

Rainwater for Everybody!

*The What, Why, & How
of Rainwater Harvesting*



Chris Maxwell-Gaines, P.E.



- Integrated water conservation solutions
- Rainwater, Graywater, Drainage, Irrigation
- Design / Build
- Residential / Commercial



What is Rainwater Harvesting?

- Active VS. Passive
- Rainwater VS. Stormwater















Man Gets Prison Sentence For Collecting Rainwater On His Own Property

Posted on April 11, 2015 by Royce Christyn in News, US // 136 Comments

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Collecting Rainwater

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Collecting rainwater on your own property can now lead to jail time, as proven by a man from Oregon who was sentenced to prison for doing just that. Who owns the rain? The US government, apparently so it seems.

Politics

Rain, Rain, Stowaway



snopes
updated Apr 13, 2015



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Claim: An Oregon man was recently jailed for collecting rainwater on his own property.



MOSTLY FALSE

Example: [Collected via e-mail, April 2015]

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The Psychology of Rainwater Collection



Stage 1: Buckets and more



Stage 2: Rain barrels





Stage 3: Multiples



Stage 4: Dress it up

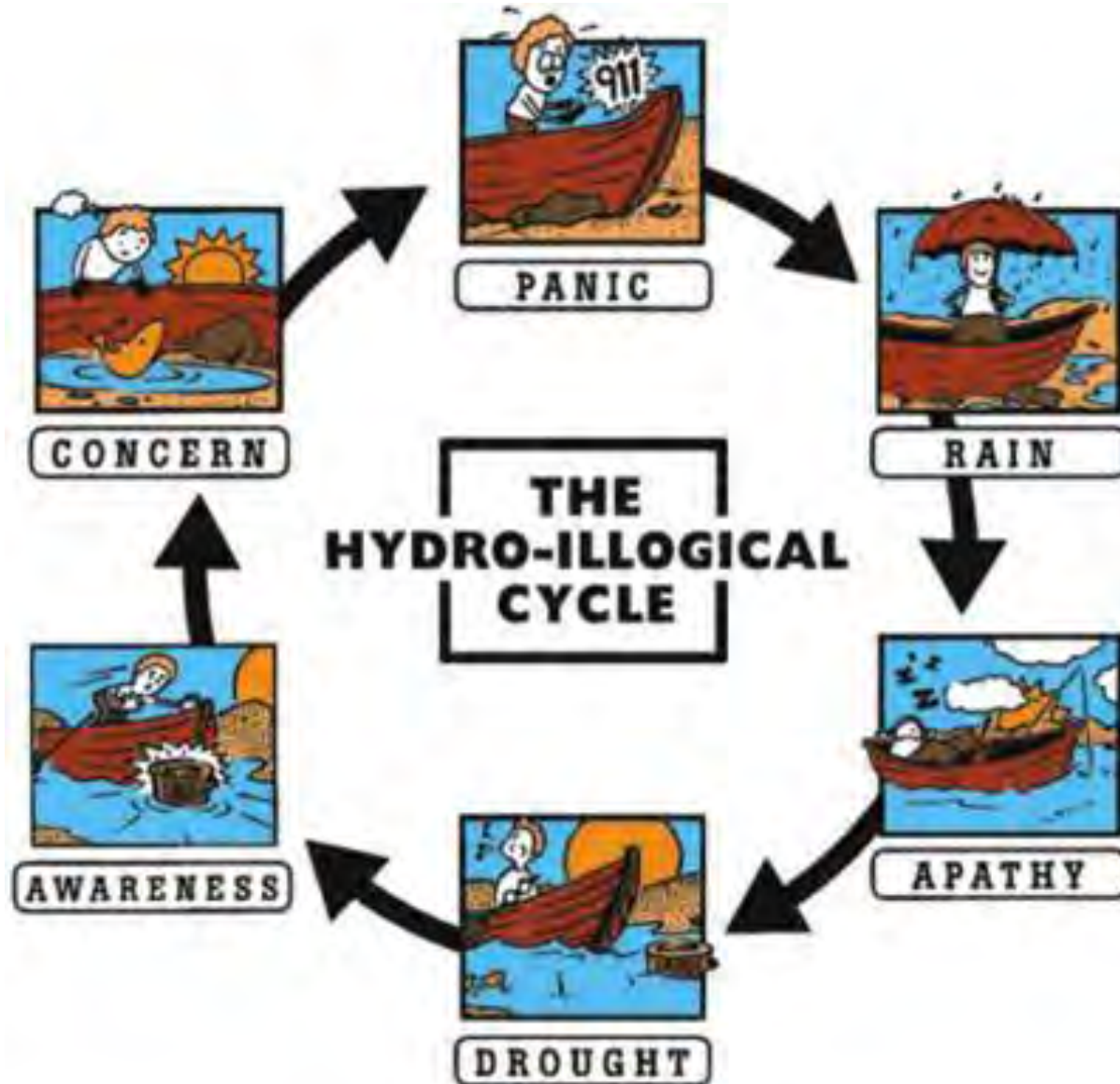




Stage 5: Do it right



Why harvest rainwater?



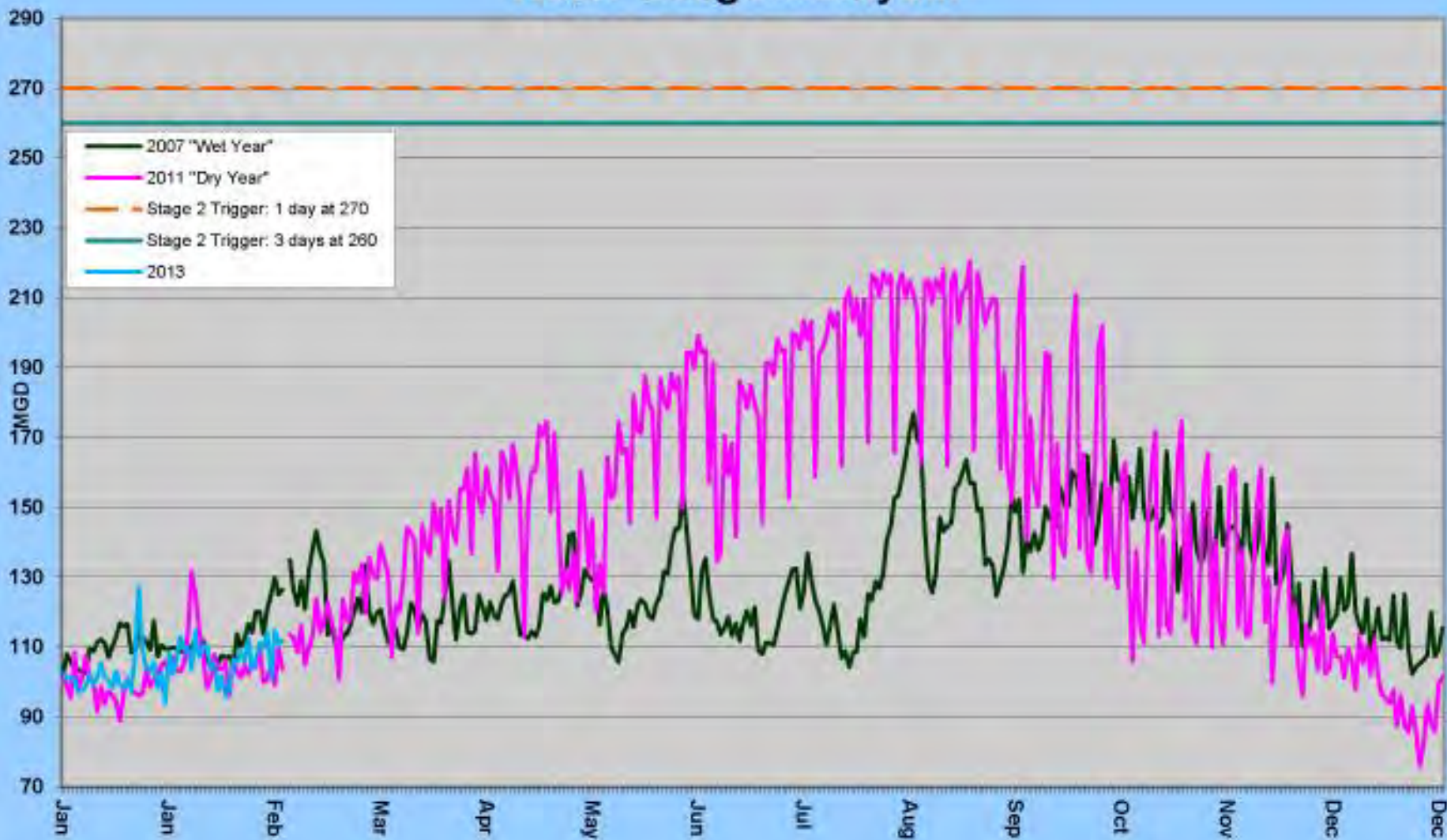
Largest irrigated crop in US?



Turf Grass !!

