
Texas A&M AgriLife Extension

ARCSA
American Rainwater Catchment Systems Association

# Rainwater Harvesting

Billy Kniffen

# Water Concerns

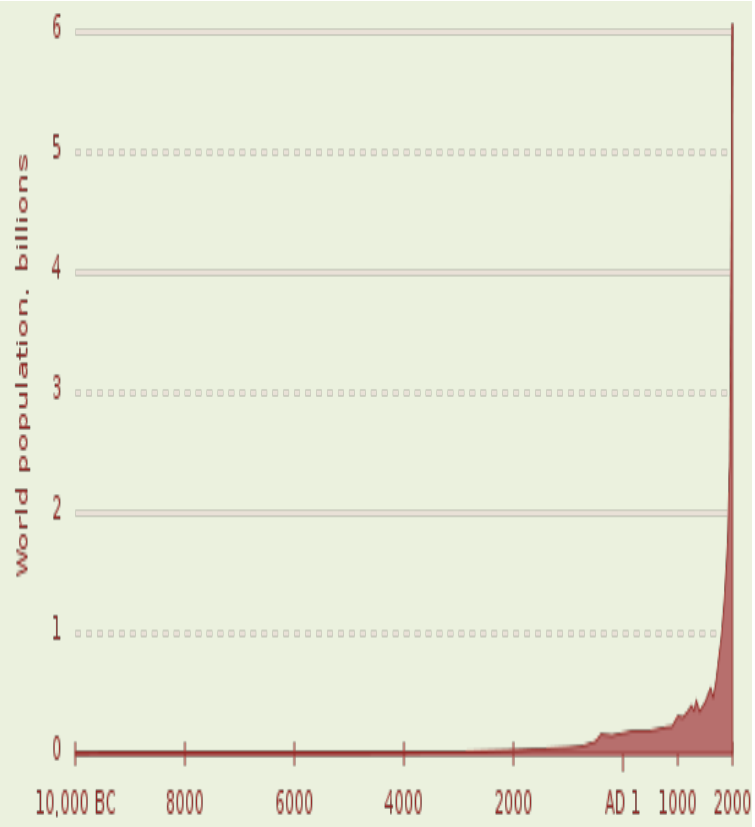
## Water is life – The New Green

**The ability to effectively manage our water resources is essential for personal and global sustainability.**

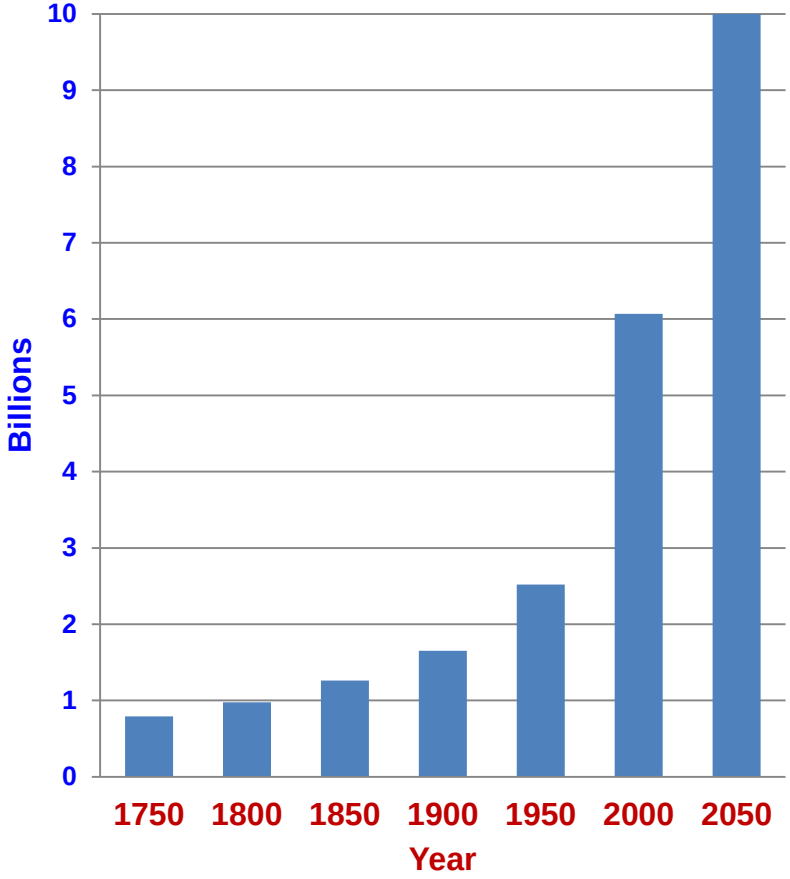
# World Population

**The water present on the planet millions of years ago is the same water present today.**

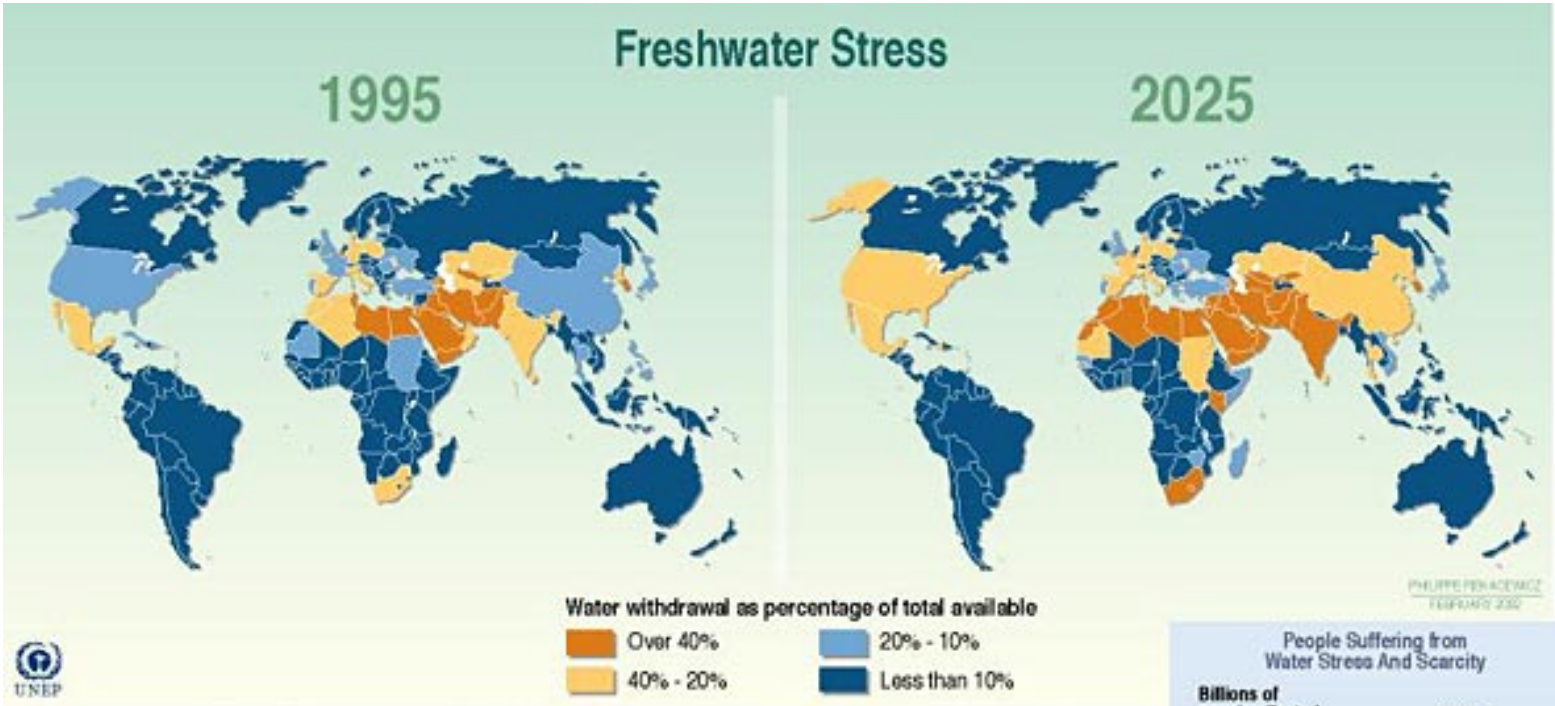
## Population over Human History



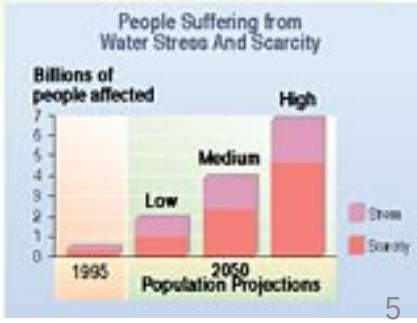

## World Population since 1750



# If all the world's water were fit into a gallon jug, the fresh water available for us to use would equal only about one tablespoon. http://www.lenntech.com/water-trivia-facts

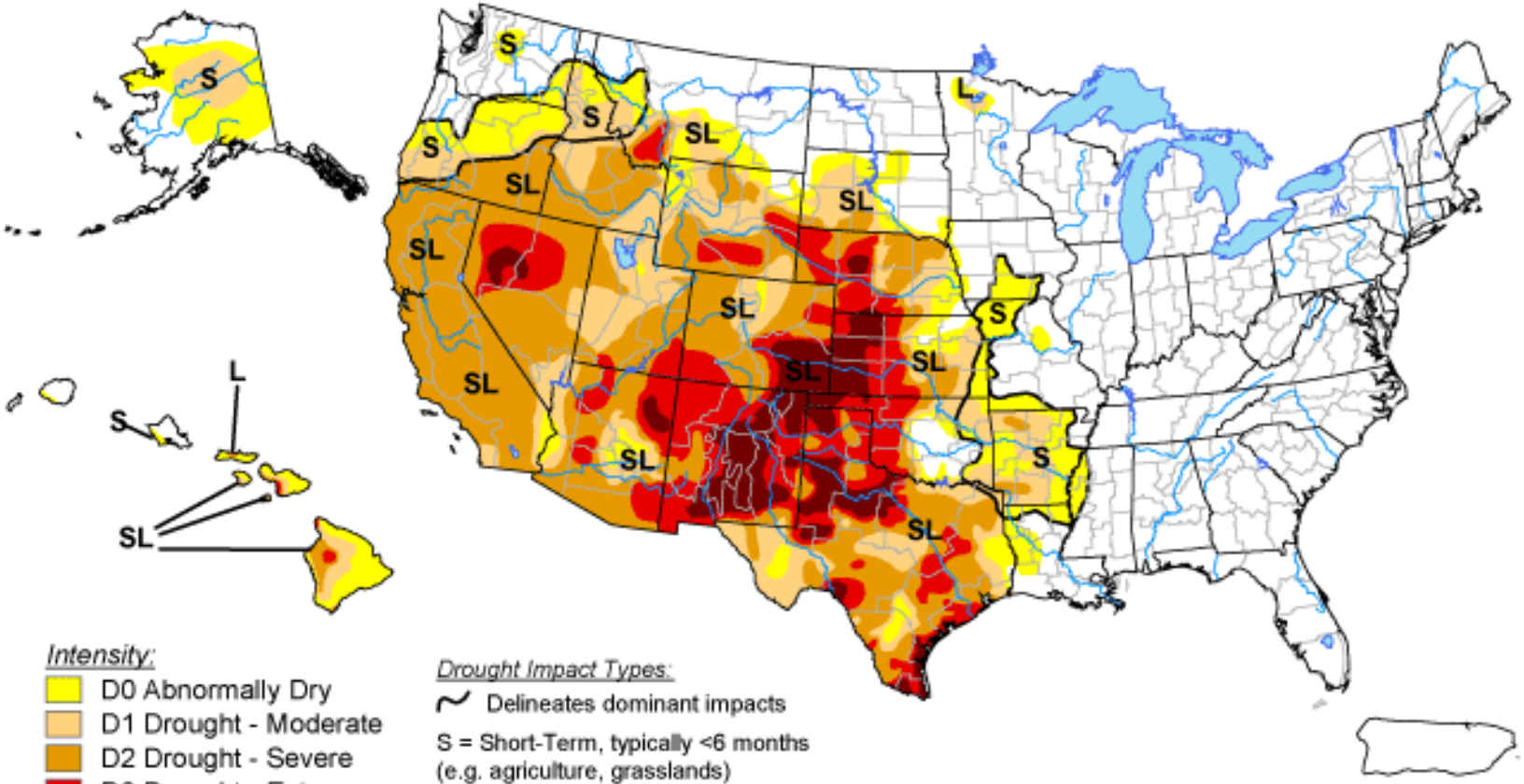



Source: World Meteorological Organisation (WMO), Geneva, 1996; Global Environment Outlook 2000 (GEO), UNEP; Earthscan, London, 1999.



