"From Customer Consensus, to Codes, to Congress – Conservation and Reuse Of Water is Working!"

Bill Hoffman
Water Management, Inc.

512-294-7193
billhoffmantx@earthlink.net
What Will Be Discussed

From the wide view to the building

- Some important concepts
- Where is the nation with respect to water availability?
- The true cost of water
- It is all used to water grass, Right????
- Energy Water Nexus at the building level
- New & Alternate Sources of Water
- Codes, Standards, Rating Systems, Regulations, etc.
- Is it working?
So how is water used?

- The hydrological Cycle vs. Supply
- Fresh vs. Saline
- Withdrawal vs. Consumption
The ultimate source of all of our fresh water is precipitation
You can only get as much as mother nature allows you to. Any more & ????
World Population
And All Need Water!

Population over Human History

World Population since 1750

Billions

Year
1750 1800 1850 1900 1950 2000 2050

World population, billions

0 1 2 3 4 5 6 7 8 9 10

10,000 BC 8000 6000 4000 2000 AD 1 1000 2000
Two Types of Natural Water Cycle
Where We Stand Today

Figure 3.1. The number of reservoirs built in the United States by time period. This figure includes dams of all sizes recorded by regulatory agencies (Gleich, 2000).

Areas where subsidence has been attributed to groundwater pumpage (Land Subsidence in the United States, USGS Circular 1182)
Examples of Groundwater Depletion
Annual evaporation map from the National Weather Service
Example of Net Evaporation on Water Loss

- 89,000 Acres of Lake Surface
- 30 Inches or Net Evaporation per Year
- 222,500 Acre-Feet of Evaporation per Year
- **199 MILLION GALLONS** lost daily
Evaporation from Lake Surfaces

- Lake Mead Looses 0.9 Billion Gallons a DAY!

- High Aswan Dam – Egypt 6-9 Billion Gallons a Day!
GLOBAL WATER SUPPLY STRESS RISK IS GROWING IN POPULATED REGIONS

Water stress indicator: withdrawal to availability ratio

<table>
<thead>
<tr>
<th>No stress</th>
<th>Mid stress</th>
<th>Very high stress</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.1</td>
<td>0.2</td>
</tr>
<tr>
<td>0.4</td>
<td>0.8</td>
<td></td>
</tr>
</tbody>
</table>

No/low stress and per capita water availability < 1,700 m³/yr

Water withdrawal: water used for irrigation, livestock, domestic and industrial purposes (2000)

Water availability: average annual water availability based on the 30-year period 1961–90

The primary message of the 2012 State Water Plan is a simple one: In serious drought conditions, Texas does not and will not have enough water to meet the needs of its people, its businesses, and its agricultural enterprises.
Withdrawal vs.. Consumption
Figure 1. Total water withdrawals by category, 2005.
USGS Estimated Withdrawals

- **Thermo Electric**: 49%
- **Irrigation**: 31%
- **Aqua Culture**: 2%
- **Industrial**: 4%
- **Public Supply**: 11%
- **Mining**: 1%
- **Livestock**: 1%
- **Domestic**: 1%
Figure B-1. Diagram of once-through cooling system
USGS Estimated Water Consumption

- Irrigation: 81%
- Livestock: 4%
- Thermo electric: 3%
- Industrial: 3%
- Domestic: 7%
- Commercial: 1%
- Mining: 1%
Percent of Water Used that is Typically Consumed in Industrial and Commercial Operations

Based on Unpublished Research by H.W.(Bill) Hoffman & Associates
Water Reuse

Where do you draw the circle?

Withdrawal vs. Consumption
OPTIMIST

HALF FULL!

Pessimist

HALF EMPTY.

Conservatism

WITH THIS YOU COULD WASH A WINNEBAGO!
The True Cost of Water
Life Cycle of Large Water Pipes

- Pre WW II Pipe
- War Time Pipe
- Post WW II Pipe

Time to Pay The Piper
In 2015 dollars!
Where the USA Stands with Water and Sewer Infrastructure


Global Priorities, Global Insights

---

**Business Executives Rate the Quality of Infrastructure**

Assessment of the quality of transport, telecommunications, and energy infrastructure on a scale of 1 to 7

<table>
<thead>
<tr>
<th>Rank</th>
<th>Country</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Switzerland</td>
<td>6.6</td>
</tr>
<tr>
<td>2</td>
<td>Singapore</td>
<td>6.5</td>
</tr>
<tr>
<td>3</td>
<td>Finland</td>
<td>6.5</td>
</tr>
<tr>
<td>4</td>
<td>Hong Kong SAR</td>
<td>6.5</td>
</tr>
<tr>
<td>5</td>
<td>France</td>
<td>6.4</td>
</tr>
<tr>
<td>6</td>
<td>United Arab Emirates</td>
<td>6.4</td>
</tr>
<tr>
<td>7</td>
<td>Iceland</td>
<td>6.3</td>
</tr>
<tr>
<td>8</td>
<td>Austria</td>
<td>6.3</td>
</tr>
<tr>
<td>9</td>
<td>Germany</td>
<td>6.2</td>
</tr>
<tr>
<td>10</td>
<td>Netherlands</td>
<td>6.0</td>
</tr>
<tr>
<td>11</td>
<td>Canada</td>
<td>5.9</td>
</tr>
<tr>
<td>12</td>
<td>Japan</td>
<td>5.9</td>
</tr>
<tr>
<td>13</td>
<td>Spain</td>
<td>5.8</td>
</tr>
<tr>
<td>14</td>
<td>South Korea</td>
<td>5.8</td>
</tr>
<tr>
<td>15</td>
<td>Saudi Arabia</td>
<td>5.8</td>
</tr>
<tr>
<td>16</td>
<td>United States</td>
<td>5.6</td>
</tr>
<tr>
<td>17</td>
<td>Switzerland</td>
<td>5.6</td>
</tr>
<tr>
<td>18</td>
<td>Singapore</td>
<td>5.5</td>
</tr>
<tr>
<td>19</td>
<td>United Arab Emirates</td>
<td>5.2</td>
</tr>
<tr>
<td>20</td>
<td>India</td>
<td>4.9</td>
</tr>
</tbody>
</table>

**Infrastructure in the United States Shows Slow Improvement**

American Society of Civil Engineers 2013 Infrastructure Report Card

<table>
<thead>
<tr>
<th>Infrastructure Sector</th>
<th>Grade</th>
<th>Trend</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aviation</td>
<td>D</td>
<td>–</td>
</tr>
<tr>
<td>Bridges</td>
<td>C+</td>
<td>↑</td>
</tr>
<tr>
<td>Dams</td>
<td>D</td>
<td>–</td>
</tr>
<tr>
<td>Drinking Water</td>
<td>D</td>
<td>↑</td>
</tr>
<tr>
<td>Energy</td>
<td>D+</td>
<td>–</td>
</tr>
<tr>
<td>Hazardous Waste</td>
<td>D</td>
<td>–</td>
</tr>
<tr>
<td>Inland Waterway</td>
<td>D-</td>
<td>–</td>
</tr>
<tr>
<td>Levees</td>
<td>D-</td>
<td>–</td>
</tr>
<tr>
<td>Ports</td>
<td>C</td>
<td>N/A**</td>
</tr>
<tr>
<td>Public Parks and Recreation</td>
<td>C-</td>
<td></td>
</tr>
<tr>
<td>Rail</td>
<td>C+</td>
<td>↑</td>
</tr>
<tr>
<td>Roads</td>
<td>C</td>
<td>↑</td>
</tr>
<tr>
<td>Schools</td>
<td>D</td>
<td>–</td>
</tr>
<tr>
<td>Solid Waste</td>
<td>B-</td>
<td>↑</td>
</tr>
<tr>
<td>Transit</td>
<td>D</td>
<td>–</td>
</tr>
<tr>
<td>Wastewater</td>
<td>D</td>
<td>↑</td>
</tr>
</tbody>
</table>

Source: American Society of Civil Engineers, 2013.
*Compared to 2009 Infrastructure Report Card.
**New category in 2013.

---

**The top eight municipal water capex markets (2011-18)**

China

USA

Japan

France

Brazil

India

Germany

Australia

---

**Total forecast spending on industrial water systems (2013-2018)**

% figures show increase in 2018 spend over 2013 spend
Some Recent Headlines

42% hike in Baltimore water, sewer rates planned over next two years

Mayor Emanuel proposed doubling (Chicago) water rates over the next five years

Huge hikes in water, sewer rates on tap across USA

Cloverdale, California facing huge 67% water, sewer rate hikes
Exhibit 1. Long-term trends in the Consumer Price Index (CPI) for utilities (1913-2012). The index is set to 100 for 1982-1984 except for telephone and wireless services, where the index is set to 100 for 1997. Date () indicates start of series.
Exhibit 4. Trends in the difference between the overall CPI and the CPI for utilities (1978-2012). The index is set to 100 for 1982-1984 except for internet and wireless services, where the index is set to 100 for 1997. Year () indicates start of series.
The Effect is International

Between 2007 and 2011, prices have risen:

- 27% in USA
- 32% in England
- 45% in Australia
- 50% in South Africa
- 58% in Canada

Even in **Chicago**, the Mayor Wants to **Double Water Rates**!
Capital Cost of Water and Wastewater Treatment

- Sea Water Desalinization
- Advanced Wastewater
- Conventional Wastewater
- Conventional Potable Water