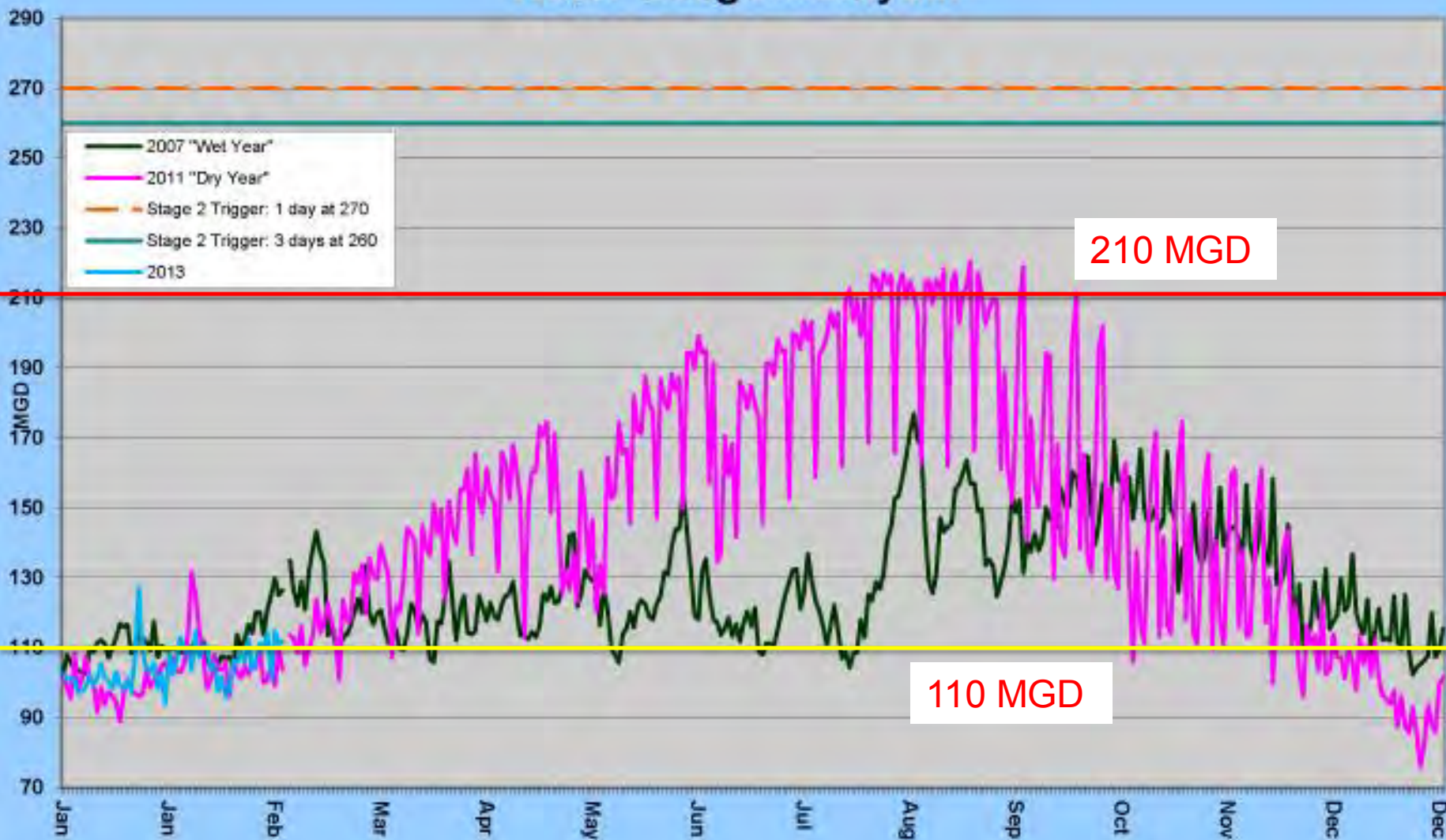


Water Usage Multiyear



Source: Austin Water website

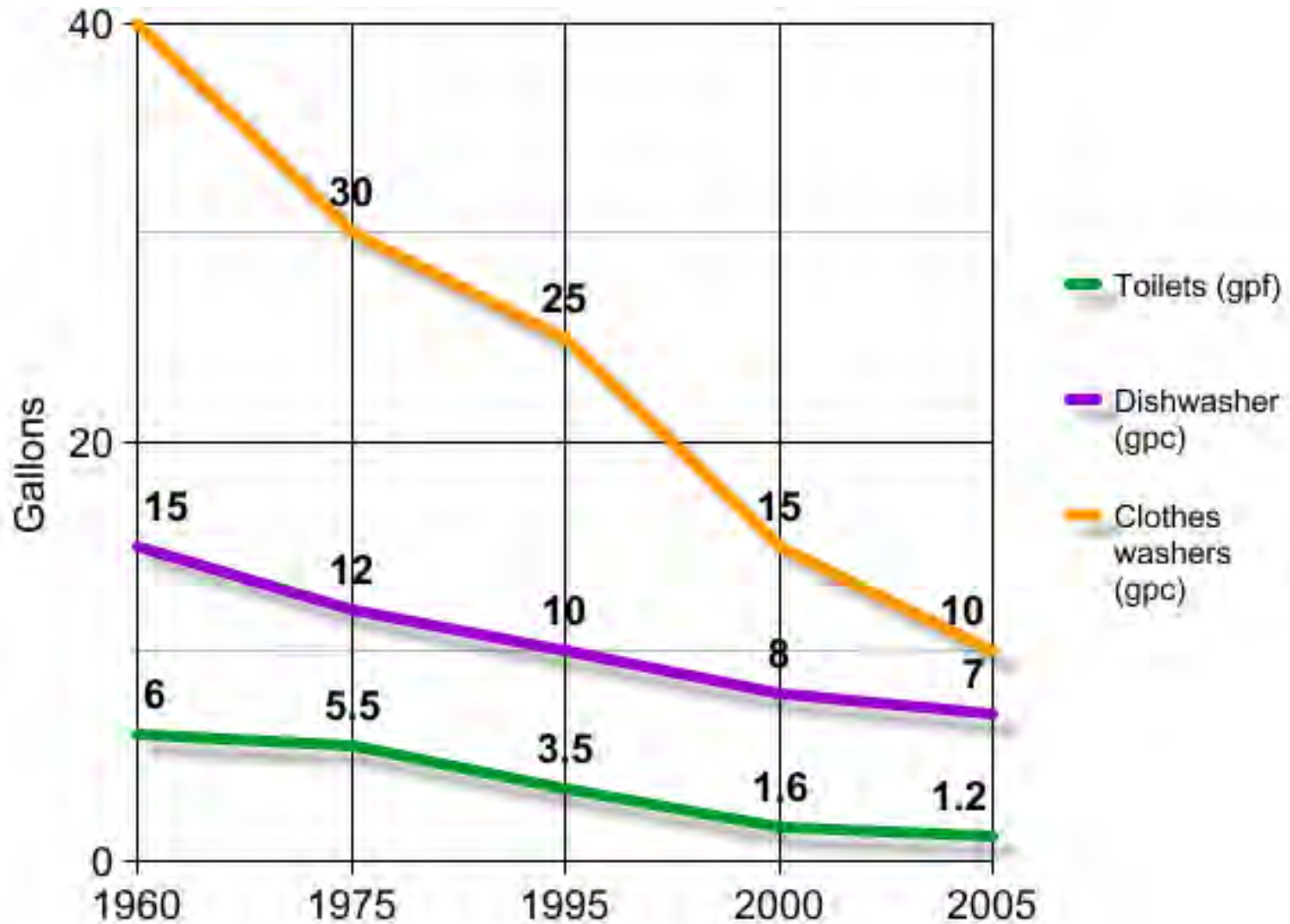
Water Usage Multiyear



210 MGD

110 MGD

Progression of Indoor Fixture Efficiency



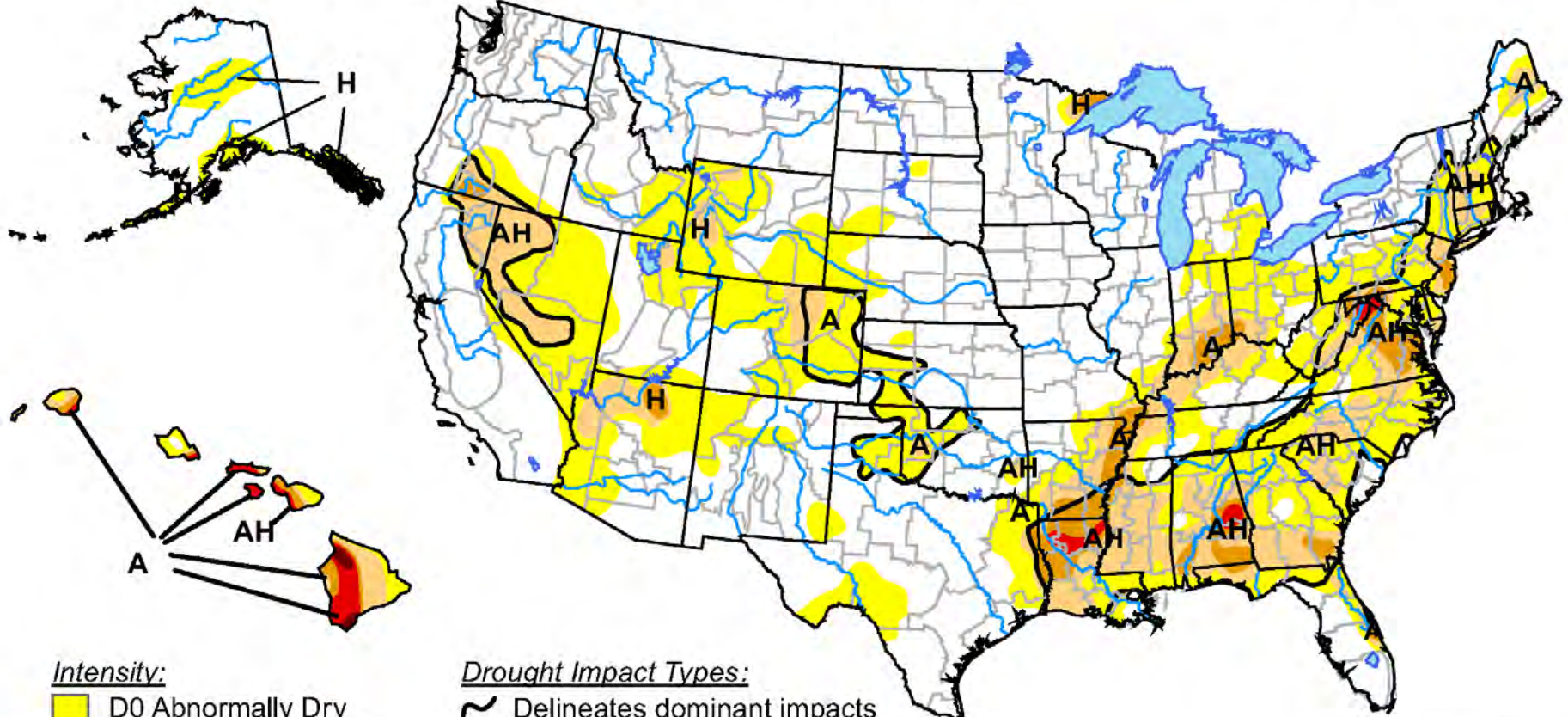
Indoor Water Conservation Standards








U.S. Drought Monitor

September 28, 2010


Valid 8 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
- A = Agricultural (crops, pastures, grasslands)
- H = Hydrological (water)

