



UNIVERSITY OF ARIZONA Water Balance

March 24, 2016

Presenters:

Chris Kopach, Assistant Vice President, Facilities Management

Damian Cox, President

Henry Johnstone, President



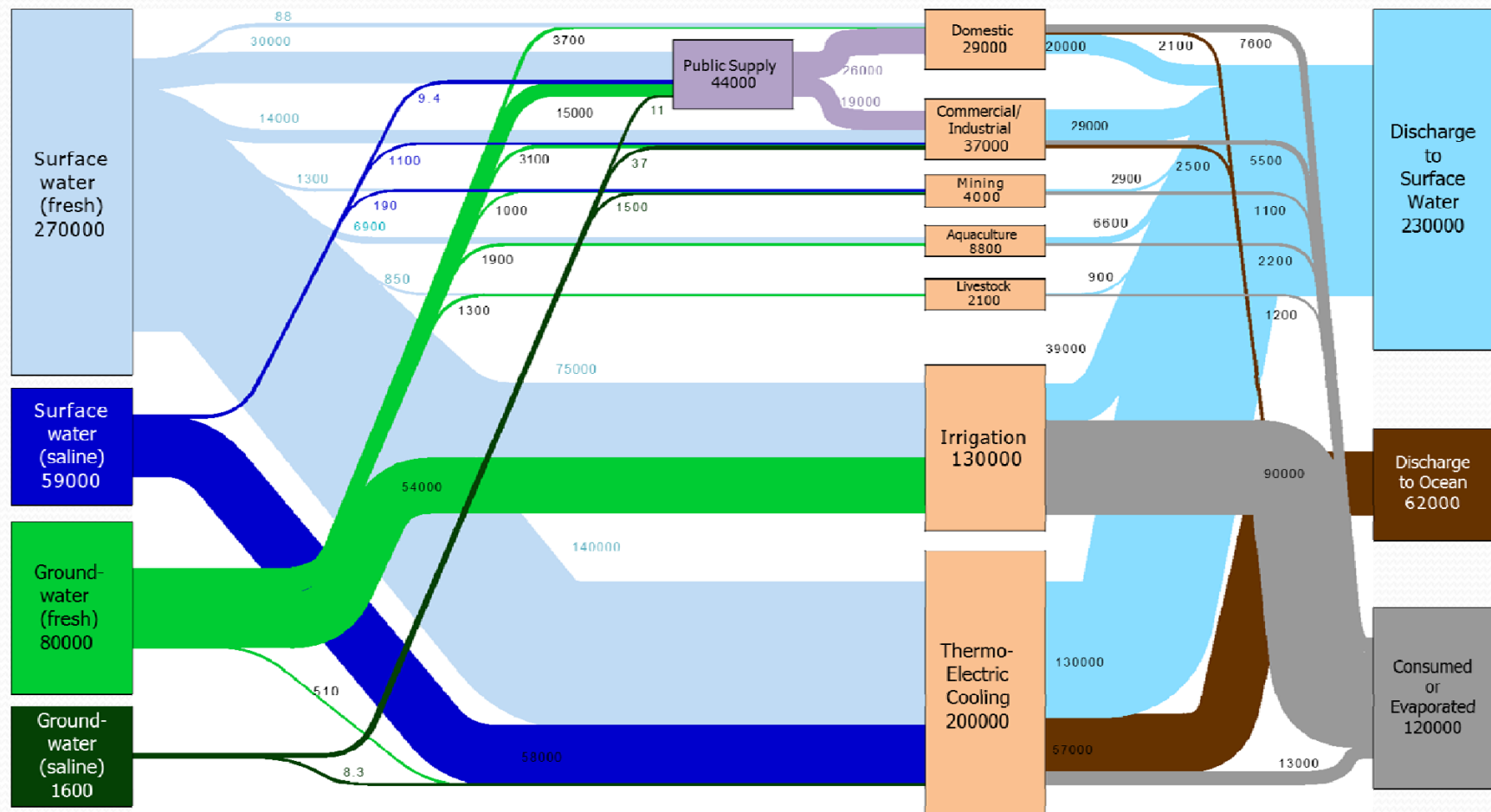
OUTLINE

- **Flow to Campus**
 - National and Regional Sources and Sinks
 - Scarcity, Costs and Trends
 - Water path to Campus
- **UA Campus Water Infrastructure**
 - Components: wells, tie in boosters, distribution, municipal reclaim
 - Costs: purchase, operation, maintenance
 - Trends
- **UA Water and Opportunities**
 - Landscape, Fields, Irrigation
 - Rain Water Harvesting
 - Buildings, Restrooms
 - Cooling Plant

RELEVANCE

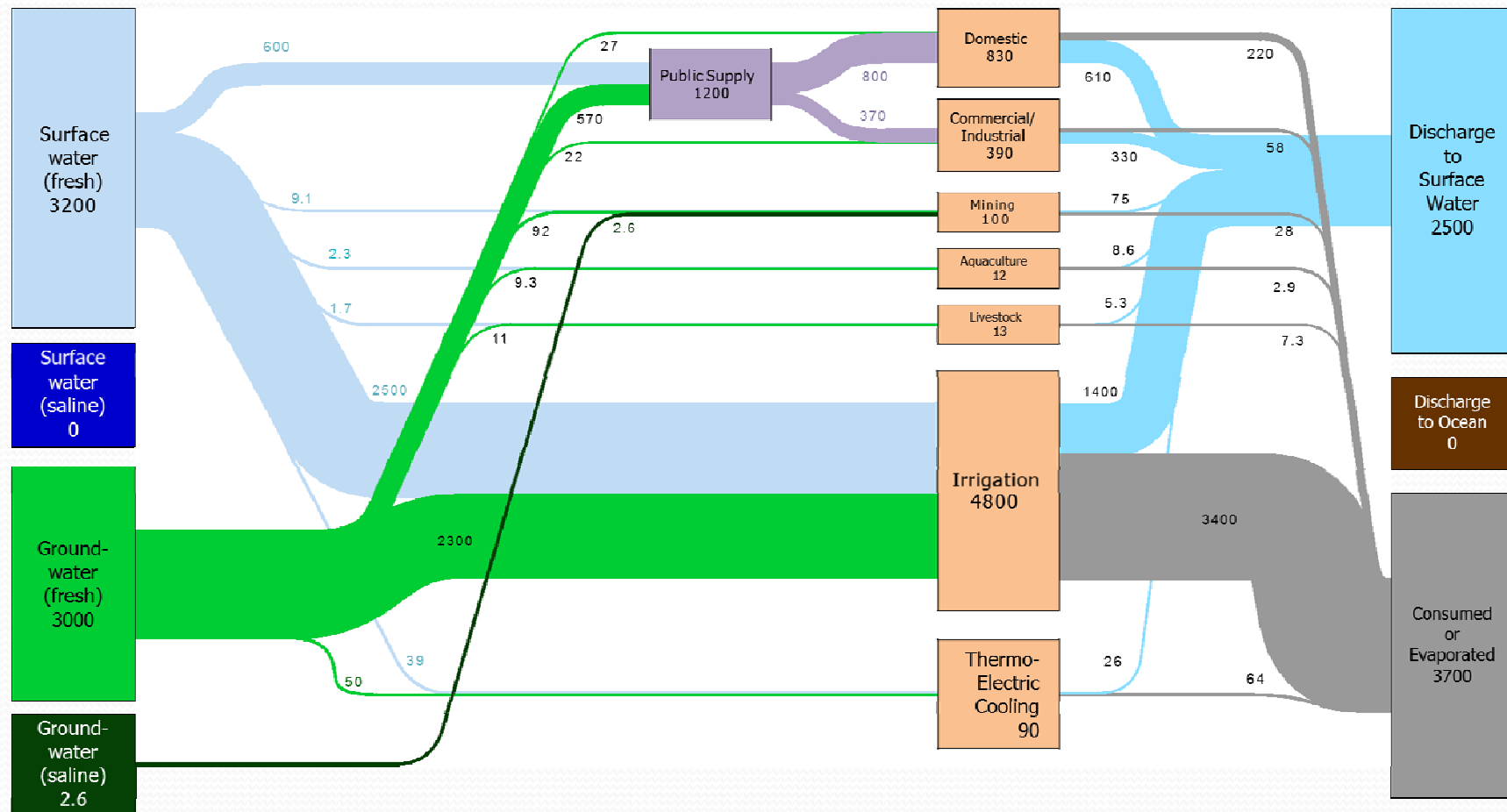
- **Topic of Intense Regional Interest**
 - Scarcity/Cost/Conservation/New Sources
- **University of Arizona's Role**
 - Nationally Recognized Academic/Research Program
 - Facilities Management Stewardship Role
 - Water production and use efficiency roadmap
 - Business Partners: ARID program

Estimated United State Water Flow in 2005: 410000 Million Gallons/Day



Source: LLNL 2011. Data is based on USGS Circular 1344, October 2009. If this information or a reproduction of it is used, credit must be given to the Lawrence Livermore National Laboratory and the Department of Energy, under whose auspices the work was performed. All quantities are rounded to 2 significant digits and annual flows of less than 0.05 MG/day are not included. Totals may not equal sum of flows due to independent rounding. Further detail on how all flows are calculated can be found at <http://flowcharts.llnl.gov>. LLNL-TR-475772

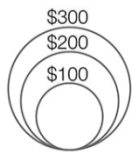
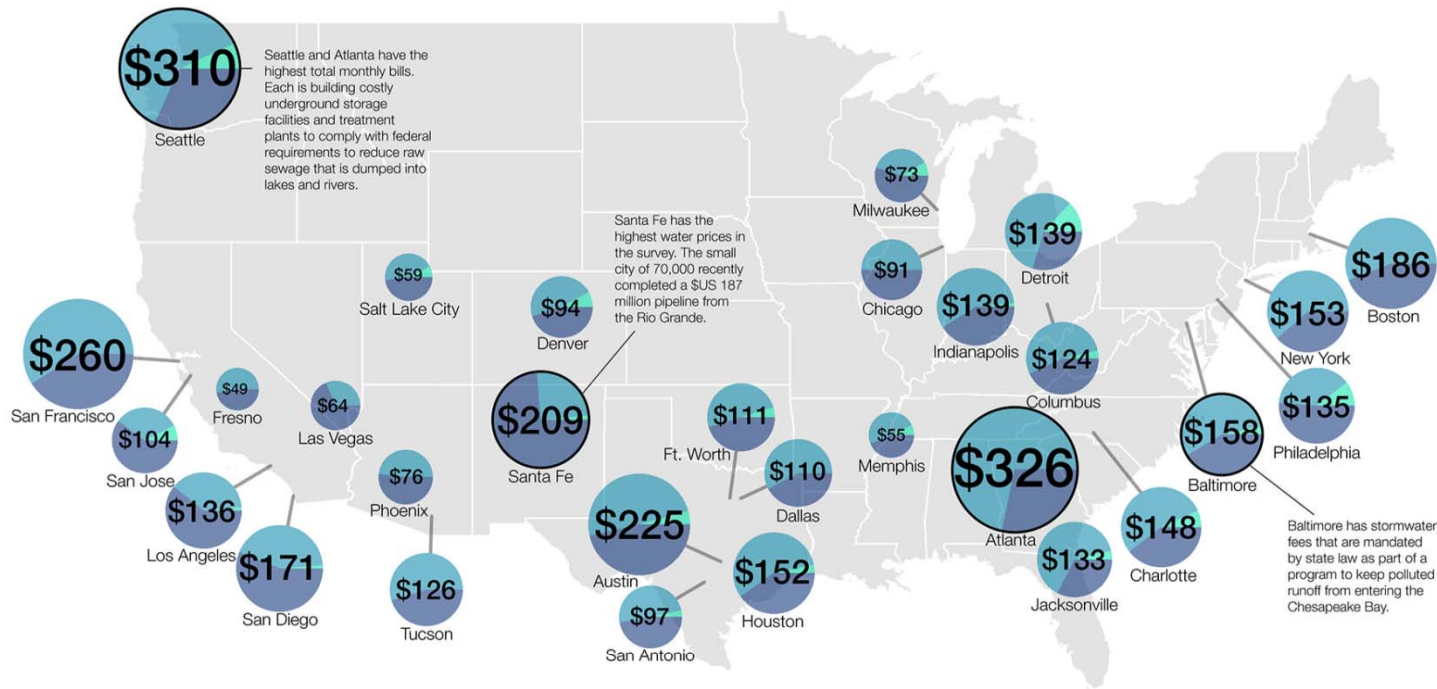
Estimated Arizona Water Flow in 2005: 6200 Million Gallons/Day



Source: LLNL 2011. Data is based on USGS Circular 1344, October 2009. If this information or a reproduction of it is used, credit must be given to the Lawrence Livermore National Laboratory and the Department of Energy, under whose auspices the work was performed. All quantities are rounded to 2 significant digits and annual flows of less than 0.05 MG/day are not included. Totals may not equal sum of flows due to independent rounding. Further detail on how all flows are calculated can be found at <http://flowcharts.llnl.gov>. LLNL-TR-475772.

