
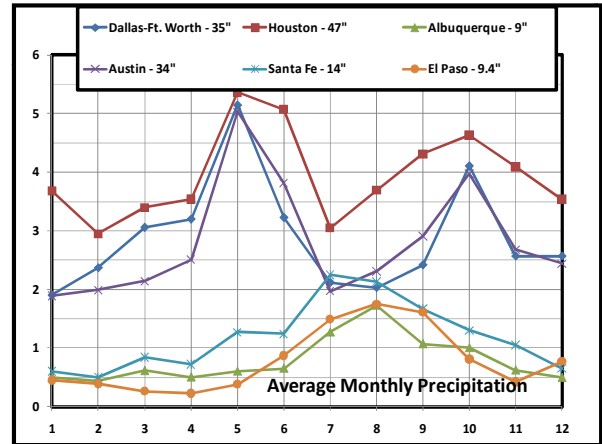
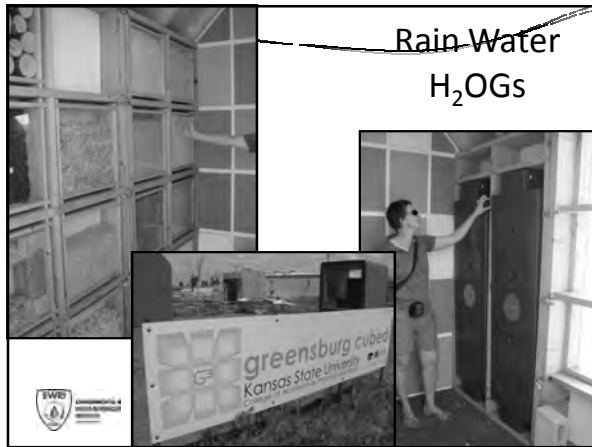


Design Tips: Cold Weather

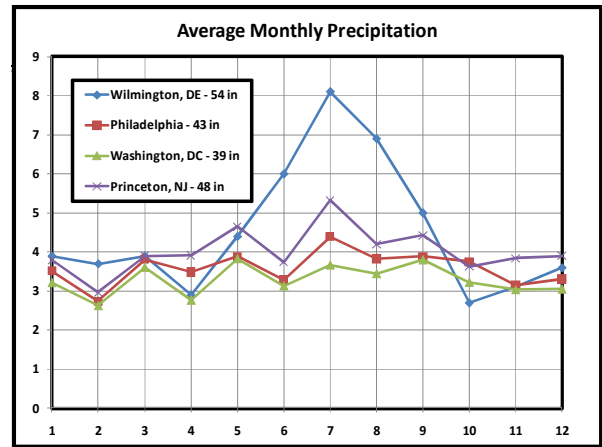
- Bury Inlet Pipe and Conveyance System Below Freeze Level
- Drain System Before First Freeze
- Use Underground System
- Use System in Building Walls