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

<http://drought.unl.edu/dm>



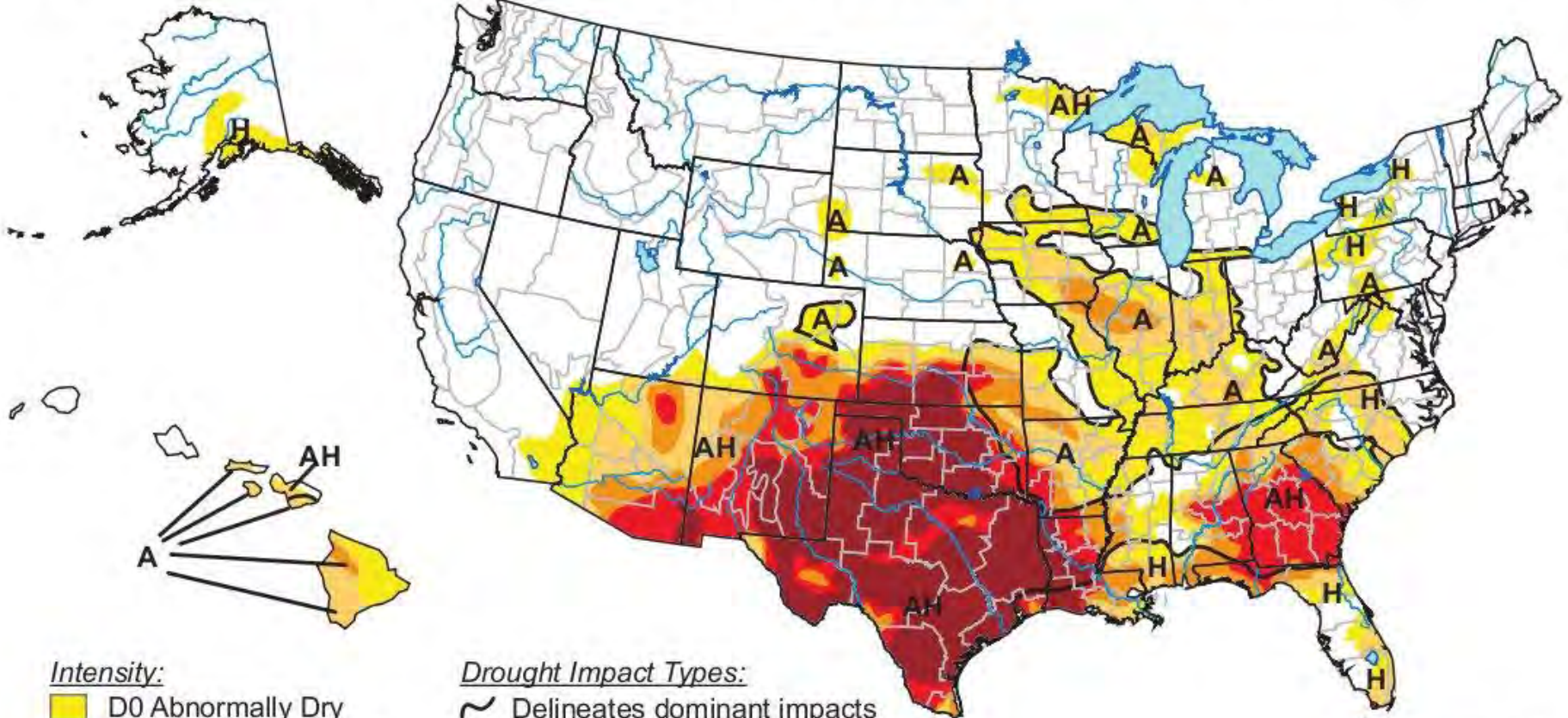
Released Thursday, September 30, 2010

Author: Richard Heim/Liz Love-Brotak, NOAA/NESDIS/NCDC

U.S. Drought Monitor

August 30, 2011


Valid 8 a.m. EDT



Intensity:

-  D0 Abnormally Dry
-  D1 Drought - Moderate
-  D2 Drought - Severe
-  D3 Drought - Extreme
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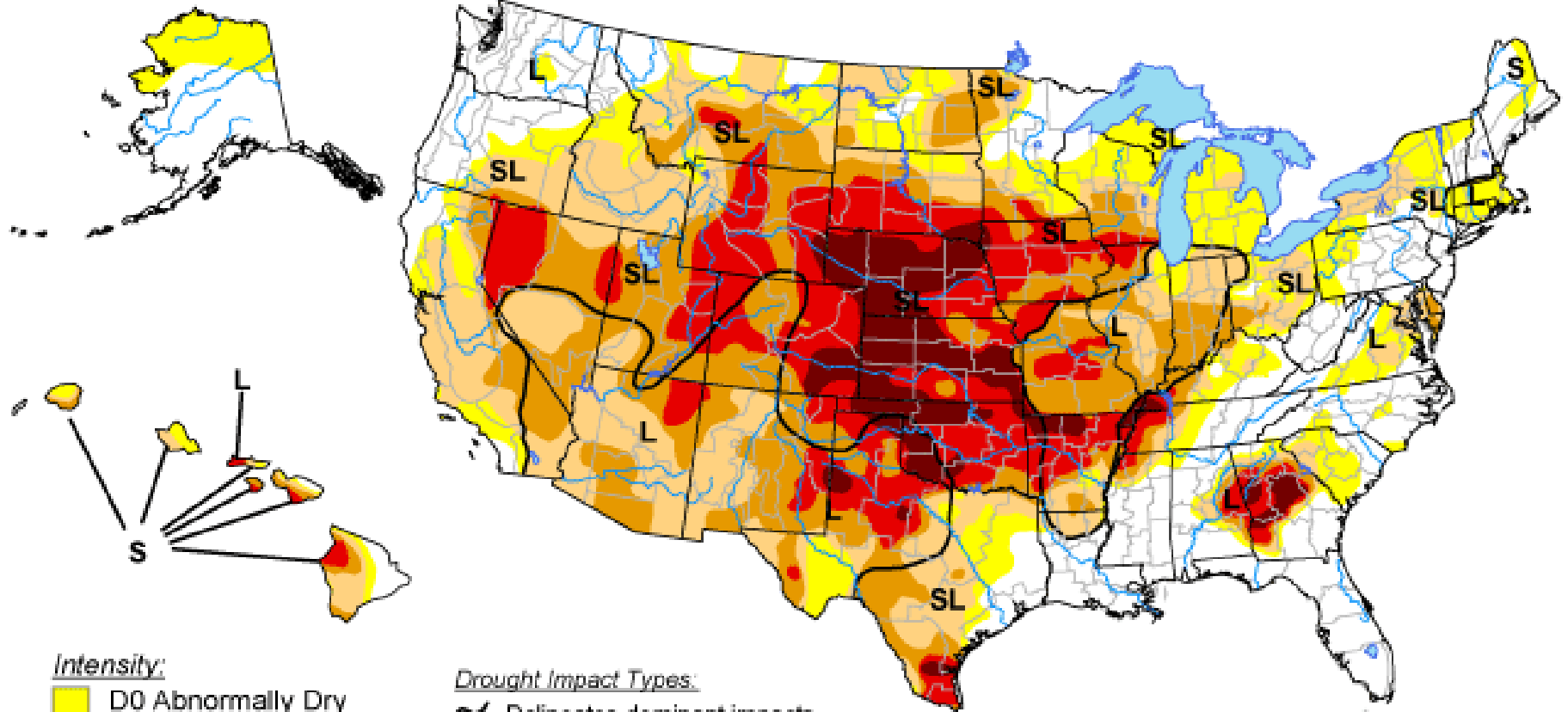
Released Thursday, September 1, 2011