Dollars per Gallon Day of Capacity

$0 $5 $10 $15 $20
National Average Water & Sewer Cost - 2013

Black & Veatch

- Residential (7,500 gal)
- Commercial
- Industrial

Dollars per 1,000 Gallons

$0 $1 $2 $3 $4 $5 $6 $7 $8 $9 $10 $11

Blue: Water  Green: Sewer
Historical Increase in Top 50 City Average Commercial Water and Sewer Rates 2001-2013

Percent Annual Increase

Dollars per Thousand Gallons

Year

2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013

Percent Annual Increase

Water
Sewer
Total
Historic Commercial Sewer Rates for New York City - 1980 to 2014

New York bills in 100's of Cubic Feet (CCF). The chart is in dollars per thousand gallons. To convert to $/CCF, multiply the cost in dollars per thousand gallons by 0.748.
PROJECTED FUTURE COST OF WATER AT CURRENT INFLATION RATE OF 5.85%
National Average Electricity Prices

(Energy Information Administration)

Cents per Kilowatt Hour

- Residential
- Commercial
- Industrial
- Transportation

Year: 2003 to 2013
And Who Knows About Natural Gas Prices With The Advent of Fracking!
Figure 1. Energy Costs for Heating Water by 55°F

Assumes 55°F Temperature Increase, 95% efficiency for electric and 75% efficiency for gas.
## Dollars per Year for Toilet Flushing in 2013

$9.81 per 1,000 gallons or $7.34 per CCF

<table>
<thead>
<tr>
<th>Gallons per Flush</th>
<th>Cents per Flush</th>
<th>Type of Facility</th>
<th>6 flushes per day</th>
<th>35 flushes per day</th>
<th>75 flushes per day</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>4.91</td>
<td>Home</td>
<td>$107</td>
<td>$627</td>
<td>$1,343</td>
</tr>
<tr>
<td>3.5</td>
<td>3.43</td>
<td>Office</td>
<td>$75</td>
<td>$439</td>
<td>$940</td>
</tr>
<tr>
<td>1.6</td>
<td>1.57</td>
<td>Restaurant</td>
<td>$34</td>
<td>$201</td>
<td>$430</td>
</tr>
<tr>
<td>1.28</td>
<td>1.26</td>
<td>Home</td>
<td>$27</td>
<td>$160</td>
<td>$344</td>
</tr>
</tbody>
</table>
# Dollars per Year for Toilet Flushing in 2033

$30.87 \textit{per 1,000 gallons or $23.09 per CCF}$

<table>
<thead>
<tr>
<th>Gallons per Flush</th>
<th>Cents per Flush</th>
<th>Type of Facility</th>
<th>Home 6 flushes per day</th>
<th>Office 35 flushes per day</th>
<th>Restaurant 75 flushes per day</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>15.44</td>
<td></td>
<td>$338</td>
<td>$1,972</td>
<td>$4,225</td>
</tr>
<tr>
<td>3.5</td>
<td>10.80</td>
<td></td>
<td>$237</td>
<td>$1,380</td>
<td>$2,958</td>
</tr>
<tr>
<td>1.6</td>
<td>4.94</td>
<td></td>
<td>$108</td>
<td>$631</td>
<td>$1,352</td>
</tr>
<tr>
<td>1.28</td>
<td>3.95</td>
<td></td>
<td>$87</td>
<td>$505</td>
<td>$1,082</td>
</tr>
</tbody>
</table>
And again -

The True Cost of Water

• Water Cost
  • Sewer/Pre-treatment
    • Energy
    • Chemicals
  • Solid Waste Disposal
    • Capital Equipment
    • Labor
    • Liability
Example of Pretreatment Wastewater Charges

- Phosphorus
- Nitrogen
- TSS
- CBOD

$ per Pound
Cents per Gallon of Water Used By Type of Use

- **Commercial Dishwasher**: Water/Sewer (Bottom blue), Energy (Middle red), Chemical (Top green), BOD/TSS Charge (Top purple)
- **Lavatory**
- **Toilet**

Legend:
- Blue: Water/Sewer
- Red: Energy
- Green: Chemical
- Purple: BOD/TSS Charge
The Cheapest Water You Will Ever Have Is The Water You Already Have!
“Water is the oil of the 21st century.”

Andrew Liveris, Chief Executive, Dow Chemical Co., August 2008.
Isn’t it all about outdoor use RIGHT????
Well at least I thought it was???????
2009 Dallas Monthly Water Treatment

Billions of Gallons per Month

January | February | March | April | May | June | July | August | September | October | November | December
% or **RESIDENTIAL** Water Use for Irrigation

- Statewide – 36%
- Houston – 20%
- Dallas – 40%

As a percent of Water Sales, Seasonal use = only about **23%** of volume but typically requires over **70%** of capacity!
Average Monthly Use by 25 Largest Cities in Texas 2001 – 2011

=23%
Electric Reliability Council of Texas Average Monthly Generation (2002-2011)

=16%
Volume Percent of Municipal Use that is Above Winter (Jan, Feb, Dec) Use

Use Weighted Average
- Amarillo
- Lubbock
- Denton
- Midland
- Frisco
- Plano
- Garland
- El Paso
- Richardson
- Arlington
- Tyler
- Carrollton
- Irving
- Fort Worth
- Abilene
- Wichita Falls
- Dallas
- Waco
- Longview
- San Antonio
- Grand Prairie
- Austin
- Laredo
- Corpus Christi
- Houston
- Brownsville
- Beaumont

Volume Percent of Municipal Use that is Above Winter (Jan, Feb, Dec) Use

0%   2%   4%   6%   8%   10%   12%   14%   16%   18%   20%   22%   24%   26%   28%   30%   32%   34%   36%   38%   40%   42%   44%   46%
Percent of City Sales by User Type

Based on 2010 TWDB Data

Percent of Use

- Residential
- Industrial
- Other (Com./Inst./Loss/etc.)

Cities:
- LUBBOCK
- SAN ANTONIO
- ARLINGTON
- IRVING
- GARLAND
- EL PASO
- AUSTIN
- PLANO
- DALLAS
- AMARILLO
- FORT WORTH
- HOUSTON
- CORPUS CHRISTI

Use Distribution:

- LUBBOCK: 50% Residential, 10% Industrial, 40% Other
- SAN ANTONIO: 60% Residential, 5% Industrial, 35% Other
- ARLINGTON: 55% Residential, 10% Industrial, 35% Other
- IRVING: 60% Residential, 10% Industrial, 30% Other
- GARLAND: 65% Residential, 5% Industrial, 25% Other
- EL PASO: 50% Residential, 20% Industrial, 30% Other
- AUSTIN: 50% Residential, 10% Industrial, 40% Other
- PLANO: 50% Residential, 10% Industrial, 40% Other
- DALLAS: 50% Residential, 10% Industrial, 40% Other
- AMARILLO: 55% Residential, 10% Industrial, 35% Other
- FORT WORTH: 50% Residential, 15% Industrial, 35% Other
- HOUSTON: 50% Residential, 10% Industrial, 40% Other
- CORPUS CHRISTI: 50% Residential, 10% Industrial, 40% Other
AWWA 2000 Study of Indoor Water Use

- Toilet: 28%
- Clothes Washer: 23%
- Shower: 18%
- Faucet: 17%
- Leaks: 14%
Water loss audits for 2010

- 16.8 percent loss
- 3.1 apparent
- 13.7 real
Non-Agricultural Water Use in Texas 2010

7.6 million ac-ft/yr.

- Residential Outdoor 15% (40% of Municipal Use)
- Residential Indoor 22%
- Com./Inst. Outdoor 6% (30% of Com./Inst. Use)
- Com./Inst. Indoor 11%
- Mining 5%
- Mfg. 21%
- Steam Elec. 10%
- Non-Revenue 10%
How Things Tend to Work

Landscape & Irrigation Design Silo

Landscape Maintenance Silo

Storm Water Engineer Silo
Landscape Design Guiding Principles

1. Design Landscape to keep water (rainwater, storm water, and irrigation water) where it falls.
2. Prepare soil shape and content to capture and hold water.
3. Design landscape to minimize the need for irrigation water (eliminate irrigation systems where possible).
4. Minimize turf areas and choose adapted and drought tolerant plant materials.
5. Meter or sub-meter installed irrigation systems.
6. Capture and use on-site sources of water and/or reclaimed water.
8. Practice proper maintenance.
Berm It! Save the Baby Swales!
Storm Water BMP’s

• Berms
• Terraces
• Swales
• Rain Gardens
• Deep, Well Amended Soil
• Infiltration/Filter Strips
• Vegetated Strips
The Energy Water Nexus
Including a Look at the "In Between" Nexus
What Happens When Energy & Water Mix
Gallons of Water Consumed (evaporated) per Million BTU's Produced

- Biodiesel from Irrigated Soy
- Ethanol from irrigated Corn
- Enhanced Oil Recovery
- Coal Gasification
- Oil Sands
- Oil Refining
- Natural Gas
- Coal Mining
- Fracking (gas)
- Petroleum Extraction

Gallons per Million BTU's
Even Traffic Lights Can Save Water

**Question** - What is the difference between these two traffic lights?

**Answer** – 1.2 gallons per day savings in water evaporated at the power plant and 90% more energy efficient.
Typical Energy Requirements for Water and Wastewater

<table>
<thead>
<tr>
<th></th>
<th>KWH per 1,000 Gallons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sea Water Desal</td>
<td>14</td>
</tr>
<tr>
<td>Brackish Water Desal</td>
<td>6</td>
</tr>
<tr>
<td>Wastewater</td>
<td>3</td>
</tr>
<tr>
<td>Potable Water</td>
<td>2</td>
</tr>
</tbody>
</table>
Indoor Use
Electric and Gas/Oil

- Refrigeration: 8%
- Appliances: 9%
- Computers & Electronics: 9%
- Lighting: 11%
- Water Heating: 12%
- Space Heating: 31%
- Space Cooling: 12%
- Other: 8%
EPA Estimates of Hot Water Use in Homes

- Shower: 37%
- Dishwasher: 14%
- Clothes Washer: 26%
- Sinks: 11%
- Bath: 12%
Hot and Cold Water Use Percentages

- **LEAKS**
  - Hot Water: 30%
  - Cold Water: 70%

- **Showers**
  - Hot Water: 70%
  - Cold Water: 30%

- **Faucets**
  - Hot Water: 60%
  - Cold Water: 40%

- **Clothes Washer**
  - Hot Water: 10%
  - Cold Water: 90%

- **Dishwasher**
  - Hot Water: 80%
  - Cold Water: 20%

- **Bath**
  - Hot Water: 80%
  - Cold Water: 20%
Supporting and Conflicting Situations

Most of the Time, Saving Water Saves Energy.  