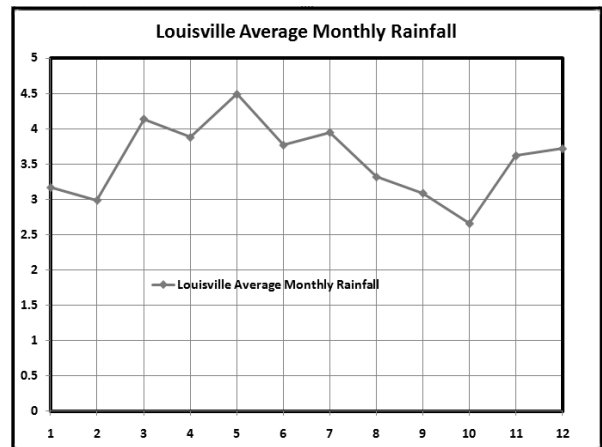
Rain Water H₂OgS

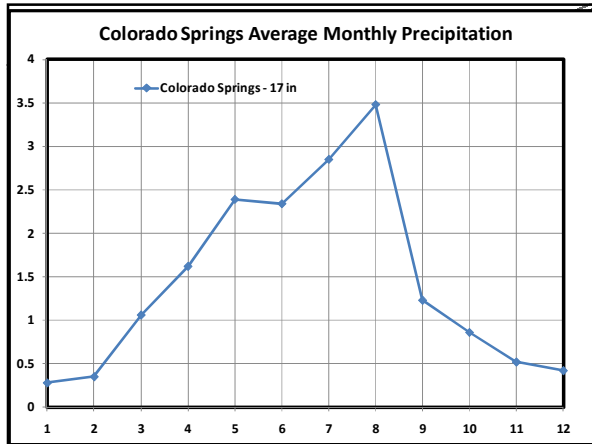


Logos: IWB, Kansas State University, Greensburg Cubes



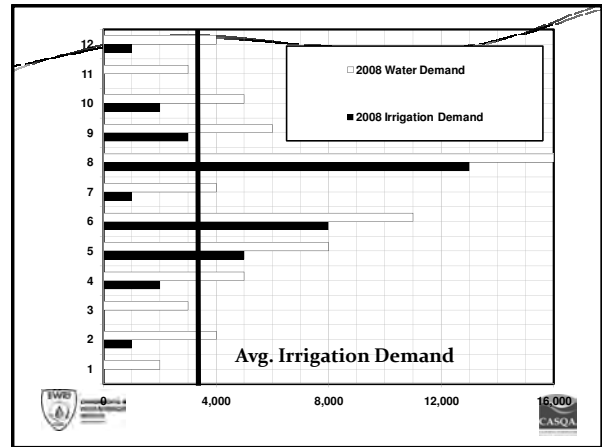
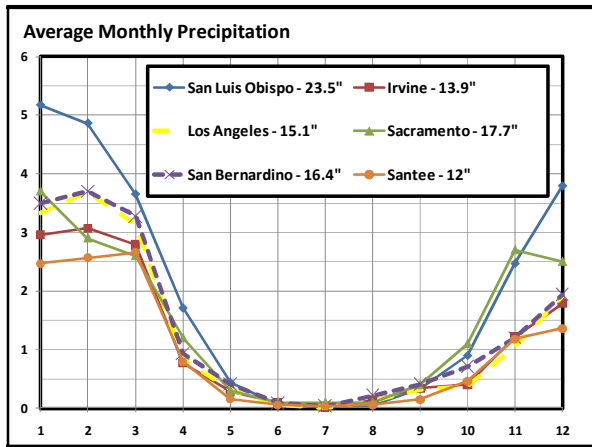

Rain Tank Supplier/Installer:
Construction EcoServices





How Much Can You Collect?

- Collection efficiency 75% to 90%
 - losses to wet roof and roof washer
 - spillage from gutters and cistern
 - 50% for small landscape systems



How Much Can You Collect?



- 600 gallons/inch of rain on 1,000 ft²
- Houston = 29 gal/ft²/yr
 - 43,500 gallons on 1,500 ft² home
- Seattle = 21 gal/ft²/yr
 - 31,500 gallons on 1,500 ft² home
- Sacramento/Anchorage = 10 gal/ft²/yr
 - 15,000 gallons on 1,500 ft² home

Monthly Water Balance

Month	Monthly Use (gal/mo)	Average Rain (in)	Rainfall Volume (gallons)	End of Mo. Storage (gallons)	Median Rain (in)	Rainfall Collected (gallons)	End of Mo. 25 (gallons)
1	0	3.68	3,329	2,500	2.82	2,551	2,500
2	1000	2.95	2,669	2,500	2.63	2,379	2,500
3	0	3.4	3,076	2,500	3.19	2,886	2,500
4	2000	3.54	3,202	2,500	2.59	2,343	2,500
5	5000	5.36	4,849	2,349	5.02	4,541	2,041
6	8000	5.07	4,586	-	3.55	3,211	-
7	1000	3.05	2,759	1,759	2.69	2,433	1,433
8	13000	3.69	3,338	-	3.52	3,184	-
9	3000	4.31	3,899	899	3.92	3,546	546
10	2000	4.63	4,188	2,500	3.79	3,428	1,975
11	0	4.09	3,700	2,500	3.27	2,958	2,500
12	1000	3.54	3,202	2,500	3.41	3,085	2,500
Totals		47.31	42,797		40.40	36,546	



Design Tips: Locating Cisterns

- Locate in Area Easy to Grade Flat
- Do Not Place Over Buried Pipes, Septic Tanks, or Drain Fields
- Maintain Separation Between Underground Cistern & Structures
- Locate Underground Systems 50'+ Away From Septic Fields or Wastewater Application Area





