2,170.00
5	3,500	0.62	10,850.00
10	3,500	0.62	21,700.00
40	3,500	0.62	86,800.00
50	3,500	0.62	108,500.00
1	5,000	0.62	3,100.00
5	5,000	0.62	15,500.00
10	5,000	0.62	31,000.00
40	5,000	0.62	124,000.00
50	5,000	0.62	155,000.00

Table 3.4 Table for rainwater potential collection from roof surfaces

•Monthly Demand and Supply

One method of determining the feasibility of a proposed system is the monthly water balance method. This method of calculation is similar to maintaining a monthly checkbook balance. Starting with an assumed volume of water already in the tanks, the volume captured each month is added to the previous balance and the monthly demand is subtracted. The initial volume of water in the tanks would be provided by hauling or capturing water prior to withdrawing water from the system. Data and calculations can be entered on an electronic spreadsheet to enable the user to compare different variables of catchment area and storage. It is suggested that prospective system owners experiment with different variables of storage capacity and, if applicable, catchment surface to find the desired level of performance and affordability for catchment size and storage capacity.

•Estimating Demand

North American households use approximately 146,000 gal of water annually, according to the American Water Works (AWWA) Research Foundation. Of this amount, 42 percent is used indoors, and the remaining 58 percent is used outdoors. By far the largest percentage of indoor water use occurs in the bathroom for toilet flushing (18.5 gal/person/day) and showering (11.6 gal/person/day). Clothes washers were the second largest water users (15 gal/person/day).

If a separate irrigation meter is not provided, a simple method for most residences of estimating outdoor irrigation demand is analyzing the water bill and comparing water usage between the summer and winter months. If water is used for landscape and gardening, there will typically be a spike in volume used. The difference between the summer and winter months will typically be the monthly outdoor usage. It is shocking to many people when they discover the vast volume of water that is used to water lawns.

•Estimating Indoor Water Demand

Currently the only approved applications of rainwater in Georgia for indoor purposes are toilet and urinal flushing and cooling tower make-up. Although a number of states have approved rainwater for use in automatic clothes washers (washing machines), this is not permissible in Georgia.

Most American families flush the toilet an average of 4 times per day per person. Calculating 1.6 gallons per flush, a family of four will use approximately 25.6 gallons per day or a total of 768 gallons per month. If toilet flushing will be the sole usage of rainwater for a household, then planning for 30 days with minimal or no rain, would require a storage tank of at least 768 gallons, or the next closest size (AWWA http://www.cepis.ops-oms.org/muwww/fulltext/repind48/energy/energy.html).

3.7 Water Conservation and System Sizing Are Linked

It is impossible to separate water conservation from system sizing, because the water demand determines the system size. Consciously conserving water (water-conserving plumbing fixtures, shorter showers, less outdoor irrigation, etc.) decreases the total demand. This results in more efficient use of our resources and enables us to do more with what we already have. For information on residential water efficiency, visit the Water Saver Home website (www.h2ouse.org), a virtual encyclopedia of water-saving tips, and AWWA's drinktap.org consumer website.

3.8 Summary

Rainfall events are complicated and an indepth understanding of local rainfall is imperative. Those comtemplating designing or installing a RWH system should have an adequate amount of rainfall data, in order to properly size their system (ARCSA GUIDE 2009, Chapter 8).

CHAPTER 4

HARVESTING COMPONENTS

4.1 Introduction and Fundamental Elements

Rainwater harvesting is the capture, diversion, and storage of rainwater for a number of different purposes including landscape irrigation, non-potable domestic use, aquifer recharge, and storm water abatement. Understanding how the fundamental components of a rainwater system work is crucial when contemplating designing or installing a RWH system (See figure 4-3, Rainwater Harvesting Flow Chart).

Rainwater systems are available in many configurations. Some have below ground storage tanks, above ground tanks, indoor controls, and some have outdoor controls. Figures 4.1 and 4.2 illustrate the primary components of each type. If the end use is

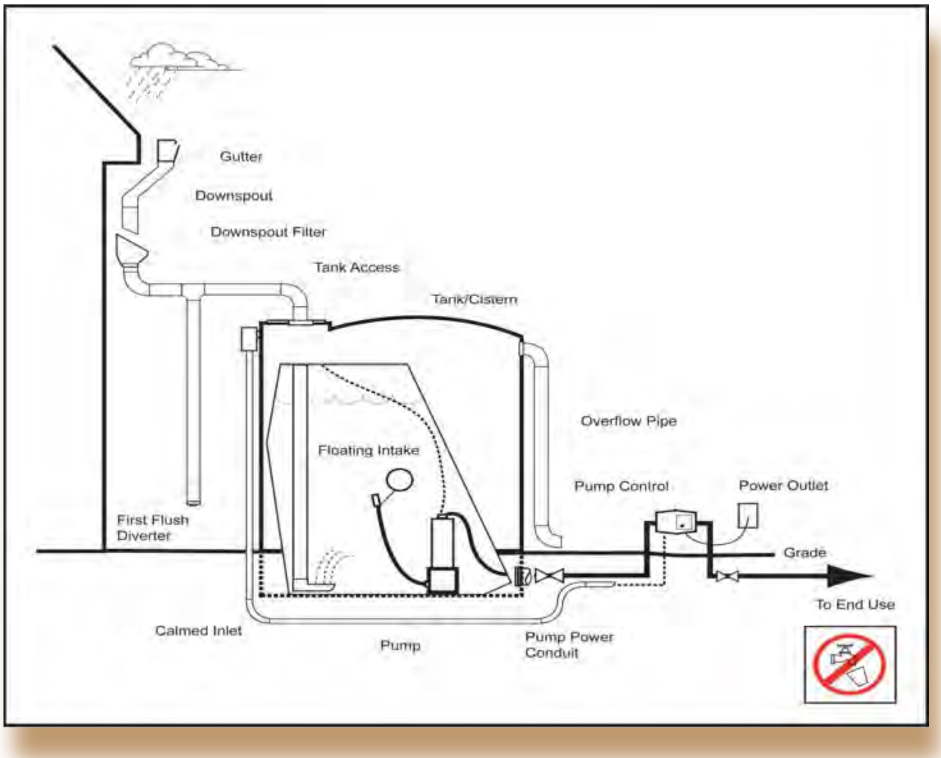

Figure 4.1 Diagram of above ground cistern

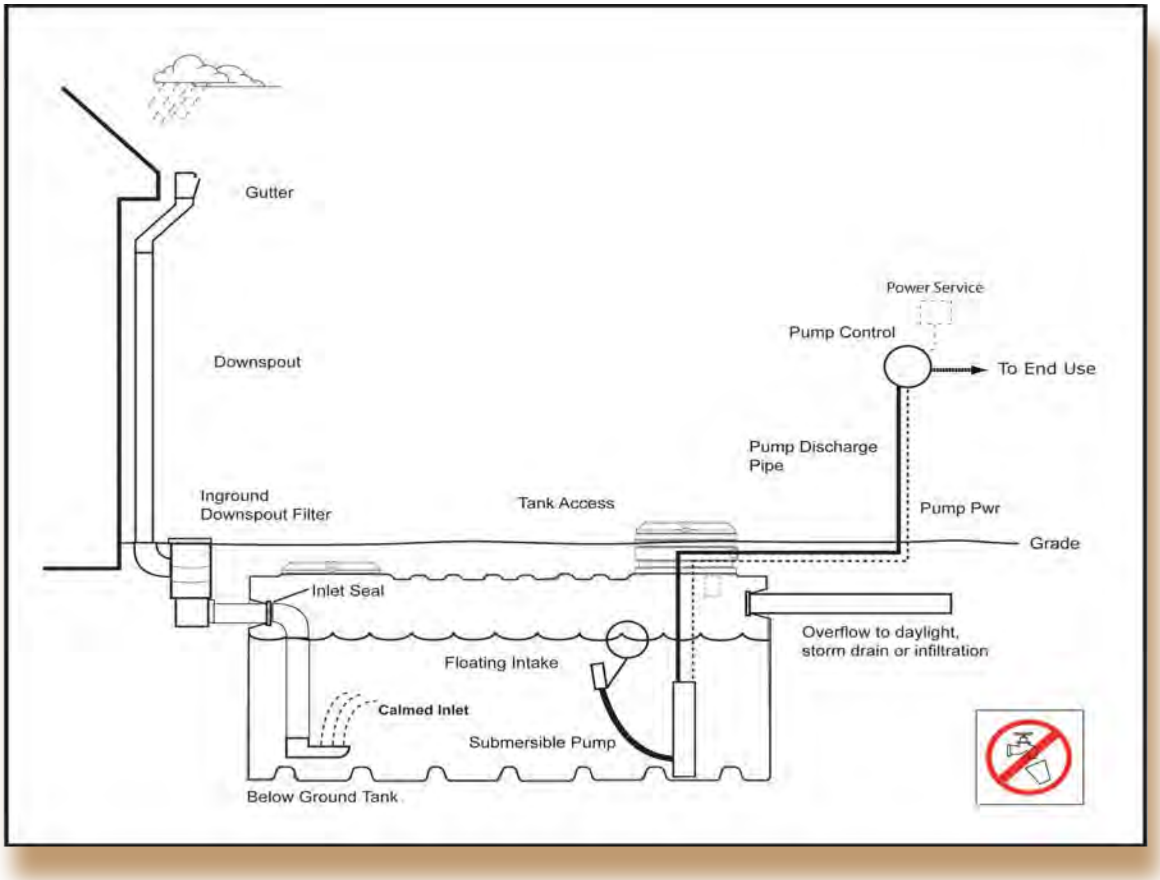

Figure 4.2 Diagram of below ground cistern

indoors for toilet and urinal flushing, or for cooling tower make-up, treatment components are included as well.