Authors: Eric Luebehusen, U.S. Department of Agriculture






U.S. Drought Monitor

September 4, 2012


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/>



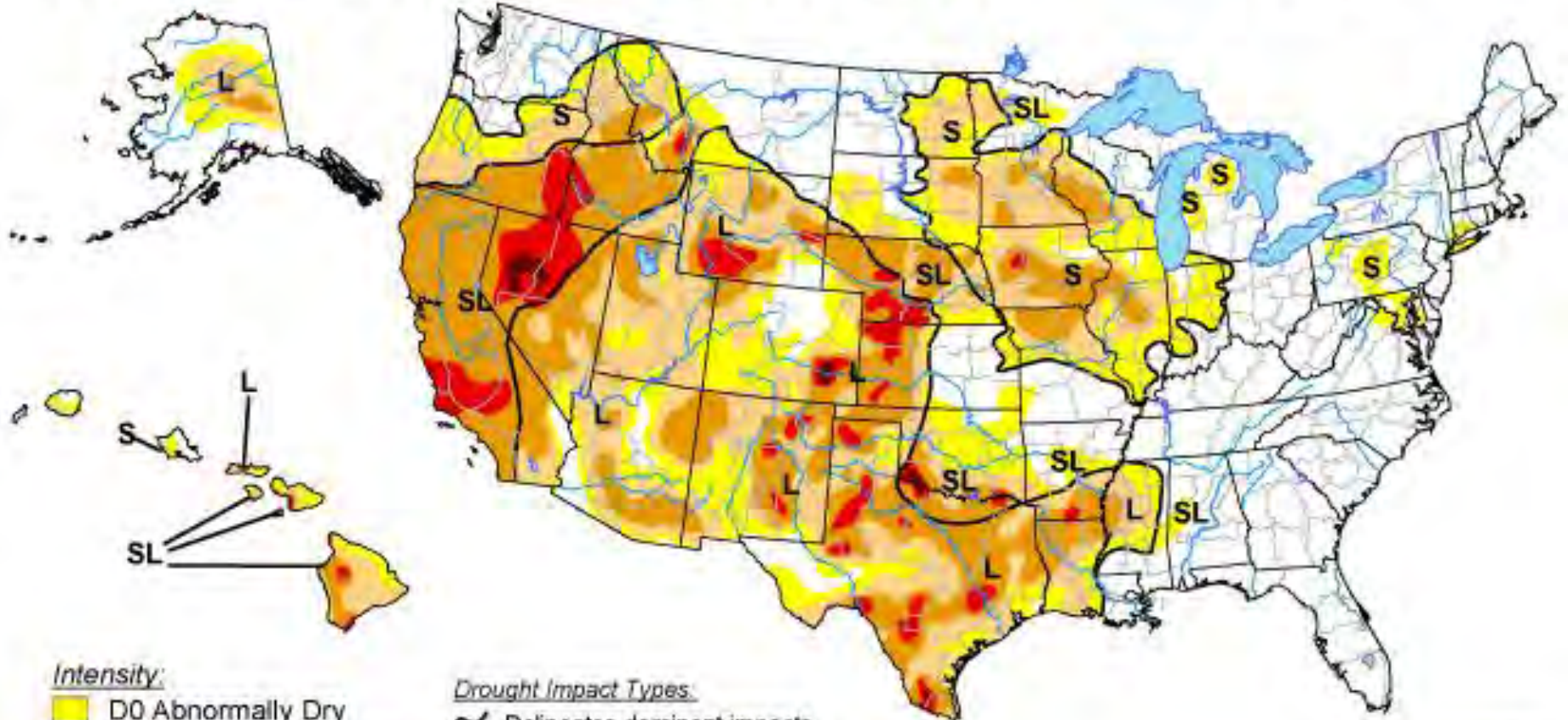
Released Thursday, September 6, 2012

Author: Brian Fuchs, National Drought Mitigation Center






U.S. Drought Monitor

September 24, 2013


Valid 7 a.m. EDT



Intensity:

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

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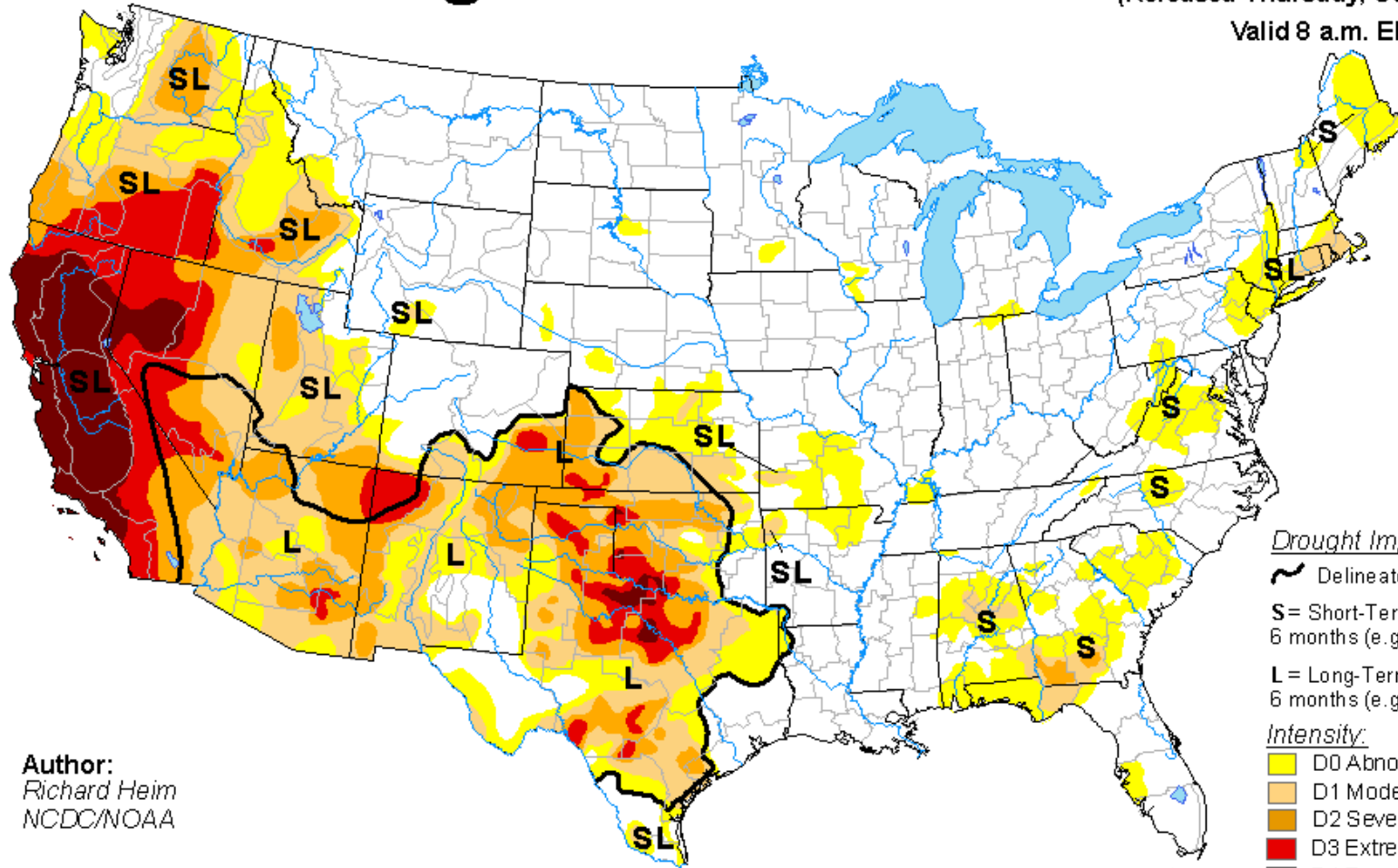
<http://droughtmonitor.unl.edu/>



Released Thursday, September 26, 2013
Author: Brad Rippey, U.S. Department of Agriculture

U.S. Drought Monitor

September 23, 2014
(Released Thursday, Sep. 25, 2014)
Valid 8 a.m. EDT



Author:
Richard Heim
NCDC/NOAA

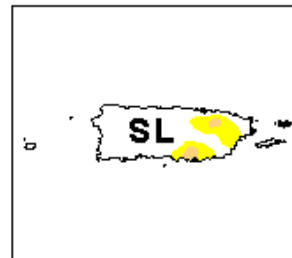
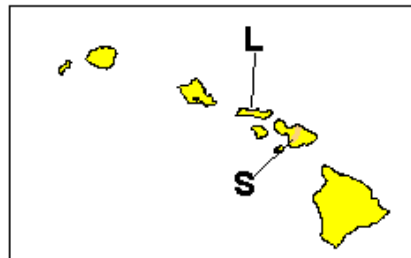
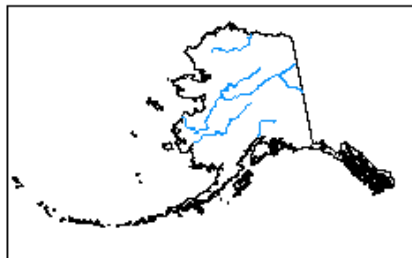
Drought Impact Types:

- ~ Delineates dominant impacts
- S= Short-Term, typically less than 6 months (e.g. agriculture, grasslands)
- L= Long-Term, typically greater than 6 months (e.g. hydrology, ecology)

Intensity:

- Yellow: D0 Abnormally Dry
- Light Orange: D1 Moderate Drought
- Dark Orange: D2 Severe Drought
- Red: D3 Extreme Drought
- Dark Red: D4 Exceptional Drought