Design Tips: Sizing Cisterns

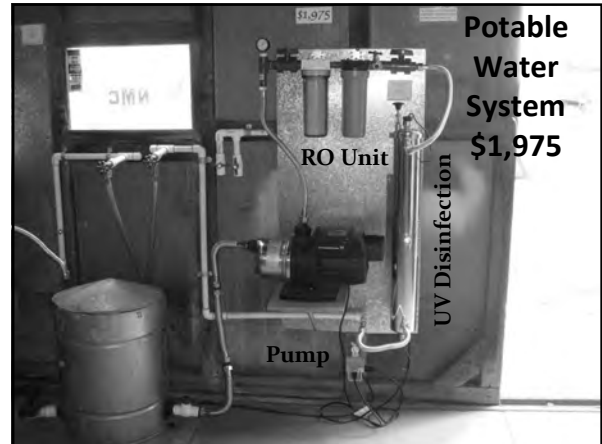
- Water Demand
 - Irrigation, Toilet Flushing, Vehicle Washing
- Commitment to Using Harvested Water
- Systems < 550 gallons are Less Efficient and Effective
- Smaller Cisterns Cost More per gallon
- 3,000 gallons of Harvested Water Irrigates Typical Landscape with 1" of Water
- Bigger is Not Always Better: Incremental Benefit Declines



Design Tips: Plumbing

- Refer to Local Codes
- Review International Plumbing Code Appendix C and Uniform Plumbing Code Chapter 16
- Cross-connection Test Typically Required by Inspectors
- Include Backflow Preventers
- May Need Separate Plumbing Systems
- May Require "Purple Pipe" and Signage





Design Tips: Misc.

- Account for Buoyancy on Underground Tanks
- Consider Seismic Requirements
 - SFPUC Uses Seismic Strapping
- Check with Drip Irrigation Manufacturer for Sediment Filtration Requirements
- Water is Heavy!
 - 62.4 lb/ft³ or 8.3 lb/gal
 - 42,000 lb/5,000 gal

Logos for IWRB and CASQA are visible at the bottom of the slide.

Potable Water Treatment

- Filters or Screens
 - Sand and Charcoal
- Disinfection to Kill Microorganisms
 - Ultraviolet Light
 - Ozone
 - Chlorine or Iodine
- Reverse Osmosis Removes Pollutants
- Buffering with Baking Soda




Logos for IWRB and CASQA are visible at the bottom of the slide.

FAQs

- Is it Water Supply, Detention, or Water Quality?
- Do Non-Potable Uses Need Treatment?
- Does Irrigation Water Need Treatment?
- What About Toilet Flushing Water?
- Concerns About Pathogens and Bacteria?



Logos for IWRB and CASQA are visible at the bottom of the slide.

What About Permits?





Operations

- Think About Existing Drainage Problems
- Plan Ahead to Use Rainwater
- Place System in Convenient and Accessible Location
- Knowledge of Water Usage Imperative
- Educate Users of System
- Consider Changes in Facility Use and Public Perception





Building Codes

- Ohio, Kentucky, Hawaii, Arizona, New Mexico, Washington, West Virginia, Texas, Portland, and U.S. Virgin Islands Have or Are Developing Rules
- Texas, Oregon, and Others Do Not Require Treatment for Non-Potable Use





Maintenance

- Remove Debris from Roof
- Clean Gutters
- Clean Screens
- Clean Roof Washers or Empty First Flush Diverters
- Clean Pre-Filters Monthly





Operations

- NCSU, BAE Monitored 3 Systems
 - Toilet Flushing
 - Irrigation
 - Vehicle Washing
- Annual Rainfall = 44"
- All Systems Oversized and Underutilized
- AUTOMATE SYSTEMS!