# U.S. Drought Monitor

**July 16, 2013**
Valid 7 a.m. EDT




*Intensity:*
- D0 Abnormally Dry
- D1 Drought - Moderate
- D2 Drought - Severe
- D3 Drought - Extreme
- D4 Drought - Exceptional

*Drought Impact Types:*

~ Delineates dominant impacts

S = Short-Term, typically <6 months (e.g. agriculture, grasslands)

L = Long-Term, typically >6 months (e.g. hydrology, ecology)

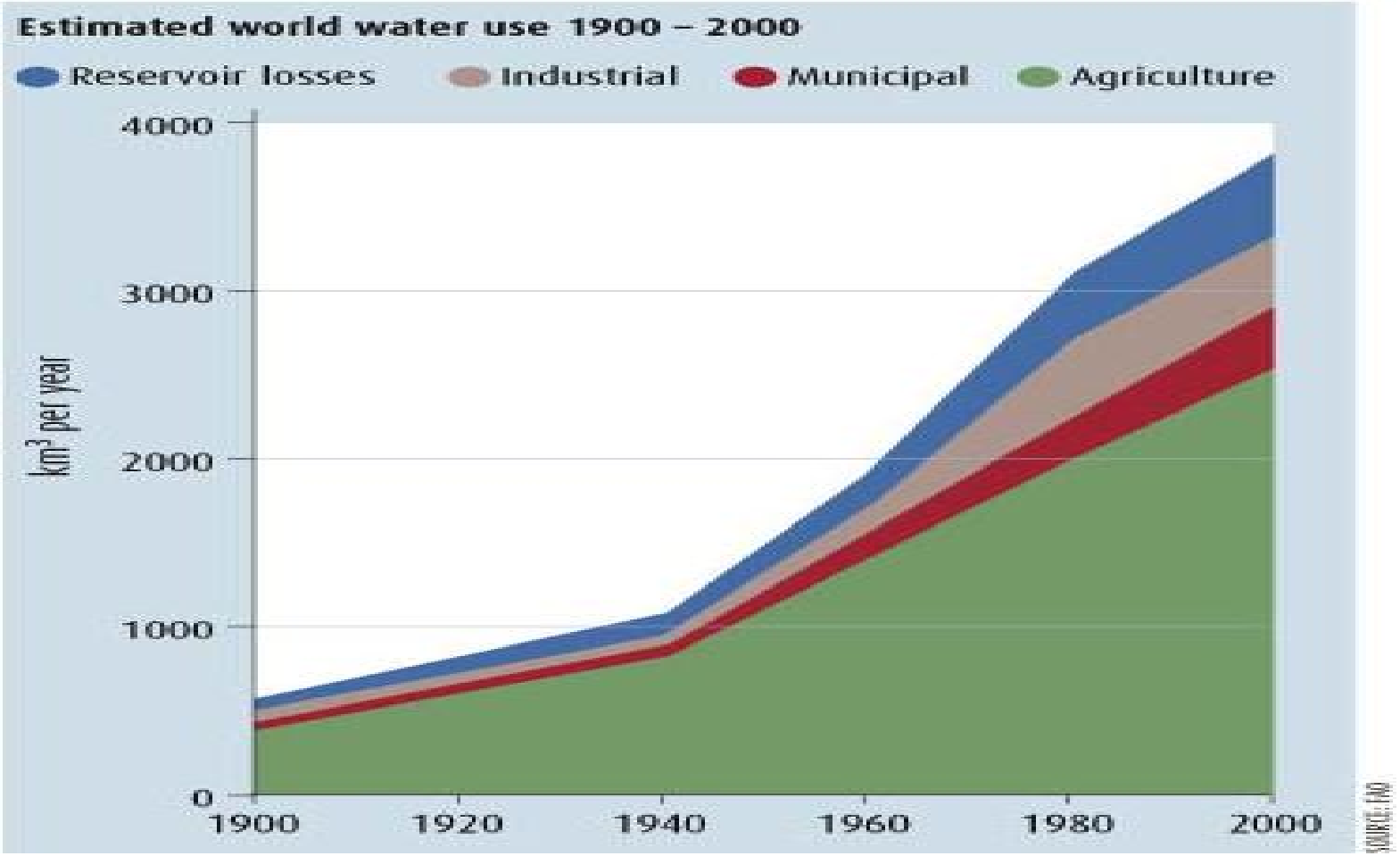
*The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.*

**http://droughtmonitor.unl.edu/**

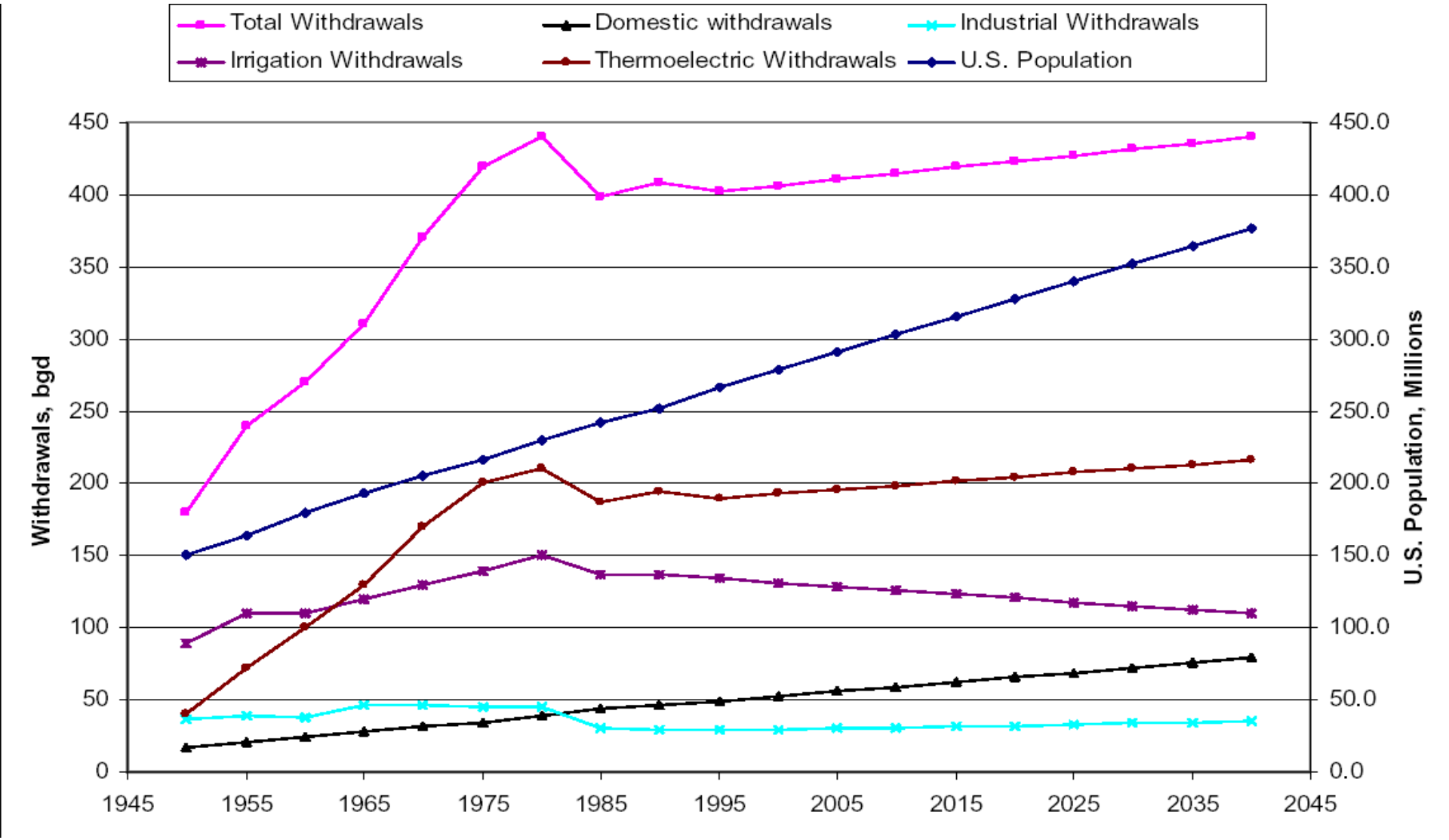
***Released Thursday, July 18, 2013***

***Author: Richard Heim, NOAA/NESDIS/NCDC***

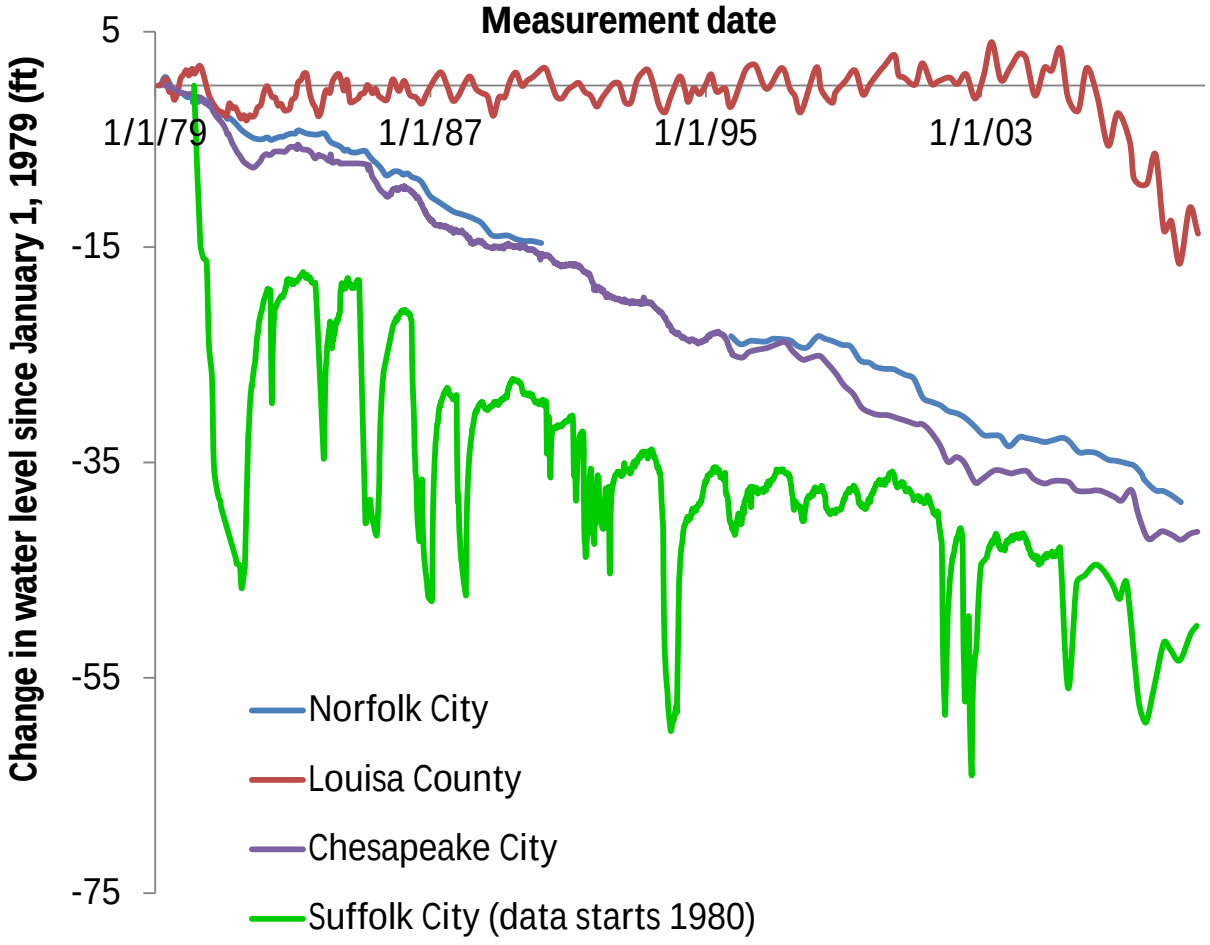
# Estimated World Water Use



# Freshwater Demand Trends



## “We never know the worth of water, till the well is dry.” Thomas Fuller, Gnomologia




**Changes in groundwater levels at monitoring wells at four sites in Virginia. These well all show declining water levels. Data are courtesy of the USGS and available through** (http://www.epa.gov/WaterSense/pubs/supply.htm).

“Water is the oil of the 21st century.”

*Andrew Liveris, chief executive, Dow, August 2008*.

# All Rainfall Is Valuable

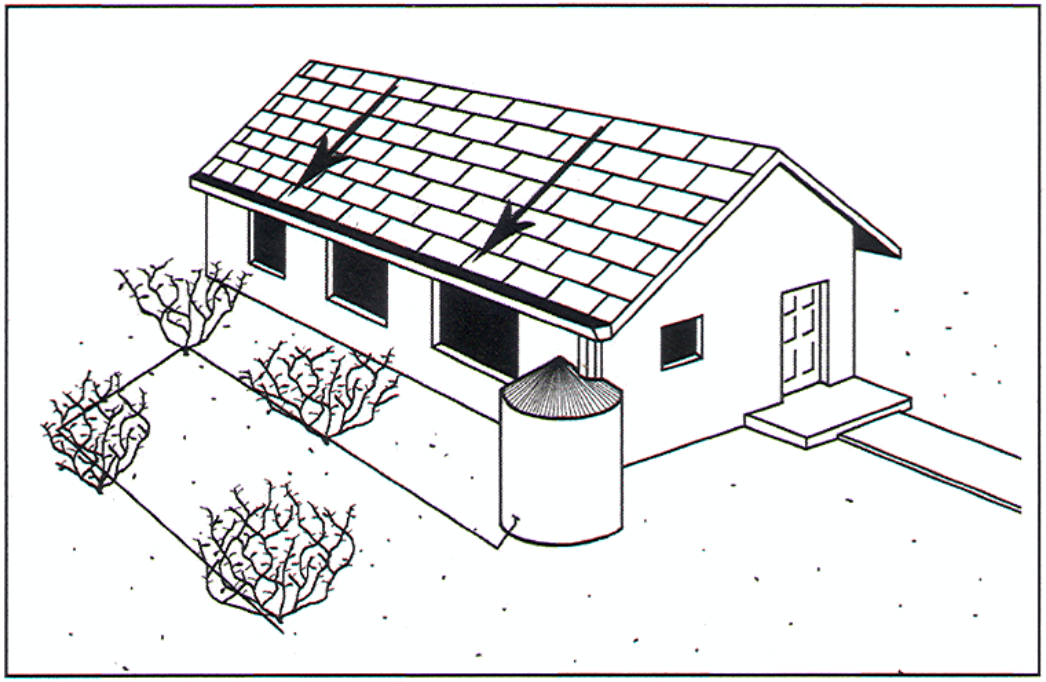
# Water is life

- Two methods to sustain water supply:
  - Increase Supply
  - Reduce Demand

# Rising Rainwater Interest

- Increased Demand for a Decreasing Supply
- Escalating Environmental and Economic Costs
- Health Concerns
- Drought - Flooding
- Providing Water to Areas Without Water
- Reducing Storm Water Runoff and Pollution
- Rainwater's Purity
- Right Thing to Do

# Passive vs.Complex /Active Rainwater Harvesting



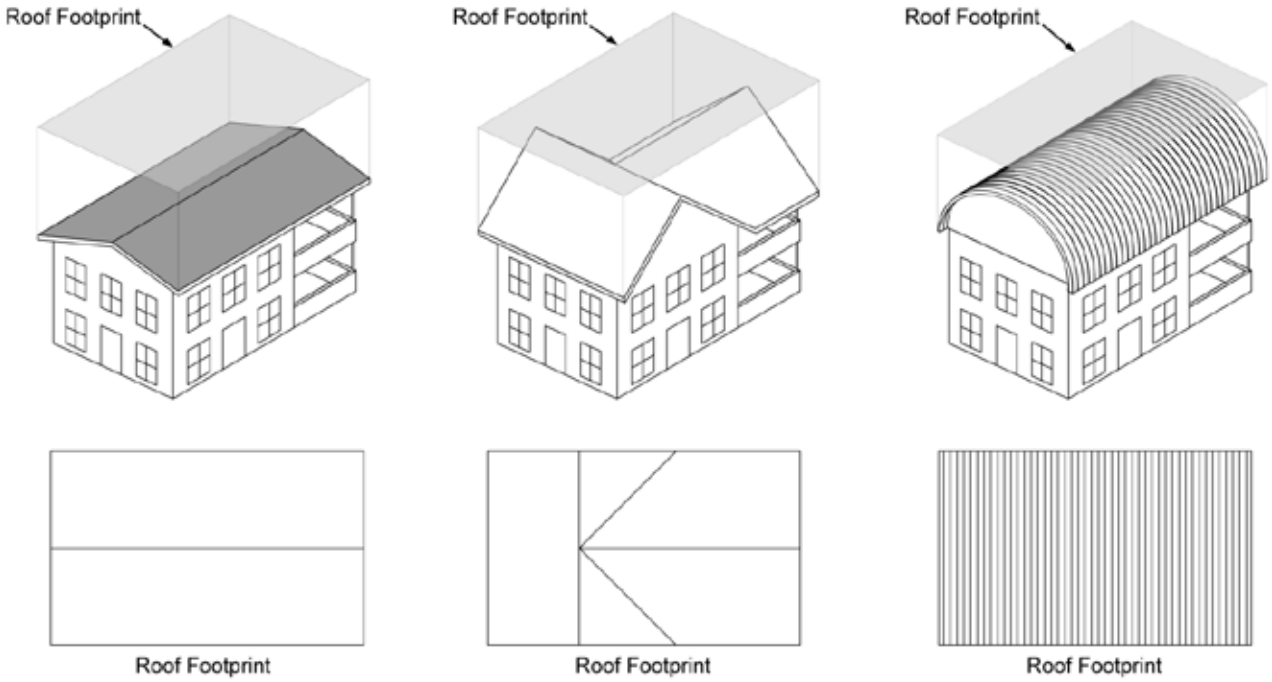
Complex water harvesting system with roof catchment, gutter, downspout, storage and drip distribution system.

