Introduction to Rainwater Harvesting

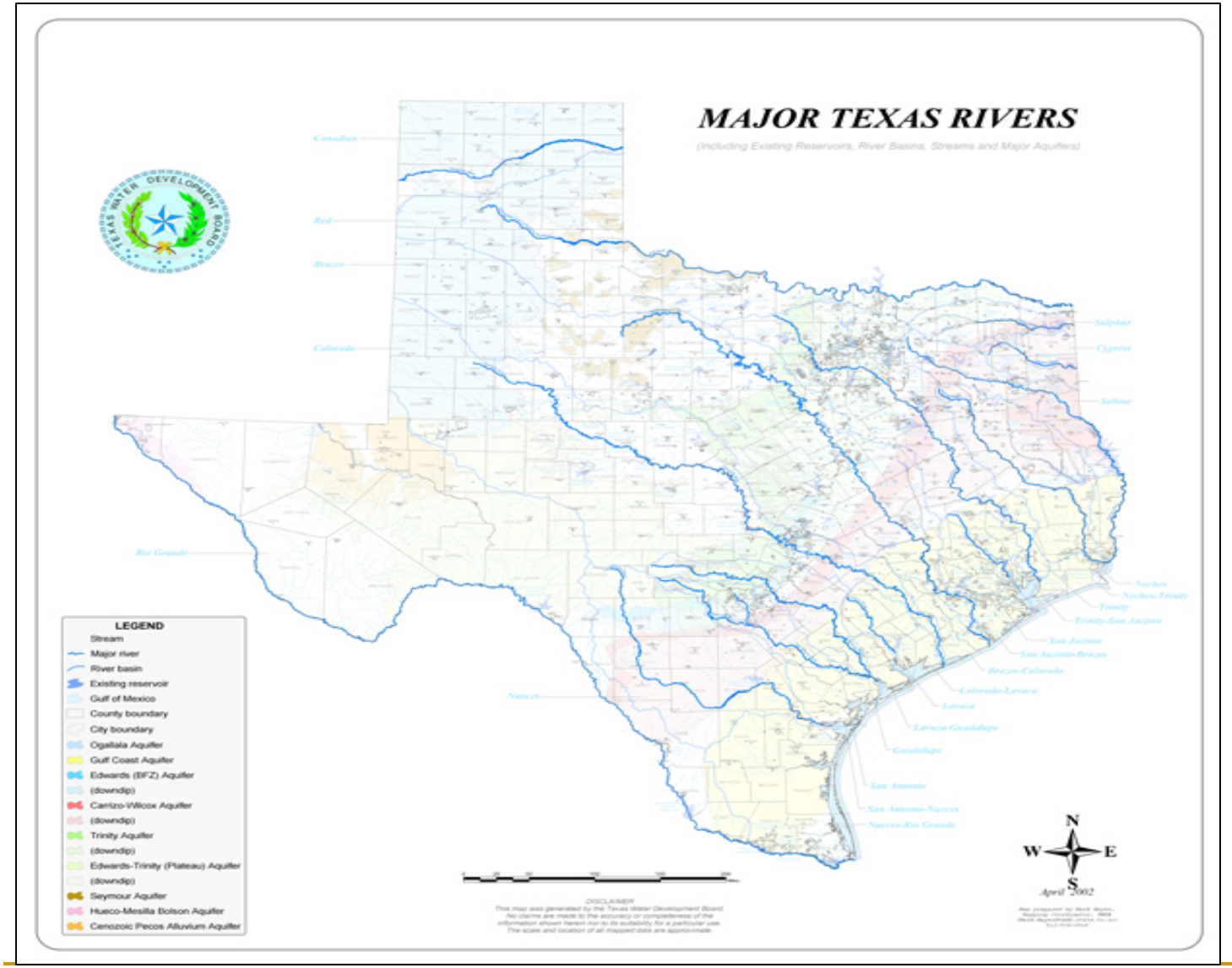
Department of Biological and Agricultural Engineering
Texas A&M University