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

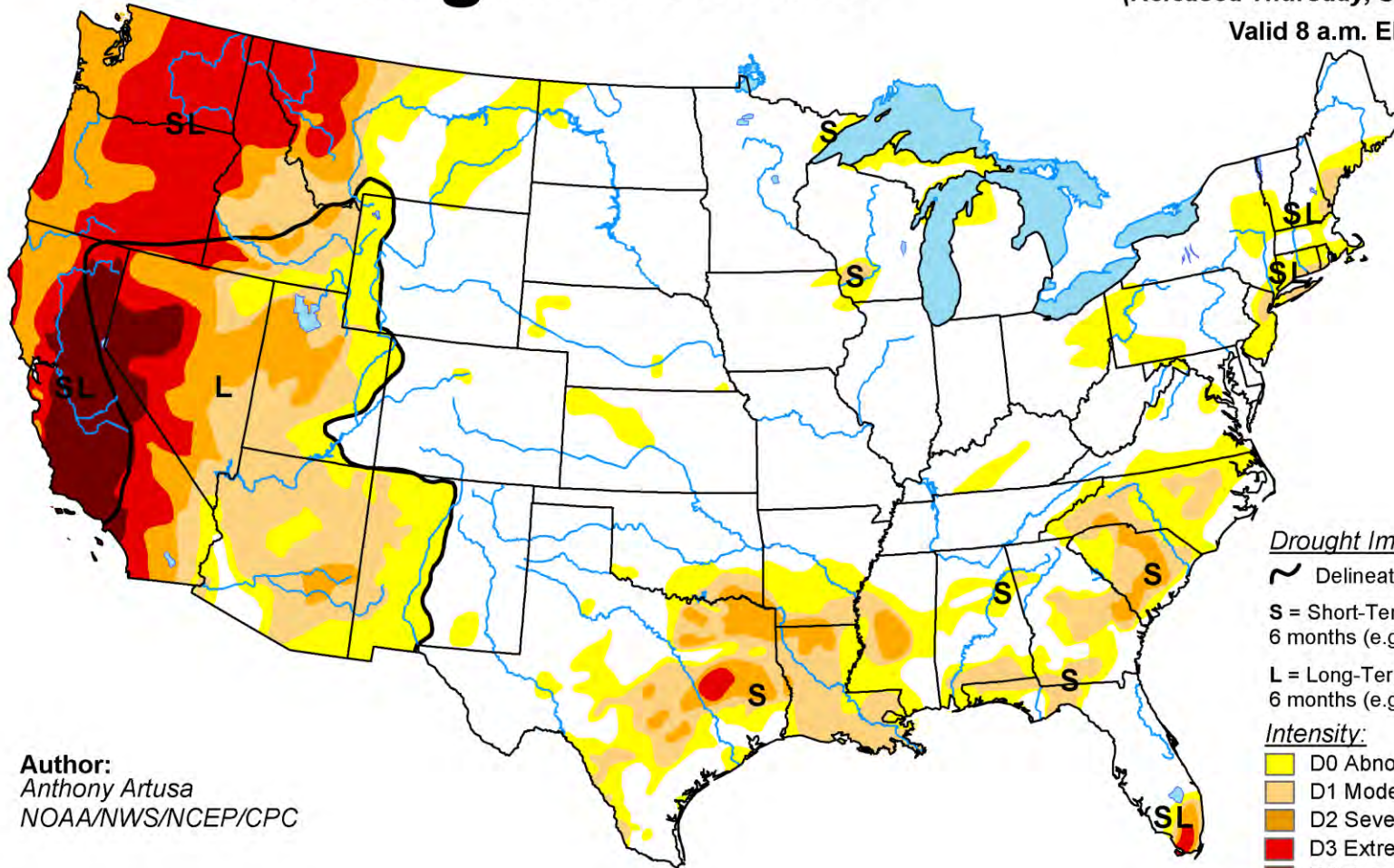


<http://droughtmonitor.unl.edu/>

U.S. Drought Monitor

September 1, 2015
(Released Thursday, Sep. 3, 2015)

Valid 8 a.m. EDT



Author:
Anthony Artusa
NOAA/NWS/NCEP/CPC

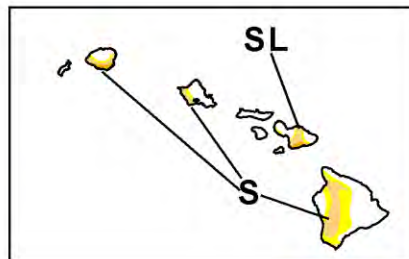
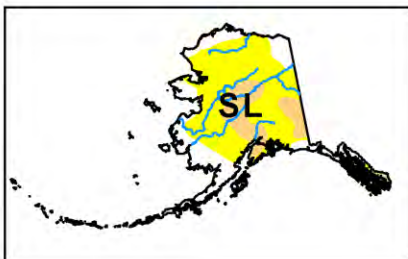
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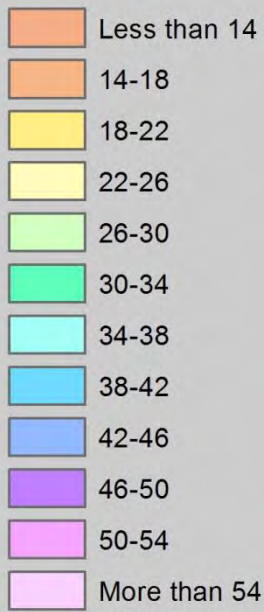
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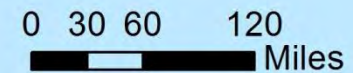
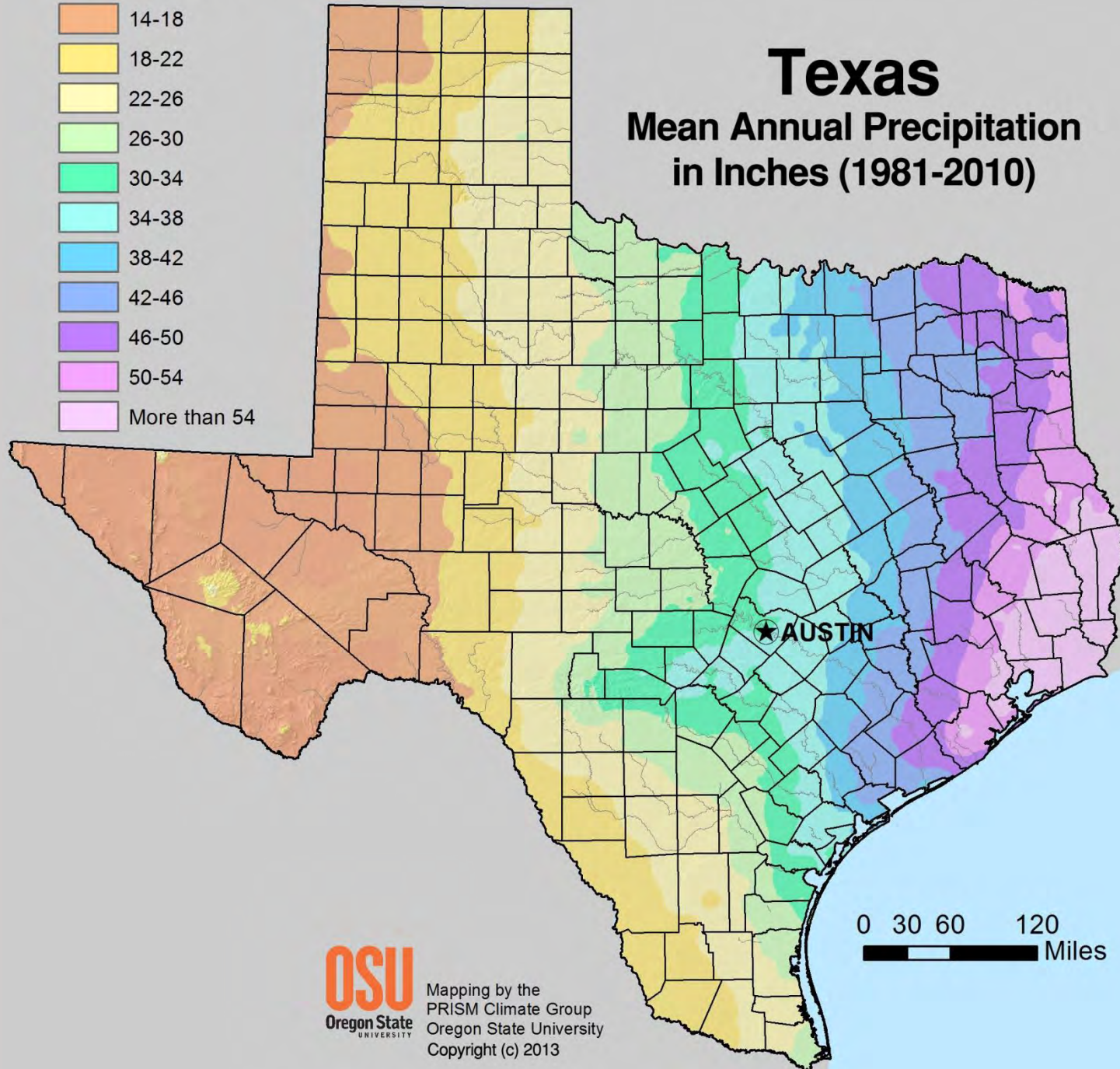
How to Harvest Rainwater?





Texas

Mean Annual Precipitation in Inches (1981-2010)



Mapping by the
PRISM Climate Group
Oregon State University
Copyright (c) 2013

Rainwater Math

“1 inch of rain on a 1,000 sq ft collection area
will yield 623 gallons”

___ in of rain X ___ roof sq ft X 0.623 gal/sq ft



Rainwater Harvesting Benefits

- Reduces stormwater runoff & provides solution to on-site drainage problems
- Better for lawn and garden plants
- Simple technology that is easy to maintain
- Recognized as a green building technique



Rainwater Uses



- Outdoor water use
 - Irrigation of landscaping and lawns
 - Other outdoor uses



- Indoor, non-potable water use
 - Toilets, urinals, & clothes washing machines



- Potable water supply
 - Filtration and disinfection required

System Sizing & Efficiency

- Three considerations:
 - Collection surface size
 - Storage volume size
 - Expected demand
- Three main methods
 - Design for Optimization
 - Design for Space
 - Design for Budget