Maintenance

- Remove Debris and Sediment from Tanks Annually
- Additional Maintenance Needed for Potable Water Systems
 - Change Filters
 - Clean UV Units
 - Clean Tanks



Community-Level Programs

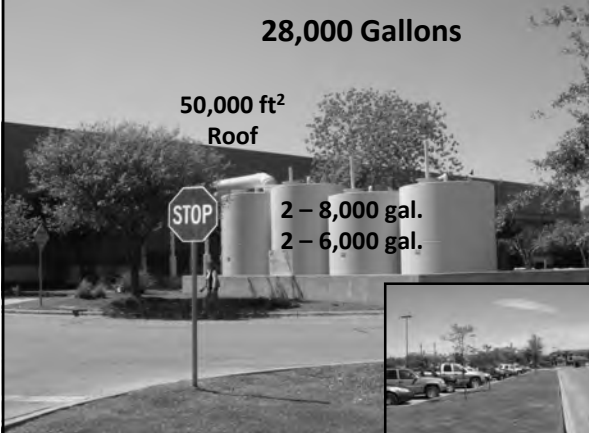
- San Francisco Public Utilities Commission
- City of Santa Monica
- Marin Municipal Water District – Pilot LID + Rainwater
- Seattle: Rain Barrels + Pilot Projects
- Los Angeles: Rain Barrel Program
- Austin, Texas: Rebates + Rain Barrels
- State of Texas – No Sales Tax + Required on State Bldgs.
- NCSU – Studies of Cistern Operation



28,000 Gallons


50,000 ft² Roof

2 – 8,000 gal.
2 – 6,000 gal.



Lady Bird Johnson Wildflower Center



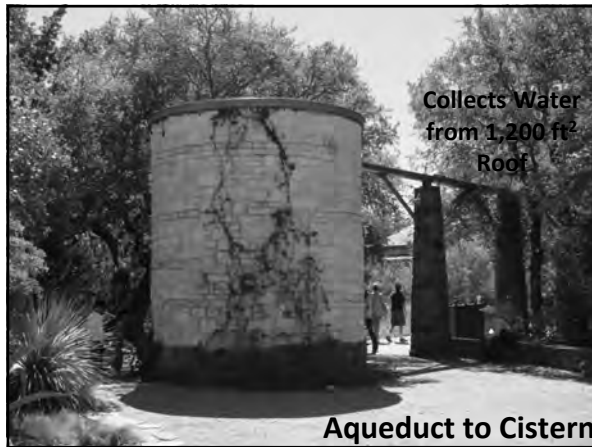
- Catchment Area = 17,000 ft²
- Cistern Capacity = 70,000 gallons
- Collects 300,000 gallons in Average Rainfall Year
- Supplies 10% to 15% Irrigation Needs







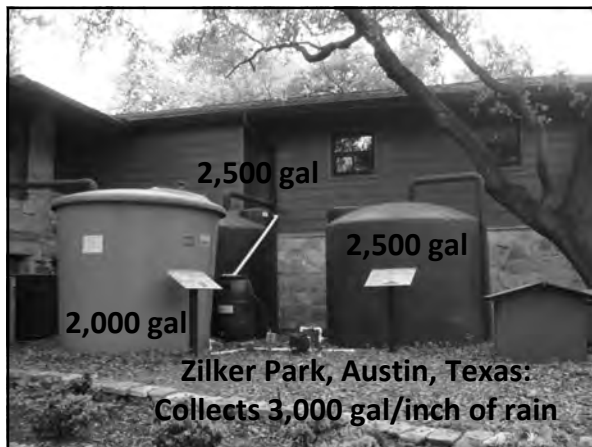
SFPUC

- Promotes Rainwater Harvesting
- GOAL: Offset 10 MGD Water Supply
- Developed Rainwater Harvesting Guidelines
- Created Memorandum of Understanding with Building Inspection and Public Health
- Promotes Graywater + Rainwater Systems
 - Year-Round Water Supply



SFPUC

- Provides Rain Barrel Rebates
 - \$30 for 1st
 - \$50 for Each Additional
- Offers Cistern Subsidy Program
 - Urban Farm Store with Irrigation Systems


SFPUC

- Completed a Few Residential Systems
 - Toilet Flushing + Laundry
- Require 1st Flush Diversion for Non-Potable Systems
- Laundry Requires Higher-Level Treatment
- Plan to Test Water Quality


City of Santa Monica

- Encourages Rainwater Harvesting
 - Many Rain Barrels + a Few 5,000 Gallon Underground Systems
- Allows Graywater Harvesting and Gray + Rain
 - 12 Systems In-Place
- Sample Rain Barrel – Cistern Details
- Bicknell Avenue Green Street
 - Permeable Concrete, Bioretention, Infiltration Basins, and Climate-Appropriate Plants