But Sometimes they Conflict!
Refrigeration & Ice Making
<table>
<thead>
<tr>
<th>Machine Capacity in Pounds of Ice Produced per Day</th>
<th>Kilowatt Hours for Air Cooled Machines</th>
<th>Kilowatt Hours for Water Cooled Machines</th>
<th>Difference</th>
<th>Energy Cost Savings (Cents per 100 pounds of ice @ 10)</th>
</tr>
</thead>
<tbody>
<tr>
<td>500 to 750</td>
<td>&lt;5.5</td>
<td>&lt;4.1</td>
<td>1.4</td>
<td>14</td>
</tr>
<tr>
<td>750 to 1500</td>
<td>&lt;5.0</td>
<td>&lt;3.5</td>
<td>1.5</td>
<td>15</td>
</tr>
<tr>
<td>1500 up</td>
<td>&lt;4.6</td>
<td>&lt;3.4</td>
<td>1.2</td>
<td>12</td>
</tr>
<tr>
<td>Average Savings per 100 Pounds of Ice Based on Electricity at 10 Cents per kWh</td>
<td></td>
<td></td>
<td></td>
<td>13.7</td>
</tr>
</tbody>
</table>
Air Cooled Cost Savings Using DOE Latest Recommended Energy Standards for Ice Machines

At a water cost of only $2.50/Kgal!!!!

<table>
<thead>
<tr>
<th>Gallons per 100 lb.</th>
<th>Cost of Water and Wastewater Combined $2.50 per kGal (Cents/100 Pounds)</th>
<th>Energy Savings per 100 Pounds With Water Cooled Equipment (Cents/100 Pounds)</th>
<th>Net Savings per 100 Pounds with Air Cooled Equipment (Cents/100 Pounds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>85</td>
<td>21.25</td>
<td>13.7</td>
<td>7.6</td>
</tr>
<tr>
<td>100</td>
<td>25</td>
<td>13.7</td>
<td>11.3</td>
</tr>
<tr>
<td>150</td>
<td>37.5</td>
<td>13.7</td>
<td>23.8</td>
</tr>
<tr>
<td>200</td>
<td>50.0</td>
<td>13.7</td>
<td>36.3</td>
</tr>
<tr>
<td>Type</td>
<td>Gallons per 100 Pounds of Ice Produced</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-----------------------------</td>
<td>----------------------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Number Qualifying</td>
<td>EPA Standard</td>
<td>Lowest Available</td>
</tr>
<tr>
<td>Continuous (flake &amp; nugget)</td>
<td>57</td>
<td>15*</td>
<td>15*</td>
</tr>
<tr>
<td>Batch</td>
<td>104</td>
<td>20</td>
<td>13</td>
</tr>
<tr>
<td>Self Contained&lt;200lb/day</td>
<td>39</td>
<td>25</td>
<td>20.3</td>
</tr>
</tbody>
</table>

* It takes 11.9 gallons of water to make 100 pounds of ice. The additional water shown for continuous ice makers is water that is contained in the ice produced. This water is not technically "wasted" since it is unfrozen water in the product. All use a total of about 15 gallons per 100 pounds of ice plus weight of water. Flake machines are more energy efficient than cube machines.
### Lifetime Utility Cost Analysis

**1000 lb/day machine, Water $3.71/kGal. Elec. 10 cents/kWh, DOE Recommended Efficiencies**

- **WATER COOLED**
- **AIR COOLED IN AIR CONDITIONED SPACE**
- **AIR COOLED REMOTE HEAD**
- **AIR COOLED IN UNAIR-CONDITIONED SPACE**

Thousands of Dollars over 8.5 Year Lifetime

### Lifetime Utility Cost Analysis

**1000 lb/day machine, Water $9.81/kGal. Elec. 10 cents/kWh, DOE Recommended Efficiencies**

- **WATER COOLED**
- **AIR COOLED IN AIR CONDITIONED SPACE**
- **AIR COOLED REMOTE HEAD**
- **AIR COOLED IN UNAIR-CONDITIONED SPACE**

Thousands of Dollars over 8.5 Year Lifetime
Other Equipment

- Soft serve
- Gelato
- Shakes & Malts
- Frozen Beverages
- Margarita Machines
- Smoothies
Once through cooling from refrigeration unit = 30,000 gallons a day!

At Avg. W/WW cost, 30,000 gallons a day = $294 a day.
Cooling and Latent Heat Removal
You may recognize the Building outlined in Green

*Red circles show cooling towers*
Every Big City is the Same

Red circles show cooling towers
Cooling Towers

The purpose of a cooling tower is to get rid of unwanted energy!
Eleven Office Buildings in Austin, Texas

All Other Uses 47%

Cooling Tower 53%
Summary of Audits of 30 Large Facilities with Cooling Towers in Downtown Fort Worth Texas

Water Management, Inc.
A Large Hospital in Florida

- Toilets: 20%
- Cooling Towers: 43%
- Other Plumbing: 8%
- Food Service: 8%
- Medical Equip.: 9%
- Leaks & Other: 8%
- Boilers: 4%
A Large Hospital in Arizona

- Domestic: 41%
- Cooling Towers: 49%
- Food Service: 4%
- Medical Equip.: 1%
- Irrigation: 5%
Grocery Store Water Use in California

Pacific Institute

- Cooling Tower: 49%
- Other: 22%
- Irrigation: 3%
- Kitchen: 9%
- Domestic: 17%
A Typical HVAC Setup

Figure 2. A typical Heat Transfer Loop in Refrigeration System
(Bureau of Energy Efficiency, 2004)
Make Up and Evaporation vs. Cycles of Concentration

Gallons per Ton Hour

Cycles of Concentration

Makeup – Gallons per

Evaporation – Gallons per
Water Savings with Next Increment of Cycles of Concentration

Incremental Increase in Cycles of Concentration

Gallons Saved per Ton-Hour

1.5 to 2.0
2 to 3
3 to 4
4 to 5
5 to 6
6 to 6
7 to 8
8 to 9
9 to 10
10 to 11
11 to 12
12 to infinity
## Cooling Tower Life Expectancy

Source: newOOMtable.doc

<table>
<thead>
<tr>
<th>Construction Material</th>
<th>Typical Life Span</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wooden</td>
<td>10</td>
<td>Low</td>
</tr>
<tr>
<td>Galvanized Metal</td>
<td>12</td>
<td>Low</td>
</tr>
<tr>
<td>Epoxy Treated Metal</td>
<td>15</td>
<td>Med</td>
</tr>
<tr>
<td>Plastic</td>
<td>20</td>
<td>Med</td>
</tr>
<tr>
<td>Plastic Coated Metal</td>
<td>25</td>
<td>Med</td>
</tr>
<tr>
<td>Stainless Steel</td>
<td>30</td>
<td>High</td>
</tr>
<tr>
<td>Ceramic</td>
<td>35</td>
<td>Highest</td>
</tr>
<tr>
<td>Air Cooled</td>
<td>20-25</td>
<td>Low</td>
</tr>
</tbody>
</table>
Savings With Cooling Tower

Energy savings
0.3 to 0.4 kWh/Ton-Hr

Equal to about
3.0 to 4.0 cents
in most markets
National Average Water & Sewer Cost - 2013

Black & Veatch

Residential (7,500 gal)

Commercial

Industrial

<table>
<thead>
<tr>
<th>Dollars per 1,000 Gallons</th>
</tr>
</thead>
<tbody>
<tr>
<td>$0</td>
</tr>
</tbody>
</table>

- Blue: Water
- Green: Sewer
Combined Water & Sewer Cost per Ton Hour  
(2013)

- **Highest**: Blue bar with no evaporation credit.
- **Average**: Blue bar with no evaporation credit.
- **Lowest**: Blue bar with no evaporation credit.