Many factors influence component selection when designing or selecting the right rainwater system for a specific end use application. Gutters, downspouts, buried utilities, soil types, soil depths, slopes, site drainage, existing plumbing, electricity, diversion of overflows, local restrictions, neighborhood covenants, and neighbors are some of the many items that deserve attention when siting RWH systems. Regardless of the complexity of the system, rainwater harvesting systems are comprised of five basic elements:

- Gutters and downspouts: conduits that channel water from the roof to the tank.
- Downspout filtration, leaf screens, first-flush diverters, and roof washers: components that remove debris and dust from the captured rainwater before it goes to the tank.
- Storage: one or more storage tanks, also called cisterns.
- Pumps and controls: devices such as level indicators, makeup water supplies, back flow preventers and/or air gaps.
- Treatment and disinfection: for non-potable indoor systems, filters and other methods to make the water suitable for use in toilet flushing, urinal flushing and as cooling tower make-up.

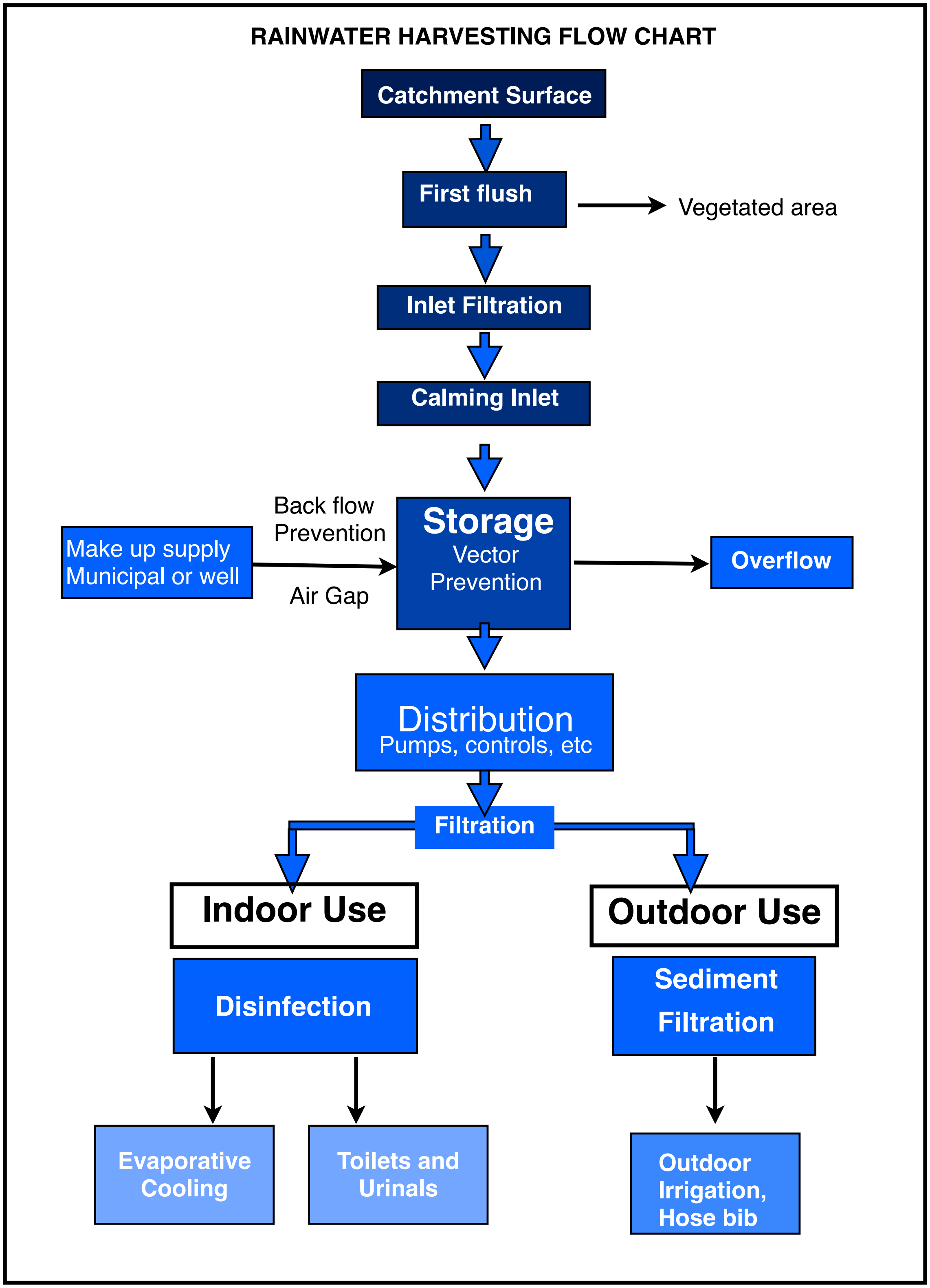

Figure 4.3 Rainwater Harvesting Flow Chart

4.2 The Catchment Surface

The roof of a building or house for purposes of this document is the only choice for the catchment surface. Water quality from different roof catchment surfaces is a function of the type of roof material, climatic conditions, and the surrounding environment (Vasudevan, 2002). Common sense should prevail in deciding whether or not to collect water from a particular surface. Care should be taken in considering how certain roofing materials that come in direct contact with rainwater affect its quality. Once again, the end use will ultimately determine the viability of a given surface. The major roof surface types commonly found in Georgia are listed below. The surface texture affects the quantity of rainwater that can be collected from a given roof, the smoother the better (Texas Manual, 2006).

-Metal Roof

Powder coated steel is one of the best surfaces to consider. It is very smooth and water sheds off it easily during rain events. In addition, it resists corrosion for extended periods of time. Although relatively more expensive than other roof materials, metal roofs will outperform most other types over time.

-Clay/Concrete and Tile Roof

Clay and concrete tiles are both porous. These materials contribute to as much as a 10 percent loss due to texture, inefficient flow, or

Condensate

While technically not originating from a roof surface, condensate from air-conditioning (dehumidification) units collectively represents a significant source of water in both residential and commercial applications. The amount of water that can be collected from any given indoor environment varies greatly, depending on seasonal climatic conditions, HVAC equipment and building size. Five to twenty-five gallons per day can be collected from many single family residences. Significantly larger volumes can be collected in commercial applications. This condensate water can be routed either by gravity flow, or with the aid of a condensate sump pump directly to the rainwater storage tank.

evaporation. To reduce water loss, tiles can be painted or coated with a sealant. There is some chance of toxins leaching from the tile sealant or paint, but this roof surface is safer when coated with a special sealant or paint to prevent bacterial growth on porous materials. The potential for chemical leaching should be considered if the water will be used for livestock, fish ponds, or other end uses with special water quality considerations (Texas Manual, 2006).

-Composite or Asphalt Shingle

The vast majority of residential roof surfaces in the United States are made of composite asphalt shingles. For applications discussed in this guide, i.e., non-potable indoor use and outdoor irrigation, there is little evidence to suggest serious detrimental water quality impacts resulting from rainwater from this type of surface. If significant amounts of contaminants are coming from an asphalt shingled roof, take additional precautions before watering edible plants. Once again, end-uses will determine the viability of a given collection surface, especially when irrigating edible plants. Cistern water should be protected from asphalt shingle grit granules and be screened by a fine downspout filter.

-Wood Shingle, Tar, and Gravel

These roofing materials are increasingly rare in new construction, and the water harvested from this type of surface can contain certain contaminants that may limit its use, due to leaching of some chemical compounds (Texas Manual, 2006).

