Institutional, Commercial and Industrial (ICI) Water Use by the Numbers

Presented at Emerging Water Technology Symposium - 2018

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What this Presentation Hopes to Shed Light On

1. How much water is use in the ICI sector?
2. Where is it used?
3. What are the benchmarks?
4. How do codes, standards and regulations impact use?
5. What are the trends?
6. What are the driving forces?

So how do we use water in the built environment?

Use vs. Consumption vs. Return Flows.

- **Water *Use* *(withdrawal)* is the amount of water withdrawn from a water source (lake, well, river, etc.)**

- **Water *Consumption* is the amount of water that is evaporated, included in a product, injected into disposal wells or otherwise not returned in liquid form to a water source.**

- ***Return flows* equal the difference between use and consumption.**

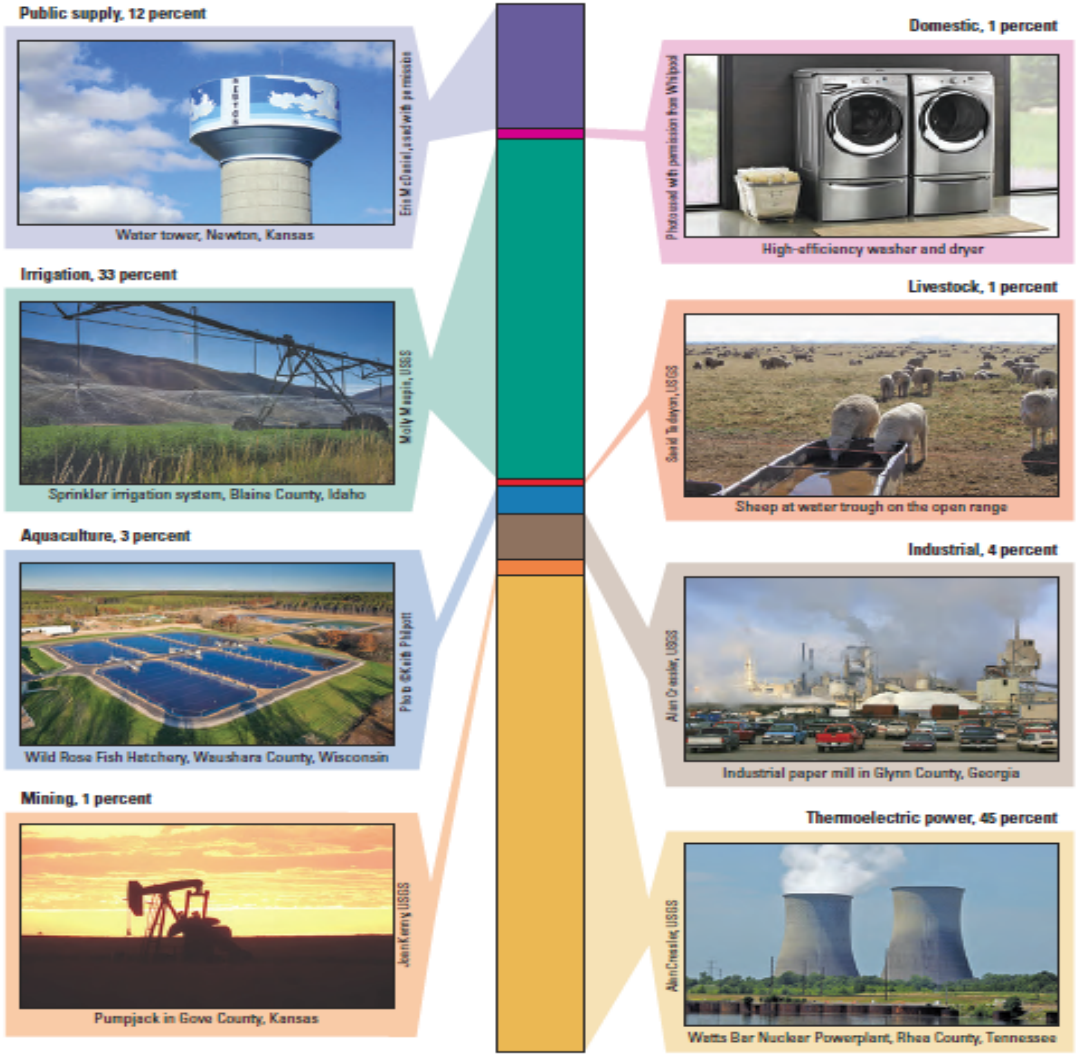


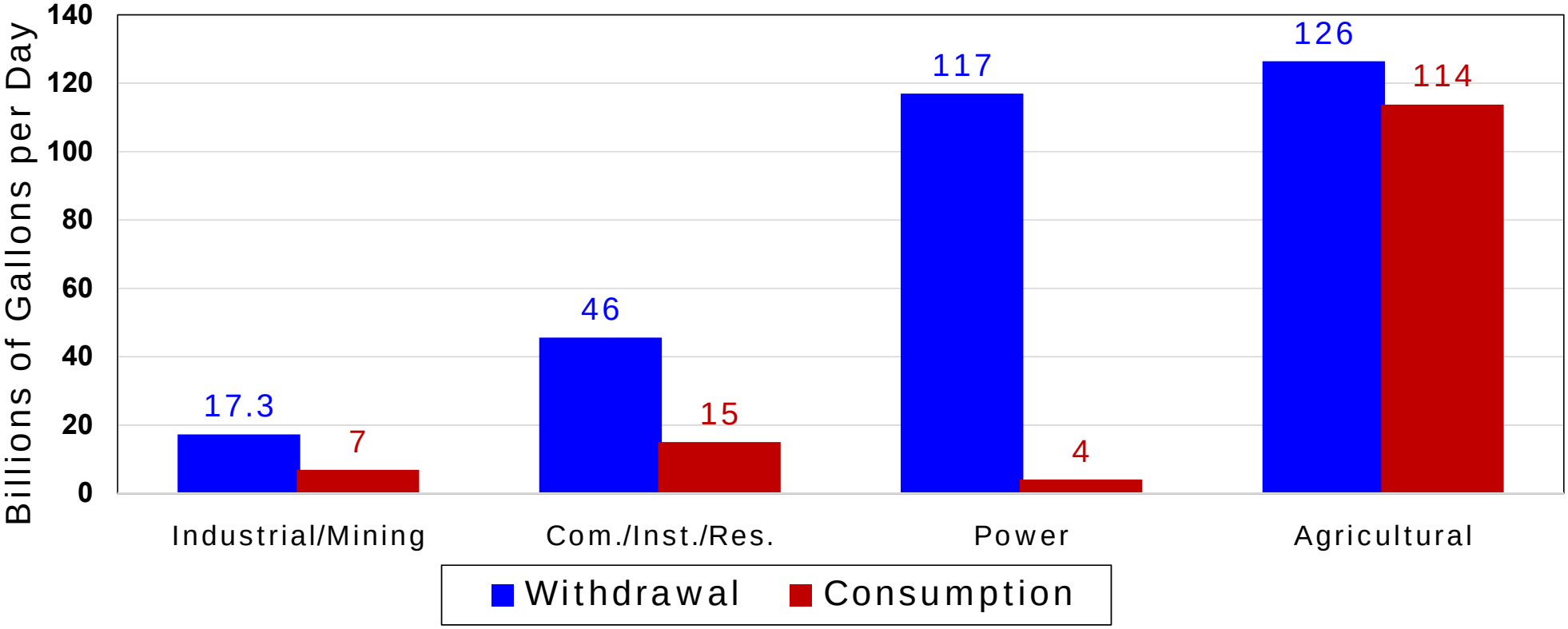
Figure 1. Total water withdrawals by category, 2010.

Withdrawal vs. Consumption - 2010

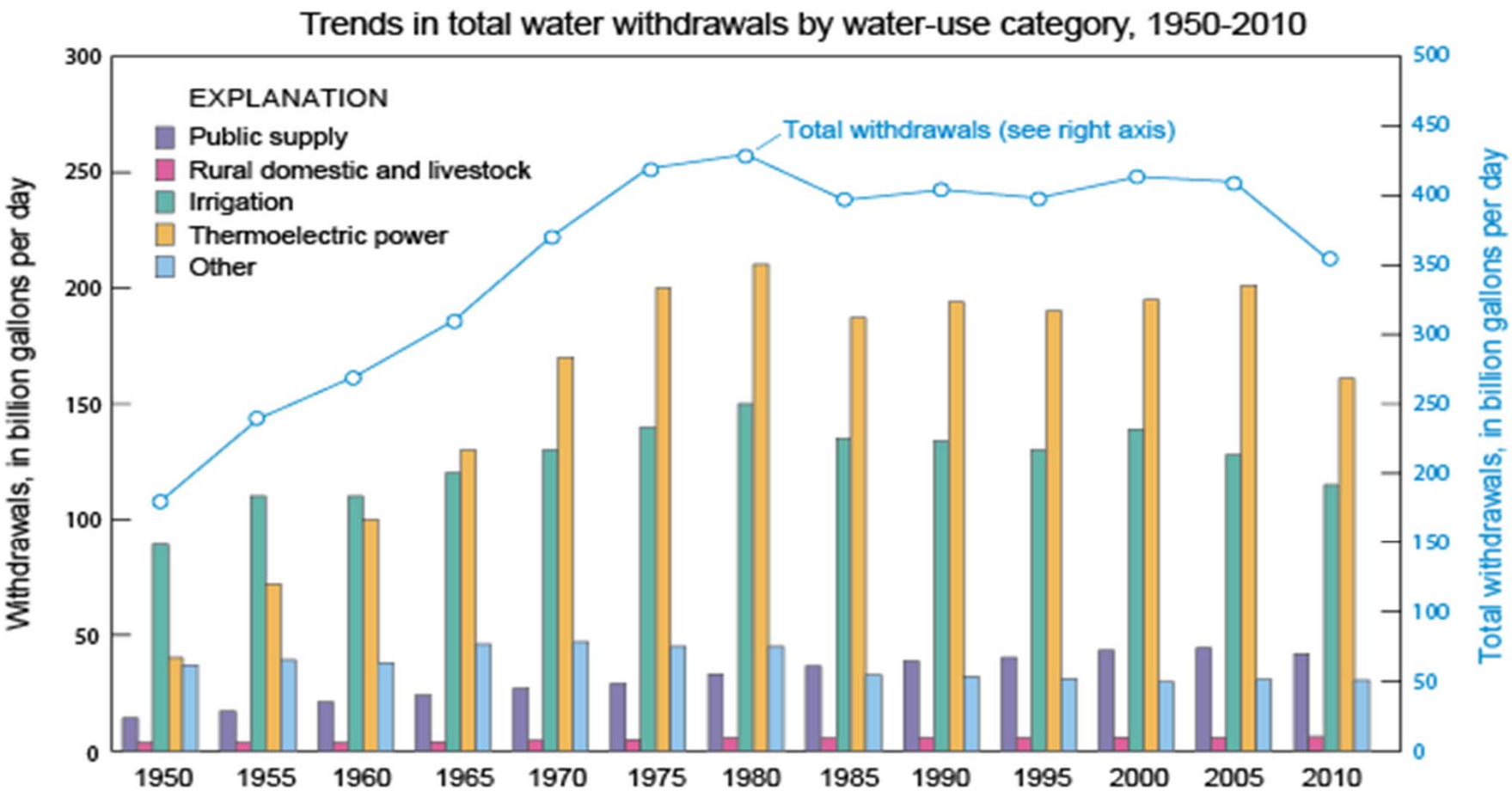
306 Billion Gal./Day Withdrawal

140 Billion Gal./Day Consumption

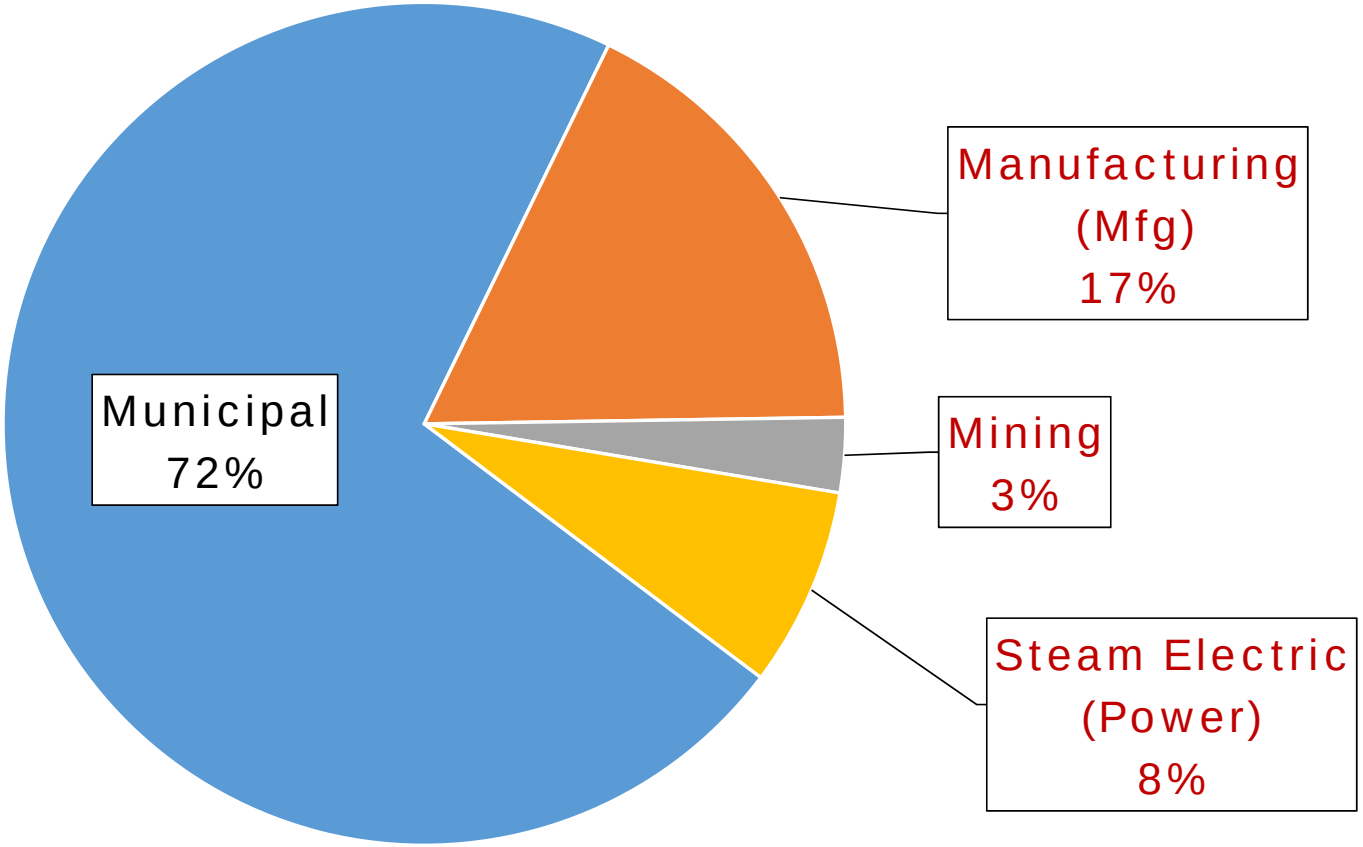
Sources: USGS and H.W.(Bill) Hoffman & Associates, LLC



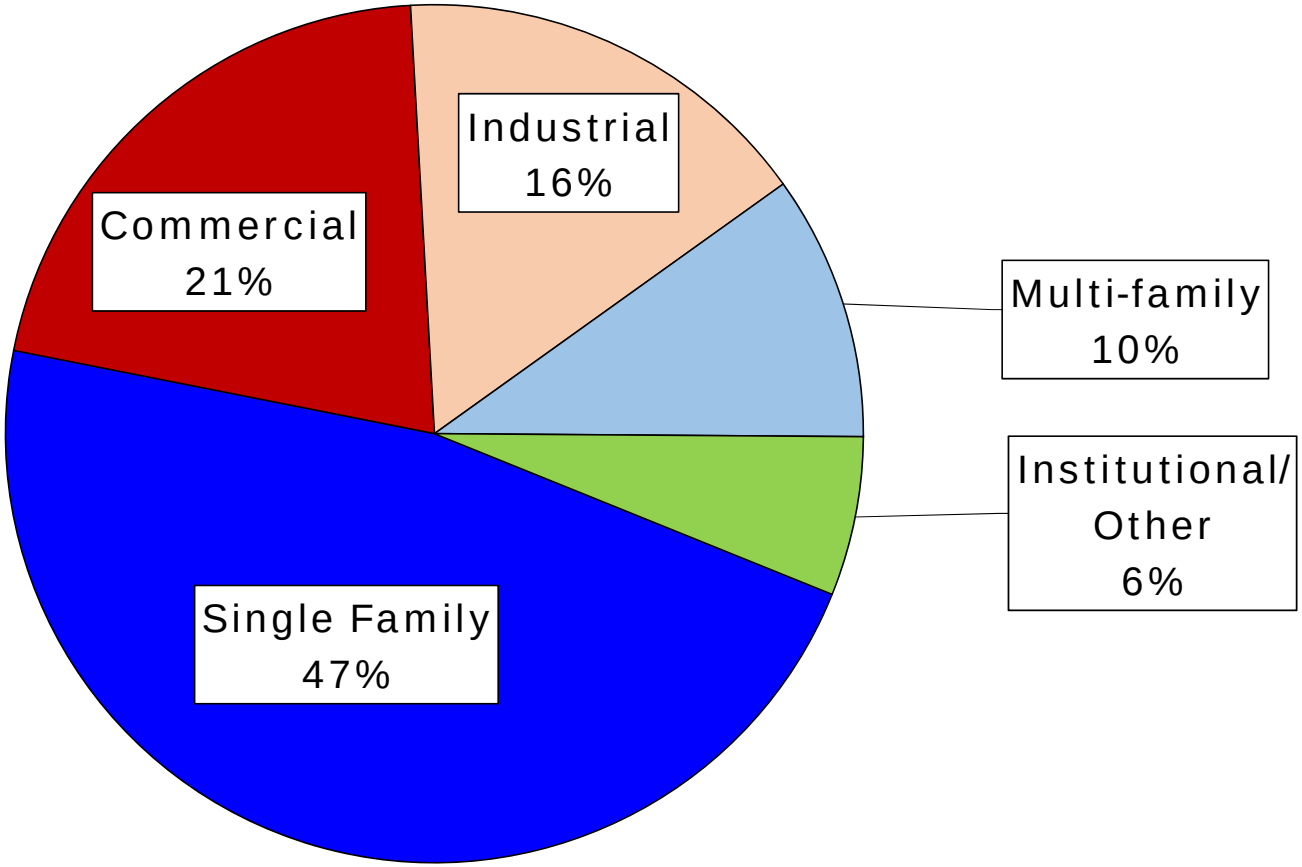
USGS Trends

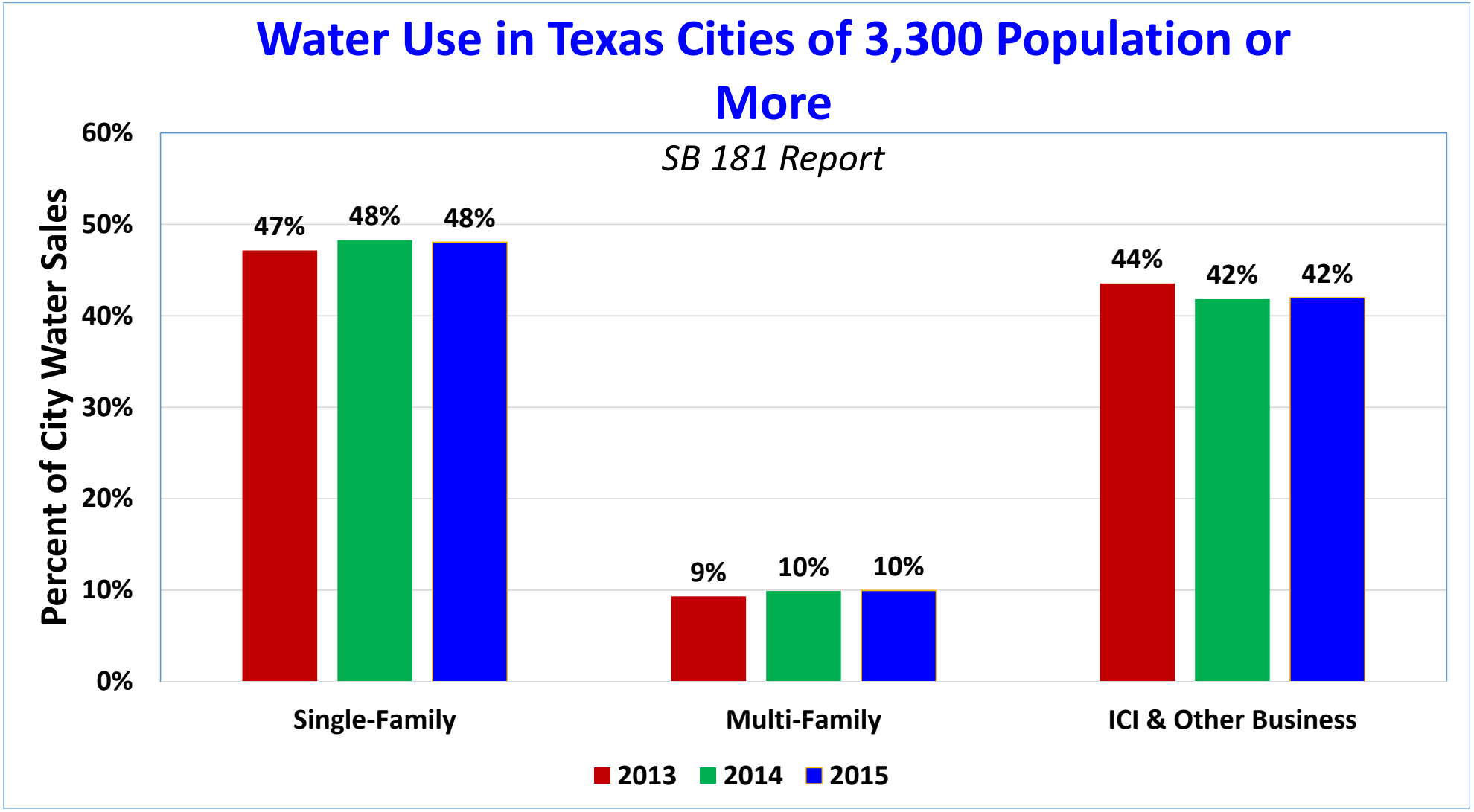

Trends in total water withdrawals by water-use category, 1950-2010
EXPLANATION
Public supply
Rural domestic and livestock
Irrigation
Thermoelectric power
Other
Total withdrawals (see right axis)
Withdrawals, in billion gallons per day
Total withdrawals, in billion gallons per day
0
50
100
150
200
250
300
350
400
450
500
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010