Cents per Ton Hour

- **With Evaporation Credit**
- **No Evaporation Credit**
### Other Water Associated Cost of Tower Operations

<table>
<thead>
<tr>
<th>Cost Factor</th>
<th>Cents per Ton Hour</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>At 2.0 gal./Ton-hour</strong></td>
<td></td>
</tr>
<tr>
<td>Water Treatment (Chemical and other)</td>
<td>lowest 0.1</td>
</tr>
<tr>
<td></td>
<td>Median 0.2</td>
</tr>
<tr>
<td></td>
<td>Highest 0.9</td>
</tr>
<tr>
<td>Labor &amp; Other</td>
<td>lowest 0.0</td>
</tr>
<tr>
<td></td>
<td>Median 0.1</td>
</tr>
<tr>
<td></td>
<td>Highest 0.1</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>lowest 0.1</td>
</tr>
<tr>
<td></td>
<td>Median 0.3</td>
</tr>
<tr>
<td></td>
<td>Highest 1.0</td>
</tr>
</tbody>
</table>
Total Water Associated Costs per Ton Hour Should Include:

- The cost of water in cents per ton hour
- The cost of sewer in cents per ton hour
- The cost of water treatment per ton hour
- The cost of labor per ton hour, etc.
Example of a 750 Ton System

• On the hottest day assume it operates at 75% of capacity over that 24 hour period which corresponds to a high irrigation day for the water utility also. *(It adds to peak water use)*

• The system has a 20% load factor for the year.

• Cooling tower makeup is 2.5 gallons per ton hour.
Water Use by 750 Ton System

• Water use on peak day at 2.5 gallons per ton hour & 75% capacity = 33,750 gallons

• Water use annually at 2.5 gallons per ton hour & 20% capacity = 3,285,000 gallons
Capital Cost of Water and Wastewater Treatment

- Sea Water Desalinization
- Advanced Wastewater
- Conventional Wastewater
- Conventional Potable Water

Dollars per Gallon Day of Capacity

$0  $5  $10  $15  $20
The Impact to the Utility and You

- Peak day use – **33,750** gallons a day added to peak day water treatment capacity requirements. Peak cooling day closely corresponds to peak water use day for utility.

<table>
<thead>
<tr>
<th>Water Treatment Capital Cost to Support Cooling Tower</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dollars per gallon day of capacity</td>
</tr>
<tr>
<td>Cost of Treatment Capacity</td>
</tr>
<tr>
<td>Capital Water Cost per Ton</td>
</tr>
</tbody>
</table>
Cooling Towers

- Do you need a tower in the first place
- Energy conservation
- Instrumentation and metering
- Drift eliminators
- Other considerations
Ways other than a cooling tower

• Direct Exchange (DX)
• Variable Frequency Drive Air Cooled
• Geothermal
• Thermal absorption and desiccant systems
Hybrid Cooling Tower
Hybrid Cooling Towers
New Water

- Reuse
- Desalinization
- Rainwater
- Gray water
- Treated On-Site Sources of Water (Auxiliary Water)
- Conservation
ENTITIES WITH REUSE PLANS

- Arlington
- Austin
- Big Spring
- Cleburne
- College Station
- Dallas Fort Worth International Airport
- El Paso
- Flower Mound
- Fort Worth
- Frisco
- Georgetown
- Irving
- Lewisville
- McAllen
- New Braunfels
- North Texas Municipal Water District
- Odessa
- San Angelo
- San Antonio
- San Marcos
- Sugarland
- Tarrant Regional Water District
- Upper Trinity Regional Water District
- Sweetwater
- White River Municipal Water District

This is a partial list of entities in Texas with Reuse Plans.
Water Reuse

Texas Facts

• Over 500 MGD now being used
• 190 Entities have obtained permits
• 14% of all future needs
• Reuse is:
  – Drought proof
  – Already developed
  – Increases with population
  – Owned by the City producing it

You just need to plumb it!
The United States produces approximately 32 billion gallons of municipal effluent per day.

Figure 3-1
Reclaimed water use in the United States
Texas total municipal desalination capacity is about 123 million gallons per day (MGD).

This includes:

• 73 MGD from brackish groundwater;

• 50 MGD from brackish surface water; and

• NONE from the Gulf of Mexico.
Depth to Saline Groundwater (USGS, 1965)
Saline Water Use

Saline-water withdrawals, 2005

- **Industrial**
  - Saline: 1,190 Mgal/d (7%)
  - Fresh: 17,000 Mgal/d (93%)

- **Mining**
  - Saline: 1,710 Mgal/d (43%)
  - Fresh: 2,310 Mgal/d (57%)

- **Thermoelectric power**
  - Saline: 58,100 Mgal/d (29%)
  - Fresh: 143,000 Mgal/d (71%)

Trends in total fresh- and saline-water withdrawals, 1950-2005

Withdrawals, in billion gallons per day

- Blue: Total freshwater
- Pink: Total saline water
IAPMO and ICC Alternate Sources
For Non-Potable Uses

1. Rainwater
2. Gray Water
3. Reclaimed Water
4. Treated On-Site Sources
On-Site Reuse is the Next Big Push

- Rainwater harvesting
- Storm water harvesting
- Air conditioner condensate
- Swimming pool filter backwash
- Cooling tower blowdown
- RO & NF reject water
- Gray water
- On-site wastewater systems
- Foundation drain water
- Others???????
Pumps & Storage Tanks for

Groundwater Recovery at AMD
This LEED Platinum project collects rainwater, gray-water foundation drain water and A/C condensate water for reuse in toilet flushing and cooling tower makeup.
AMD Lantana Site

• Largest known rainwater/AC condensate harvesting project
• Used for irrigation and cooling tower makeup
• 1.3 Million Gallons
ONLY IN TEXAS!
AWWA 2000 Study of Indoor Water Use

- Toilet: 28%
- Clothes Washer: 23%
- Shower: 18%
- Faucet: 17%
- Leaks: 14%
Estimated Indoor Home Use

(Hoffman, 2010)

- Current best
- Current Code
- US Average
- Pre - 1970's

Gallons per Person per Day

- Black
- Gray
- Leaks
GE Zenon Technology

[Diagram showing relative size of common materials and processes for separation, including ST Microscope, Scanning Electron Microscope, Optical Microscope, and Visible to Naked Eye ranges.]

- Dissolved Salts
- Colloids
- Giardia Cysts
- Human Hair
- Suspended Solids
- Beach Sand
- Virus
- Bacteria
- Pin Point
- Parasites
- REVERSE OSMOSIS (Hyperfiltration)
- ULTRA FILTRATION
- GRANULAR MEDIA
- NANO FILTRATION
- MICRO FILTRATION

ZeeWeed®
AQUUS™ System
On-site Non-potable Water Use

Guide for the collection, treatment, and reuse of alternate water supplies in San Francisco
On-site Water Systems Worldwide – It’s Happening Now!
16 States Have Graywater Regulations

Arizona
California
Connecticut
Colorado
Massachusetts
Montana
Nevada
New Jersey
New Mexico
New York
Oregon
Texas
Utah
Washington
Wyoming
Vermont

Texas Regulations implemented in 2004 do not include AC Condensate, Foundations Drain water, and similar non-potable sources. Texas Law is now out of date!

See TCEQ Regulation SUBCHAPTER F: USE OF GRAYWATER SYSTEMS

§§210.81 - 210.85

My Opinion
Examples of Urban On-Site Reuse

Solaire, Battery Park NYC
65% Reduction in Potable Water

Dock Side Green – Victoria Canada
65% Reduction in Potable Water

60% of non-potable water demand in Tokyo is met by recycled water
IAPMO and ICC Alternate Sources For Non-Potable Uses

1. Rainwater
2. Reclaimed Water
3. Gray Water
4. Treated On-Site Sources
“Water is the oil of the 21st century.”

Andrew Liveris,
Chief Executive,
Dow Chemical Co.,
August 2008.
Going Green is the “In Thing”
According to Charlie Brown
Codes, Standards, Guidelines, & Rating Systems

- **Codes** provide minimum safeguards for people with regard to building safety and fire prevention. Codes protect health, safety and welfare. *How to build it.*

- **Standards** are developed as an extension of code requirements. Standards represent consensus on how a material, product or assembly is to be designed, manufactured, tested or installed to obtain a specific level of performance. *How to make it.*

- **Guidelines** provide information on how best to apply codes and standards and other practices to achieve the best result. *Suggests best way to do it.*

- **Rating Systems** are used to determine if a project, building, or product meets certain “green” standards. *Tells how “green” a project or building is.*
Federal Milestones

- Clean Water Act – 1972
- DOE - 1977
- Energy Star – 1992
- Current Energy Policy Act - 2005
- Water Sense - 2006
Examples of Codes
Examples of Standards

ASHRAE STD 191
Under Development
The following information is taken from the MaP Maximum Performance Web Page

http://www.map-testing.com/

By John Koeller, P.E.
Koeller & Company
Yorba Linda, California
jkoeller@map-testing.com
April 16, 2012
<table>
<thead>
<tr>
<th>Applications</th>
<th>Guidelines, code or standard?</th>
<th>Code-adoptable language?</th>
<th>Minimum thresholds or points?</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential &amp; non-residential</td>
<td>Code</td>
<td>Yes</td>
<td>Minimum thresholds</td>
<td>Became effective in 2011</td>
</tr>
<tr>
<td>All except Single Family Residential</td>
<td>Guidelines</td>
<td>No</td>
<td>Prerequisite + points</td>
<td>LEED 2009 mandates 20% reduction from baseline; 2012 version in review</td>
</tr>
<tr>
<td>Single Family Residential (SFR)</td>
<td>Guidelines</td>
<td>No</td>
<td>Both</td>
<td>Active – being updated</td>
</tr>
<tr>
<td>Residential above 3 stories + all commercial</td>
<td>ANSI Standard</td>
<td>Yes</td>
<td>Points</td>
<td>Final standard ANSI-approved; published in April 2010</td>
</tr>
<tr>
<td>Residential above 3 stories + all commercial</td>
<td>ANSI Standard</td>
<td>Yes</td>
<td>Minimum thresholds</td>
<td>Version 2 released: SS189.1-2011</td>
</tr>
<tr>
<td>All except SFR</td>
<td>ANSI Standard</td>
<td>Yes</td>
<td>Minimum thresholds</td>
<td>Process began July 1, 2008; provisions being drafted; no certain release date</td>
</tr>
<tr>
<td>Residential</td>
<td>ANSI Standard</td>
<td>Yes</td>
<td>Points</td>
<td>Final standard ANSI-approved; published in Jan 2009 as ICC-700</td>
</tr>
<tr>
<td>Residential above 3 stories + all commercial</td>
<td>Code</td>
<td>Yes</td>
<td>Minimum thresholds</td>
<td>Final version 2 released in April 2012</td>
</tr>
<tr>
<td>Residential above 3 stories + all commercial</td>
<td>Code</td>
<td>Yes</td>
<td>Minimum thresholds</td>
<td>Final version 1 released in March 2012</td>
</tr>
<tr>
<td>Residential</td>
<td>Guidelines</td>
<td>No</td>
<td>Minimum thresholds</td>
<td>Final specification issued in December 2009</td>
</tr>
</tbody>
</table>
## NATIONAL GREEN BUILDING STANDARDS & CODES
### Comparison of specific water use efficiency provisions – maximum water use

