University Water Use

A Study in Benchmarking

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EWTS

2022

San Antonio, Texas

What Will be Discussed

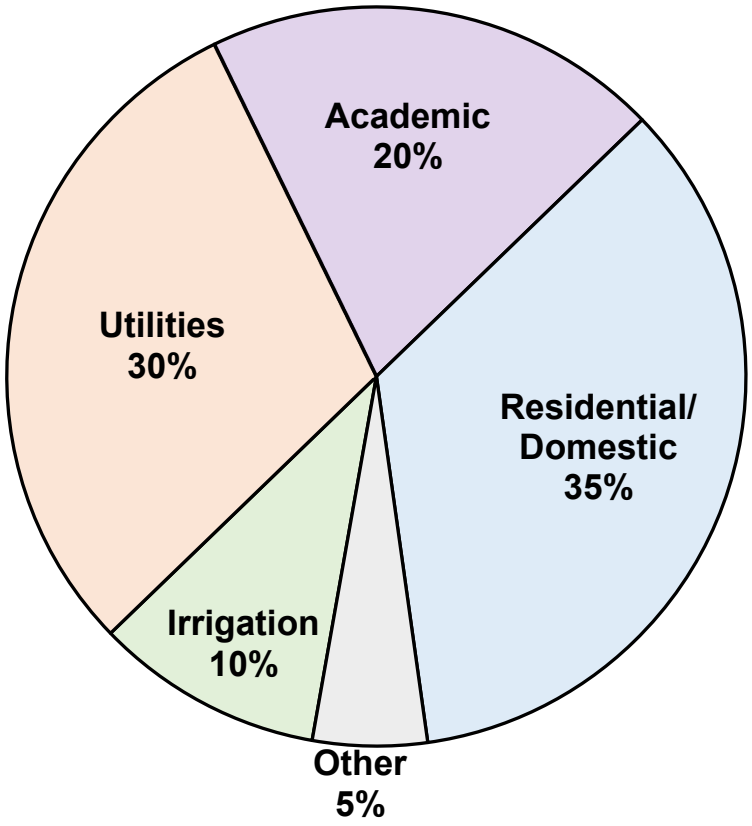
- How Water is Used
- Data Sources
- Benchmarks
- Geography of Water Use
- Breakdown of Higher Education Demographics
- How to Use Demographics and Benchmarks to Estimate Future Water Use

How Water is Used

Examples of Water Audits Conducted by Various Universities

University	Quadrant	Irrigation	Utilities	Residential	Academic	Dining	Lab	Undivided Domestic	Athletics	Other
Stamford University	South West	35%	17%	29%	15%				2%	2%
University of California Berkeley	South West	8%	12%	25%	27%		27%			1%
University of California Santa Barbara	South West	1%	14%	43%	42%					
University of Colorado	South West		21%	33%	25%		16%		5%	
Emory University	South East	3%	37%					60%		
Agness Scott College	South East			49%	26%	12%			13%	
University of Maryland	North East	10%	44%	25%					19%	2%
Colgate University	North East		16%	46%	6%	7%			25%	
Dickinson College	North East			45%	25%				18%	12%
Clemson	South East			46%	29%	12%			13%	
University of Texas Austin	South West	10%	55%	8%	10%	7%				10%
3 TX Community Colleges	South West	41%	31%			2%			21%	5%
University of Virginia	South East		46%		14%	23%				17%

A Ball Park Breakdown of University Water Use



A Large Portion of Water Use on Campuses is Use in Very Familiar Ways

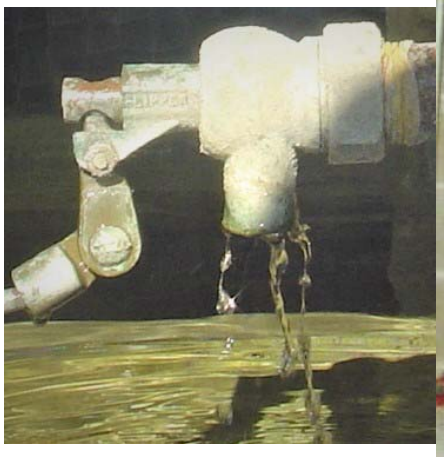

chips
2012 8 9

Irrigation

A typical Fire tube Steam Boiler

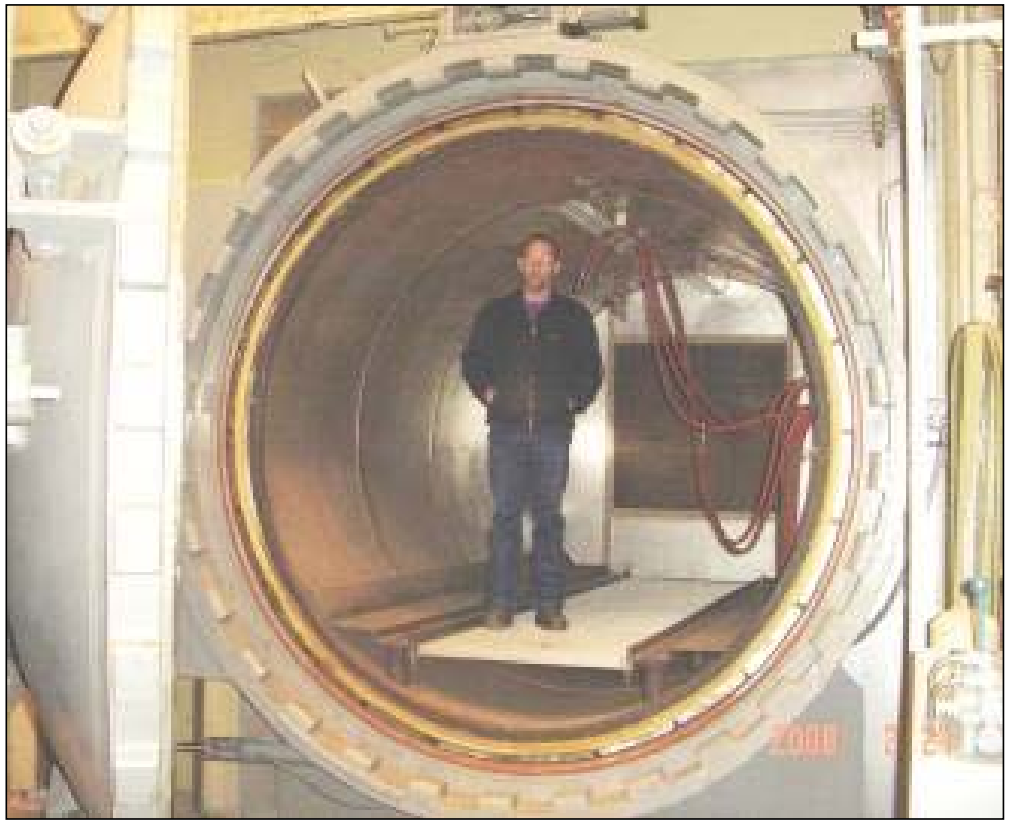
Cooling Towers

Re-look to figure out what may have been missed.



Athletics and Swimming Pools

Sterilizers of all Sizes



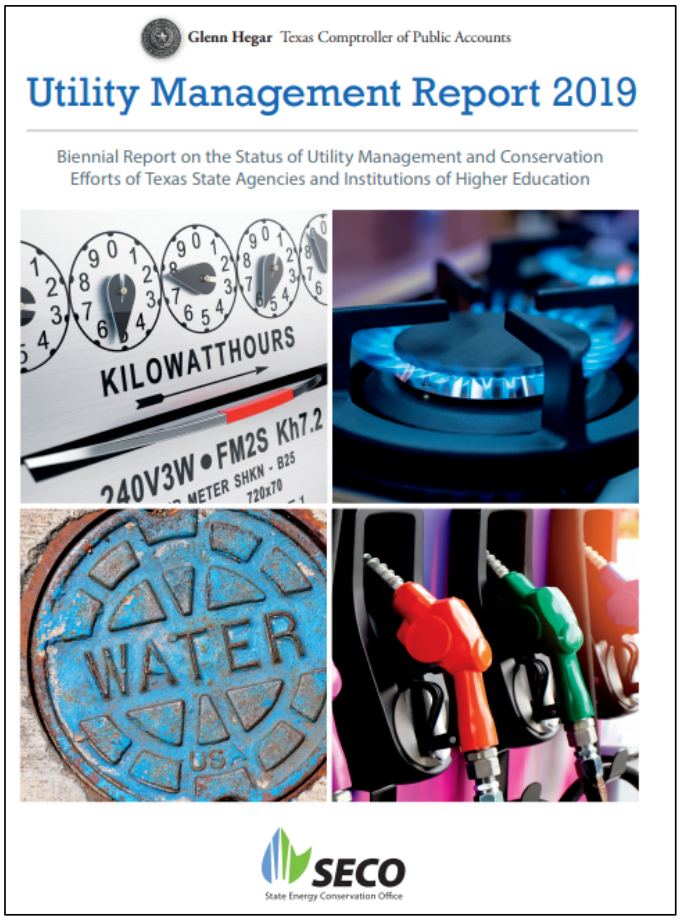
LABS of Every Kind

Data Bases

Data and Analysis Sources

- Association for the Advancement of Sustainability in Higher Education (**AASHE**) Sustainability Tracking, Assessment & Rating System (**STARS**)
- US Department of Education - The Changing Demographics of Higher Education
- Texas Data (State Energy Conservation Office)
- NOAA Weather Data
- American Hospital Directory

Texas State Energy Conservation Office (SECO) Energy and Water Consumption Data



Utility Consumption Among Institutions of Higher Education, Fiscal 2018

University	Electricity (kWh)	Natural Gas (kBtu)	Water (kgal)
711-Texas A&M University	423,189,994	2,328,133,580	1,766,191
729-University of Texas Southwestern Medical	334,774,600	1,173,040,285	592,098
506-UT MD Anderson Cancer Center	315,626,972	330,676,714	Not Available
723-University of Texas Medical Branch Galveston	199,350,310	1,040,898,605	433,411
733-Texas Tech University	154,689,090	788,980,341	777,994
745-UT Health Science Center at San Antonio	132,586,020	596,489,570	179,998
754-Texas State University	122,946,564	378,119,180	63,560
714-University of Texas at Arlington	120,451,269	353,724,785	347,521
743-University of Texas at San Antonio	115,894,439	278,259,393	158,568
752-University of North Texas	111,563,895	238,801,380	Not Available
738-University of Texas at Dallas	108,939,650	358,581,877	234,044
721-University of Texas at Austin	100,479,620	4,432,786,300	509,991
746-University of Texas Rio Grande Valley	90,596,156	65,401,357	191,559
753-Sam Houston State University	82,806,165	120,817,970	Not Available
744-UT Health Science Center at Houston	73,254,133	89,363,571	165,094

Notes:
(1) Consumption totals presented as reported by each entity in ENERGY STAR Portfolio Manager. Consumption data were corrected where obvious errors were noted.
(2) Consumption totals do not include supplemental district chilled water, district hot water, district steam or onsite generation.