# How to Collect Rainwater

- .6 gallons per square foot roof per 1” rainfall
- 2,000 sq. foot roof X 1" rain = 1,200 gal. water
- 1,200 gal. X 20" rainfall per year= 24,000 gal/yr

# Supply

- Footprint of the building



# My Home and Barn

5000 sq. foot of roof

5000 x .6 gallons/foot =

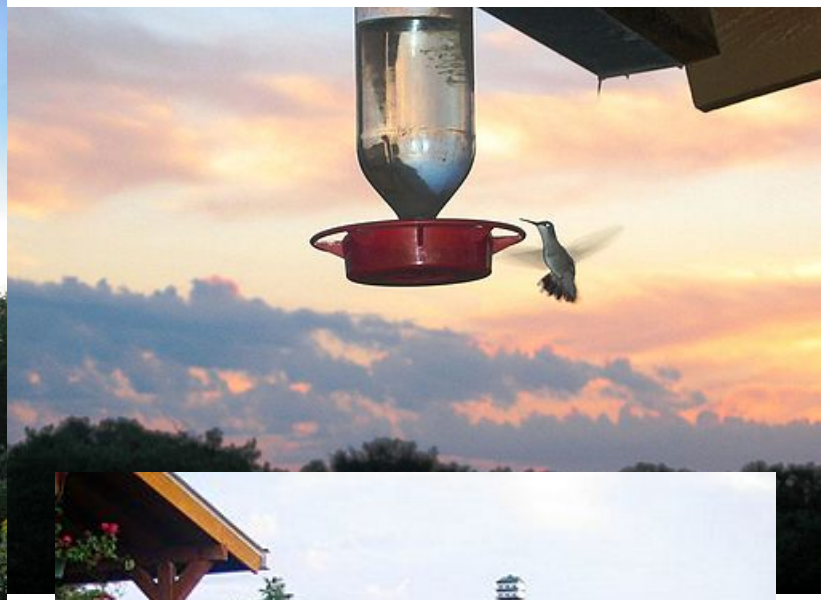
3,000 gallons of water per 1” rain

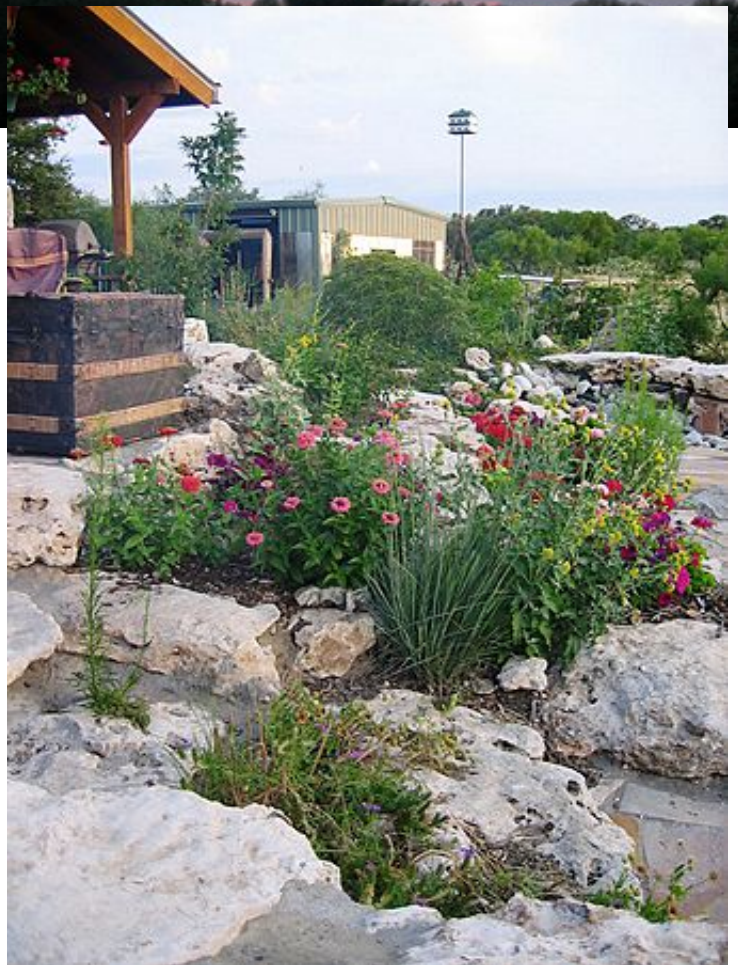
First flush and wet system
Volume per first flush 30 gallons total

# Rain Barn and Greenhouse 2500 Square Foot Roof


WYLIE

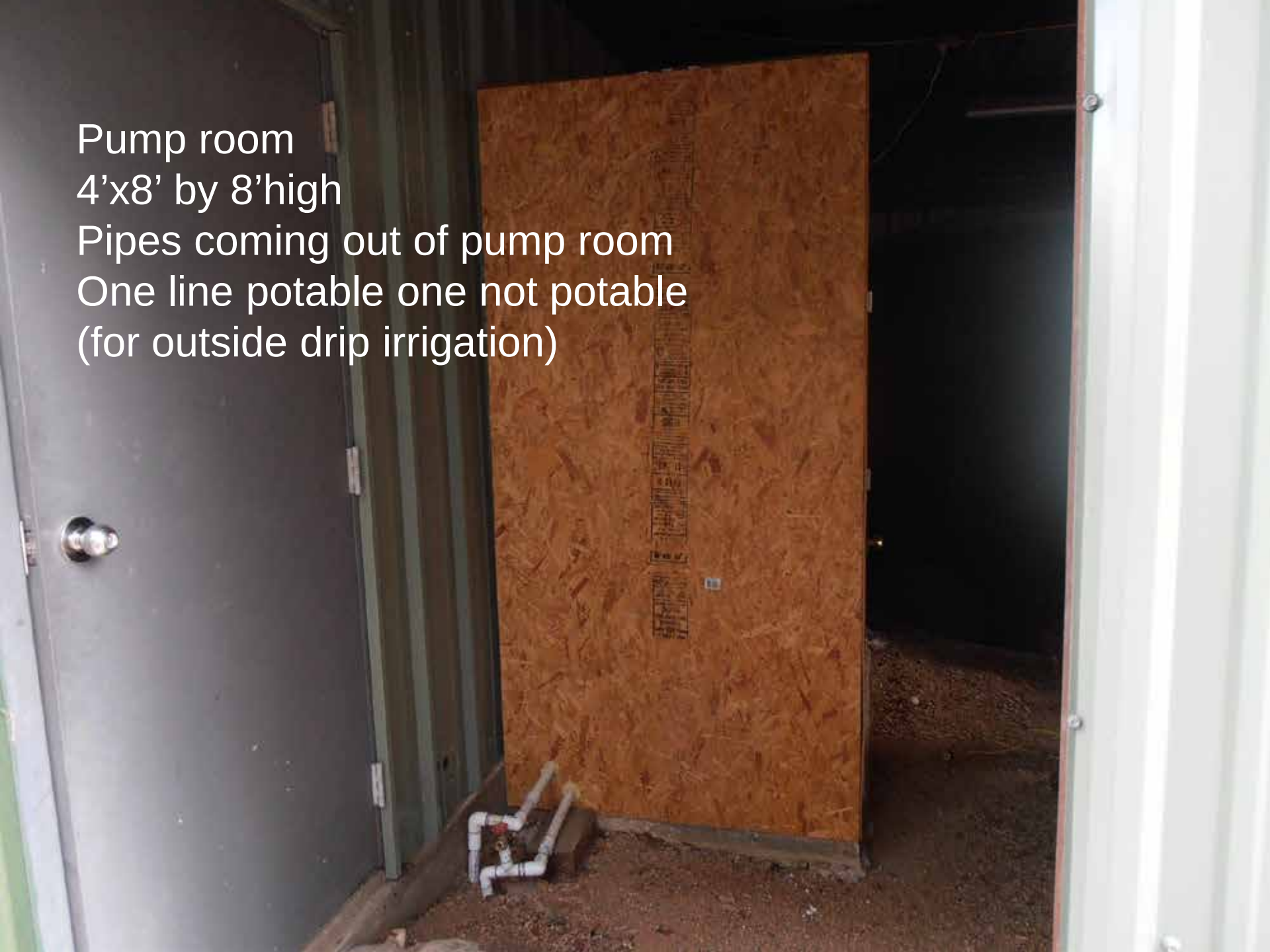
Rain barn – 16,500 gallons storage inside and 9,000 gallons out back. Total 25,500 gallons





2” ball valve on each tank and faucet. All tanks tied together with 1 ½” pvc. One feeder line to pump room. Tanks setting on river gravel .Mainline below ground .


Overflow from tank-to tank 4” pvc


Pump room
4’x8’ by 8’high
Pipes coming out of pump room
One line potable one not potable
(for outside drip irrigation)

**1 horse pump and**
**40 gallon pressure tank**

# 3 filters – 80 micron, 20 micron and 5 micron charcoal filter

# Ultraviolet light Disinfection system

# Water Usage – Inside The Home

- **19 gallons per person inside the home**
- **2 people – 38 gallons per day**
- **1,140 gallons per month**
- **38 x 365 days = 13,870**
- **13,870 / 3,000 = 4.62” per year**

# Landscaping for Rainwater Capture

# Water Usage – Outside The Home

- September – 82 gallons per day
- Use for May – September (5 months)
- 82 x 30 x 5 = 12,300 gallons
- 12,300 + 13,870 = 26,170
- 26,170 / 3,000 = **8.72 inches per year**
- **Drought of Record – 1951 = 7.64”**

  **1953 = 9.22”**

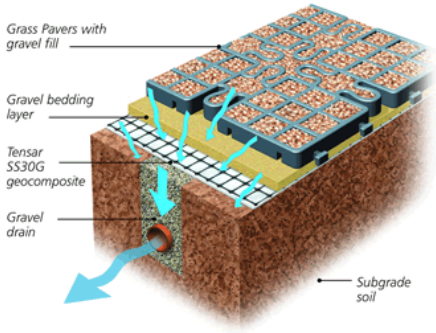
  **Nov. 2010 – Nov. 2011 – 5.5”**

# Menard, TX Margie Russell Memorial Garden

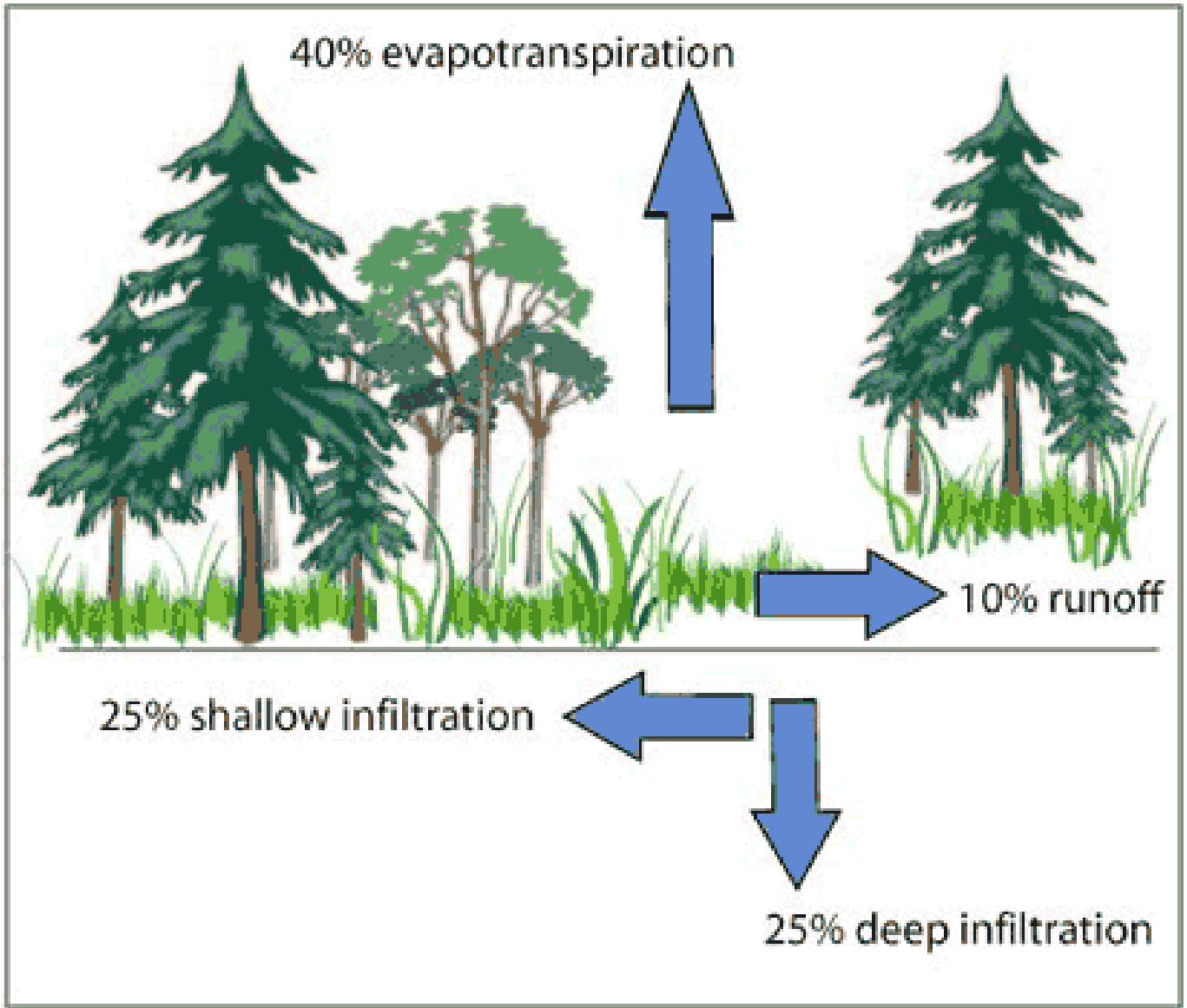
Rain Garden Bringing Water in off Street