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential toilets OR &quot;private&quot; setting in commercial – flushometer type (gals per flush)</td>
<td>HET: 1.28g²</td>
<td>HET: 1.28g²</td>
<td>HET: 1.28g²</td>
<td>HET: 1.28g²</td>
<td>HET: 1.28g²</td>
<td>HET: 1.28g²</td>
</tr>
<tr>
<td>Residential toilets or &quot;private&quot; setting in commercial – tank-type (gallons per flush)</td>
<td>HET: 1.28g² + WaterSense</td>
<td>HET: 1.28g² + WaterSense</td>
<td>HET: 1.28g²</td>
<td>HET: 1.28g² + WaterSense</td>
<td>HET: 1.28g² + WaterSense</td>
<td>1.6g⁴</td>
</tr>
<tr>
<td>Commercial toilets – &quot;public&quot; setting and remote (gallons/flush)</td>
<td>HET: 1.28g²</td>
<td>1.28g² (tank-type must comply with WaterSense)</td>
<td>1.6g⁴</td>
<td>1.6g⁴</td>
<td>1.6g⁴</td>
<td></td>
</tr>
<tr>
<td>Commercial toilets – &quot;public&quot; setting and nonremote (gallons/flush)</td>
<td>HET: 1.28g²</td>
<td>HEU: 0.5 gpf</td>
<td>HEU: 0.5 gpf + WaterSense</td>
<td>HEU: 0.5 gpf</td>
<td>HEU: 0.5 gpf + WaterSense</td>
<td>HEU: 0.5 gpf + WaterSense</td>
</tr>
<tr>
<td>Flushing urinals (gallons per flush)</td>
<td>HEU: 0.5 gpf</td>
<td>HEU: 0.5 gpf</td>
<td>HEU: 0.5 gpf</td>
<td>HEU: 0.5 gpf</td>
<td>HEU: 0.5 gpf</td>
<td>HEU: 0.5 gpf</td>
</tr>
<tr>
<td>Non-water urinals</td>
<td>Permitted</td>
<td>Permitted</td>
<td>Permitted</td>
<td>Permitted</td>
<td>Permitted; requires upstream discharges to drain from other fixtures or fittings</td>
<td>Permitted; requires upstream discharges to drain from other fixtures or fittings</td>
</tr>
<tr>
<td>Residential &amp; commercial &quot;private&quot; lavatory faucets (gallons/minute)</td>
<td>1.5 gpm⁶</td>
<td>1.5 gpm + WaterSense</td>
<td>1.5 gpm</td>
<td>1.5 gpm + WaterSense</td>
<td>1.5 gpm + WaterSense</td>
<td>1.5 gpm + WaterSense</td>
</tr>
<tr>
<td>Commercial &amp; non-residential &quot;public&quot; lavatory faucets (gals/min.)</td>
<td>0.4 gpm⁸</td>
<td>0.5 gpm</td>
<td>0.5 gpm</td>
<td>0.5 gpm</td>
<td>0.5 gpm</td>
<td>0.5 gpm</td>
</tr>
<tr>
<td>Commercial kitchen &amp; bar sink faucets (gallons per minute)</td>
<td>1.8 gpm; allows temporary override to 2.2 gpm⁹</td>
<td>0.5 gpm</td>
<td>Hands-free in food prep area &amp; in dish room of commt kitchen</td>
<td>0.5 gpm</td>
<td>0.5 gpm</td>
<td>0.5 gpm</td>
</tr>
<tr>
<td>Commerical &amp; non-residential &quot;public&quot; lavatory faucets (gals/min.)</td>
<td>0.4 gpm</td>
<td>0.5 gpm</td>
<td>0.5 gpm</td>
<td>0.5 gpm</td>
<td>0.5 gpm</td>
<td>0.5 gpm</td>
</tr>
<tr>
<td>Commerical &amp; non-residential &quot;public&quot; lavatory faucets (gals/min.)</td>
<td>0.4 gpm</td>
<td>0.5 gpm</td>
<td>0.5 gpm</td>
<td>0.5 gpm</td>
<td>0.5 gpm</td>
<td>0.5 gpm</td>
</tr>
<tr>
<td>Commerical &amp; non-residential &quot;public&quot; lavatory faucets (gals/min.)</td>
<td>0.4 gpm</td>
<td>0.5 gpm</td>
<td>0.5 gpm</td>
<td>0.5 gpm</td>
<td>0.5 gpm</td>
<td>0.5 gpm</td>
</tr>
<tr>
<td>Commerical &amp; non-residential &quot;public&quot; lavatory faucets (gals/min.)</td>
<td>0.4 gpm</td>
<td>0.5 gpm</td>
<td>0.5 gpm</td>
<td>0.5 gpm</td>
<td>0.5 gpm</td>
<td>0.5 gpm</td>
</tr>
<tr>
<td>Commerical &amp; non-residential &quot;public&quot; lavatory faucets (gals/min.)</td>
<td>0.4 gpm</td>
<td>0.5 gpm</td>
<td>0.5 gpm</td>
<td>0.5 gpm</td>
<td>0.5 gpm</td>
<td>0.5 gpm</td>
</tr>
</tbody>
</table>
# National Green Building Standards & Codes

Comparison of specific water use efficiency provisions – maximum water use

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Commercial metering faucets (gallons per cycle)</td>
<td>0.20 gpc</td>
<td>0.25 gpc</td>
<td>0.20 gpc</td>
<td>0.25 gpc</td>
<td>0.25 gpc</td>
<td></td>
</tr>
<tr>
<td>Residential kitchen faucets (gallons per minute)</td>
<td>1.8 gpm; allows temporary override to 2.2 gpm</td>
<td>2.2 gpm</td>
<td>2.2 gpm</td>
<td>1.8 gpm; allows temporary override to 2.2 gpm</td>
<td>2.2 gpm</td>
<td></td>
</tr>
<tr>
<td>Residential showerheads (gallons per minute)</td>
<td>2.0 gpm + WaterSense</td>
<td>2.0 gpm</td>
<td>2.0 gpm</td>
<td>2.5 gpm</td>
<td>2.0 gpm + WaterSense</td>
<td></td>
</tr>
<tr>
<td>Non-residential showerheads (gallons per minute)</td>
<td>2.0 gpm</td>
<td>2.0 gpm</td>
<td>2.5 gpm</td>
<td>2.0 gpm</td>
<td>2.0 gpm</td>
<td></td>
</tr>
<tr>
<td>Residential showering compartment – size increment for second showerhead</td>
<td>Requires a second control valve</td>
<td>2,600 sq. in.</td>
<td>3,000 sq. in.</td>
<td>1,800 sq. in.</td>
<td>2,600 sq. in.</td>
<td></td>
</tr>
<tr>
<td>Residential shower valve (automatic compensating valve)</td>
<td></td>
<td></td>
<td></td>
<td>Meet ASSE 1016 OR ASME A112.18.1/CSA B125.1 for temp control when tested at 2.0 gpm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tub spout diverter leakage (gallons per minute)</td>
<td>0.01 gpm when new, 0.05 gpm after 15,000 cycles</td>
<td></td>
<td></td>
<td>0.1 gpm</td>
<td>0.1 gpm</td>
<td></td>
</tr>
<tr>
<td>Commercial pre-rinse spray valve (gallons per minute)</td>
<td>1.3 gpm ¹⁵</td>
<td>1.3 gpm</td>
<td>1.3 gpm with auto shut-off</td>
<td>1.3 gpm with auto shut-off</td>
<td>1.3 gpm with auto shut-off</td>
<td></td>
</tr>
<tr>
<td>Drinking fountain – manual (gallons per minute)</td>
<td></td>
<td></td>
<td></td>
<td>Auto shut-off</td>
<td>0.7 gpm with auto shut-off</td>
<td></td>
</tr>
<tr>
<td>Drinking fountain – metered (gallons per cycle)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.25 gpc</td>
<td></td>
</tr>
<tr>
<td>Appliances, Equipment, Irrigation &amp; Alternate Water</td>
<td>CalGREEN&lt;sup&gt;1&lt;/sup&gt;</td>
<td>ASHRAE SS189.1&lt;sup&gt;1&lt;/sup&gt; (v.2-2011)</td>
<td>ASHRAE S191P (unreleased draft)</td>
<td>ICC 700-2008 (with NAHB)</td>
<td>IAPMO Green Plumbing &amp; Mech Code Supplement (v.2-2012)</td>
<td>ICC Green Code (v.1 Final-2012)</td>
</tr>
<tr>
<td>--------------------------------------------------</td>
<td>----------------------</td>
<td>--------------------------------</td>
<td>--------------------------------</td>
<td>--------------------------</td>
<td>---------------------------------------------------</td>
<td>--------------------------------</td>
</tr>
<tr>
<td>On-site reclaimed water (incl. graywater) treatment systems</td>
<td>(future)</td>
<td>Encouraged through the treatment and use of alternate (non-potable) sources of water</td>
<td>Points available for use of alternate sources</td>
<td>Specific provisions for equipment installation &amp; water treatment</td>
<td>NSF 350 listed</td>
<td>Included</td>
</tr>
<tr>
<td>Rainwater harvesting</td>
<td>(future)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Landscape irrigation</td>
<td>Weather-based irrigation controllers req’d</td>
<td>ET-based; smart technology; restrictions on turf</td>
<td>ET-based; smart technology; restrictions on turf</td>
<td>Non-mandatory provisions; some turf restrictions</td>
<td>75% of irrig needs satisfied with water from alternate sources; if controller used, smart controller req’d; other specific landscape provisions</td>
<td>If automatic irrig controller used, smart controller req’d; alternate non-potable water sources encouraged; other specific landscape provisions</td>
</tr>
<tr>
<td>Water features (fountains, etc.)</td>
<td></td>
<td>Use alternate water sources (non-potable) where available; recirculation required</td>
<td></td>
<td>Use alternate water sources (non-potable) where available</td>
<td>Use alternate (non-potable) water source; potable water use OK for small features.</td>
<td></td>
</tr>
<tr>
<td>Commercial clothes washers - public access: common area laundry rooms, hotels, laundromats (water factor max.)</td>
<td></td>
<td></td>
<td></td>
<td>Energy Star &amp; WF of 7.5 gal</td>
<td>Energy Star where applicable</td>
<td></td>
</tr>
<tr>
<td>Commercial clothes washers – all others (water factor maximum)</td>
<td></td>
<td></td>
<td></td>
<td>WF of 8.0 gal</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## NATIONAL GREEN BUILDING STANDARDS & CODES
Comparison of specific water use efficiency provisions – maximum water use