THE PRICE OF WATER: 2015

Combined water, sewer and stormwater prices for households in 30 major U.S. cities.

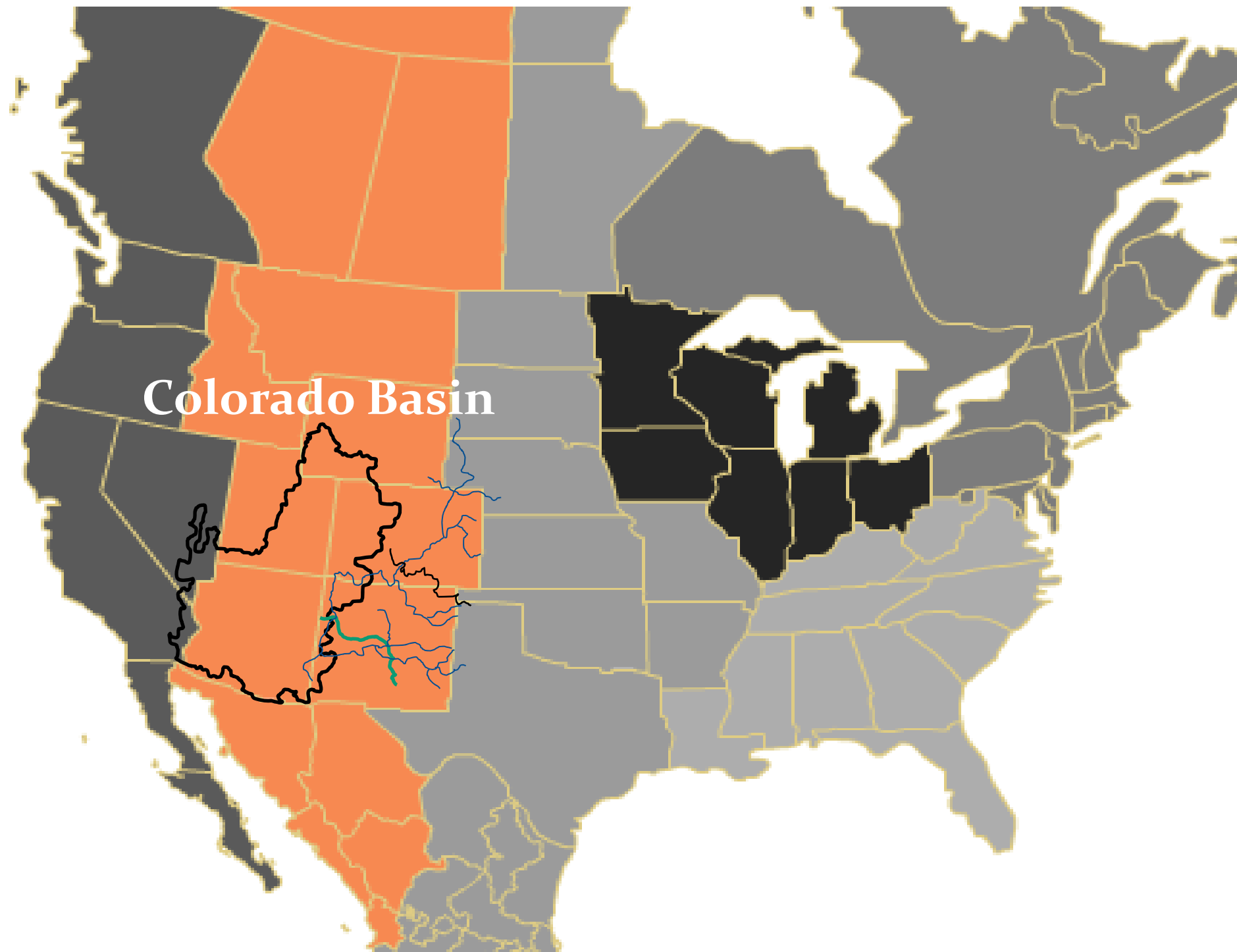


Water prices pay for treating, pumping, and delivering water, while sewer prices cover the cost of cleansing the water that goes down the drain.

Sewer prices are often higher than water prices because more energy and chemicals are required for treatment. Following the Clean Water Act, the federal government gave grants for new treatment plants during the 1970s and 1980s. Over the past three decades, however, new spending has been cut for local sewer infrastructure.

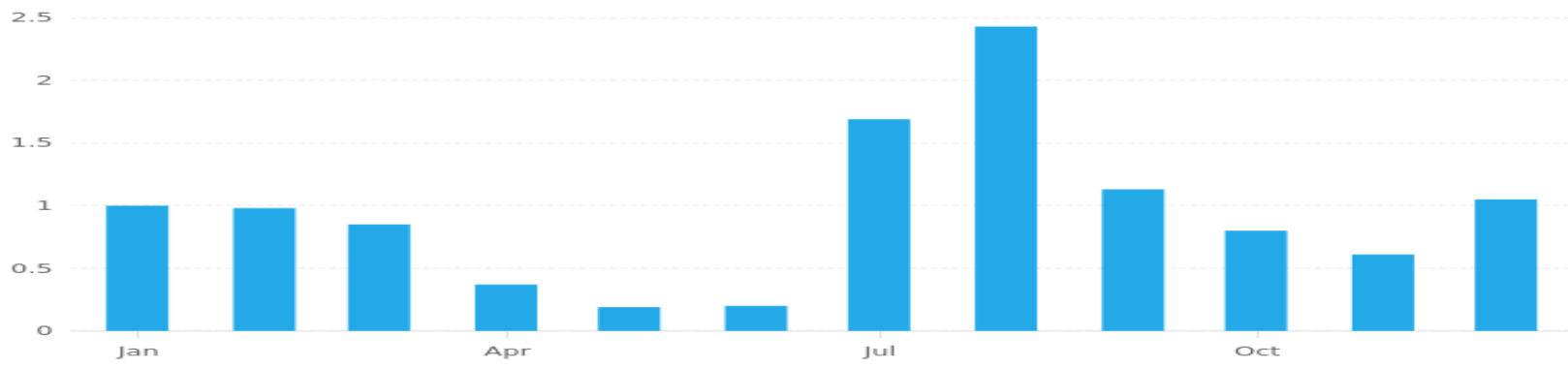
Stormwater fees are not included in every city's monthly bill. Some cities use general tax revenues to pay for projects to reduce polluted runoff from streets and parking lots. However, these projects must then compete for funds with other departments like police and schools.

Rates current as of April 1, 2015.
Monthly bill calculated for a family of four using 100 gallons per person per day.
Source: Circle of Blue research, based on utility water rates.



Tucson, Arizona Average Rainfall by Month

Average Rainfall (in)

