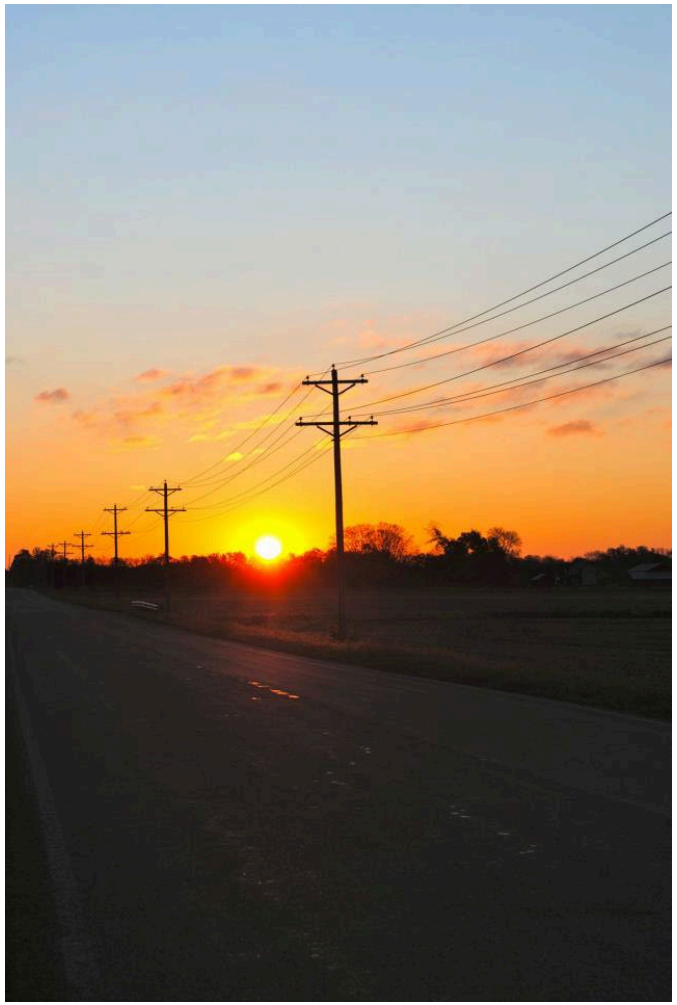
Saving Water and Saving Energy in Growing Communities

Jonah Schein
WaterSense Program

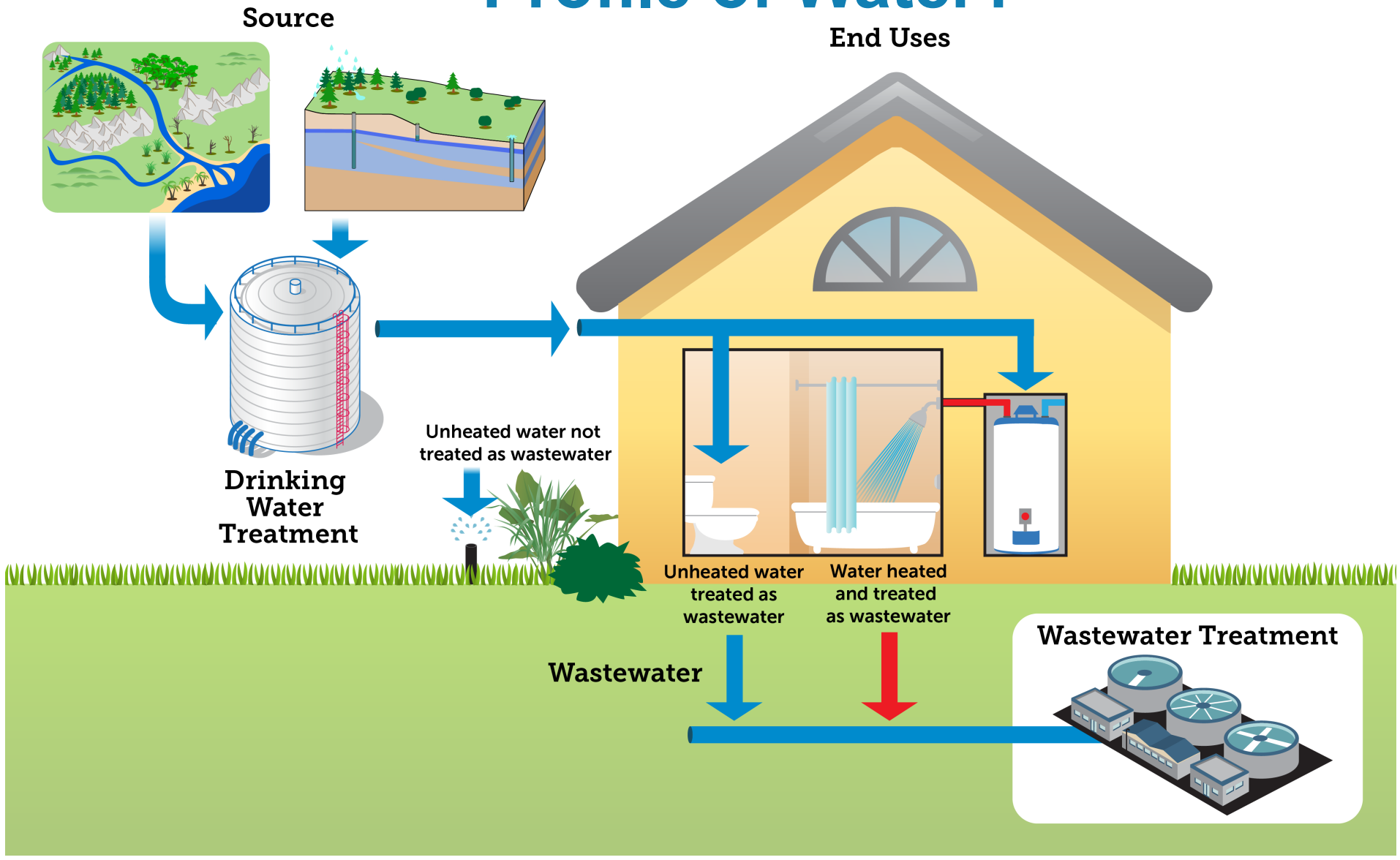
Water and Energy

- Every gallon of water has an energy “footprint”
- Moving, treating, and heating water uses energy
- Water related energy uses account for more than 500 tWh/year
  - More than 14% of total consumption for 2020



EPA

What Influences the Energy Profile of Water?



look for WaterSense Meets EPA Criteria

EPA

Cadanera Case Study

45 WaterSense labeled homes in Southern California

Local Water Use Profile

Energy used for various sources of water used locally (kWh/AF)

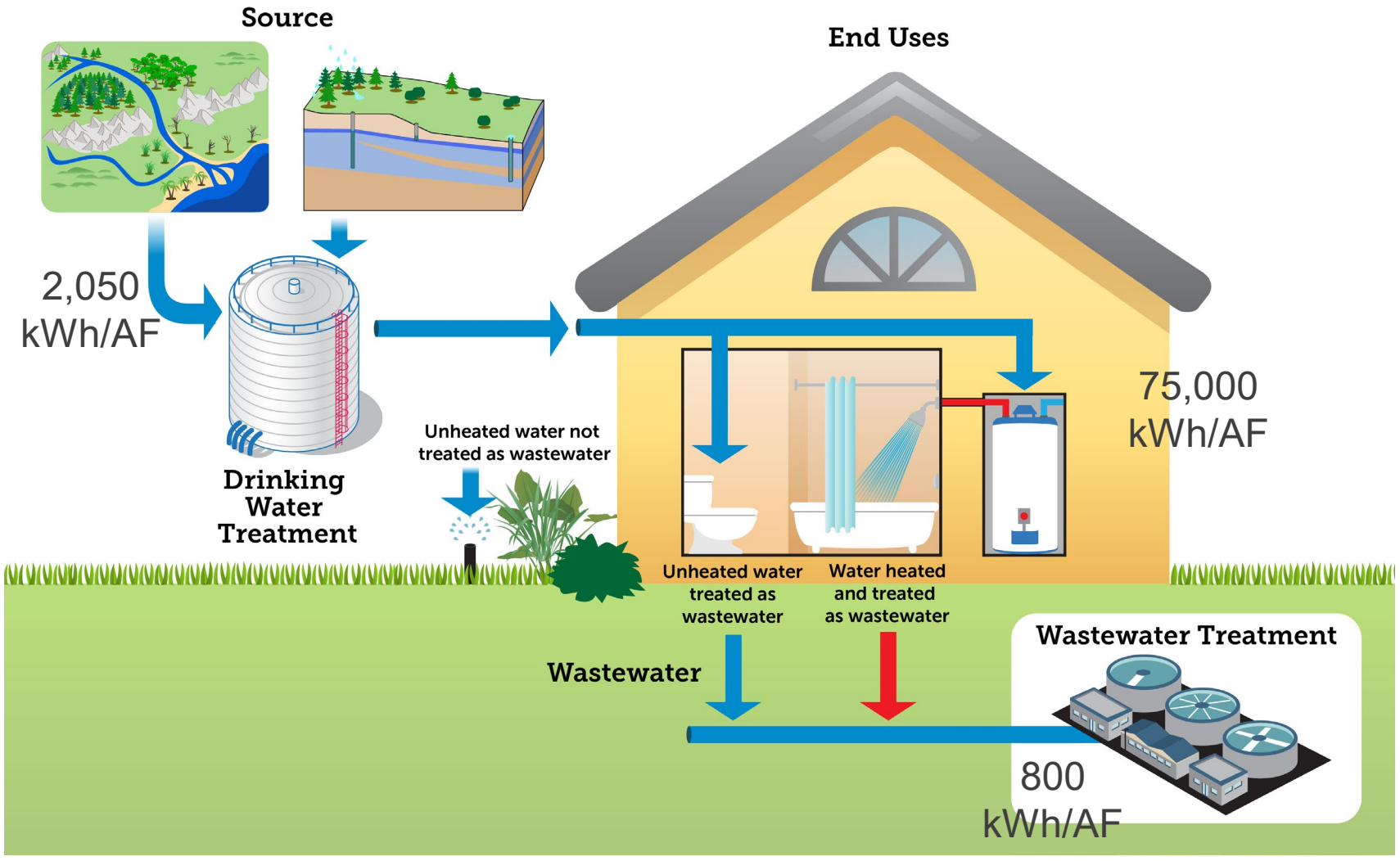
Source	Extraction/ Conveyance	Treatment	Distribution	Total Energy
Groundwater	576	3	163	**742**
Recycled	0	521	163	**684**
Colorado River Aqueduct	2,500	144	163	**2,807**
State Water Project	3,214	144	163	**3,521**