Association for the Advancement of Sustainability in Higher Education

Sustainability Tracking, Assessment & Rating System *(STARS)* covering over 565 Campuses

AASHE Technical Manuel

AASHE STARS Data Contains a Wealth of Information

- Annual potable & total water use
- Type of academic institution (associates, baccalaureate, masters, PhD without hospitals & PhD with hospital;
- Location
- Agricultural land, vegetated landscape areas, hospitals, medical schools, etc.;
- Building and property square feet;
- Residential square feet;

- Full time equivalent students;
- Remote or distance learning students;
- Staff and faculty numbers;
- Students and faculty living on campus;
- Weighted campus users
- Laboratory and clinical space;
- Energy use;
- Climatic regions;
- And much more.

What is Benchmarking

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!

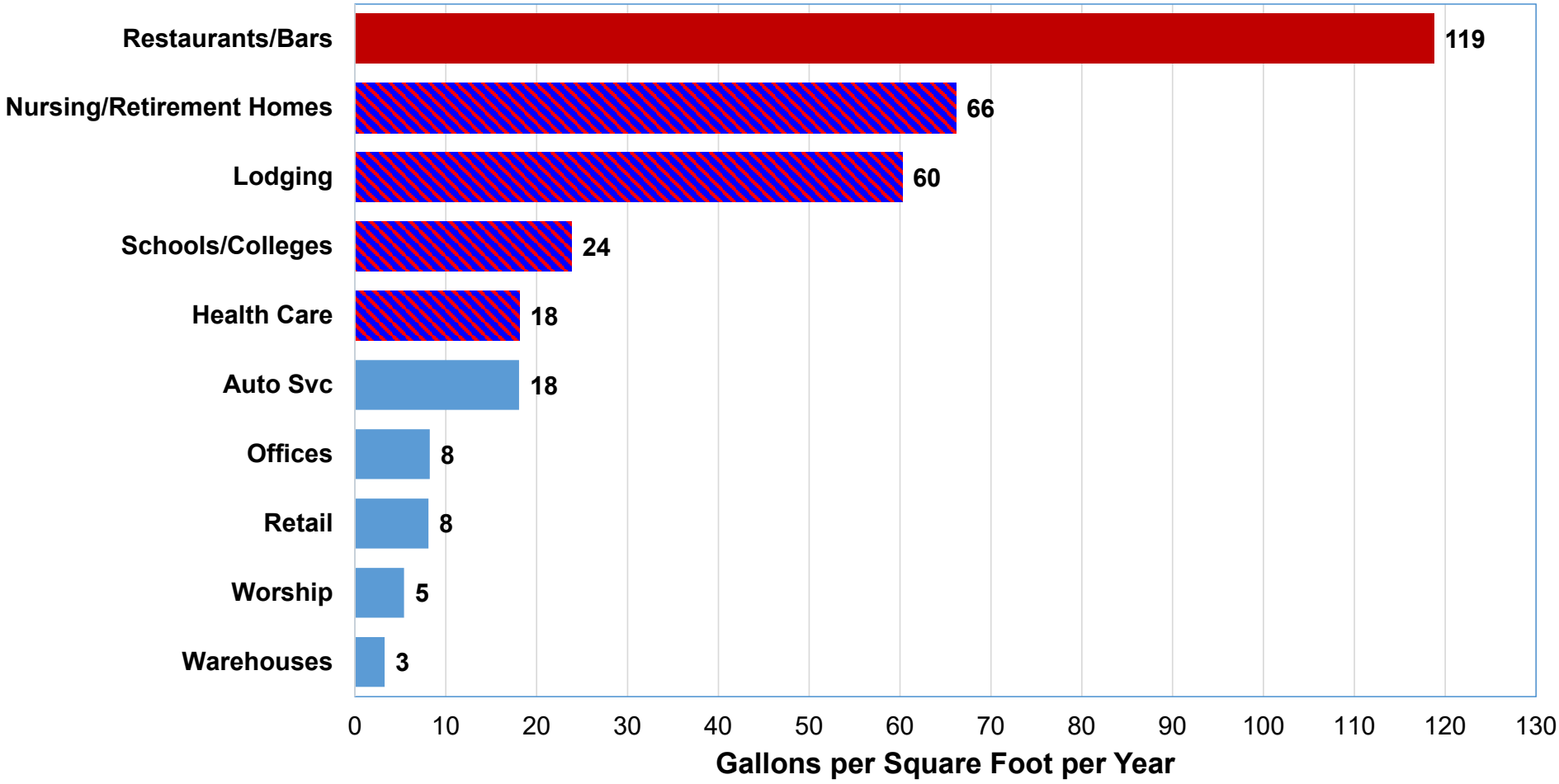
Summary of 13 Studies Reporting Water Use by
Gallons per Square Foot of Space per Year

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 [7]2015 [7]	New York Benchmark Law [8]	Washington DC Bench - mark Law[9]	Philadelphia Benchmark Law [10]	Minneapolis Benchmark Law [11]	WRF Report 4375 2015 – Tampa [12]	WRF Report 4375 2015 – Austin [13]	WRF Report 4619 2015 – Tampa [14]
	Gallons per Square Foot of Heated Space per Year													
Restaurants		221		173 to 211	130 to 330	215								119
Senior Care Facilities	61	106		62 to 101				86						66
Hotels	54	85		79 to 165	60 to 115	72	55	71	55	100		62	75	60
Hospitals	51	31				58				68				
Grocery/ Supermarkets	24	95	36		52 to 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				8
Unrefrigerated Warehouses	4	8						3	2	4				
Colleges/ Universities							23	14	24	75				
Residence Halls/ Dormitories							31	50	41					
Multi-Family							35	54	40					

WRF 4618 Averages of Six Utilities

https://www.researchgate.net/publication/318890470



Welcome to the Denominator Dilemma

- Data available includes:
  - square feet of facilities
  - Demographic data
- Most dominators based on area are expressed in gallons per square foot per year
- Demographic data presents several dilemmas
  - AASHE calculates “Weighted Campus Users per year”
  - Most benchmarking efforts are based gallons per demographic factor per day
- Full time equivalent days and student days are examples

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, FTE
Restaurant	Meals Served, Covers	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

How AASHE Calculates "Weighted Campus Users"

Weighted campus user

"Weighted campus user" is a measurement of an institution's population that is adjusted to accommodate how intensively certain community members use the campus. This figure is used to normalize resource consumption and environmental impact figures in order to accommodate the varied impacts of different population groups. For example, an institution where a high percentage of students live on campus would witness higher greenhouse gas emissions, waste generation, and water consumption figures than otherwise comparable non-residential institution since students' residential impacts and consumption would be included in the institution's totals.

STARS calculates the figure according to the following formula. Please note that users will not have to calculate this figure themselves; the result will be calculated automatically when the data are entered into the online Reporting Tool.

$$\text{Weighted campus users} = (A + B + C) + 0.75\,[\,(D - A) + (E - B) - F\,]$$

A= Number of students resident on-site

B= Number of employees resident on-site

C= Number of other individuals resident on-site and/or staffed hospital beds

D= Total full-time equivalent student enrollment

E= Full-time equivalent of employees (staff + faculty)

F= Full-time equivalent of students enrolled exclusively in distance education

Estimating Total Occupied Hours per Year for Full Time Equivalents (FTE)

Persons	Hours/Year on Campus
Remote	0
FTE no live in	1008
Staff/Employ	1980
live in Student	4200
live in Staff	6730
Normalized to Working Hours	1980

The net Result is that One FTE year for Combined Students (fall, spring and some summer) plus faculty and staff is about 1980 hours per year and 8.5 hours a day:

232 days per year.

For student days, the average number of days average college students spend in class was considered.

Based on data from 121 universities, an estimate of 155.8 student day per year was obtained