Municipal and Industrial Water Use in Texas



Municipal Water Sales in Texas - 2015

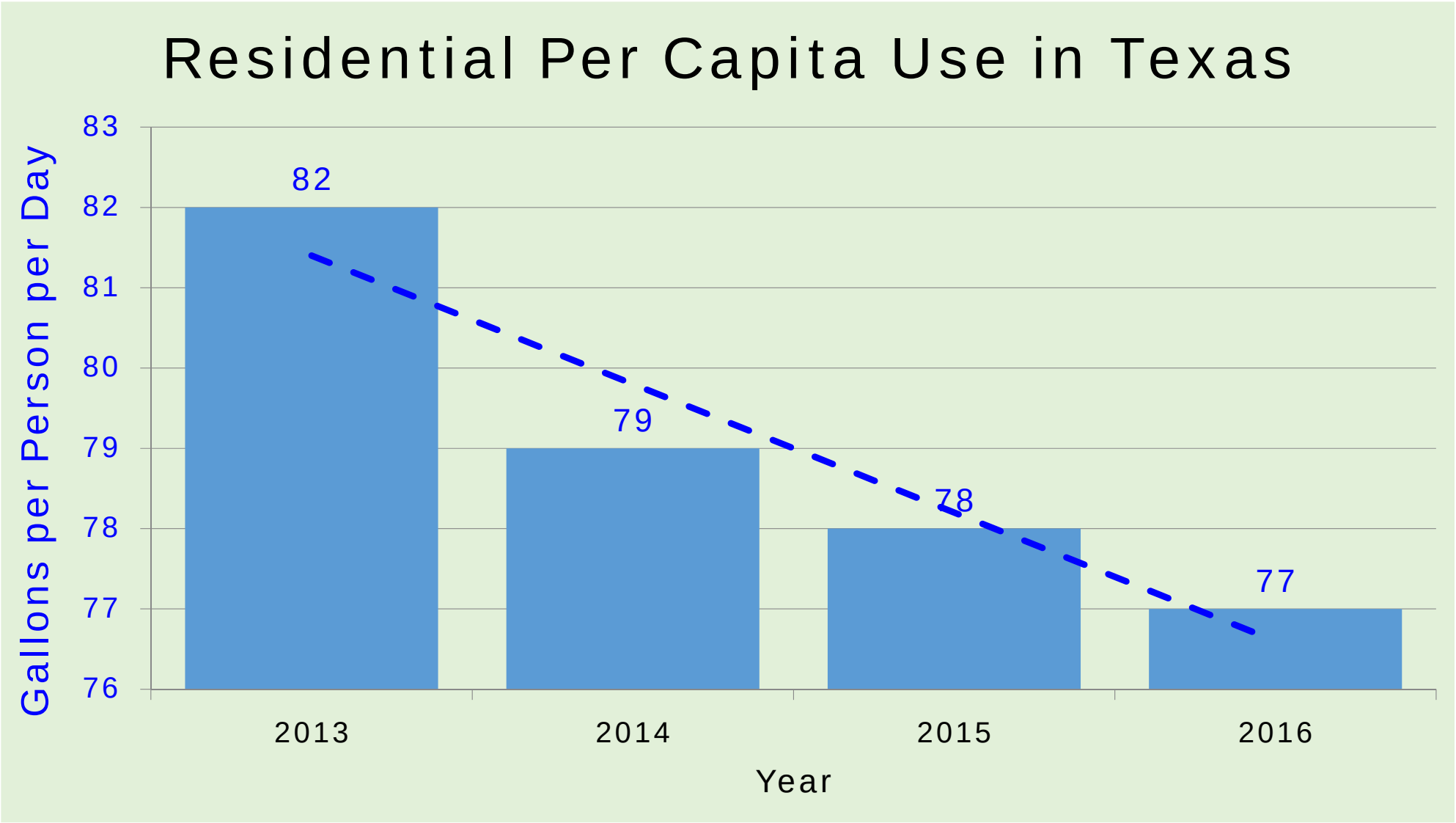



Water Use in Texas Cities of 3,300 Population or More
SB 181 Report
Percent of City Water Sales
60%
50%
40%
30%
20%
10%
0%
47%
48%
48%
9%
10%
10%
44%
42%
42%
Single-Family
Multi-Family
ICI & Other Business
2013
2014
2015

Multi-Family Is Commercial?

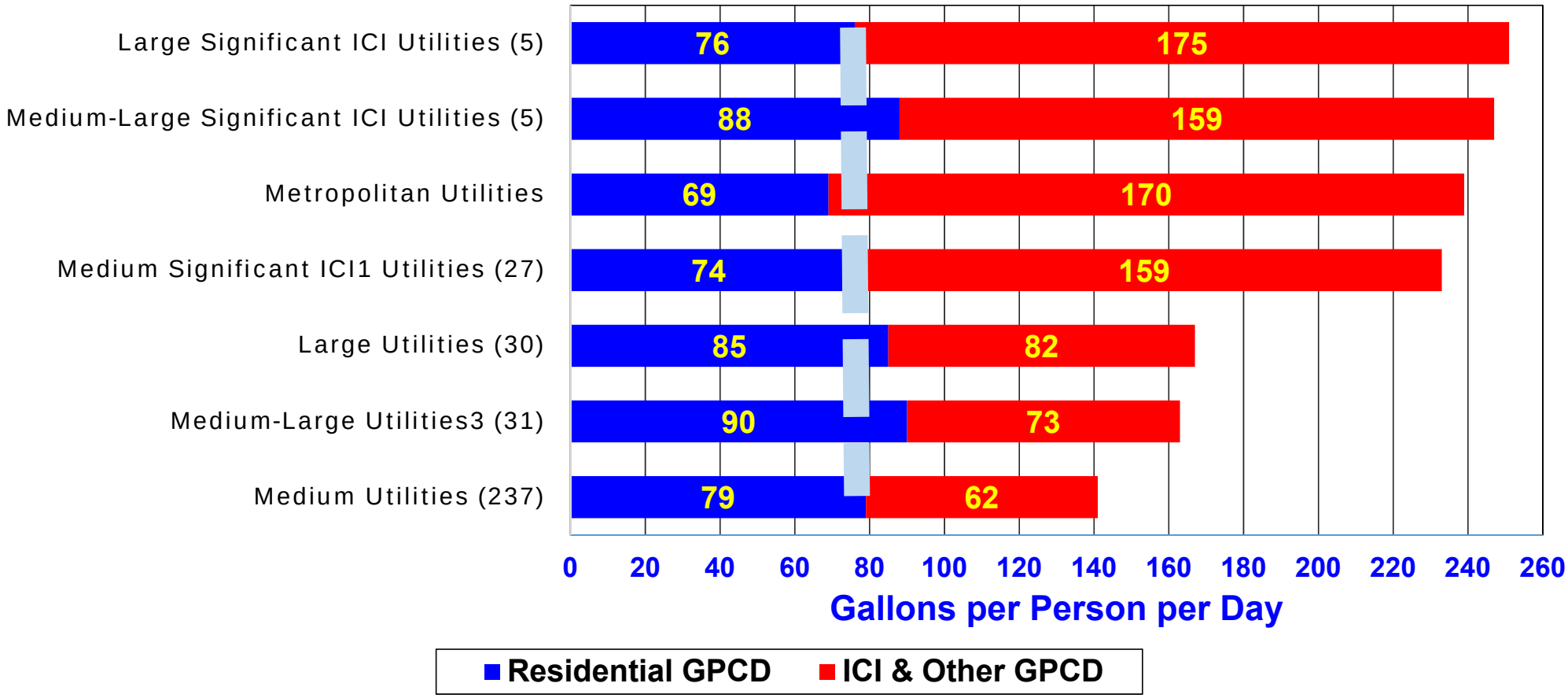
They are commercial facilities supplying domestic users

- **The company owns and operates the property for profit.**
- **The company is responsible for plumbing repairs.**
- **Unless the utility meters each apartment, the company pays the water bill.**
- **On-property uses (irrigation, pools, common laundry, etc.) are all on the company bill.**


Residential Per Capita Use in Texas
Gallons per Person per Day
83
82
81
80
79
78
77
76
82
79
78
77
2013
2014
2015
2016
Year

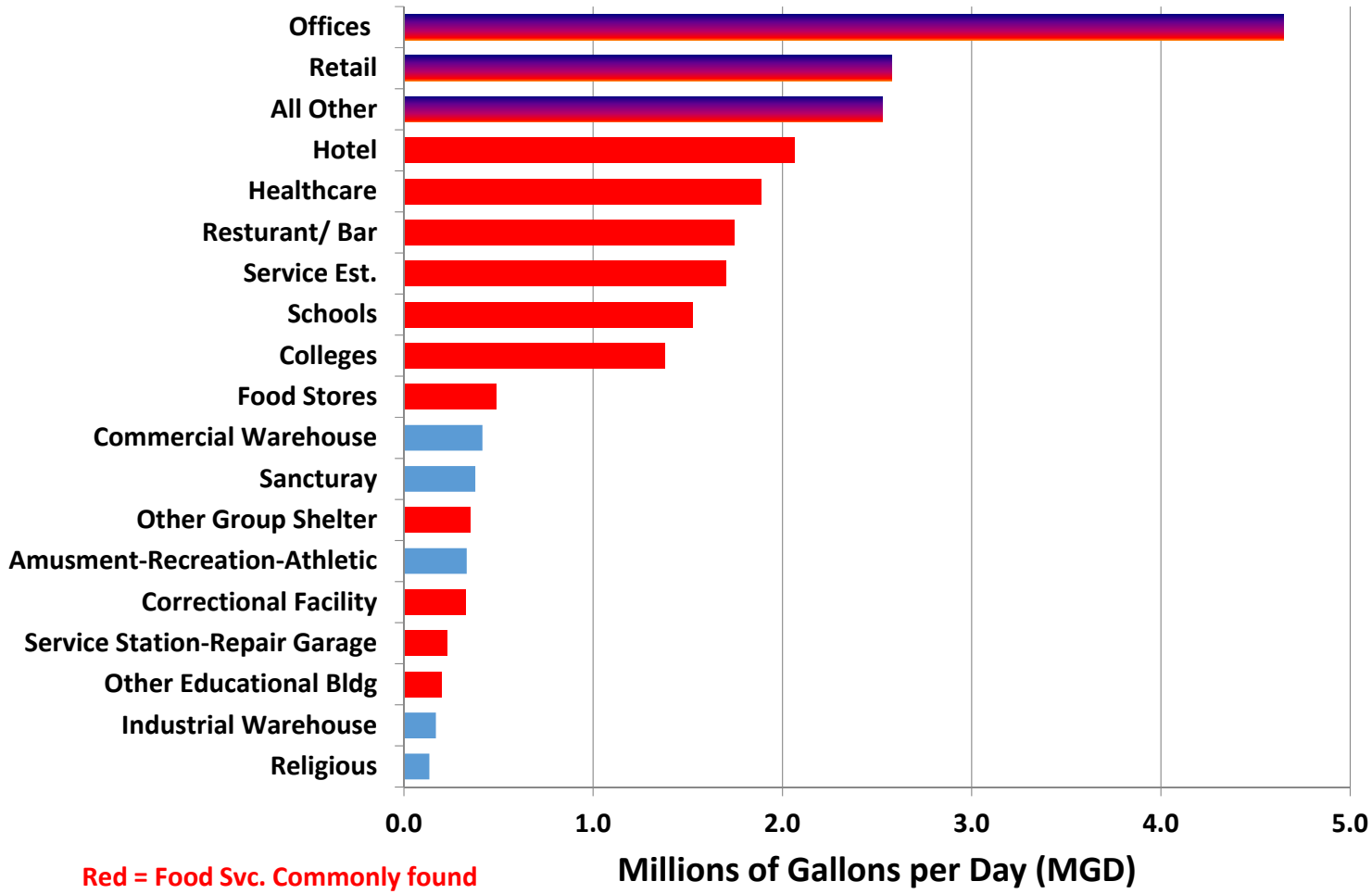
Texas Utilities Water Sales

TWDB 2015 - SB 181 Report



Where & How it is used

Water Use by Commercial/Institutional Users
Austin, Texas Study 2010

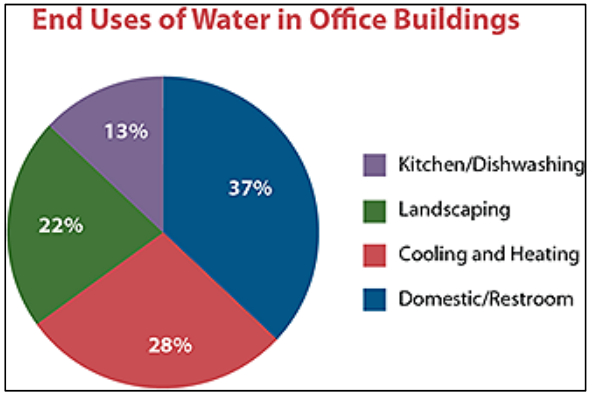


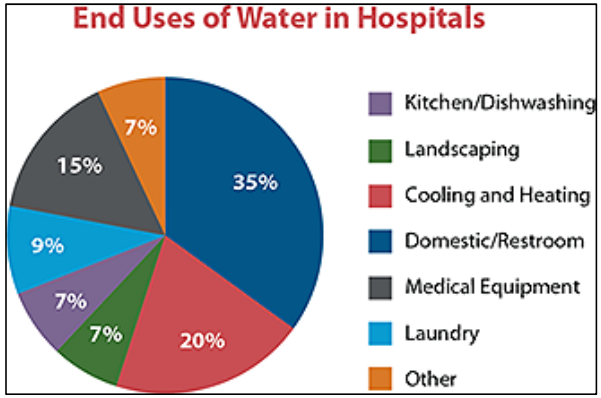
Water Use By Type of Activity

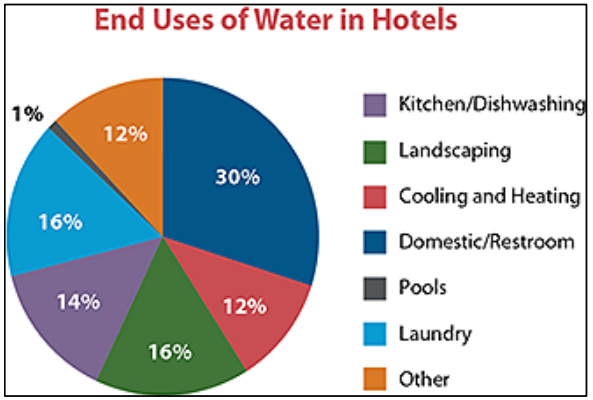
Facility Type	Type of Use									
	Domestic	Laundry & Dry Cleaning	Cooling & Heating	Food Service	Medical / Lab Equipment	Landscape Irrigation	Water Features	Water Treatment	Washing & Outdoor Cleaning	Alternate Sources
Office	X		?	X		X	?	?	?	?
Restaurants	X	?	?	X		X	?	?	?	?
K-12 Schools	X	X	?	X	X	X	?	?	?	?
Universities	X	?	?	X	?	X	?	?	?	?
Other Educational Facilities	X	?	?	X	?	X	?	?	?	?
Lodging/Hotel	X	X	?	X		X	?	?	?	?
Theaters / Entertainment / Museums, etc.	X		?	X		X	?	?	?	?
Hospitals	X	?	?	X	X	X	X	?	?	?
Clinics of all types	X	?	?		X	X	X	?	?	?
Retirement Homes / Nursing Homes	X	X	?	X	X	X	?	?	?	?
Dormitory / Residence Hall	X	X	?	X		X	?	?	?	?
Multi-Family / Apartments	X	X	?	X		X	?	?	?	?
Religious Establishments	X		?	X		X	?	?	?	?
Warehouses (unrefrigerated)	X		?			X	?	?	?	?
Warehouses (refrigerated)	X		?			X	?	?	?	?
Supermarket/Grocery	X	?	?	X		X	X	?	?	?
Convenience Stores	X		?	X		X	?	?	?	?
All Other Retail	X	?	?	X	?	X	?	?	?	?
Gymnasiums	X		?			X	?	?	?	?
Meeting Places	X		?	?		X	?	?	?	?
Commercial Laundries	X	X	?	?		X		X	?	?

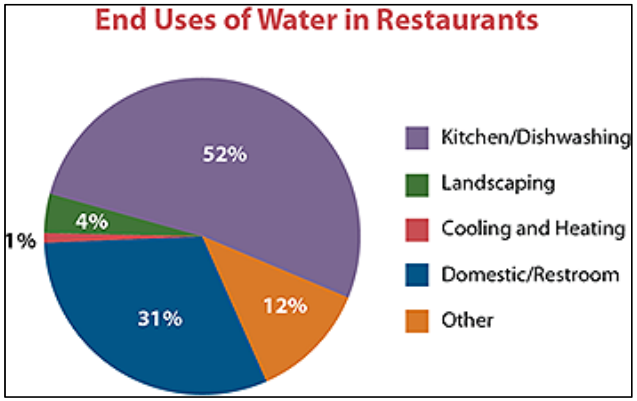
EPA WaterSense End Use Charts

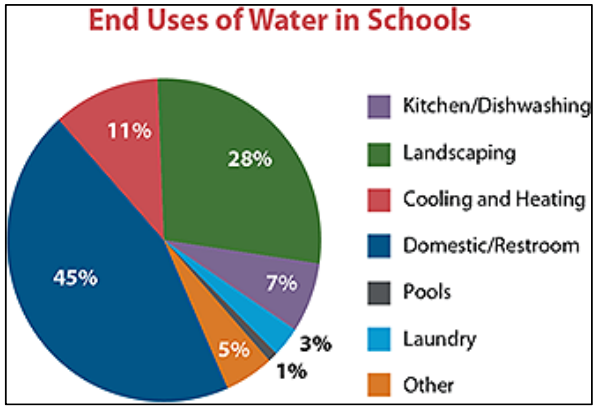
https://www3.epa.gov/watersense/commercial/types.html#tabs-educational