Local Water Use Profile

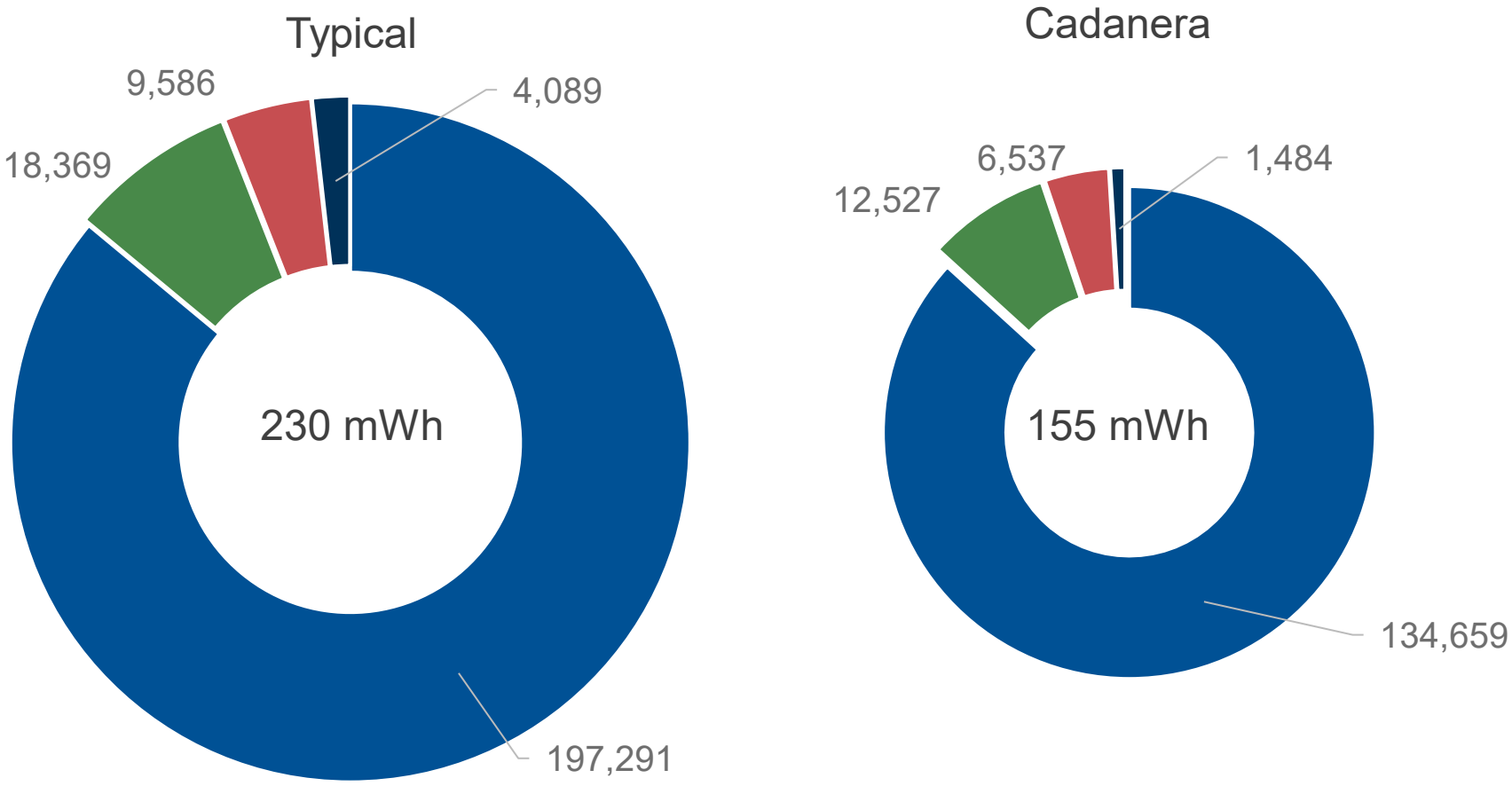
Source	Volume (AF/year)	Energy (total kWh/AF Delivered)
Groundwater	19,146	742
Recycled	743	684
Colorado River Aqueduct	9,831	2,807
State Water Project	12,823	3,521
Total	**42,500 AF/Year**	**2,050 Average kWh/AF Delivered**

A conservative estimate for the national average is 674 kWh/AF

What Influences the Energy Profile of Water?



Annual Energy Used for Water by Cadanera

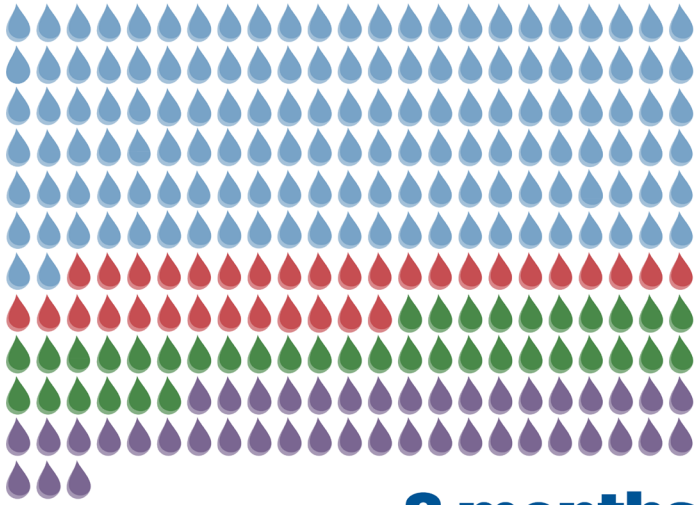


WaterSense Through 2021

look for WaterSense Meets EPA Criteria

WaterSense partners helped save

6.4 trillion gallons of water

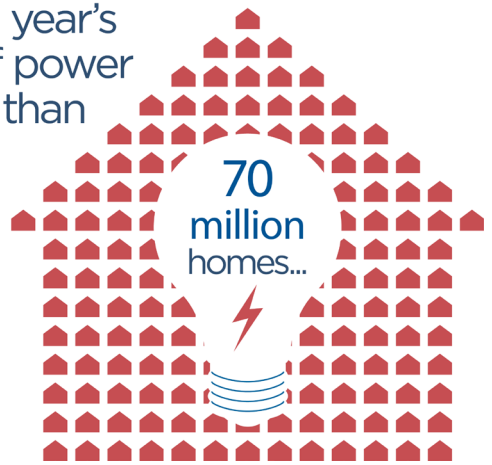


1.1 trillion gallons saved in 2021

That's the water used in **8 months** by all U.S. households!

WaterSense has helped reduce the amount of energy needed to pump, treat, and heat water by

754 billion kilowatt hours, enough to supply a year's worth of power to more than



WaterSense partners helped consumers save

$135 billion in water and energy bills

WaterSense partners helped eliminate

288 million metric tons of greenhouse gas emissions...

...the equivalent of planting **4.8 billion trees**

EPA

WaterSense Labeled Products

More than **43,000** product models have earned the label. Water factors are included in many **ENERGY STAR** certified products.

Flushing Urinals

Showerheads

Lavatory Faucets

Flushometer Valve Toilets

Tank-Type Toilets

Irrigation Controllers

Spray Sprinkler Bodies

WaterSense labeled homes

- Provides a whole-house/building approach to water efficiency
- Available for single and multifamily, new and existing construction
  - Most activity is in new construction
- Third-party certified to use at least 30% less water than typical new construction

EPA

ENERGY STAR® Portfolio Manager®

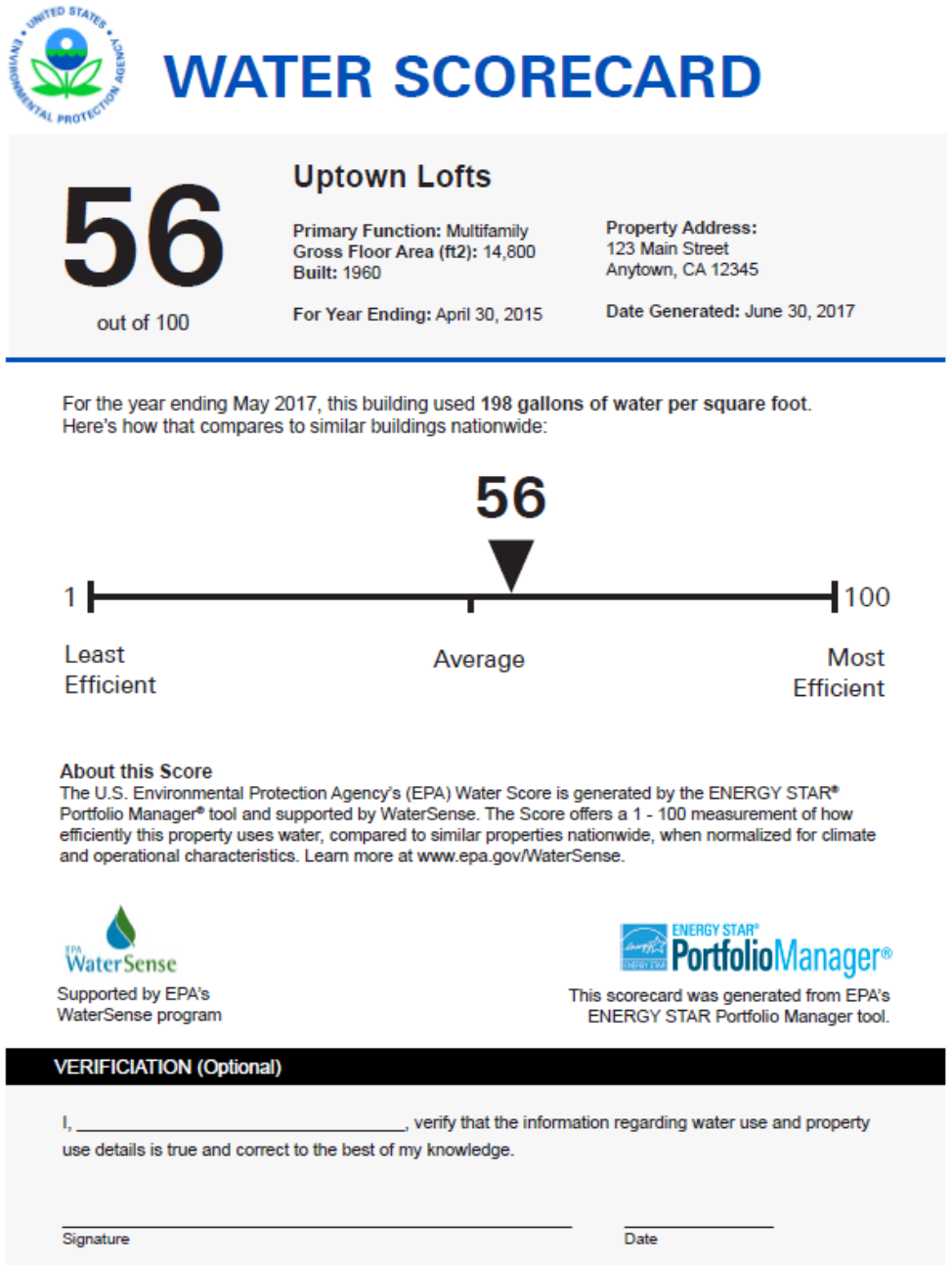
Who Uses Portfolio Manager?