<table>
<thead>
<tr>
<th>Metering and Sub-metering</th>
<th>CaIGREEN¹</th>
<th>ASHRAE SS189.1¹ (v.2-2011)</th>
<th>ASHRAE SS191P (unreleased draft)</th>
<th>ICC 700-2008 (with NAHB)</th>
<th>IAPMO Green Plumbing &amp; Mech Code Supplement (v.2-2012)</th>
<th>ICC Green Code (v.1 Final-2012)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tenant water use (usage in gallons per day)</td>
<td>Where non-residential tenant usage &gt;100g + all buildings where &gt;1000g</td>
<td>Tenants or buildings where &gt;1,000 g</td>
<td>Tenants or buildings where &gt;1,000 g</td>
<td>Where tenant use is &gt;500 g/day OR high-use occupancy OR total building area &gt;50K sq.ft.</td>
<td>Where usage &gt;1,000 g/day</td>
<td></td>
</tr>
<tr>
<td>Process water use – industrial/commercial (usage in gals per day)</td>
<td>Where usage &gt;1,000 g</td>
<td>Where usage &gt;1,000 g</td>
<td>All where usage &gt;1,000 g</td>
<td>Industrial where usage &gt;1,000 g</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ornamental water features, swimming pools, in-ground spas</td>
<td>Make-up water supply to all ornamental water features</td>
<td>Make-up water supply lines</td>
<td>Make-up water supply to swimming pool</td>
<td>Make-up water supply lines</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sub-metering cooling towers</td>
<td>Towers of &gt;500 gpm flow (through-put); make-up and blow-down water supply lines</td>
<td>Towers of &gt;500 gpm flow (through-put)</td>
<td>Make-up water supply</td>
<td>Towers of 100 tons or greater; make-up and blow-down water supply lines</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Evaporative coolers</td>
<td>Where use in excess of 0.6 gpm meter make-up water supply</td>
<td>Where use in excess of 0.6 gpm meter make-up water supply</td>
<td>Where cooler has air flow in excess of 30K cfm</td>
<td>Where use in excess of 0.6 gpm meter make-up water supply</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Evaporative condensers</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fluid coolers</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boilers</td>
<td>Steam &amp; hot water boilers rated at 500K Btu/hr or more</td>
<td>Steam &amp; hot water boilers rated at 500K Btu/hr or more</td>
<td></td>
<td>Make-up water supply to boilers collectively exceeding 1 mil Btu/hr</td>
<td>Make-up water supply to boilers drawing more than 100K gallons annually or rated at 500K Btu/hr or more</td>
<td></td>
</tr>
<tr>
<td>--------------------------------------------------</td>
<td>-----------</td>
<td>--------------------------</td>
<td>-------------------------------</td>
<td>--------------------------</td>
<td>--------------------------------------------------------</td>
<td>---------------------------------</td>
</tr>
<tr>
<td>Residential water softeners</td>
<td></td>
<td></td>
<td></td>
<td>Permitted where water hardness ≥ 8 grains/gallon; demand-initiated regeneration reqd; max water use 5 gal (19L) per 1K grains of hardness removed; salt efficiency exceeding 3400 grains of total hardness removed per kg of salt; NSF 44 listed</td>
<td>Demand-initiated regeneration reqd; max water use 5 gal (19L) per 1K grains of hardness removed; salt efficiency no less than 4000 grains of total hardness removed per kg of salt; NSF 44 listed</td>
<td></td>
</tr>
<tr>
<td>Reverse osmosis water treatment system</td>
<td></td>
<td></td>
<td></td>
<td>NSF 58 listed; auto shut-off</td>
<td>NSF 58 listed; auto shut-off</td>
<td></td>
</tr>
<tr>
<td>Water-powered pumps</td>
<td></td>
<td></td>
<td></td>
<td>Water-powered sump pumps prohibited, except for emergency; emergency pumps shall be at least 58% efficient</td>
<td>Water-powered sump pumps prohibited, except for emergency; emergency pumps shall be at least 67% efficient</td>
<td></td>
</tr>
<tr>
<td>Automated vehicle wash facilities</td>
<td></td>
<td></td>
<td>Make-up water restrictions: In-bay-40gal/vehicle; Conveyor &amp; express type-35gal/vehicle; spray wands &amp; foamy brushes-3.0 gpm</td>
<td>50% water reuse; other water restricted as follows: In-bay-40gal/vehicle; Conveyor &amp; express type-35gal/vehicle</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Self-service vehicle wash facilities</td>
<td></td>
<td></td>
<td></td>
<td>Spray wands: 3.0 gpm</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: The table compares specific water use efficiency provisions for various applications under different codes and standards.
### NATIONAL GREEN BUILDING STANDARDS & CODES
Comparison of specific water use efficiency provisions – maximum water use

<table>
<thead>
<tr>
<th>Metering and Sub-metering</th>
<th>CaIGREEN³</th>
<th>ASHRAE SS189.1³ (v.2-2011)</th>
<th>ASHRAE S191P (unreleased draft)</th>
<th>ICC 700-2008 (with NAHB)</th>
<th>IAPMO Green Plumbing &amp; Mech Code Supplement (v.2-2012)</th>
<th>ICC Green Code (v.1 Final-2012)⁴</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sub-metering irrigation</td>
<td>Where non-residential landscape &gt;1,000 sq.ft.**</td>
<td>Where total irrigated landscape &gt;25,000 sq.ft.</td>
<td>Where total irrigated landscape &gt;25,000 sq.ft.</td>
<td>Yes, &gt;2,500 sq.ft. irrig landscape</td>
<td>Yes, all irrig systems that are automatic</td>
<td></td>
</tr>
<tr>
<td>Building Meter Data Management System</td>
<td>Require remote data communication to central system, recording hourly consumption data</td>
<td></td>
<td></td>
<td>Requires means of communicating metered water data to user; direct connection to central building system not required</td>
<td>Meters must be capable of connecting &amp; communicating water use data; direct connection to central bldg system not req'd</td>
<td></td>
</tr>
</tbody>
</table>
## NATIONAL GREEN BUILDING STANDARDS & CODES
Comparison of specific water use efficiency provisions – maximum water use