# Low Impact Development (LID)

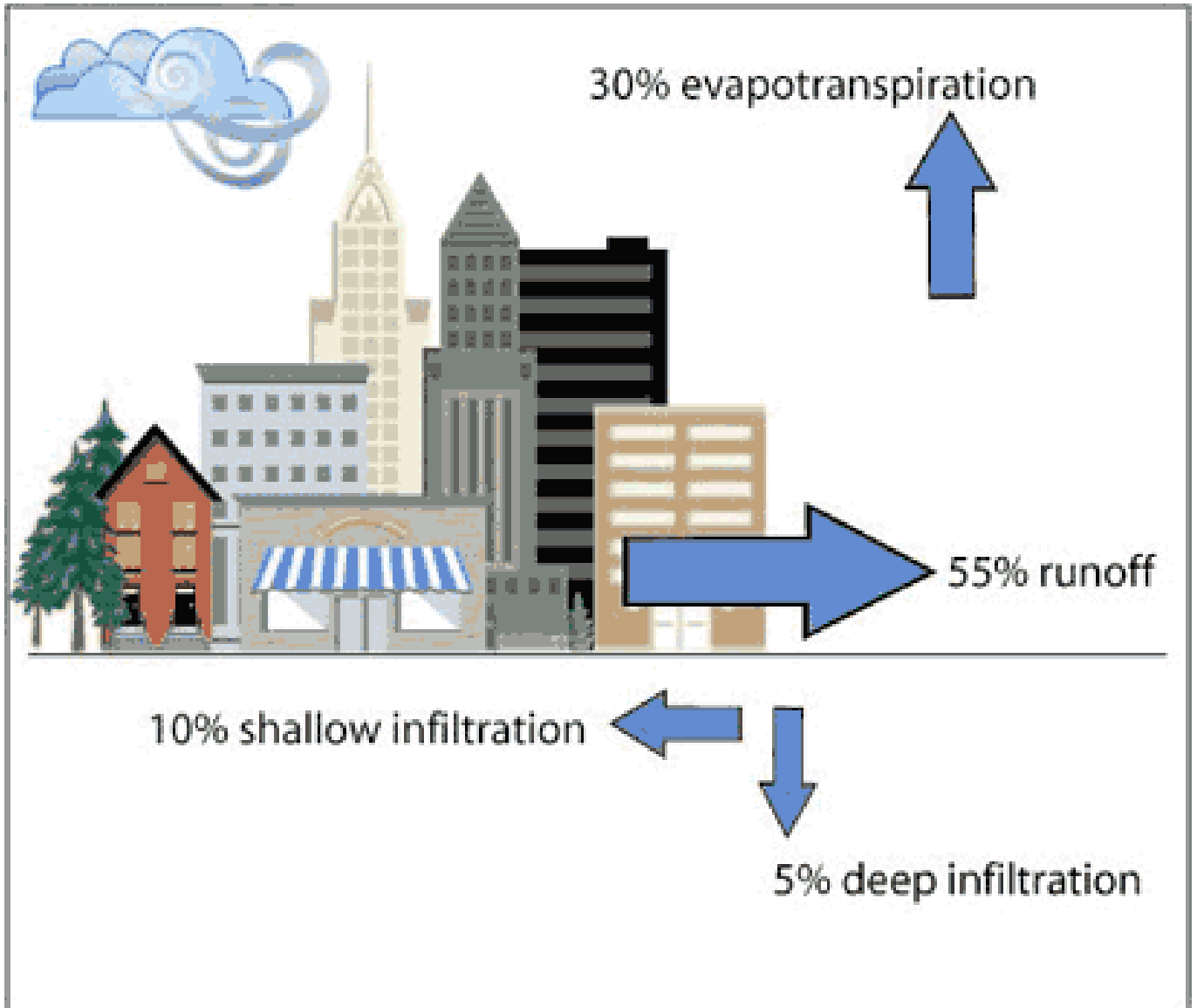
- Low impact development (LID) is increasingly being adopted as an alternative to traditional water management systems.
- LID includes practices such as bioretention, green roofs, rainwater harvesting, and permeable pavements.