- More than half a million properties track energy use
- 25% of the commercial building stock in the U.S.
- More than half of Fortune 100 companies
- Half of the largest healthcare organizations
- Numerous municipalities that require reporting of energy and/or water through Portfolio Manager

EPA

EPA Water Score for Multifamily Buildings

- For existing multifamily buildings
- Provides a 1-100 score analogous to an ENERGY STAR score
- Supported through ENERGY STAR Portfolio Manager
- Creates a meaningful peer comparison



WATER SCORECARD

56
out of 100

Uptown Lofts

Primary Function: Multifamily
Gross Floor Area (ft2): 14,800
Built: 1960

For Year Ending: April 30, 2015

Property Address:
123 Main Street
Anytown, CA 12345

Date Generated: June 30, 2017

For the year ending May 2017, this building used **198 gallons of water per square foot**.
Here's how that compares to similar buildings nationwide:

56

1 — 100

Least Efficient | Average | Most Efficient

About this Score
The U.S. Environmental Protection Agency's (EPA) Water Score is generated by the ENERGY STAR® Portfolio Manager® tool and supported by WaterSense. The Score offers a 1 - 100 measurement of how efficiently this property uses water, compared to similar properties nationwide, when normalized for climate and operational characteristics. Learn more at www.epa.gov/WaterSense.

EPA WaterSense
Supported by EPA's WaterSense program

ENERGY STAR® PortfolioManager®
This scorecard was generated from EPA's ENERGY STAR Portfolio Manager tool.

VERIFICIATION (Optional)

I, _____, verify that the information regarding water use and property use details is true and correct to the best of my knowledge.

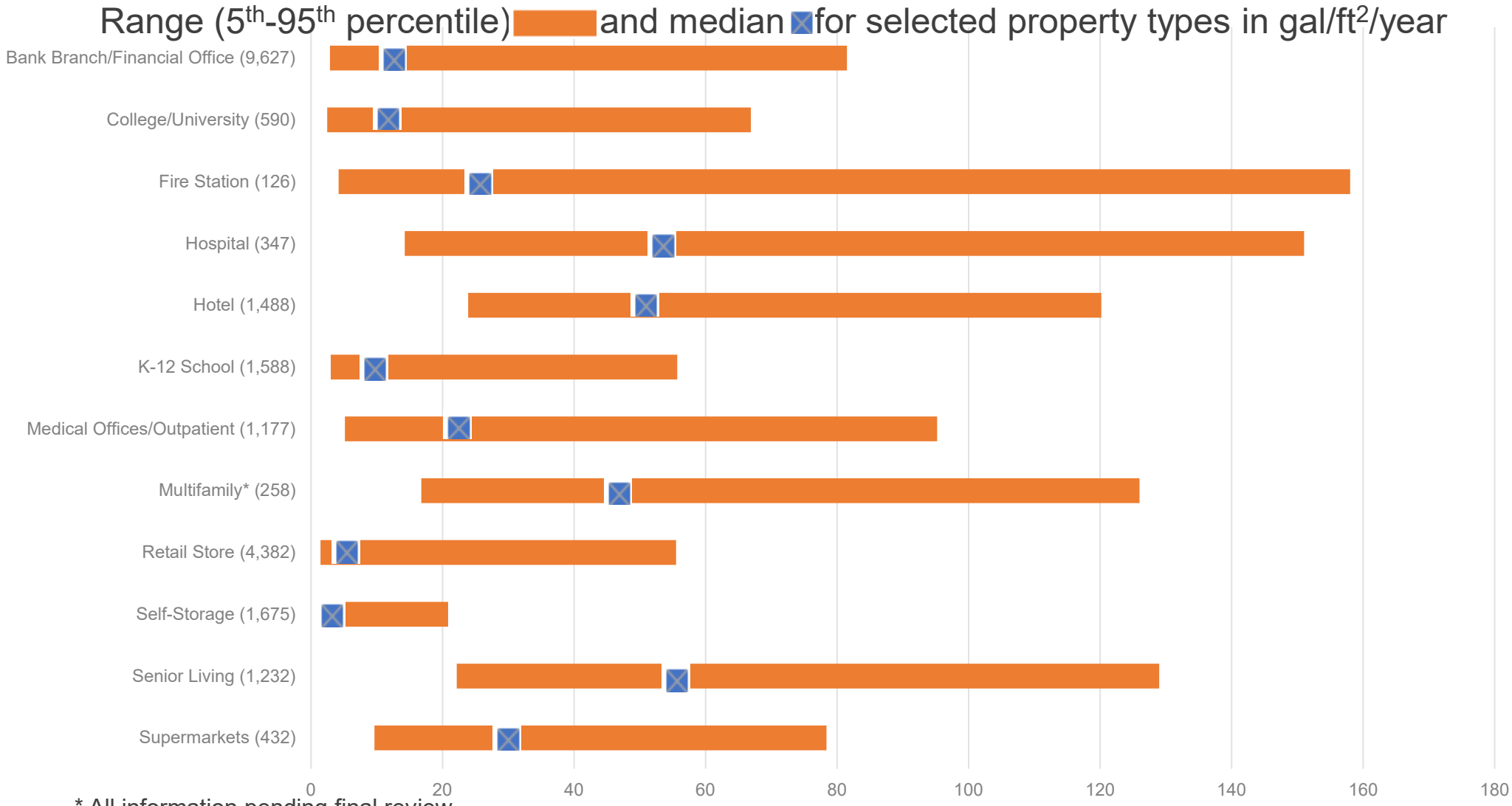
_____ Signature

_____ Date

look for WaterSense Meets EPA Criteria

EPA

Harnessing Portfolio Manager's Data



* All information pending final review

** The data above comes from ENERGY STAR Portfolio Manager entered by individual account holders or their service providers and may not have been verified by EPA. It also may not be representative of the building stock in the United States as a whole, or any individual location.

WaterSense Resources

- Water use information by facility type
- Best management practices
- Water-saving tips
- Assessment tools
- Worksheets and checklists
- Live and recorded training webinars
- Case studies and more!

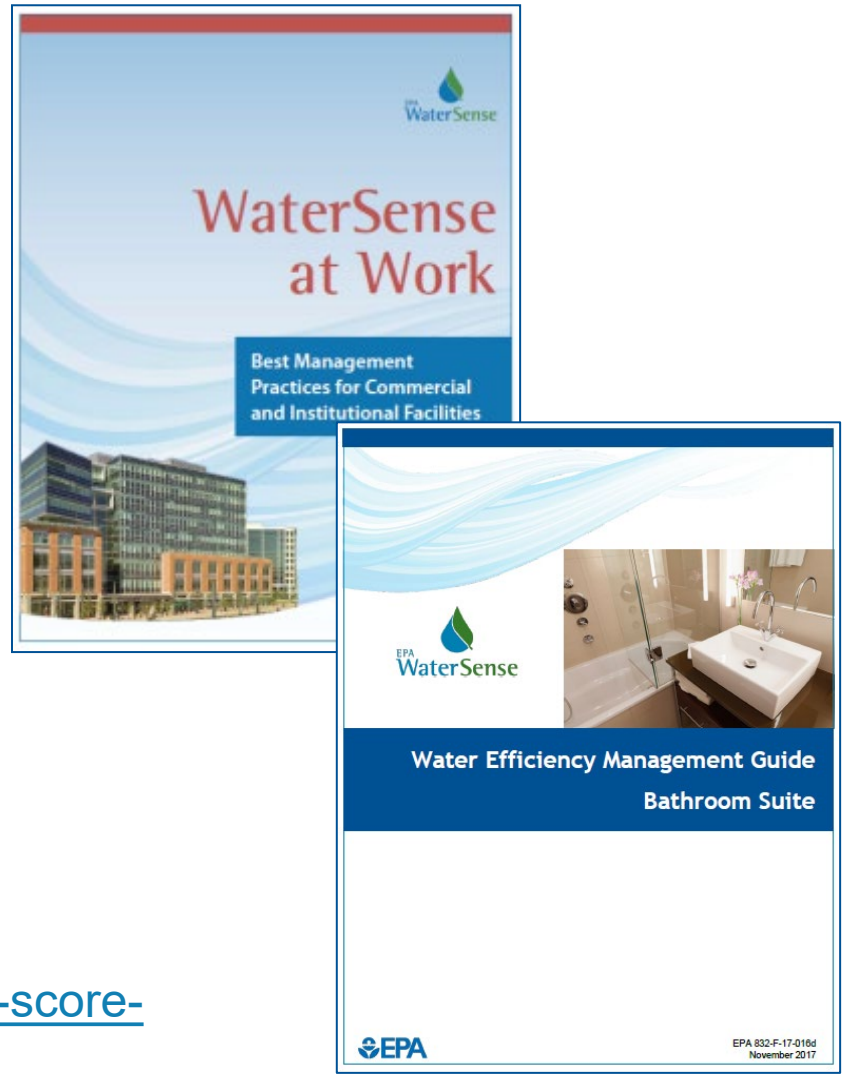
www.epa.gov/watersense/tools-ci-facilities