Geography

Geographical Considerations

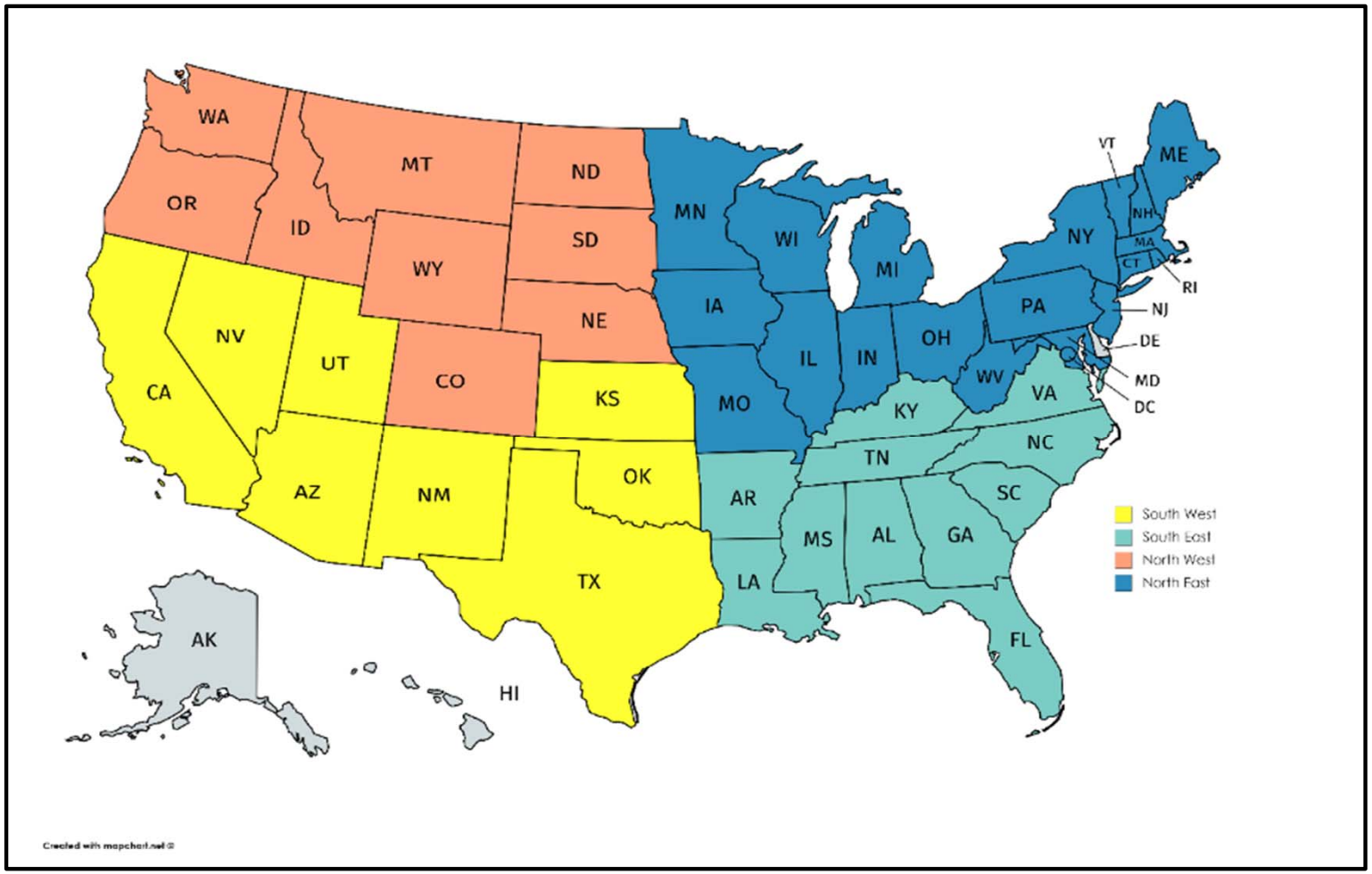
Water Use Factors

- People related water use
- Square feet of buildings water use
- With and without agricultural land