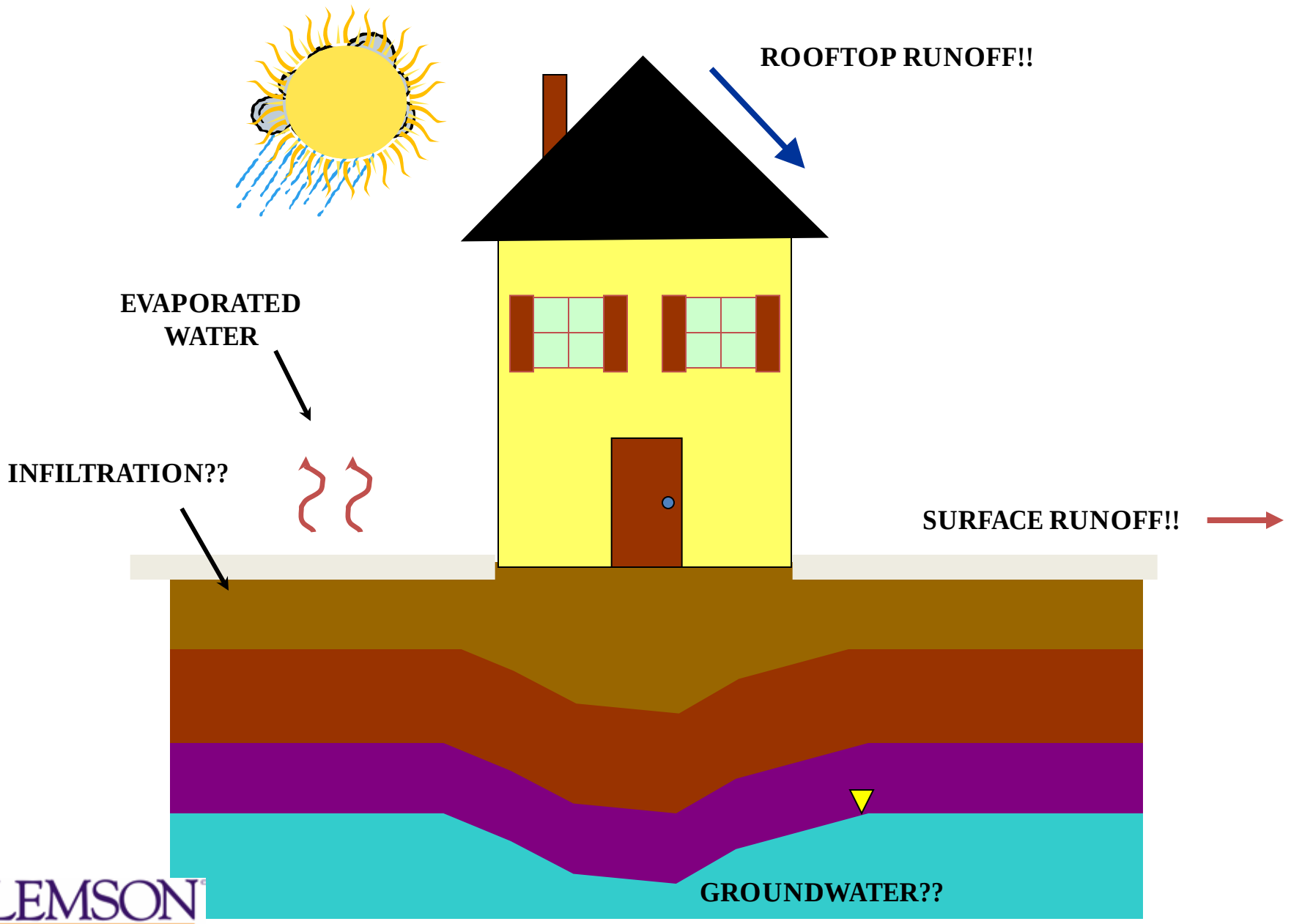

# Pre Development



# Post Development

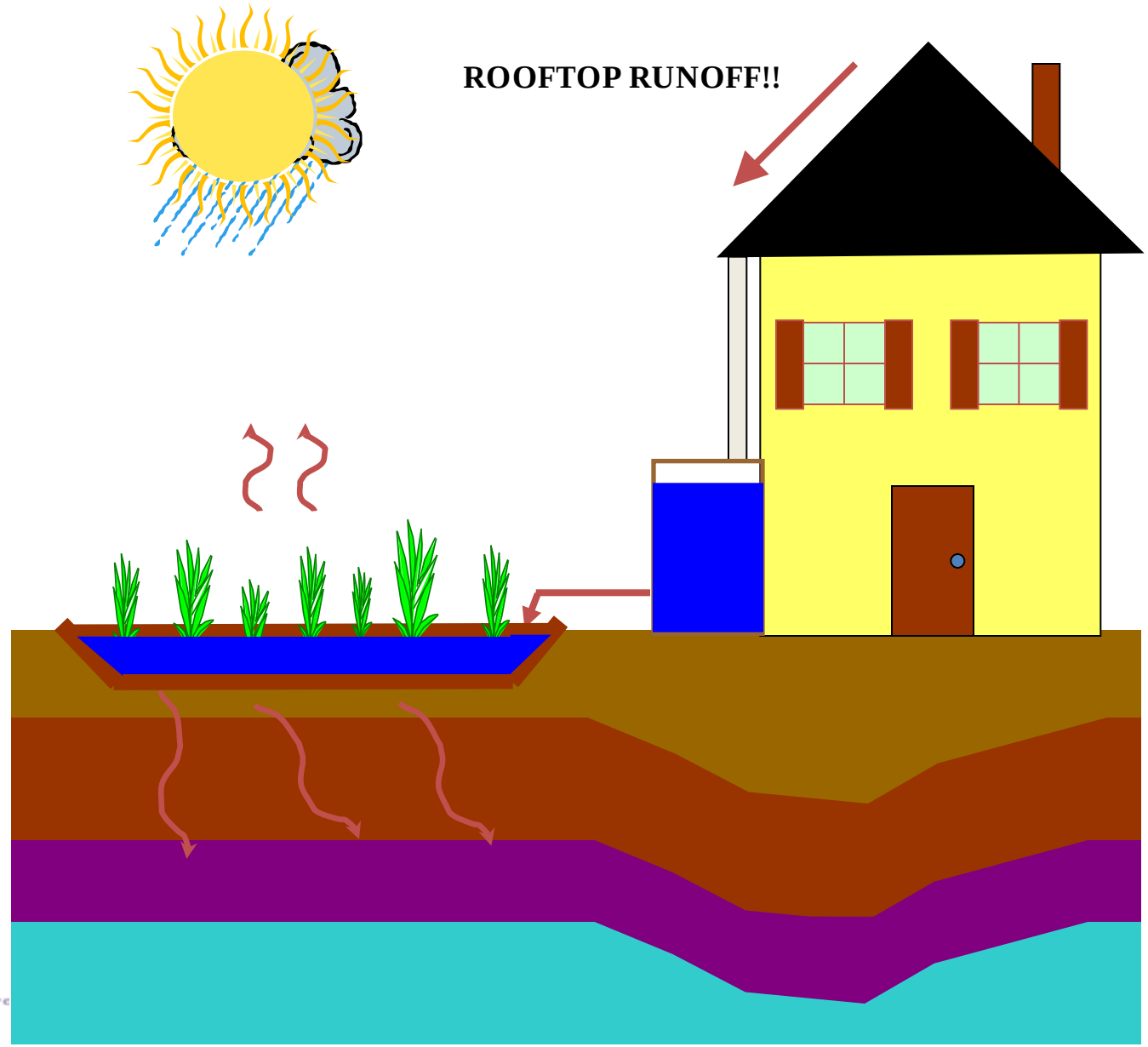


# Urban Water Budget – Pavement and Rooftop Scenario




CLEMSON
PUBLIC SERVICE

# Urban Water Budget – Rainwater Harvesting Scenario



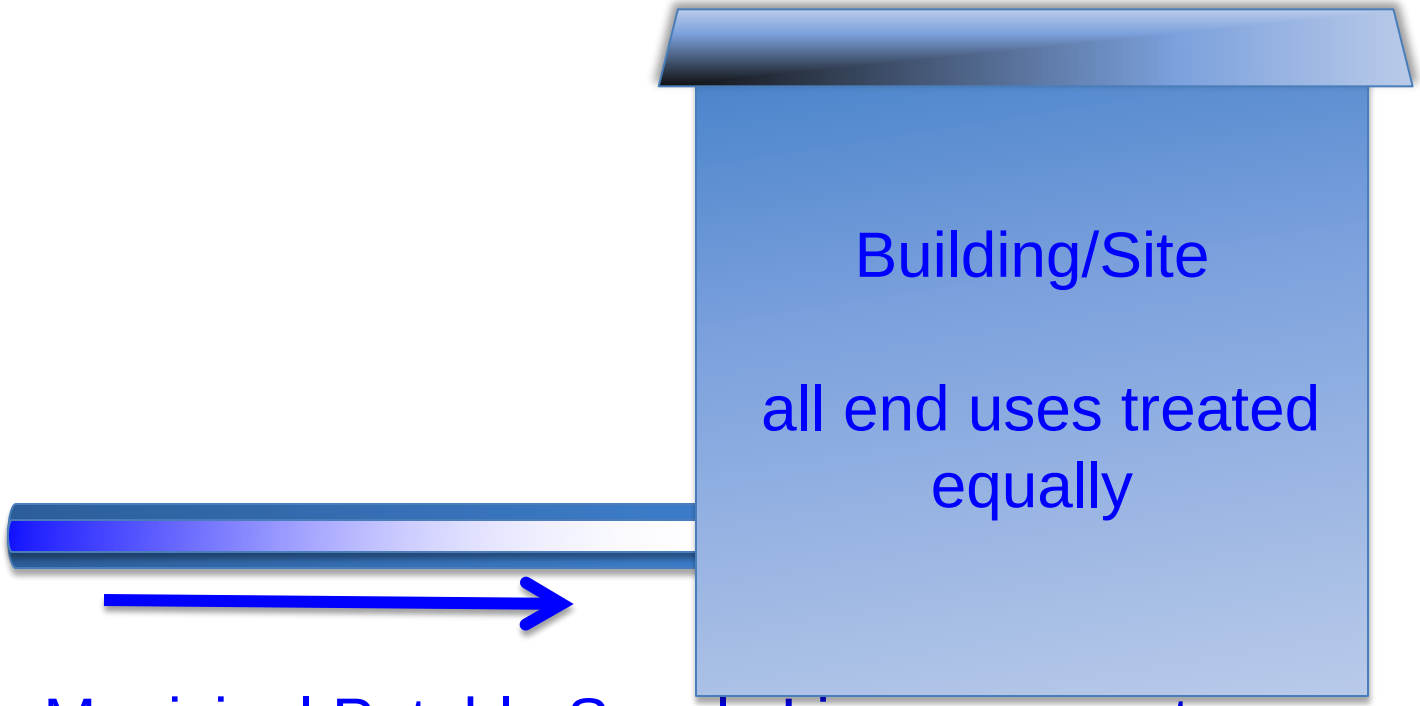

CLEMSON
PUBLIC SERVICE

# We are entering into a new era of water management.

## Consider this:

- We pay to bring water in.
- We pay to get rid of it.
- We pay to get rid of the free water (rain) via stormwater fees and infrastructure.

# Current Water Supply Paradigm




Municipal Potable Supply Line represents an **unlimited** supply of Potable water for all end uses.

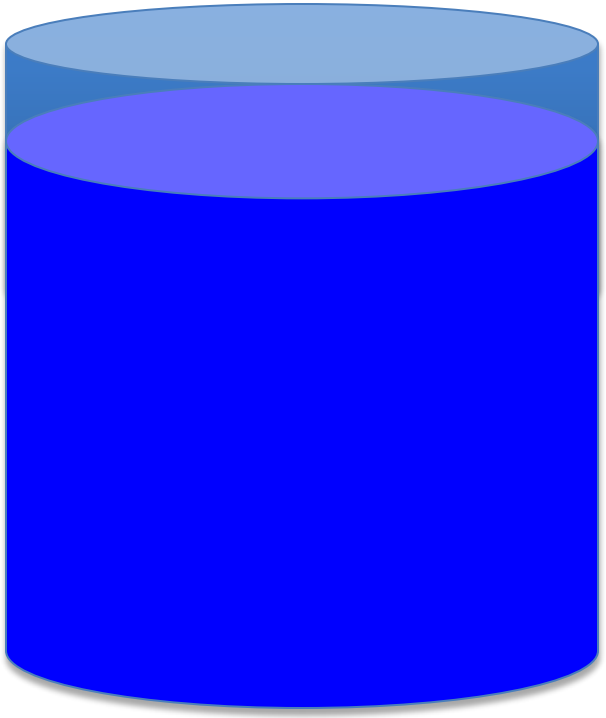
# New Water Supply Paradigm.


Municipal Potable supply line for specific uses

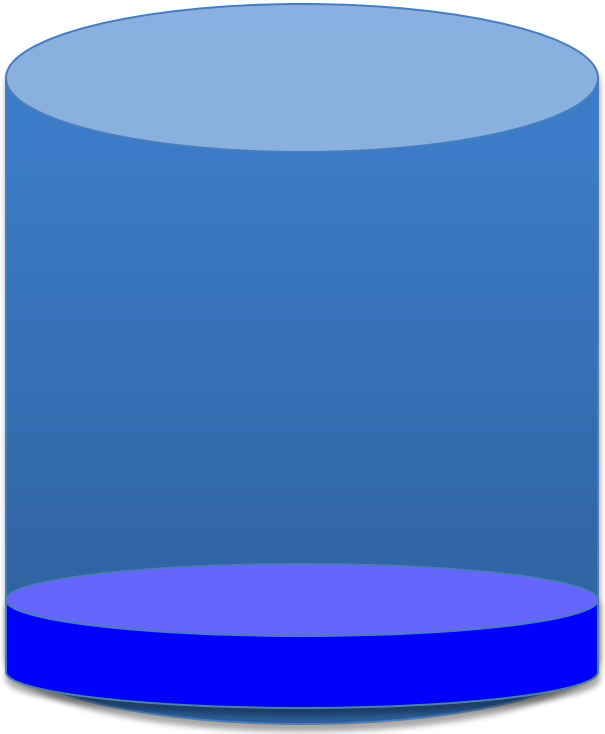
Non-Potable (Rainwater) Supply line for non-potable uses, represents a finite amount.

# Three approaches to rainwater/stormwater management

Cistern managed for water supply

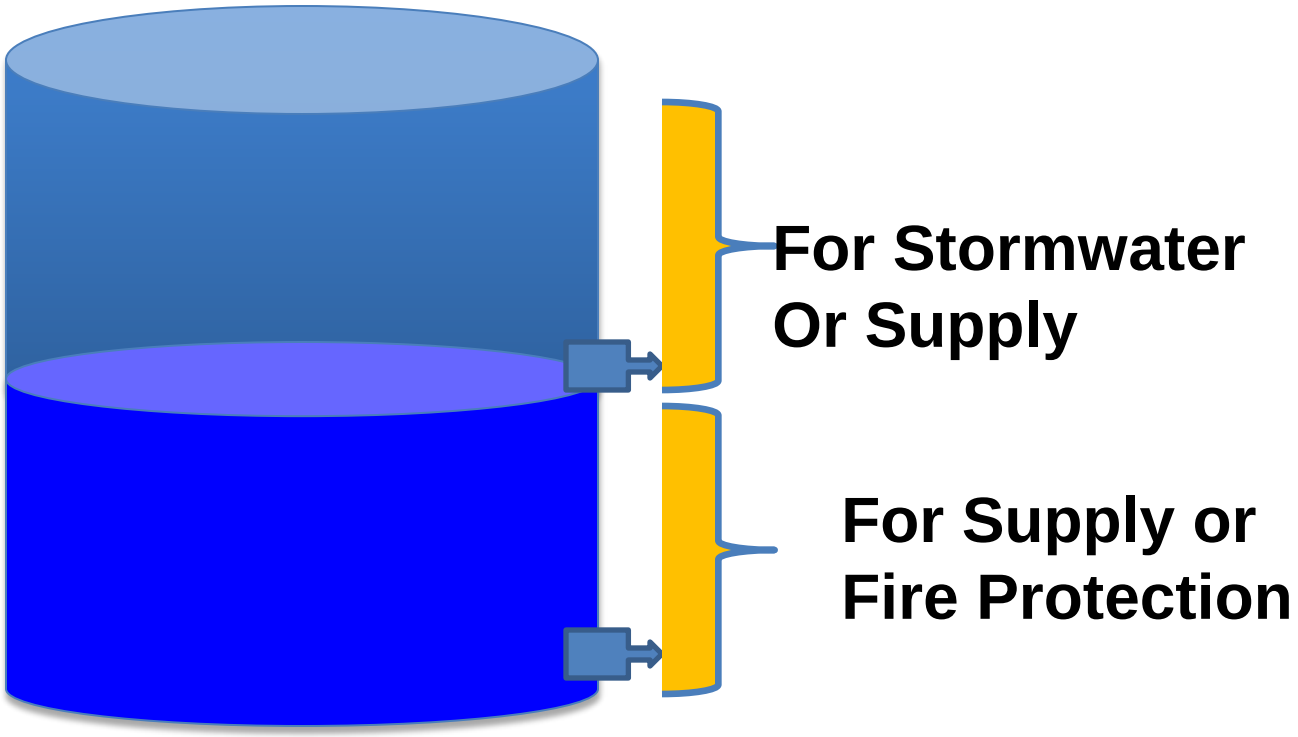


Cistern managed for stormwater control



AND

# Cistern managed for BOTH water supply and managed for stormwater control or fire protection



# Definitions

## Rainwater Harvesting

**Rainwater harvesting** is the accumulating and storing, of rainwater collected from the roofs of houses, tents, local institutions and other **above ground impervious surfaces**. It may be used for potable and non-potable in-home use, livestock, irrigation, wildlife, firefighting or to refill aquifers in a process called groundwater recharge. Water runoff from the ground, roads, parking lots impervious areas is called **Stormwater harvesting.**

# Residential Wastewater

**Graywater** or Greywater or Gray Water is untreated household wastewater that has not come into contact with toilet waste meat preparation sinks including water from:

- Showers
- Bathtubs
- Hand washing lavatories
- Sinks (not used for disposal of hazardous or toxic materials)
- Sinks (not used for food preparation or disposal)
- Clothes-washing machines (excludes diapers and other human excreta)

# Reused, Recycled or Reclaimed Water

**R**eused, recycled or reclaimed water is water that is used more than one time before it passes back into the natural water cycle. Thus, water recycling is the reuse of treated wastewater for beneficial purposes such as agricultural and landscape irrigation, industrial processes, toilet flushing, or replenishing a groundwater basin (referred to as groundwater recharge).

# Rainwater is not:

- Recycled water.
- Reclaimed water.
- Reused water.

# Rainwater is:

- Primary source water.
- Water that has never been used.


TEA ROOM
Martha's Bloomers.com
www.WorldsLargestTeapot.com

# Annual Rainfall – Denver
# 15.8” Annual Rainfall

January - 0.5

February - 0.5

March – 1.3

**April - 1.9**

**May – 2.3**

**June – 1.6**

**July – 2.2**

**August – 1.8**

**September - 1.1**

October – 1.0

November – 1.0

December – 0.6

# Annual Rainfall – Atlanta, GA
# 50.2” Annual Rainfall

**January – 5.0**

February – 4.7

**March – 5.4**

April – 3.6

May – 4.0

June – 3.6

**July – 5.1**

August – 3.7

September - 4.1

**October – 3.1**

November – 4.1

December – 3.8

# Annual Rainfall – Los Angeles
# 13.2” Annual Rainfall

**January – 3.0**

**February – 3.1**

March – 2.4

**April – 0.6**

**May – 0.2**

**June – 0.1**

**July – 0.0**

**August – 0.1**

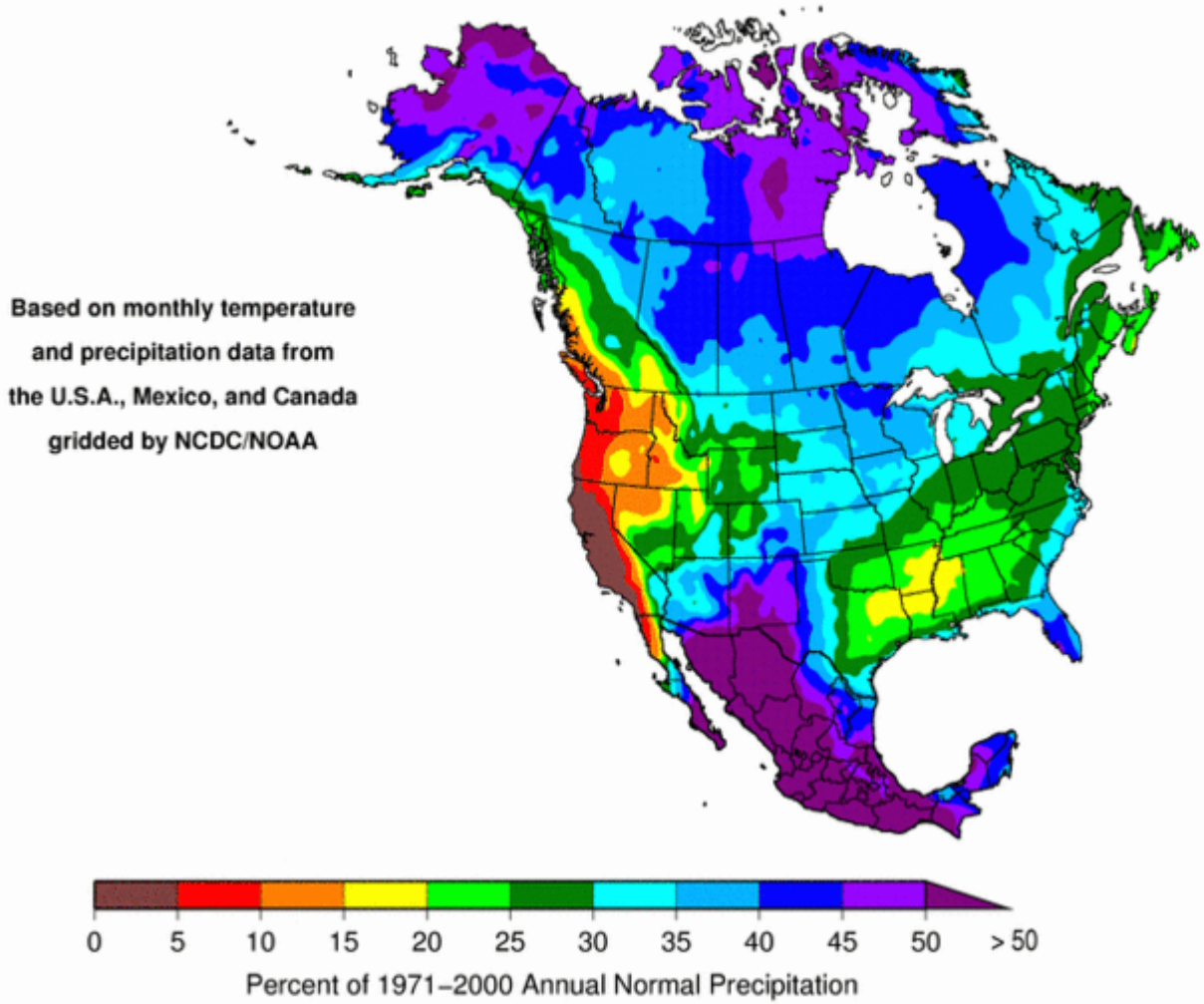
**September – 0.3**

**October – 0.4**

November – 1.1

December – 1.8

# Percent of Annual Normal Precipitation, July to September



# Calculate Supply and Demand

- Rainfall Amount
- Size of Roof
- Use and/or Need
- Rain intensity
- Rain Frequency (or length between rains)
- Storage Size
- Is there a back-up supply