Best Management Practices

WaterSense at Work: best practices for all buildings

- Water management planning
- Water use monitoring and user education
- Sanitary fixtures, kitchen equipment
- Outdoor water use, Mechanical systems
- Lab & medical equipment
- Onsite alternative sources of water

Multi-family Guides and Assessment Worksheets



www.epa.gov/watersense/water-score-multifamily-housing

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EPA

Saving Water and Saving Energy in Growing Communities

Dan Cole, Sr. Director of Technical Services, IAPMO

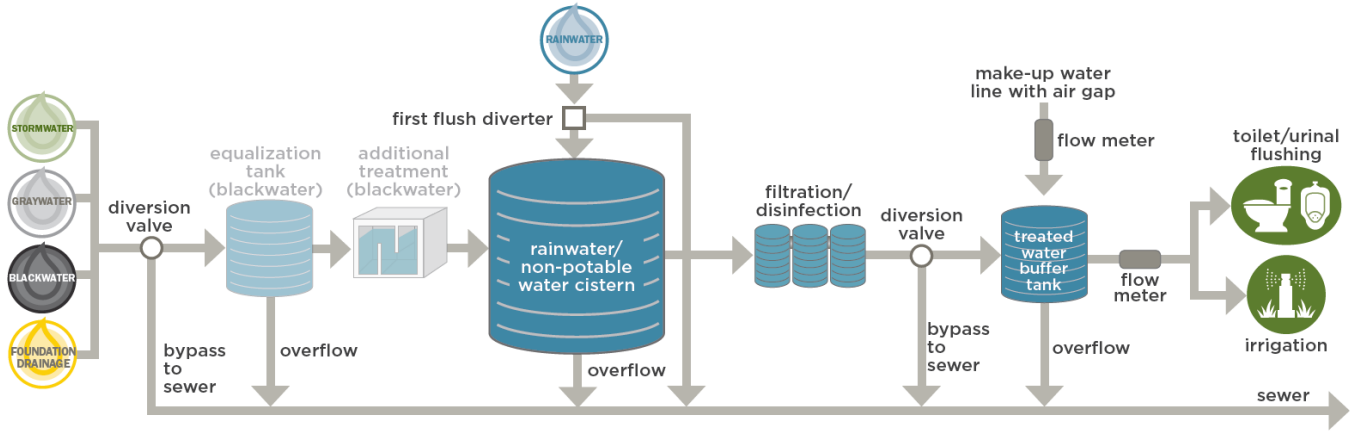
2023 NECC Conference

Saving Water
Optimize water use practices attributed to the built environment

Water Conserving Fixtures




Onsite Treatment Systems

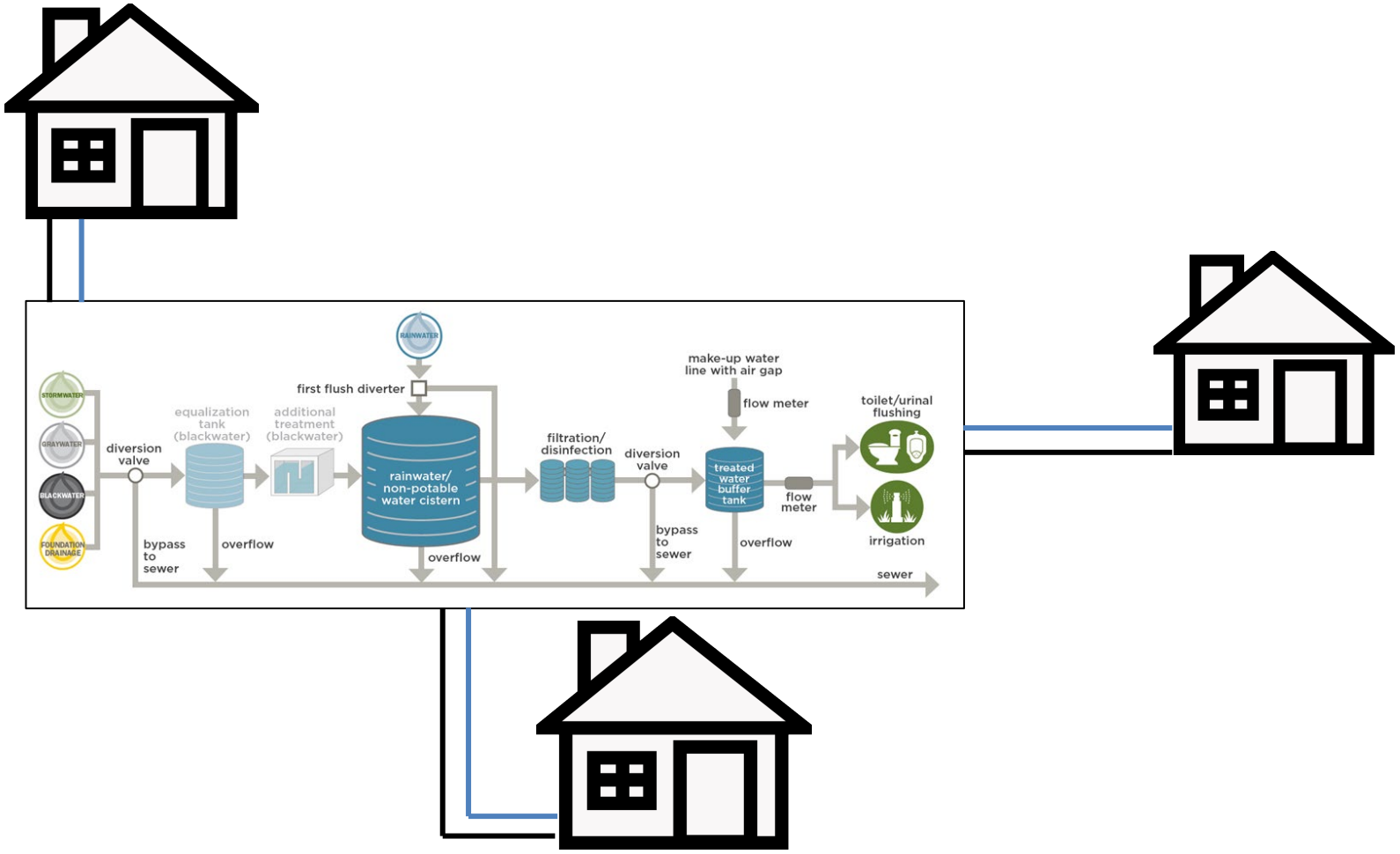


Saving Water
Optimize water use practices attributed to the built environment

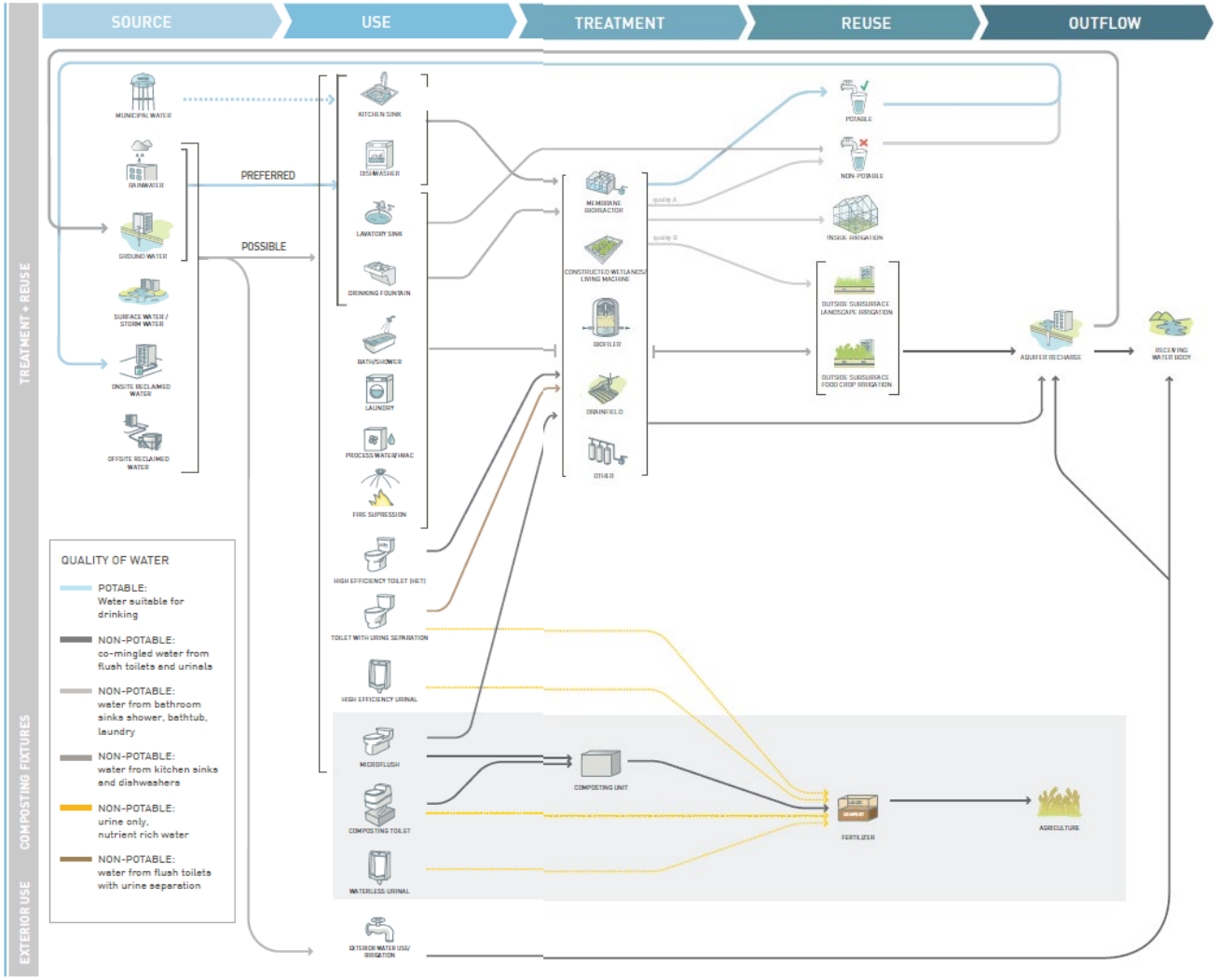
Composting and Urine Diversion

Water Heating Design

Decentralized Potable and Non-Potable Water Systems



Decentralized Systems Integration



Toward Net Zero Water: Best Management Practices for Decentralized Sourcing and Treatment, 2011