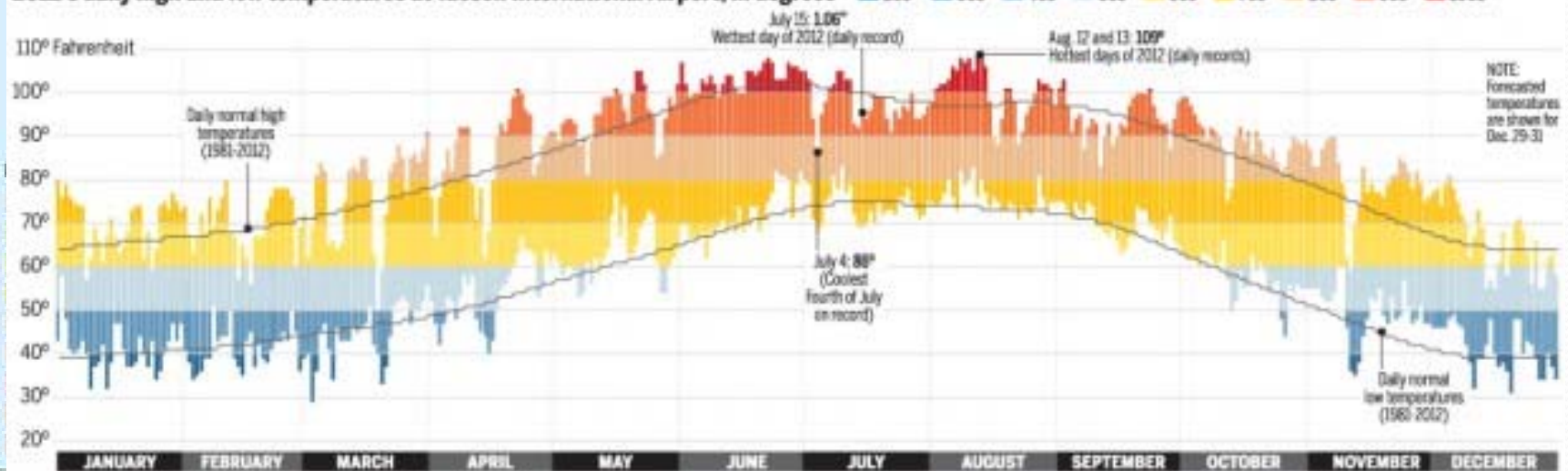


Created on October 5th, 2015

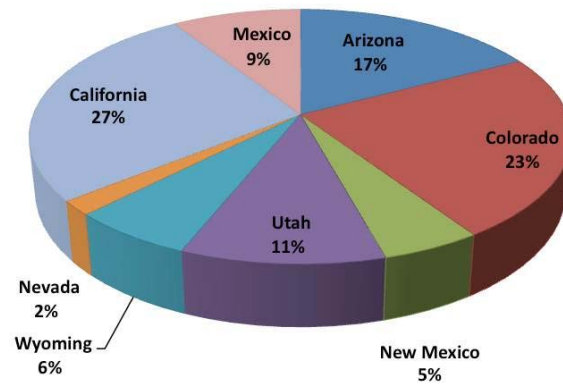
GRAPHIQ

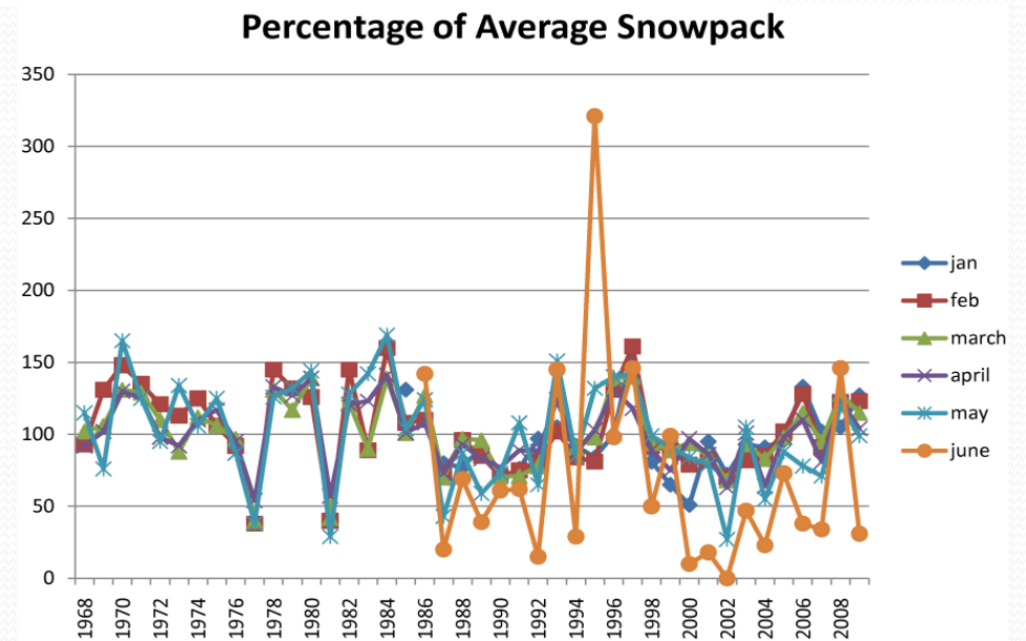
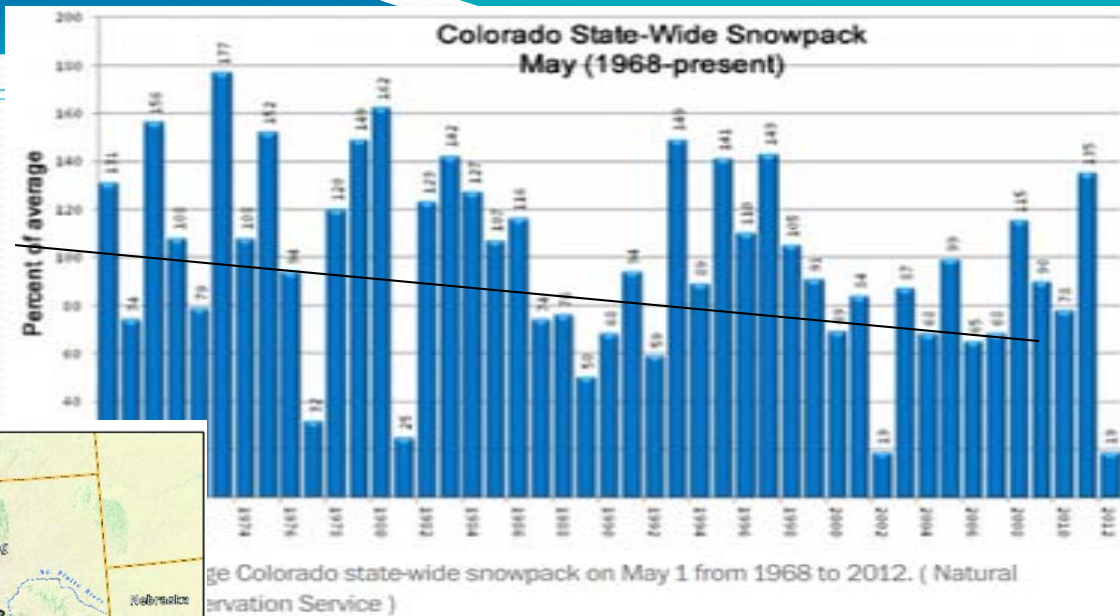


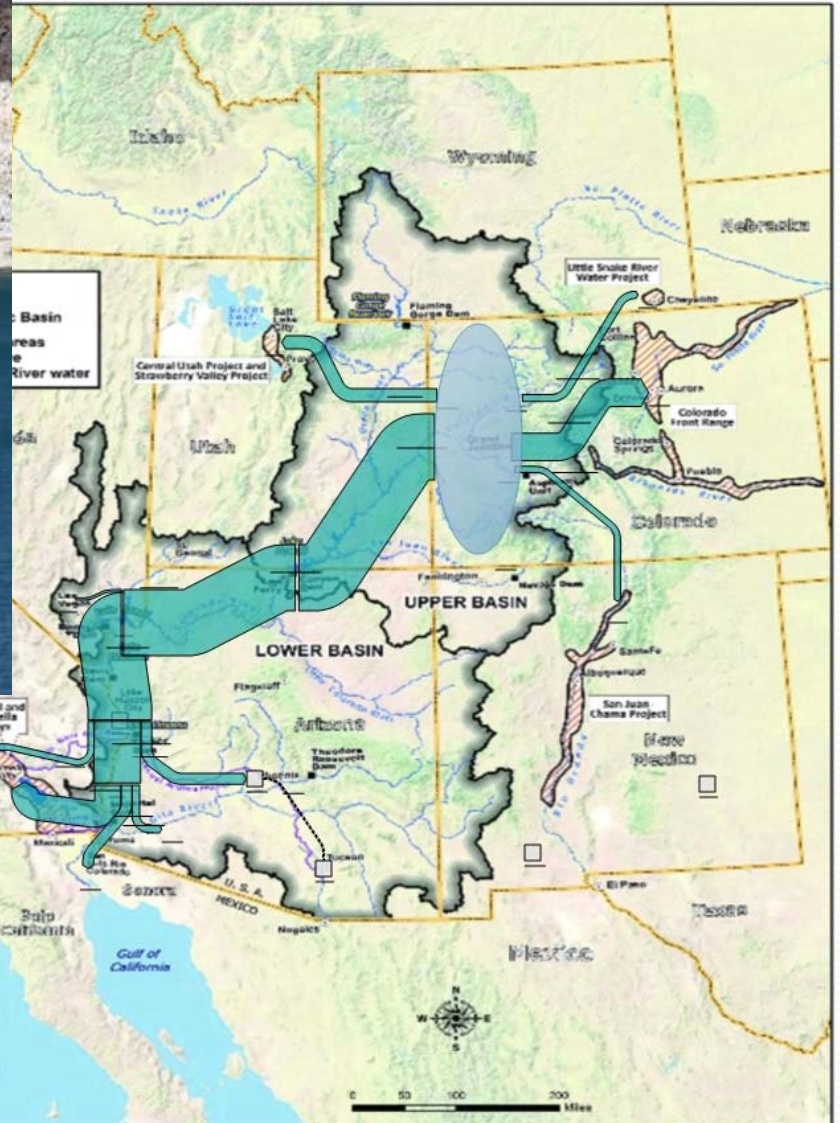
2012's daily high and low temperatures at Tucson International Airport, in degrees

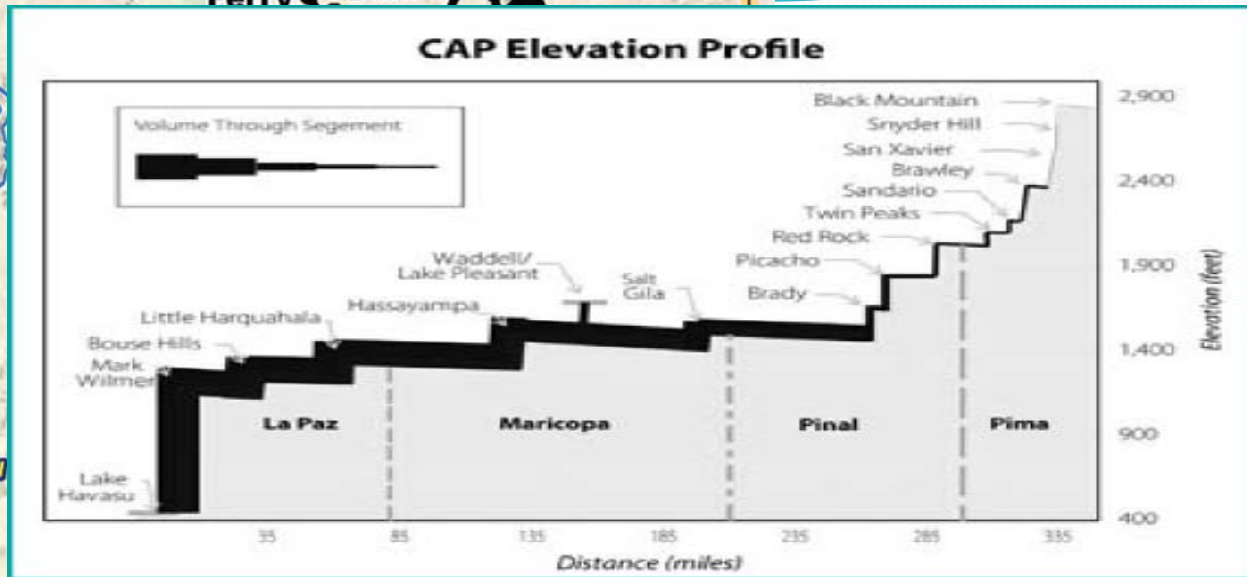
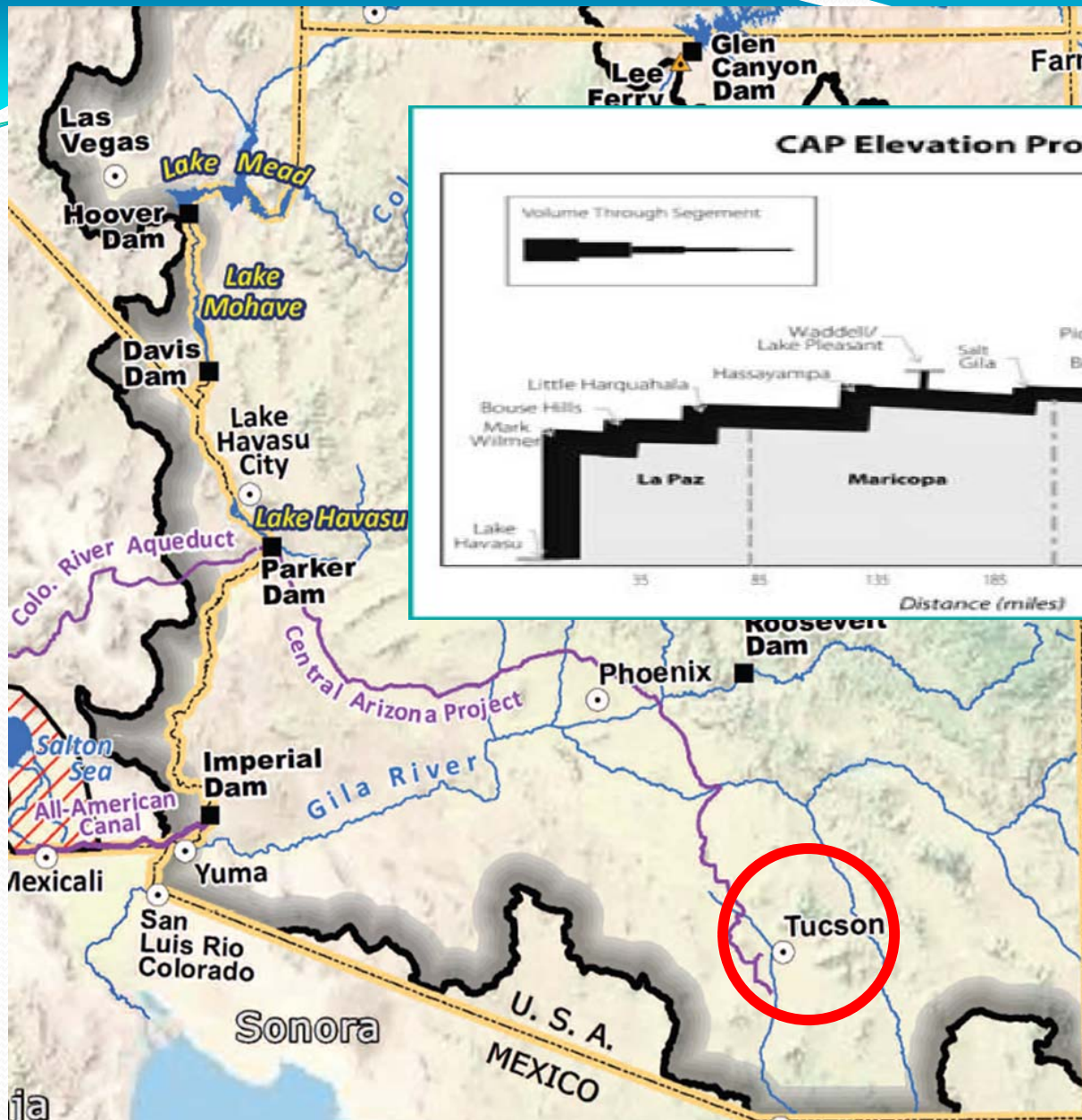