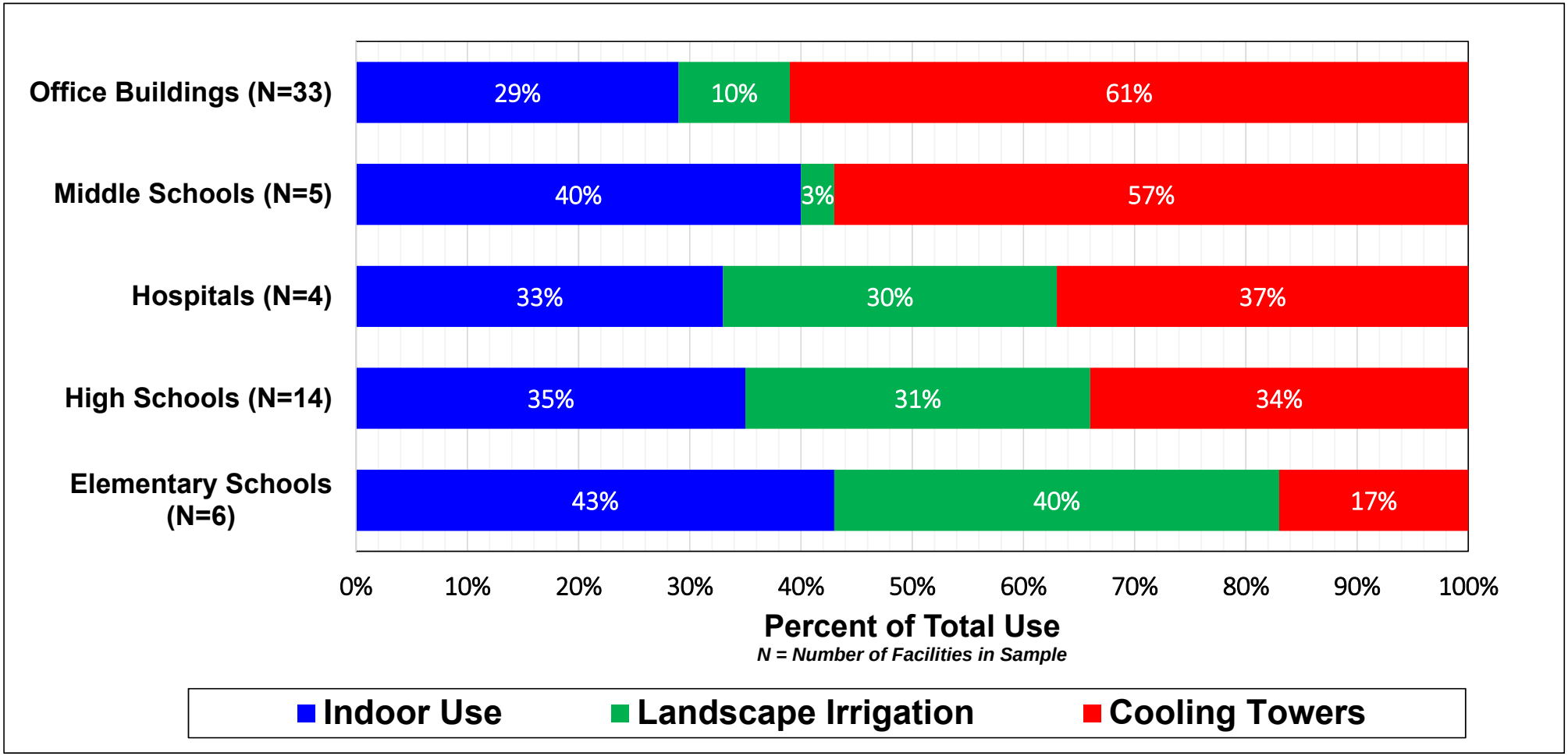




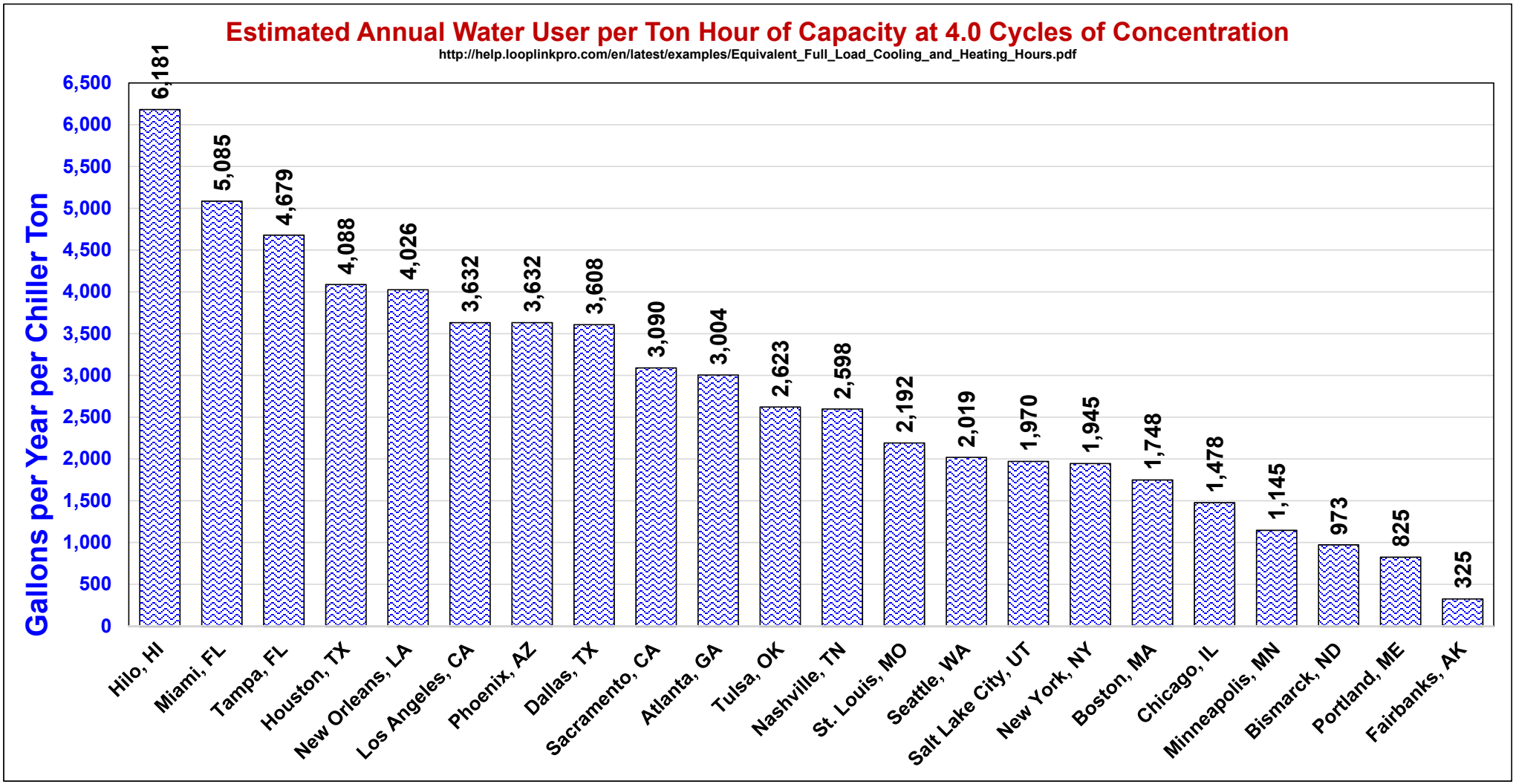


How Water is Used in Texas Facilities With Cooling Towers

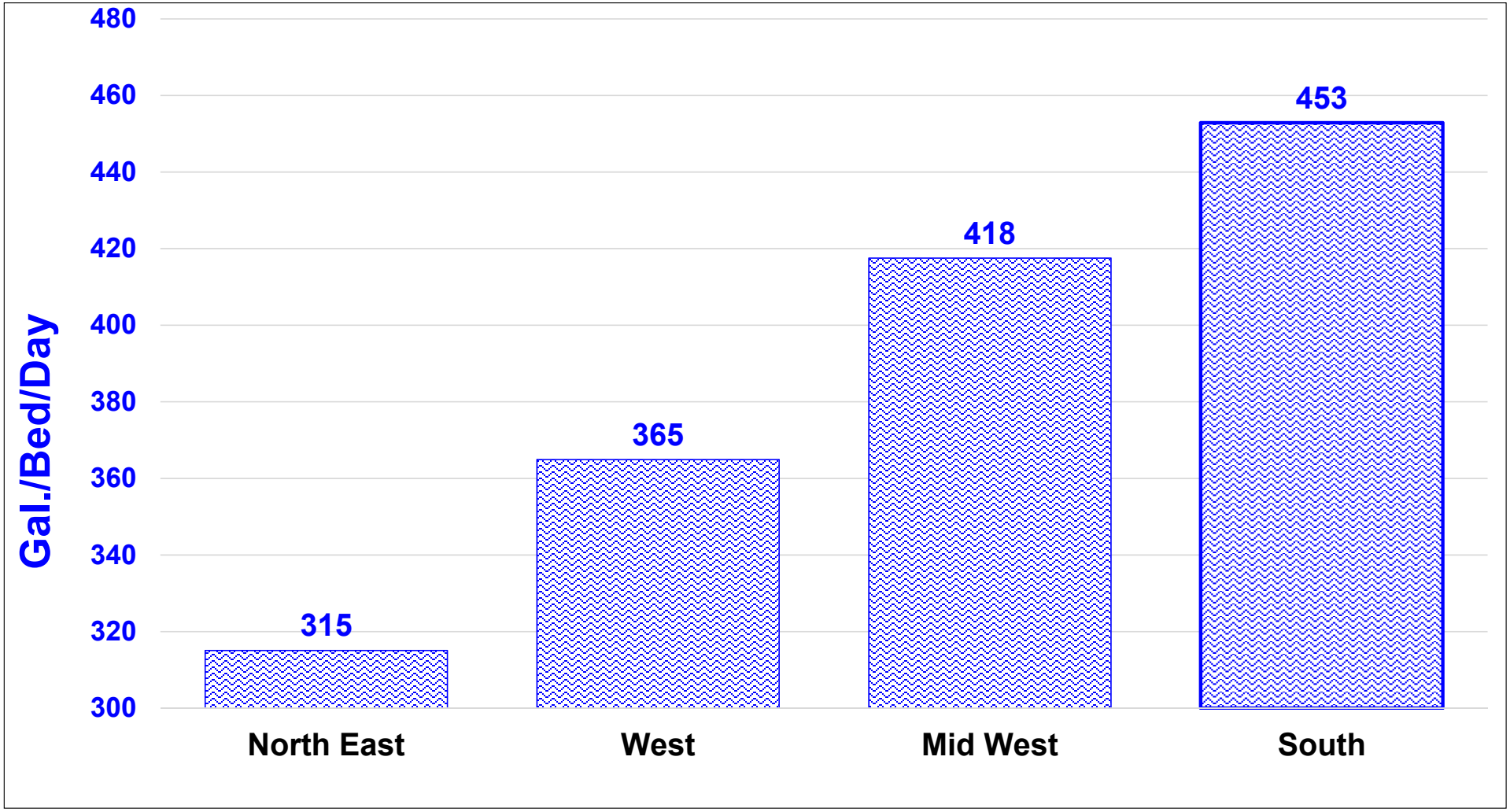
Special Study of Audits in Austin, Dallas, and Fort Worth



Impact of Geography on Cooling Water Use

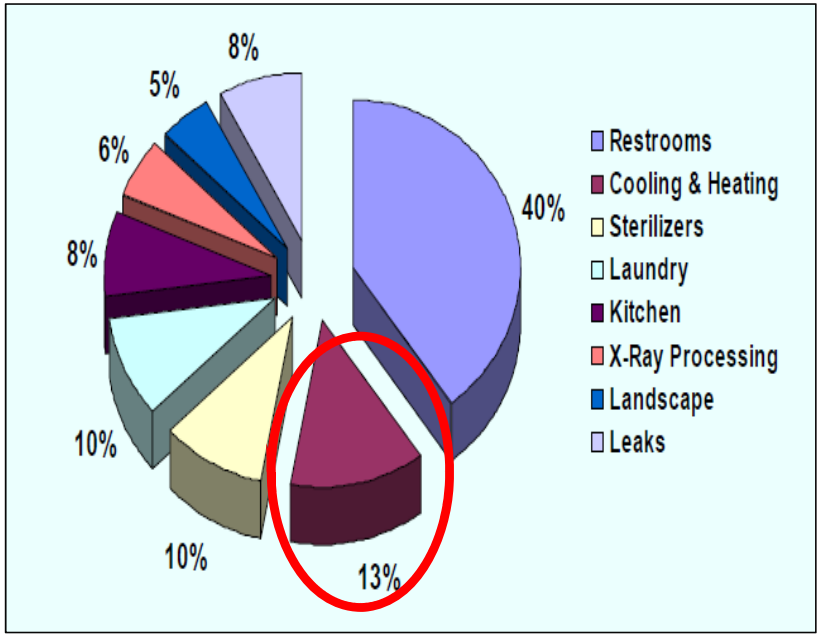


Hospital Use per Bed based on CBECS

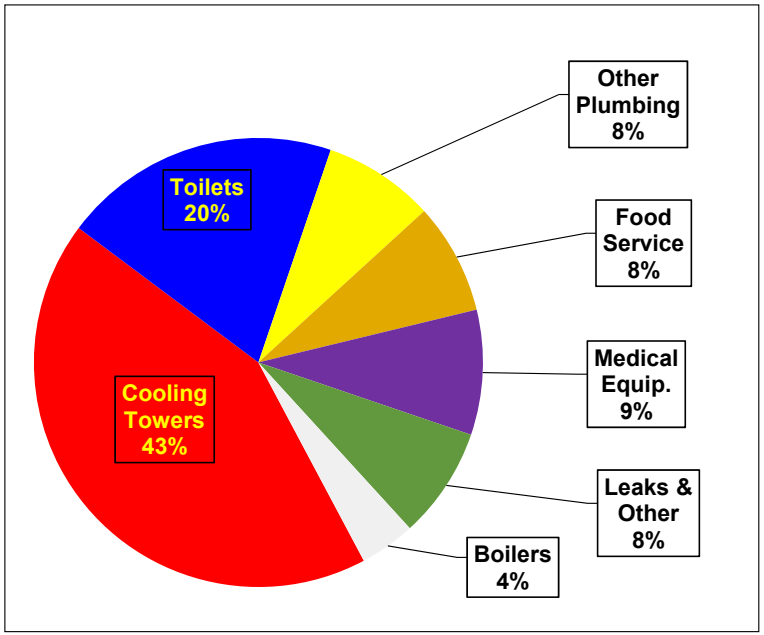


HOSPITAL USE CHARACTERISTICS

Northern Climate

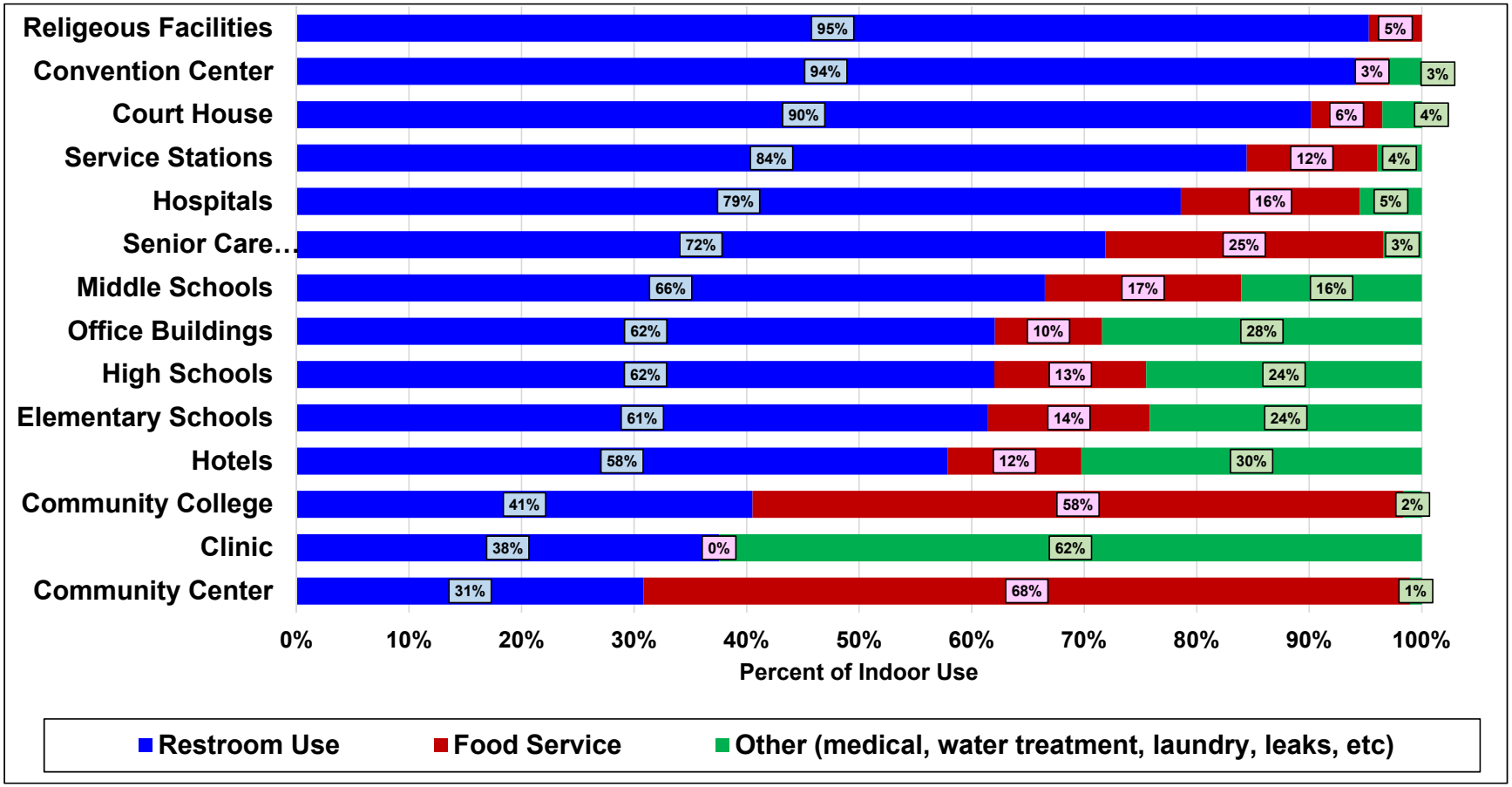


South & South West



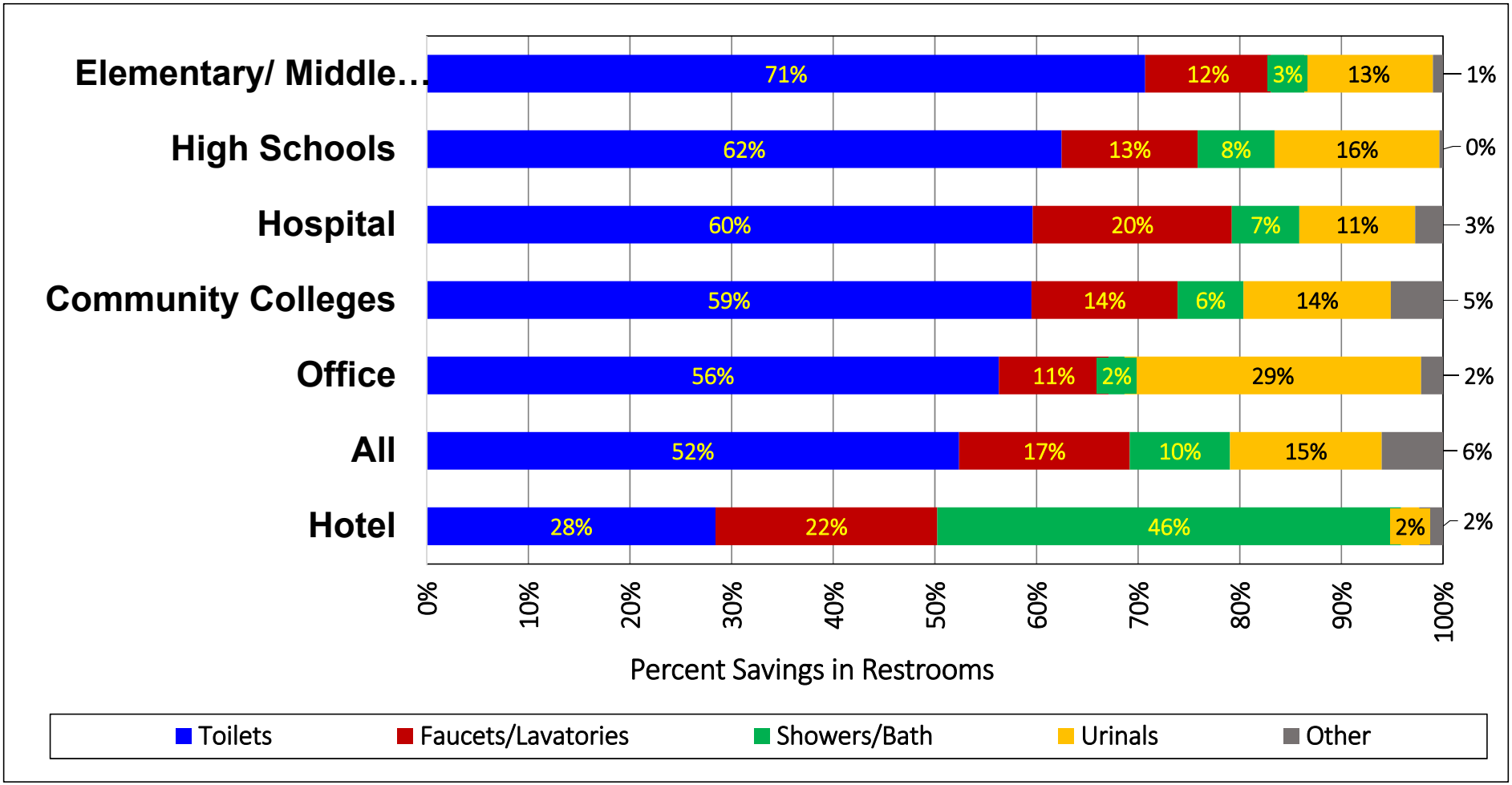
How Water Is Used *Indoors* at Audited Facilities