<table>
<thead>
<tr>
<th>Commercial Food Service</th>
<th>CalGREEN(^5)</th>
<th>ASHRAE SS189.1(^5) (v.2-2011)</th>
<th>ASHRAE S191P (unreleased draft)</th>
<th>ICC 700-2008 (with NAHB)</th>
<th>IAPMO Green Plumbing &amp; Mech Code Supplement (v.2-2012)</th>
<th>ICC Green Code (v.1 Final-2012)(^6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commercial food service - cubed ice makers</td>
<td></td>
<td>Energy Star (air cooled)</td>
<td>Energy Star (air cooled)</td>
<td>Energy Star (air cooled)</td>
<td>25 gal per 100 lbs. of ice produced; air cooled</td>
<td></td>
</tr>
<tr>
<td>Commercial food service - all other ice makers not covered by Energy Star</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Commercial food service - connectionless steam cooker (gal per hour)</td>
<td>(defers to Calif Energy Commission on food service appliances)</td>
<td>2.0g</td>
<td>2.0g per pan</td>
<td>5.0g per pan</td>
<td>2.0g per pan</td>
<td></td>
</tr>
<tr>
<td>Commercial food service - connected steam cooker (gals per hour)</td>
<td></td>
<td>2.0</td>
<td></td>
<td>5.0g per pan</td>
<td>5.0g per pan</td>
<td></td>
</tr>
<tr>
<td>Commercial food service - dishwashers (gallons)</td>
<td></td>
<td>Energy Star</td>
<td>Energy Star</td>
<td>Energy Star</td>
<td>Energy Star OR 2.2 gal/tank OR 2.2 gpm for rackless</td>
<td></td>
</tr>
<tr>
<td>Commercial food service - combination ovens (gallons/hr)</td>
<td></td>
<td>10g</td>
<td>3.5 g per pan</td>
<td>3.5 g per pan</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Commercial food service - dipper wells (gallons per minute)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Max flow per minute equal to the capacity of the DW, not to exceed 2.2 gpm</td>
<td></td>
</tr>
<tr>
<td>Commercial food waste disposers (gals per minute)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>No load: 1.0 g Full load: 8.0 g</td>
<td></td>
</tr>
<tr>
<td>Commercial pre-rinse spray valve (gallons per minute)</td>
<td></td>
<td>1.3 gpm(^7)</td>
<td>1.3 gpm</td>
<td>1.3 gpm with auto shut-off</td>
<td>1.3 gpm with auto shut-off</td>
<td></td>
</tr>
<tr>
<td>Commercial kitchen faucets (gallons per minute)</td>
<td>1.8 gpm allows temporary override to 2.2 gpm(^8)</td>
<td></td>
<td></td>
<td></td>
<td>2.2 gpm(^9)</td>
<td></td>
</tr>
</tbody>
</table>

\(^5\) Source: California Green Building Standards Code

\(^6\) Source: International Association of Plumbing and Mechanical Officials

\(^7\) Source: ASHRAE Standard 191P

\(^8\) Source: ICC 700-2008

\(^9\) Source: IAPMO Green Plumbing & Mech Code Supplement
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Smart controllers</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Backflow prevention</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Rain sensor (and others)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Soil moisture sensor</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Hydrozones</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Matched Precipitation Rate</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Pop-up sprinklers 4&quot; minimum</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Pressure regulation</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>MSMT nozzles</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Maximum precipitation rate</td>
<td>1.0 in/h</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Narrow area (feet)</td>
<td>4 ft</td>
<td>4 ft</td>
<td>8 ft</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No runoff</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>No overspray on hard surfaces</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>No line drainage</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Slop. Maximum PR</td>
<td>0.50 in/h</td>
<td>0.75 in/h</td>
<td>0.75 in/h</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimum DULQ</td>
<td>0.65</td>
<td>0.65</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimum efficiency</td>
<td>73%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drip irrigation</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Inpected/verification</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Commissioned system</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mandatory irrigation audit</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>NO IRRIGATION SYSTEM</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

Possible Points: 2 15 25

(v) = voluntary compliance, but not required. IAPMO is "designed" to use alternate water sources.

Notes:
LEED 2012 (April draft), not yet finalized, Point-based rating system, Voluntary program
GBI Green Building Initiative, Green Globes Point-based rating system, Voluntary Program
EPA WaterSense for New Homes program, Landscape and irrigation requirements for labeling a new home, Voluntary Program.
SITES, Sustainable Site Initiative patterned after LEED with prerequisites and credits. It is being updated for 2012 Voluntary Program.
FEMP Federal Energy Management Program with published BMPs for landscaping and irrigation intended to be used on Federal facilities.
EO 13514 Presidential Executive Order to reduce energy and water use in Federal Buildings. Compliance guidelines have been published.
IGCC International Green Construction Code by ICC, an overlay to plumbing and mechanical codes, uses ASHRAE 189.1 as an alternate compliance path.
IAPMO International Association of Plumbing and Mechanical Officials has published a Green Supplement to plumbing and mechanical codes.
CALGreen is the Green Code used in California that covers residential and non-residential properties.
MWELO is California's Model Water Efficient Landscape Ordinance that is referenced in CALGreen and each city has a version that is at least as restrictive.
ASHRAE 189.1 Standard for the Design of High Performance Green Buildings (Except Low-Rise Residential) Standard written in code language
NGBS National Green Building Standard (aka ICC 700) by National Home Builders Association written as a point-based standard/code for residential properties.

Ultimately, the Authority Having Jurisdiction can include or modify requirements in model codes and standards used as codes.
Water Using Appliance Energy Star® Market Penetration in 2011

- Commercial Dishwashers
- Commercial Ice Machines
- Commercial Steam Cookers
- Commercial Clotheswashers
- Residential Dishwashers
- Residential Clotheswashers

Bar chart showing market penetration percentages for each category.
Summary of Qualifying Food Steamer Models Based on New June 2013 EPA EnergyStar® Standards

<table>
<thead>
<tr>
<th>Range of Water Use</th>
<th>Type of Steamer</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Gallons per Hour or Use)</td>
<td>Boilerless Type</td>
</tr>
<tr>
<td>All Levels of Water Use</td>
<td>147</td>
</tr>
<tr>
<td>Number Over 15.1 Gallons/Hour</td>
<td>0</td>
</tr>
<tr>
<td>Number between 5.0 and 15 Gallons/Hour</td>
<td>0</td>
</tr>
<tr>
<td>Number Between 4.9 and 15.0 Gallons/Hour</td>
<td>0</td>
</tr>
<tr>
<td>Number Between 2.0 and 5.0 Gallons/Hour</td>
<td>13</td>
</tr>
<tr>
<td>Number Between 1.5 and 2.0 Gallons/Hour</td>
<td>2</td>
</tr>
<tr>
<td>Number Between 1.1 and 1.5 Gallons/Hour</td>
<td>122</td>
</tr>
<tr>
<td>Number Under 1.0 Gal/Hour</td>
<td>10</td>
</tr>
</tbody>
</table>

EnergyStar® rated equipment is primarily rated for energy efficiency. Some energy efficient models are now water efficient. Customers are recommended to purchase boilerless steamers using 1.5 gallons per hour or less and boiler type steamers that use 15 gallons per hour or less. Boilerless equipment should be the choice for most situations.
Commercial Steam Cookers Key Product Criteria

Commercial steam cookers must meet the requirements provided in either Table 1 or Table 2 below to qualify as ENERGY STAR.

**Table 1: Energy Efficiency Requirements for Electric Steam Cookers**

<table>
<thead>
<tr>
<th>Pan Capacity</th>
<th>Cooking Energy Efficiency*</th>
<th>Idle Rate (watts)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-pan</td>
<td>50%</td>
<td>400</td>
</tr>
<tr>
<td>4-pan</td>
<td>50%</td>
<td>530</td>
</tr>
<tr>
<td>5-pan</td>
<td>50%</td>
<td>670</td>
</tr>
<tr>
<td>6-pan and larger</td>
<td>50%</td>
<td>800</td>
</tr>
</tbody>
</table>

**Table 2: Energy Efficiency Requirements for Gas Steam Cookers**

<table>
<thead>
<tr>
<th>Pan Capacity</th>
<th>Cooking Energy Efficiency*</th>
<th>Idle Rate (Btu/h)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-pan</td>
<td>38%</td>
<td>6,250</td>
</tr>
<tr>
<td>4-pan</td>
<td>38%</td>
<td>8,350</td>
</tr>
<tr>
<td>5-pan</td>
<td>38%</td>
<td>10,400</td>
</tr>
<tr>
<td>6-pan and larger</td>
<td>38%</td>
<td>12,500</td>
</tr>
</tbody>
</table>
# Energy Efficiency Requirements for Commercial Dishwashers

![Energy Efficiency Requirements for Commercial Dishwashers](http://www.energystar.gov/index.cfm?c=comm_dishwashers.pr_crit_comm_dishwashers)

<table>
<thead>
<tr>
<th>Machine Type</th>
<th>High Temp Efficiency Requirements</th>
<th>Low Temp Efficiency Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Idle Energy Rate*</td>
<td>Water Consumption**</td>
</tr>
<tr>
<td>Under Counter</td>
<td>≤ 0.50 kW</td>
<td>≤ 0.86 GPR</td>
</tr>
<tr>
<td>Stationary Single Tank Door</td>
<td>≤ 0.70 kW</td>
<td>≤ 0.89 GPR</td>
</tr>
<tr>
<td>Pot, Pan, and Utensil</td>
<td>≤ 1.20 kW</td>
<td>≤ 0.58 GPSF</td>
</tr>
<tr>
<td>Single Tank Conveyor</td>
<td>≤ 1.50 kW</td>
<td>≤ 0.70 GPR</td>
</tr>
<tr>
<td>Multiple Tank Conveyor</td>
<td>≤ 2.25 kW</td>
<td>≤ 0.54 GPR</td>
</tr>
<tr>
<td>Single Tank Flight Type</td>
<td>Reported</td>
<td>GPH ≤ 2.975x + 55.00</td>
</tr>
<tr>
<td>Multiple Tank Flight Type</td>
<td>Reported</td>
<td>GPH ≤ 4.96x + 17.00</td>
</tr>
<tr>
<td>Type of Machine</td>
<td>Water Consumption (see footnote)</td>
<td>High Temperature Sanitizing</td>
</tr>
<tr>
<td>---------------------------------</td>
<td>---------------------------------</td>
<td>----------------------------</td>
</tr>
<tr>
<td></td>
<td></td>
<td>High</td>
</tr>
<tr>
<td>Multiple Tank Flight-type</td>
<td>(GPH)</td>
<td>141.2</td>
</tr>
<tr>
<td>Single Tank Flight-type</td>
<td>(GPH)</td>
<td>112</td>
</tr>
<tr>
<td>Pot, Pan, and Utensil</td>
<td>(GPSF)</td>
<td>0.42</td>
</tr>
<tr>
<td>Multiple Tank Rack Conveyor</td>
<td>(GPR)</td>
<td>0.53</td>
</tr>
<tr>
<td>Single Tank Rack Conveyor</td>
<td>(GPR)</td>
<td>0.63</td>
</tr>
<tr>
<td>Stationary Single Tank Door</td>
<td>(GPR)</td>
<td>0.9</td>
</tr>
<tr>
<td>All Under Counter</td>
<td>(GPR)</td>
<td>0.84</td>
</tr>
</tbody>
</table>