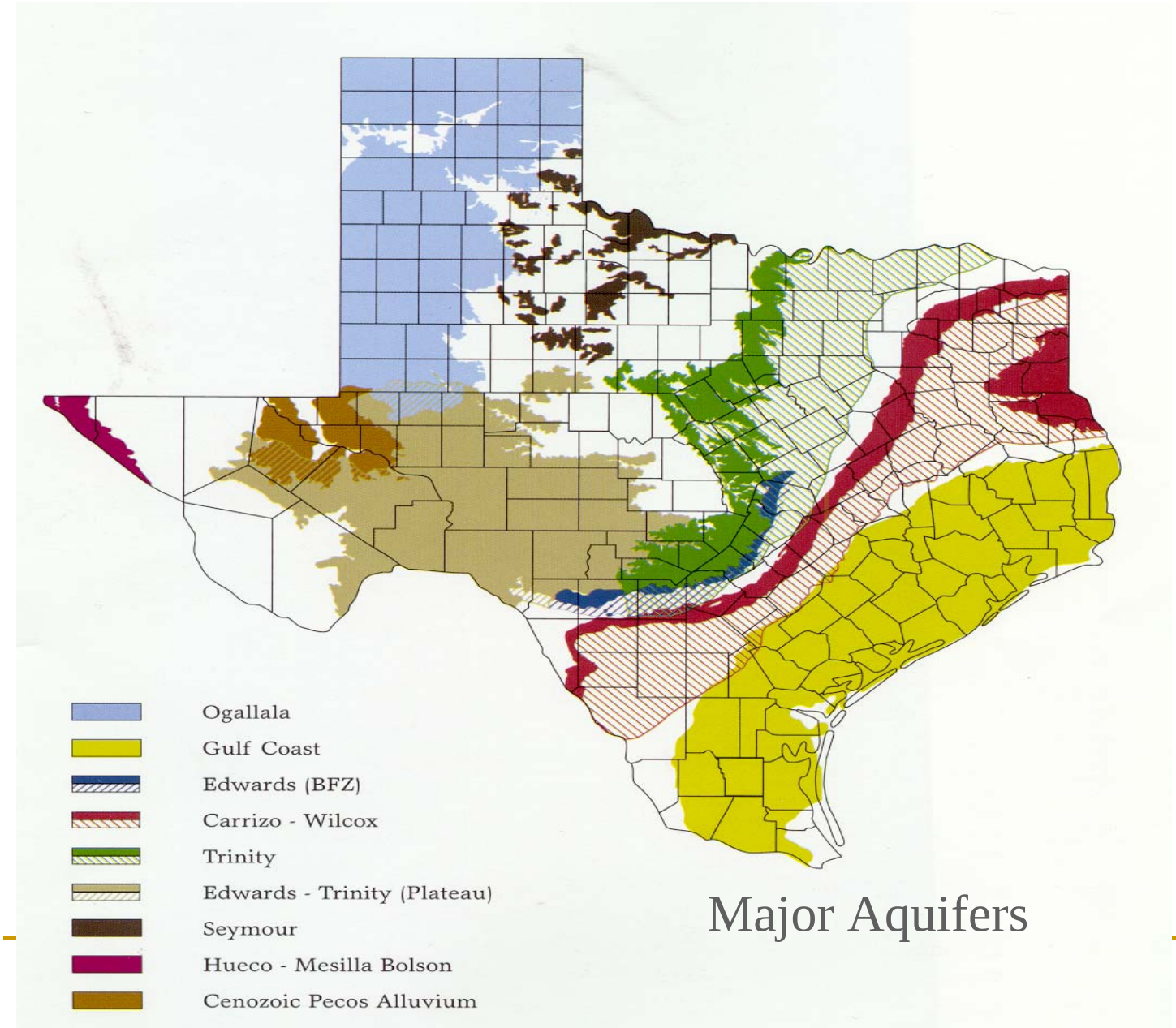
TEXAS A&M UNIVERSITY SYSTEM
Biological and Agricultural Engineering Department

