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Some Key Results from REUWS2

Single Family Residential End Uses of Water Study Update

Water Research Foundation Project 4309

Research Team

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- Bill Gauley, Canadian sites
- Hazen and Sawyer, Jack Kiefer, Modeling
- Ben Dziegielewski, Benchmarking

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Study Funders & Participants

Cash Funders:

- Water Research Foundation, Denver, CO
- City of Fort Collins Utilities, Fort Collins, CO
- City of Portland Water Bureau, Portland, OR
- City of Scottsdale, AZ
- Clayton County Water Authority, Morrow, GA
- Denver Water, Denver, CO
- Regional Municipality of Peel, Mississauga, ON
- Regional Municipality Waterloo, Kitchener, ON
- San Antonio Water System, San Antonio, TX
- Tacoma Public Utilities, Tacoma, WA
- Tacoma Power, Tacoma, WA
- Tampa Bay Water, Clearwater, FL
- Toho Water Authority, Kissimmee, FL

Participants (In-Kind Funders):

- Alliance for Water Efficiency, Chicago, IL
- Austin Water Utility, Austin, TX
- Chicago Dept. of Water Management, Chicago, IL
- City of Aurora Utilities, Aurora, CO
- City of Henderson, Henderson, NV
- City of Santa Barbara, Santa Barbara, CA
- City of Santa Fe, Santa Fe, NM
- Cobb County Water System, Marietta, GA
- Colorado Springs Utilities Dept., Colorado Springs, CO
- EPCOR Water Services Inc., Edmonton, AB
- Miami-Dade Water & Sewer Dept., Miami, FL
- Mountain View City Water Div., Mountain View, CA
- Otay Water District, Spring Valley, CA
- Philadelphia Water Dept., Philadelphia, PA
- San Diego Public Utilities Dept., San Diego, CA
- S. Central Connecticut Regional Water Authority, New Haven, CT
- Town of Cary Water Dept., Cary, NC

Study Sites for Logging (9 Level 1 sites)

REUWS1 (1996-97)	REUWS2 (2008-2012)
Boulder, CO	Fort Collins, CO
Denver, CO	Denver, CO
Cambridge/Waterloo, ON	Peel, ON
Eugene, OR	Cambridge/Waterloo, ON
Las Virgenes, CA	Scottsdale, AZ
Lompoc, CA	San Antonio, TX
Phoenix, AZ	Clayton Count, GA
Scottsdale/Tempe, AZ	Toho, FL
San Diego, CA	Tacoma, WA
Seattle, WA	
Tampa, FL	
Walnut Valley, CA	

These sites provided billing data, participated in the surveys, and supplied 100 home logging samples.

Study Sites for Survey (16 Level 2 sites)

North American Survey Group	North American Survey Group
Philadelphia, PA	City of Henderson, NV
Cobb County Water Authority, GA	City of Chicago, IL
City of San Diego, CA	City of Mountain View, CA
City of Santa Barbara, CA	City of Santa Fe, NM
Town of Cary, N.C.	City of Colorado Springs, CO
City of Aurora, CO	EPCOR, Edmonton, AL
Regional Water Authority of CT	Maimi-Dade County, FL
City of Austin, TX	Portland Water Bureau, OR

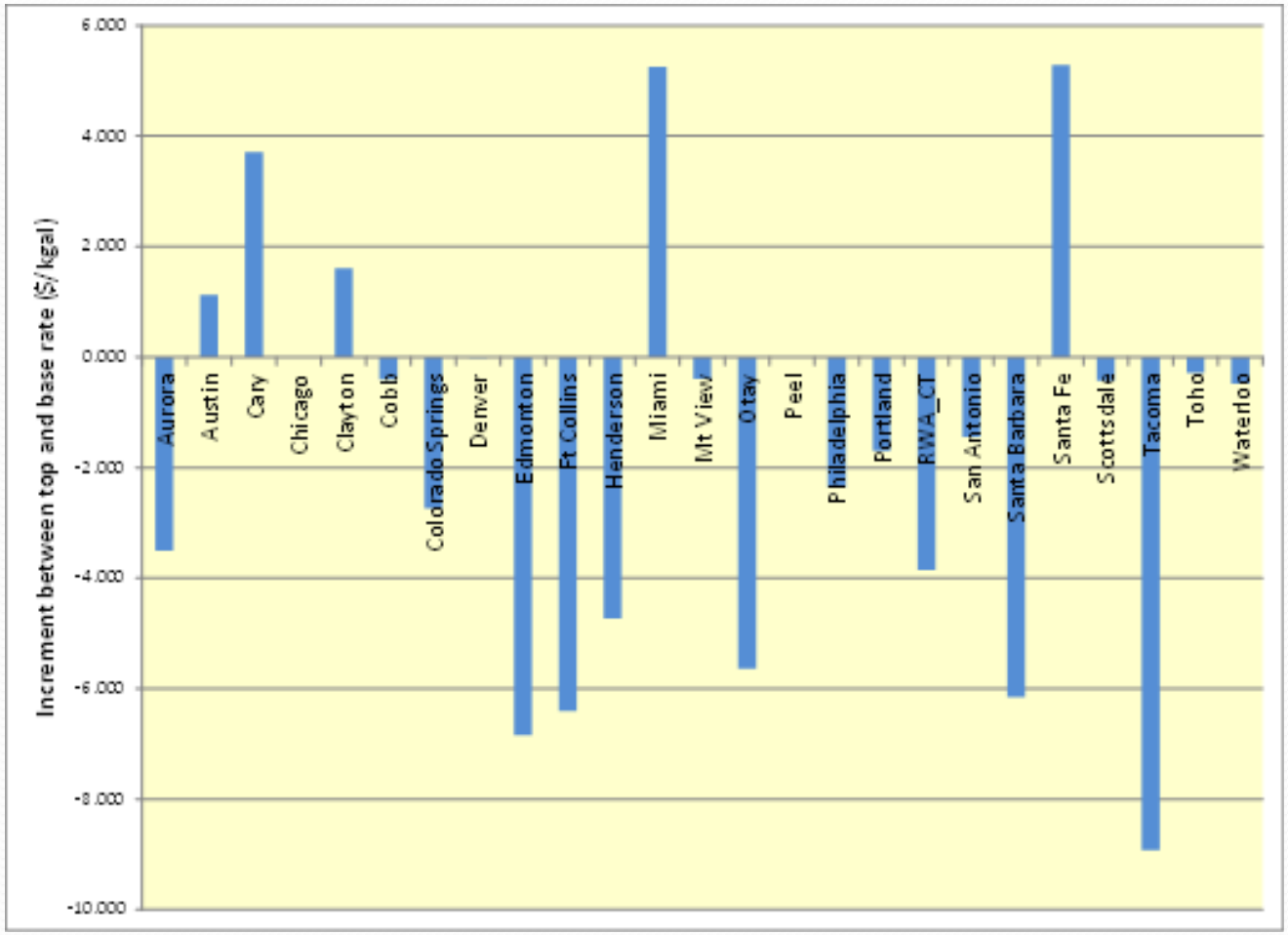
These sites provided billing data and participated in the survey.

Study Site Locations (for logging)

Some Differences in the Studies

- REUWS1 had 8 out of 12 (67%) sites in the southwest (intense irrigation)
- REUWS2 had 4 out of 9 (44%) sites in southwest
- Five of the REUWS2 sites were located in the areas with little irrigation occurring (southeast, northeast & northwest)
- REUWS2 only logged one time per site instead of 2
- REUWS2 included hot water analysis for 110 homes
- REUWS2 included aerial photo based landscape analysis for all homes.
- REUWS2 included a group of 16 sites for which survey and water use data were assembled, but not data logged. (North American Survey Group)

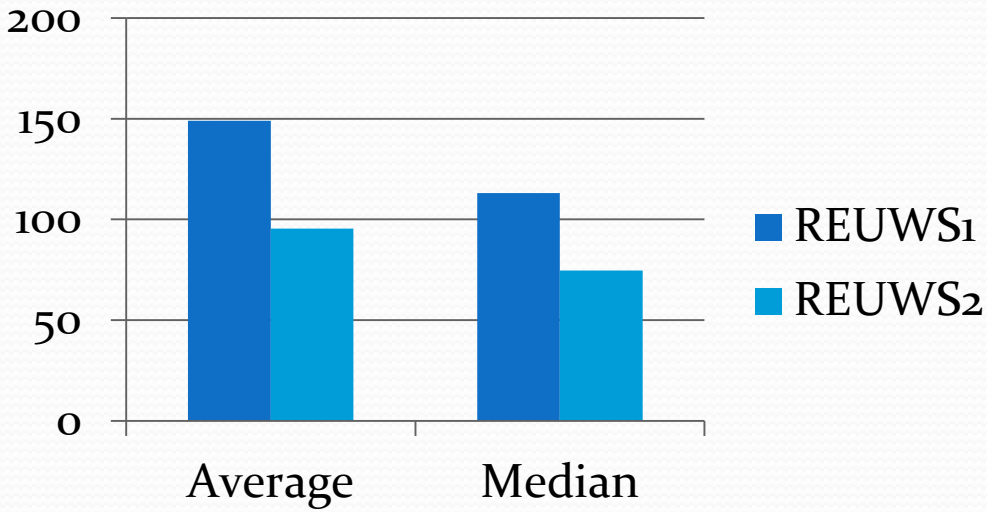
Increment in average cost for water between base and top rates: 20/25 do not increase.