# TWDB Calculator

| | Water Demand | Total Demand | Average rainfall | Collection surface size | Gallons/ft2 coefficient | Efficiency factor | Rainfall collected | End of month storage |
|---|---|---|---|---|---|---|---|---|
| JAN | 28,000 | 28,000 | 2.12 | 15,000 | 0.62 | 0.9 | 17,744 | 9,744 |
| FEB | 28,000 | 28,000 | 2.6 | 15,000 | 0.62 | 0.9 | 21,762 | 3,506 |
| MAR | 28,000 | 28,000 | 3.18 | 15,000 | 0.62 | 0.9 | 26,617 | 2,123 |
| APR | 28,000 | 28,000 | 3.38 | 15,000 | 0.62 | 0.9 | 28,291 | 2,414 |
| MAY | 28,000 | 28,000 | 5.34 | 15,000 | 0.62 | 0.9 | 44,696 | 19,109 |
| JUN | 28,000 | 28,000 | 3.7 | 15,000 | 0.62 | 0.9 | 30,969 | 22,078 |
| JUL | 28,000 | 28,000 | 2.48 | 15,000 | 0.62 | 0.9 | 20,758 | 14,836 |
| AUG | 28,000 | 28,000 | 2.13 | 15,000 | 0.62 | 0.9 | 17,828 | 4,664 |
| SEP | 28,000 | 28,000 | 3.18 | 15,000 | 0.62 | 0.9 | 26,617 | 3,281 |
| OCT | 28,000 | 28,000 | 4.55 | 15,000 | 0.62 | 0.9 | 38,084 | 13,364 |
| NOV | 28,000 | 28,000 | 2.59 | 15,000 | 0.62 | 0.9 | 21,678 | 7,043 |
| DEC | 28,000 | 28,000 | 2.71 | 15,000 | 0.62 | 0.9 | 22,683 | 1,725 |

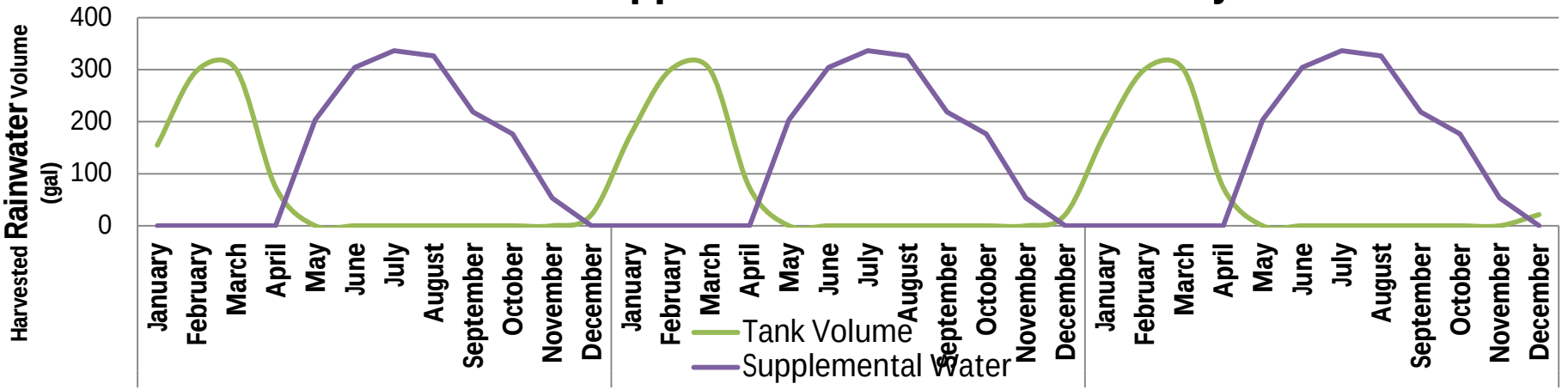
# Texas AgriLife Extension Service Rainwater Harvesting Calculator

To use the calculator fill in all highlighted input values.

| Input Values | |
|---|---|
| Catchment area (ft²): | 150 |
| Collection efficiency (%): | 95 |
| Initial tank volume (gal): | 0 |
| Tank size (gal): | 300 |
| Plant water use coeff: | 1 |
| Irrigated area (ft²): | 100 |
| Monthly indoor demand (gal): | 0 |

| Avg. monthly rainfall (in) | | Avg. PET (in) | AC Condensate (gal) |
|---|---|---|---|
| January: | 3 | 1.79 | 0 |
| February: | 3.1 | 2.12 | 0 |
| March: | 2.4 | 3.3 | 0 |
| April: | 0.6 | 4.49 | 0 |
| May: | 0.2 | 4.73 | 0 |
| June: | 0.1 | 5.03 | 0 |
| July: | 0 | 5.4 | 0 |
| August: | 0.1 | 5.38 | 0 |
| September: | 0.3 | 3.94 | 0 |
| October: | 0.4 | 3.4 | 0 |
| November: | 1.1 | 2.42 | 0 |
| December: | 1.8 | 2.22 | 0 |
| Total: | 13.1 | 44.22 | 0 |

| Yearly Percent Average Rainfall (%) | |
|---|---|
| Year 1: | 100% |
| Year 2: | 100% |
| Year 3: | 100% |



# Rain Intensity

- El Paso – 2.0 inches per hour
  - 0.021 gallons per square foot per minute
- Tucson – 3.0”/hr
  - 0.031 g/sq’/min
- San Antonio – 4.4”/hr
  - 0.036 g/sq’/min

| City | Inches/Hour | GPM/Square Foot |
|---|---|---|
| Daytona Beach | 4.0 | 0.042 |
| Palm Beach | 5.0 | 0.052 |
| El Paso | 2.0 | 0.021 |
| Houston | 4.6 | 0.048 |
| Banger, Maine | 2.2 | 0.023 |
| San Diego | 1.5 | 0.016 |

# Rain Intensity - Denver

- **2.2” per hour**
- **0.023 Gallons per minute per square foot**

- 1000 sq’ x 0.023 = 23 gallons/minute

# Sizing Gutters

**1/16” slope/ft. and 2” per hour**

3 gutter – 680 sq’

**4” gutter – 720 sq’**

5” gutter – 1,250 sq’

(For each downspout)

# Vertical Piping/Downspouts

- 3” – 67 gpm 3220 sq’ roof
- 4” – 144 gpm 6,920 sq’ roof

# From Rain Barrels

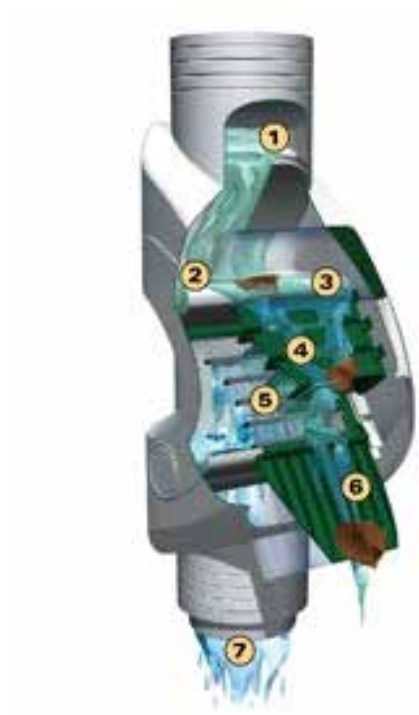
Rain Saucers


CLEAN GREEN
LAWN CARE

# First - Roof

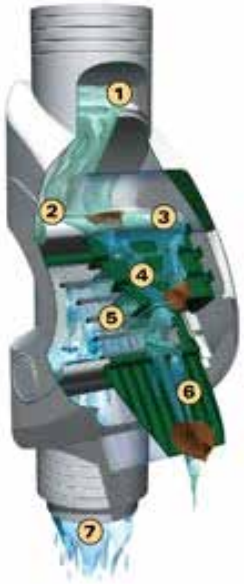

nj.com

- **Preventing debris from going into a tank is cheaper and easier than removing it from the tank**
- **Prune Trees**

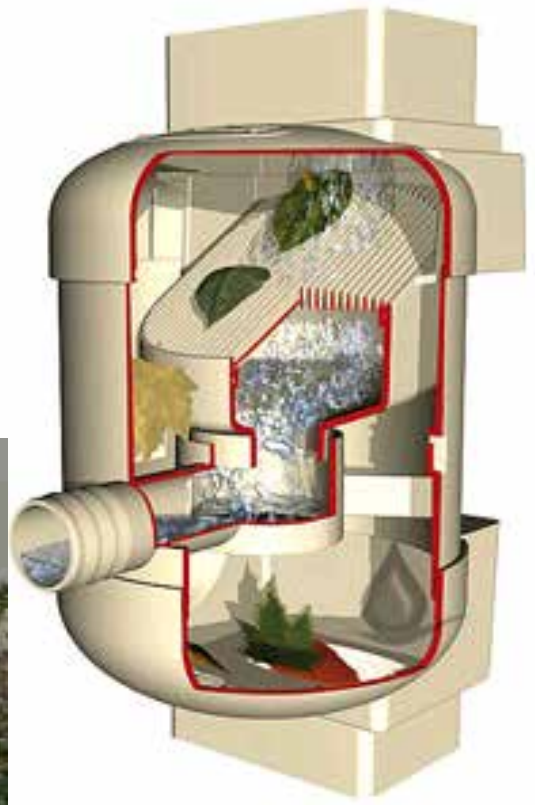



ARCSA

American Rainwater Catchment Systems Association

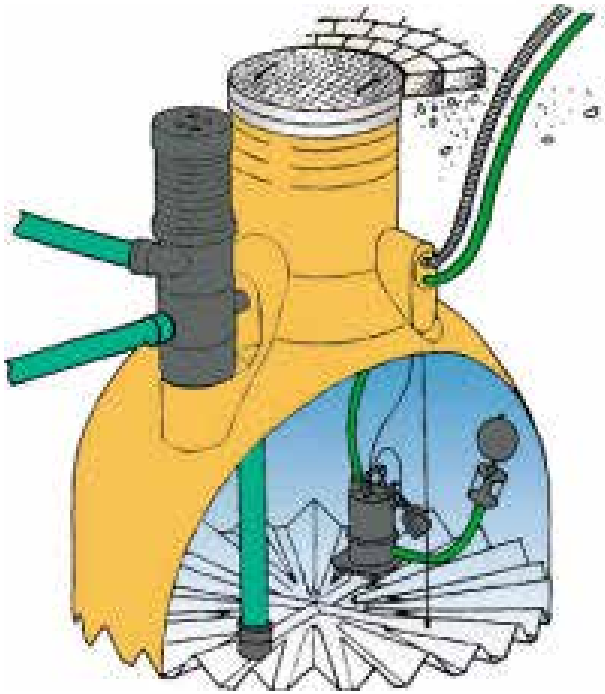

1
2
3
4
5
6
7

# Graf Quattro Twist
# Downspout Filter and Diverter

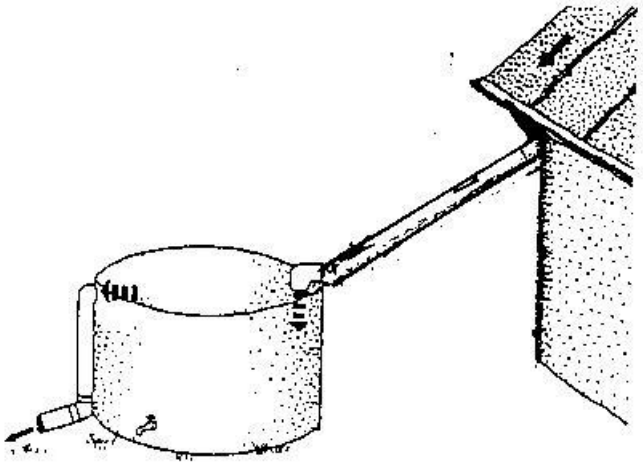


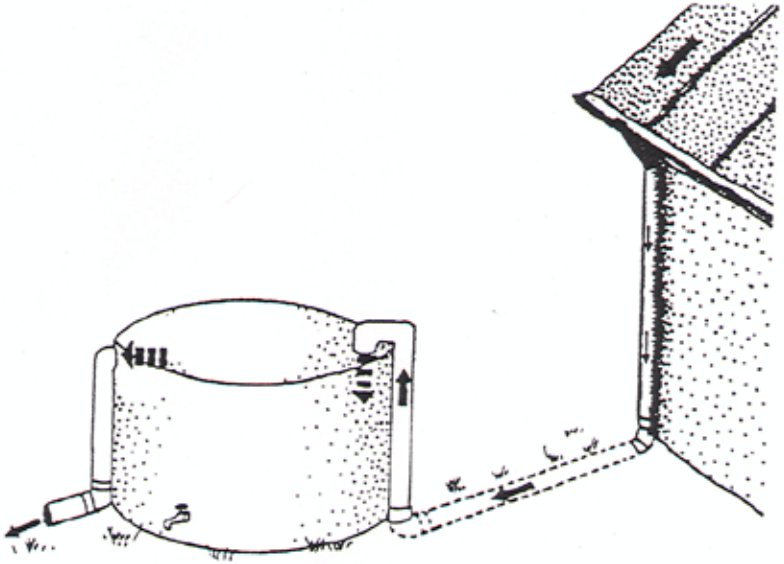
# 3P Technik VF1 Volume Filter


wisy



# Dry Line vs. Wet Line





# El Paso's Kay Bailey Hutchinson Desalinization Facility And TECH2O Educational Center


ARCSA
American Rainwater Catchment Systems Association


ARCSA
American Rainwater Catchment Systems Association


WD-40


ARCSA
American Rainwater Catchment
Systems Association

# How Many Drops Are There in 1 Gallon of Water?

ARCSA
American Rainwater Catchment Systems Association


How Many Drops Are There in 1 Gallon of Water?
90,400 Drops
ARCSA
American Rainwater Catchment Systems Association