-Slate

Slate's smoothness makes it ideal for a catchment surface. However, cost consideration may preclude its use.

-Vinyl/rubberized

There are many new roofing materials on the market today primarily used in commercial construction. These materials typically have thermally or chemically welded seams. Check with the roofing material manufacturer for suitability as a collection surface.

4.3 Gutters and Downspouts

Roof gutters direct the flow of rainwater running off the eaves of a building. Some gutter installers can provide continuous or seamless gutters. The most common materials for gutters and downspouts are half-round PVC, vinyl, and seamless aluminum. Regardless of material, other necessary components in addition to the horizontal gutters are the drop outlet, which routes water from the gutters downward through the downspout pipe. Whenever possible, fit the downspout pipe snugly to the side of the house. If this is not possible then simply make sure that the pipe is stable and is firmly connected to the inlet of the tank using rubber grummets. Avoid downspouts/pipes installations that

A calming inlet is designed to mix the relatively more anaerobic water at the bottom of the tank with the more oxygenated water closer to the surface of the tank. This is installed at the end of the inlet pipe and rests on the bottom of the tank.

Figure 4.4 Calming Inlet

could be easily knocked out of position. Sound building and construction practices should prevail. Additional components include the hardware, brackets, and straps to fasten the gutters and downspout to the fascia and the wall, and finally to the storage tank itself. (Texas Manual, 2006).

-Gutter Sizing and Installation

Always check with the local building authority as to compliance with local codes and ordinances. It is important to consider that many roofs consist of one or more roof “valleys”. A roof valley occurs where two roof planes meet. This is most common and easy to visualize when considering a house with an “L” or “T” configuration. A roof valley concentrates rainfall runoff from two roof planes before the collected rain reaches a gutter. Depending on the size of roof area terminating in a roof valley, the slope of the roof, and the intensity of rainfall, the portion of gutter located where the valley water leaves the eave of the roof may not be able to capture all the water at that point. This can result in excessive spillage or overrunning. Therefore consider installing an overrun dam to minimize water lost at these valley points during heavy rain events (Texas Manual, 2006).

Other factors that may result in over running of gutters include an inadequate number of downspouts, excessively long roof distances from ridge to eave, steep roof slopes, and inadequate gutter maintenance. Variables such as these make any gutter sizing rule-of-thumb difficult to apply. Consult your gutter supplier/ installer about your situation with special attention to determine where excessive splash-out may occur (Texas Manual, 2006).

Gutters should be installed with a slope towards the downspout. Sound building practices should prevail whenever modifying or installing a new roof gutter system.

4.4 Primary Filtration

To remove debris that gathers on the catchment surface, and assure high quality water, some filtration is necessary. Some of the many types of filters are shown below.

Figure 4.5 Downspout filter

-Leaf Screens

The best first defense in keeping debris out of a rainwater harvesting system is a leaf screen along the gutter or in the downspout. It helps prevent large debris from entering the storage tank. These screens are usually made of 1/4 inch mesh in wire frames that fit along the length of the gutter. Leaf screens must be regularly cleaned to be effective. If not regularly maintained, leaf screens can become clogged and prevent rainwater from flowing into the tank. Built-up debris can also harbor bacteria and compromise the quality of water.

Leaf guards/screens are necessary in locations where trees are nearby or overhanging (most locations in the Southeastern U.S.). Guards with profiles conducive to allowing leaf litter to slide off are also available.

-Downspout Filters

The funnel-type downspout filter is typically made of PVC and fitted with an aluminum or stainless steel screen (see Figure 4.5). This type of filter offers the advantage of easy accessibility for cleaning. The funnel is cut into the downspout pipe at the same height or slightly higher than the highest water level in the storage tank. Care must be taken to have the filter high enough to prevent contamination from dogs, but low enough not to discourage the owner/operator from maintaining and cleaning the filter on a regular basis.

-Strainer Baskets

Strainer baskets are spherical cage-like strainers that fit into the inlet of the tank. The homeowner may need to experiment with various strainer basket screen sizes. Available screen sizes range from fine filters to coarse mesh sizes. See Figure 4.6.

Figure 4.6 Strainer Basket

An exact one size fit-all formula for calculating how much initial water needs to be diverted from the tank as first flush does not exist because there are so many variables. For example, the slope and smoothness of the collection surface, the intensity of the rain event, the length of time between events (which adds to the amount of accumulated contaminants), and the nature of the contaminants. In order to effectively wash a collection surface and thus reduce the amount of contaminants entering the collection storage, one must take into account the factors previously mentioned.

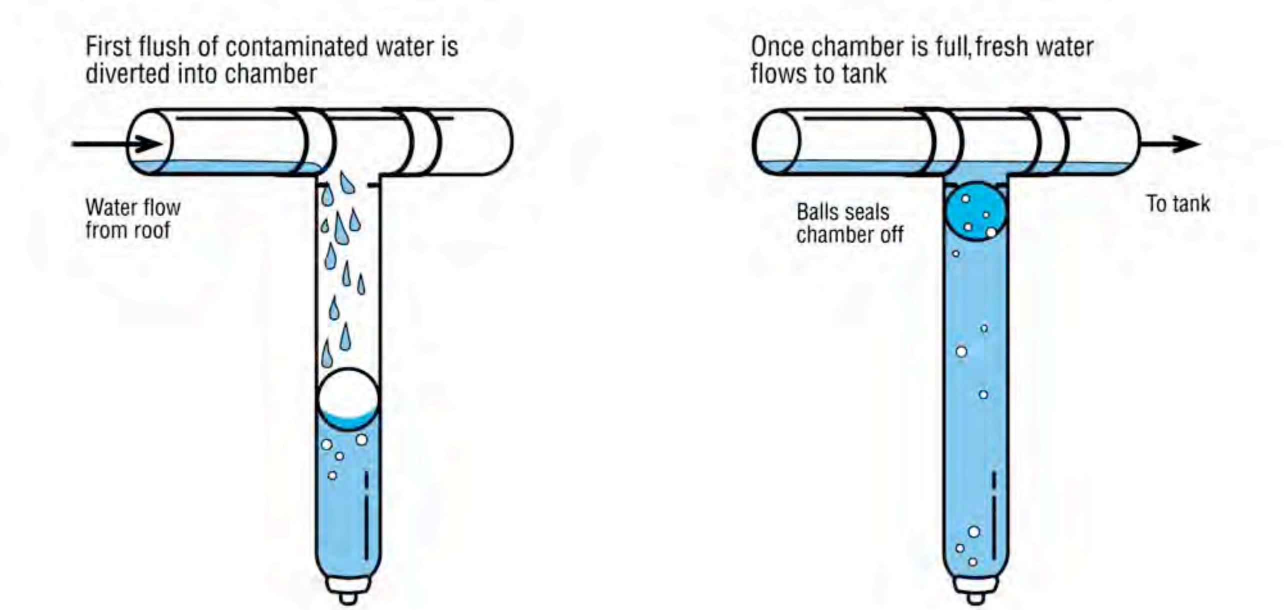

Figure 4.7 First Flush Diverter

-First-Flush Diverters

A roof can be a natural collection surface for dust, leaves, blooms, twigs, insect bodies, droppings, pesticides, and other airborne residues. The first-flush diverter routes the first flow of water from the catchment surface away from the storage tank. The flushed water can be routed to a planted area. While leaf screens remove the larger debris, such as leaves, twigs, and blooms that fall on the roof, the first-flush diverter gives the system a chance to rid itself of the smaller contaminants, such as dust, pollen, and bird and rodent droppings.

The simplest first-flush diverter is constructed with a PVC standpipe. The standpipe fills with water first during a rainfall event; the balance of water is routed to the tank. The standpipe is drained continuously via a pinhole or by

Figure 4.8 Wooden tank

leaving the screw closure slightly open. In any case, cleaning of the standpipe is accomplished by removing the PVC cover and removing collected debris after each rainfall event (Texas Manual, 2006). There are several other types of first-flush diverters. The ball valve type consists of a floating ball that seals off the top of the diverter pipe (Figure 4.7) when the pipe fills with water. Opinions vary on the volume of rainwater to divert to the first flush device. The number of dry days, amount and type of debris, and roof surface are all variables to consider.

4.5 Storage

The storage tank or cistern generally is the most critical design component of a rainwater harvesting system. In most cases it is permanent and its placement should be carefully thought out.