Calculated as total billed amount for water and W.W./total consumption = ($/kgal)

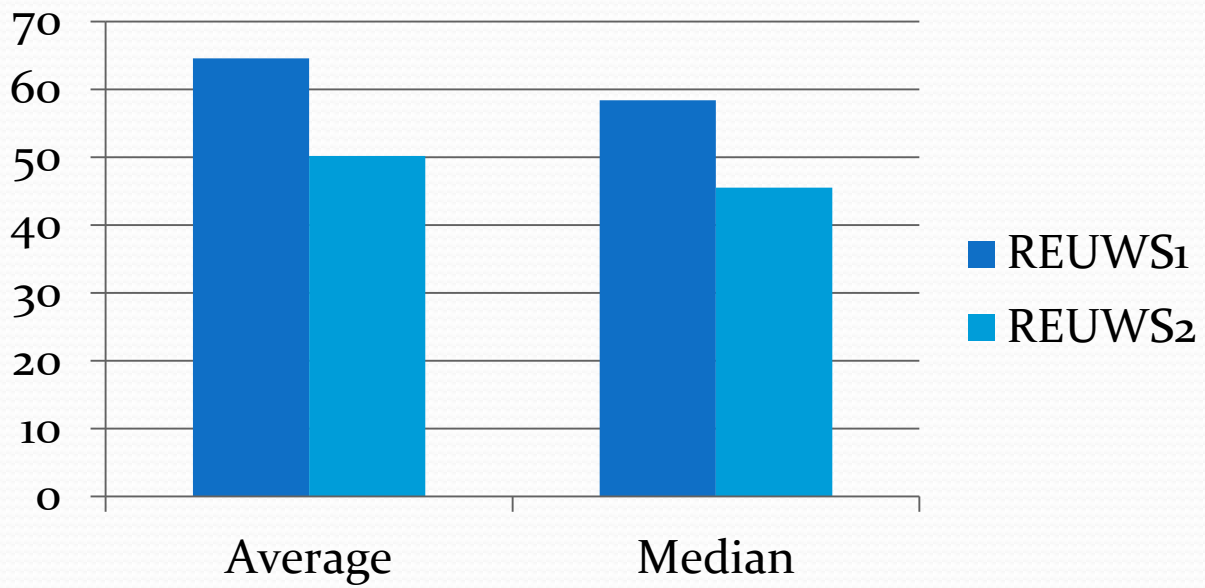
Annual Use (Indoor + Outdoor)

Annual Household Water Use	REUWS1	REUWS2 N=838
Average (kgal),	149	95.5 (36% decrease)
Median (kgal)	113	74.7



Indoor Use

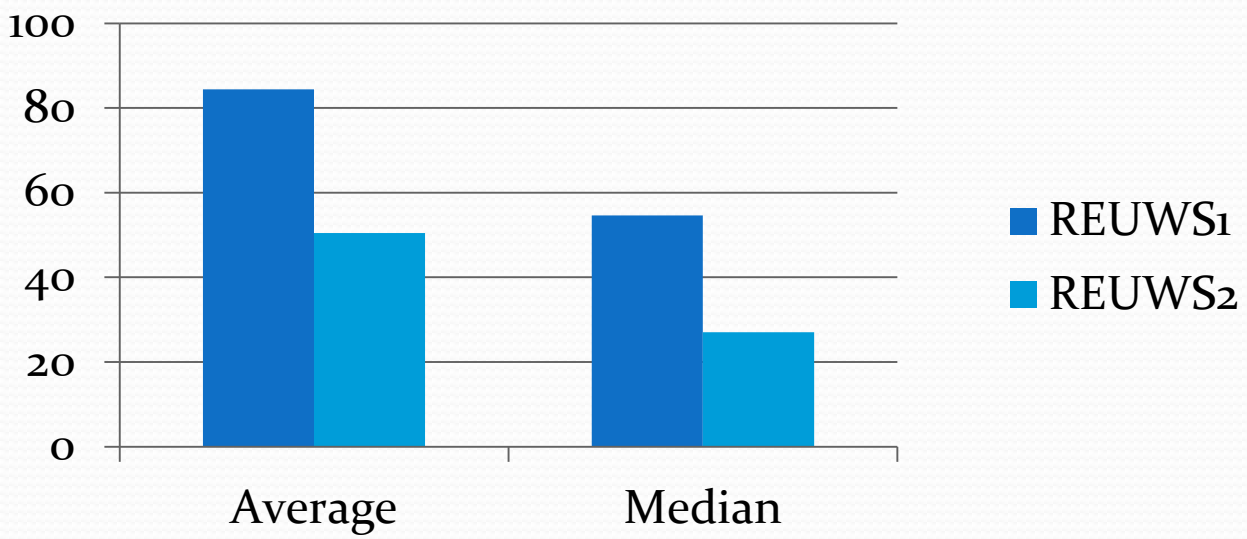
Annual Indoor Use	REUWS1	REUWS2 (N=763)
Average (kgal/hh)	64.6	50.2 (22% decrease)
Median (kgal/hh)	58.4	45.5



This decrease is due to factors that are similar in all sites (e.g. # residents and types of fixtures). It does represent a trend.

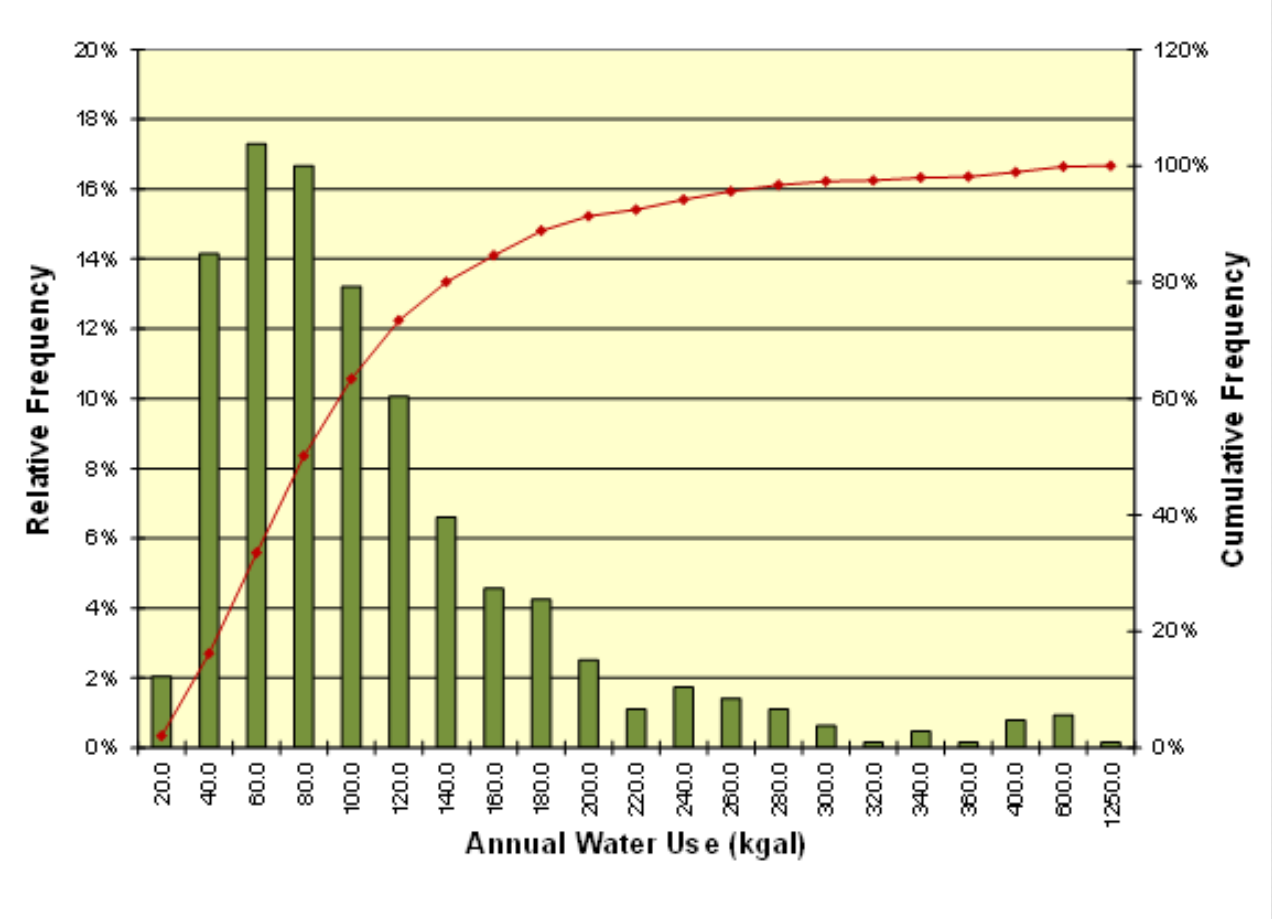
Annual Outdoor Use

Annual Outdoor Use	REUWS1	REUWS2 (N=835)
Average (kgal/hh)	84.4	50.5 (40% decrease)
Median (kgal/hh)	54.6	27.0