Carbon Footprint Calculations

Table 4.13. Power Consumption ±30% (kWh/kgal) up to Flow Range in MGD

Flow (MGD)	Conventional Customized	Conventional Package	Membrane Customized	Natural Systems
0–0.005	33.1	24.1	73.3	5.3
0.005–0.025	15.0	14.0	25.0	5.0
0.025–0.05	6.4	10.0	15.0	4.5
0.05– 0.1	5.0	3.8	6.0	3.4
0.1–0.5	4.0	3.7	4.0	2.0

Note: Power consumption does not include any pumping to the treatment plant. Values are considered approximate and should be used for guidance only. Actual power consumption will depend on additional processes and any additional pumping between stages at the treatment plant.

Water Demand Calculator

Water Demand Calculator (WDC v2.1)

PROJECT NAME : - - - - -

Click for Drop-down Menu → Single-Family Residence

Thursday, April 27, 2023
2:53 PM

FIXTURE GROUPS		FIXTURE	ENTER TOTAL NUMBER OF FIXTURES	PROBABILITY OF USE (%)	ENTER FIXTURE FLOW RATE (GPM)	MAXIMUM RECOMMENDED FIXTURE FLOW RATE (GPM)
Bathroom Fixtures	1	Bathtub (no Shower)	0	1.00	5.5	5.5
	2	Bidet	0	1.00	2.0	2.0
	3	Combination Bath/Shower	0	5.50	5.5	5.5
	4	Faucet, Lavatory	0	2.00	1.5	1.5
	5	Shower, per head (no Bathtub)	0	4.50	2.0	2.0
	6	Water Closet, 1.28 GPF Gravity Tank	0	1.00	3.0	3.0
Kitchen Fixtures	7	Dishwasher	0	0.50	1.3	1.3
	8	Faucet, Kitchen Sink	0	2.00	2.2	2.2
Laundry Room Fixtures	9	Clothes Washer	0	5.50	3.5	3.5
	10	Faucet, Laundry	0	2.00	2.0	2.0
Bar/Prep Fixtures	11	Faucet, Bar Sink	0	2.00	1.5	1.5
Other Fixtures	12	Fixture 1	0	0.00	0.0	6.0
	13	Fixture 2	0	0.00	0.0	6.0
	14	Fixture 3	0	0.00	0.0	6.0

COMPUTED RESULTS FOR PEAK PERIOD CONDITIONS

Total No. of Fixtures in Calculation

99th Percentile Demand Flow

Hunter Number

Stagnation Probability

DOWNLOAD RESULT

RESET WDC

↓ Select Units for Water Demand ↓

GPM | LPM | LPS

RUN WDC

← CLICK BUTTON ←

Water Demand Calculator

- Right size the water distribution system
- Reduces water volume in the piping system
- Reduced stagnation time in pipes
- Quicker hot water delivery time
- Reduces carbon emissions
- Saves energy

ARUP Report

Water Savings

Building Type	Unit Water Savings per fixture use (gallons)	Building Water Savings per unit per day (gallons)	Building Water Savings per building per day (gallons)	Annual Building Water Savings (gallons)
Single Unit	0.62	1.24	1.24	451
6-Unit	0.68	1.36	8.16	2,980
45-Unit	0.54	4.34	195	71,258

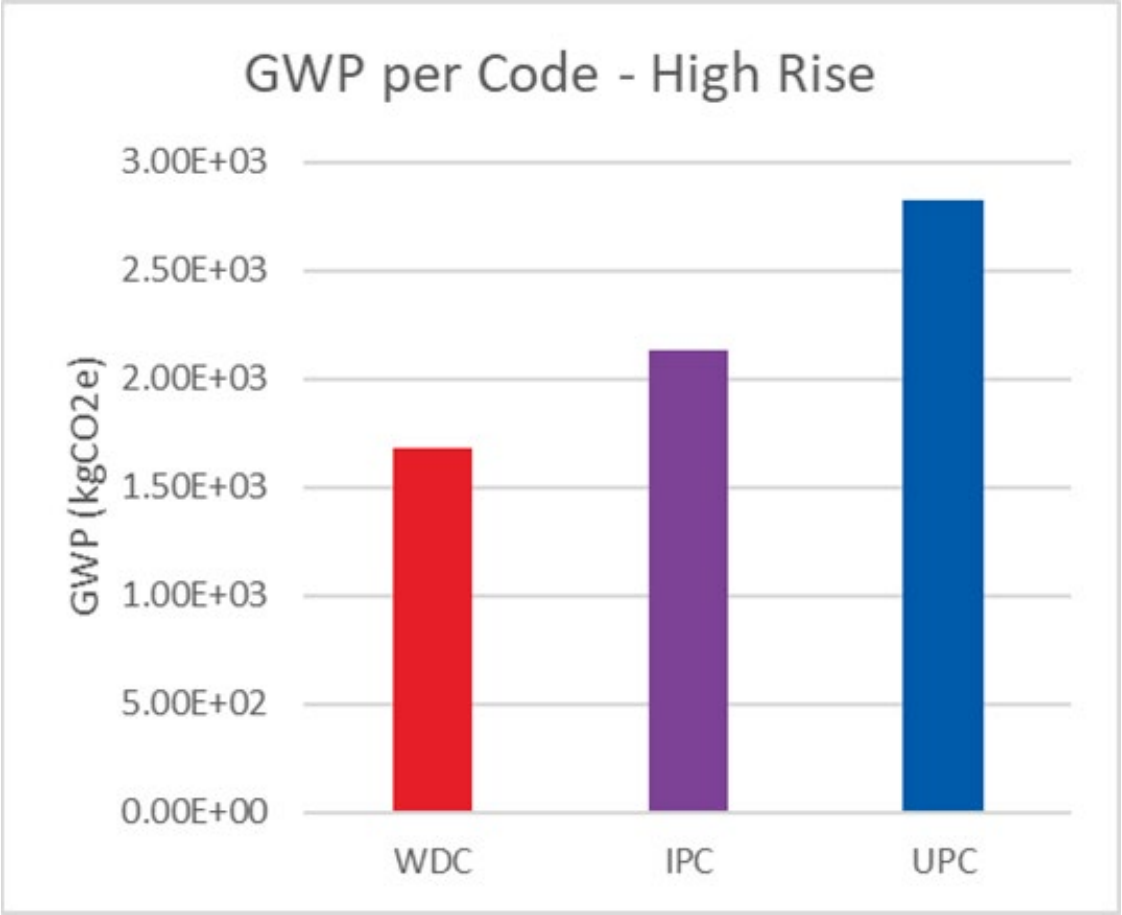
ARUP Report

Energy Savings as CO_2 emissions

	2021 Single Family Permits	EPA eGrid emissions factor (lb CO2/MWh)	Difference in tons CO_2 between WDC & IPC
New York	11,099	233.5	248
Arizona	46,561	846.6	3,769
Missouri	13,941	1480.7	1,974

ARUP Report

Embedded Carbon Reduction



Cost Savings

Cost Savings (US Dollars / Percent)

NEW YORK CITY Single-Family Home Savings $ / %		
Savings vs.	Copper	PEX
UPC ($)	$401	$56
UPC (%)	2%	0.3%
IRC ($)	$1,126	$81
IRC (%)	4%	0.4%

PITTSBURGH Single-Family Home Savings $ / %		
Savings vs.	Copper	PEX
UPC ($)	$299	$48
UPC (%)	2%	0.4%
IRC ($)	$857	$72
IRC (%)	6%	1%

OKLAHOMA CITY Single-Family Home Savings $ / %		
Savings vs.	Copper	PEX
UPC ($)	$277	$287
UPC (%)	2%	3%
IRC ($)	$804	$74
IRC (%)	7%	1%

NEW YORK CITY 6-Unit Multi-Family Savings $ / %		
Savings vs.	Copper	PEX
UPC ($)	$3,995	$9,482
UPC (%)	3%	8%
IPC ($)	$7,602	$9,012
IPC (%)	5%	8%

PITTSBURGH 6-Unit Multi-Family Savings $ / %		
Savings vs.	Copper	PEX
UPC ($)	$3,150	$8,509
UPC (%)	4%	12%
IPC ($)	$6,156	$8,212
IPC (%)	7%	12%

OKLAHOMA CITY 6-Unit Multi-Family Savings $ / %		
Savings vs.	Copper	PEX
UPC ($)	$3,037	$7,821
UPC (%)	5%	15%
IPC ($)	$6,033	$8,668
IPC (%)	9%	16%

NEW YORK CITY 45-Unit Multi-Family Savings $ / %		
Savings vs.	Copper	PEX
UPC ($)	$52,409	$33,154
UPC (%)	8%	5%
IPC ($)	$58,877	$26,494
IPC (%)	9%	4%

PITTSBURGH 45-Unit Multi-Family Savings $ / %		
Savings vs.	Copper	PEX
UPC ($)	$40,686	$28,226
UPC (%)	10%	8%
IPC ($)	$44,987	$22,535
IPC (%)	11%	6%