Design for Optimization

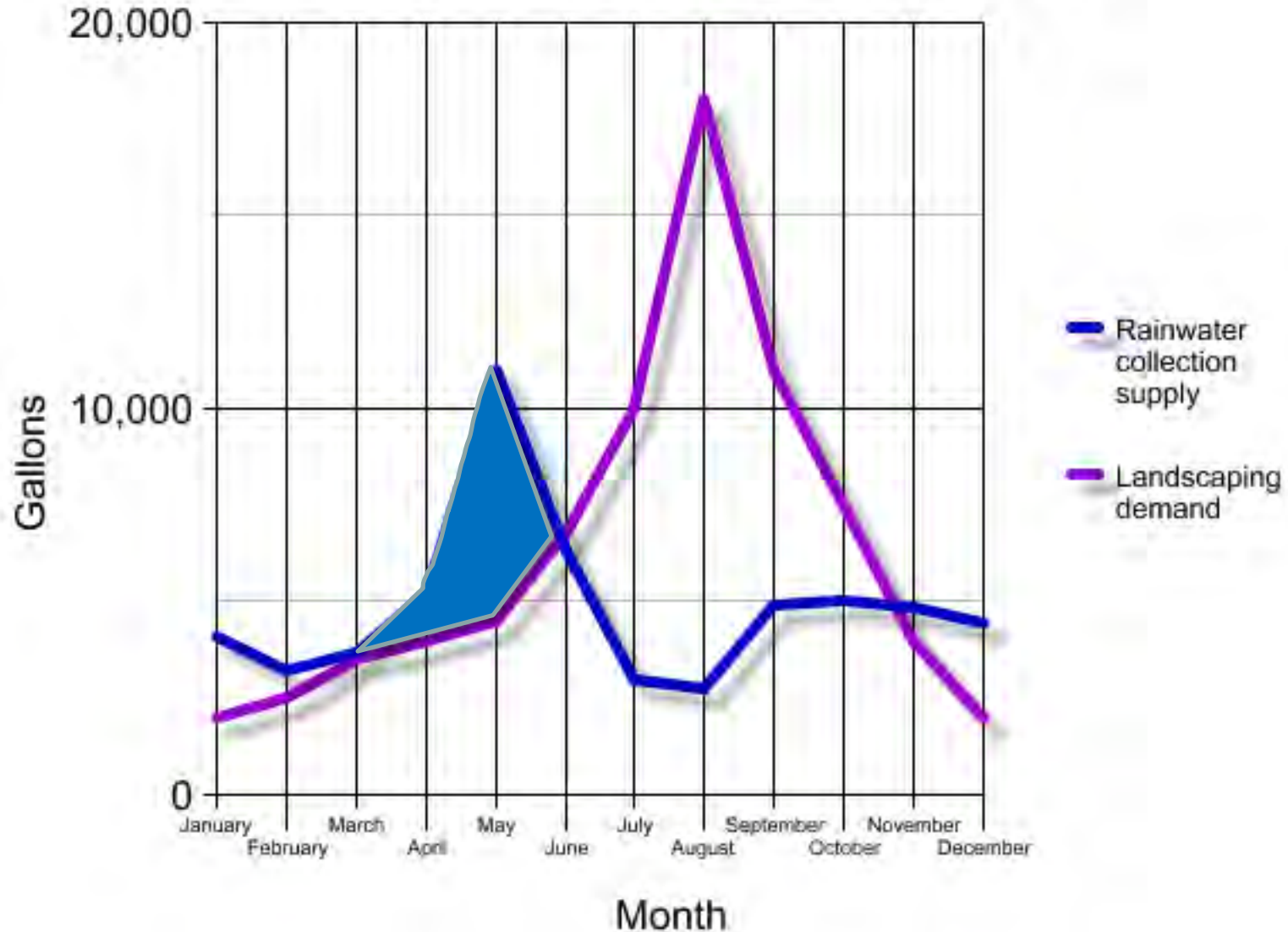
- Use water budgets to identify optimal cistern size

Calculations using Average Rainfall: Dallas/Fort Worth area

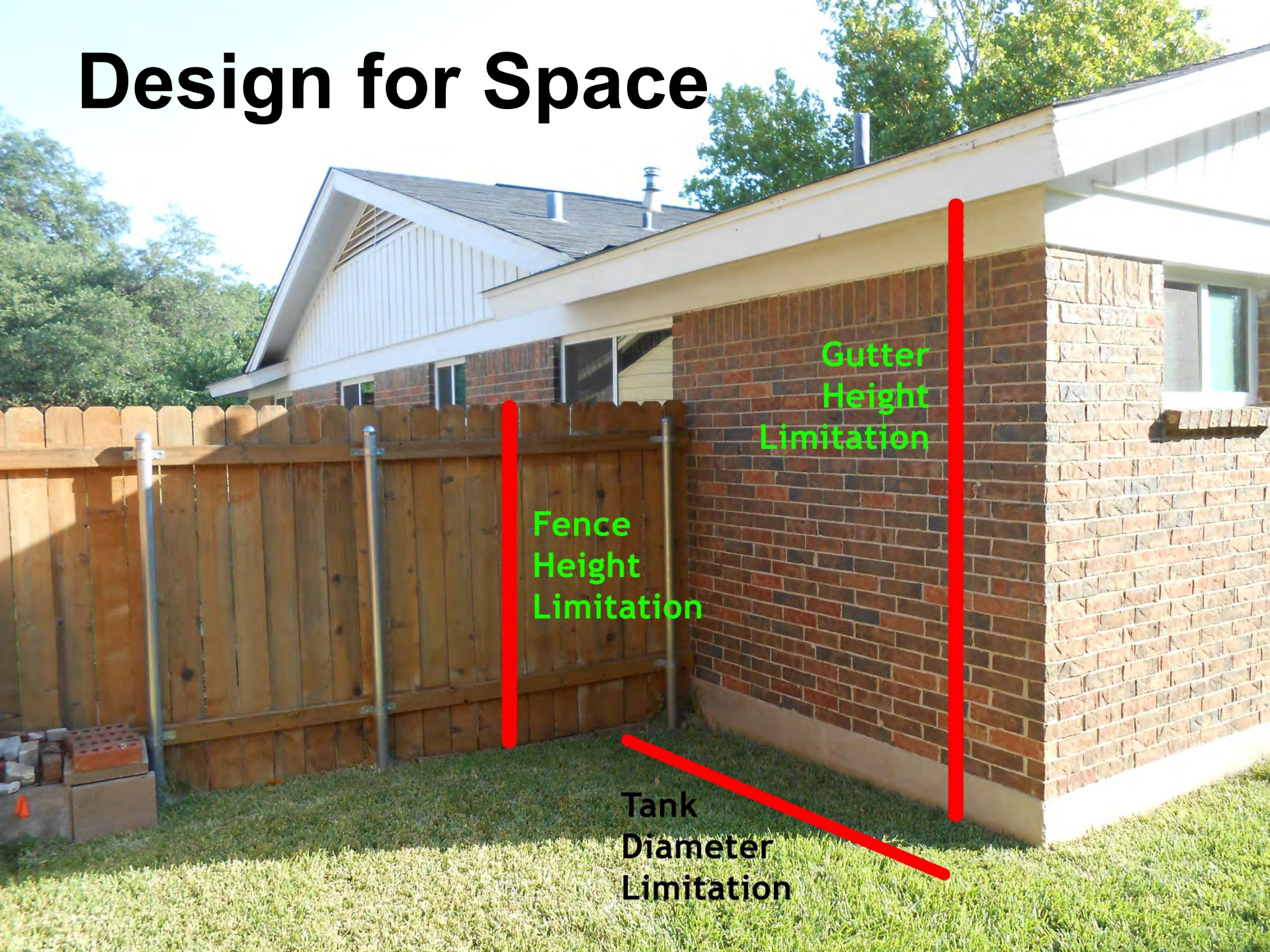
	Indoor demand (gal)	Irrigation (gal)	Total demand (gal)	Rainfall collected (gal)	End of month storage (gallons)	Municipal Water Saved (gallons)
January	0	2,034	2,034	14,896	12,862	2,034
February	0	6,702	6,702	18,735	22,400	6,702
March	0	10,816	10,816	23,957	22,400	10,816
April	0	22,506	22,506	24,187	22,400	22,506
May	0	11,904	11,904	41,694	22,400	11,904
June	0	41,705	41,705	24,418	5,112	41,705
July	0	55,414	55,414	16,048	0	21,160
August	0	53,798	53,798	16,125	0	16,125
September	0	32,928	32,928	18,582	0	18,582
October	0	4,773	4,773	30,791	22,400	4,773
November	0	3,409	3,409	18,659	22,400	3,409
December	0	0	0	19,196	22,400	-
Total:						150,981*

The Importance of Storage Volume

Hypothetical 3,000 sf building with landscaping



Design for Space



Gutter
Height
Limitation

Fence
Height
Limitation

Tank
Diameter
Limitation

Design for Budget

- Most frequent limit for systems intended for irrigation only
- Systems can be expanded at a later time