Special Study of Audits in Austin, Dallas, and Fort Worth

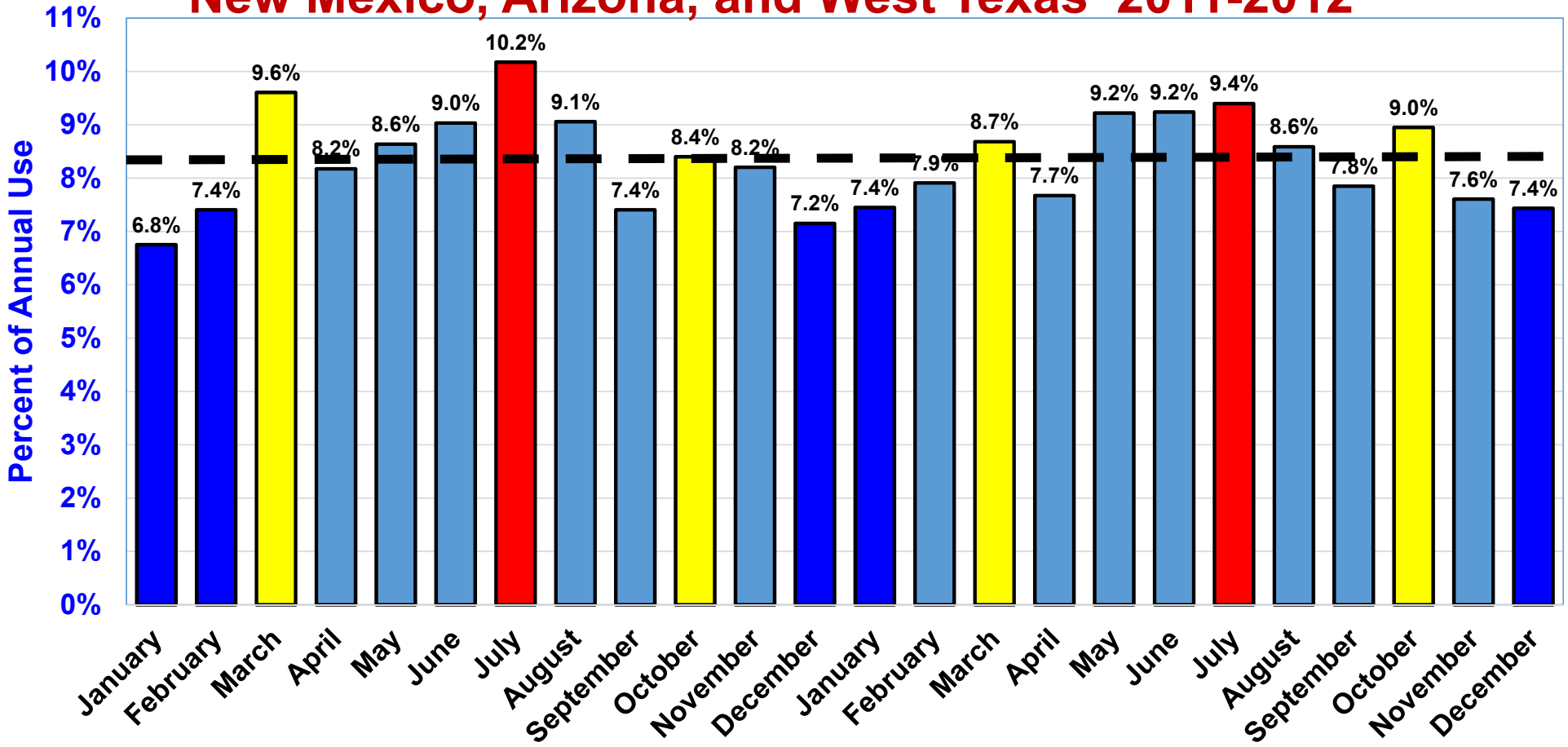


Percent Restroom Use by Type of Use

Special Study of Audits in Austin, Dallas, and Fort Worth

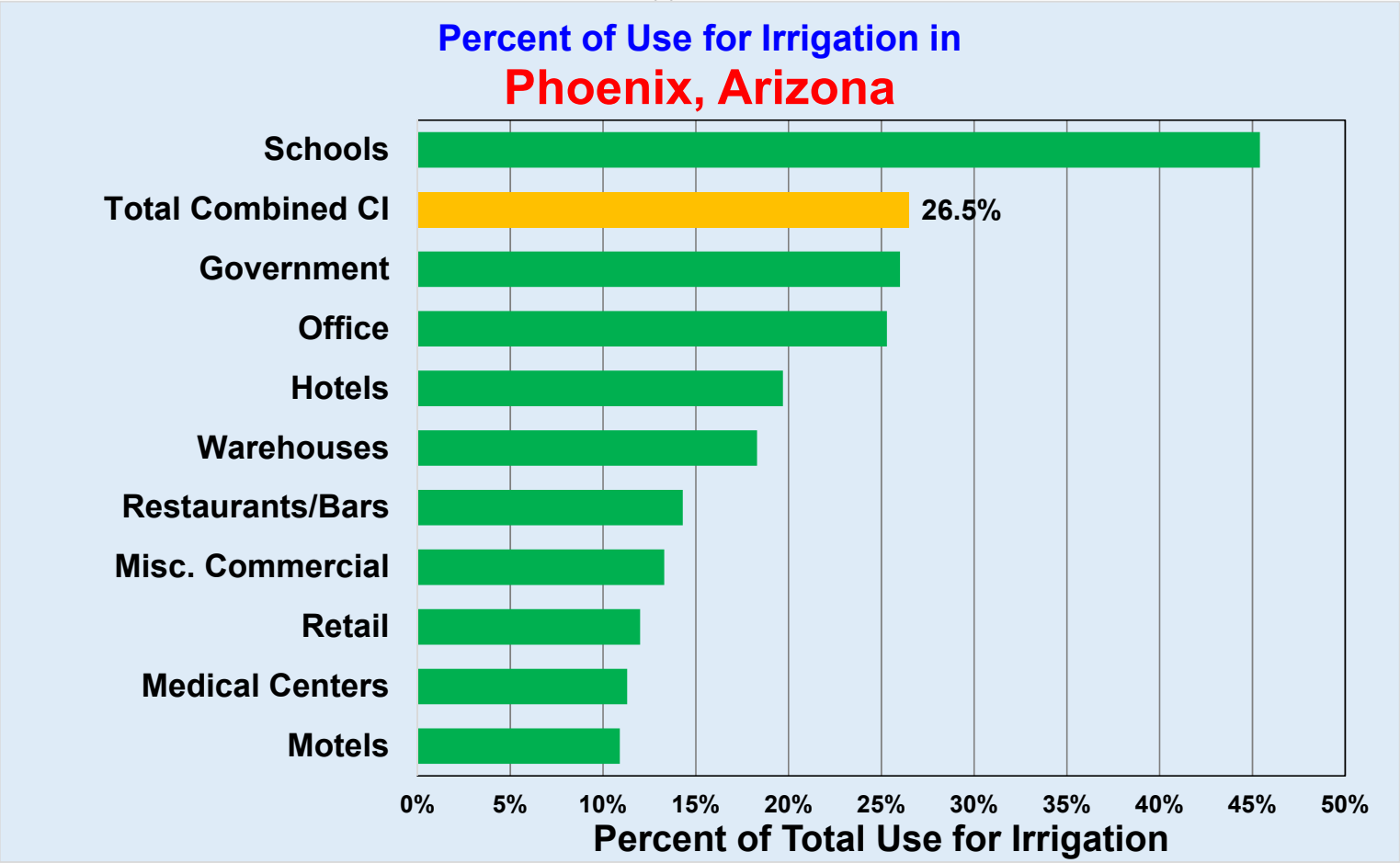


Monthly Percent of Annual Use for 15 Hotels In New Mexico, Arizona, and West Texas 2011-2012



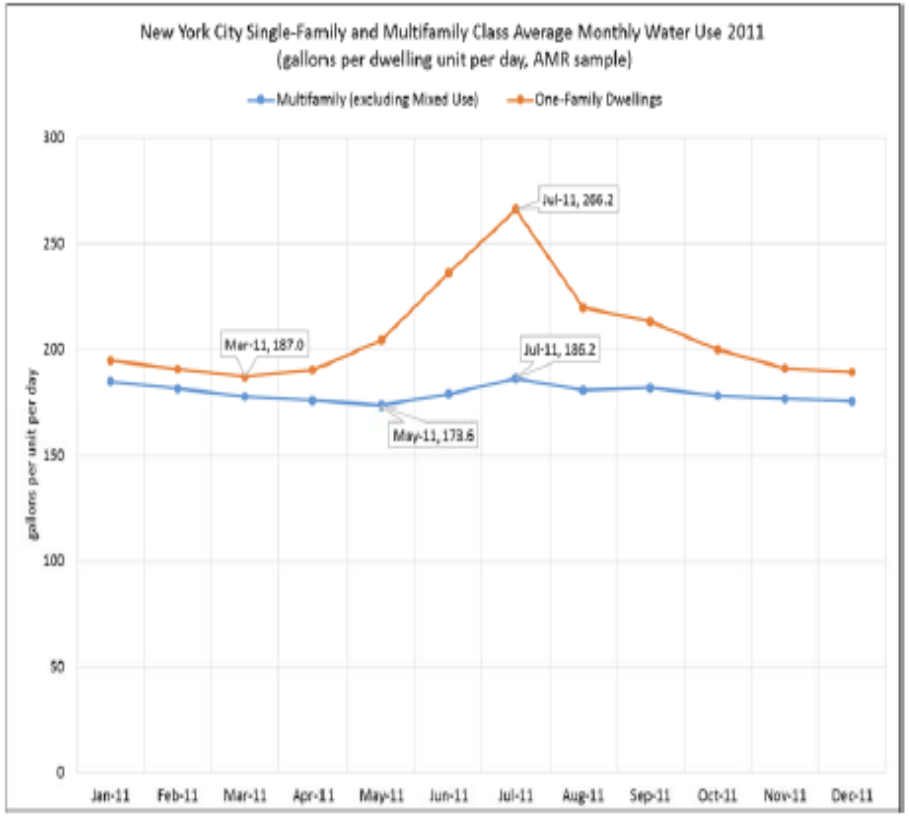
Commercial & Institutional Landscape use from ARID area

WRF 4375



Multi-Family Irrigation Use Low in These Cities

WRF 4554



igure 3.2 Monthly residential water use patterns for New York City

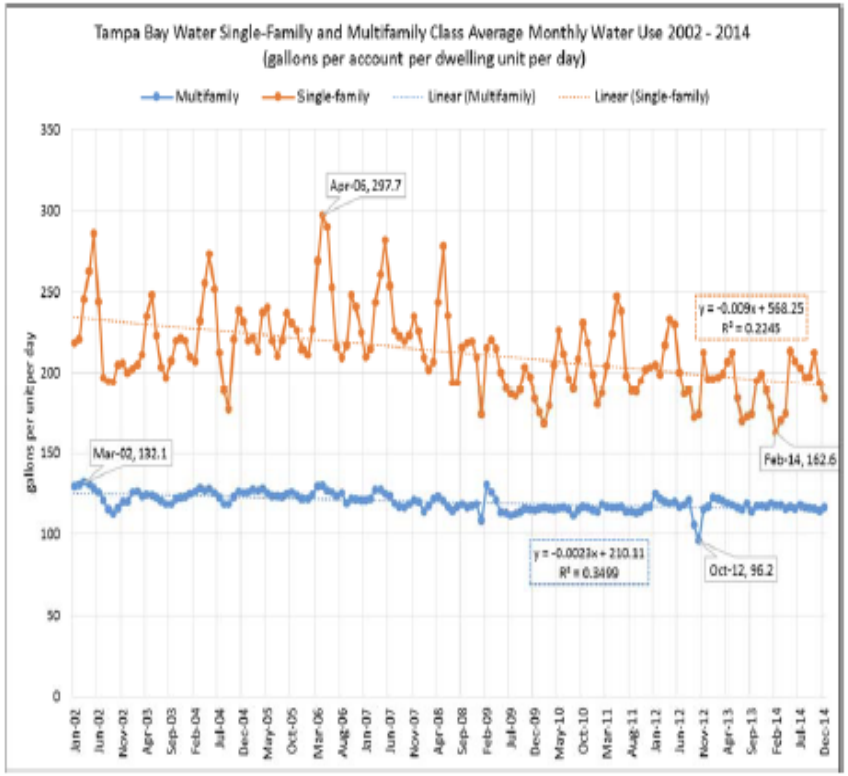


Figure 3.5 Monthly residential water use patterns for Tampa Bay Water

Multi-Family Irrigation Use High in These Cities

WRF 4554

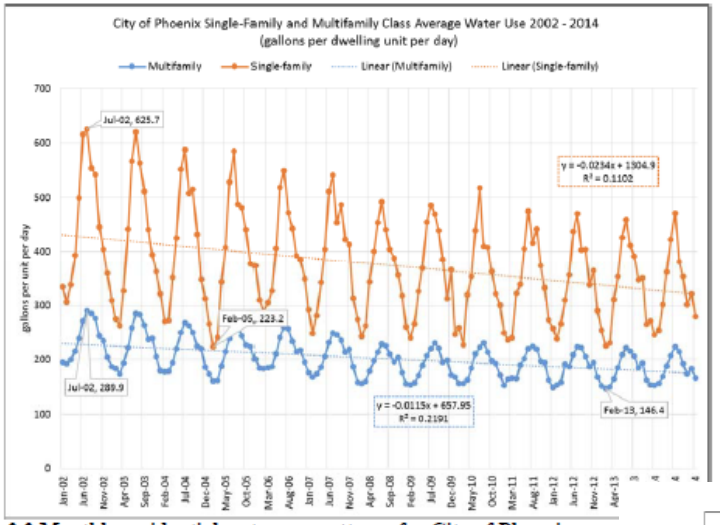


Figure 3.3 Monthly residential water use patterns for City of Phoenix

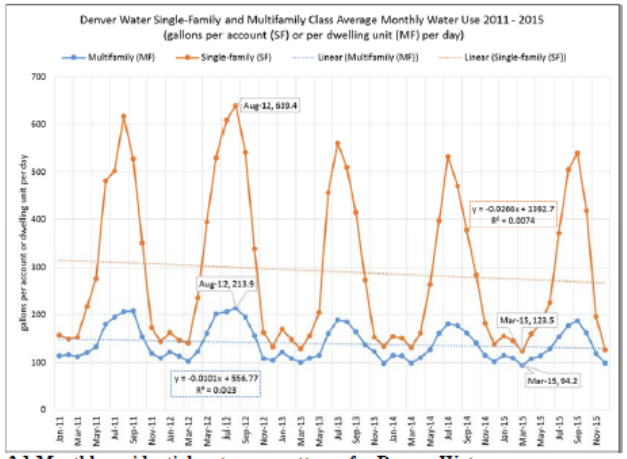


Figure 3.1 Monthly residential water use patterns for Denver Water

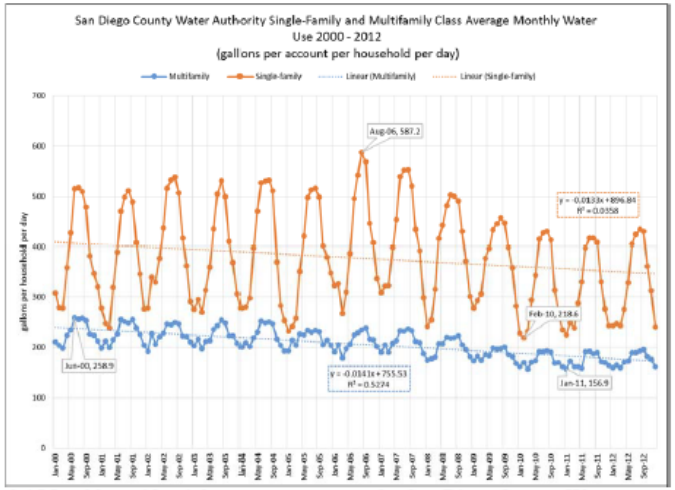


Figure 3.4 Monthly residential water use patterns for San Diego County Water Authority

Benchmarking

Major New Data Initiatives that will Impact ICI Use

- US EPA Energy Star Portfolio Manager data on commercial and institutional use,
- Better Buildings Challenge,
- 3050 District,
- Water Research Foundation studies,
- USGS data,
- Academic research,
- CBECS – commercial buildings energy consumption survey
- Many new local initiatives

What is Benchmarking?

- Benchmarking is comparing one's business processes and performance metrics to industry bests and best practices from other companies. *(From Wikipedia)*

- For water, this means dividing water use *(Numerator)* by some meaningful measure of the facility *(Denominator)* and then comparing that to other establishments of the same type.

- Welcome to the Denominator Dilemma!

Examples of Possible Denominators

Facility Type	Function Metric	Facility Metric	Other People Metrics
Hotel	Guests	Rooms, Square Feet	Employees
Hospital	Patients, Discharges, Out-Patients, Patient Nights	Beds, Square Feet	Employees
School	Students	Square Feet	Faculty, Staff
Restaurant	Meals Served, Covers (tickets) People Served	Number of Seats, Square Feet	Employees
Office	Employees, Visitors	Square Feet	
Retirement Home	Residents	Rooms, Beds, Square Feet	Employees
Commercial Laundries	Pounds of Laundry	Washer Capacity, Square Feet	Employees
Multi-Family	Number of Residents	Dwelling Units, Square Feet	
Automotive Shop	Vehicles Serviced	Square Feet, Number of Bays	Employees
Manufacturing	Units of Product Produced, Dollars Produced	Square Feet, Number of Pieces of Equipment	Employees

Time Metric

- Year
- Month
- Week
- Day
- Hour

Examples of information in the 2009 Water Use in Santa Fe Report

file:///C:/Users/user/Downloads/Water_Use_in_Santa_Fe_2009%20(1).pdf

Use is in *Acre Feet per Year*

Schools - Middle	1998/99		2007/08		2008/09	
Alameda Junior High/	# students	use/100 students	# students	use/100 students	# students	use/100 students
Carlos Gilbert	484	2.80	475	1.90	475	1.71
Capshaw Junior High	512	3.80	450	1.85	450	2.33
De Vargas Junior High	535	3.40	535	0.43	535	0.26
Ortiz Middle School	581	2.90	545	2.67	580	2.28
Average		**3.23**		**1.71**		**1.64**
2007/2008 Average			**1.68**			

What you divide by makes a huge difference

- **Middle schools average 1.68 acre feet per year per 100 students.** *(5,474 gallons per year per 100 per student)*

- **If divided by 365 days a year, gallons per student per day = 15.0 gal/student/day.**

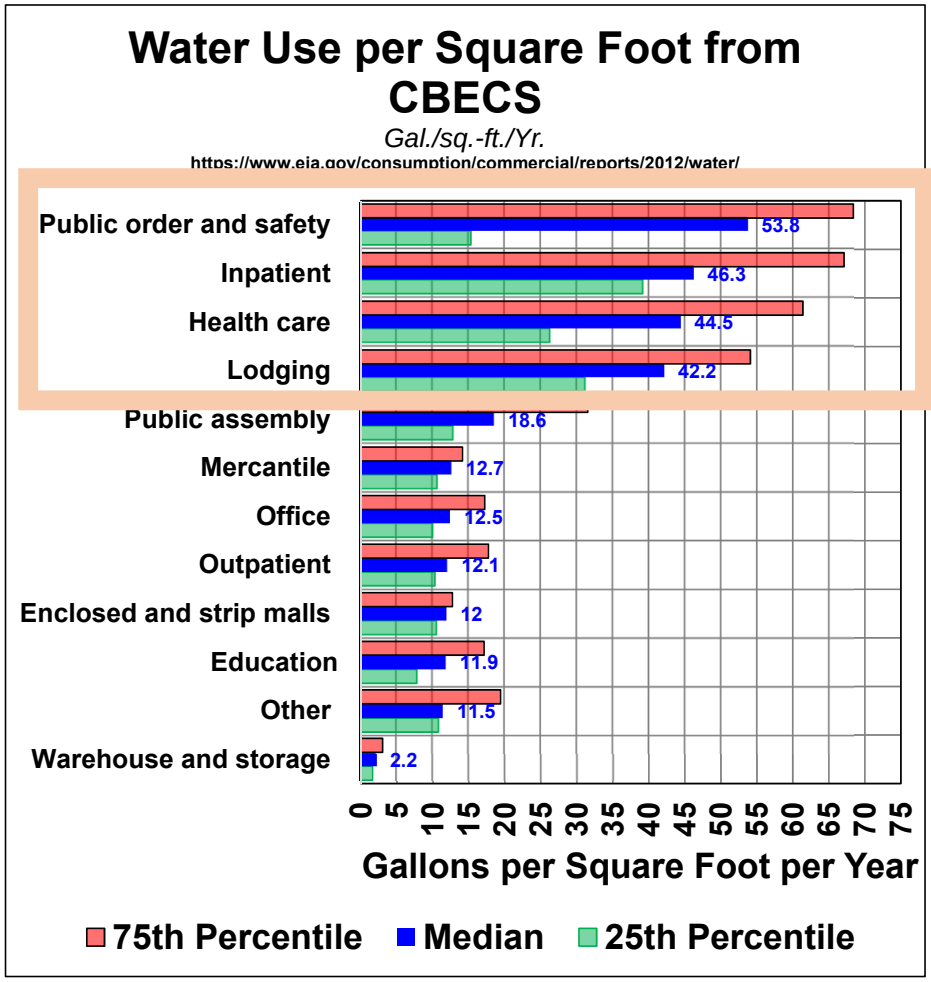
- **However, students are only at school about 185 days a year. Based on 185 days per year, per capita student use = 29.6 gal/student/day.**

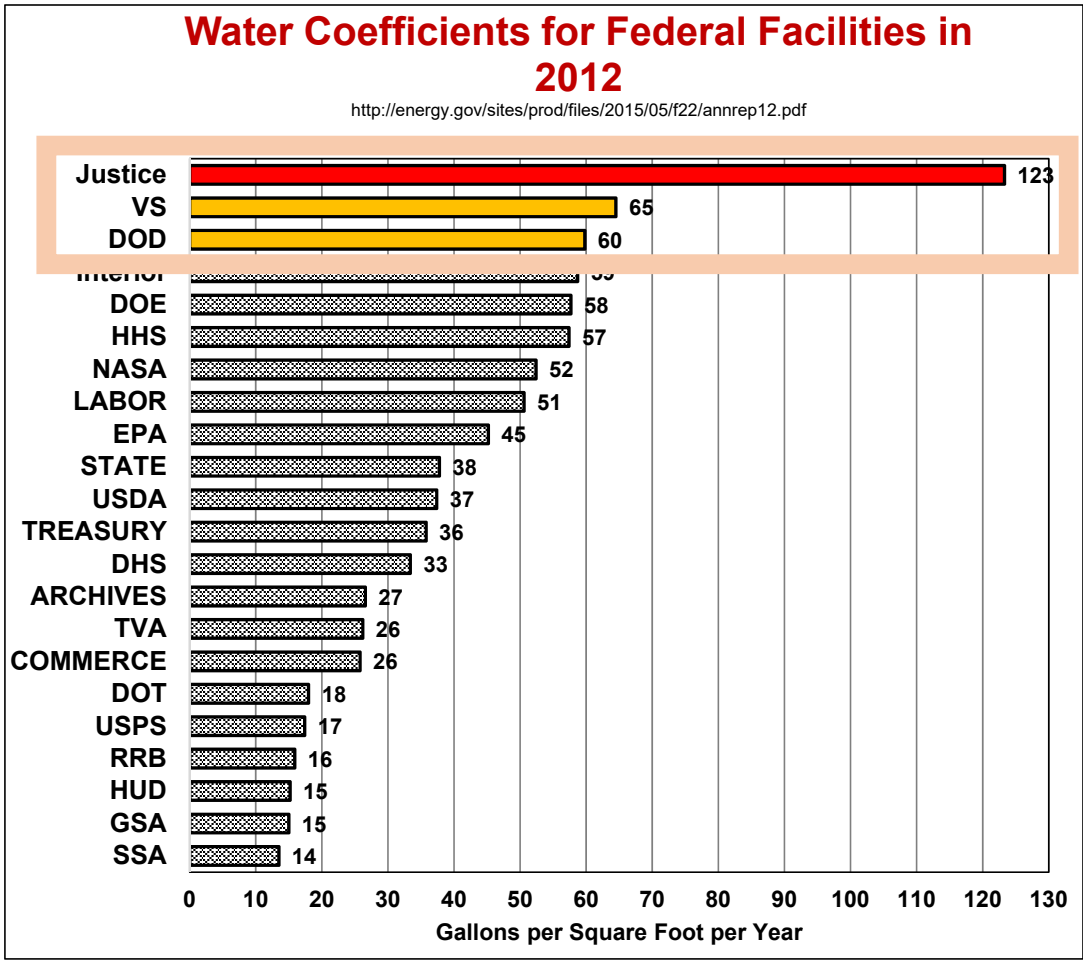
Summary of 13 Studies Reporting Water Use by Gallons per Square Foot of Space per Year