The size of the storage is dictated by several variables including: the rainwater supply (local precipitation), demand, projected length of time without rain (dry spells), catchment surface area (larger area equals more water), aesthetics, personal preference, and budget. A myriad of variations on storage tanks and cisterns have been used over the centuries,

MATERIALS	FEATURES	CAUTION
Plastics		
Barrels 55 gal -150 gal	Commercially available; Inexpensive	Use only new cans
Fiberglass	Commercially available; Alterable and moveable	Must be sited with smooth solid level footing
Polyethylene/polypropylene	Commercially available; Alterable and moveable	May be UV-degradable, can be painted or tinted if not inhibited
Metals		
Steel Drums (55-gallons)	Commercially available; Alterable and movable	Verify prior to use for toxics; Prone to corrosion and rust
Galvanized steel tanks	Commercially available; Alterable and moveable	Possible corrosion and rust; Should be lined for indoor use
Concrete and Masonry		
Ferrocement	Durable and immoveable	Potential to crack and fail
Stone, concrete block	Durable and immoveable	Difficult to maintain
Monolithic/Poured-in-place	Durable and immoveable	Potential to crack and fail
Wood		
Treated pine, fir, cypress	Attractive, durable, can be disassembled and moved	Expensive

Table 4.1 Storage tank materials descriptions

Height (feet)	6-foot Diameter	12-foot Diameter	18-foot Diameter
6	1269	5073	11414
8	1691	6764	15220
10	2114	8455	19025
12	2537	10146	22830
14	2959	11837	26634
16	3882	13528	30439
18	N/A	15219	34244
20	N/A	16911	38049

Table 4.2 Tank volume for a given height and diameter (gallons)
Note: Approximately 10% of volume is lost to the anaerobic zone at the bottom of the tank.

some of which are: earthenware cisterns, large pottery containers, above-ground vinyl-lined swimming pools, concrete or brick cisterns, galvanized steel tanks and site-built stone-and-mortar cisterns (Texas Manual, 2006).

An above-ground storage tank need not to be an eyesore. Plastic or metal tanks can be wrapped with wood and fitted with metal tops resulting in aesthetically pleasing additions to the landscape. They can be screened with plant material or fencing. Corrugated metal tanks can reflect architectural elements in some commercial and residential applications. Ferrocement owner-built tanks are another option and can provide significant storage at relatively low costs. Table 4.1 describes some of these options and provides a feature comparison.

For purposes of practicality, this manual will focus on the most common, easily installed, and readily available storage options in Georgia. Storage tanks for indoor non-potable use must be made of nonabsorbent and corrosion-resistant materials. Tanks must be opaque, either upon purchase or painted later to inhibit algal growth. Small amounts of light, especially sunlight, can stimulate algal growth and can cause a thick soup-like formation in the tank. In addition, rainwater harvesting system storage tanks must never have been used to store toxic materials. Tanks must be covered and provided with vents screened to discouraged mosquito breeding. Tanks must be accessible for cleaning and maintenance.

-Tank Siting

Cisterns may be installed above or below grade. In some projects tanks may be partially buried or rainwater may be collected in a small tank below ground and then pumped into an above ground storage tank. Research local ordinances, covenants, and restrictions, when selecting storage tank types. Determine if the tank will need to be buried or camouflaged. Consider how your RWH system will be viewed by neighbors, and try to minimize any negative aesthetic impacts.

Underground utilities, high water tables or shallow bedrock may limit the sites available for tank burial. Locate utilities, and investigate groundwater and geological restrictions during the planning phase. Buoyant forces can act on an empty underground tank and cause it to float out of the ground. Careful consideration should be given to manufacturer's installation guides and instructions in order to correctly site and protect tanks against negative impacts of soils with a high water table.

Locate tanks as close to the supply and demand points as possible to reduce the distance water is conveyed. To ease the load on the pump, tanks should be placed as high as practicable. Of course, the tank inlet must be lower than the lowest downspout from the catchment area. When converting from well water, or if using a well backup, siting the tanks near the well house facilitates the use of existing plumbing. Overflow from tanks must be diverted to normal stormwater pathways in a non-erosive manner. In addition, water runoff from tank overflow should not enter septic system drain fields. Tank overflow and drainage should be routed so that it does not affect the foundation of the tanks or any other structures (Macomber, 2001). To ensure a safe water supply, underground tanks should be located at least 50 feet away from animal stables or above ground application of treated wastewater. Tank placement should also take into consideration accessibility by a delivery truck for installation or removal, preferably near a driveway or roadway.

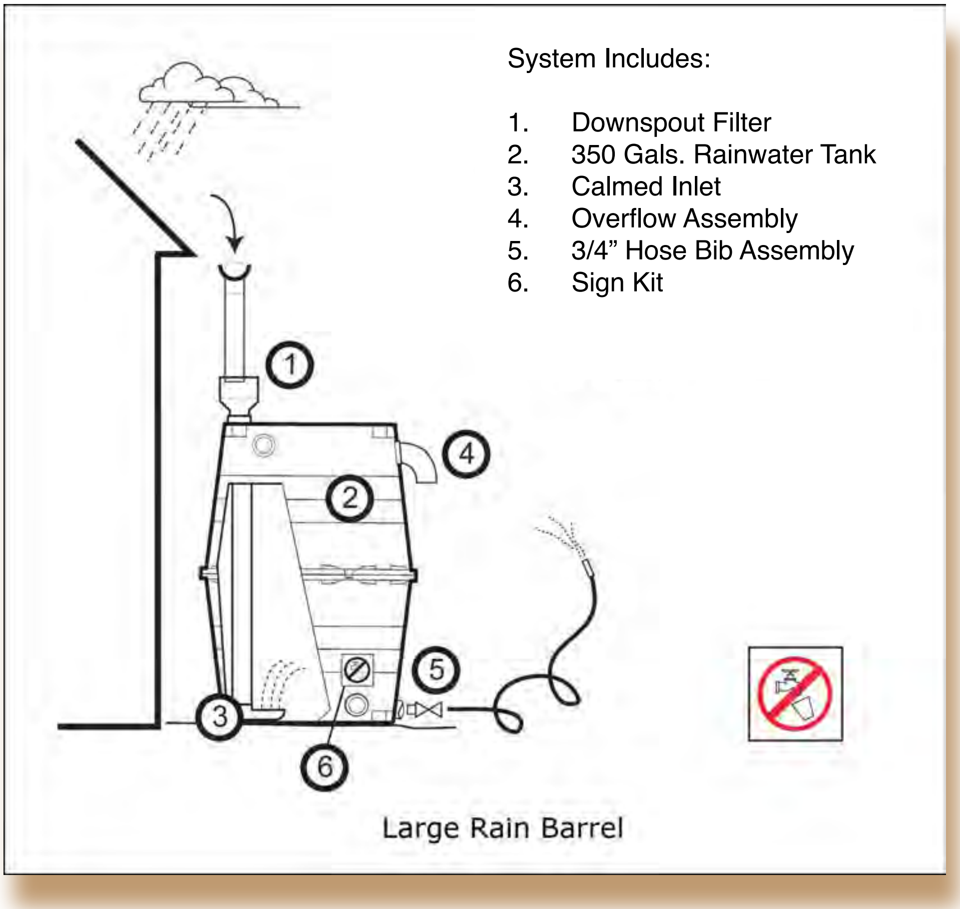

Figure 4.9 Schematic for 350 gallon rain barrel

Existing structures should be considered when installing a RWH system. Water is normally conveyed from downspouts to storage tanks by gravity. Think carefully about the location of gutters and downspouts to maximize the use of existing gutters and to collect water from a roof area that will support water demand. The tank foundation must be flat, and capable of supporting the weight of maximum storage. A leaning tank may collapse; therefore, tanks should be placed on a stable, level pad. When the condition of the soil is unknown, enlisting the services of a structural engineer may be necessary to insure the stability of the soil supporting the full cistern weight. The pad or bed should be inspected after rainfall events.

Locate tanks in areas that are not subject to erosion, flooding or other factors that might undermine the integrity of the foundation. Consider how electricity can be delivered to the pump of your RWH system, and how rainwater supply lines can be safely added to existing plumbing.

Figure 4.10 Rain barrel (75 gallon)

Figure 4.11 Plastic polypropylene tanks

4.6 Tank Materials

-Rain Barrel

One of the simplest rainwater installations, and a practical choice for many urban dwellers, is the 55 to 75-gallon drum used as a rain barrel for watering of plant beds. Some commercially available rain barrels are manufactured with upper and lower ports linking the primary barrel to a second barrel (and potentially others) linked together in series. Screening at any orifice or entry point to the tank discourages vectors such as mosquitos. A food-grade plastic barrel used for bulk liquid storage in restaurants and grocery stores can be fitted with a bulkhead fitting and spigot for garden watering. However those that are not opaque must be screened from sunlight.