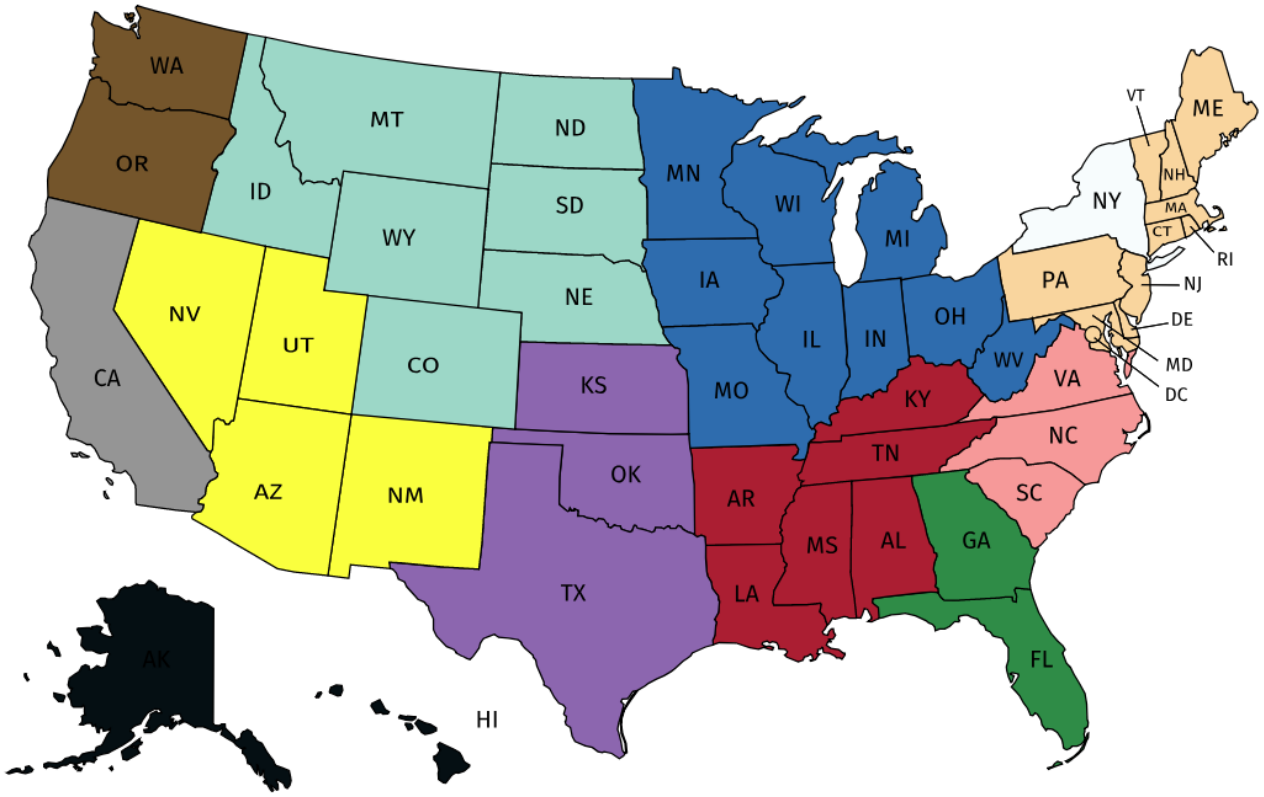
Geographical Implications

- Temperature
- Rainfall
- Latitude and longitude

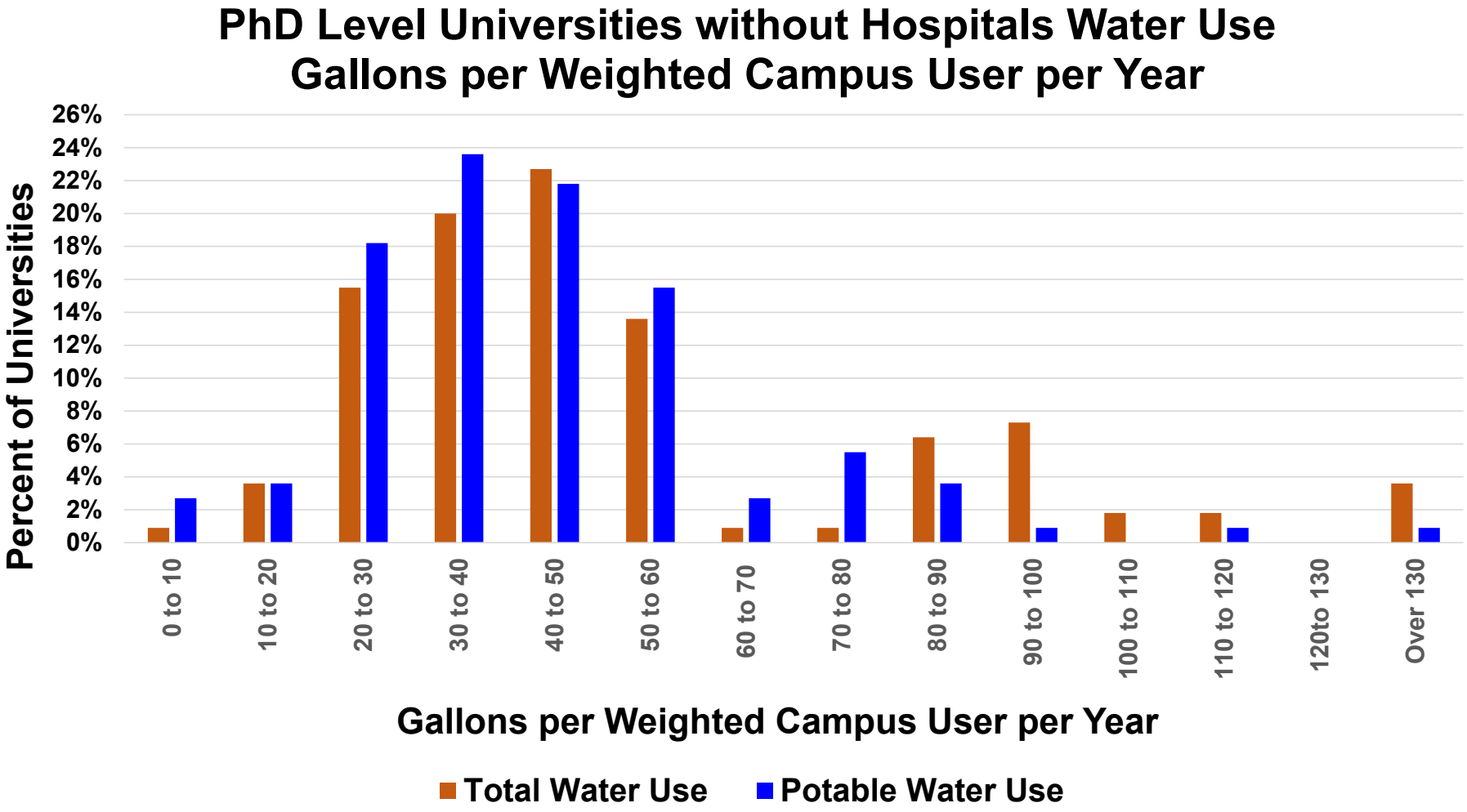
Regions in Analysis



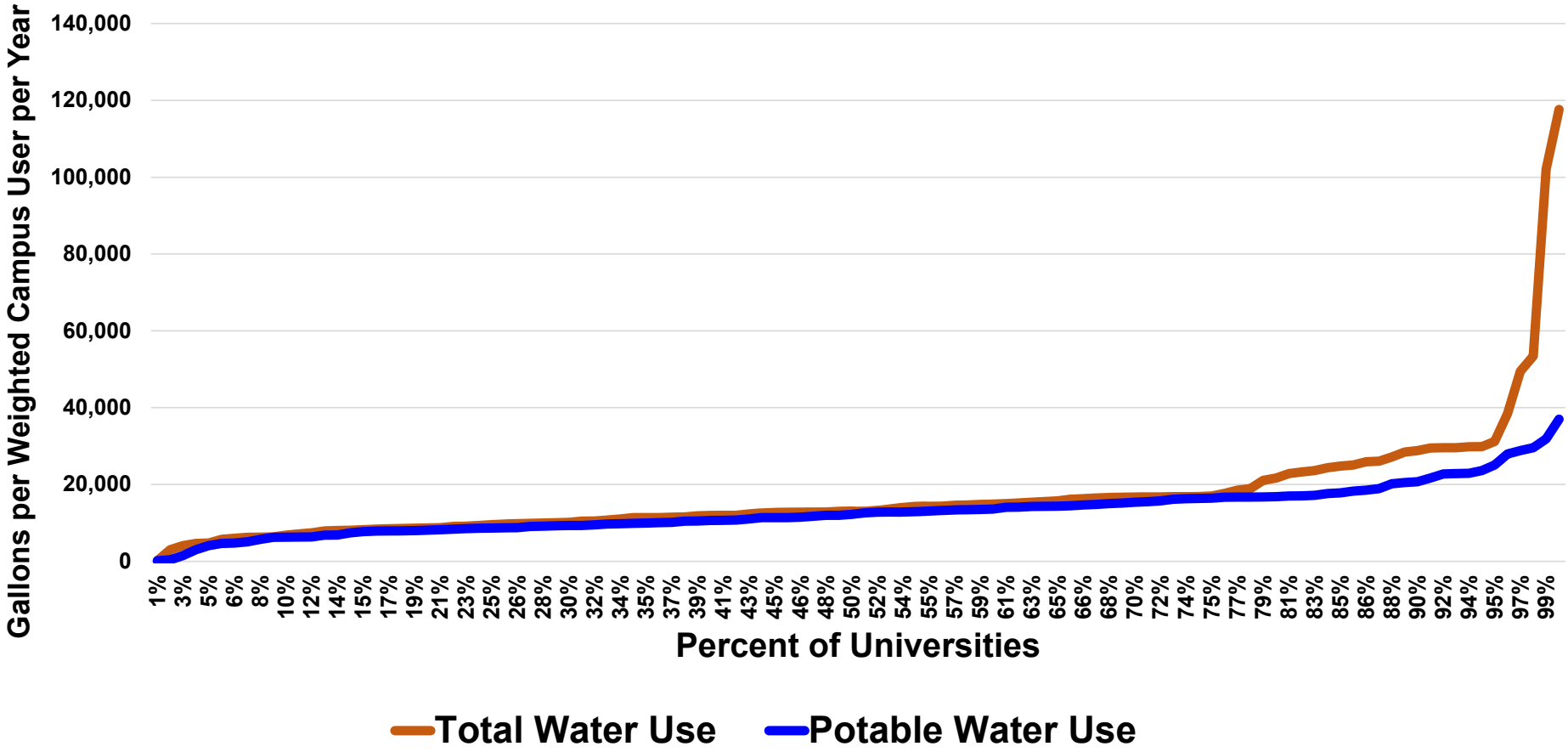
State Groupings for Detailed Geographic Analysis of Water Use

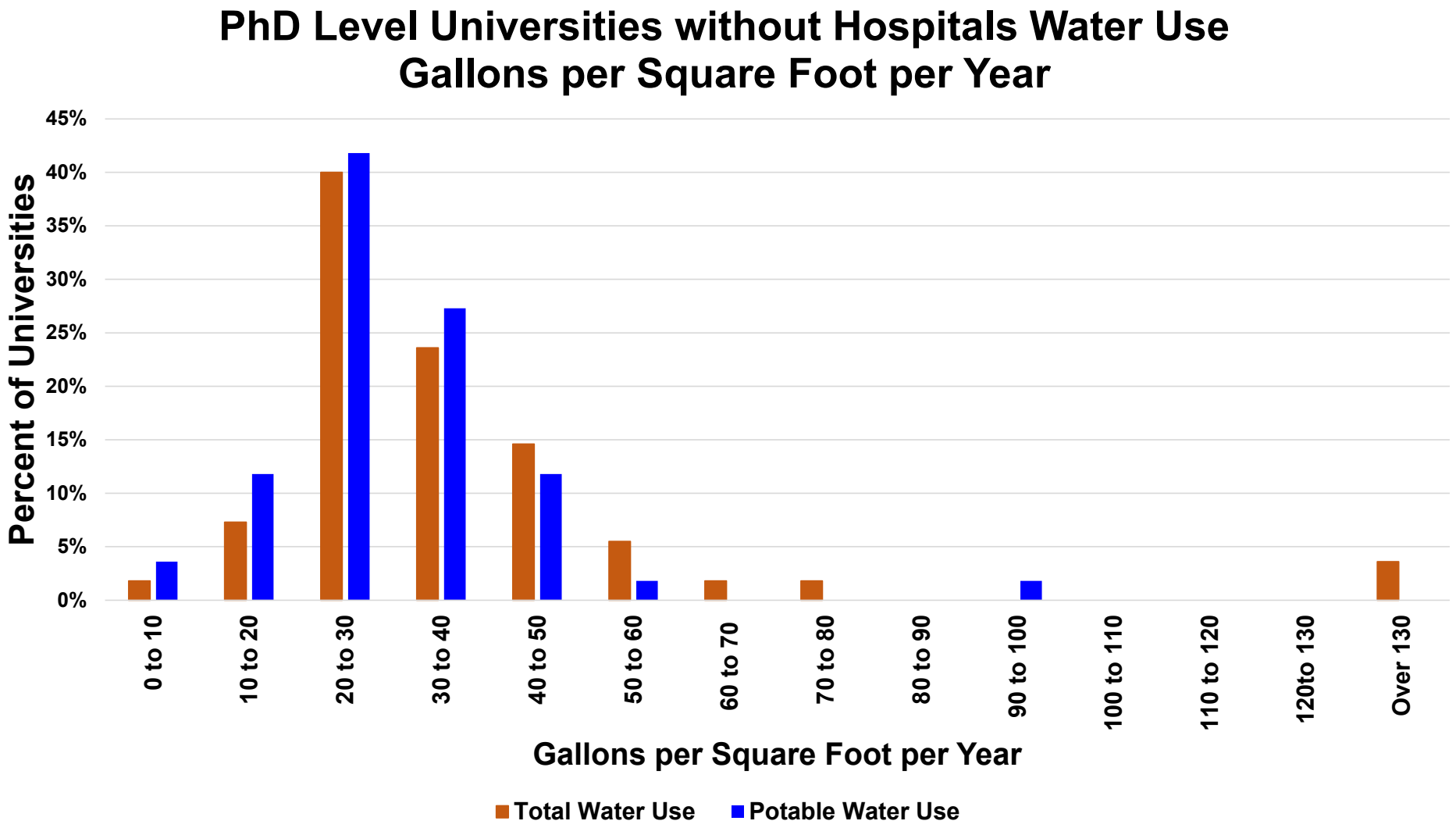


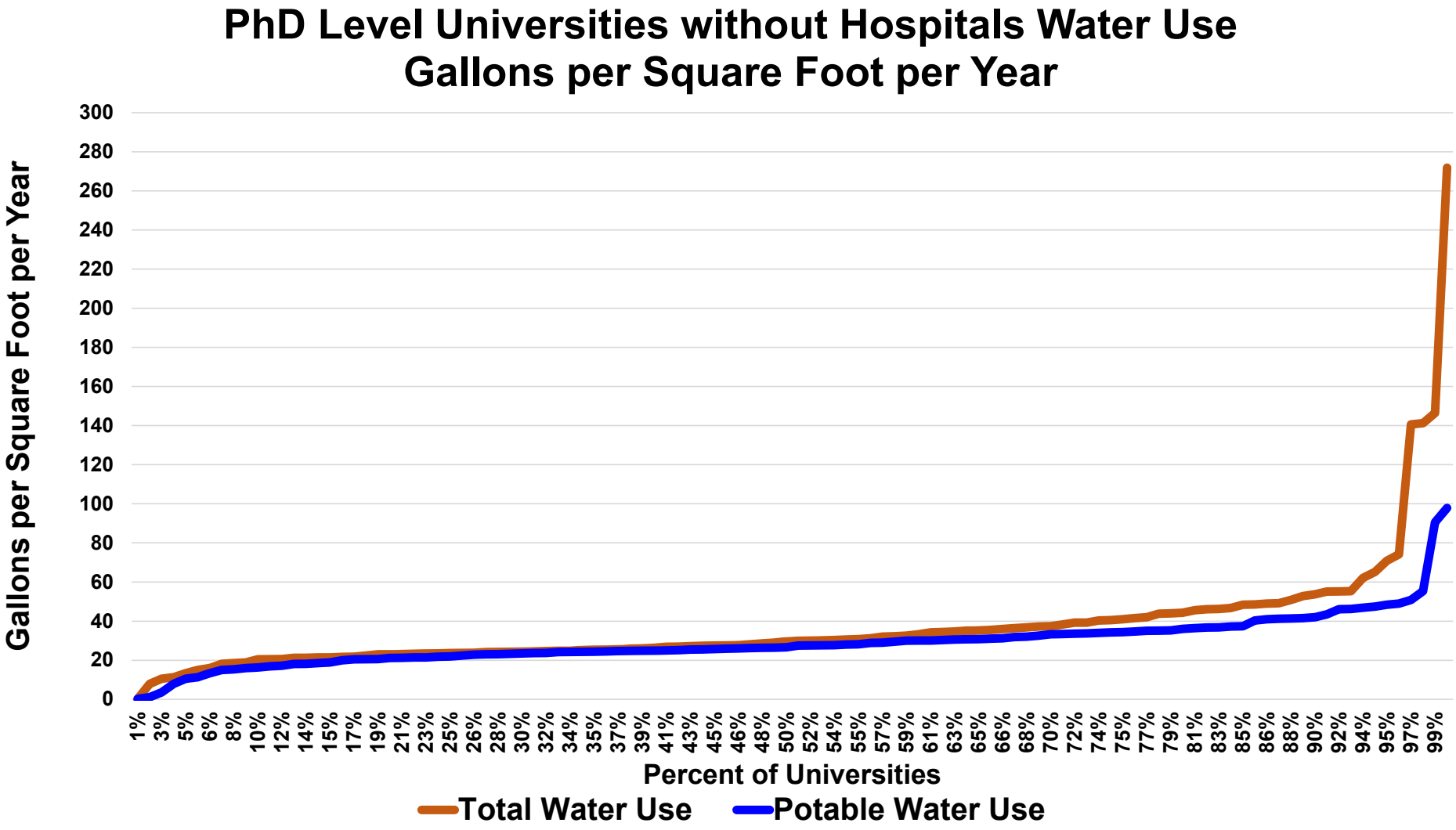
Statistics, Statistics, and more Statistics