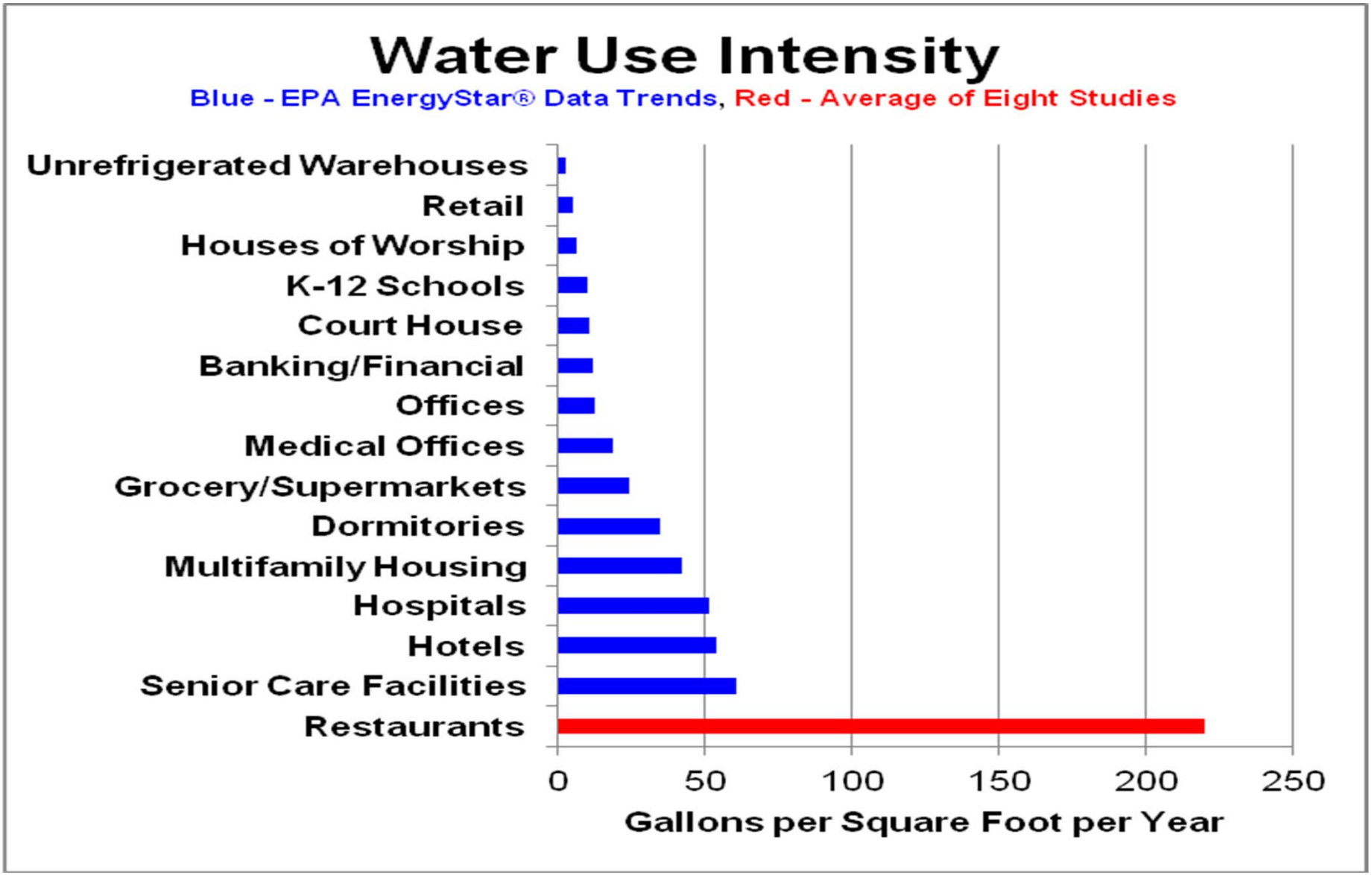
Median or Mean as reported

Type of Facility	EPA Portfolio Manager[1]	University of Florida[2]	Santa Fe, New Mexico[3]	Colorado Water Wise - Brendle Group.[4]	Water Research Foundation End Use Study 2000[5]	Austin 2013[6]	Boston Benchmark Law 77 2015[7]	New York Benchmark Law[8]	Washington DC Bench - mark Law[9]	Philadelphia Benchmark Law[10]	Minneapolis Benchmark Law[11]	WRF Report 375 2015 – Tampa[12]	WRF Report 375 2015 – Austin[12]
	Gallons per Square Foot of Heated Space per Year												
Restaurants		221		173 to 211	130 to 330	215							
Senior Care Facilities	61	106		62 to 101				86					
Hotels	54	85		79 to 165	60 to115	72	55	71	55	100		62	75
Hospitals	51	31				58				68			
Grocery/ Supermarkets	24	95	36		52to 64					24			
Medical Offices	19	34	49					33		35			
Offices	13	20	26		9 to 15		12	13	15	17	11		
Banking/ Financial	12	89											
Court House	11												
K-12 Schools	10	20		12 to 19	8 to 16			7	10	13			
Houses of Worship	7	15								11			
Retail/ Shopping Centers	5	32	20					10		16			
Unrefrigerated Warehouses	4	8						3	2	4			
Colleges/ Universities							23	14	24	75			
Residence Halls/ Dormitories							31	50	41				
Multi-Family							35	54	40				

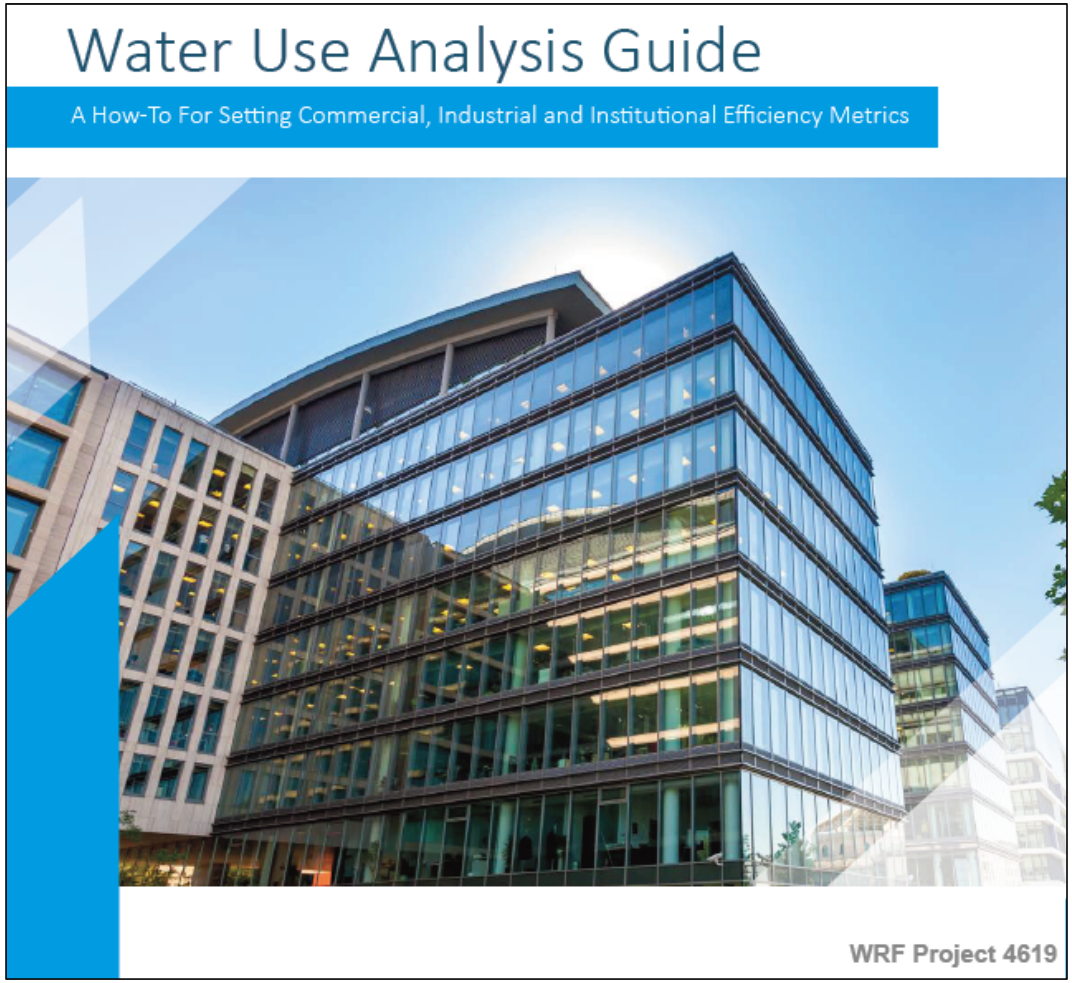
CBECS and Energy Star Data



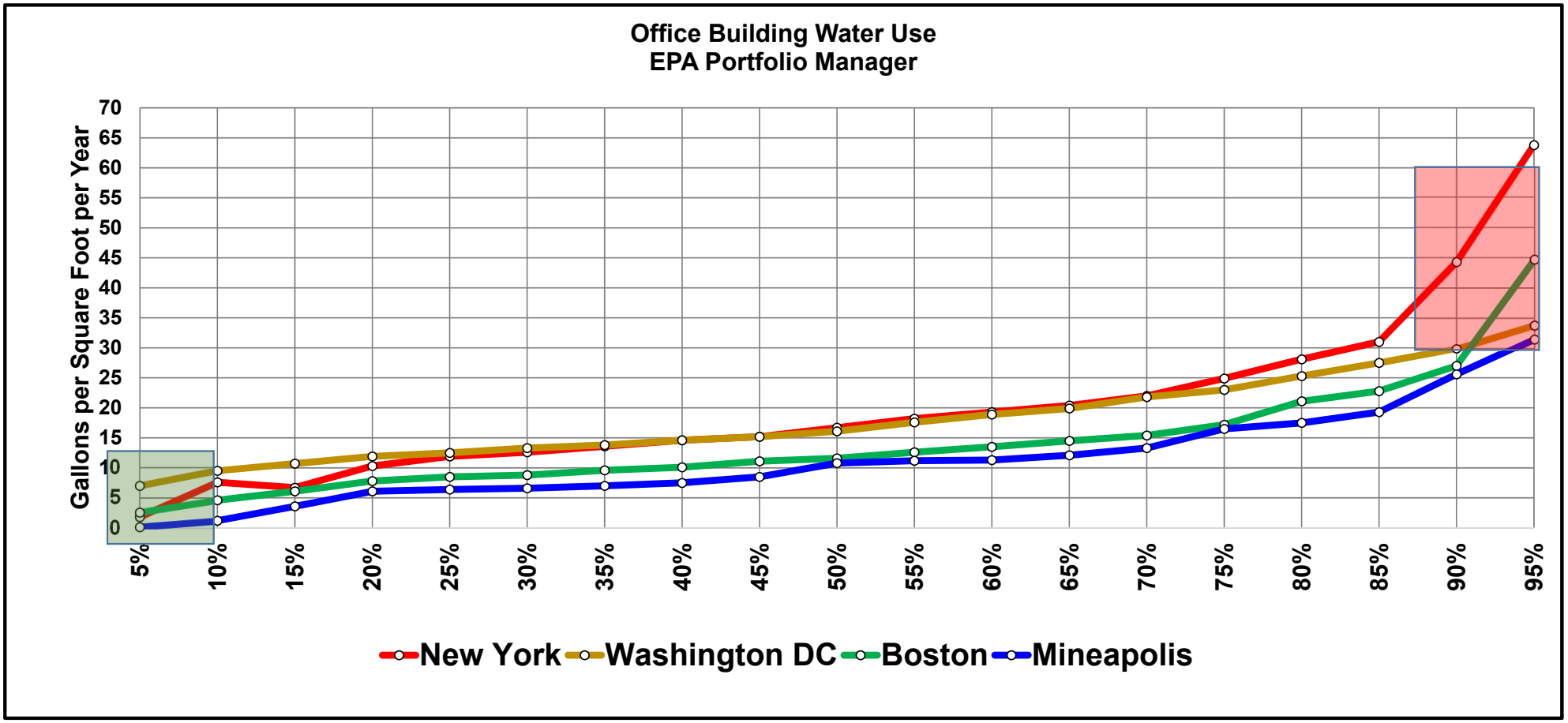


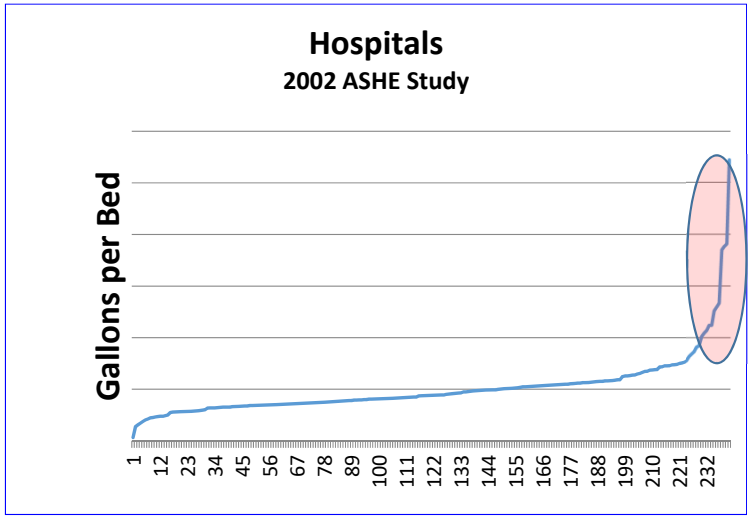

Water Use Intensity
Blue - EPA EnergyStar® Data Trends, Red - Average of Eight Studies
Unrefrigerated Warehouses
Retail
Houses of Worship
K-12 Schools
Court House
Banking/Financial
Offices
Medical Offices
Grocery/Supermarkets
Dormitories
Multifamily Housing
Hospitals
Hotels
Senior Care Facilities
Restaurants
0
50
100
150
200
250
Gallons per Square Foot per Year

WRF # 4619 Report
Will Be Available Later This Year

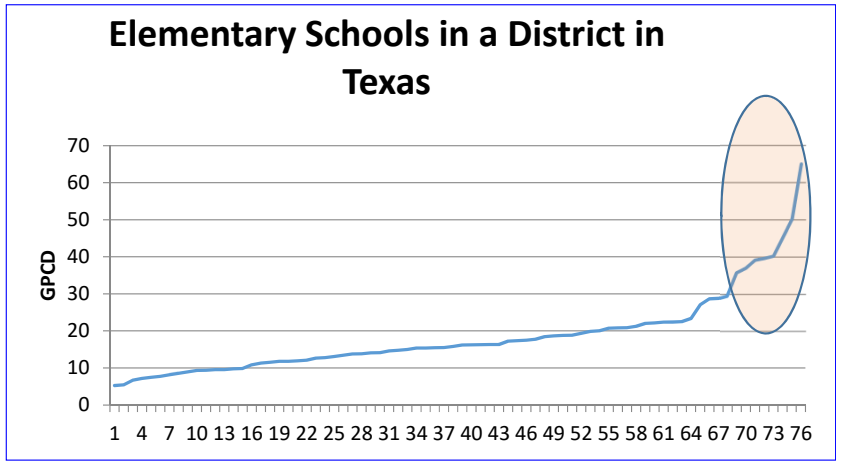


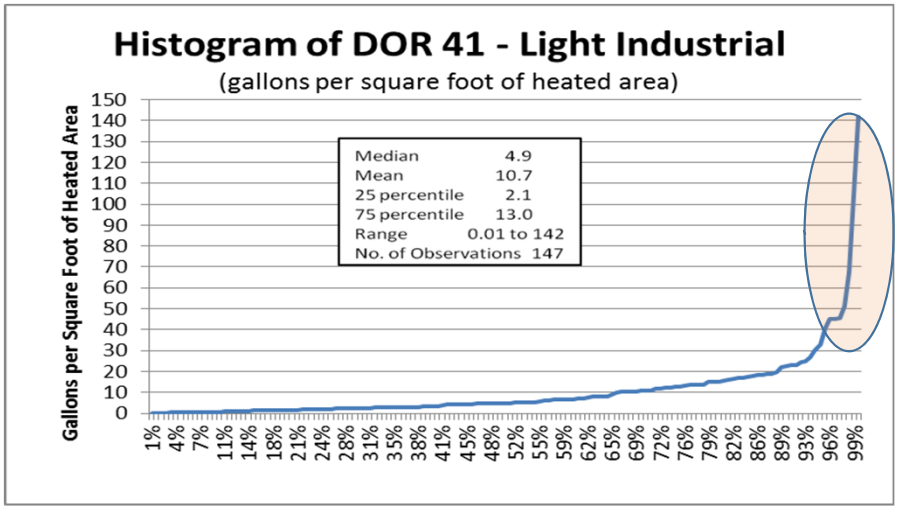
Same Cities Without High and Low Data





Do You see the same Pattern Here?





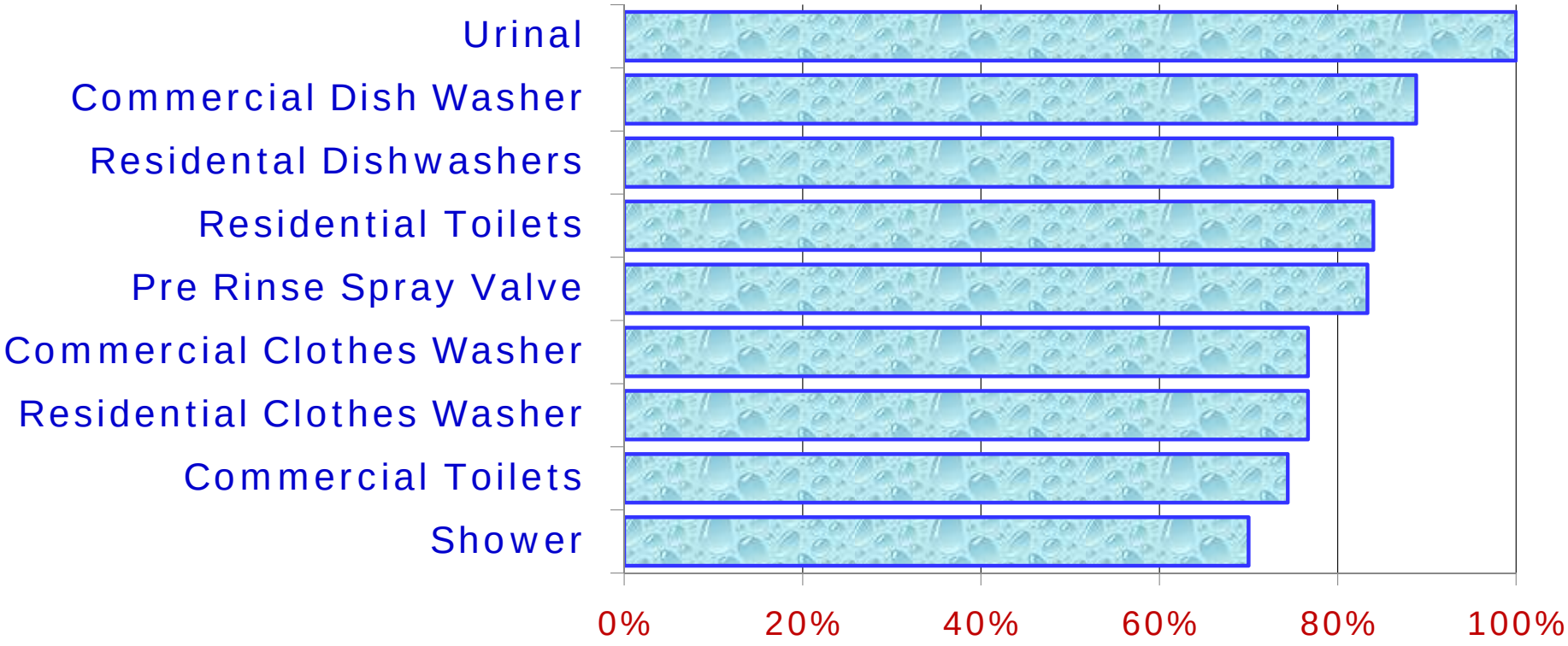
Codes, Standards, and Regulations

Major Regulatory Code, and Standards Developments

- ❑WE – STAND
- ❑Green Building initiatives (LEED, GB, etc.)
- ❑Other code and standard development
  - ASHRAE 189.1
  - ASHRAE 191.P`
  - IGCC
- ❑Texas, California, Georgia, and New York plumbing requirement
- ❑EPA Appliance and Equipment Standards *(Energy Star and Water Sense)*
- ❑New DOE requirements

How has new technology helped?