Figure 4.12 Below ground fiberglass tanks

-Above Ground Polypropylene

Polypropylene tanks are commonly sold at farm and ranch supply retailers for all manner of storage uses. They are also available through internet companies. Standard tanks must be installed above ground. For below ground installations, specially reinforced tanks are necessary to withstand soil pressures, expansion and contraction. They are relatively inexpensive, durable, lightweight, and long lasting. Polypropylene tanks are available in capacities from 300 gallons up to 10,000 gallons. Polypropylene tanks do not retain paint well, so it is necessary to find off-the-shelf tanks manufactured with opaque plastic. The fittings of these tanks generally come with the tank itself (Texas Manual,2006).

-Fiberglass

Fiberglass tanks are built in standard capacities up to 50,000 gallons and in both vertical and horizontal configurations. The durability of fiberglass has been tested and proven, weathering the elements for years in the petroleum and water storage industries. They are easily repaired. The fittings on fiberglass tanks are an integral part of the tank, eliminating the potential problem of leaking from an after-market fitting that may be field installed improperly (Texas Manual, 2006). The tanks in Figure 4.12 would have to be placed on a suitable foundation and then be backfilled with the appropriate backfill material.

-Below Ground Polypropylene

Tanks are buried typically for aesthetic or space-saving reasons. In-ground tanks are often more costly than their above ground counterparts for two reasons: the cost of excavations and structural requirements of the tank itself. The cost of a more heavily reinforced tank needed for installation at depths of two feet or more can drive up the tank prices. These deeper installations require the walls of poly tanks to be manufactured thicker and with interior bracing structures.

Figure 4.13 Below ground polypropylene tanks

Caution: Never install a tank without referring to the manufacturer's installation instructions. Underground tanks are for underground applications only. In many parts of Georgia expansive soils are common (clay) and they can collapse underground tanks if installed incorrectly. Make sure to confirm that the selected underground tank is compatible with its surrounding soils, and that the foundation and backfill are in accordance with the manufacturer's recommendations, and local building codes.

Certain tanks in certain soils and location types may not be suitable for direct burial (Texas Manual, 2006).

Some owners of RWH systems use multiple smaller tanks in sequence with isolation valves to meet their storage needs. This has the advantage of allowing the owner to empty tanks individually to perform maintenance without losing all the stored water in the system. However, this approach can increase costs due to redundancy in materials and installation procedures.

-Metal

Galvanized sheet metal tanks (Figure 4.14) are also a smart option for the urban or suburban garden. They are available in sizes from 1,500 to over 200,000 gallons, and are lightweight and easy to relocate. Most tanks are corrugated galvanized steel dipped in hot zinc for corrosion resistance. When lined, they are lined with polyethylene or PVC, or coated on the inside with epoxy paint. The paint, which also extends the life of the metal, should be Federal and Drug Administration (FDA) and National Sanitation Foundation (NSF) approved. Bolted steel tanks can be transported and assembled virtually anywhere with a small crew and are not hindered by transportation sizes as other tanks may be. These systems are sold in kit form and can be bolted together with a few tools. Some tank manufacturers of this type require certified installers for full warranties.

Figure 4-14 Corrugated steel tank

-Concrete

Concrete tanks are either poured in place or prefabricated. They can be constructed above ground or below ground. Poured-in-place tanks can be integrated into new construction under a patio or a basement, and their placement is considered permanent. Involving the expertise of a structural engineer to determine the size and spacing of reinforcing steel to match the structural loads of a poured-in-place concrete citern is highly recommended (Texas Manual, 2006). A concrete tank constructed of prefabricated stacked rings with sealant around the joints is another possibility. A more common type in Georgia is the use of new, previously unused underground septic tanks. These tanks are fabricated off-site and dropped into place.

Figure 4.15 Wooden aboveground tank

Concrete may be prone to cracking and leaking, especially when underground tanks are located in clay soil. Leaks can be easily repaired although the tank may need to be drained to make the repair. To prevent leakage concrete tanks should be line or sealed.

-Wood

For aesthetic appeal, a wooden tank is often a highly desirable choice for urban, suburban and rural settings. Wooden tanks, similar to wooden water towers at railroad depots, were historically made of redwood. Modern wooden tanks are usually made of pine, cedar, or cypress wrapped with steel tension cables, and lined with a heavy mil plastic or vinyl liner. These tanks are available in capacities from 700 to 200,000 gallons, and are site-built by skilled technicians. They can also be dismantled and reassembled at a different location (Texas Manual, 2006).

4.7 Pumps and Controls

Since elevation separation (distance in vertical height from water storage to end use) is rarely sufficient to give even the minimal pressure needed, two common ways to achieve proper household water pressure are (a) a pump, pressure tank, pressure switch, and check valve (familiar to well owners), or (b) an on-demand-

Use	Pressure (ft)	Pressure (psi)	Flow
Impact Sprinkler	93	40	4.5 GPM
Pressure washer	46	20	4 gpm
Toilet	46	20	6 gpm
Garden hose nozzle	81	35	5 gpm

Table 4.3 Typical minimum requirements of commons fixtures in water-harvesting

pump. Pump systems draw water from the storage tanks, pressurize it, and store it in piping networks. Sometimes a bladder type pressure tank is needed to maintain water pressure. These tanks prevent the pump from cycling on and off to meet small demands. The typical pump and pressure tank arrangements consists of a 3/4 or 1 horsepower pump, usually a shallow well jet pump or a multistage centrifugal pump, a check valve, and pressure switch. A one-way check valve between the storage tank and the pump prevents pressurized water from being returned to the atmospheric pressure tank. The pressure switch regulates operation of the pump thereby controlling pressure in the tank. The pressure tank, with a typical capacity of 40 gallons, maintains pressure throughout the system. When the pressure tank reaches a preset threshold, the pressure switch cuts off power to the pump. When there is demand from the household, the pressure switch detects the drop in pressure in the tank and activates the pump, drawing more water into the pressure tank.

Figure 4.16 Submersible on demand pump with floating suction

Figure 4.17 On demand external pump

On-demand pumps eliminate the need for a pressure tank. They are designed to activate in response to a demand. These pumps combine a pump, motor, controller, check valve, and pressure switch with pressure tank function all in one unit. They are self-priming and are built with a check valve incorporated into the suction port. In addition, some on-demand pumps are specifically designed to be used in rainwater systems.

Intake filters prevent debris from entering the pump intake. These filters assist in preventing clogs, improving reliability, and increasing pump life. The floating suction filter (see Figure 4.16) attached to the intake on the pump allows the pump to draw water from the storage tank 6 to 16 inches below the water surface. Water at this level is cleaner, fresher and relatively more oxygenated than water closer to the bottom of the tank. These intake devices provide filtration, usually between 100 and 200 microns.

Choose a pump that is capable of delivering the flow and pressure needed to meet the particular demands of the system. Consult a professional to determine the pressure requirements for any indoor toilet or urinal flushing application.

Figure 4.18 In line strainer type filter

4.8 Treatment and Disinfection

RWH systems less than 200 gallons for outdoor non-potable applications normally need no treatment or disinfection. However, filtration sufficient to keep out particles from irrigation valves or spray heads may be required. In line strainer type filters can serve this purpose (see Figure 4.18). Larger outdoor systems may require treatment and disinfection appropriate for the end use of the water, and all indoor systems used for toilet flushing or urinal flushing require treatment and disinfection. This subject is covered in detail in Chapter 5.

CHAPTER 5

WATER QUALITY AND TREATMENT COMPONENTS

5.1 Introduction

The raindrop as it falls from the cloud is normally free of harmful pathogens and chemicals. The environment, the catchment surface, and the storage tanks can affect the quality of harvested rainwater (Texas Manual, 2006). Unnecessary degradation of roof-collected rainwater can be minimized by sensible preventive management procedures. Some of these measures are associated with design and installation, while others are associated with ongoing maintenance. Well designed systems will generally prevent problems from occurring, so corrective action to restore water quality will be needed infrequently. Roof-collected rainwater that is captured and stored correctly can be a safe, economical and sustainable source of water (Abbott, 2008).

The owner of a rainwater harvesting system becomes the owner of “their own” water supply system. This represents a dramatic departure from just turning on the tap and expecting the water to flow out. The owner is solely responsible for routine operation, including maintaining clean gutters and filters, repairing leaks, monitoring of water quality and performing system upgrades.

5.2 Factors Affecting the Quality of Harvested Rainwater

Although rainwater is relatively pure, it is still necessary to establish minimum water quality guidelines for its use. Roof collected rainwater will come in contact with certain contaminants as it moves from the roof to the storage tank. Where rainwater is used for outdoor operations, such as irrigation or outdoor hose bibbs, etc., minimal, if any, filtration is required. Collecting rainwater for indoor purposes does require a number of steps to ensure its successful use.