OKLAHOMA CITY 45-Unit Multi-Family Savings $ / %		
Savings vs.	Copper	PEX
UPC ($)	$38,800	$28,520
UPC (%)	12%	10%
IPC ($)	$42,441	$22,761
IPC (%)	13%	8%

Cost Savings

Meter Downsize Example	Minimum Connection Fee Savings	Maximum Connection Fee Savings	Mean Connection Fee Savings	Median Connection Fee Savings	Number of Communities
3/4" to 5/8"	($7.99)	$2,997.00	$421.62	$36.36	21
1" to 3/4"	$0.00	$17,564.00	$1,883.05	$887.00	35
1.5" to 1"	$100.00	$19,661.00	$3,699.98	$2,573.50	42
2" to 1.5"	$0.00	$33,571.00	$4,598.31	$2,812.00	42
3" to 2"	$520.00	$82,583.00	$18,512.13	$11,425.27	31
4" to 3"	$0.00	$148,649.00	$24,648.19	$12,357.00	30
6" to 4"	$208.08	$478,979.00	$52,718.44	$25,670.00	30
8" to 6"	$35.52	$210,000.00	$58,349.85	$33,899.65	27
10" to 8"	$65.98	$465,254.69	$97,056.65	$37,910.50	18
12" to 10"	$65.97	$580,272.00	$137,762.23	$45,900.00	13

Table 4: Summary Statistics for Connection Fee Savings Related to Downsizing Meter Size by One Size, as of 2020

Cost Savings

Meter Downsize Example	Minimum Connection Fee Savings	Maximum Connection Fee Savings	Mean Connection Fee Savings	Median Connection Fee Savings	Number of Communities
1.5" to 5/8"	$185.00	$40,222.00	$6,557.22	$3,910.00	27
2" to 3/4"	$250.00	$57,808.00	$9,687.79	$4,920.00	37
3" to 1"	$690.00	$132,132.00	$28,389.50	$18,392.00	31
4" to 1.5"	$300.00	$264,803.00	$48,021.76	$25,730.00	31
6" to 2"	$600.00	$710,211.00	$92,853.86	$47,090.00	30
8" to 3"	$2,160.00	$435,154.00	$133,123.43	$79,290.00	24
10" to 4"	$309.58	$559,878.33	$193,456.83	$95,074.50	18
12" to 6"	$167.47	$994,752.00	$255,949.32	$108,760.00	14

Table 10: Summary Statistics for Connection Fee Savings Related to Downsizing Meter Size by Three Sizes, as of 2020

Cost Savings

Copper Construction	Naples, FL (vs. IRC/IPC)	Portland, OR (vs. UPC)	San Diego, CA (vs. UPC)	San Francisco, CA (vs. UPC)	Tamps Bay, FL (vs. IRC/IPC)
Market Rating	Low Cost Market	High Cost Market	High Cost Market	High Cost Market	Low Cost Market
Single Family					
Material and Labor Savings (copper)	$ 804	$ 401	$ 401	$ 401	$ 804
Meter Connection Fee (1" to 3/4")	$ 2,124	$ 3,412	$ 3,375	$ 17,564	$ 4,200
Total	**$ 2,928**	**$ 3,813**	**$ 3,776**	**$ 17,965**	**$ 5,004**
6-Unit Multi-Family					
Material and Labor Savings (copper)	$ 6,033	$ 3,995	$ 3,995	$ 3,995	$ 6,033
Meter Connection Fee (IPC - 1-1/2" to 1") (UPC – 2" to 1")	$ 3,540	$ 18,769	$ 19,656	$ 37,635	$ 3,500
Total	**$ 9,573**	**$ 22,764**	**$ 23,651**	**$ 41,630**	**$ 9,533**
45-Unit Multi-Family					
Material and Labor Savings (copper)	$ 42,441	$ 52,409	$ 52,409	$ 52,409	$ 42,441
Meter Connection Fee (IPC - 3" to 1-1/2") (UPC – 4" to 1-1/2")	$ 15,576	$ 68,249	$ 73,164	$ 150,059	$ 31,500
Total	**$ 58,017**	**$ 120,298**	**$ 125,573**	**$ 202,468**	**$ 73,941**

WE•Stand

For more information visit

https://www.iapmo.org/we-stand

WE STAND

WE•Stand

IAPMO's Water Efficiency and Sanitation Standard (WE•Stand) is an American National Standard, replacing the *Green Plumbing and Mechanical Code Supplement*. The publication of WE•Stand is noteworthy, as it is the first-ever standard that focuses solely on achieving safe and efficient water use in both residential and non-residential buildings.

WE•Stand Technical Committee: The publication of the WE•Stand is a result of the exceptional work completed by the WE•Stand Technical Committee. Comprised of leading industry experts, the provisions contained in this standard reflect centuries of collective experience and knowledge of the committee. With representation from code officials, manufacturers, plumbing engineers, contractors, the plumbing trades, water-efficiency proponents, water utilities, landscape irrigation experts, representatives of other associations and academia, the contents of the WE•Stand include the latest comprehensive provisions aimed towards achieving safe and reliable water efficiencies in and around buildings.

See below for some significant provisions contained in the current edition of the WE•Stand:

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SYSTEM REQUIREMENTS FOR WATER DEMAND CALCULATOR

Water in High Performance Buildings

National Energy Codes Conference
Chicago May 2-4, 2023

Gary Klein

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916-549-7080

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Key Principles

- Reduce the waste
- Improve the use
- Increase the efficiency

What Reduces Hot Water Use?

- End uses closer to water heater(s)
- Insulating hot water supply piping
- Truly “Instantaneous” water heaters
- Warmer incoming cold water

- Lower flow rate plumbing fixtures
- Lower volume plumbing appliances
- Using waste heat running down the drain to preheat cold water

- Anything else?

What Increases Hot Water Use?

- End uses further from water heater(s)
  - More volume to clear
- Uninsulated hot water supply piping
  - More uses start out with colder water
- Lower flow rate plumbing fixtures
  - Increases waste while waiting for hot water to arrive
- “Instantaneous” water heaters
  - Cold water runs through while ramping up to temp
- Colder incoming cold water
  - Increases the percent of hot water in the mix
- Anything else?

The most valuable water to conserve is hot water at the top of the tallest building, with the highest elevation, in the area with the greatest pressure drop.

Customers

1. What do they expect?
2. What do they want?
3. How do we increase customer satisfaction?

What Are We Aiming For?

1. People want:
   - The water flowing from their showers and faucets to “feel” right.
   - Their toilets to flush first time, every time.
   - Clean clothes, dishes and bodies
   - The service of hot water, as efficiently as possible.
2. It does not make sense to discuss efficiency until the desired service has been provided.

How Do We Increase Customer Satisfaction?

1. Reduce the Time-to-Tap
   a) Reduce the Distance from the Source to the Use
   b) Right-Size the Piping based on Modern Flow Rates and Realistic Simultaneity
2. Reduce the Pressure Drop
   a) In the Pipe and Fittings
      1) Minimize the length
      2) Minimize the number of pressure-consuming fittings
   b) In the Faucets and Shower Valves
3. Install Pressure-Independent Faucet Aerators and Showerheads

The Ideal
Hot Water Distribution System

- Has the smallest volume (length and smallest "possible" diameter) of pipe from the source of hot water to the hot water outlet.
- Sometimes the source of hot water is the water heater, sometimes a trunk line.
- For a given layout (floor plan) of hot water locations the system will have:
  - The shortest buildable trunk line
  - Few or no branches
  - The shortest buildable twigs
  - The fewest plumbing restrictions
  - Insulation on all hot water pipes, minimum R-4

How Long Should We Wait?

Volume in the Pipe (ounces)	Minimum Time-to-Tap (seconds) at Selected Flow Rates					
	0.25 gpm	0.5 gpm	1 gpm	1.5 gpm	2 gpm	2.5 gpm
2 1	4	1.9	0.9	0.6	0.5	0.4
4 2	8	4	1.9	1.3	0.9	0.8
8 4	15	8	4	2.5	1.9	1.5
16 8	30	15	8	5	4	3
24 12	45	23	11	8	6	5
32 16	60	30	15	10	8	6
64 32	120	60	30	20	15	12
128 64	240	120	60	40	30	24

Cut the pipe volume in half to get these times

ASPE Time-to-Tap Performance Criteria

	Acceptable Performance	1 – 10 seconds
	Marginal Performance	11 – 30 seconds
	Unacceptable Performance	31+ seconds