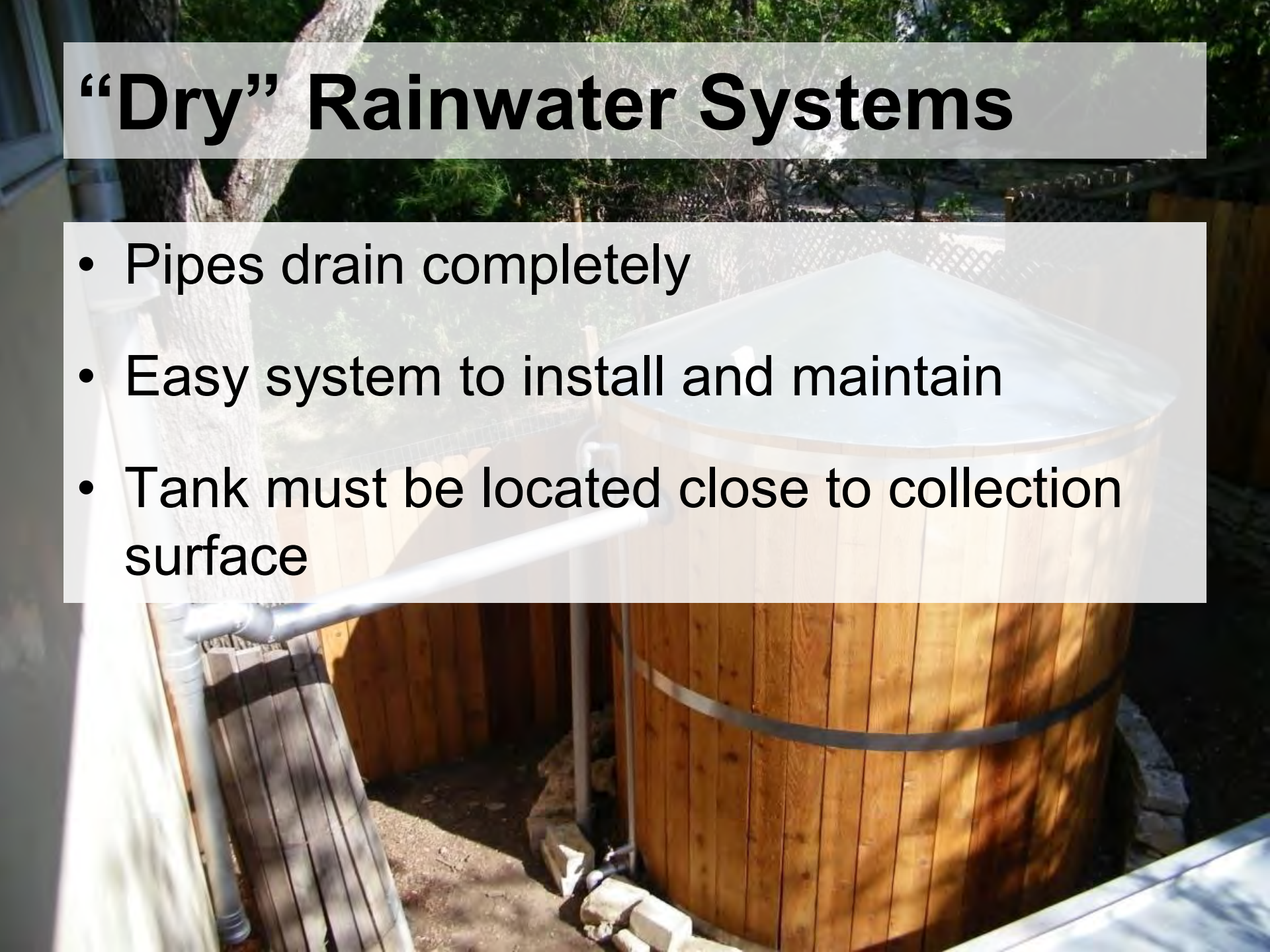


“Dry” Rainwater Systems



“Dry” Rainwater Systems

- Pipes drain completely
- Easy system to install and maintain
- Tank must be located close to collection surface

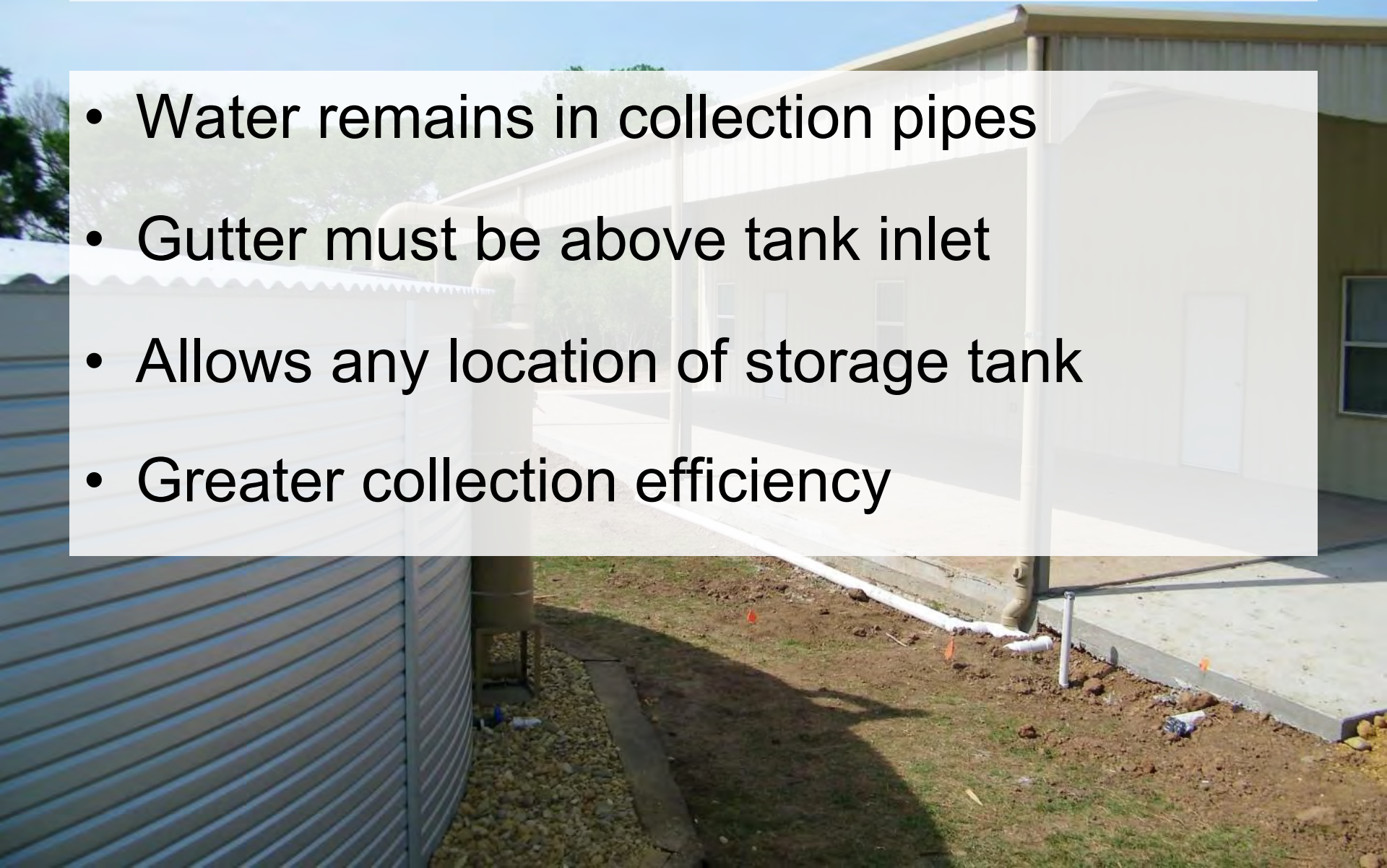


“Wet” Rainwater Systems

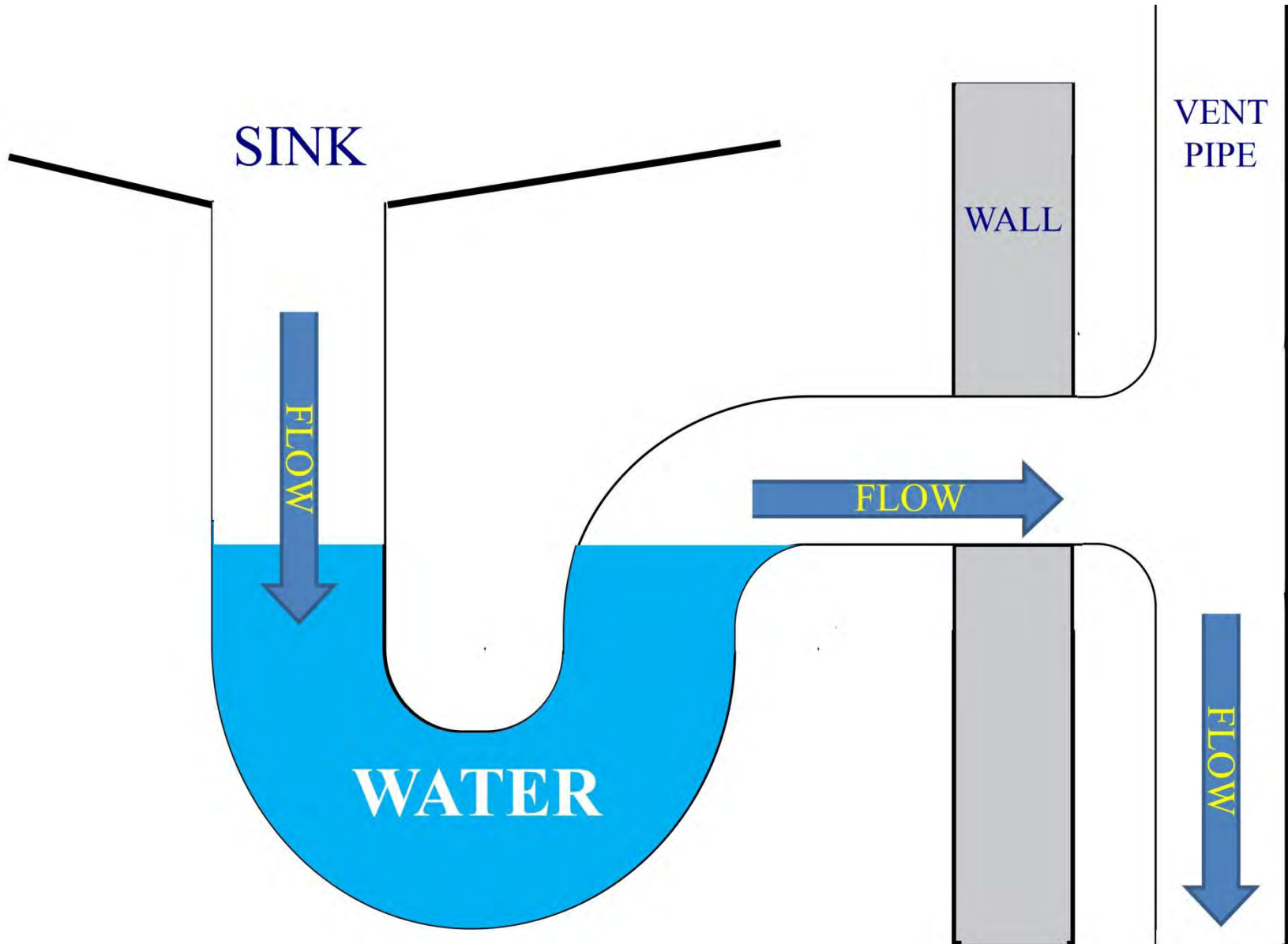


“Wet” Rainwater Systems

- Water remains in collection pipes
- Gutter must be above tank inlet
- Allows any location of storage tank
- Greater collection efficiency



Imagine a P-Trap...