Tree branches and any vegetation that interferes with the gutters should be pruned. Gutters may be screened or fitted with leaf-guards to prevent larger objects from washing down from the roof. Downspouts can have filters placed in line with the water flow to further remove large particulates.

“First flush diverters (See Figure 5.1) are devices that minimize contamination of the rain tank water by diverting the first amount of rain which washes away the dust, debris, bird

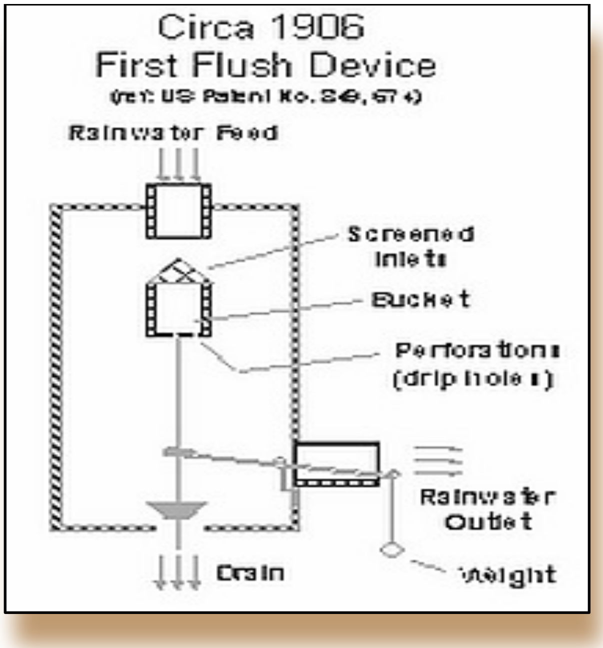

Figure 5.1 First flush diverter

and other animal droppings, etc., off the roof away from the tank" (Abbott, 2008).

As a general rule of thumb, the cleaner the water going into the cistern, the higher the water quality and the better the system's overall performance will be. According to Stan Abbott "spectacular improvements in the water quality in the rain tanks are attributed to first flush diverters" (Abbott, 2008).

Where rainwater is used for non-potable use inside an occupied facility, i.e. toilets, urinals, and cooling tower make-up, the water must be appropriately disinfected as required by State code. In addition, the water must also be filtered as a safeguard against small debris or sediment entering the toilet valves, thus maintaining proper function. This filtration will also assist in the prevention of discoloration of plumbing fixtures. Further discussion of filtration is included later in this chapter. Once again, the end use of the water will determine the type and level of filtration.

•Collection Surface Contamination

During the conveyance process from catchment surface to storage tanks, water can become contaminated with bird wastes, air borne pollutants, mosquitoes, small animals and other organic and inorganic materials, including the roof material itself.

In the Southeastern US, springtime pollen can fall in seemingly unending quantities. This pollen can build up and is not desirable inside the tank. In addition to first flush diverters, tank overflow located near the top of the tank helps direct some of these contaminants away from the tank.

•Algae Growth and Vectors

Tanks that are not opaque permit light to enter and stimulate the growth of algae. Relatively little amounts of light, even indirect light, are needed to grow algae in a closed tank. Opaque tanks maintain higher water quality than translucent tanks. Proper screening of inlets, outlets, and overflows connected to the tank will further reduce the effects of vectors such as mosquitoes and rodents.

•Sediment Buildup

It is impractical to completely eliminate sediment from entering and accumulating in the tank. Sediment found in rain tanks is normally composed of both inorganic and organic materials. Proper inlet water screening and the addition of a first flush diverter will aid in minimizing sediment buildup in storage tanks. It takes very small amounts of organic matter to adversely affect the odor and color of the stored water.

5.3 Water Treatment For Non-potable Outdoor Use Systems

Where rainwater is used for non-potable use such as hand-watering, vehicle washing, etc., and for non-critical operations, such as irrigation and wash down, a high level of filtration may not be necessary. However, some filtration will likely be needed to prevent clogging sprinklers, or drip irrigation emitters. Filtration sufficient for the successful working of the equipment is generally all that is required for outdoor non-potable systems.

Drip irrigation manufacturers or vendors should be contacted regarding filtering of water for these types of irrigation systems.

5.4 Water Treatment For Non-potable Indoor Use Systems

•Use in Toilet and Urinal Flushing

For non-potable water systems, where rainwater is used indoors, treatment generally consists of filtration and disinfection processes in series before distribution to the plumbing system. Harvested rainwater intended for indoor uses must be filtered and disinfected, in accordance with all relevant state plumbing codes.

It is important to note that the water must be passed through a sediment/particulate filter and possibly carbon filter (for odor control) prior to entering the U.V. chamber.

•Filtration

Cartridge filters may be placed on the discharge side of the pump, which provides pressure to the plumbing system. To ensure adequate flow and pressure of the water supply, the filters need to be sized for the intended use of the water. A number of different filters can be used to provide the particulate removal necessary to address the specific non-potable water use. Filters of different sizes and from numerous manufacturers are commercially available.

The presence of suspended material in water, such as finely divided organic material (plankton, clay, silt and other inorganic material) is indicated through turbidity, (cloudiness) measured as NTU (nephelometric turbidity units). High turbidity interferes with disinfection. Maintaining turbidity levels below 10 NTU improves disinfection effectiveness (AWWA, 2006). According to the Texas Rainwater Harvesting Evaluation Committee, a 5 micron sediment filter is adequate for reducing the suspended solids for non-potable indoor uses. A higher level of treatment can be achieved with a 3 micron sediment filter followed by a 3 micron activated carbon filter. In order to assure that the filter does not leach undesirable contaminants into the water, use filtration systems that have been certified to meet ANSI/NSF Standard 61 requirements.

•Disinfection

Disinfecting rainwater for indoor non-potable use is required to control microbial growth that could cause odors and affect the operation of plumbing fixtures. Disinfection can be accomplished in a number of ways including ultraviolet (U.V.) disinfection, ozonization, treatment with chlorine or iodine, or other approved disinfectants.

Testing conducted in Germany demonstrates that the risk of *E.coli* contact with the human mouth from toilet flushing was virtually non-existent (Ecker, 2007). This study resulted in a recommendation that special disinfection measures were unnecessary for rainwater dedicated to non-potable uses. However, according to the Texas Rainwater Harvesting Evaluation Committee (2006), disinfecting non-potable rainwater for indoor use is desirable to control microbial growth which could cause fowling and affect the operation of plumbing fixtures. Following filtration, disinfection can be accomplished by passing the water through ultraviolet light, or treating it with chlorine.

Even though bacterial contamination of water for indoor non-potable use is not as critical as that used for potable purposes, total coliform and fecal coliform sampling can be used to evaluate a general level of acceptable microbial contamination for non-potable water. The acceptable level of total coliform for non-potable water should be less than 500 cfu/100 ml, and fecal coliform levels should be less than 100 cfu/100 ml. (Lye, 2005). Keep in mind that the more the system is monitored for water quality, the better the system will perform. Table 5.1 details some treatment techniques commonly used in RWH.

•Chlorination

For those choosing to disinfect with chlorine, automatic self-dosing systems are available. Following filtration, an in-line erosion chlorinator, or an injection pump can be used to disinfect harvested rainwater, and maintain a level of 0.2 mg/L of chlorine residual. In-line erosion chlorinators are one option for chlorinating harvested rainwater. Calcium hypochlorite tablets or pellets are placed inside the erosion chlorinator; as water flows through the unit, the calcium hypochlorite slowly dissolves and releases chlorine into the water.

Use chlorine compounds that are certified in accordance with ANSI/NSF Standard 60

Method	Location	Result
SCREENING		
Leaf Screens and Strainers	Gutters and downspouts	Prevents leaves and other debris from entering the tank
SETTLING		
Sedimentation	Within tank	Settles out particulate matter
FILTERING		
Roof washer	Before tank	Eliminates suspended material
In-line/multi-cartridge	After pump	Sieves sediment
Activated charcoal	After sediment filter	Removes chlorine, reduces odor
First flush Diverter	Before tank	Reduces suspended material
Sand Filtration	After pump	Removes particulates
MICROBIOLOGICAL TREATMENT/DISINFECTION		
Boiling/distilling	Before use	Kills microorganisms
Chemical treatments (Chlorine)	Within tank or at pump (liquid, tablet, or granular) Before activated charcoal filter	Kills microorganisms
Ultraviolet Light	After activated charcoal filter Before tap	Kills microorganisms
Ozonization	After activated charcoal filter Before tap	Kills microorganisms

Table 5.1 Treatment Techniques

requirements. Avoid products that contain fragrances and UV stabilizers. Do not use products designed for use in swimming pools as these products often contain cyanide based UV stabilizers.