Texas Cooperative EXTENSION
The Texas A&M University System

Rainfall in your watershed

- What is a watershed?
  - An area of land that drains to a common point
- Quick facts
  - Texas has more than 191,000 miles of rivers
  - Texas has almost 2 million acres of lakes
  - 40% of TX springs are no longer running
  - 30-50% of total water is used for landscape irrigation
  - The state population will nearly double in the next 50 yrs
  - Population growth for Ellis county increased 20% & TX 10% from 2000 to 2005


MAJOR TEXAS RIVERS
(Including Existing Reservoirs, River Basins, Streams and Major Aquifers)
TEXAS WATER DEVELOPMENT BOARD
Canadian
Red
Brazos
Colorado
Rio Grande
Nueces
Sulphur
Cypress
Sabine
Neches
Neches-Trinity
Trinity
Trinity-San Jacinto
San Jacinto
San Jacinto-Brazos
Brazos-Colorado
Colorado-Lavaca
Lavaca
Lavaca-Guadalupe
Guadalupe
San Antonio
San Antonio-Nueces
Nueces-Rio Grande
LEGEND
Stream
Major river
River basin
Existing reservoir
Gulf of Mexico
County boundary
City boundary
Ogallala Aquifer
Gulf Coast Aquifer
Edwards (BFZ) Aquifer
(downdip)
Carrizo-Wilcox Aquifer
(downdip)
Trinity Aquifer
(downdip)
Edwards-Trinity (Plateau) Aquifer
(downdip)
Seymour Aquifer
Hueco-Mesilla Bolson Aquifer
Cenozoic Pecos Alluvium Aquifer
N
W
E
S
April 2002
DISCLAIMER
This map was generated by the Texas Water Development Board.
No claims are made to the accuracy or completeness of the
information shown herein nor to its suitability for a particular use.
The scale and location of all mapped data are approximate.