# How Many Seconds are in 1 Day?


ARCSA
American Rainwater Catchment Systems Association

# How Many Seconds are in 1 Day?

**86,400**


ARCSA
American Rainwater Catchment Systems Association

# Dry Line to 15,000 Gallon Tank, Denton, TX

# RWH Tank Options


- 620 gallon slim line tank
- First Flush
- Dry Conveyance
- Installed November 2009 in Pacific Grove

# Cisterns Come in many sizes and types of material

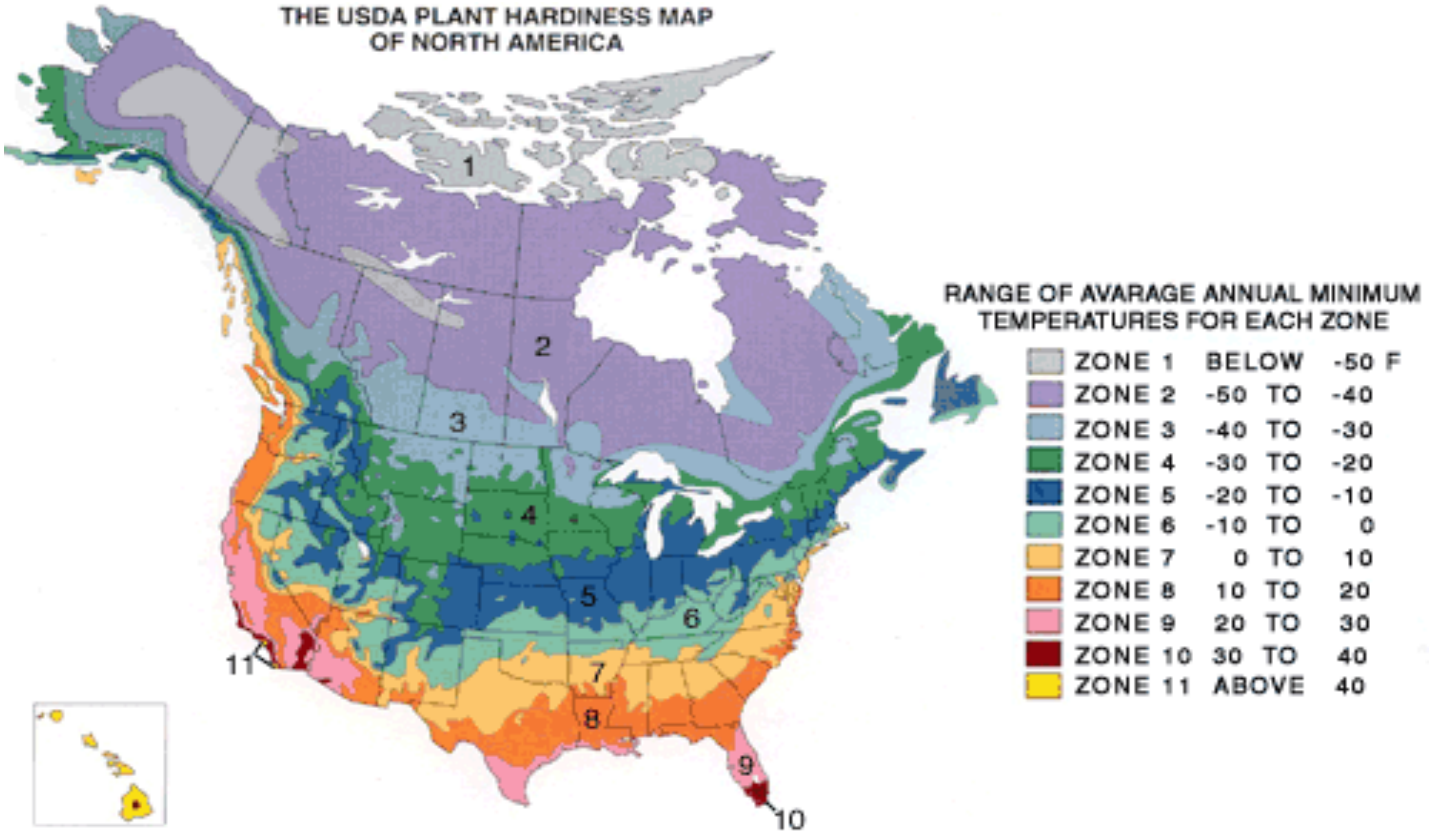


TRI-CITY

***4 Million-Gallon***, modular, NSF Annex G-certified potable tank

Fiber Technology Corporation

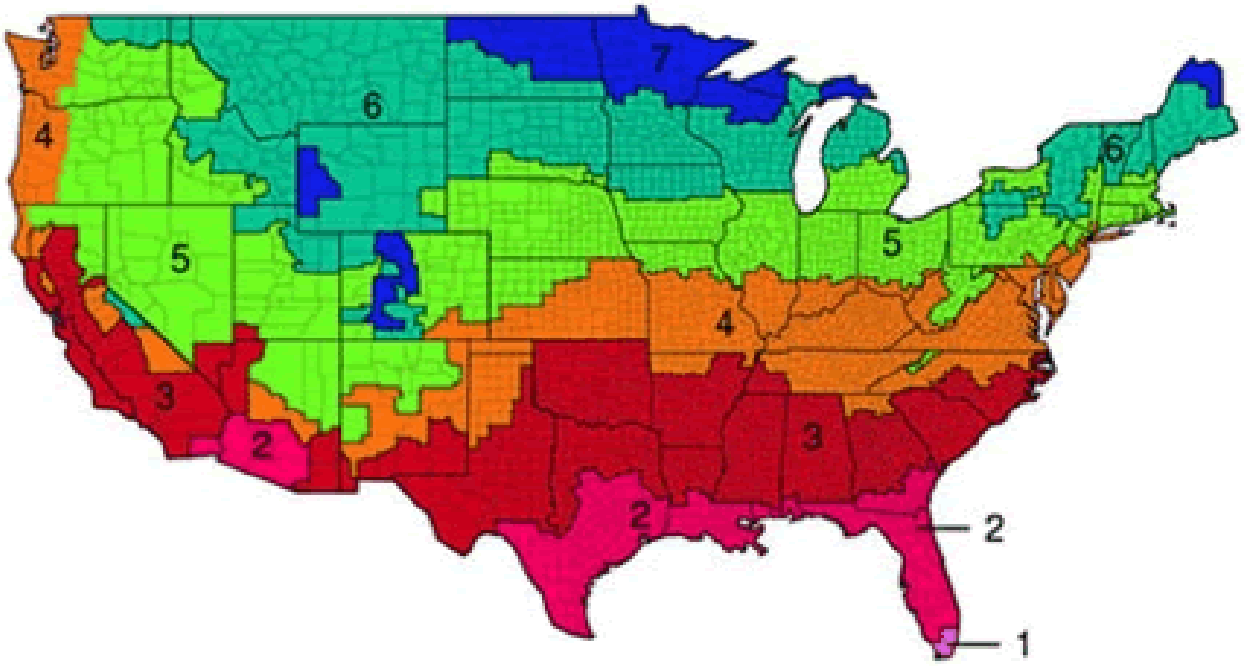
# USA: A Range of Climates




Source: backyardgardener.com

ARCSA
American Rainwater Catchment Systems Association

# USA: Varying Temperatures




ASHRAE Minimum Building Insulation Recommendations (per Standard 189):
Zone 1: R-20
Zone 2 – 5: R-25
Zone 6: R-30
Zone 7 – 8: R-35

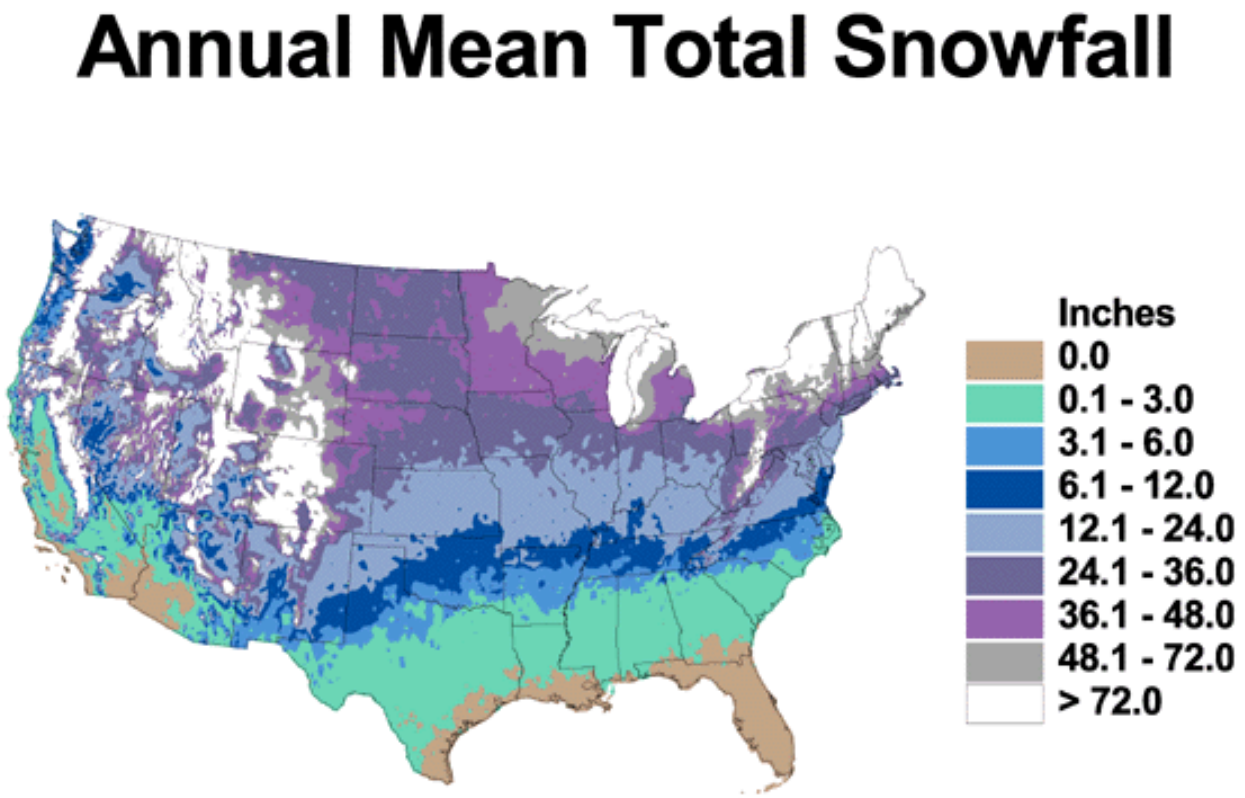
Source: ASHRAE.ORG

The house insulation r value of insulating boards are:

| | |
|---|---|
| Expanded polystyrene | 4/inch |
| Extruded polystyrene | 5/inch |
| Polyisocyanurate & Polyurethane | 6-7/inch |

ARCSA
American Rainwater Catchment Systems Association

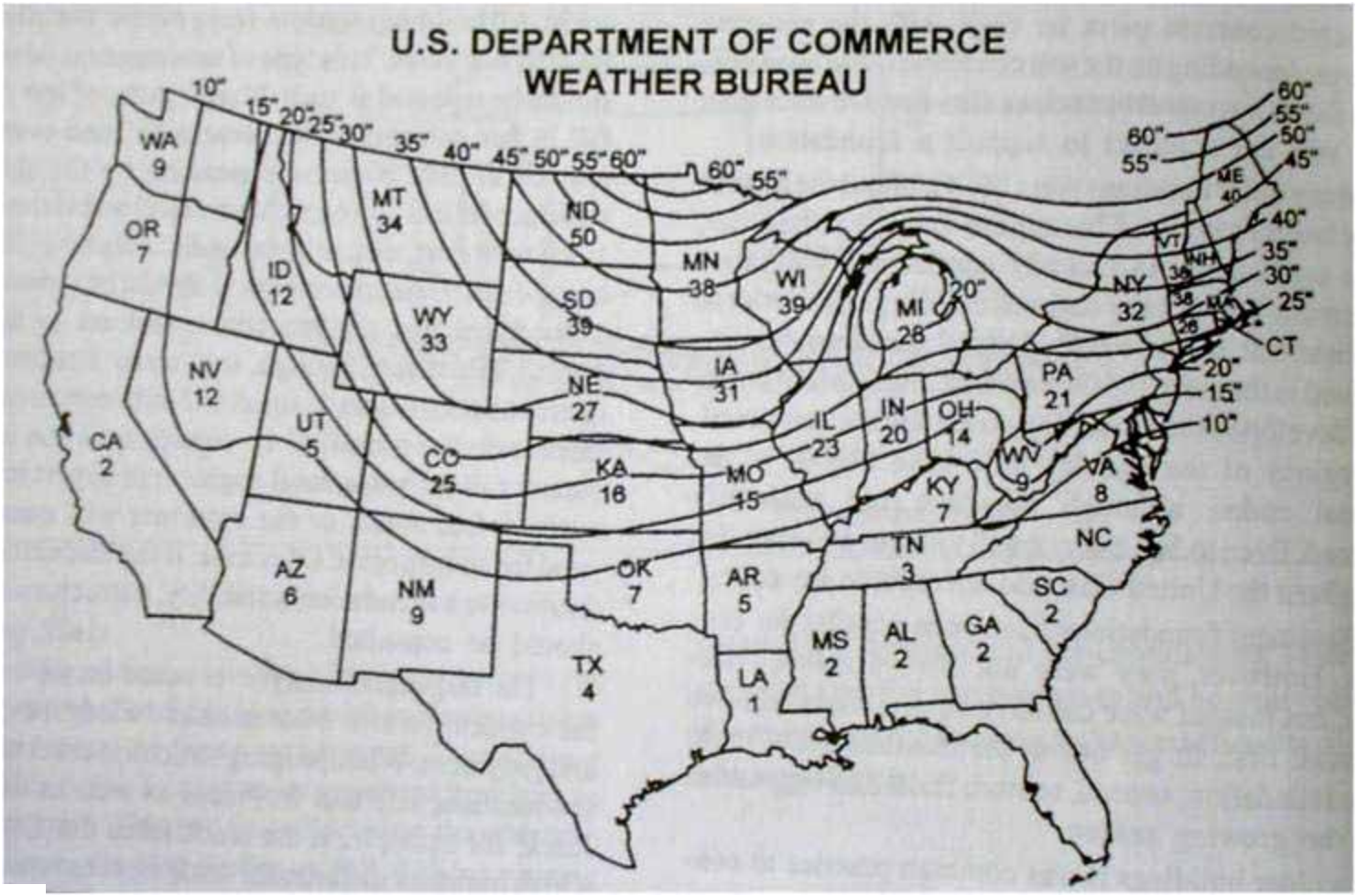
# USA: Varying Snowfall




Source: mscd.edu

ARCSA
American Rainwater Catchment Systems Association

# USA: Varying Frost Lines




ARCSA
American Rainwater Catchment Systems Association

# Protection From Freezing

- **Tank Options:**
  - Locate Indoors
  - Bury below frost line
  - Insulate
  - Circulate/Aerate
  - Winterize
  - Heat with elements or resistant wire

The next series of slides come from this document. I have not asked for permission to publish or re-use.