•Cartridge Filters and Ultraviolet (UV) Light

When using UV light it is important to follow the manufacturer's installation guidelines and to pre-filter the water before it enters the UV chamber.

One possible disinfection array consists of two inline filters in series, (a particulate fiber cartridge filter followed by an activated charcoal filter), and an ultraviolet light. This disinfection set-up is placed after the on-demand pump. It is important to note that cartridge filters must be replaced regularly. Otherwise, the filters can actually harbor bacteria and their food supply. Clear-bodied holders are slightly more costly but allow the user to visually check the filter from the outside. The filter mechanically removes suspended particles. In theory, activated charcoal can absorb objectionable odors and tastes, and even some protozoa and cysts (Macomber, 2001).

In order for a UV system to work properly, the water passing through it must be relatively clear and free of particles. UV disinfection must be preceeded by adequate filtration. The ANSI/NSF standard 55 establishes testing requirements for UV water treatment systems. UV systems that meet Class A requirements of this standard are capable of producing an UV dose of 40 mJ/cm^2. The UV light must be rated to accommodate the flow. It is best to purchase certified equipment. Maintenance of the UV light involves cleaning of the quartz sleeve and the bulb itself. Some UV lights are designed with an integral wiper unit. Again, follow the manufacturer's instructions and recommendations.

•Ozone

Chemically, ozone is O_3. It is essentially a more reactive form of molecular oxygen made up of three atoms of oxygen. Ozone acts as a powerful oxidizing agent to reduce color, eliminate foul odors, and reduce total organic carbon in water. For disinfection purposes, an ozone generator forces ozone into storage tanks through rings or a diffuser stone. Ozone is unstable and reacts quickly to revert to O_2 and dissipates through the atmosphere within 15 minutes. Therefore, Ozone is a powerful disinfectant, careful consideration should be given to manufacturer's recommended installation guidelines (Texas Manual, 2006).

•Corrosion Control

Not all rainwater is pH neutral. Some rainwater is slightly acidic and contains dissolved minerals that can be corrosive. Because harvested rainwater that is used indoors in Georgia will only be delivered to toilets and urinals, the use of plastic delivery pipe, and fixtures made with non-corrosive materials are recommended.

5.5 Additional Requirements for Cooling Tower Make-up Water

Cooling towers, evaporative condensers and fluid coolers are required to be installed in accordance with the manufacturer's installation instructions, and specific requirements listed under the International Mechanical Code (IMC).

All cooling towers and evaporatively cooled mechanical equipment are located outside since they normally utilize outdoor air to operate. Normally the inside plumbing system provides make-up water to these systems, always incorporating back flow prevention. Therefore it is important that water-cooled equipment used to condition interior spaces or equipment located indoors meet the requirements of the indoor plumbing codes and guidelines.

5.6 Conclusions

Rainwater is not subject to the same level of contamination as surface water supplies, especially when proper care is taken during the rain harvesting process. Appropriate filtration/treatment does not mean one size fits all. The end use determines the level of filtration needed. Common sense and sound installation practices should prevail. Careful ongoing and recurring maintenance by the owner or operator is the best way to assure the highest level of water quality. Other resources are available through the ARCSA website that address this subject in greater detail (see references section).

The Georgia plumbing code 2009 (Georgia Amendments to the 2006 International Plumbing, Appendix I, "Rainwater Recycling Systems") allows rainwater to be collected, treated and used indoors for toilet and urinal flushing, and as cooling tower make-up water. This represents a major step forward in pursuing water conservation goals in the state of Georgia.

GLOSSARY

CALMING INLET. A device located at the bottom of a storage tank that permits water to enter a storage tank with minimal disturbance to particles that may have settled to the bottom of the tank.

CISTERN. The central water storage component of the rainwater harvesting system. Protection and maintenance of the cistern or storage tank is essential for the health of the system.

CODE. Refers to the International Plumbing Code with Georgia Amendments as well as other Georgia State Minimum Standard Codes and local ordinances.

COLLECTION AREA. Area from which rainwater is collected for use in a rainwater harvesting system (e.g. roof area).

DEBRIS EXCLUDER. A screen or other device installed on the gutter or down spout system to prevent the accumulation of leaves, needles, or other debris in the system.

DISINFECTION. Reduction of viable micro-organisms to a level that is deemed suitable for the intended applications. Typical units of measure are Colony Forming Units per 100ml liter (cfu/100ml).

DRY RUNNING PROTECTION. System for protecting the water pump against running when no water is present.

FILTRATION. Physical removal of liquid-born contaminants by means of separation from the output flow. Particulate filtration removes suspended particles, measured in units of total suspended solids (TSS), while other forms of filtration, such as carbon/absorption filtration, removes dissolved compounds measured in units of total dissolved solids (TDS).

FIRST FLUSH DEVICE. A device or method for removal of debris from collection surface by diverting initial rainfall from entry into the cistern.

FLAT. Having a slope no greater than 1 in 50.

GROUND WATER. Water that infiltrates into the ground and no longer flows across the surface.

HARVESTED WATER. Rainwater that is collected in the cistern.

HYDRAULIC FILTER EFFICIENCY. Ratio between the water amount flowing to the filter and the water amount supplied for utilization.

INFILTRATION FIELD. Element in the ground that is filled with gravel, ballast or special non-permeable plastic elements and that stores rainwater that is fed into it on an intermediate basis before the water evaporates into the atmosphere or seeps into the surrounding soil.

LEACH FIELD, EVAPORATION / TRANSPIRATION FIELD. Element in the ground that is filled with gravel, ballast or special permeable plastic elements and that stores rainwater that is fed into it on an intermediate basis before the water seeps into the surrounding soil.

MAKE-UP WATER SUPPLY. Municipal water or other reliable water source that is used to supply the cistern when the harvested water is depleted. To be used for essential needs such as flushing a toilet.

MINIMUM WATER VOLUME. Residual water volume that is constrained by the process in which neither sediment nor scum can be sucked in for the protection of the pump.

OVERFLOW LEVEL. The highest level that water in a cistern can rise before flowing out of the tank.

OVERFLOW LINE. Line for leading excess rainwater away when the cistern is full.

PIPING SYSTEM. Pipes that convey the harvested rainwater and distribute it to various fixtures.

PRECIPITATION CHARACTERISTICS. Characteristics of a precipitation event (e.g. intensity, duration).

PROCESS WATER. Water for household and commercial areas of use that does not have to have the quality of drinking water.

PROCESS WATER LINE. System of lines from the process water pump to the individual points at which water is drawn.

PROCESS WATER PUMP. Pumps process water from the rainwater reservoir to the points at which water is drawn.

PROCESS WATER REQUIREMENTS. Planning value for the process water amount that is expected to be required in a specified period of time.

SYSTEM PRESSURE. Pressure needed to deliver water to the designated fixtures.

QUANTITY OF PRECIPITATION. Amount of rain, expressed as the water height in inches over a horizontal area for a span of time under consideration.

RAINWATER. Water collected from runoff of roofs or other structures after a rain event. Rainwater may also include condensate.

RAINWATER HARVESTING SYSTEM. Water system for utilizing rainwater, consisting of a cistern, pipe, fittings, pumps and/or other plumbing appurtenances, required for and/or used to harvest and distribute rainwater

RAINWATER YIELD. Useful water volume (water inflow) determined over a certain period of time.

RETURN ELBOW. A section of pipe with a 180-degree bend.

ROOF DRAINAGE SYSTEM. A system, comprised of roof drains, overflow drains, scuppers, gutters and down spouts, used to convey the rainwater from the roof surface to the cistern

ROOF FILTRATION. A device or procedure to mechanically remove sediment and debris (i.e. first flush diverters).

SCREEN. A filtration device, constructed of corrosion resistant wire or other approved mesh, having openings in determined areas.

SEDIMENTATION. Separation of solids from the water via gravity.

SLOPED OR SLOPING. Having a slope greater than 1 in 50.

SUB-SURFACE IRRIGATION. Water that is applied below ground level and is not directly exposed to the above ground surface and/or surrounding air.

SUN BARRIERS. A cover, or erected structure, specifically to shelter a cistern from the direct rays of the sun.

SURFACE IRRIGATION. Water that is applied above ground level and is directly exposed to the above ground surface and/or air.

SURFACE WATER. Any rainwater that touches the ground and flows across the surface of the ground (roadway, parking surface, gully, creeks, streams, etc.).

USEFUL VOLUME. Volume that can be completely used during operation (typically 80 – 90% of storage volume).

YIELD COEFFICIENT. Ratio of the rainwater annually flowing into the rainwater harvesting system to the total amount of rainwater in the accompanying precipitation area allowing for leakage, splashing, evaporation, etc. (Typically .75 - .90).