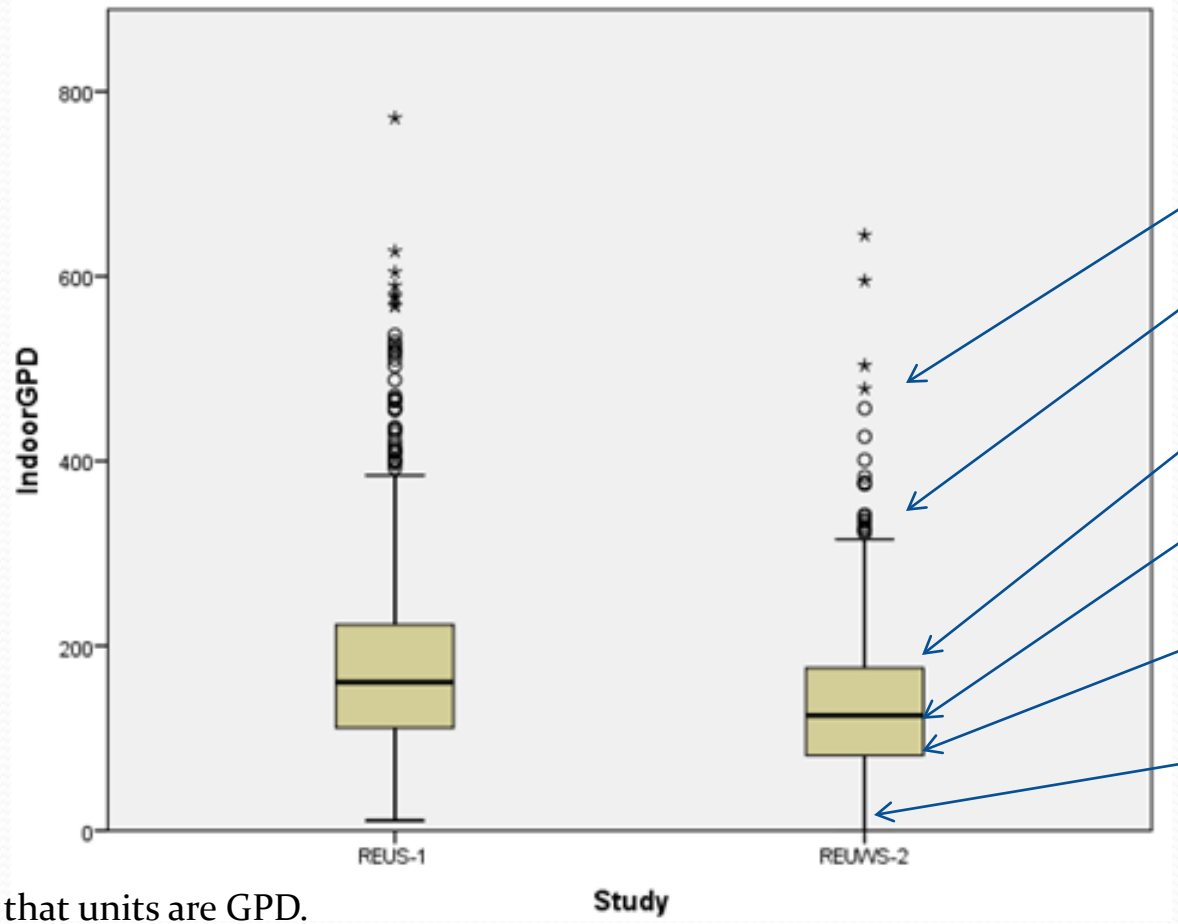
This decrease is due to many factors specific to localities, e.g. local weather, landscape design, and irrigation practices. It does not demonstrate a trend.

Typical log normal relationship:



Water use patterns are log normal, and this is an important fact when considering how best to affect use in a population.

Reduction in indoor household use:



>90 %'ile

90 %'ile

75 %'ile

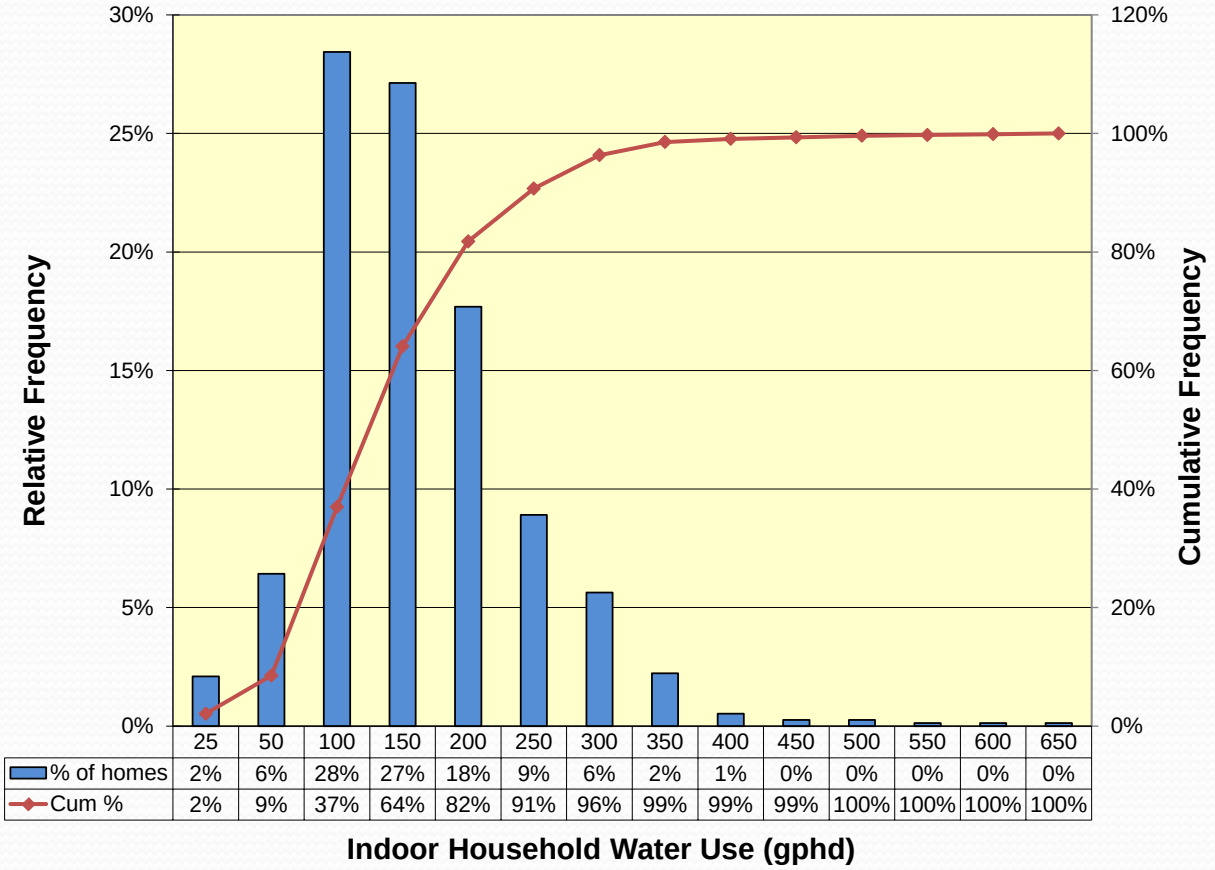
Median (50%'ile)