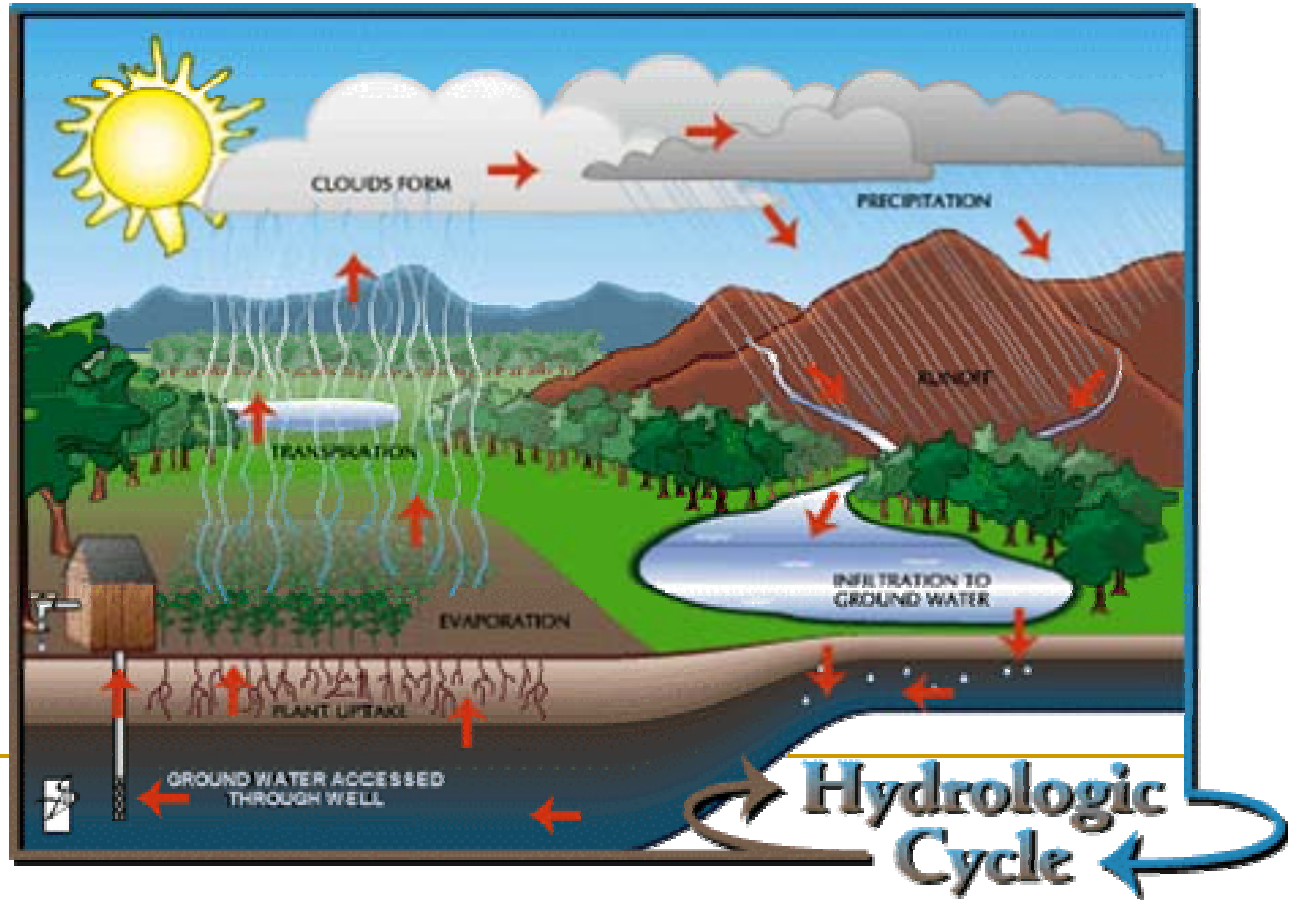
Major Aquifers

Water Quality Impacted by

- Natural processes
- Activities of man

Rainfall in your watershed

- Understanding the Hydrologic Cycle



What is rainwater harvesting?

- **Rainwater harvesting** is the capture, diversion, and storage of rainwater for use in landscaping and other purposes.

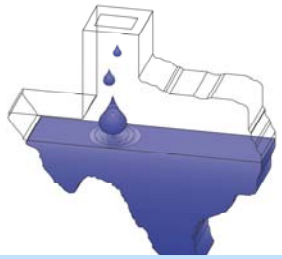
Why harvest rainwater?

- Rainwater harvesting
  - Saves money
  - Reduces demand on municipal water supply
  - Makes efficient use of a valuable resource
  - Reduces flooding, erosion, and contamination of surface water
  - Decreasing supply of fresh water

Why harvest rainwater?

- Water Awareness & Conservation
  - How much water do I use?
    - Average per person is 60-80 gallons a day
  - How can I conserve water?
    - Number 1 household water user is commode at 20%
  - Where does my water come from?
    - Well water, Surface lake, Rain
  - How long will I have fresh water?

Renewed Interest in Collecting Rainwater



- Increased Demand for a Decreasing Supply
- Escalating Environmental and Economic Costs
- Health Concerns
- Conservation and Drought
- Providing Water to Areas Without Water
- Reducing Storm Water
- Rainwater's Purity

Why harvest rainwater?

Rainfall Depth (in.)		Volume per 1000 ft^2 of catchment area (gal)
0.5		312
1		623
1.5		934
2		1246
2.5		1558
3		1869

Where can rainwater harvesting be used?

Rainwater harvesting can be used in small residential landscapes.