GPH - Gallons per Hour, GPSF Gallons per Square Foot, GPR - Gallons per Rack
<table>
<thead>
<tr>
<th></th>
<th>Standard</th>
<th>Front Loaders</th>
<th>Top Loaders</th>
</tr>
</thead>
<tbody>
<tr>
<td>EnergyStar® Residential</td>
<td>6.0</td>
<td>6.0</td>
<td>NONE</td>
</tr>
<tr>
<td>EnergyStar® Commercial</td>
<td>4.5</td>
<td>4.5</td>
<td>NONE</td>
</tr>
<tr>
<td>Federal Standard</td>
<td>6.5</td>
<td>6.5</td>
<td>9.5</td>
</tr>
</tbody>
</table>
### Summary of EPA Energy Star® Qualified Commercial Ice Machines as of July 2013

<table>
<thead>
<tr>
<th>Type</th>
<th>Gallons per 100 Pounds of Ice Produced</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number Qualifying</td>
</tr>
<tr>
<td>Continuous (flake, nugget)</td>
<td>57</td>
</tr>
<tr>
<td>Batch</td>
<td>104</td>
</tr>
<tr>
<td>Self Contained&lt;200lb/day</td>
<td>39</td>
</tr>
</tbody>
</table>

* It takes 11.9 gallons of water to make 100 pounds of ice. The additional water shown for continuous ice makers is water that is contained in the ice produced. This water is not technically "wasted" since it is unfrozen water in the product. All use a total of about 15 gallons per 100 pounds of ice plus weight of water. Flake machines are more energy efficient than cube machines.
Summary of **Combination Oven** Water Use Rates from Food Service Technology Center Energy Rebate Information July 2013

*27 models ranging from 6 to 40 pans*
“Green Building” Rating Systems

- Numerous national green building GUIDELINES...
  - USGBC LEED Program: “LEED 2009”
  - U.S. EPA WaterSense℠ for New Homes
  - CHPS - Collaborative for High Performance Schools
  - GGHC - Green Guide for Health Care ™
  - Built Green ™
  - Florida Water Star℠
  - Environments for Living ® (Masco)
  - Build-it-Green ™
  - Green Globes – Green Build Initiative
US Green Building Council
2012 LEED Products

Homes

Neighborhoods

Commercial

2013 LEED Commercial

• New Construction
• Existing Buildings
• Core & Shell

❖ Schools
❖ Health Care
❖ Retail
LEED Water 2013

• Metering
• Landscape
• Fixtures & fittings
• Cooling towers
• Medical equipment
• Appliances & equipment
• Wastewater
EPA EnergyStar® & WaterSense®

**EnergyStar®**
- Residential & Commercial Dishwashers
- Residential & Commercial Clothes washers
- Commercial kitchen equipment

**WaterSense®**
- Toilets & Urinals
- Faucets & Showers
- Pre-rinse Spray Valves
- Irrigation Controllers
The Drainline Transport of Solid Waste in Buildings

November 2012
President Order
E.O. 13514

- 30% reduction in vehicle fleet petroleum use by 2020;
- 26% improvement in water efficiency by 2020;
- 50% recycling and waste diversion by 2015;
- 95% of all applicable contracts will meet sustainability requirements;
- Implementation of the 2030 net-zero-energy building requirement;
- Implementation of the stormwater provisions of the Energy Independence and Security Act of 2007, section 438; and
- Development of guidance for sustainable Federal building locations in alignment with the Livability Principles put forward by the Department of Housing and Urban Development, the Department of Transportation, and the Environmental Protection Agency.
Reduction in Water Use Since 1980

- Urinal
- Commercial Dish Washer
- Residential Dishwashers
- Residential Toilets
- Pre Rinse Spray Valve
- Commercial Clothes Washer
- Residential Clothes Washer
- Commercial Toilets
- Shower

Percent Reduction in Use for Best in Class

Since 1980
By 2030, about half of the buildings in America will have been built after 2000.

Census Projections of US Population (High to Low)
Changing Patterns of Water Use in Texas

- Non-Ag. Use
- Agricultural Use
- Total Use

Millions of Acre-Feet per Year

- 2010: Non-Ag. Use ~ 7, Agricultural Use ~ 10, Total Use ~ 17
- 2020: Non-Ag. Use ~ 9, Agricultural Use ~ 12, Total Use ~ 21
- 2030: Non-Ag. Use ~ 11, Agricultural Use ~ 14, Total Use ~ 25
- 2040: Non-Ag. Use ~ 13, Agricultural Use ~ 16, Total Use ~ 29
- 2050: Non-Ag. Use ~ 15, Agricultural Use ~ 18, Total Use ~ 33
- 2060: Non-Ag. Use ~ 17, Agricultural Use ~ 20, Total Use ~ 37
The Cheapest Water You Will Ever Have Is The Water You Already Have!
So is it working?
Seattle Washington

The graph shows the population trend and water consumption in Seattle, Washington, from 1975 to 2010.

- **Population**: The population is shown in the left vertical axis, increasing steadily from around 600,000 in 1975 to over 1,300,000 by 2010.

- **Total Consumption**: The total consumption of water is shown in the middle line, showing a slight decrease from the late 1980s to the late 1990s, indicating a period of water conservation or efficiency improvements.

- **Non-Revenue Water** and **Billed Consumption**: These are shown in the lower two lines. Non-revenue water is lower than billed consumption, indicating that a portion of the water consumed is not billed, possibly due to leaks or other non-measured uses.

- **Consumption in Millions of Gallons Per Day (Annual Average)**: The right vertical axis represents the consumption in millions of gallons per day, peaking around 260 million gallons per day around 2000, and decreasing to around 120 million gallons per day by 2010.

The graph illustrates the demographic and water use trends of Seattle, highlighting periods of population growth and water use efficiency.
Los Angeles

Exhibit 3A
Historical City of Los Angeles Water Use

Population

Active Water Demands

Thousands of Acre-Feet

Population in Millions

<table>
<thead>
<tr>
<th>Year</th>
<th>Thousand Acre-Feet</th>
<th>Population in Millions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1970</td>
<td>600</td>
<td>1.2</td>
</tr>
<tr>
<td>1974</td>
<td>600</td>
<td>1.2</td>
</tr>
<tr>
<td>1978</td>
<td>500</td>
<td>1.5</td>
</tr>
<tr>
<td>1982</td>
<td>550</td>
<td>1.8</td>
</tr>
<tr>
<td>1986</td>
<td>650</td>
<td>2.0</td>
</tr>
<tr>
<td>1990</td>
<td>700</td>
<td>2.1</td>
</tr>
<tr>
<td>1994</td>
<td>750</td>
<td>2.2</td>
</tr>
<tr>
<td>1998</td>
<td>800</td>
<td>2.4</td>
</tr>
<tr>
<td>2002</td>
<td>850</td>
<td>2.8</td>
</tr>
<tr>
<td>2006</td>
<td>900</td>
<td>3.2</td>
</tr>
<tr>
<td>2010</td>
<td>950</td>
<td>4.0</td>
</tr>
</tbody>
</table>
Phoenix, Arizona
El Paso Water Consumption

2010 Goal: 140 GCD

*Data courtesy of El Paso Water Utilities
San Antonio, Texas

Figure 4: Monthly Average Residential Indoor (winter) Usage in Gallons 1994 – 2012
Austin

Gallons Per Capita Per Day

Gallons Per Capita Per Day is down 13% since Fiscal Year 2006

190 170 157 152 142 137 137

192 193 194


*Estimate
Gallons Used per Dollar (2005) of Manufacturing Output in USA
Trends and Technology Gaps for Water Usage

- **1997**: 250 nm / 200 mm
- **1999, 2001**: 180 nm / 300 mm, 150 nm / 300 mm
- **2003**: 130 nm / 300 mm
- **2006**: 100 nm / 300 mm
- **2009**: 70 nm / 450 mm
- **2012**: 50 nm / 450 mm

- Tactical Solutions
- Strategic Solutions
- Research Gaps

- **Recycle**
- **Conservation**
- **Metrology**
- **Advanced Control**

**NSF/SRC Engineering Research Center for Environmentally Benign Semiconductor Manufacturing**
Water Use for Pulp and Paper Mills

Gallons per Ton of Paper

- Pre 1980's Kraft
- Current Bleached Kraft
- Recycle (with deinking)
- Recycle (no deinking)
The Cheapest Water You Will Ever Have Is The Water You Already Have!
Our challenge it to get people to look at the wet stuff that falls from the sky differently!
So Let’s Get Started