25 %'ile

10 %'ile

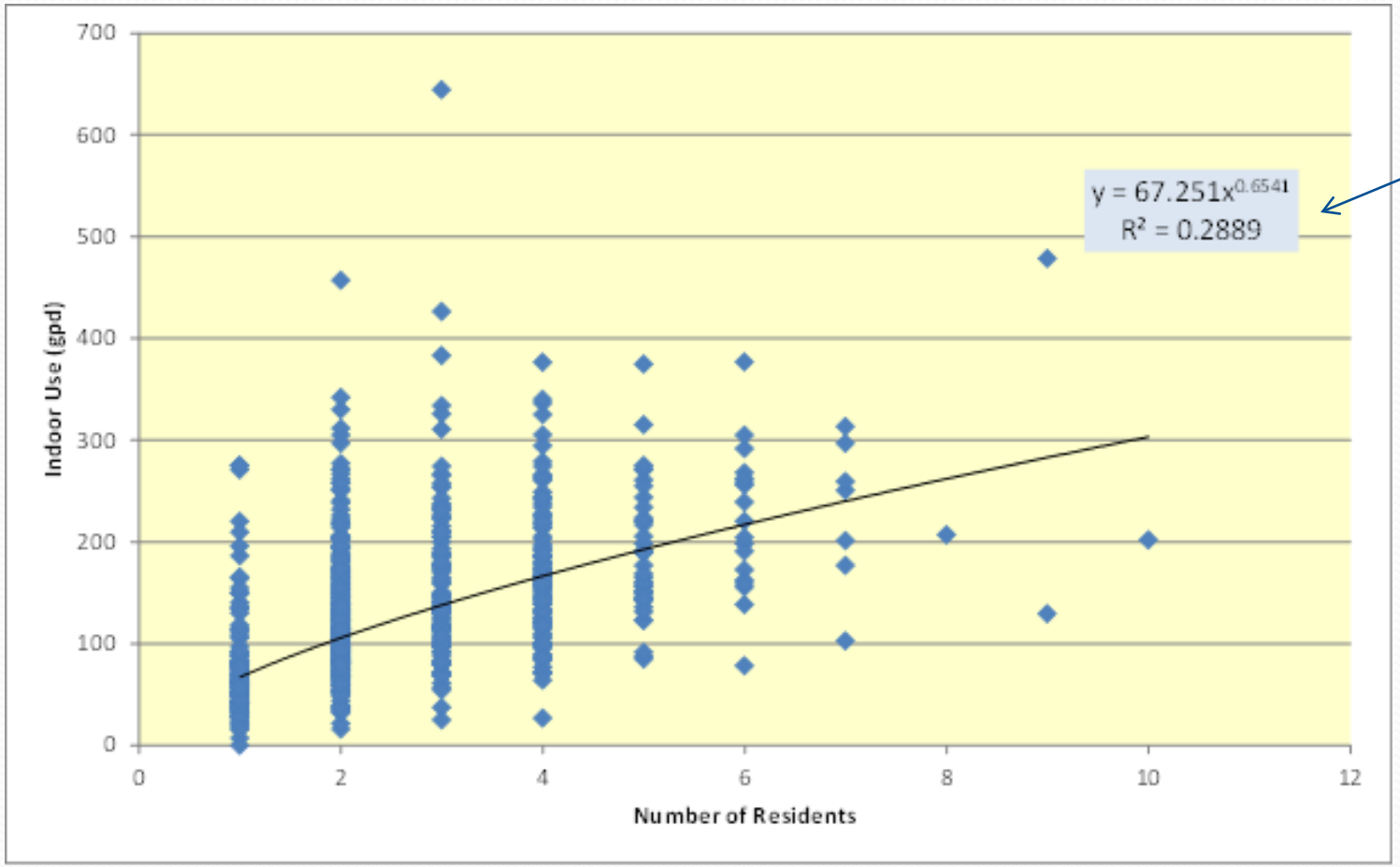
Note that units are GPD.

Distribution of indoor use:



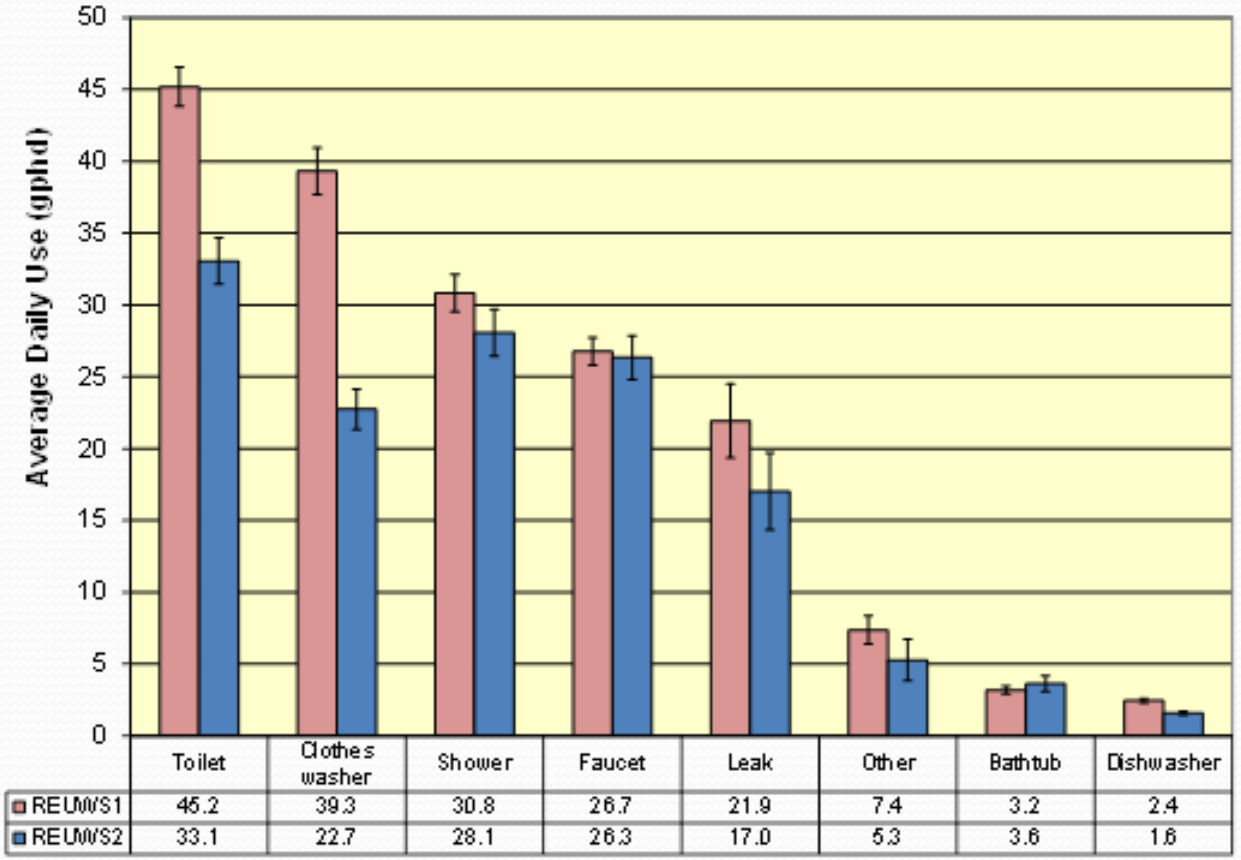
	25	50	100	150	200	250	300	350	400	450	500	550	600	650
% of homes	2%	6%	28%	27%	18%	9%	6%	2%	1%	0%	0%	0%	0%	0%
Cum %	2%	9%	37%	64%	82%	91%	96%	99%	99%	99%	100%	100%	100%	100%

Indoor use vs number of residents follows power curve:



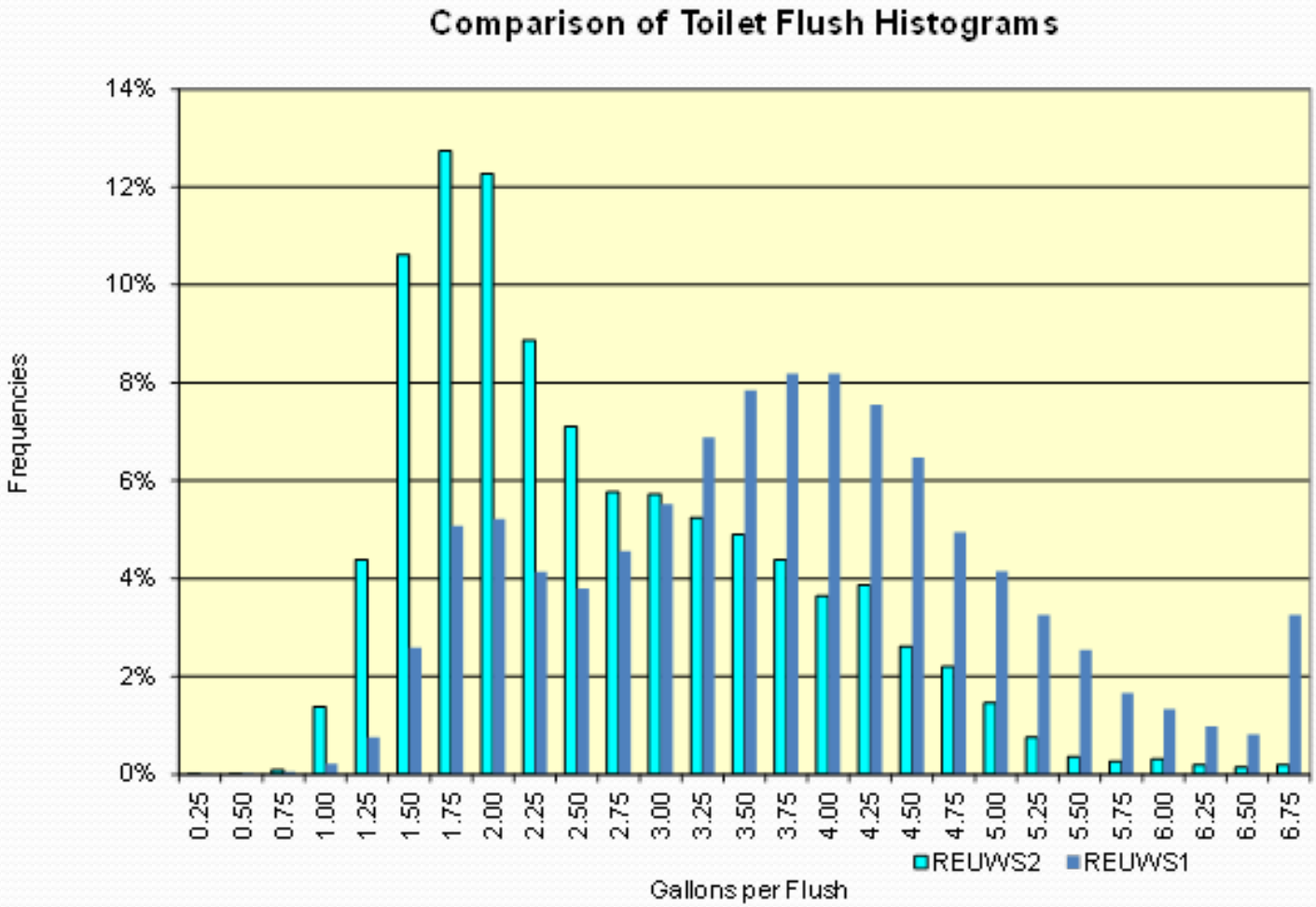
This is a non-linear relation ship.

Changes in indoor end uses between REUWS1 and REUWS2:



	Toilet	Clothes washer	Shower	Faucet	Leak	Other	Bathtub	Dishwasher
REUWS1	45.2	39.3	30.8	26.7	21.9	7.4	3.2	2.4
REUWS2	33.1	22.7	28.1	26.3	17.0	5.3	3.6	1.6

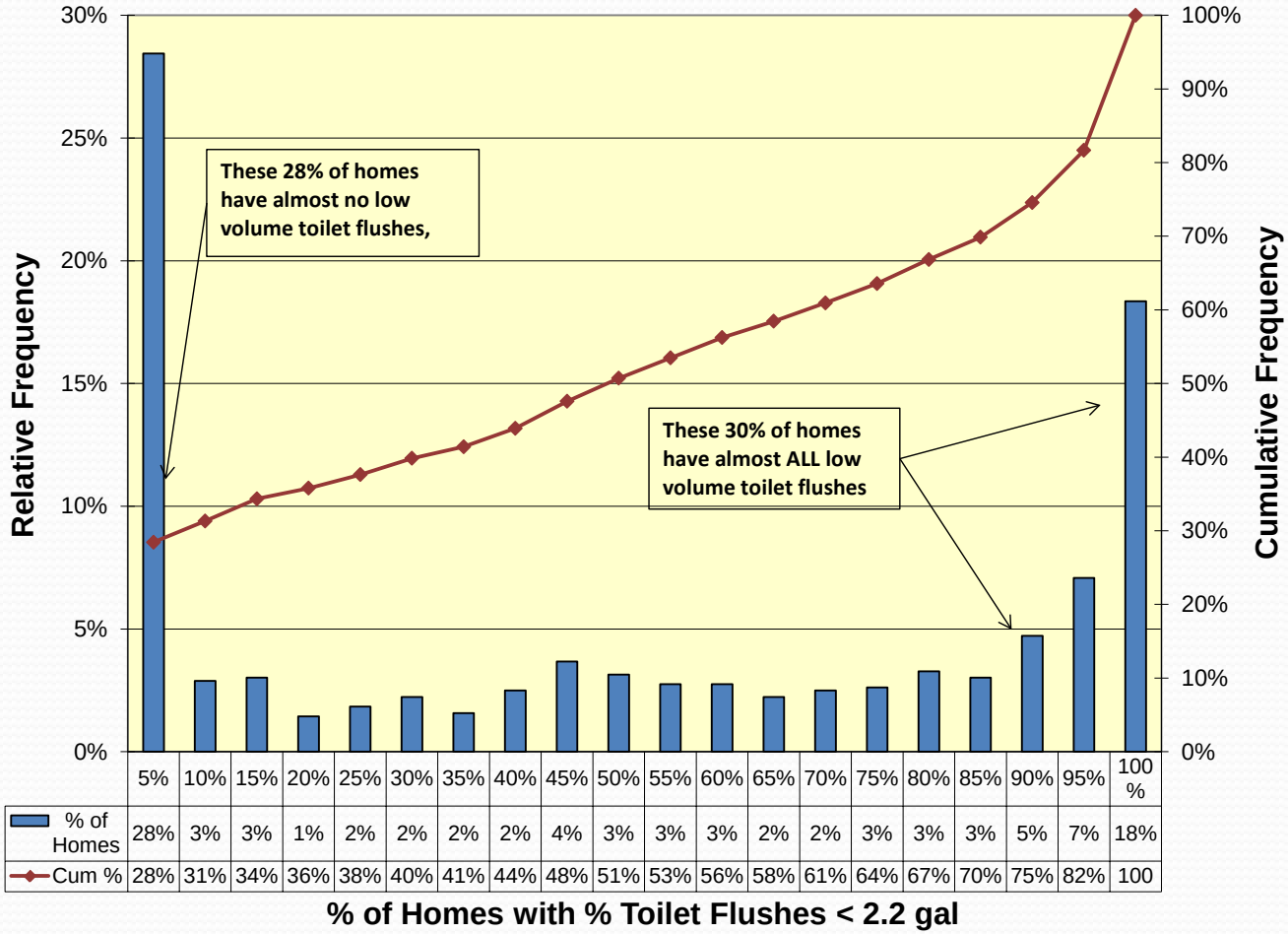
Shift in toilet flush volumes:



Mixture of toilets:

This shows the distribution of homes that have from 5% to 100% of their flushes at less than 2.2 gallons.

The higher the percent of flushes the higher the level of efficiency for the toiles in the homes.