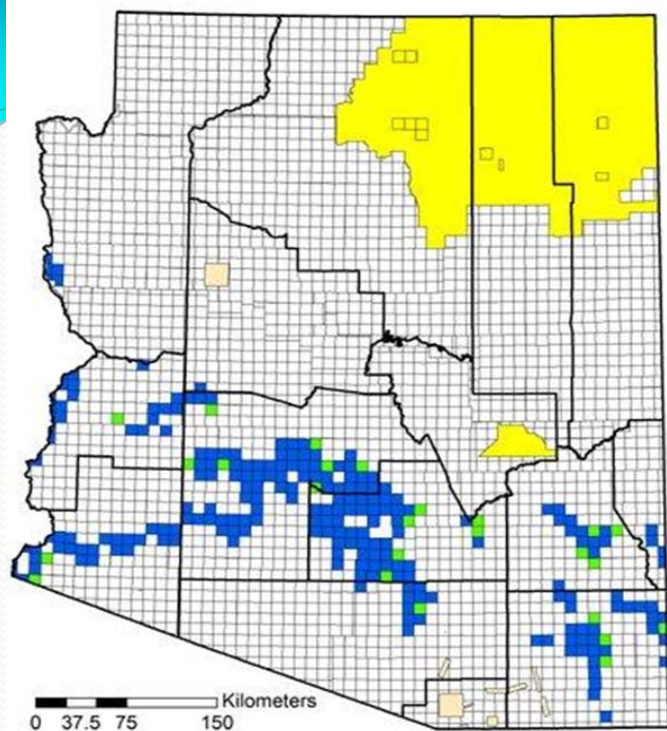
Colorado River Apportionment



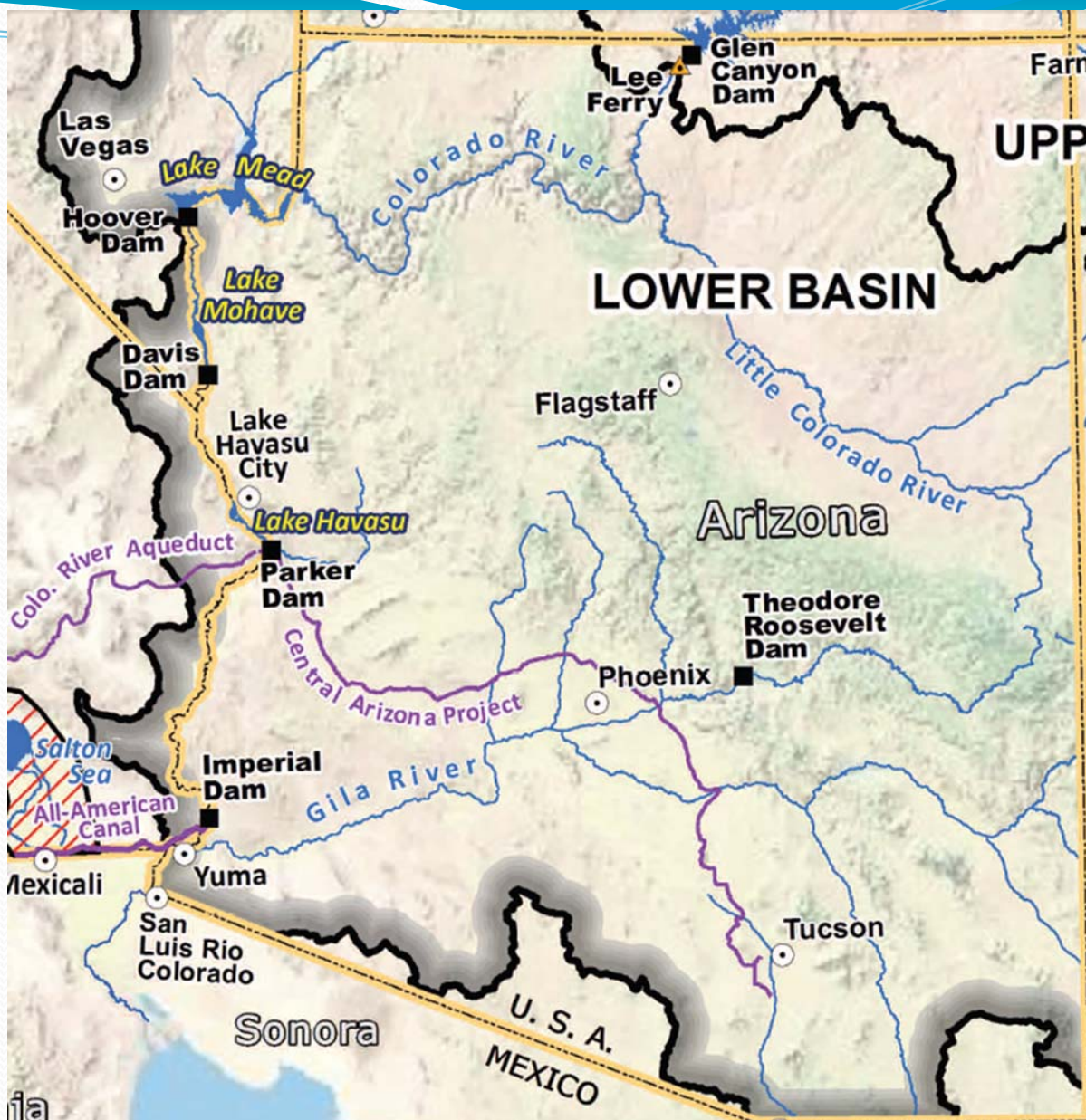
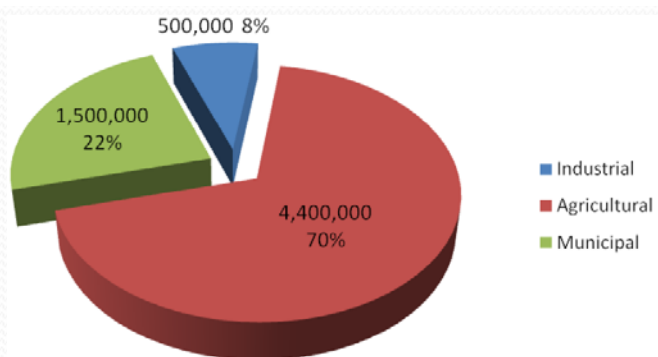






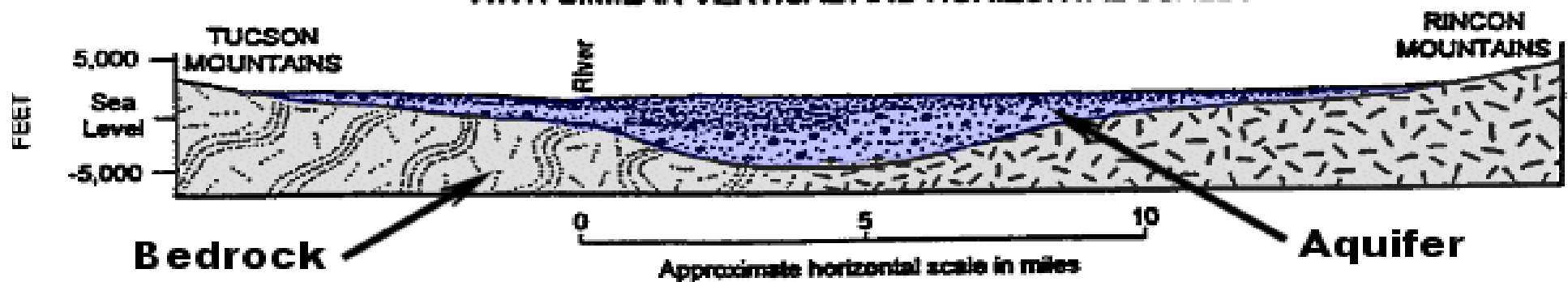


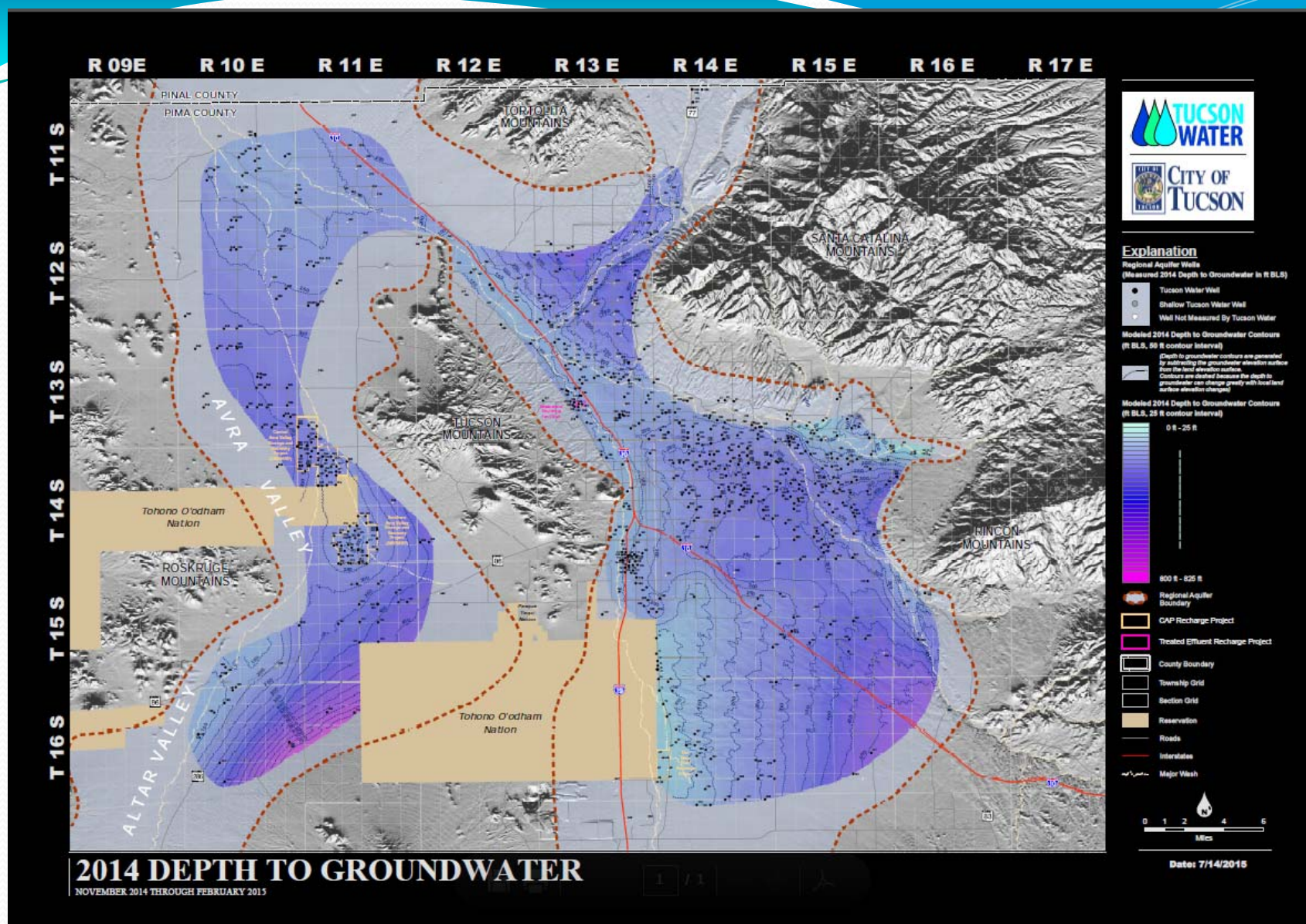
Cartography by C. Ellers-Kirk, The University of Arizona, 2008