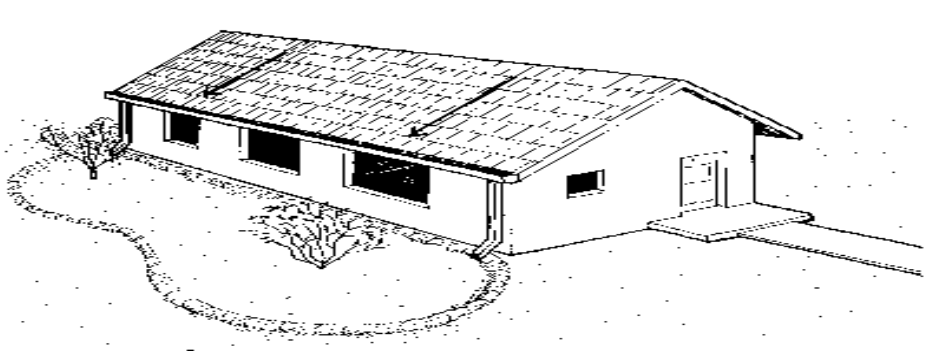
- Attract & provide water for wildlife, birds, and butterflies
- Add interest, soothing sound, and beauty.

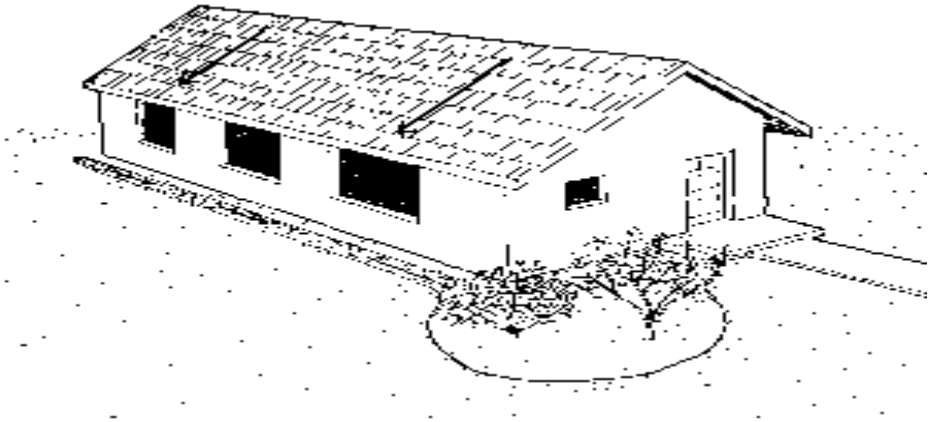
Where can rainwater harvesting be used?

Rainwater harvesting can be used in small residential landscapes.

- Supplement landscape water needs
- Provide water for nurseries & green houses.
- Flushing toilets, laundry, wash cars.
- Treated and used for in home use.

Rain Gardens





Where can rainwater harvesting be used?

- Rainwater harvesting can be used in large-scale landscapes.
  - Parks
  - Schools
  - Commercial Sites
  - Parking Lots
  - Apartment Complexes
  - Residential Homes

Rainwater Collection Tanks

Rainwater Collection Tanks

How Rainwater Harvesting Works

- A rainwater harvesting system consists of
  - The supply – rainwater
  - The demand – plant water needs
  - The collection system
- Simple and complex systems
  - Simple – distribute rainwater immediately
  - Complex – store some or all of rainwater for later use

Supply: Rainfall

- Supply comes in the form of *runoff*, rainwater that flows off a surface.
- If the surface is impermeable, runoff occurs immediately.
  - Pavement
  - Concrete
  - Roofs

- If the surface is permeable, runoff occurs when the surface is saturated.

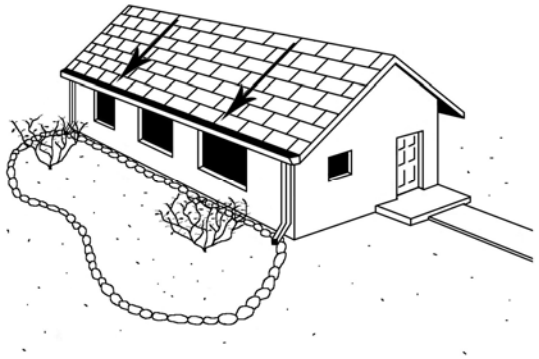
Demand: Plant Water Requirements

- The amount of water needed is determined by
  - Type of plants
  - Number of plants
  - Growth stage of plants
  - Size of plants

- Plants native to the region are the best choices because their water requirements are met by normal rainfall amounts.