Rainwater System Components



Rainwater System Components

Gutter or inlet screening

“Your first line of defense”



Inlet Filtration is VITAL



Inlet Filtration is NOT First Flush

- Inlet filters keep large debris out
- First flush from the roof carries a higher concentration of pollutants
- Inlet filtration + First flush = Best Practice



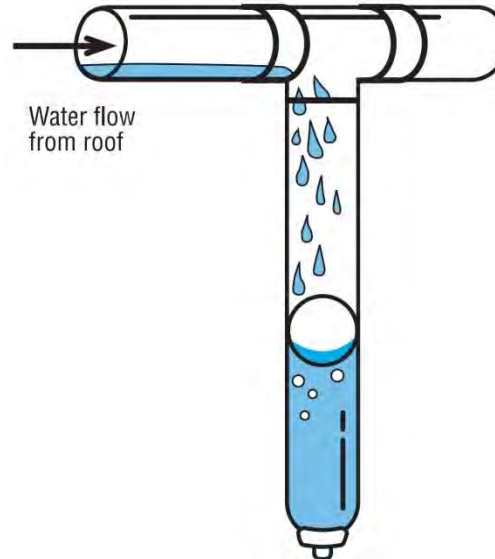
Rainwater System Components



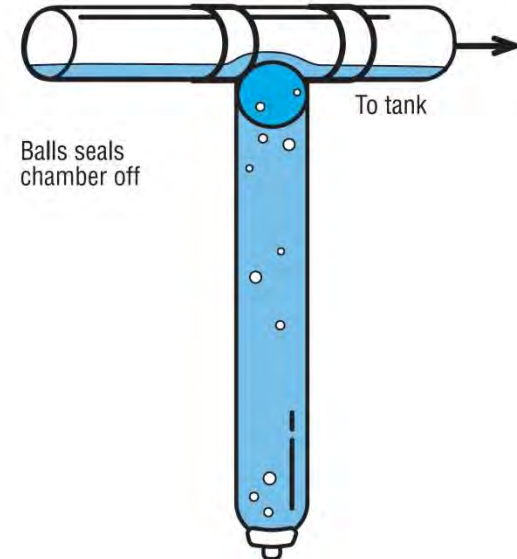
First flush diverter

Diverts the initial wash of the roof

First flush of contaminated water is diverted into chamber



Once chamber is full fresh water flows to tank

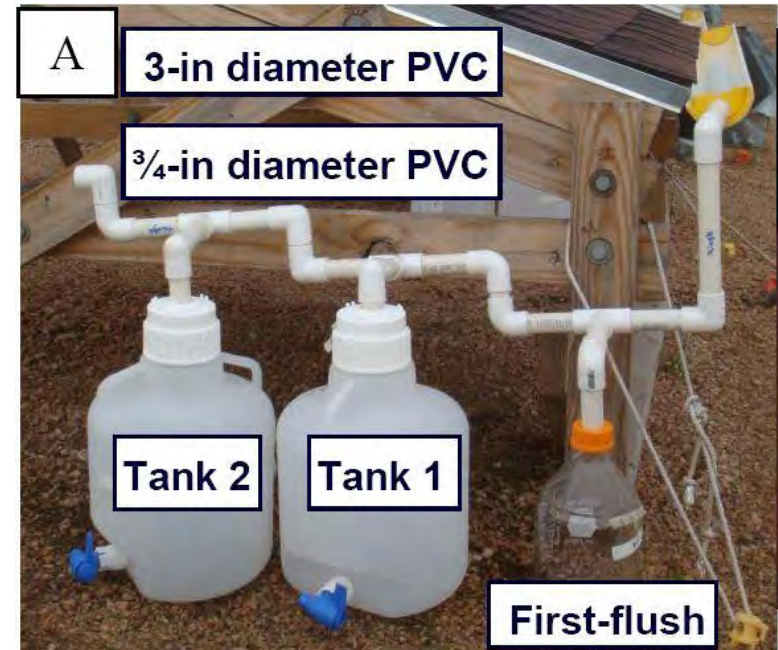


Adequate First Flush Amount ??



Roof Water Quality and First Flush

- *“Effect of Roof Material on Water Quality for Rainwater Harvesting Systems – Additional Physical, Chemical, and Microbiological Data Report”* - Texas Water Development Board, Jan 2011
- Tested 5 different roof types
- Collected rainwater from 6 events in 2009 & 2010



Turbidity (NTU)

Median (min - max)

Roof type	First-flush	Tank 1	Tank 2
Shingle	14 (4-41)	9 (3-24)	9 (3-14)
Galvalume®	31 (2-102)	7 (2-30)	7 (2-9)
Tile	26 (5-64)	16 (2-36)	4 (2-9)
Cool	37 (9-105)	7 (2-26)	5 (2-13)
Green	4 (3-15)	3 (3-11)	4 (3-4)
Ambient rain	4 (3-8)		

TSS (mg/L)

Median (min - max)

Roof type	First-flush	Tank 1	Tank 2
Shingle	29 (6-123)	30 (6-128)	38 (12-53)
Galvalume®	96 (4-260)	58 (2-87)	33 (20-75)
Tile	95 (3-164)	23 (1-80)	19 (0-37)
Cool	114 (6-238)	76 (6-118)	33 (4-46)
Green	18 (3-84)	12 (3-53)	10 (1-49)
Ambient rain	17 (0-46)		

Total Coliform (CFU/100mL)

Median (min - max)

Roof type	First-flush	Tank 1	Tank 2
Shingle	2470 (1500-8100)	800 (203-6933)	256 (177-733)
Galvalume®	767 (300-1267)	167 (<1-770)	416 (117-500)
Tile	1680 (1017-5617)	832 (225-983)	567 (293-783)
Cool	1882 (1683-5450)	917 (130-3750)	226 (150-867)
Green	333 (13-1233)	12 (<1-1300)	8 (7-833)
Ambient rain	550 (340-648)		

- **TWDB suggests >10 gallons / 1,000 sf**
- Ultimately depends on use of rainwater, roof type, and locational issues



Rainwater System Components

Tank inlet filter and screen



Rainwater System Components

Pump system

- Pump sized for demand
- Different type of systems:
 - Hose bibb only
 - Connected to irrigation
 - On-demand
- Don't have to settle for onsite water pressure



Rainwater System Components

Backup water supply

- Auto-fill mechanism
- Manual fill
- Auto-switch

- Remember,
Air gap or RPZ



Rainwater System Components

Water Level Gauge





Metal cisterns



Polyethylene cisterns



Fiberglass cisterns



Corrugated metal cisterns



Pioneer Water Tanks



Rainwater Tank Cladding



Underground tank systems



How much rainwater?



- *Camp Mabry, Austin daily rainfall data, 1998 to 2014*
- *Assumed usage of 50 gallons/day*

Scenario #1

- *1,000 sf of collection area*

Scenario #2

- *1,700 sf of collection area*

Scenario #3

- *2,350 sf of collection area*



Collection Area Analysis

Collection Area Change, 1,000 gallon cistern, 50 gallons/day usage						
	Scenario #1		Scenario #2		Scenario #3	
Below 25%	52.2%	* 36.1%	37.9%	* 24.6%	31.2%	* 19.6%
Between 25% and 75%	29.4%		34.0%		35.6%	
Over 75%	18.4%	* 4.2%	28.1%	* 7%	33.2%	* 8.8%
Gallons used	195,350		230,600		245,900	

- Doubling collection area provided 50,000 more gallons of used rainwater over 26 years
- Larger collection area gave more opportunities

Collection Area & Cistern Size Analysis

Collection Area Change, 2500 gallon cistern, 50 gallons/day usage						
	Scenario #1		Scenario #2		Scenario #3	
Below 25%	42.9%	* 22.6%	21.8%	* 9.8%	12.9%	* 4.9%
Between 25% and 75%	34.6%		34.2%		33.6%	
Over 75%	22.5%	* 2.6%	44.0%	* 5.9%	53.5%	* 8.0%
Gallons used	236,850		276,000		290,950	

- Doubling cistern size provided 41,000 more gallons of used rainwater over 26 years (1k gal cistern scenario)
- Larger collection area gave more opportunities

Collection Area & Daily Usage Analysis

Collection Area Change, 2,500 gallon cistern, 100 gallons/day usage						
	Scenario #1		Scenario #2		Scenario #3	
Below 25%	78.6%	* 16.4%	54.8%	* 37.2%	43.8%	* 28.3%
Between 25% and 75%	16.4%		29.3%		31.5%	
Over 75%	5.1%	* 0.6%	15.9%	* 2.8%	24.6%	* 4.7%
Gallons used	262,700		384,000		439,000	

- Doubling usage provides for better usage of larger collection area and larger cistern

Rainwater Incentives

- Austin & San Marcos provide rebates up to \$5,000 for systems over 300 gallons
- Rainwater harvesting equipment is sales tax exempt in TX
- Hays County gives property tax exemption
- LCRA provides impervious cover credits



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