Source: Domestic Water Heating Design Manual – 2nd Edition, ASPE, 2003, page 234

For volume per foot see 2018 UPC Table L 502.7 or 2018 IPC Table E 202.1

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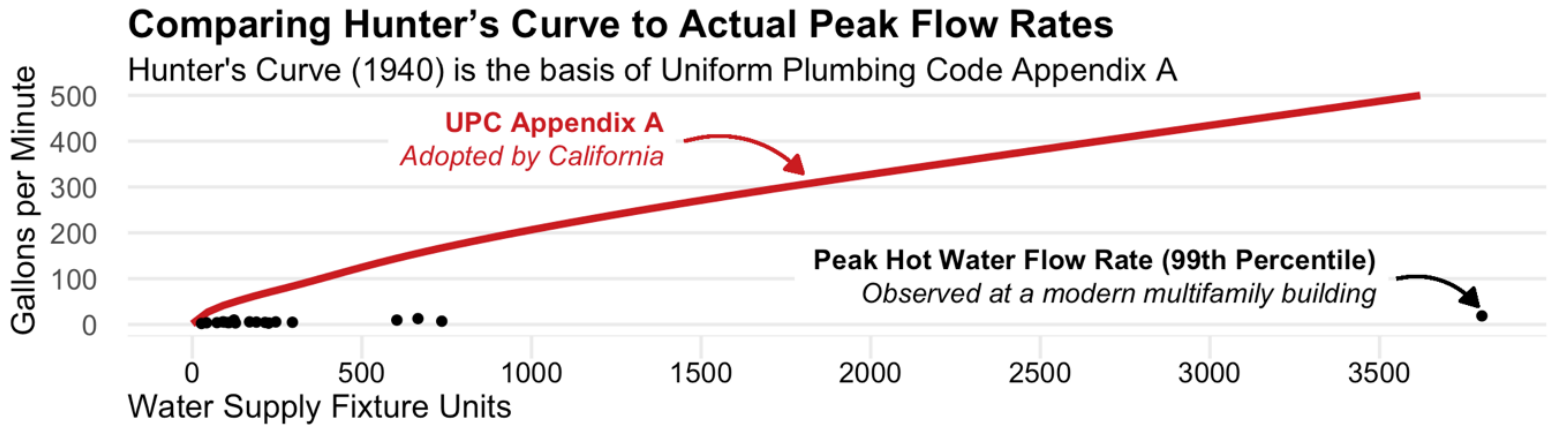
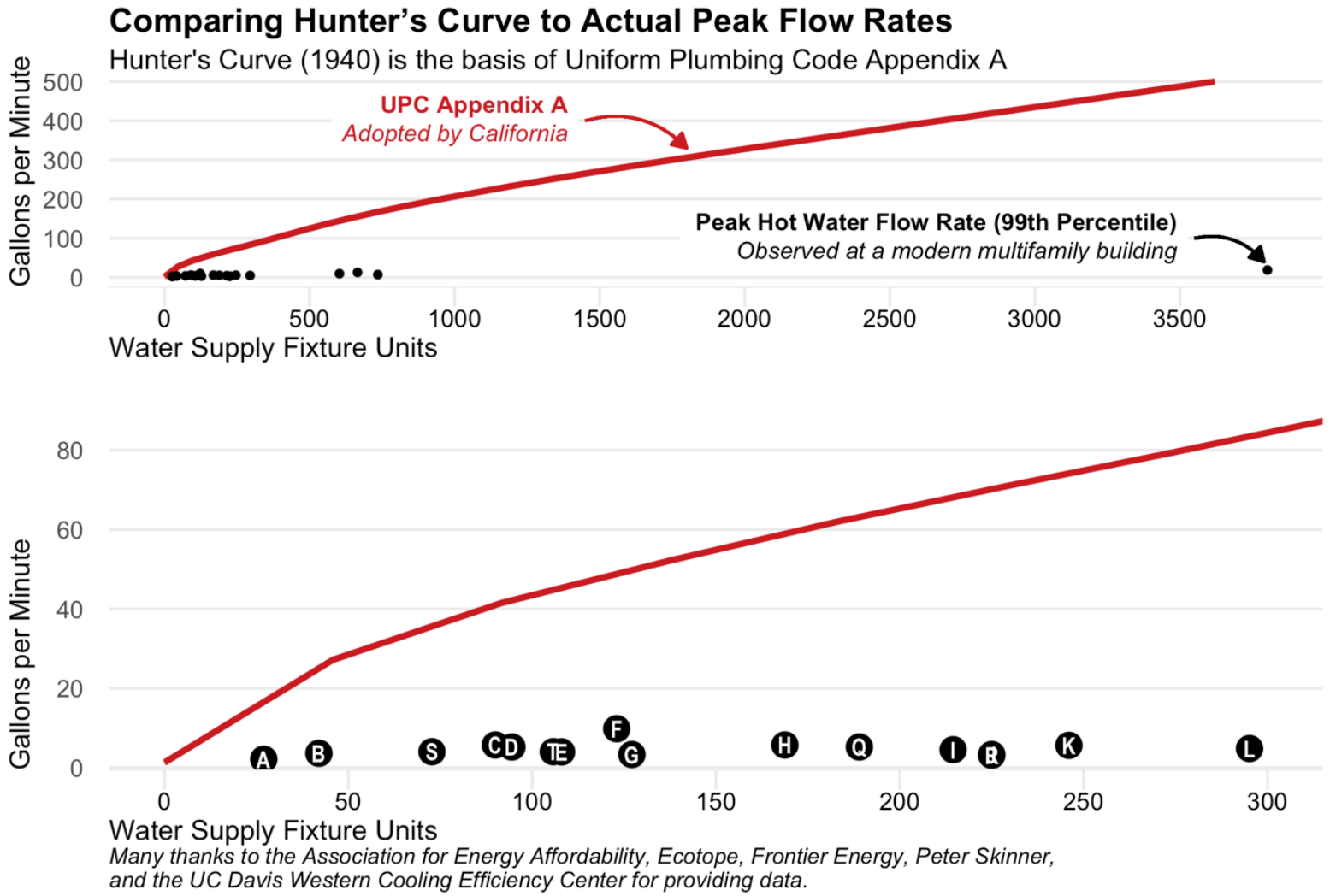
Peak Flow Rates-Measured vs Predicted

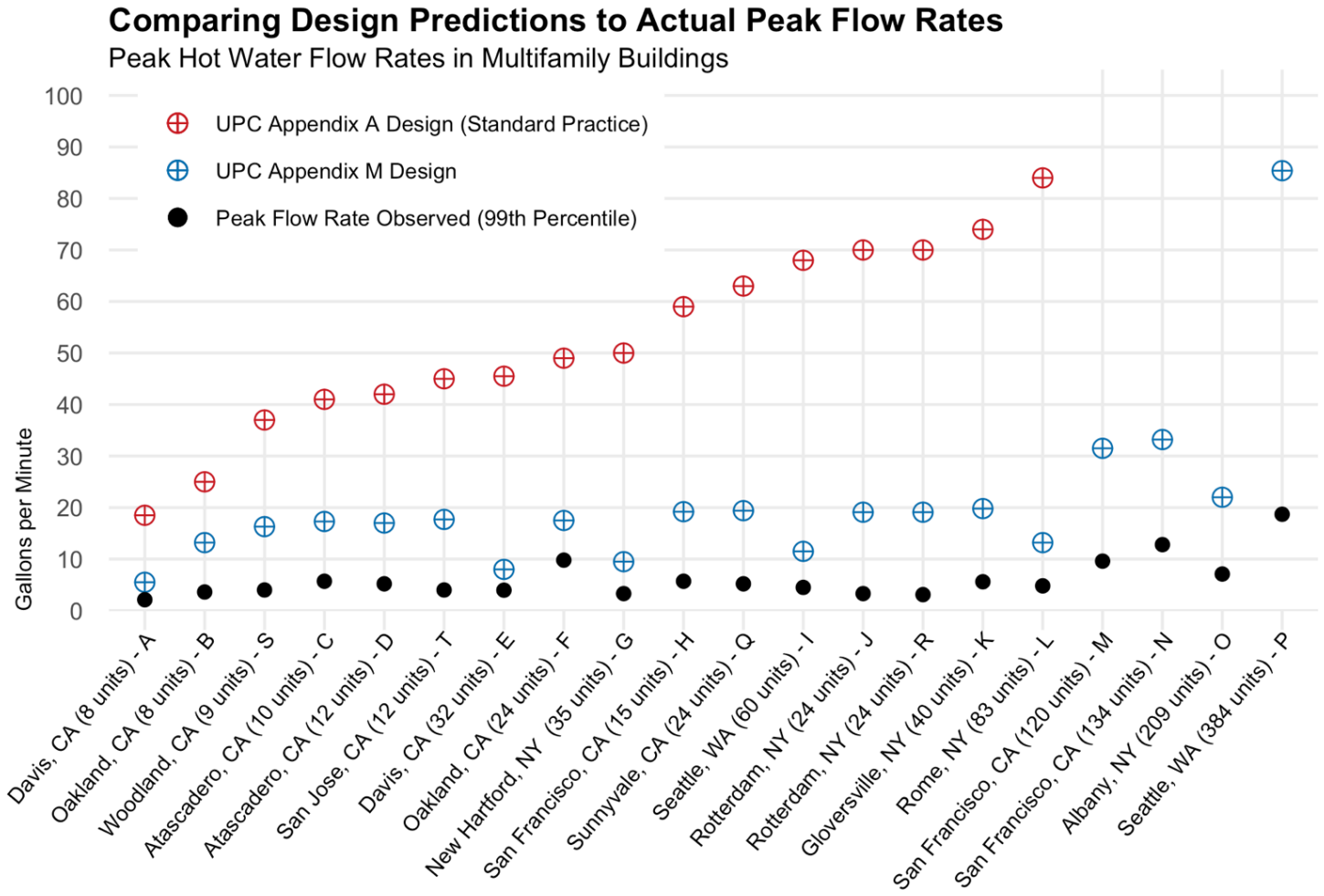


Peak Flow Rates-Measured vs Predicted



Many thanks to the Association for Energy Affordability, Ecotope, Frontier Energy, Peter Skinner, and the UC Davis Western Cooling Efficiency Center for providing data.

Peak Flow Rates-Measured vs Predicted



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The Housing and Community Development proposal to include Appendix M from the 2021 UPC into the California Plumbing Code was approved by California Building Standards Commission's PEME-CAC
March 15-16, 2023

The next steps are 45- and 15-day language. If all goes well, the proposal will be approved by the CBSC sometime this summer and will become code in the middle of 2024.

https://www.dgs.ca.gov/BSC/Rulemaking/2022-Intervening-Cycle/2022-CAC-Mtgs

Why Your Shower Feels Wimpy

Let's Look at a 2nd Floor Shower

	PSI	PSI
Street Pressure	60	80
Go up 20 feet	- 9	- 9
Tub/Shower Valve	- 11	- 11
Losses in the piping	- 20	- 20
Total of the Pressure Losses	- 40	- 40
Residual Pressure at the shower head	20	40

Showerhead flow rates are determined at 80 psi.