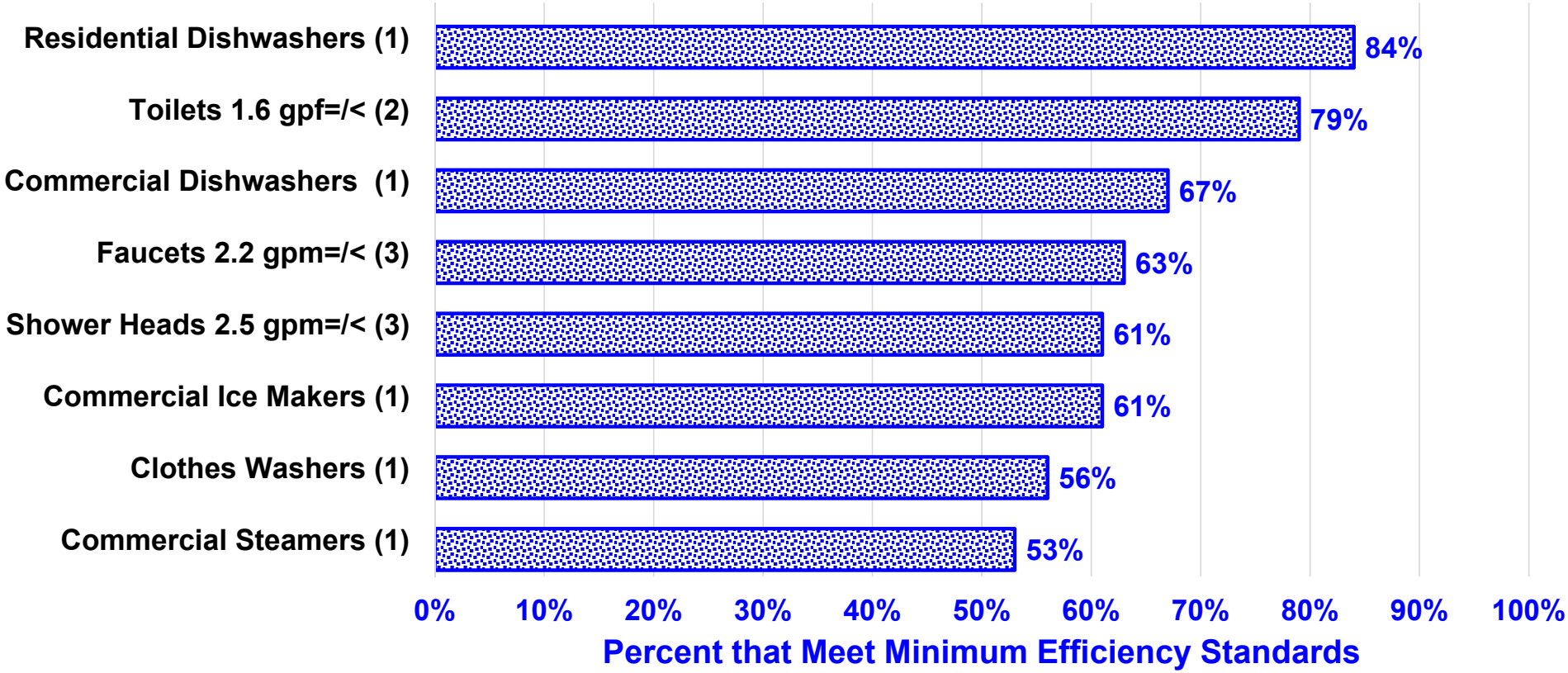
Reduction in Water Use Since 1980



Percent Reduction in Use for *Best in Class*

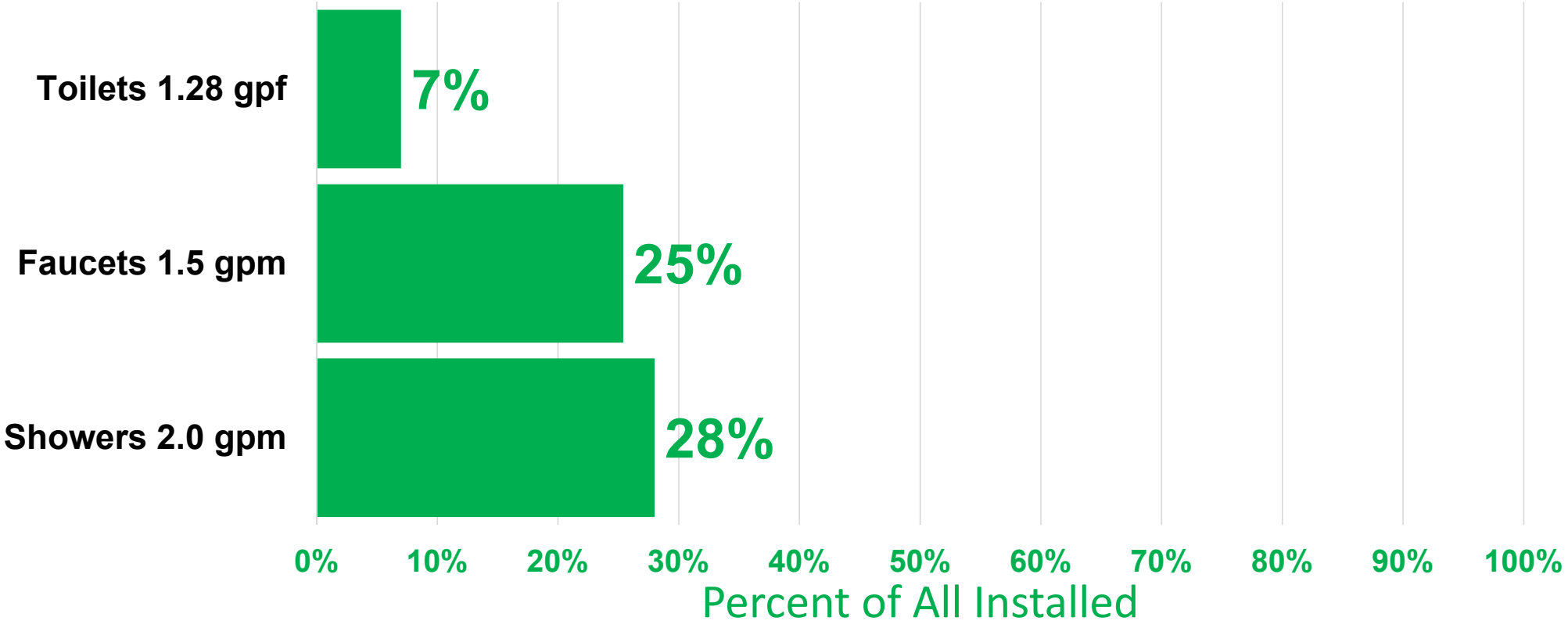
Market Penetration of *Minimally Acceptable* Water Saving Fixtures and Appliances

(1) Energy Star Market Penetration Study - 2015
(2) US Market Penetration Of WaterSense Shower Heads, Lavatory Faucets And Toilets - 2015
(3) A Saturation Study of Non-Efficient



WaterSense Residential Fixture Market Penetration as of ***2015***

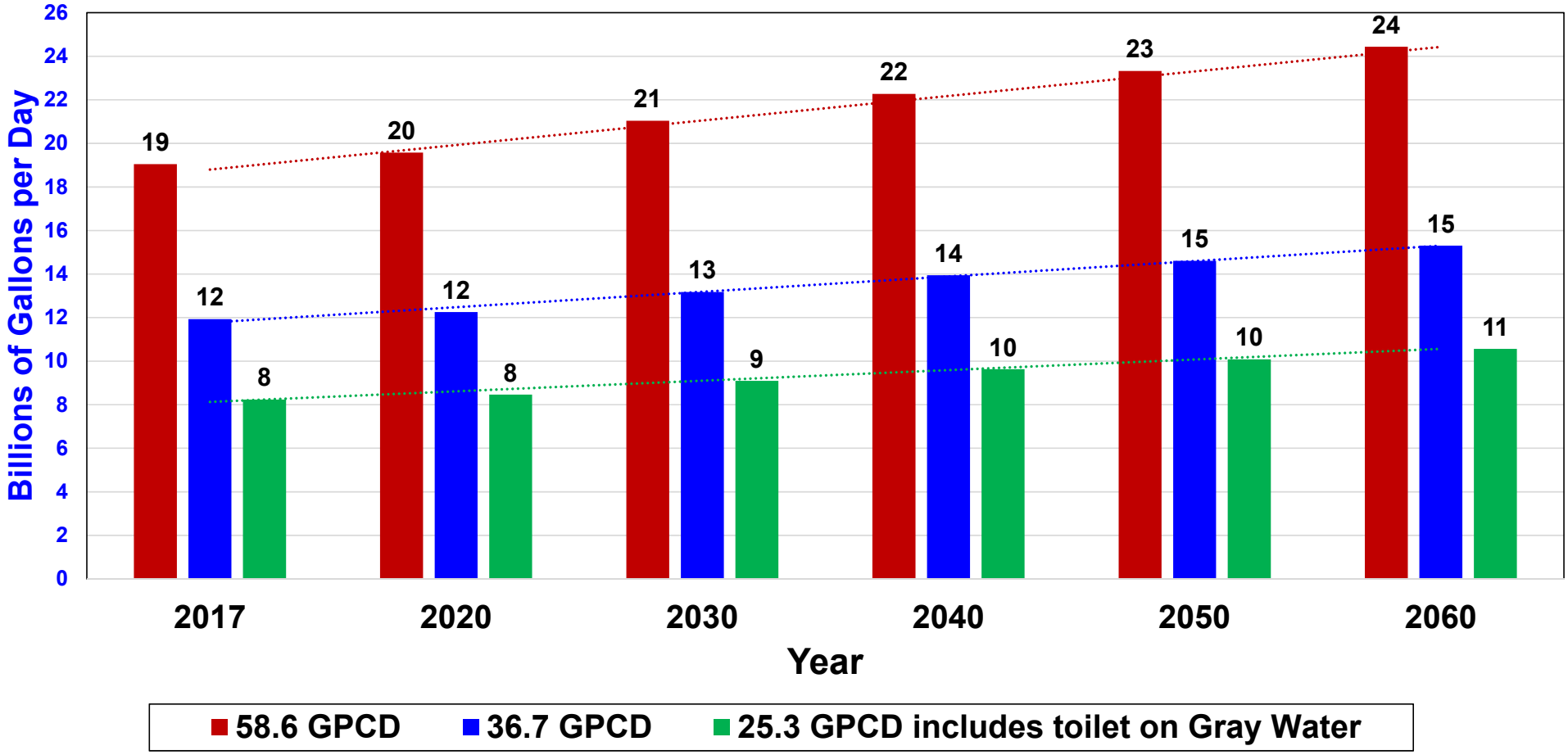
We still have a long way to go!



Hey, I don’t make this stuff up!

Indoor Residential Use in USA

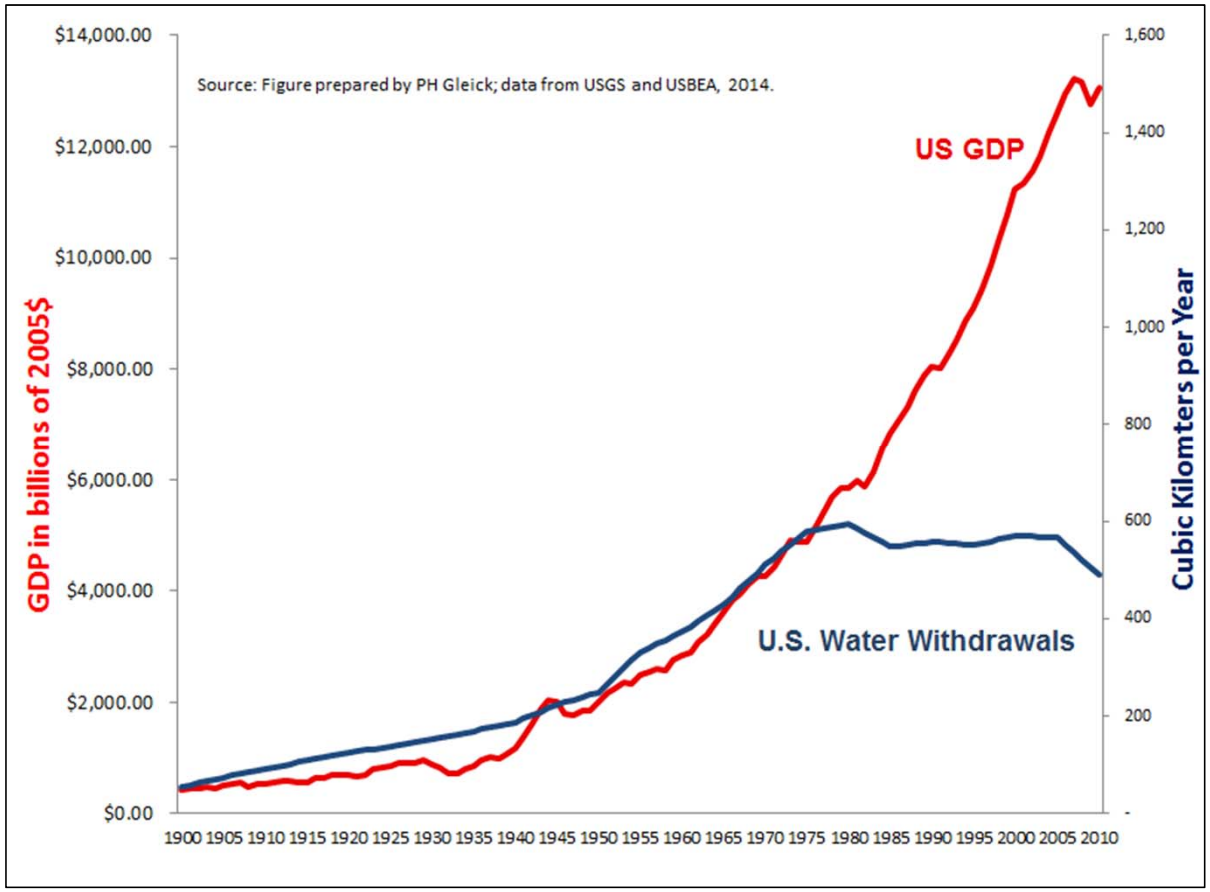
Aquacraft & H.W (Bill) Hoffman & Associates, LLC



Trends

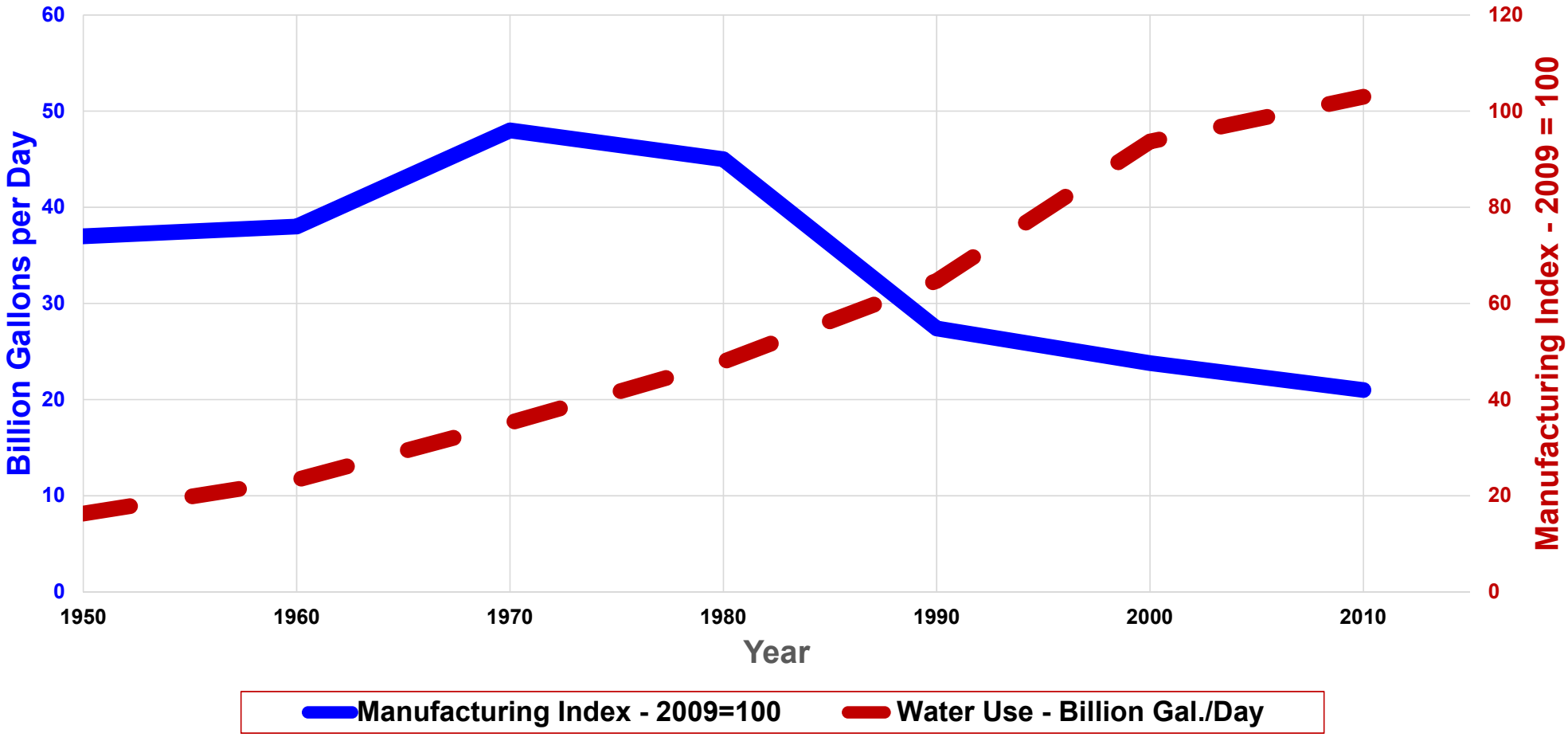
Post Clean Water Act of 1972 Impact on Industrial Water Use