BYGGFORSK
NBI: A515.161

# WATER CISTERN CONSTRUCTION for SMALL HOUSES

ALASKA BUILDING RESEARCH SERIES HCM-01557

**Introduction**

This publication is one of nine that has been translated from Norwegian. They are taken from a series of publications produced by the Norwegian Building Research Institute (NBI) series, "Byggdetaljer," which literally translated means "building details." The translations were done by Dr. Nils Johanson and Richard D. Seifert of the University of Alaska Fairbanks with the cooperation and permission of NBI, Oslo, Norway. The financial support for the translations and printing came through the Alaska Department of Community and Regional Affairs, from USDOE Grant DE-FG06-80CS6908. The publications use the original index code of the Norwegian "Byggdetaljer" series so that specific translations can be directly cited. All questions on these translations should be directed to Richard D. Seifert, Cooperative Extension Service, P.O. Box 756180, University of Alaska Fairbanks, Fairbanks, Alaska 99775-6180. Phone: 907-474-7201

http://www.uaf.edu/files/ces/publications-db/catalog/eeh/HCM-01557.pdf

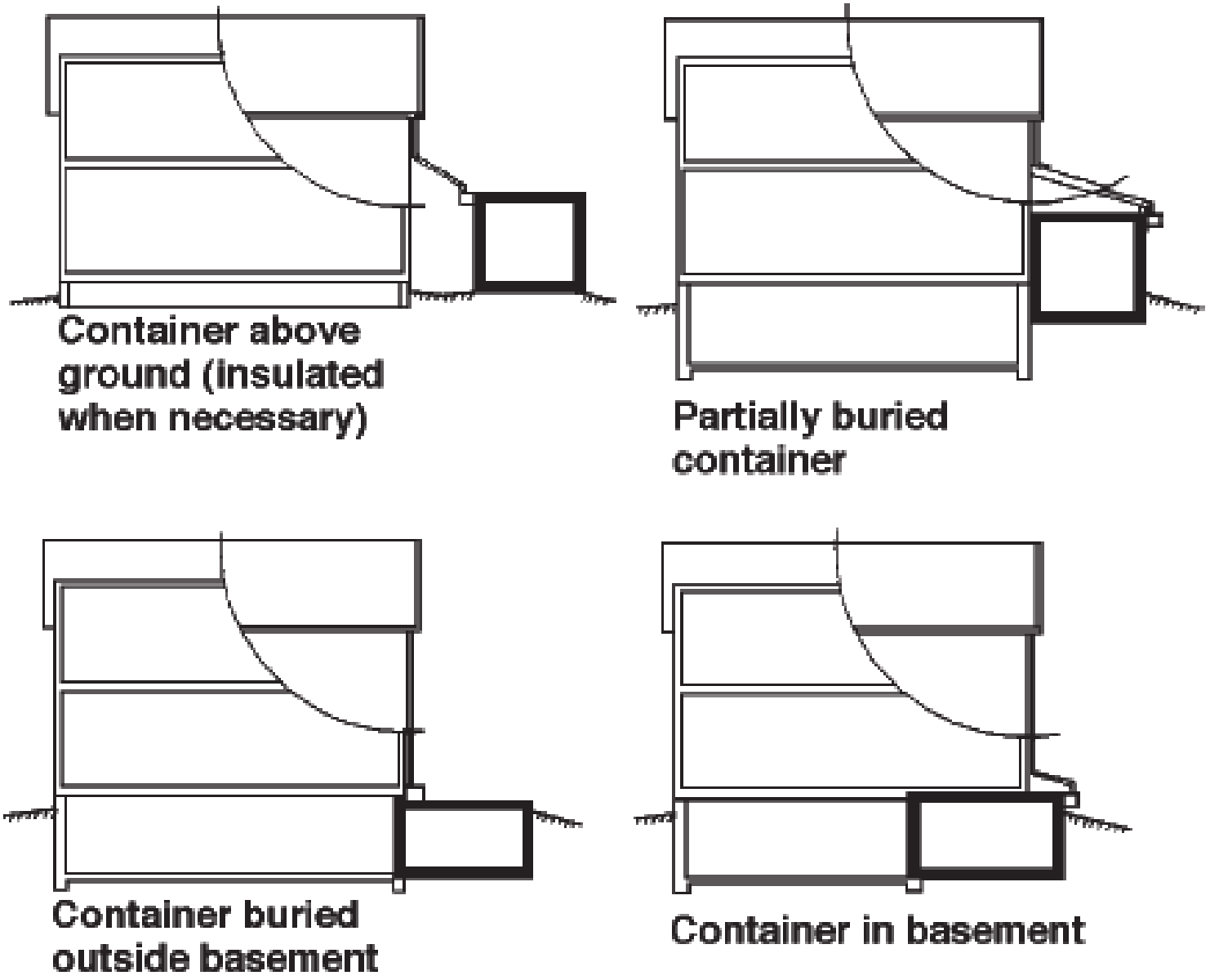



Figure 22
Examples of placement of systems.


Over-temperature Protection
ALLIED SINKING TANK DE-ICER
Safe For Plastic Tanks
Durable Cord Protection
Rugged and Weather-resistant
Guaranteed For One Full Year
Thermostatically Controlled
ALLIED PRECISION INDUSTRIES, INC


Over-temperature Protection


EASILY CONVERTS BETWEEN A FLOATER, SINKER, OR DRAIN-PLUG DE-ICER
ENERGY EFFICIENT—Keeps Entire Tank Ice-free Without Overheating The Water
Durable Aluminum Base
Multiple Thermostat Control
Large, Finned Base Runs Cooler Than Conventional De-icers
Special Patented Adaptor Included To Easily Route Cord Through Drain Hole
Safe In Plastic Tanks
Heavy Duty Anti-chew Protector
Three-Year Warranty
3 in 1
DE-ICER
FLOATER / SINKER / DRAIN PLUG
Model DT15
1500 Watts
120 Volts
60 Hz
ADAPTOR INCLUDED
Special patented adaptor included to route cord through drain hole if desired. Keeps power cord protected from livestock. See side panel for complete description.
$ 37.99

# Using Rainwater

# Drip Irrigation

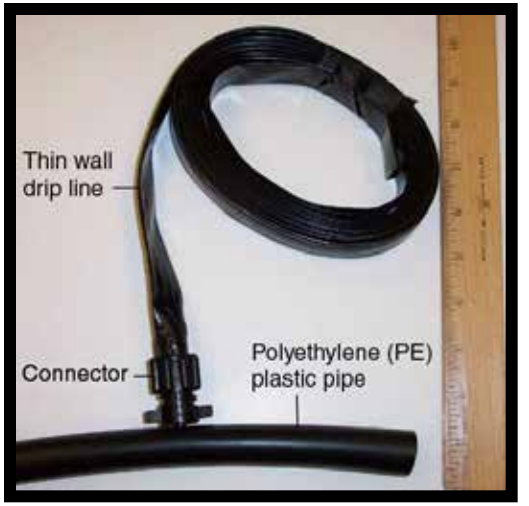

GARDEN CENTER

# Green Houses
# Water Features

# Wildlife

# Livestock Water

# Types of Drip Irrigation



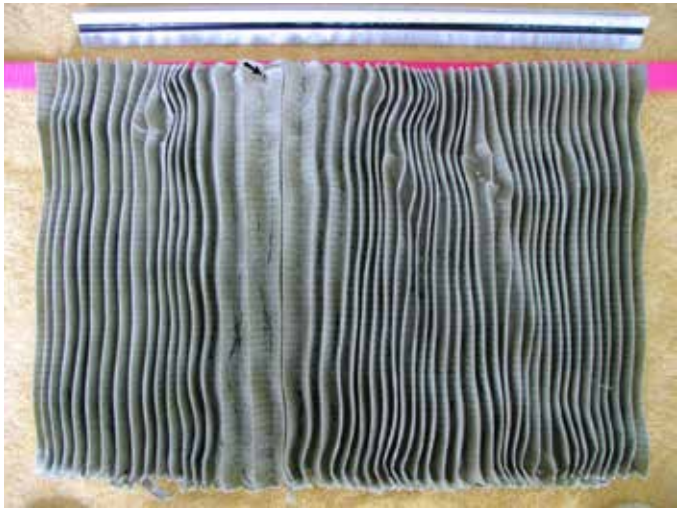

By-product


FIRE DEPARTMENT
10,000 GALLON DRAFT
TANK AND HOSE
GO TO THE END OF ROBERTS ROAD
BY THE GREEN ROOFED BARN.


# McDonald Observatory - For Fire Protection

# In-home Use

# Mosquitoes & Midges

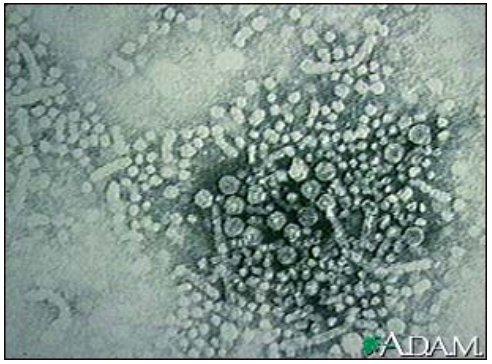


# The Bugs

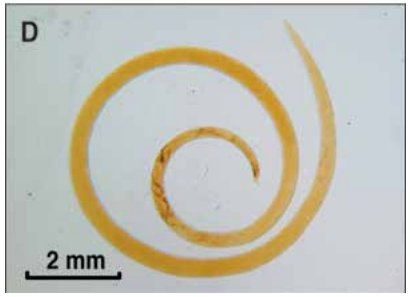
Getting Rid of:

Bacteria

Virus




Parasites




Protozoa

# Filtration

- Coarse solids
  - Screen
  - Disk
- Sediment filter – 1, 3- to 5- micron
  - Bag filter
  - Cartridge filter

# Disinfection, not Sterilization

The goal of **disinfection** is to rid the water stream of those organisms capable of causing infection.

**Sterilization is freeing the water stream of ALL LIFE.**

Possible options for disinfecting rainwater delivered by system

**Distillation**
**Reverse Osmosis**
**Chlorination**
**Ultraviolet light – UV**
**Ozone**

# pH Rainwater naturally Acidic

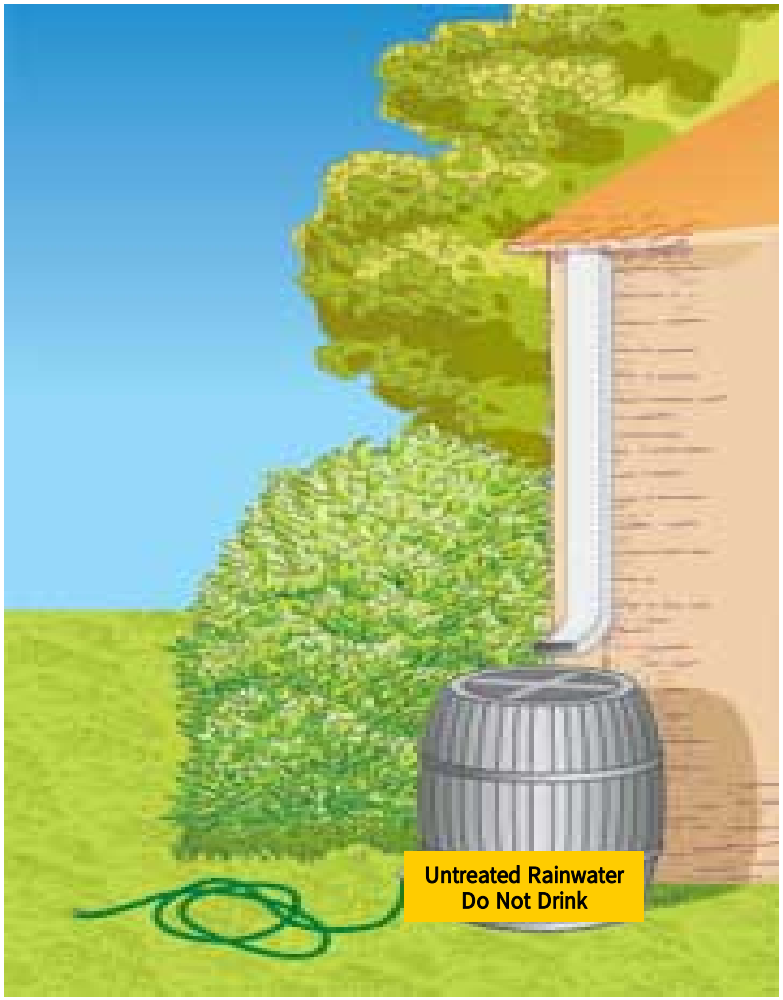
**4.5 to 6.3**
**Acidic**
**Affects Copper**
**Raise with -**
**Baking Soda**

# Individual RAIN BARRELS for collection of Rainwater

## General Treatment Goals

1. **Nothing grows within: Mosquitoes, Algae**
2. **No Debris that will promote odor**
3. **No Animal matter present**
4. **Label Non Potable Water Sources as below :**

UNTREATED RAINWATER
DO NOT DRINK



***"The nation behaves well if it treats the natural resources as assets which it must turn over to the next generation increased and not impaired in value."*** Teddy Roosevelt

# Resources

- ARCSA website www.arcsa.org - FREE public domain rainwater harvesting manuals: TX, VA, GA, FL, HI, Ontario. "Resources & Documents" many free publications and hyperlinks to rainwater information around the world
- Texas A&M University http://rainwaterharvesting.tamu.edu

Thank You - Billy Kniffen

Rainwater Harvesting

ARCSA

American Rainwater Catchment Systems Association