For fixed orifice showerheads, the flow rate will be much less

Flow rate at 40 psi = 0.7 * Flow Rated at 80 psi

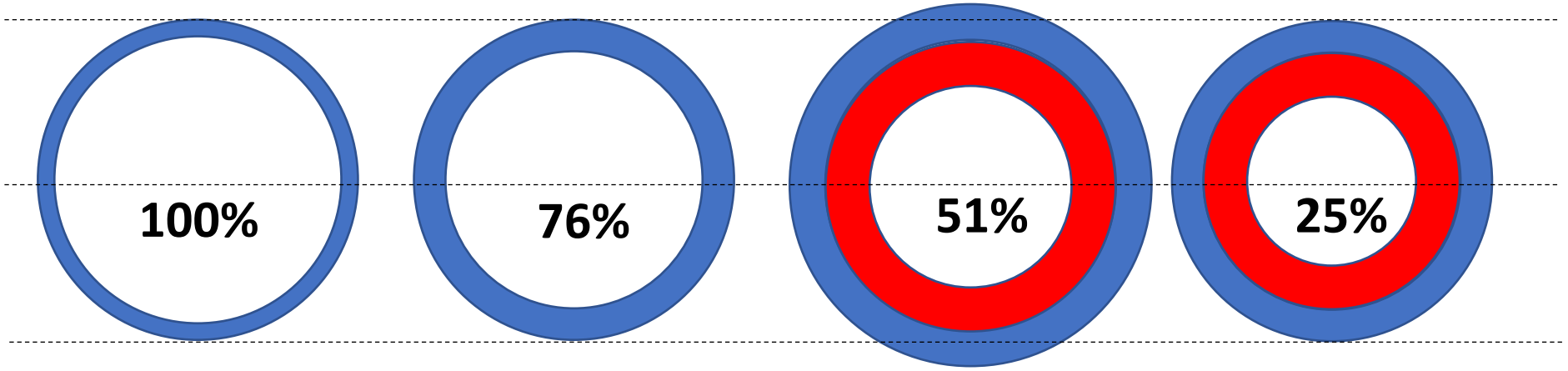
Flow rate at 20 psi = 0.49 * Flow Rated at 80 psi

Similar reductions for faucets with flow rated at 60 psi

Downey, CA

Arcata, CA

Relative Size of the Waterway for Selected 0.5inch Pipe and Fittings



Copper Type-L

PEX or CPVC

PEX Cold-Expansion

PEX Crimp or Press

0.5 inch Nominal Pipe (inches)				
Size	Nom OD	Wall Ave	Tol+/-	Nom ID
1/2 PEX ASTM F876	0.625	0.070	0.010	0.475
1/2 CPVC, ASTM D2846	0.625	0.07	0.01	0.475
1/2 inch Copper Type-L ASTM B88	0.625	0.040	0.004	0.545

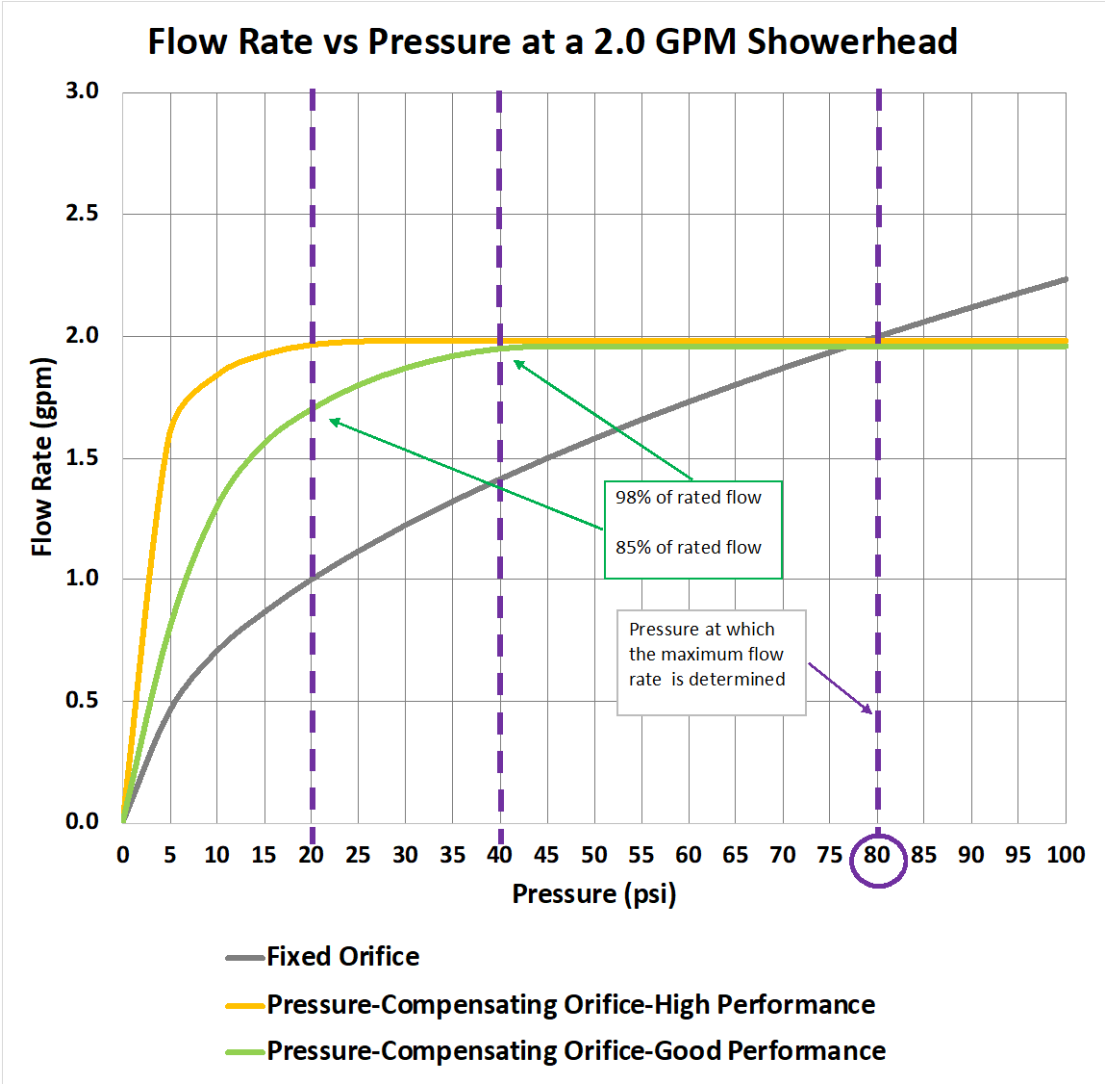
Target Flow Rates

Target Flow Rates for 0.375 Inch Pipe					
Flow Velocity (ft/s)	2	4	6	8	10
	Flow Rate Target (gpm)				
0.375 inch PEX	0.60	1.20	1.80	2.40	3.00
0.375 inch CPVC	0.63	1.27	1.90	2.54	3.17
0.375 inch Copper	0.91	1.81	2.72	3.62	4.53

Target Flow Rates for 0.5 Inch Pipe					
Flow Velocity (ft/s)	2	4	6	8	10
	Flow Rate Target (gpm)				
0.5 inch PEX	1.10	2.21	3.31	4.42	5.52
0.5 inch CPVC	1.15	2.30	3.45	4.61	5.76
0.5 inch Copper	1.45	2.91	4.36	5.82	7.27

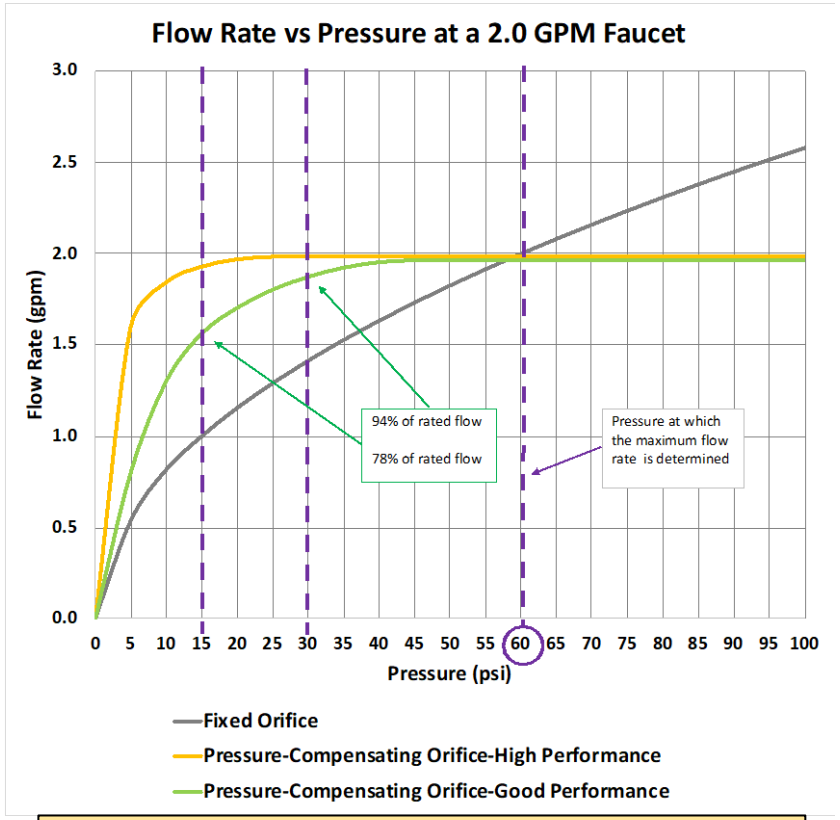
Pressure Independent Showerheads

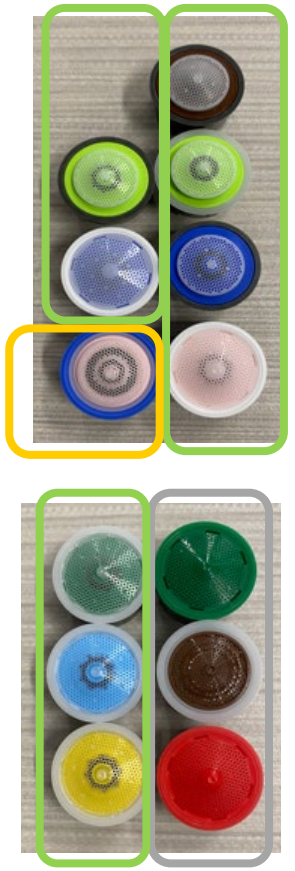
Which one do you want?



Pressure Independent Faucets

Which one do you want?





Select Good or High-Performance Faucet Aerators to Increase Customer Satisfaction.

Will more stringent codes and standards get us to a more resilient lower carbon future?

Given human nature,
it is our job
to provide the infrastructure
that supports efficient behaviors.

Questions?