The single most important pivot point was the Clean Water Act

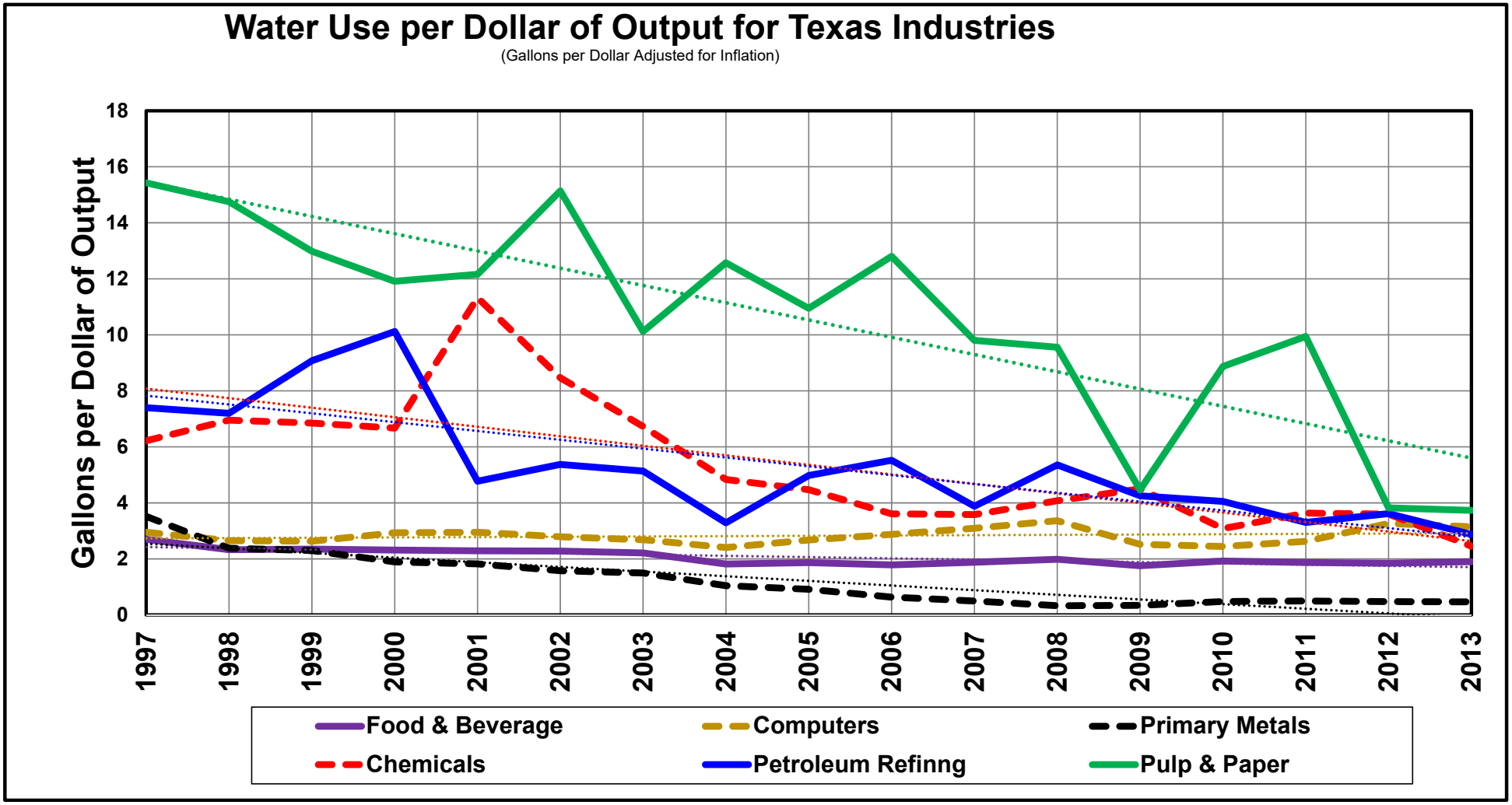


Manufacturing Index vs Water Use in USA

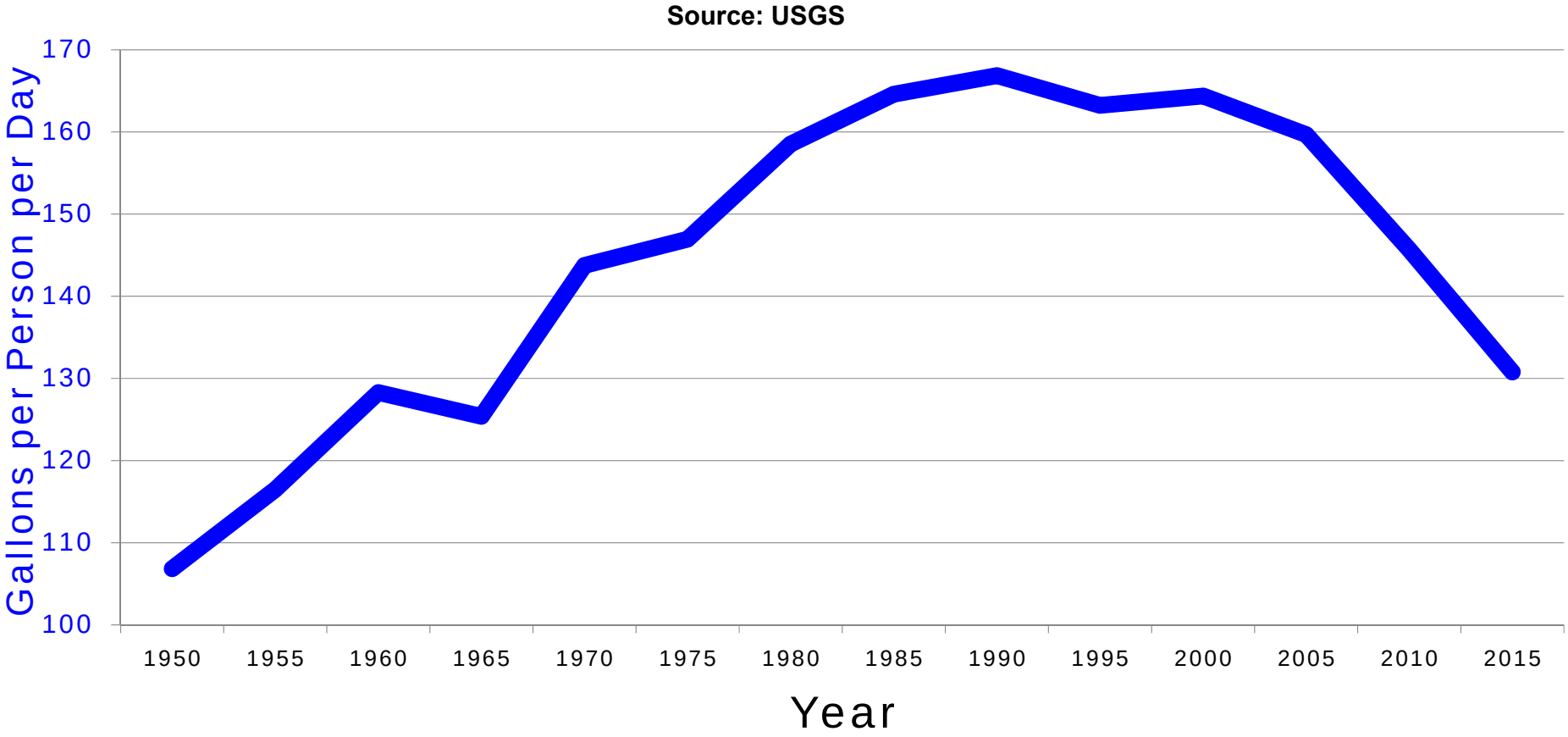
Sources: USGS & Dept. of Commerce

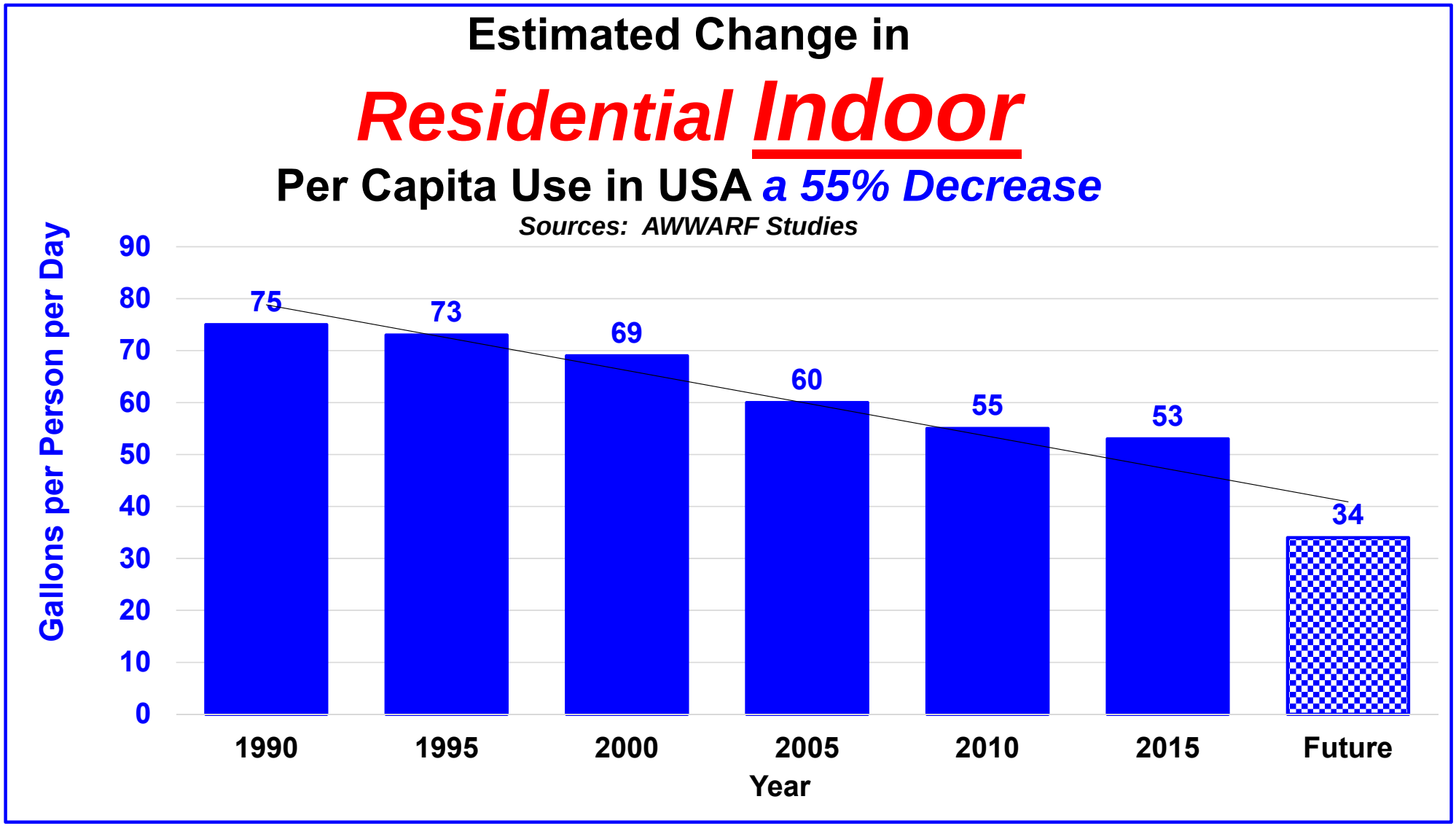


Examples of Trend Benchmarking for Industry



Per Capita Water Use in USA



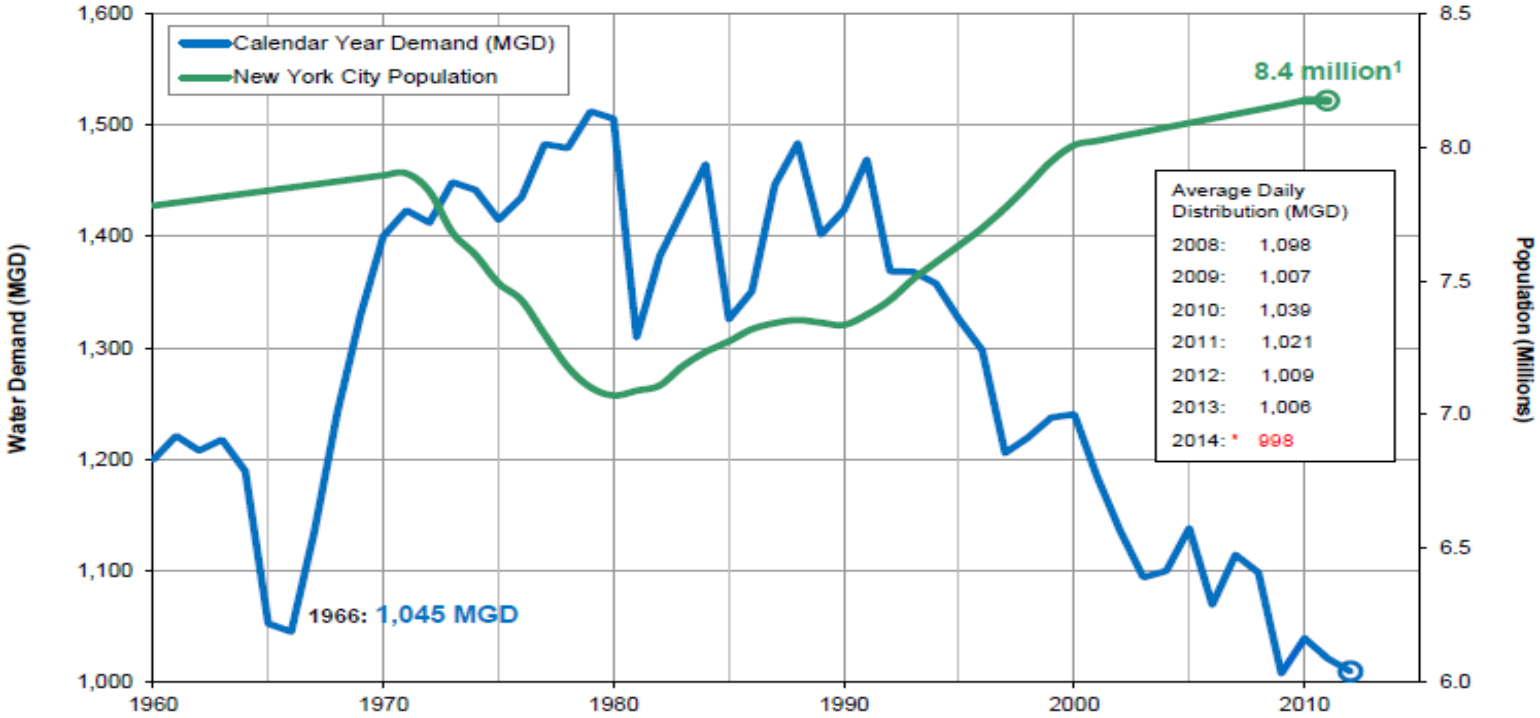

Estimated Change in
Residential Indoor
Per Capita Use in USA a 55% Decrease
Sources: AWWARF Studies
Gallons per Person per Day
90
80
70
60
50
40
30
20
10
0
75
73
69
60
55
53
34
1990
1995
2000
2005
2010
2015
Future
Year

New York City

Source: Vlada Kenniff

Historical Water Demand & Population

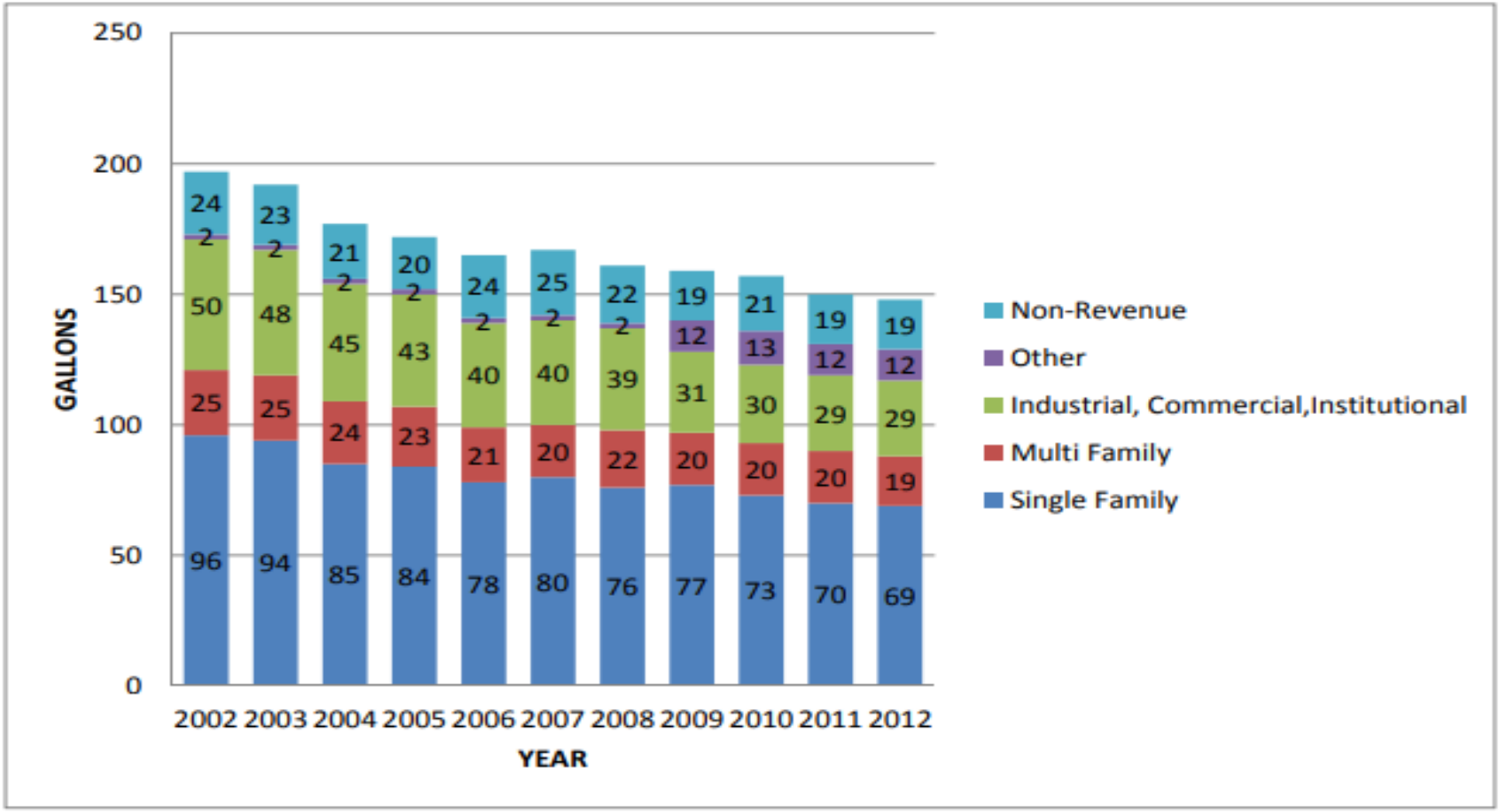
- Distribution has declined approximately 30% since the early 1990s – despite increasing population
- Since 2009, water usage has been below the 1960s drought-of-record

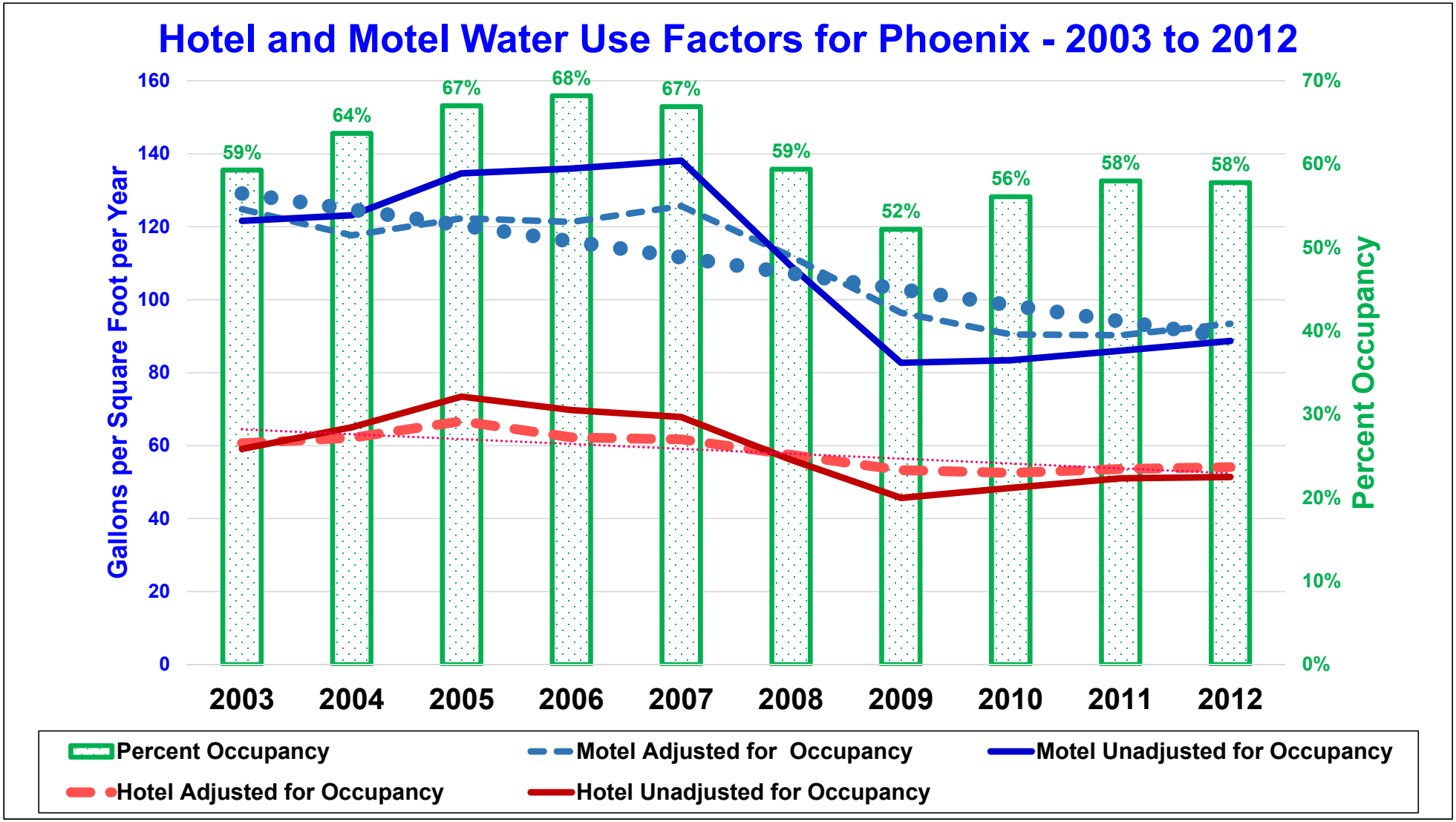


1 Official 2013 New York City Department of City Planning Estimate.

Albuquerque Bernalillo County Water Utility Authority

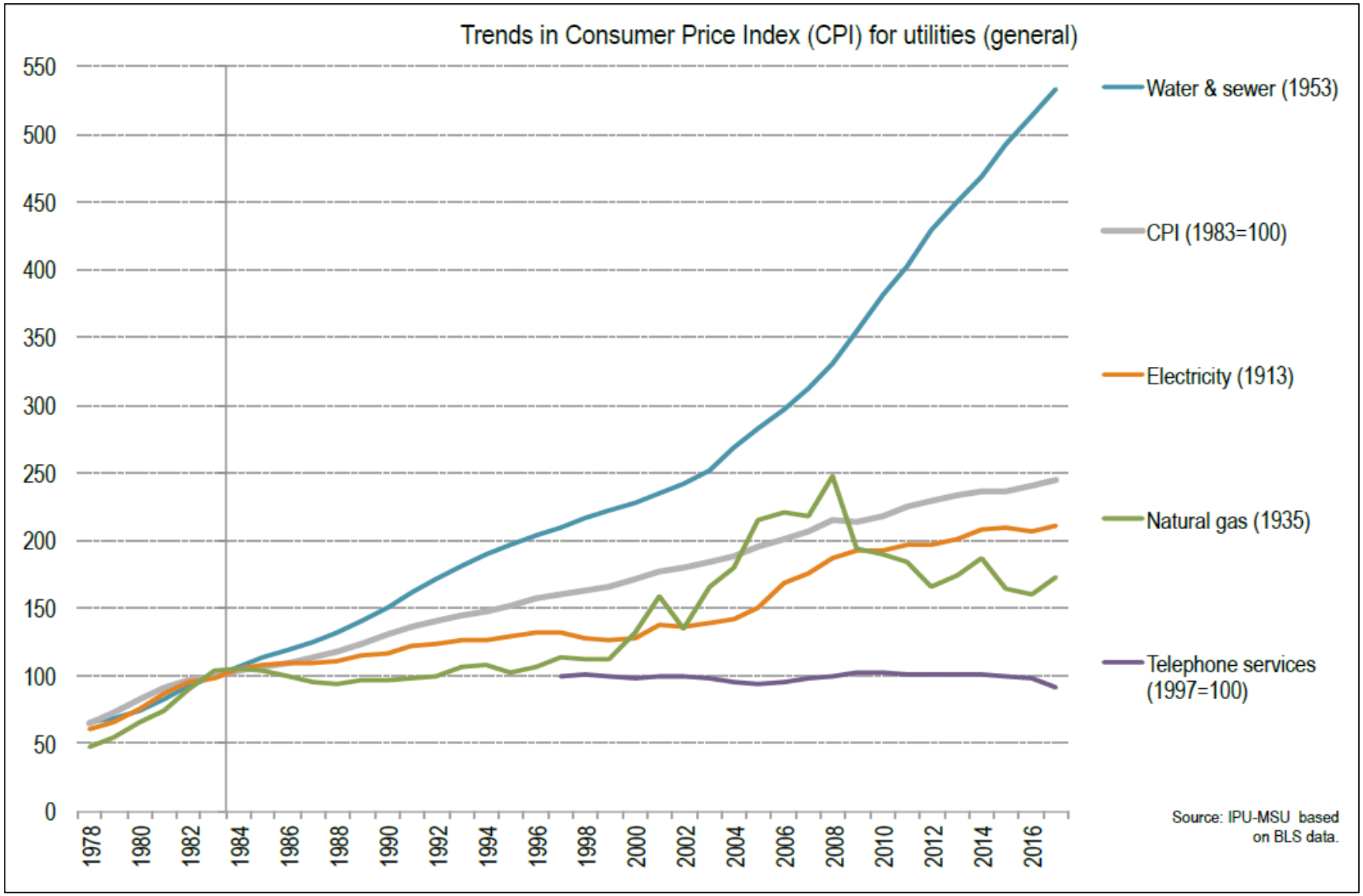
Figure 5 – GPCD Allocated by Customer Class 2002-2012




Hotel and Motel Water Use Factors for Phoenix - 2003 to 2012
Gallons per Square Foot per Year
Percent Occupancy
160
140
120
100
80
60
40
20
0
70%
60%
50%
40%
30%
20%
10%
0%
59%
64%
67%
68%
67%
59%
52%
56%
58%
58%
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
Percent Occupancy
Motel Adjusted for Occupancy
Motel Unadjusted for Occupancy
Hotel Adjusted for Occupancy
Hotel Unadjusted for Occupancy

Five Future Driving Forces for ICI

1. Rising Cost of Water and Wastewater
2. Codes, Standards, and Regulations
3. Technical Advances
4. Going Green
5. Future Regional Water Shortages


Trends in Consumer Price Index (CPI) for utilities (general)
550
500
450
400
350
300
250
200
150
100
50
0
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
Water & sewer (1953)
CPI (1983=100)
Electricity (1913)
Natural gas (1935)
Telephone services (1997=100)
Source: IPU-MSU based on BLS data.