The Presidio

- Potable Water as Back-Up Supply Bypasses Cisterns
- Irrigation Demand Not Adequate for Volume Captured
- Average Annual Rainfall = 20 in.
- Average Annual Collection
 - 600 gal/1,000 ft² x 20 in =
 - 12,000 gal/1,000 ft²
 - 10,800 gal @ 90% Efficiency
 - 54,000 gal/yr for 5,000 ft²



The Presidio Army Base Monterey, CA

- Required by City to Harvest Rainwater
- Harvests Rainwater for Toilet Flushing
- 50 Buildings/Barracks with High Occupancy



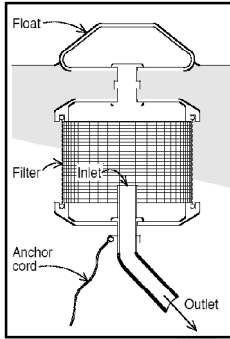

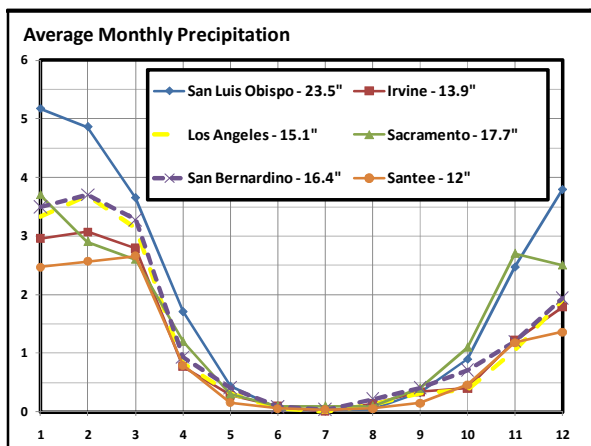


Photo Source: <http://www.monterey.army.mil>



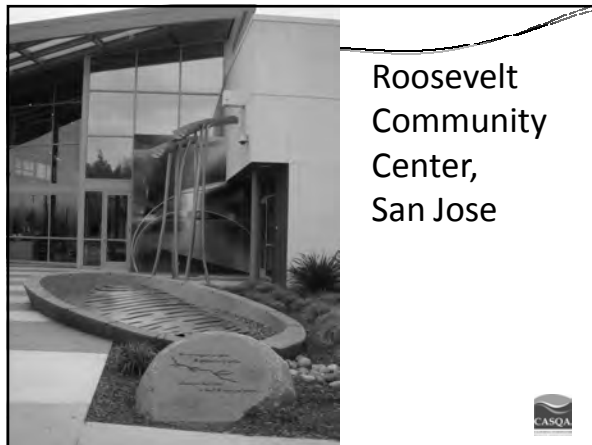
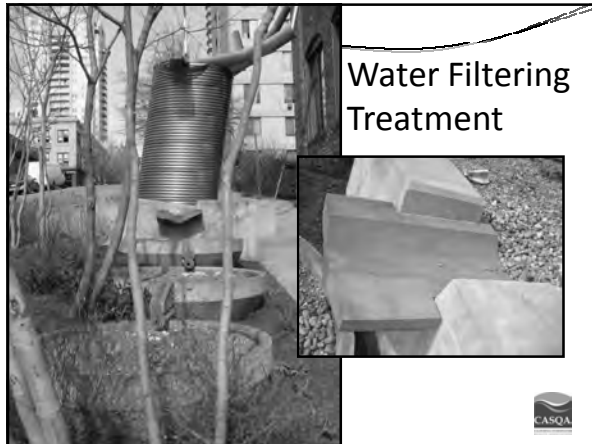
The Presidio

- Ultra Low Flow Toilets (ULFT)
 - 1.6 gal/flush
 - 6 flushes/occupant/day
 - 3,500 gal/yr/occupant
 - 350,000 gal/yr/100 occupants

Hand with "Thumb" and "Vertical Garden" Sculpture



Contact Information

- Jennifer J. Walker, P.E., D.WRE, CFM
 - President, Watearth, Inc.
 - jwalker@watearth.com
 - 1.877.302.2084 or 916.212.1783 (direct)
 - www.watearth.com

IWRD International Water Resources Development Corporation

CASQA