Simple Rainwater Harvesting Systems

- A simple water harvesting system consists of a catchment, a distribution system, and a landscape holding area.



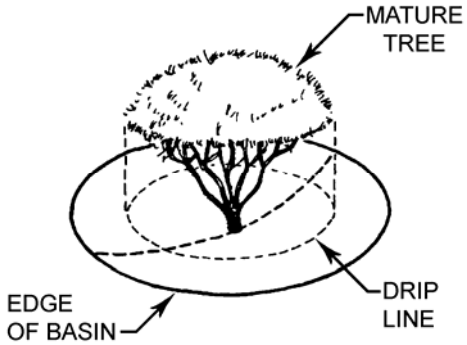
  - Catchment
    - Any area from which water can be collected (e.g. roofs, pavement, or soil surface)
    - Hard, smooth surfaces best
    - Amount of water collected depends on size, surface texture, slope, and rainfall received

Simple Rainwater Harvesting Systems

- A simple water harvesting system consists of a catchment, a distribution system, and a landscape holding area.
  - Distribution System
    - Channel water from catchments to landscape holding area
    - Include gutters and downspouts, sloped sidewalks, hillsides, street curb cutouts and channels, and ditches
    - Use gravity, gates, or a small pump to cause flow through the distribution system

Simple Rainwater Harvesting Systems

- A simple water harvesting system consists of a catchment, a distribution system, and a landscape holding area.
  - Landscape Holding Area
    - Concave depression covered by grass or plants
    - Store water for direct landscape use and reduce flooding and erosion
    - May be linked through spillways
    - Create landscape holding areas by digging out a depression and using the resulting soil as a berm around the depression



Harvesting Urban Rainwater to Reduce Erosion and Flooding

- Rain falling on impermeable surfaces runs off immediately, creating flooding and erosion potential.
- Harvesting urban rainwater can prevent flooding and erosion.
- Methods to harvest urban rainwater include:
  - Crescent-shaped berms around plants on slopes
  - Gabions (piles of large rocks encased in wire mesh)
  - French drains (holes or trenches filled with gravel)
  - Permeable paving materials, such as gravel, crushed stone, and open or permeable paving blocks, on steep slopes
  - Terrace grading (stair-step-like shelves) of slopes

Should I invest in a complex rainwater harvesting system?

- Complex systems include water storage, cost more to build, and yield greater water savings.
- Factors to consider in deciding whether or not to invest in a complex system:
  - Availability of other water supplies for irrigation
  - Need for professional assistance in design and construction
  - Cost of storage container, pumps, and maintenance
  - Long investment payback period – several years
  - Personal commitment to “water conservation ethic”

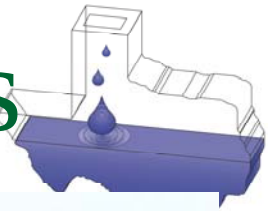
Should I invest in a complex rainwater harvesting system?

- Reduce the cost of a complex system by
  - Building a smaller storage container to harvest less than the total landscape need
  - Limiting landscape area or reducing plant density
  - Replacing high-water-use plants with medium- or low-water-use plants

Complex Rainwater Harvesting Systems

- A complex rainwater harvesting system consists of catchments, a conveyance system, storage, and a distribution system.
  - Catchments
    - The “yield” that a catchment provides depends on its size and surface texture.
    - Surface textures include:
      - High yield – concrete, asphalt, and smooth roofing material
      - Medium yield – bare soil; compacted clay best
      - Low yield – areas with plants, such as grass or groundcover

Roofs and Collection Surfaces



Complex Rainwater Harvesting Systems

- A complex rainwater harvesting system consists of catchments, a conveyance system, storage, and a distribution system.
  - Conveyance Systems
    - Direct water from catchments to storage containers
    - Roof conveyance systems use canals or gutters and downspouts to direct water into storage containers