The Cost of One Toilet Flush

Cost to Flush a Toilet at Current Inflation Rate of 5.85%		
Gallons per Flush	Cents per Flush in 2017	Cents per Flush in 2037
5	5.6	17.6
3.5	3.9	12.3
1.6	1.8	5.6
1.28	1.4	4.5

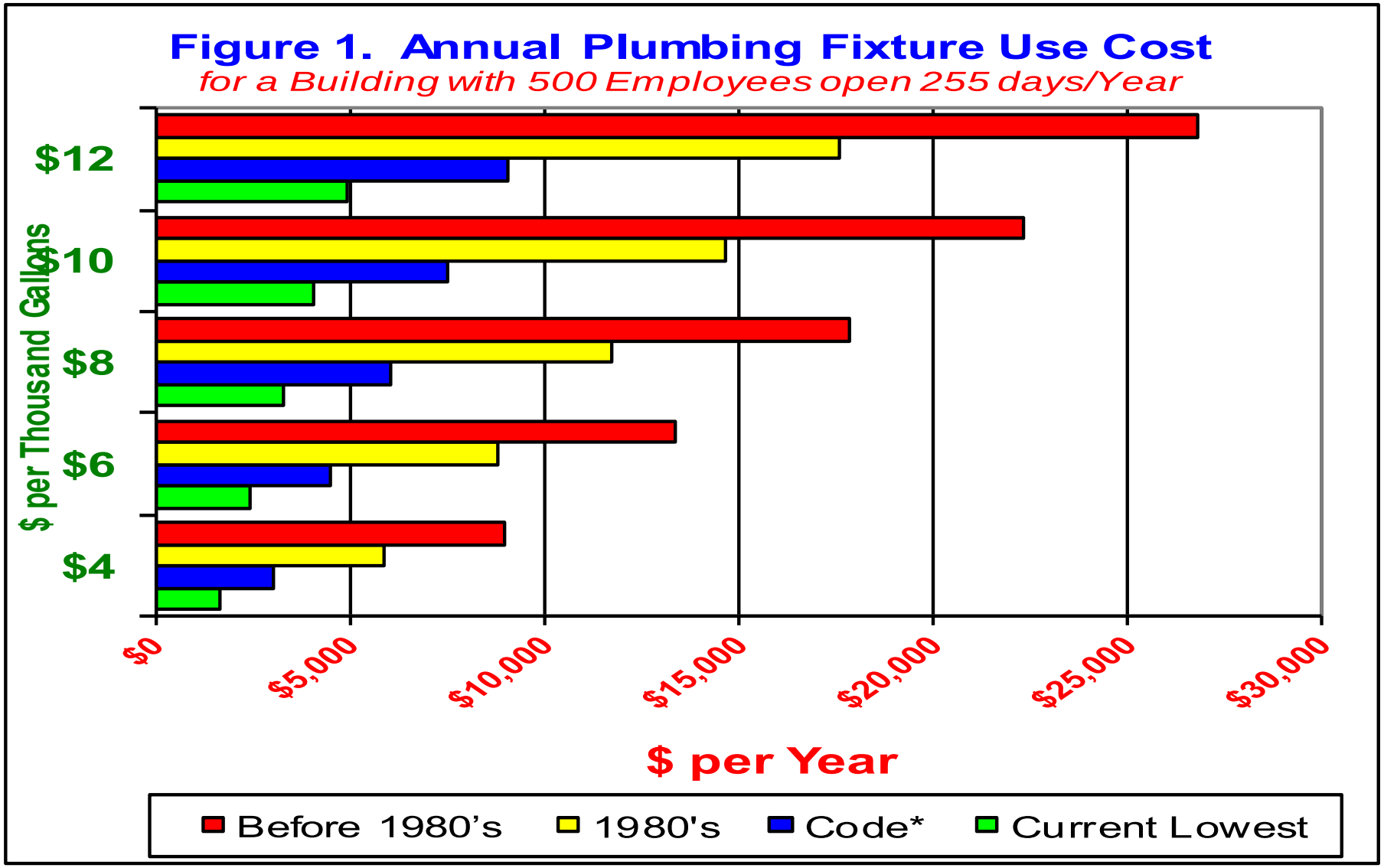


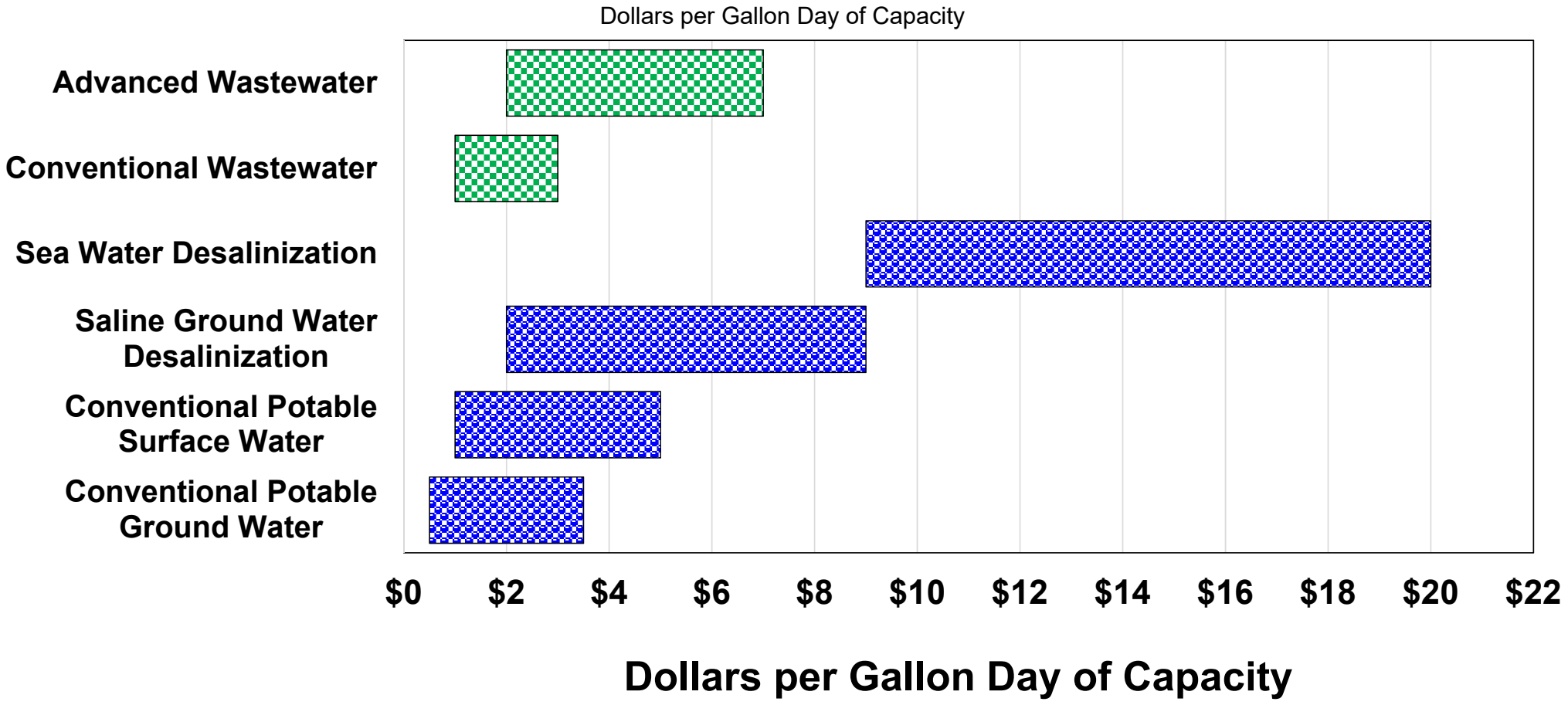
Figure 1. Annual Plumbing Fixture Use Cost
for a Building with 500 Employees open 255 days/Year
$ per Thousand Gallons
$12
$10
$8
$6
$4
$0
$5,000
$10,000
$15,000
$20,000
$25,000
$30,000
$ per Year
Before 1980's
1980's
Code*
Current Lowest

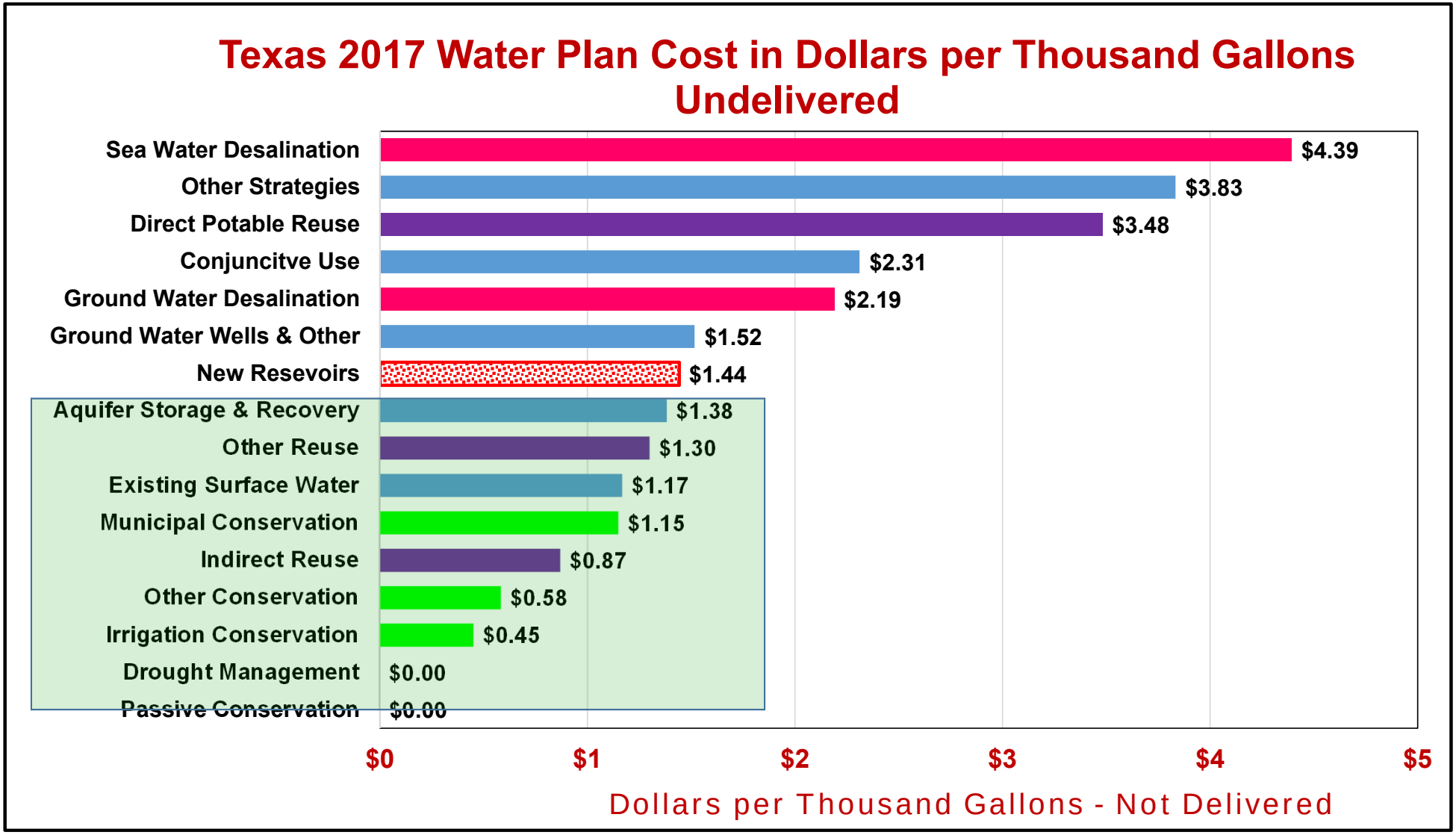
Equipment Life Utility Cost Comparisons

For the Toilet Replacement Example

Year	Water & Sewer Rate per Thousand Gallons	Toilet Savings per Year
2016	$11.27	$214.54
2017	$11.93	$227.09
2018	$12.63	$240.38
2019	$13.37	$254.44
2020	$14.15	$269.32
2021	$14.98	$285.08
2022	$15.85	$301.76
2023	$16.78	$319.41
2024	$17.76	$338.09
2025	$18.80	$357.87
2026	$19.90	$378.81
2027	$21.06	$400.97
2028	$22.30	$424.43
2029	$23.60	$449.25
2030	$24.98	$475.54
2031	$26.44	$503.35
2032	$27.99	$532.80
2033	$29.63	$563.97
2034	$31.36	$596.96
2035	$33.19	$631.88
2036	$35.14	$668.85
2037	$37.19	$707.98
2038	$39.37	$749.39
2039	$41.67	$793.23
2040	$44.11	$839.64
25 Year Total Savings		**$11,525.04**

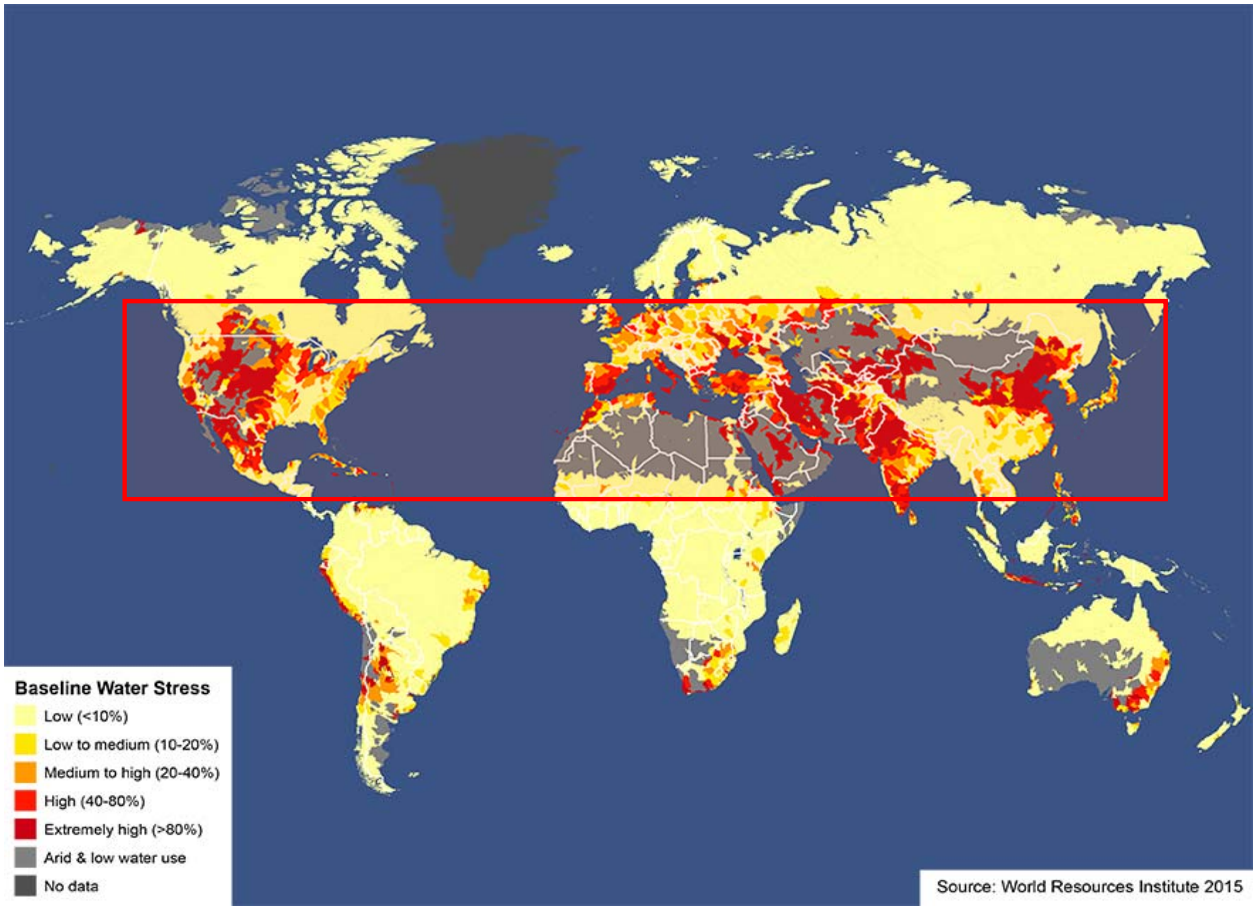
Capital Cost for Water & Wastewater Treatment Facilities




Texas 2017 Water Plan Cost in Dollars per Thousand Gallons Undelivered
Sea Water Desalination
$4.39
Other Strategies
$3.83
Direct Potable Reuse
$3.48
Conjuncitve Use
$2.31
Ground Water Desalination
$2.19
Ground Water Wells & Other
$1.52
New Resevoirs
$1.44
Aquifer Storage & Recovery
$1.38
Other Reuse
$1.30
Existing Surface Water
$1.17
Municipal Conservation
$1.15
Indirect Reuse
$0.87
Other Conservation
$0.58
Irrigation Conservation
$0.45
Drought Management
$0.00
Passive Conservation
$0.00
$0
$1
$2
$3
$4
$5
Dollars per Thousand Gallons - Not Delivered

Water Stress Index

And the latitude of stress.



Map of United States Showing Cumulative Groundwater Decline

Source: USGS, Konikow, L.F., 2013

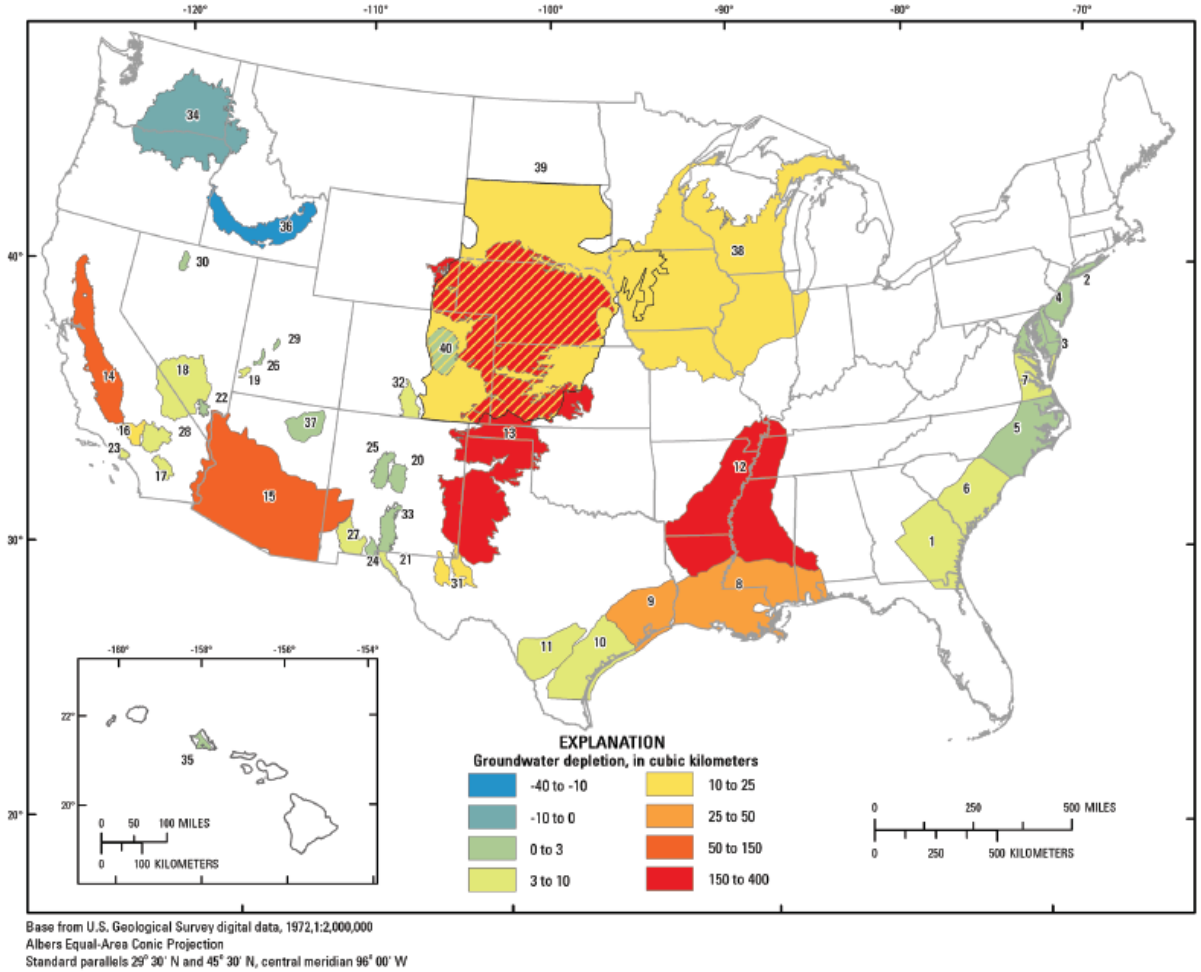


Figure 2. Map of the United States (excluding Alaska) showing cumulative groundwater depletion, 1900 through 2008, in 40 assessed aquifer systems or subareas. Index numbers are defined in table 1. Colors are hatched in the Dakota aquifer (area 39) where the aquifer overlaps with other aquifers having different values of depletion.

No Water

No Beer!

Failure to Conserve and Reuse will leave us hanging out there!

Questions?

Institutional, Commercial and Industrial (ICI) Water Use by the Numbers

Presented at Emerging Water Technology Symposium - 2018

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