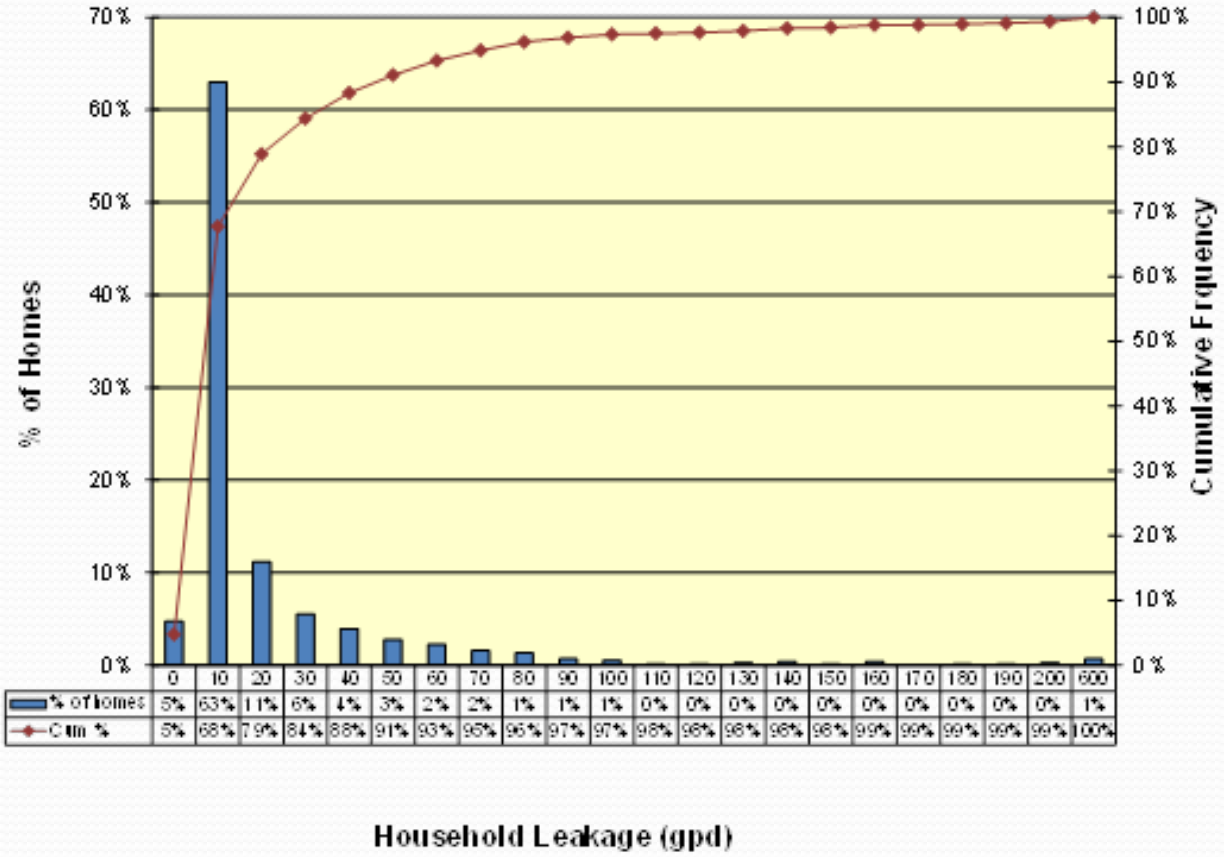


	5%	10%	15%	20%	25%	30%	35%	40%	45%	50%	55%	60%	65%	70%	75%	80%	85%	90%	95%	100 %
% of Homes	28%	3%	3%	1%	2%	2%	2%	2%	4%	3%	3%	3%	2%	2%	3%	3%	3%	5%	7%	18%
Cum %	28%	31%	34%	36%	38%	40%	41%	44%	48%	51%	53%	56%	58%	61%	64%	67%	70%	75%	82%	100

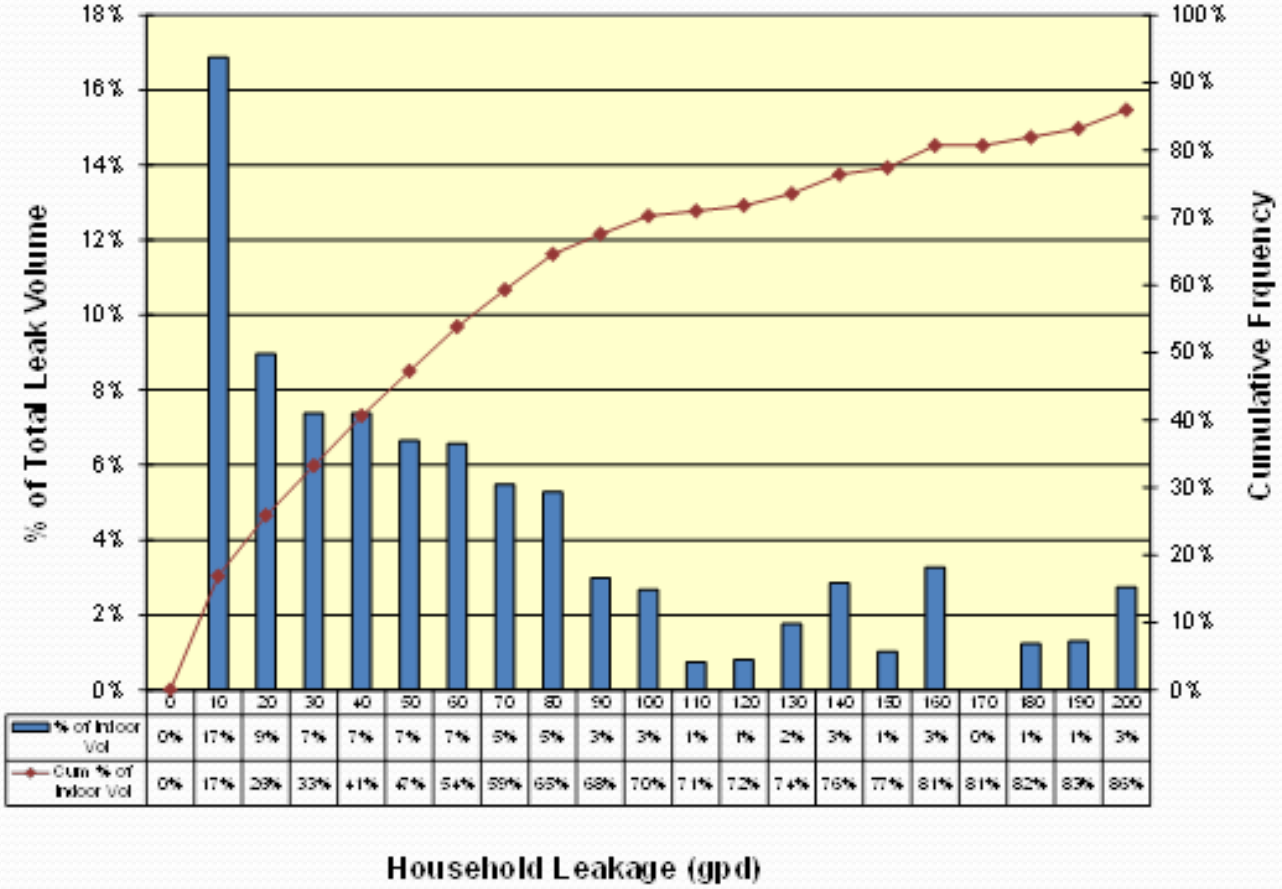
Improvements in CW efficiency

	REUWS1	REUWS2
Average loads per household per day	0.81	0.78
Average loads uses per person per day	0.3	0.3
Average gallons per load	**41**	**31**
Median gallons per load	40	31
Average daily use for clothes washing	**39.3 ± 1.6 gpd**	**22.7 ± 1.4 gpd**
Median daily use for clothes washing	32.8 gpd	17.8 gpd

Highly skewed leakage pattern



Large leakers account for most leakage volume



Key facts on leakage:

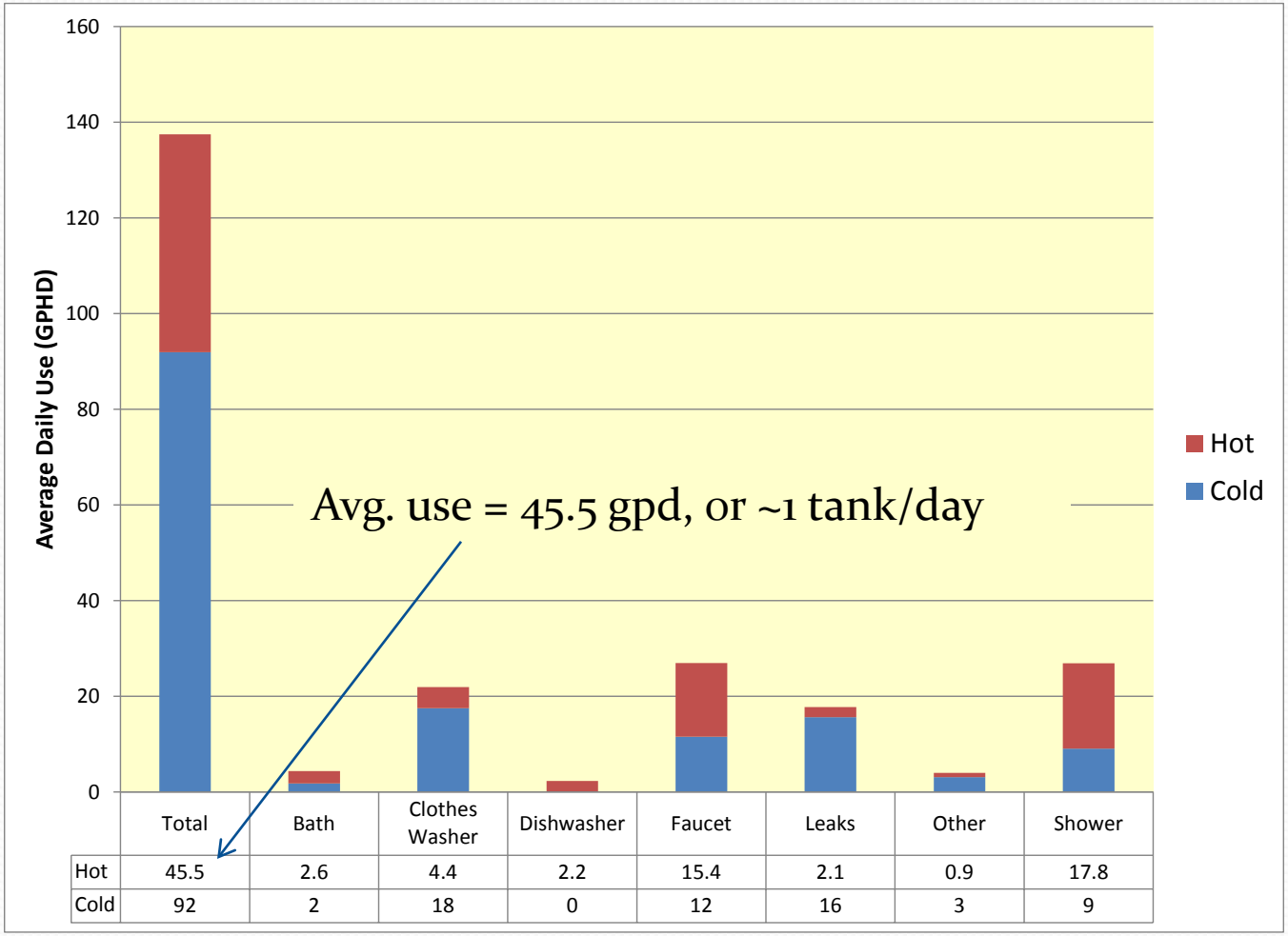
- The ~80% of homes at rates of 20 gpd or less contribute only 29% of the total leakage volume,
- the top 10% of the homes at rates of 50 gpd or more contributed approximately one half of the total leakage, while
- the 3% of homes at rates of 100 gpd or more contributed 31% of the total leakage. i.e. that means that ~20 homes in this study contributed nearly 1/3rd of the total leakage.

Increase in occurrence of high efficient CW, Toilets and Showers over time

Fixture	Criteria	Average Rate of Change
Clothes Washers	< 30 gpl	3.1%/yr
Toilets	< 2.0 gpf	2.3%/yr
Showers	< 2.5 gpm	0.5%/yr

Based on the % of homes meeting efficiency criteria

Hot water use (faucets and showers are main users).

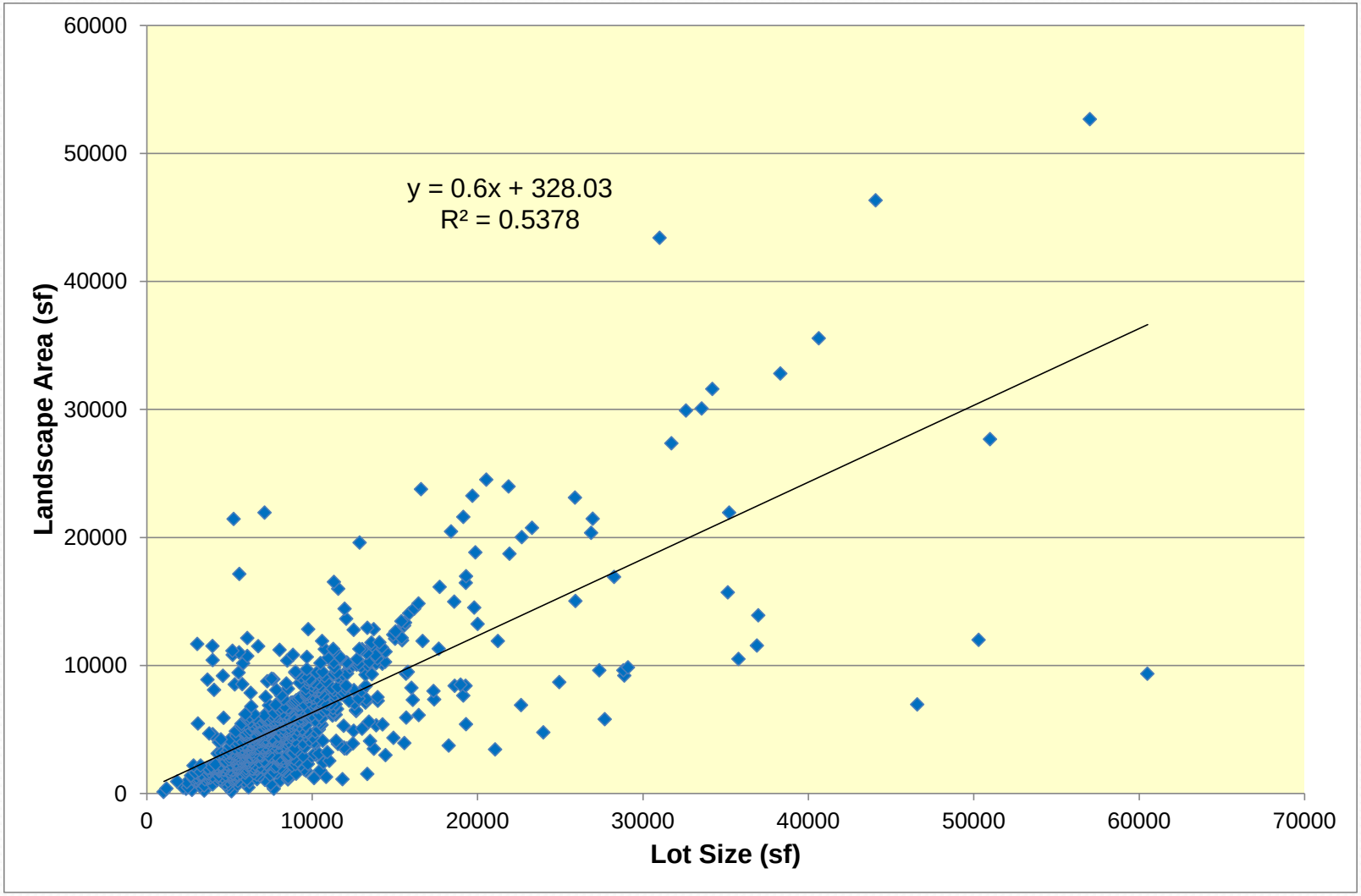


	Total	Bath	Clothes Washer	Dishwasher	Faucet	Leaks	Other	Shower
Hot	45.5	2.6	4.4	2.2	15.4	2.1	0.9	17.8
Cold	92	2	18	0	12	16	3	9

Effects of Hot Water Recirculation systems

- These devices do appear to reduce household water use by a modest amount.
- When looking at the full data set 88 out of 696 homes reported having such a device. Their shower and faucet use decline by ~ 6gpd.
- When looking at just the 7 out of 110 hot water homes who reported having a device, their faucet and shower use declined by ~2 gpd (their faucet use increased and their shower use decreased).
- More study required.