PhD Level Universities without Hospitals Water Use
Gallons per Weighted Campus User per Year
Percent of Universities
26%
24%
22%
20%
18%
16%
14%
12%
10%
8%
6%
4%
2%
0%
0 to 10
10 to 20
20 to 30
30 to 40
40 to 50
50 to 60
60 to 70
70 to 80
80 to 90
90 to 100
100 to 110
110 to 120
120to 130
Over 130
Gallons per Weighted Campus User per Year
Total Water Use
Potable Water Use

PhD Level Universities without Hospitals Water Use
Gallons per Weighted Campus User per Year

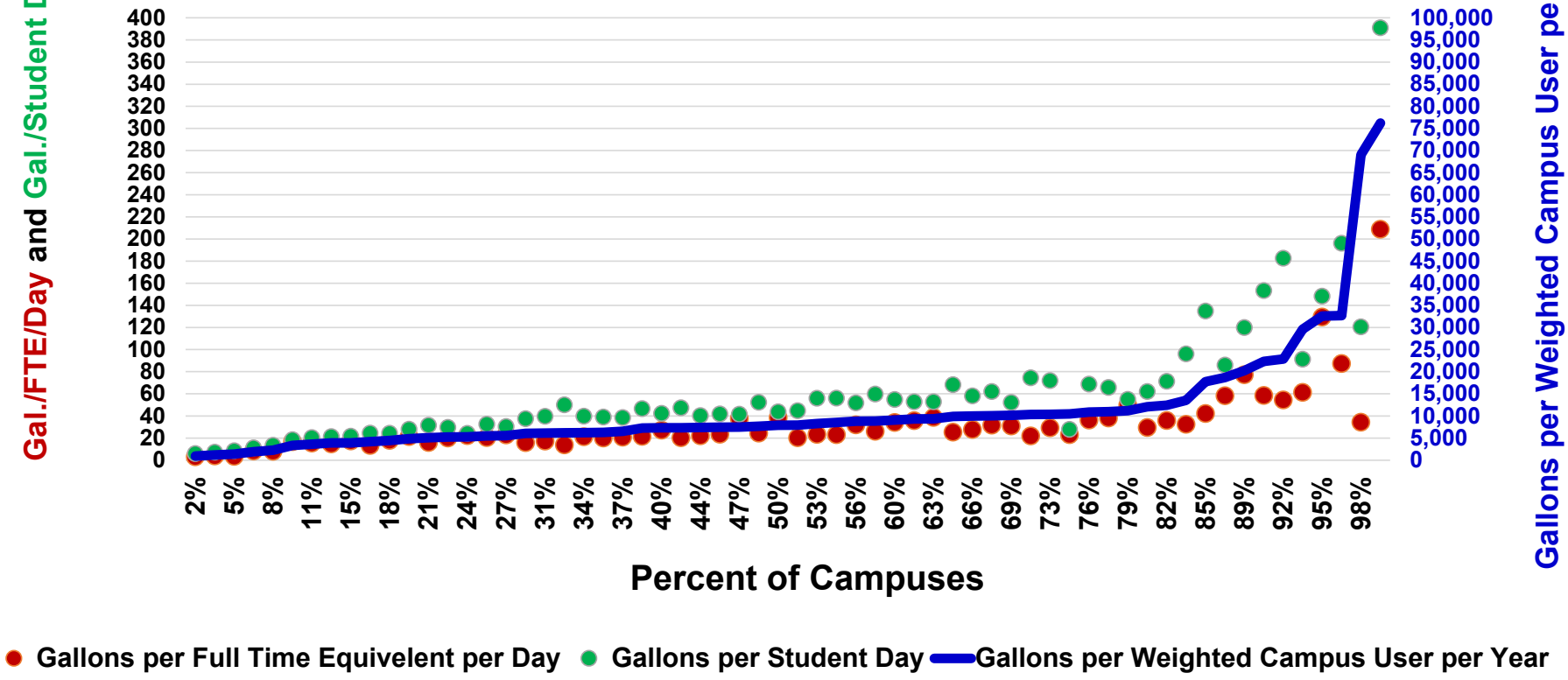


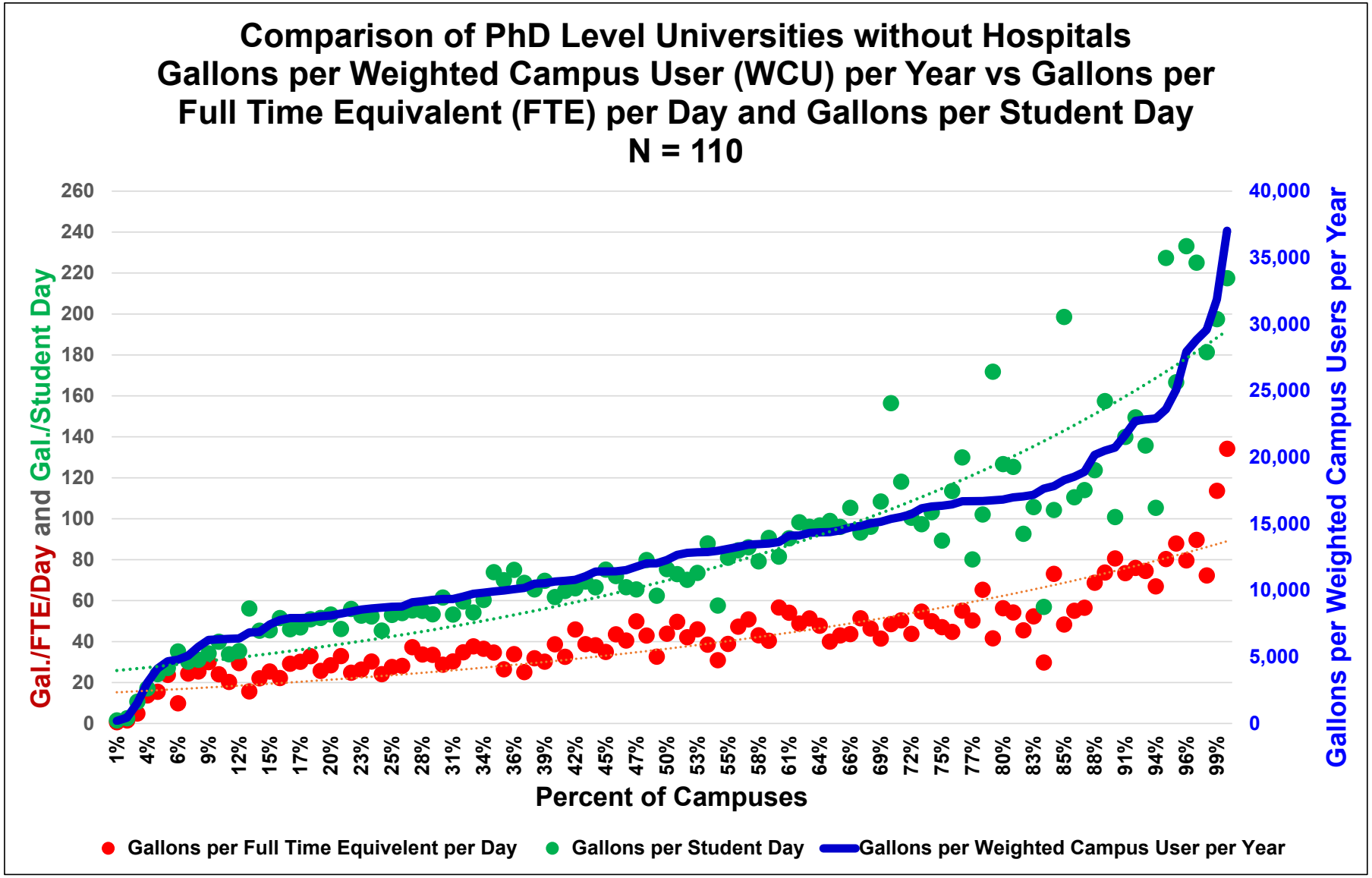

PhD Level Universities without Hospitals Water Use
Gallons per Square Foot per Year
Percent of Universities
45%
40%
35%
30%
25%
20%
15%
10%
5%
0%
0 to 10
10 to 20
20 to 30
30 to 40
40 to 50
50 to 60
60 to 70
70 to 80
80 to 90
90 to 100
100 to 110
110 to 120
120to 130
Over 130
Gallons per Square Foot per Year
Total Water Use
Potable Water Use


PhD Level Universities without Hospitals Water Use
Gallons per Square Foot per Year
Gallons per Square Foot per Year
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
1%
3%
5%
6%
8%
10%
12%
14%
15%
17%
19%
21%
23%
25%
26%
28%
30%
32%
34%
35%
37%
39%
41%
43%
45%
46%
48%
50%
52%
54%
55%
57%
59%
61%
63%
65%
66%
68%
70%
72%
74%
75%
77%
79%
81%
83%
85%
86%
88%
90%
92%
94%
95%
97%
99%
Percent of Universities
Total Water Use
Potable Water Use

Comparison of Masters Level Universities
Gallons per Weighted Campus User (WCU) per Year vs Gallons per Full Time Equivalent (FTE) per Day and Gallons per Student Day