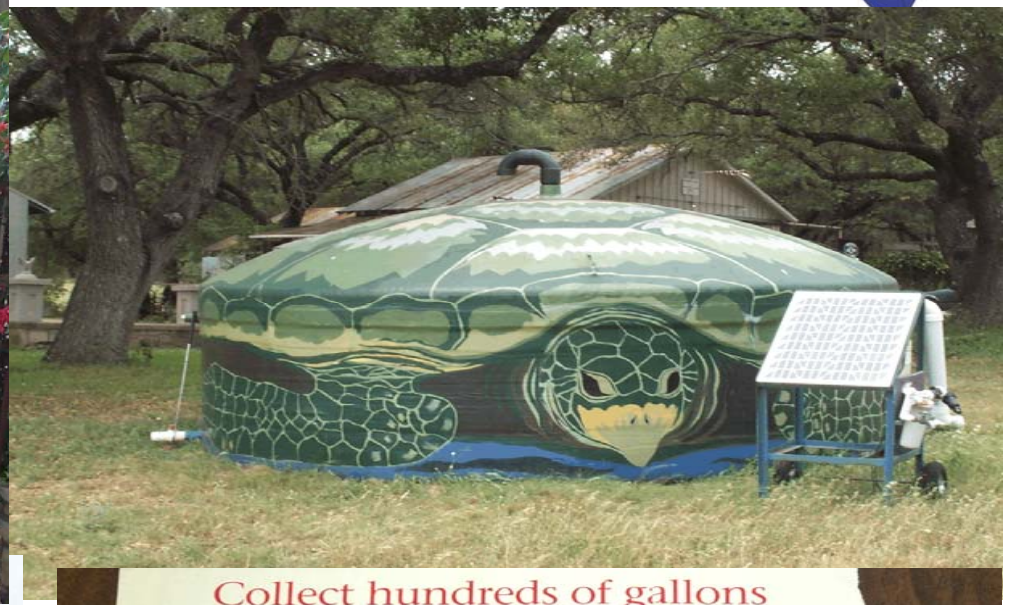
Gutters – Convey the water to the tank
Roof washers - removes trash, debris & dust

Complex Rainwater Harvesting Systems

- A complex rainwater harvesting system consists of catchments, a conveyance system, storage, and a distribution system.
  - Storage
    - Storage makes rainwater available when needed.

Rain Barrels

Tanks are available in many sizes and types of material



Complex Rainwater Harvesting Systems

- A complex rainwater harvesting system consists of catchments, a conveyance system, storage, and a distribution system.
  - Distribution System
    - Channels water to plants from storage containers.

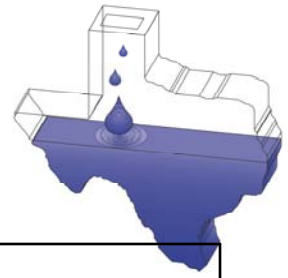
Distribution Systems

Drip irrigation
Water garden
Wildlife and Livestock water
Sprayer tanks
Sprinklers, misters & watering with pressure
In home potable use

Designing and Building a Complex Rainwater Harvesting System

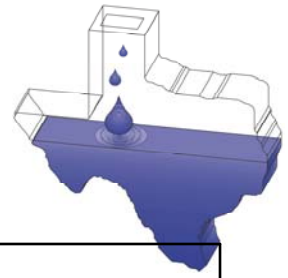
- **Step 1**: Site Analysis
- **Step 2:** Calculations
  - Calculate Supply
  - Calculate Demand
  - Balance Supply and Demand
- **Step 3:** Final Design and Construction
- **Step 4:** Field Testing
  - System Maintenance