Landscape area vs lot size

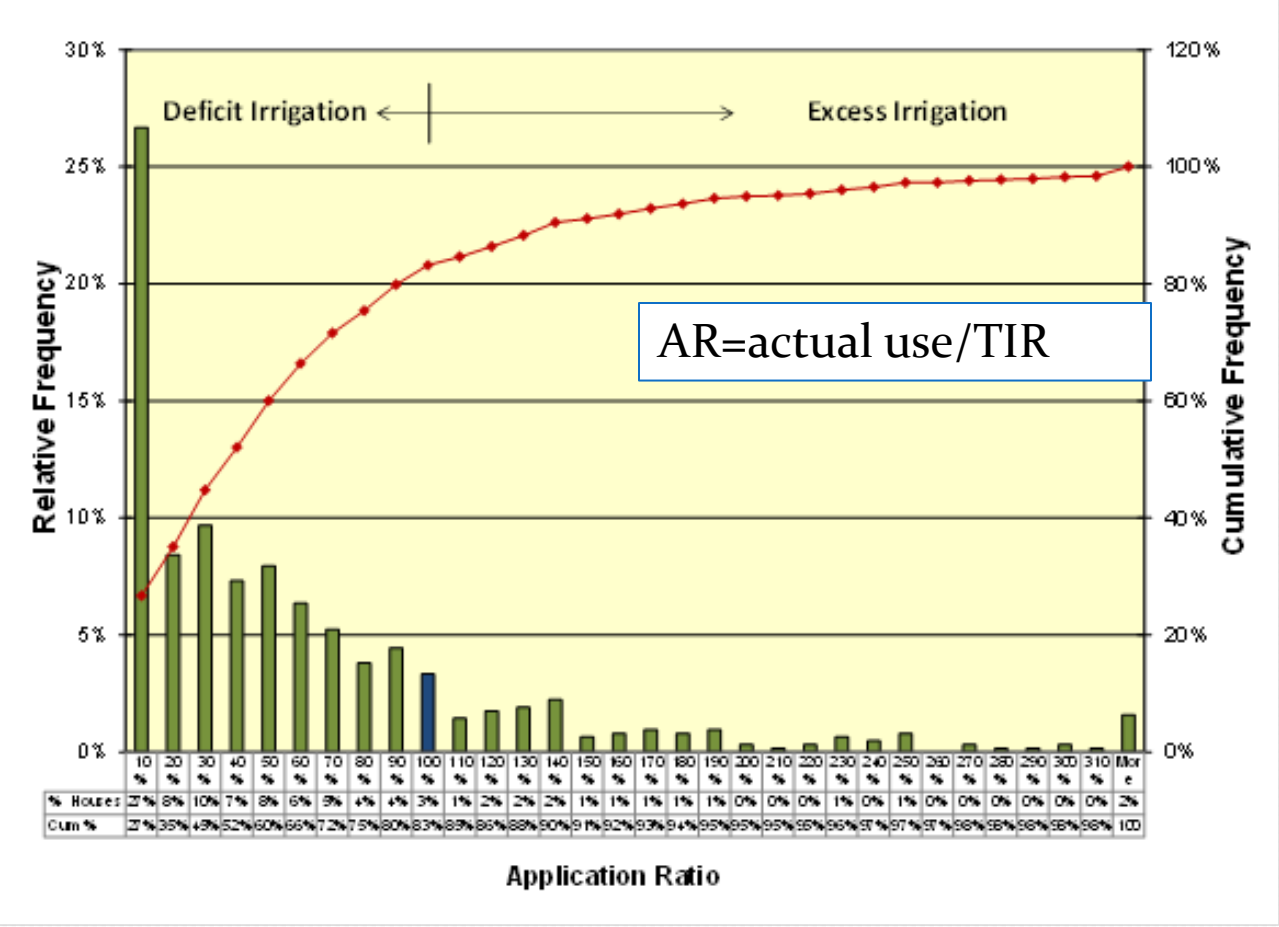


Big range of outdoor use:

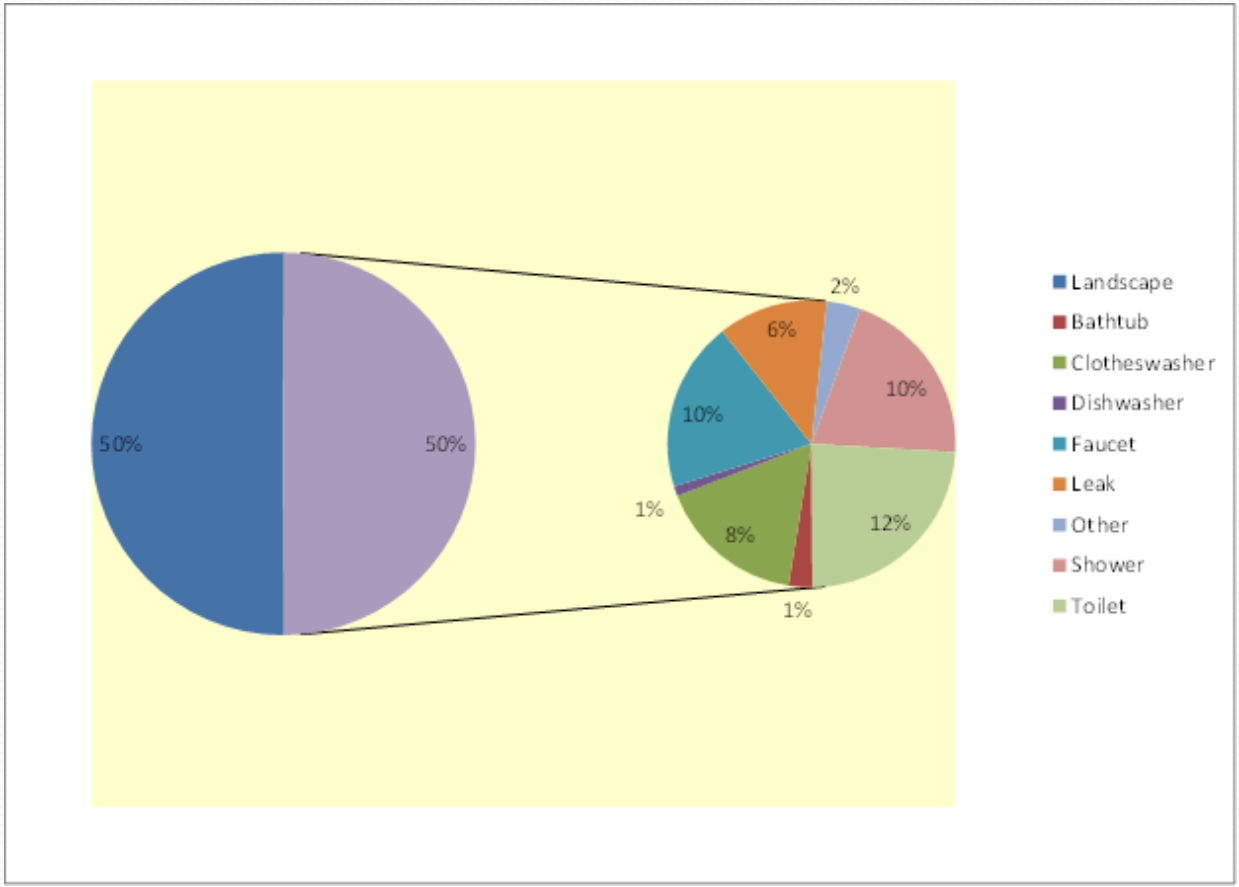
Site	Average of Annual_kgal	Average of Outdoor_kgal	% Outdoor
Clayton	57.5	19.2	33%
Denver	119.4	77.0	65%
Fort Collins	98.3	55.9	57%
Peel	76.6	24.1	31%
San Antonio	103.9	62.0	60%
Scottsdale	175.1	120.4	69%
Tacoma	68.6	27.0	39%
Toho	83.2	33.1	40%
Waterloo	55.5	13.0	23%
Grand Total	95.5	50.5[1]	53%

Only 4 out of 9 sites used more than 50% of annual water outdoors (all these were in the southwest).

Distribution of application ratios



Summary of total household water use(as % of annual use)



Potential end uses with leak control

	Toilet	Clothes washer	Shower	Faucet	Leak	Other	Bathtub	Dishwasher
REUWS1	45.2	39.3	30.8	26.7	21.9	7.4	3.2	2.4
REUWS2	33.1	22.7	28.1	26.3	17.0	5.3	3.6	1.6
Future	16.5	11.7	23.3	24.8	4.3	1.5	4.2	2.0

Indoor models (key factors)

- Number of persons residing in home
- Number of teenagers
- Number of children
- Parcel size (proxy for income)
- Adults employed outside of the home
- Number of persons home during day
- Sewer rate
- Presence of high efficiency toilets and clothes washers
- Presence of hot water recirculation systems

Indoor model predicts

- Teenagers use ~20% more shower water than adults
- Children use ~ 12% less shower water than adults
- For every 1% increase in percent of efficient toilets there will be a .58% reduction in water use for toilets
- For every 1% increas3 in percent of efficient CW there will be a .53% decrease in water use for CW.
- With 100% occurrence of high efficiency devices household use would drop to ~112 gphd from 138 (~19%) or 10 kgal/year

Outdoor model (key factors)

- Irrigated area
- Net ET
- Cost for water
- In-ground sprinklers
- Occurrence of excess irrigation

Outdoor model predicts

- Modest conservation scenario:
  - A 10% reduction in irrigated area
  - A 10% increase in price for outdoor water
  - A 15% reduction in occurrence of over-irrigation
  - Results in an 18% reduction in outdoor water use (~10kgal per year)
- Aggressive conservation scenario:
  - A 25% reduction in irrigated area
  - A 25% increase in cost for outdoor water
  - A 90% reduction in occurrence of over-irrigation
  - Results in a 47% reduction in outdoor use (~25 kgal/yr)

Conclusions

- Residential water use has declined since 1995
- Good prospects for additional indoor savings of ~ 20% (~10 kgal per home/yr)
- Ultimately, indoor demands could fall to <90 gphd given better leakage control.
- Outdoor savings depend on reduction of irrigated areas, sending better price signals, reducing the percent of homes that are over-irrigating
- On a national basis outdoor savings from 10-25 kgal per home per year are achievable.