N = 63




Comparison of PhD Level Universities without Hospitals
Gallons per Weighted Campus User (WCU) per Year vs Gallons per Full Time Equivalent (FTE) per Day and Gallons per Student Day
N = 110
Gal./FTE/Day and Gal./Student Day
Gallons per Weighted Campus Users per Year
260
240
220
200
180
160
140
120
100
80
60
40
20
0
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
1%
4%
6%
9%
12%
15%
17%
20%
23%
25%
28%
31%
34%
36%
39%
42%
45%
47%
50%
53%
55%
58%
61%
64%
66%
69%
72%
75%
77%
80%
83%
85%
88%
91%
94%
96%
99%
Percent of Campuses
Gallons per Full Time Equivelent per Day
Gallons per Student Day
Gallons per Weighted Campus User per Year

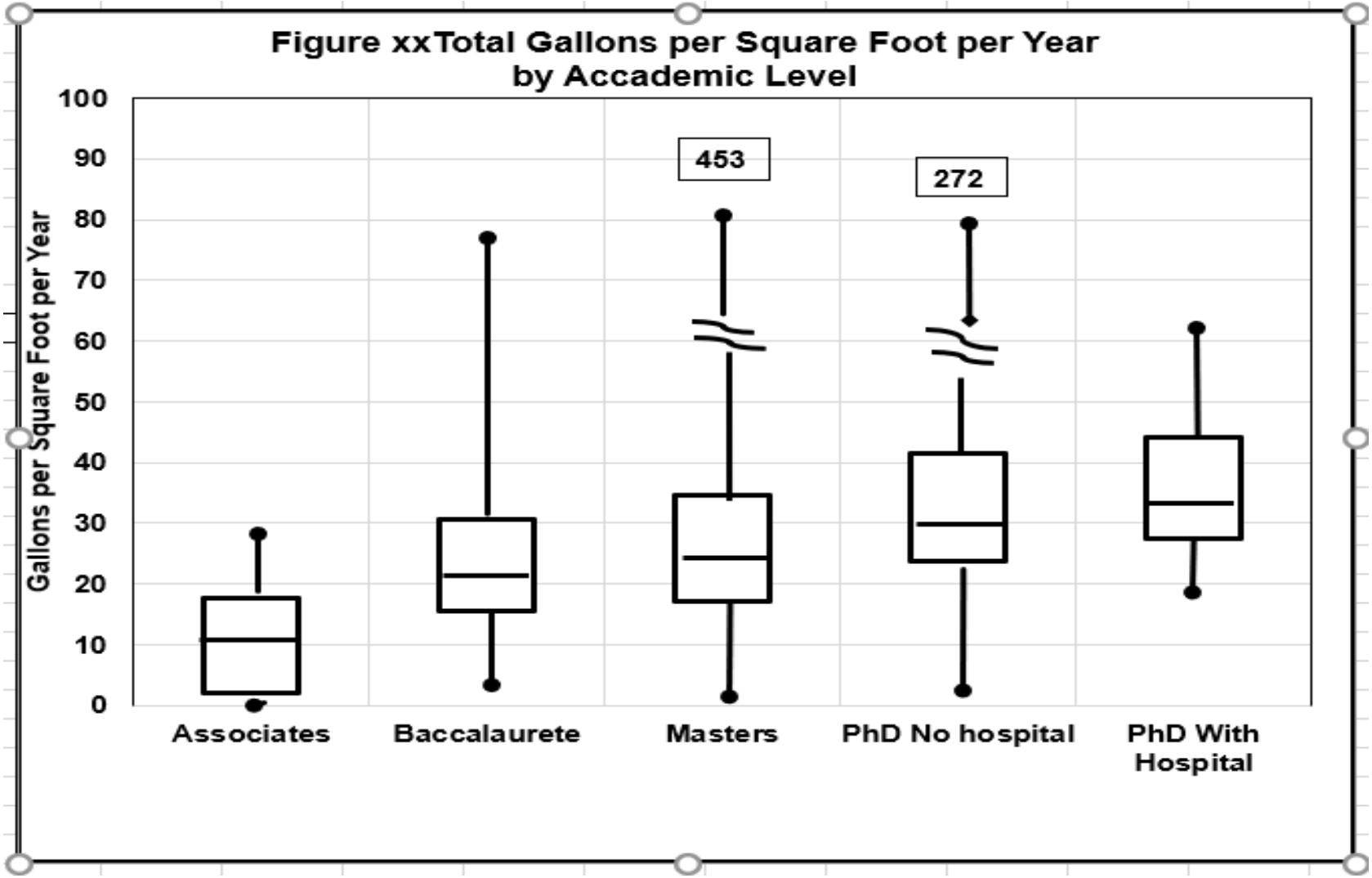


Figure xxTotal Gallons per Square Foot per Year
by Accademic Level
Gallons per Square Foot per Year
100
90
80
70
60
50
40
30
20
10
0
453
272
Associates
Baccalaurete
Masters
PhD No hospital
PhD With Hospital