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H2ouse, Water Saver Home, www.h2ouse.org

Case Study # 1 - Southface Institute

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PROJECT: **SOUTHFACE'S ECO OFFICE**

LOCATION: ATLANTA, GEORGIA

APPLICATION: OUTDOOR IRRIGATION, TOILET FLUSHING, MECHANICAL HEAT EXCHANGERS, STORMWATER RUNOFF REDUCTION

SYSTEM: 14,500 GALLON UNDERGROUND CISTERN WRAPPED WITH A 30 MIL EPDM MEMBRANE TO CONTAIN THE RAIN WATER., UV DISINFECTION, LEVEL CONTROLS, 1700 GALLON POLYETHYLENE TANK.

Water savings and rainwater use are two of the goals at Southface's Eco Office. To achieve these objectives, Southface installed a 14,500 gallon in-ground cistern which collects water from the roof and surrounding grounds, and an additional 1700 gallon cistern on the roof top which collects rainwater from the surface of solar electric panels. The collected water is used for toilet flushing, evaporative cooling of mechanical equipment and outdoor irrigation, including water for the green roof. Through selection of efficient plumbing fixtures and use of site collected rainwater, the Eco Office uses 84% less water than a comparable code-built office building.

Case Study #2 - Ga Institute Of Technology

PROJECT:	**GEORGIA INSTITUTE OF TECHNOLOGY**
LOCATION:	ATLANTA, GEORGIA
APPLICATION:	OUTDOOR LANDSCAPE IRRIGATION
SYSTEM:	ONE 6,000 GALLON ABOVE GROUND CORRUGATED METAL TANK WITH LINER,EXTERNAL PUMP, ELECTRONIC LEVEL CONTROLS , VORTEX FILTER.

As part of Georgia Tech's commitment to sustainability, an above ground condensate/rainwater collection system was designed into the new courtyard renovation for the old Civil Enginner building on Main Campus. The water from the cistern is used to irrigate the newly landscaped and planted courtyard.

Case Study # 3 - Paul D. Coverdell Center for Biomedical Research

PROJECT: PAUL D. COVERDELL CENTER FOR BIOMEDICAL REASEARCH

LOCATION: UNIVERSITY OF GEORGIA CAMPUS, ATHENS, GEORGIA

APPLICATION: COOLING TOWER MAKE-UP AND TOILET FLUSHING

SYSTEM: 40,000 GALLON 10' BY 12' UNDERGROUND PRECAST CONCRETE CISTERN, EXTERNAL FLOODED SUCTION PUMP.

The condensate and rainwater collection system at the Coverdell Center, located on UGA's south campus, utilizes a precast concrete cistern. A separate mechanical room houses the pumping equipment, make-up supply, chlorination system, monitoring and level controls. Constructed in 2006, this system was the first of its type on the University campus . The system is expected to save nearly a million gallons of water a year.

Case Study # 4 - Tate Student Center

PROJECT: **TATE STUDENT CENTER**

LOCATION: **UNIVERSITY OF GEORGIA CAMPUS, ATHENS, GEORGIA**

APPLICATION: **OUTDOOR IRRIGATION AND TOILET FLUSHING**

SYSTEM: **75,000 GALLON PRECAST CONCRETE CISTERN, EXTERNAL FLOODED SUCTION DUPLEX PUMP SYSTEM, INLET FILTRATION, SEDIMENT STRAINER, MAKE-UP SUPPLY**

The Tate Student Center boasts the largest cistern on UGA's campus. In response to the drought and as part of an ongoing effort towards a more sustainable campus, the University built a rainwater collection system for irrigating the surrounding grounds and for flushing toilets. This system collects condensate water, roof water, and surface water from a green roof. A separate mechanical room houses the pumping and treatment systems. Make up water supply to the main cisterns assures continual operation.

Case Study # 5 - McKenney's Facility

PROJECT: MCKENNEY'S RESEARCH FACILITY

LOCATION:	ATLANTA, GEORGIA
APPLICATION:	EVAPORATIVE COMPRESSOR COOLING RESEARCH WATER MAKEUP, SITE IRRIGATION
SYSTEM:	25,000 GALLONS OF STORAGE , FIRST FLUSH SYSTEM , VARIABLE SPEED PUMPING STATION, 3 STAGES OF FILTRATION FOR VARIOUS COMPONENTS REQUIREMENTS, NON-CHEMICAL BASED BIOCIDE, AND OVER 50 TEMPERATURE, HUMIDITY,CURRENT, POWER, WATER FLOW AND PH SENSORS AND PRODUCTS FOR MONITORING THE VARIOUS SYSTEMS.

McKenney's designed and installed a rainwater harvesting system at their new facility in Atlanta, Georgia. The system includes 25,000 gallons of storage and a first flush system rated at over 2300 gallons per minute peak rain event, for harvesting over 57,000 SF of roof area (Phase 1), for a variety of roof surfaces. The system is used to increase the efficiency of the HVAC system. Captured rainwater is delivered via a spray system to take advantage of evaporative cooling effects to reduce air temperature of the roof top units (RTUs), allowing it to operate more efficiently and reduce both site and regional water and energy use. This system provides energy savings for McKenney's new LEED Gold building registered headquarters as well.

Case Study # 6 - Sandy Creek Nature Center

PROJECT:	**SANDY CREEK NATURE CENTER**
LOCATION:	ATHENS, GEORGIA
APPLICATION:	LANDSCAPE IRRIGATION
SYSTEM :	ONE 500 GALLON ABOVE GROUND P.E. TANK, INDOOR CONDENSATE PUMP,GRUNDFOS MQ 1 HP PORTABLE PUMP, 120 VAC,10 GPM @50PSI.

The Sandy Creek Nature Center features 225 acres of woodland and wetlands, with an Interpretive Center housed in a green-friendly building. As part of its ongoing commitment towards environmental sustainability, the Nature Center invested in a condensate recovery system. Currently the stored water is used for irrigation. It is envisioned that the tank will be connected to the existing roof gutters and will harvest rainwater to flush toilets at the facility.

Case Study # 7 - Athens Montessori School

PROJECT: ATHENS MONTESSORI SCHOOL

LOCATION: ATHENS, GEORGIA

APPLICATION: LANDSCAPE IRRIGATION

SYSTEM: ONE 500 GALLON ABOVE GROUND P.E. TANK, LEADER 1 HP PORTABLE PUMP, 120 VAC,10 GPM @50PSI. FIRST FLUSH DIVERTER AND LEAF FILTRATION.

The Athens Montessori School is commited to environmental education. Partially as a response to the drought and as ongoing effort towards meeting greater environmental sustainability, the school invested in a small scale Rainwater Harvesting System on its Main Campus. The collected water is used to supplement irrigation around the school grounds. The rainwater collection system included a 500 gallon storage tank and a portable pump.

Case Study # 8 - Underground Residential System

PROJECT:	**RESIDENTIAL SYSTEM**
LOCATION:	DULUTH, GEORGIA
APPLICATION:	OUTDOOR IRRIGATION
SYSTEM:	5,000 GALLON CAPACITY,, (2) 2500 LOW PROFILE CISTERNS, IN LET FILTRATION, SELF CLEANING BASKET FILTER,LEVEL INDICATOR W/ BACK UP SUPPLY, INTERNAL SUBMERSIBLE PUMP,FLOATING SUCTION, LEVEL MONITORING AUTO REFILL

Outdoor watering restrictions brought on by drought conditions prompted this homeowner to install an underground rainwater collection system. Rainwater is collected from the roof of this residence and stored in two interconnected underground polyethylene tanks. Water is used for outdoor irrigation. The homeowner is able to maintain the landscape, despite local outdoor watering bans. The two lower photos are before and after shots of the cistern installation.

Case Study # 9 - Small-scale Residential System

PROJECT:	**RESIDENTIAL SYSTEM**
LOCATION:	**WATKINSVILLE, GEORGIA**
APPLICATION:	**LANDSCAPE IRRIGATION**
SYSTEM:	**ONE 1500 GALLON ABOVE GROUND P.E. TANKS W/ ECOS CPK 1 200 W/ SS PUMP 1" FLOAT EXTRACTOR AND PUMP CONTROL, 10 GPM @ 50 PSI, 120VAC, FIRST FLUSH DIVERTER, EXTERNAL HOSE BIB, AND LEVEL CONTROL.RMH10 COMPACT PUMP STATION**

Encouraged to take some personal action as a response to the drought in Georgia, the owner wanted supplemental water to do outdoor irrigation. The system consist of a 1500 gallon above ground Polyethylene tank with internal pump, first flush diverter, floating suction, and related controls.