**SCHEMATIC CROSS SECTION OF UPPER SANTA CRUZ VALLEY SUBBASIN
WITH SIMILAR VERTICAL AND HORIZONTAL SCALES**







UA Campus Water Infrastructure

University of Arizona Water Balance



3/28/2016



University of Arizona Campus

- 390 Acres
- 12 MSF Conditioned
- 42,600 Students
- 15,300 Staff
- 6,604 Residence Beds

Primary Water Uses

- Landscape-Fields
- Buildings
- Cooling



Central Heating and Refrigeration Plant

- 12,000 Ton Cooling Tower
- 10,000 Water Chillers
- 800 Ton Glycol Chiller
- 6,400 Ton-hr Ice Storage
- 180,000 lb/hr Steam
- 7 MW GTG



Arizona Health Sciences Central Plant

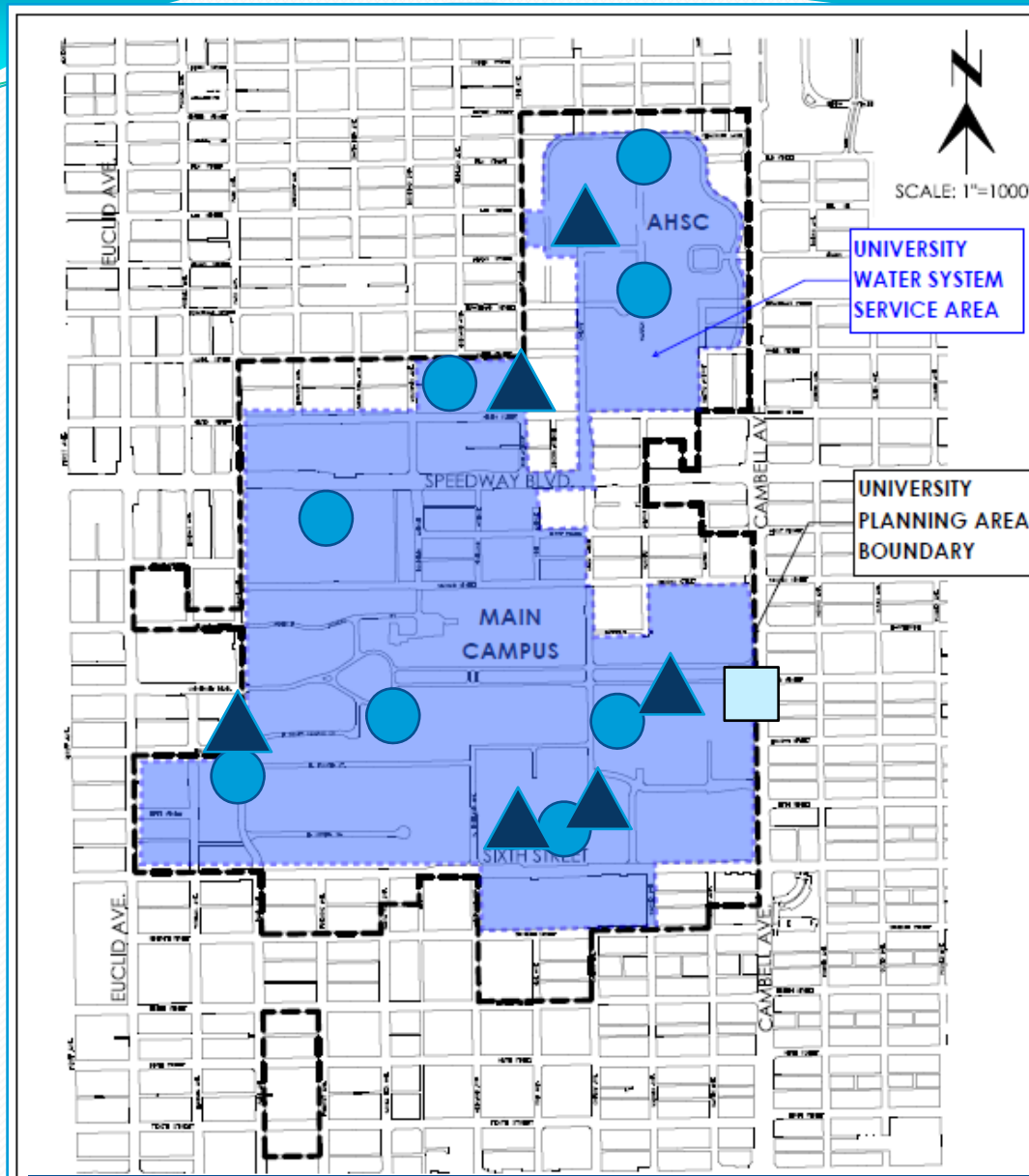
- 10,000 Ton Cooling Tower
- 10,000 Water Chillers
- 155,000 lb/hr Steam
- 6 MW GTG



Central Refrigeration Building

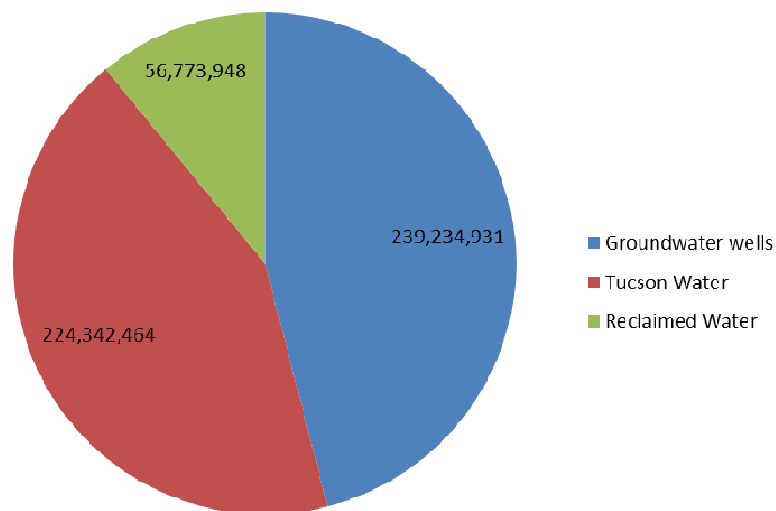
- 13,000 Ton Cooling Tower
- 12,000 Water Chillers
- 2,400 Ton Glycol Chiller
- 20,000 Ton-hr Ice Storage

UA WATER SOURCES

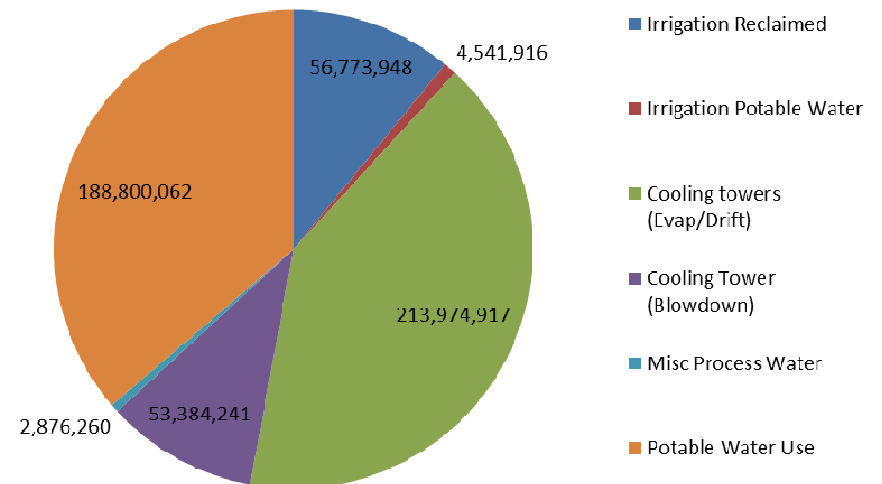


TYPICAL WATER CONSUMPTION AT UNIVERSITY OF ARIZONA

**Water Supply (gal/year)
2015 - 520 Million gallons**



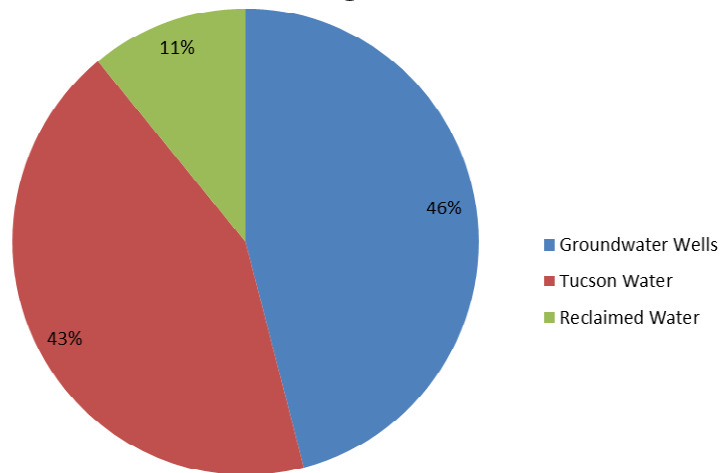
Total Water Usage (gal/year)



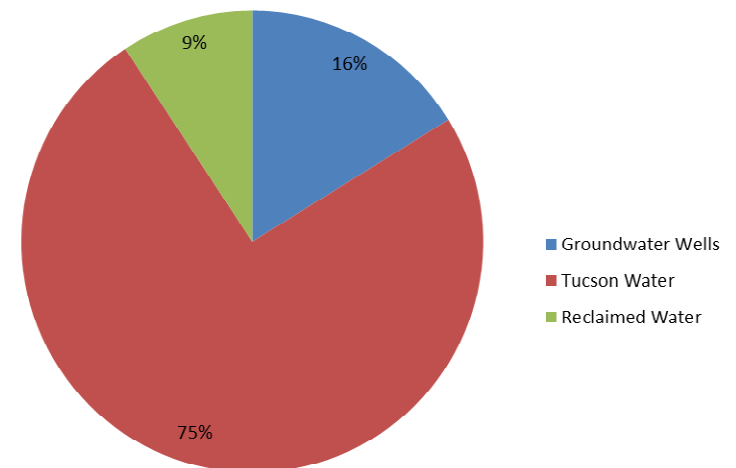
UA WATER SYSTEM

	Consumption (kgal)	Commodity ((\$/kgal)	Electrical (\$/kgal)	O&M (\$/kgal)	Total (\$/kgal)	Annual Costs
Groundwater Wells	239,235	\$ 0.009	\$ 0.06	\$ 1.10	\$ 1.169	\$ 279,666
Tucson Water	224,342	\$ 5.27	\$ 0.03	\$ 0.46		\$ 1,292,047
Reclaimed Water	56,774	\$ 2.83				\$ 160,507
Total	520,351					\$ 1,732,220