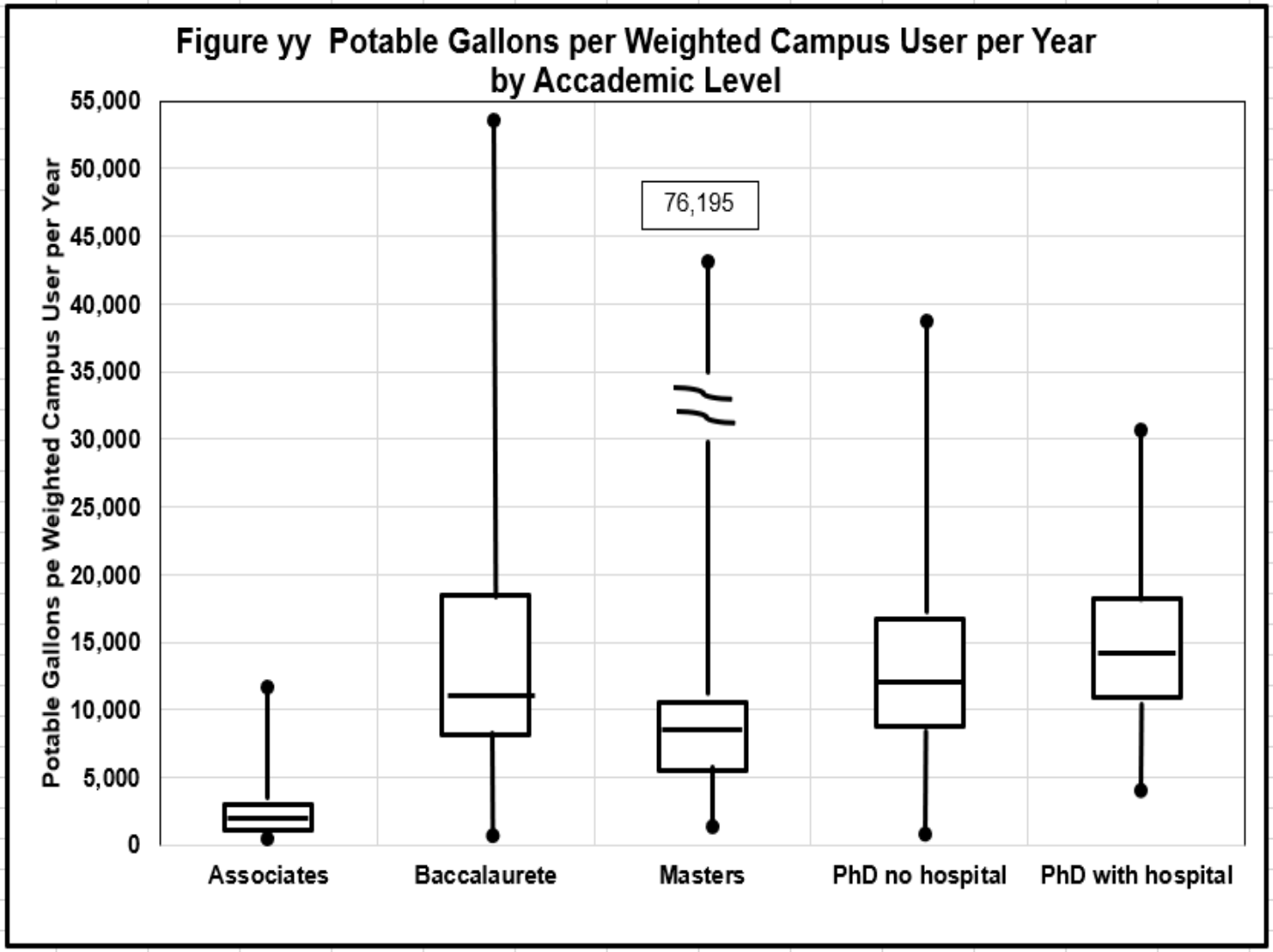
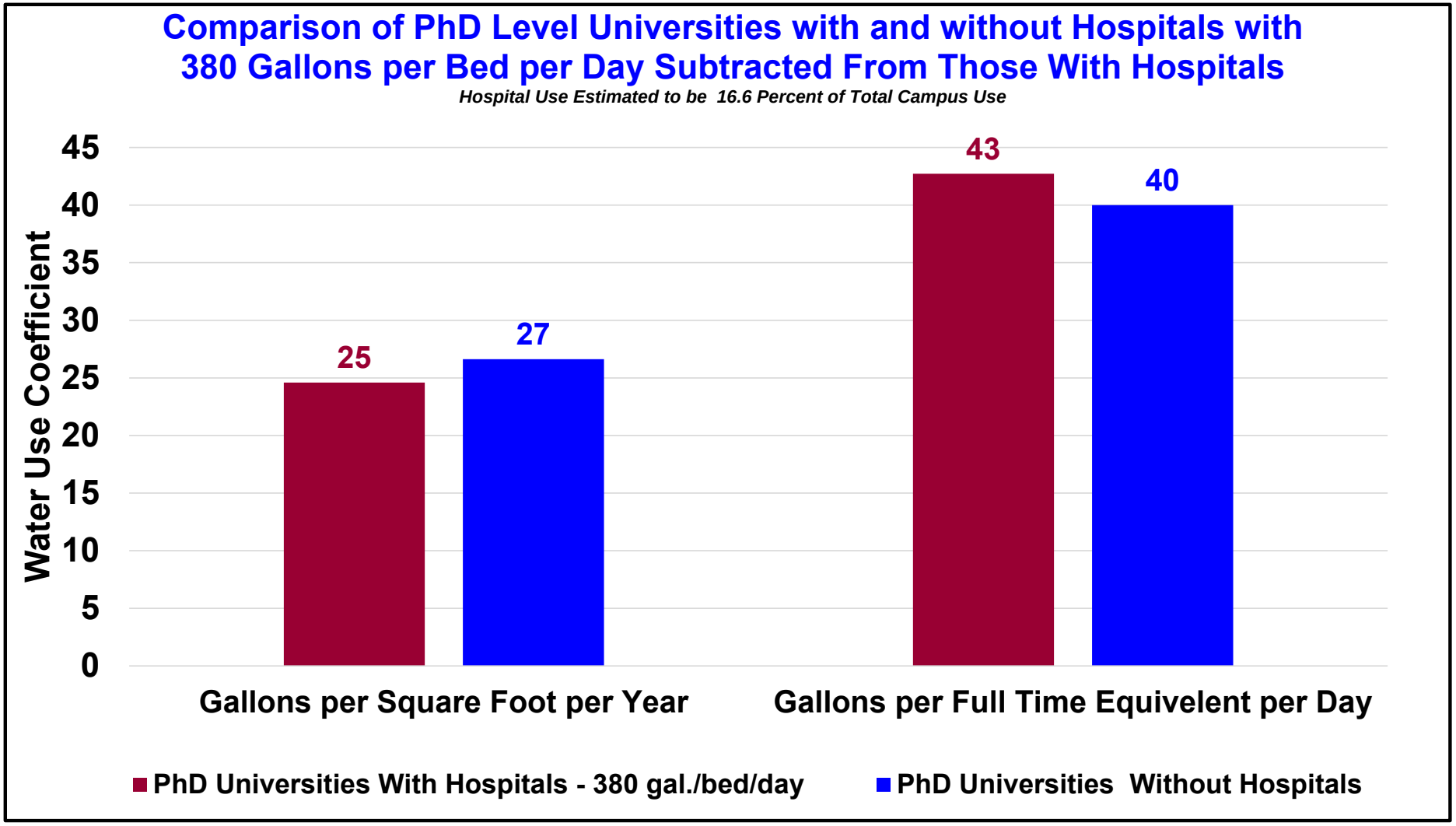
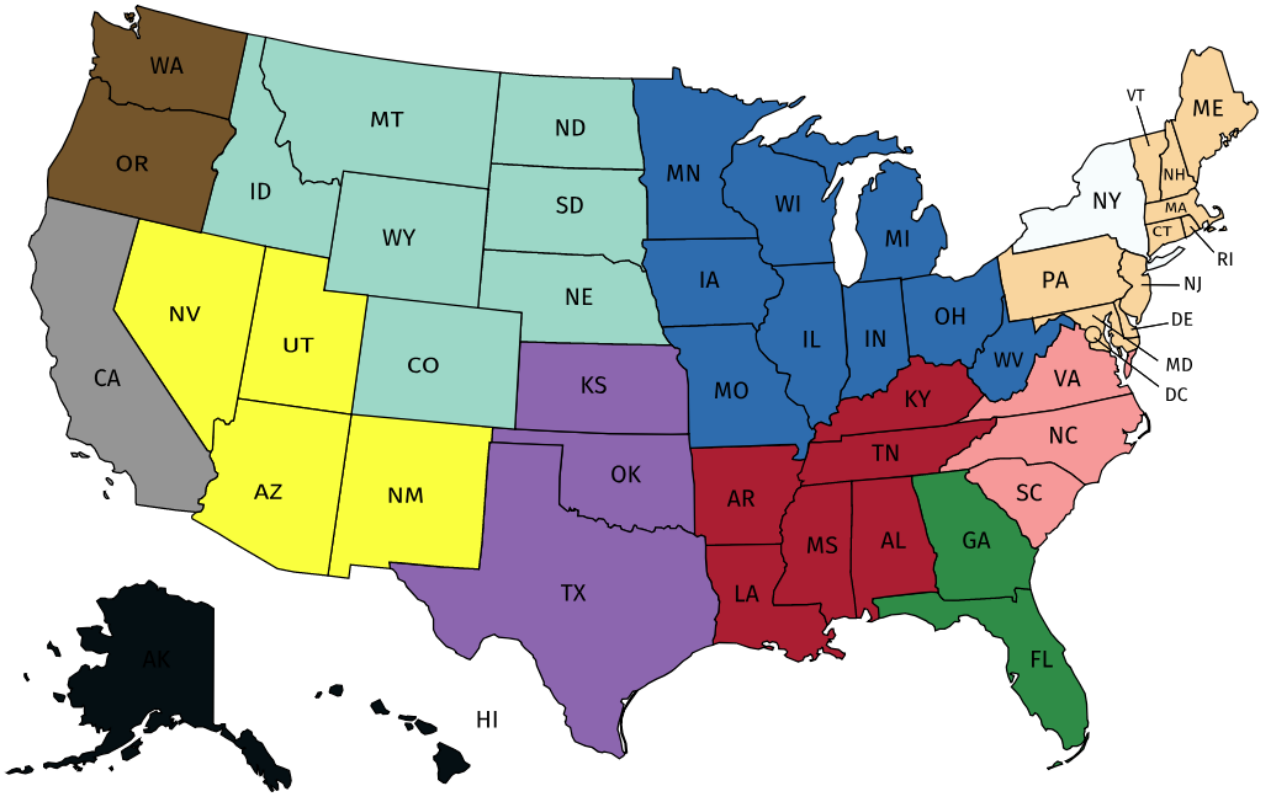
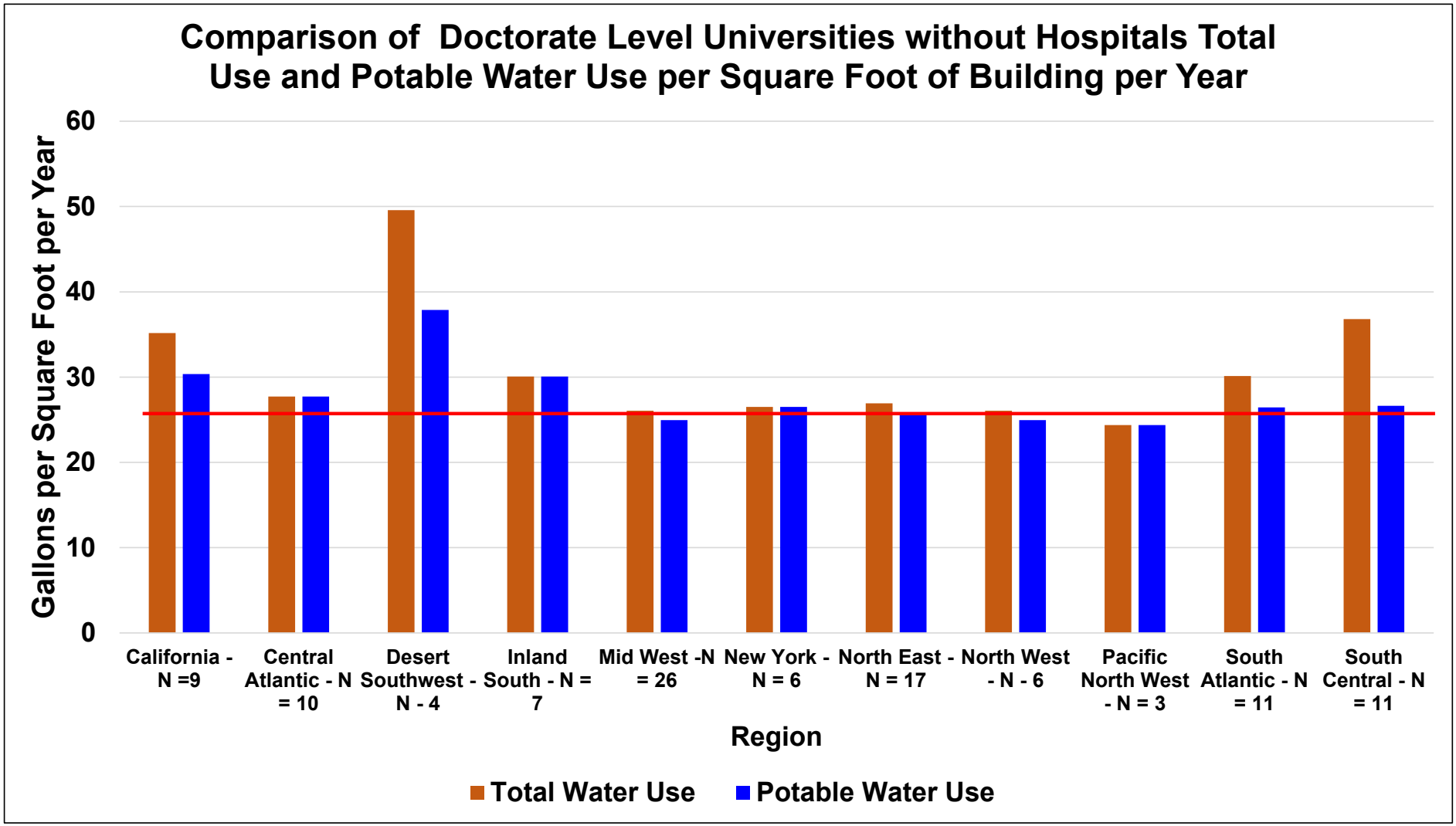


Figure yy Potable Gallons per Weighted Campus User per Year by Accademic Level
Potable Gallons pe Weighted Campus User per Year
55,000
50,000
45,000
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
76,195
Associates
Baccalaurete
Masters
PhD no hospital
PhD with hospital