Example 1: Calculating Supply



Rainfall Harvesting Supply Worksheet						
	A	**B**	**C**	**D**	**E**	**F**
Follow the lettered instructions for each month.	Enter the rainfall amount in inches for each month.	Multiply "A" by 0.623 to convert inches to gallons per square foot.	Enter the square footage of the catchment surface.	Multiply "B" by "C" to yield the gross gallons of rainfall per month.	Enter the runoff coefficient for your catchment surface.	Multiply "D" by "E" to obtain the total monthly yield of harvested water in gallons.
January	1.66	1.03	1625	1681	0.9	**1512**
February	1.75	1.09	1625	1772	0.9	**1594**
March	1.89	1.18	1625	1913	0.9	**1722**
April	2.60	1.62	1625	2632	0.9	**2369**
May	4.72	2.94	1625	4778	0.9	**4301**
June	4.30	2.68	1625	4353	0.9	**3918**
July	2.03	1.26	1625	2055	0.9	**1850**
August	2.57	1.60	1625	2602	0.9	**2342**
September	3.00	1.87	1625	3037	0.9	**2733**
October	3.86	2.40	1625	3908	0.9	**3517**
November	2.58	1.61	1625	2612	0.9	**2351**
December	1.96	1.21	1625	1984	0.9	**1786**
Annual	32.92			33,327		**29,995**

Example 2: Calculating Demand



Rainfall Harvesting Demand Worksheet						
	A	**B**	**C**	**D**	**E**	**F**
Follow the lettered instructions for each month.	Enter the ET amount in inches for each month.	Enter the appropriate plant water use coefficient.	Multiply “A” by “B” to obtain plant water needs in inches.	Multiply “C” by 0.623 to convert inches to gallons per square foot.	Enter the total square footage of landscaping.	Multiply “E” by “D” to obtain total landscaping water demand in gallons.
January	2.07	0.75	1.55	0.97	1200	1161
February	2.77	0.75	2.08	1.29	1200	1553
March	4.40	0.75	3.30	2.06	1200	2467
April	5.33	0.75	4.00	2.49	1200	2989
May	7.58	0.75	5.69	3.54	1200	4250
June	8.21	0.75	6.16	3.84	1200	4603
July	7.96	0.75	5.97	3.72	1200	4463
August	8.03	0.75	6.02	3.75	1200	4502
September	6.19	0.75	4.64	2.89	1200	3471
October	4.95	0.75	3.71	2.31	1200	2775
November	3.14	0.75	2.36	1.47	1200	1761
December	2.15	0.75	1.61	1.00	1200	1206
Annual	62.78		47.09			35,201

Examples 1 and 2 Supply/ Demand Balance Worksheet

Storage/Supplemental Municipal Use Worksheet				
Month	Yield	Demand	Cumulative Storage (Yield – Demand)	Supplemental Use
YEAR 1				
January	1,512	1,161	351	0
February	1,594	1,553	392	0
March	1,722	2,467	0	353
April	2,369	2,989	0	620
May	4,301	4,250	51	0
June	3,918	4,603	0	634
July	1,850	4,463	0	2,613
August	2,342	4,502	0	2,160
September	2,733	3,471	0	738
October	3,517	2,775	742	0
November	2,351	1,761	1,332	0
December	1,786	1,206	1,912	0

Why harvest rainwater?

- WHY NOT!!!!
- Rainwater harvesting
  - Saves money
  - Reduces demand on municipal water supply
  - Makes efficient use of a valuable resource
  - Reduces flooding, erosion, and contamination of surface water

Other Resources

- Russell A. Persyn, Ph.D. *Rainwater Harvesting*, 2004 (Texas Agricultural Extension).
- City of Albuquerque, *Rainwater Harvesting: Supply from the Sky*.
- Billy Kniffen, *Rainwater Harvesting in Menard County* (Menard County Extension).
- Lower Colorado River Authority, *Saving from a Rainy Day* (Austin, TX).
- Wendy Todd Price and Gail Vittori, *Texas Guide to Rainwater Harvesting, Second Edition* (Texas Water Development Board, 1997).
- Jerry Turrentine, *Wildlife Watering Facilities* (USDA – Natural Resource Conservation Service, 1992).
- Patricia H. Waterfall, *Harvesting Rainwater for Landscape Use* (Arizona Department of Water Resources, 1998).

Web Sites

- Rainwaterharvesting.tamu.edu
- Texaswater.tamu.edu