Comparison of PhD Level Universities with and without Hospitals with 380 Gallons per Bed per Day Subtracted From Those With Hospitals
Hospital Use Estimated to be 16.6 Percent of Total Campus Use
Water Use Coefficient
45
40
35
30
25
20
15
10
5
0
25
27
43
40
Gallons per Square Foot per Year
Gallons per Full Time Equivelent per Day
PhD Universities With Hospitals - 380 gal./bed/day
PhD Universities Without Hospitals

State Groupings for Detailed Geographic Analysis of Water Use

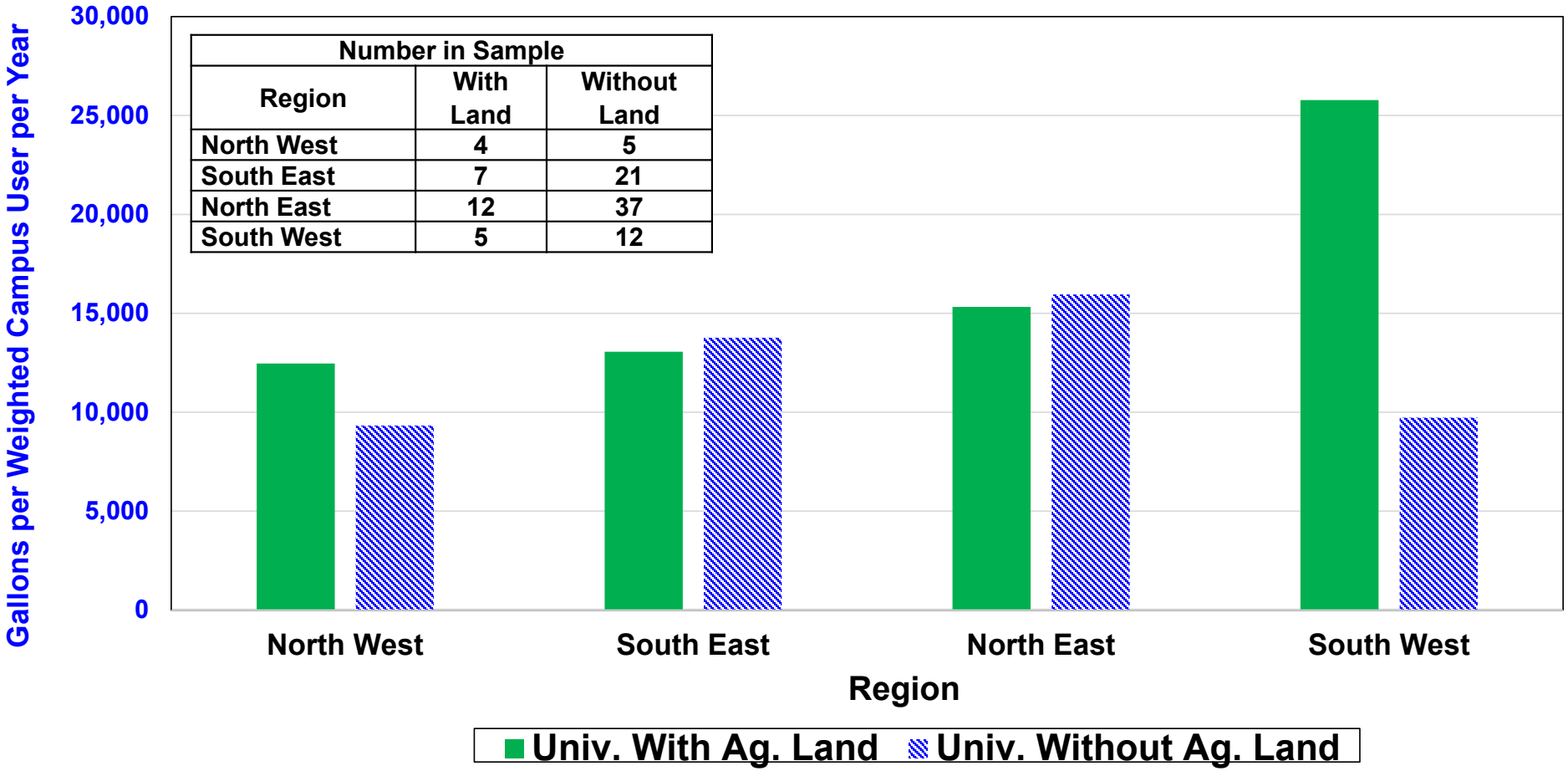



Comparison of Doctorate Level Universities without Hospitals Total Use and Potable Water Use per Square Foot of Building per Year
Gallons per Square Foot per Year
60
50
40
30
20
10
0
California - N =9
Central Atlantic - N = 10
Desert Southwest - N - 4
Inland South - N = 7
Mid West -N = 26
New York - N = 6
North East - N = 17
North West - N - 6
Pacific North West - N = 3
South Atlantic - N = 11
South Central - N = 11
Region
Total Water Use
Potable Water Use

Comparison of PhD Level Universities Total Water Use
With and Without More Than Five Acres of Agricultural Land

Gallons per Weighted Campus User per Year (Gal/WCU/Yr.)

Number in Sample		
Region	With Land	Without Land
North West	4	5
South East	7	21
North East	12	37
South West	5	12



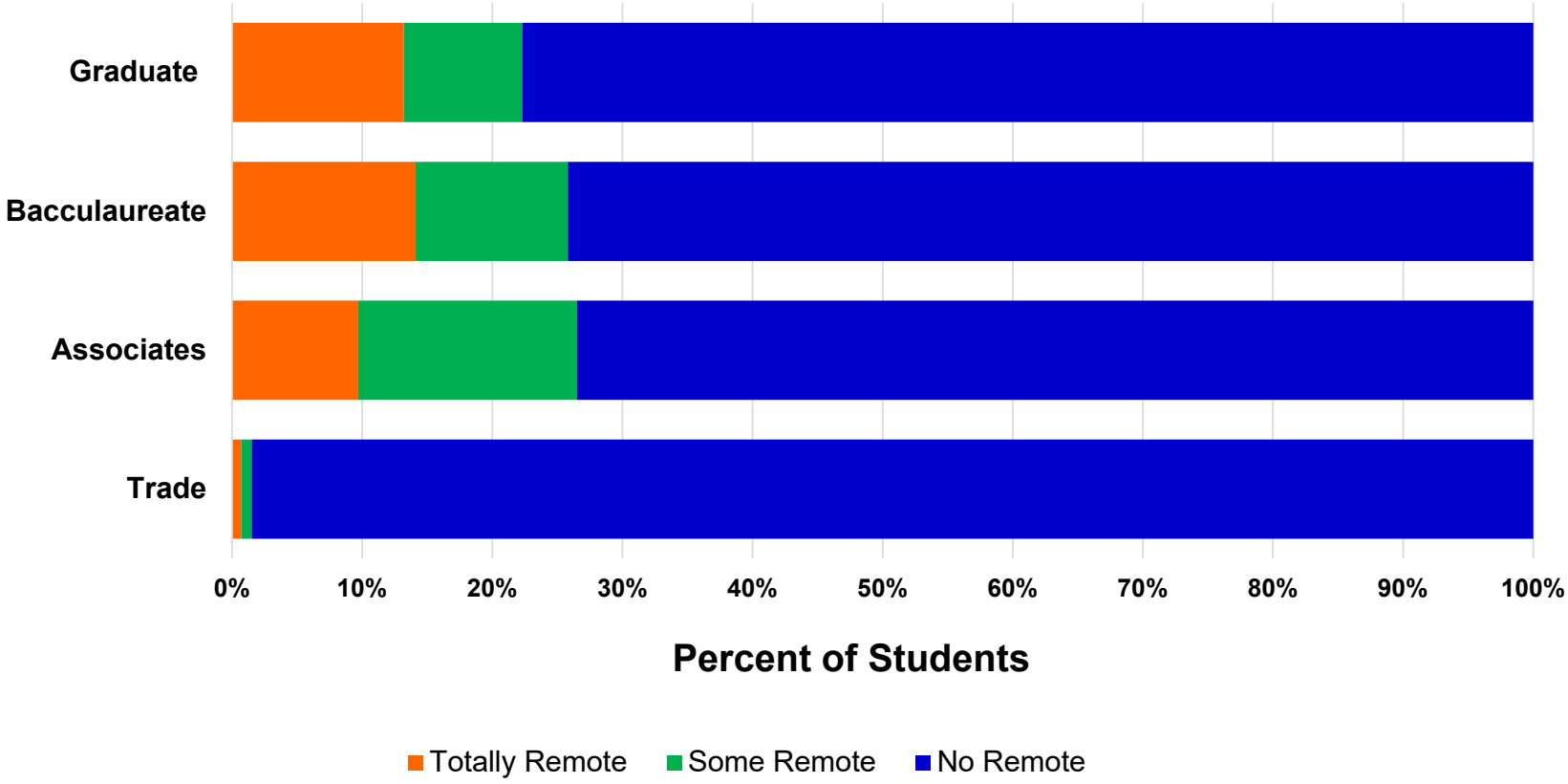
Impact of Students and Facility Living on Campus on Water Use

Level	% Living on Campus	Gallons Increase per Year per 1% Living on Campus	Average Gallons per Weighted Campus User per Year	% increase in water use per One % Living on Campus
PhD	23%	35	13,105	0.3%
Masters	24%	85	11,487	0.7%
Baccalaureate	44%	87	14,112	0.6%

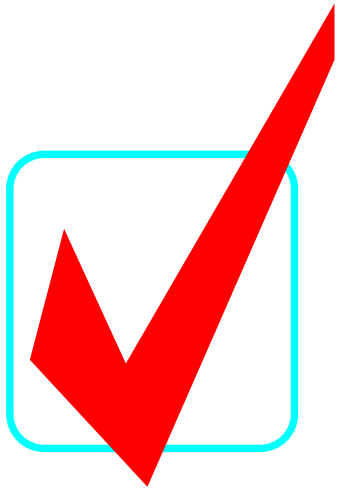
Demographics

Remote/Distance Learning Enrollment Percent by Type of Student

Source: Nat. Center for Edu. Statistics
https://nces.ed.gov/pubs2014/2014023.pdf



The



End

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