**Water Supply
2015
520 Million gallons**



**Water Supply Cost
2015
\$1,732,220**



WATER AT UNIVERSITY OF ARIZONA

ONGOING INITIATIVES AND OPPORTUNITIES

CONSERVATION

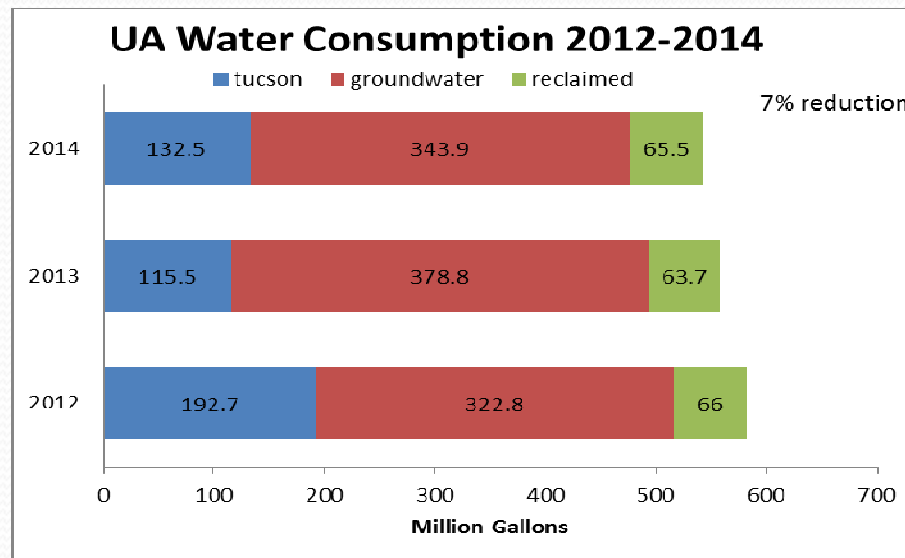
Irrigation, Buildings, Central Plants

MONITORING AND CONTROL

SCADA : Cannot Control What Is Not Measured

PLANNING FOR STORAGE

400,000 Gal Tank to Reduce Tucson Water Purchase





Landscape-Fields

Xeriscape



3/28/2016

Landscape

Reclaimed
Water
Irrigation



3/28/2016

Irrigation
Controls



26

Reclaimed Water Athletic Fields



Athletic Fields

85% Reclaimed
Water



Water Harvesting

390 acres
11.3 inches
120,000,000 gallons

22% of 540,000,000





Restroom Water Efficiency Solutions

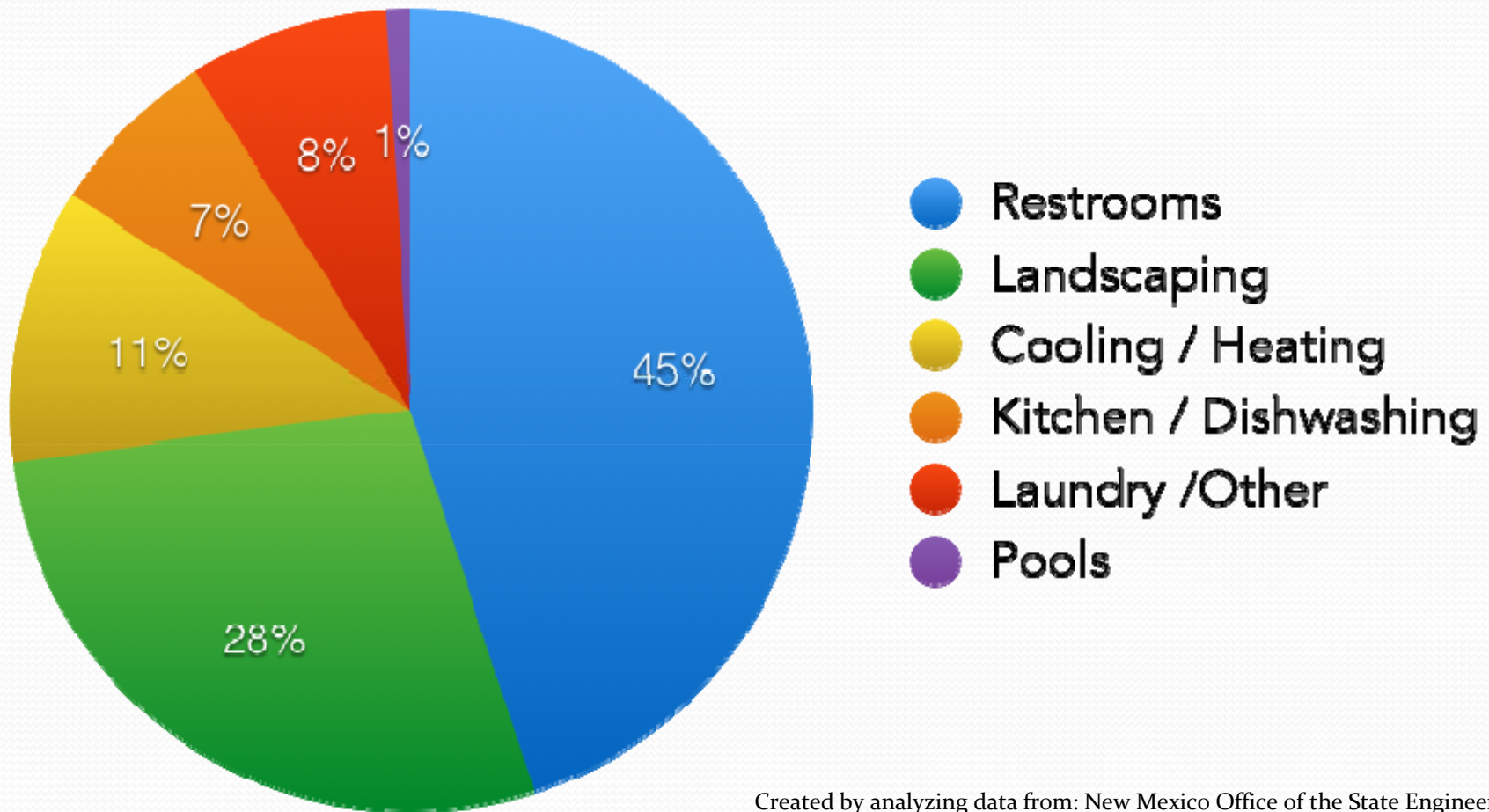




Why conserve restroom water?



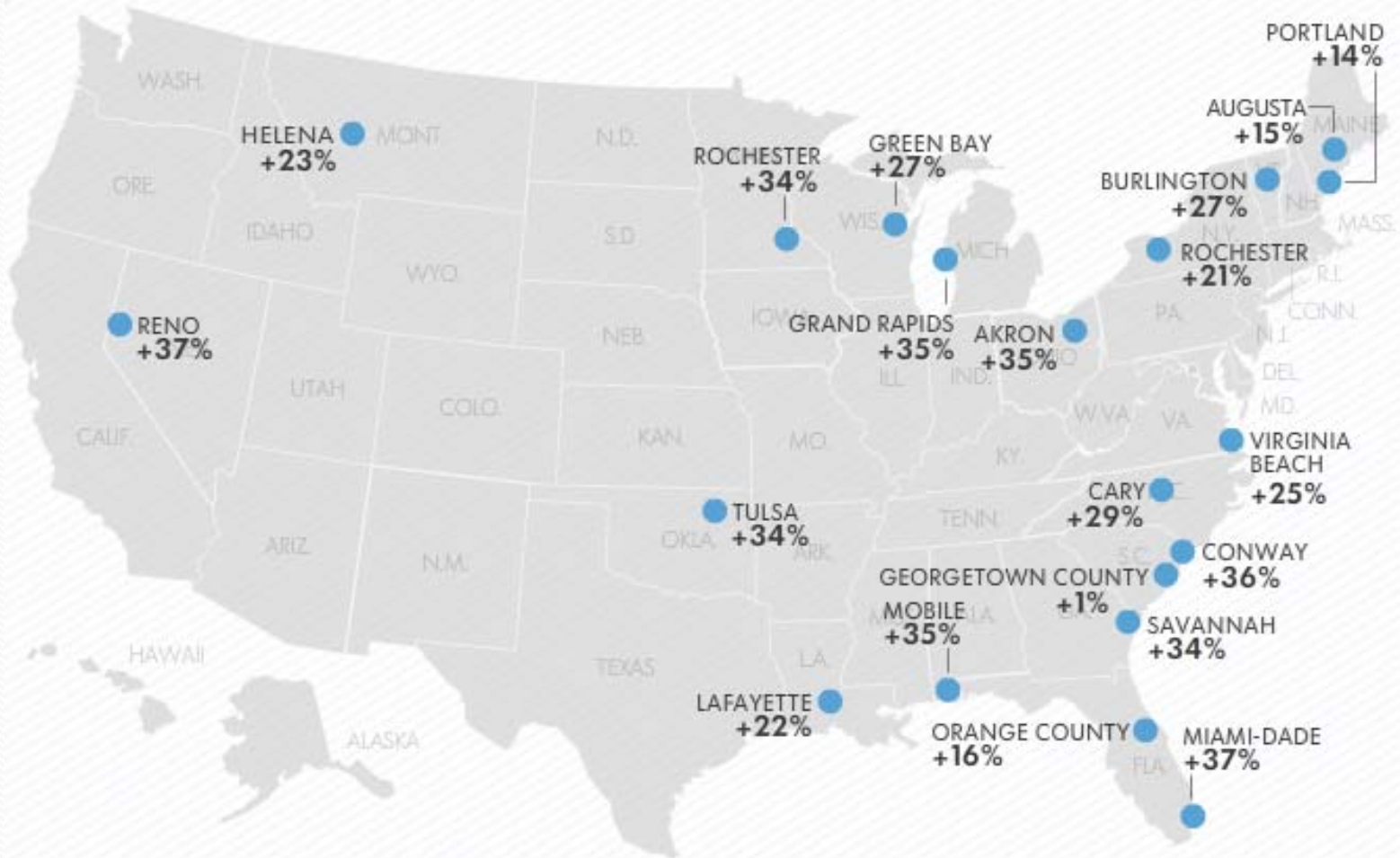
End Uses of Water in Schools



Created by analyzing data from: New Mexico Office of the State Engineer, American Water Works Association (AWWA), AWWA Research Foundation and East Bay Municipal Utility District.

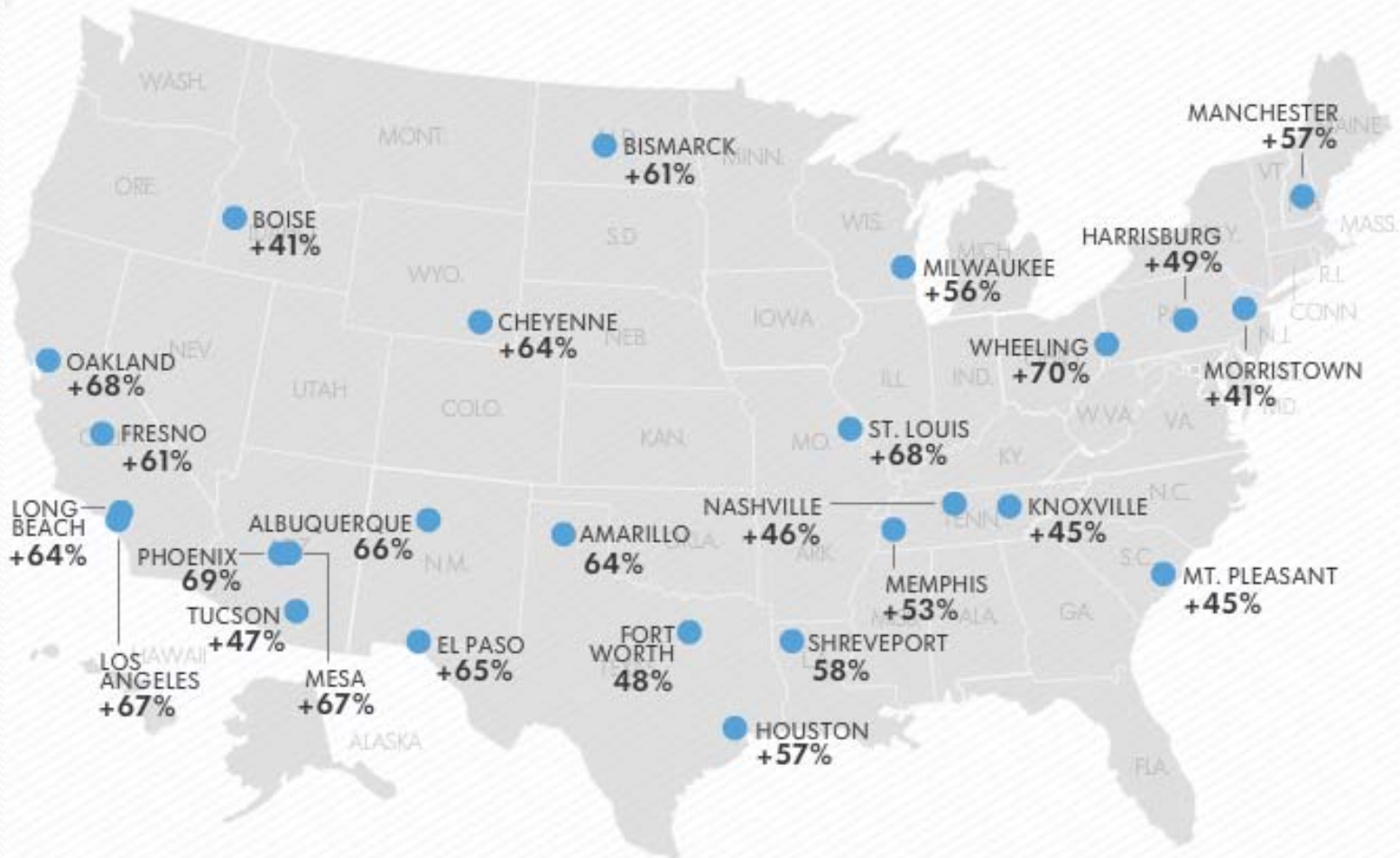
THE PRICE OF WATER IS RISING:

2002 - 2012



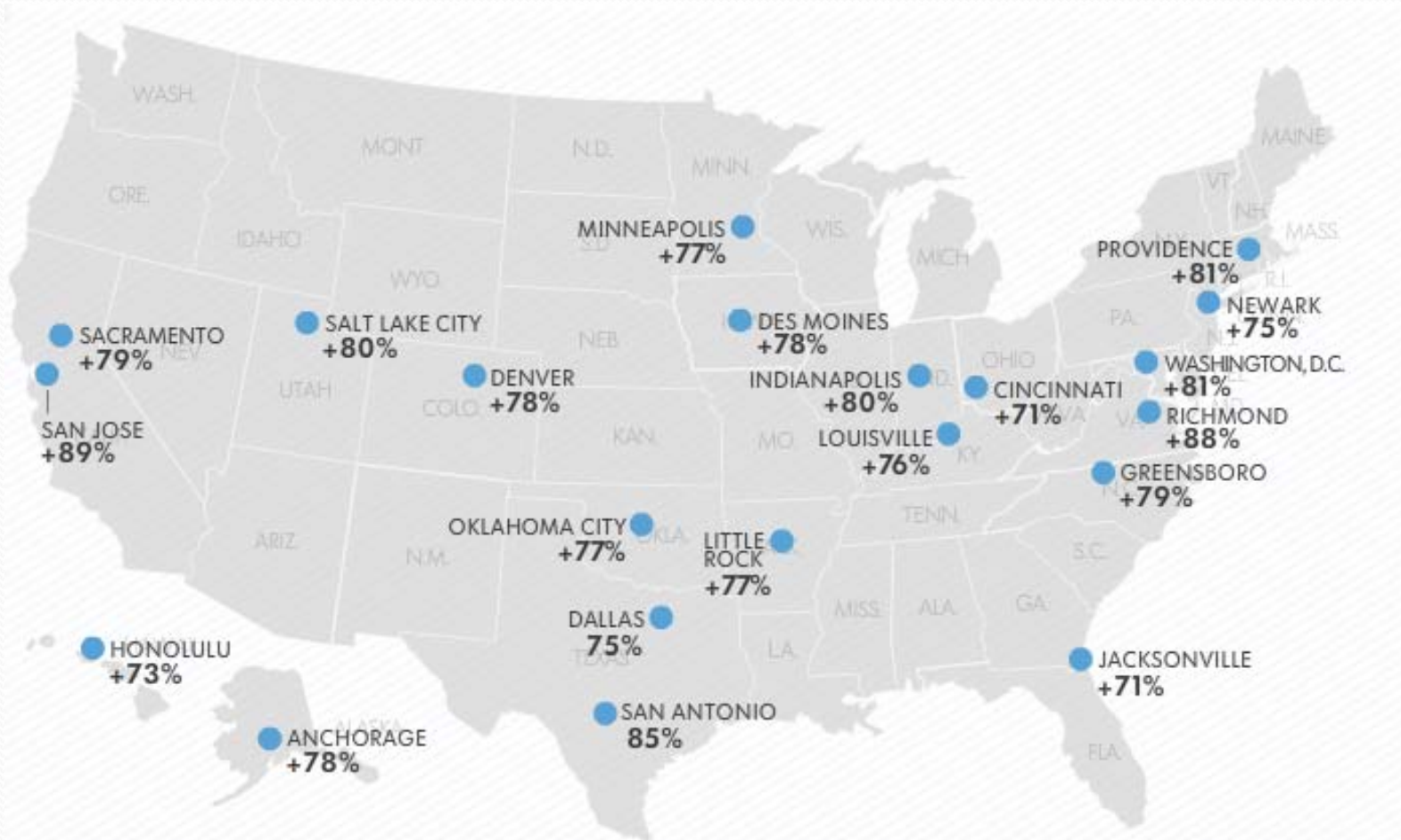
THE PRICE OF WATER IS RISING:

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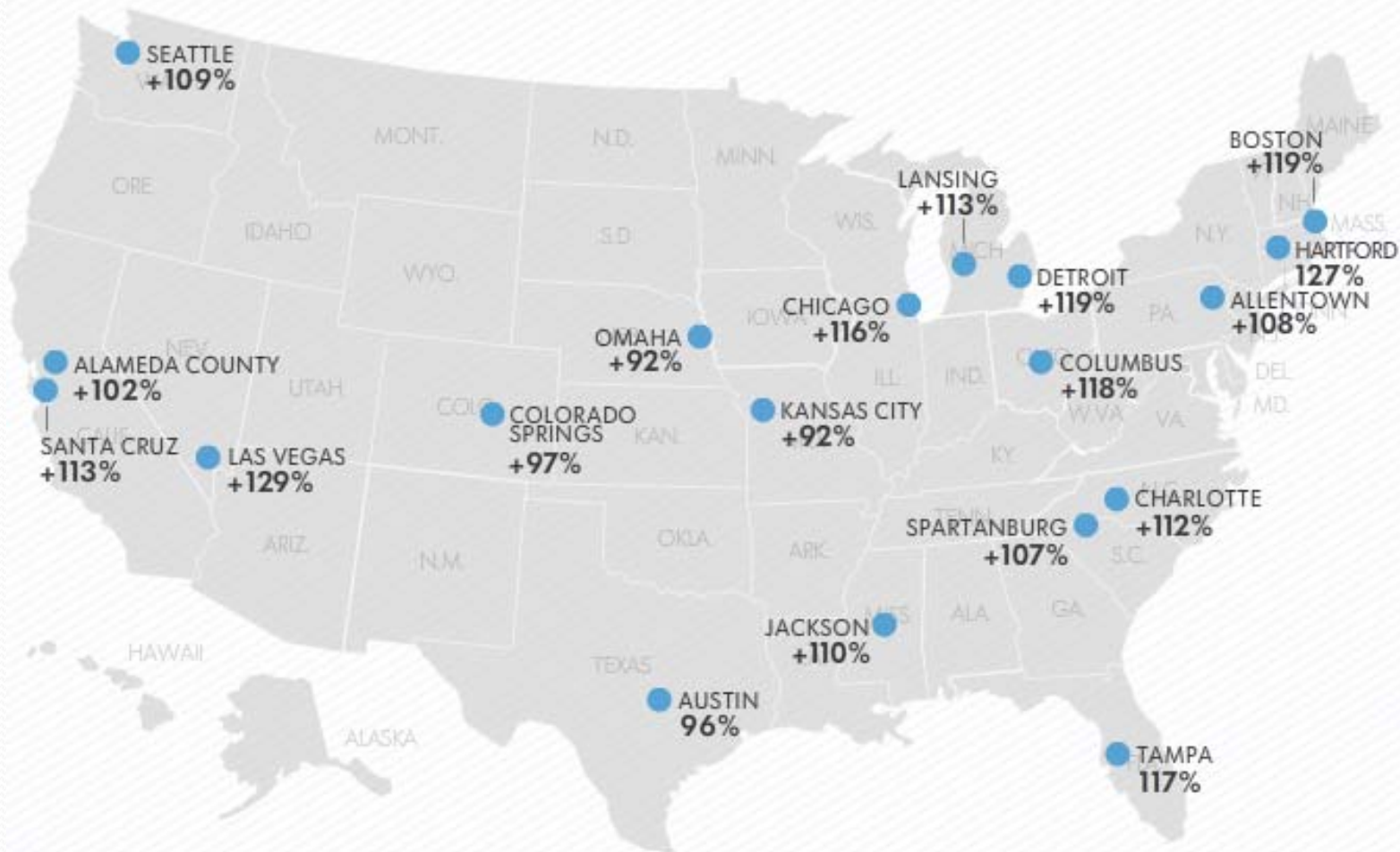
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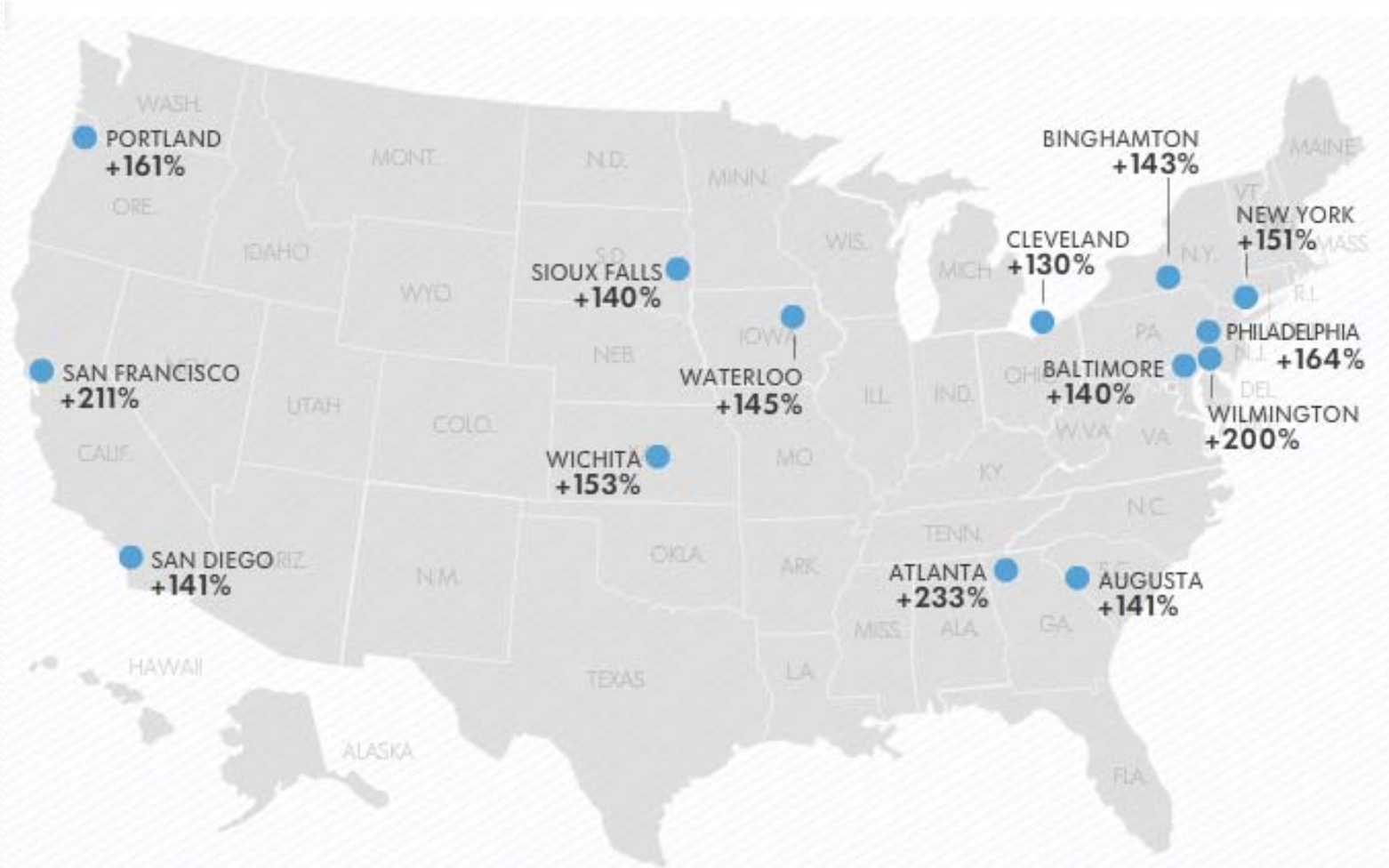
THE PRICE OF WATER IS RISING:

2002 - 2012



THE PRICE OF WATER IS RISING:

2002 - 2012





Drivers of Increasing Water Rates:

- Infrastructure Upgrades
- Supply & treatment costs
- Compliance with clean-water mandates.
- Pension / health care costs
- security safeguards
- Drought



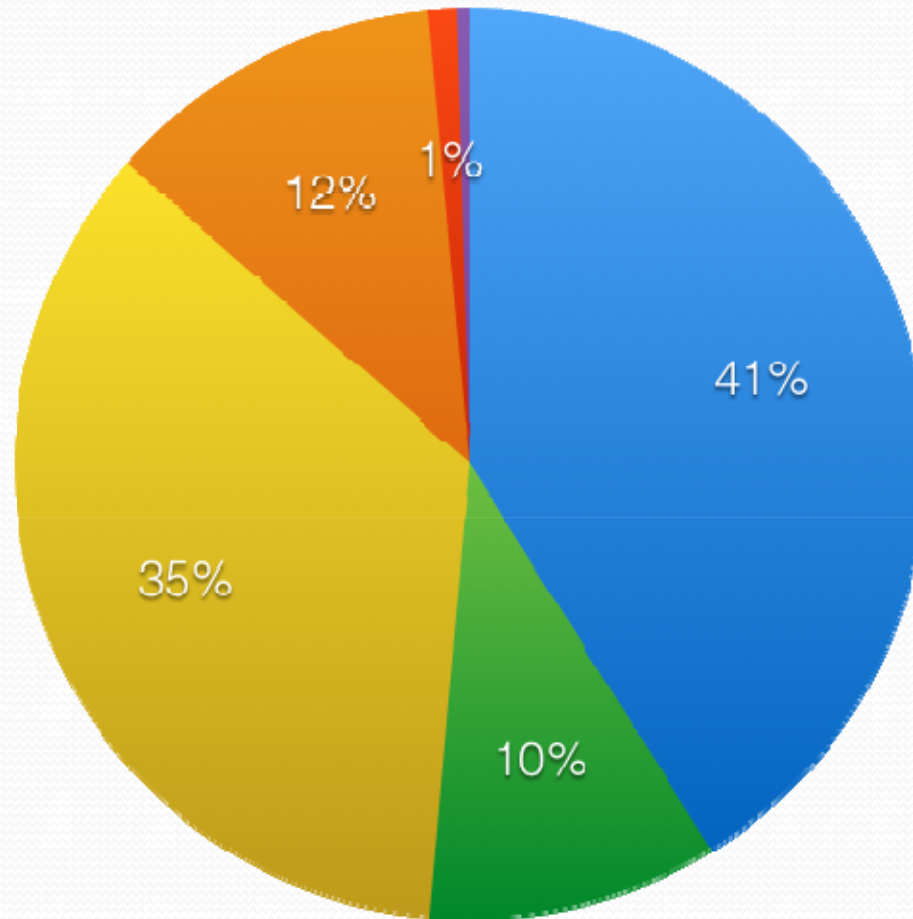


University of Arizona

57,900 students / employees



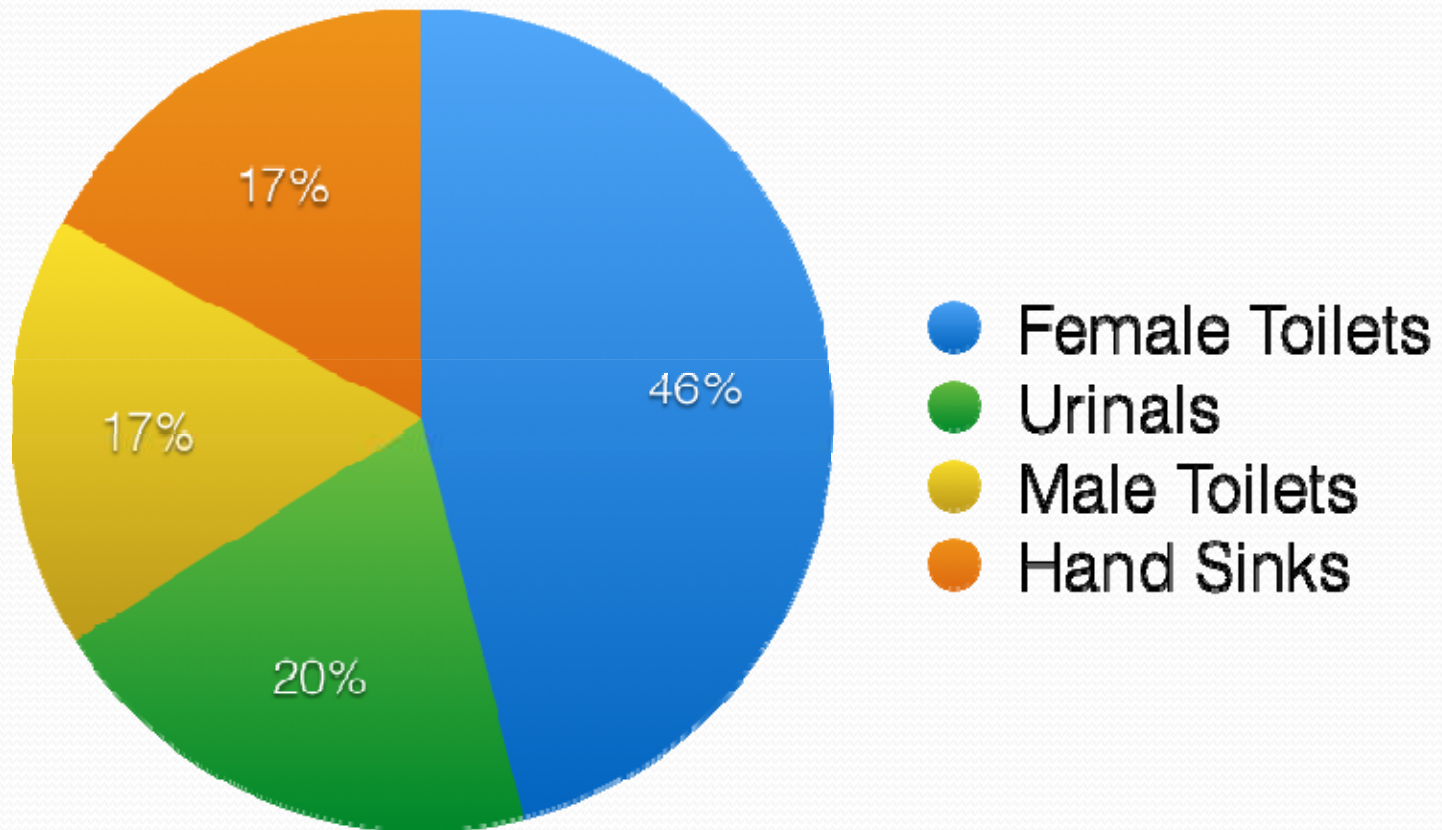
University of Arizona Overall Water Use



Total Consumption:
542,000,000 gallons

- Cooling Towers
- Cooling Tower Blow Down
- Domestic Potable
- Irrigation (recycled water)
- Irrigation (potable water)
- Miscellaneous

University of Arizona Restroom Water Use by Fixture





University of Arizona Recommended Restroom Changes:

Urinals : Waterless / Ecoblue Cube System

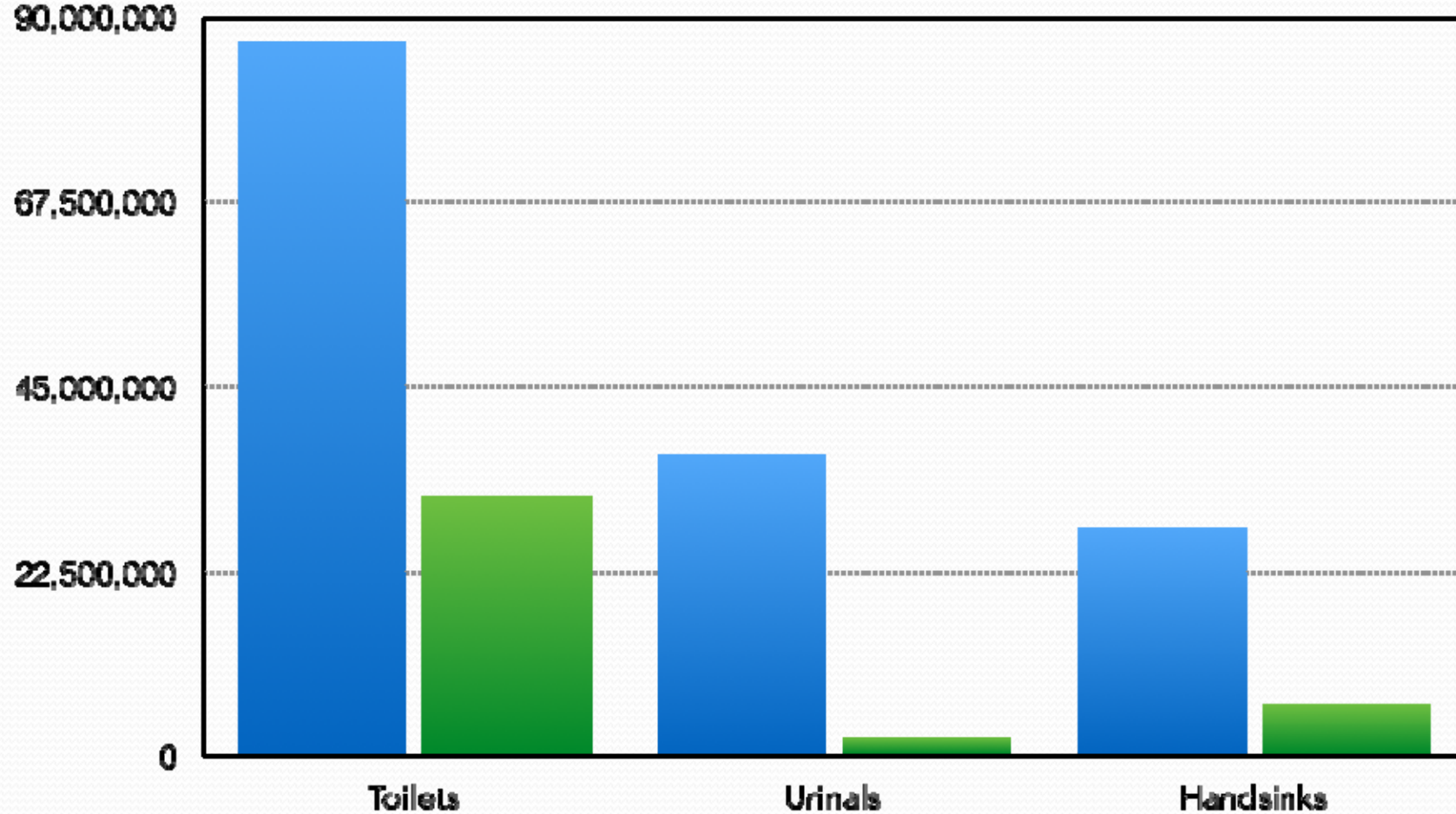
Toilets: High efficiency

Hand Sinks: High efficiency faucets / flow controllers



University of Arizona Restroom Water Use by Fixture

Gallons Of Water
90,000,000



Before

After

University of Arizona Total Restroom Water Use

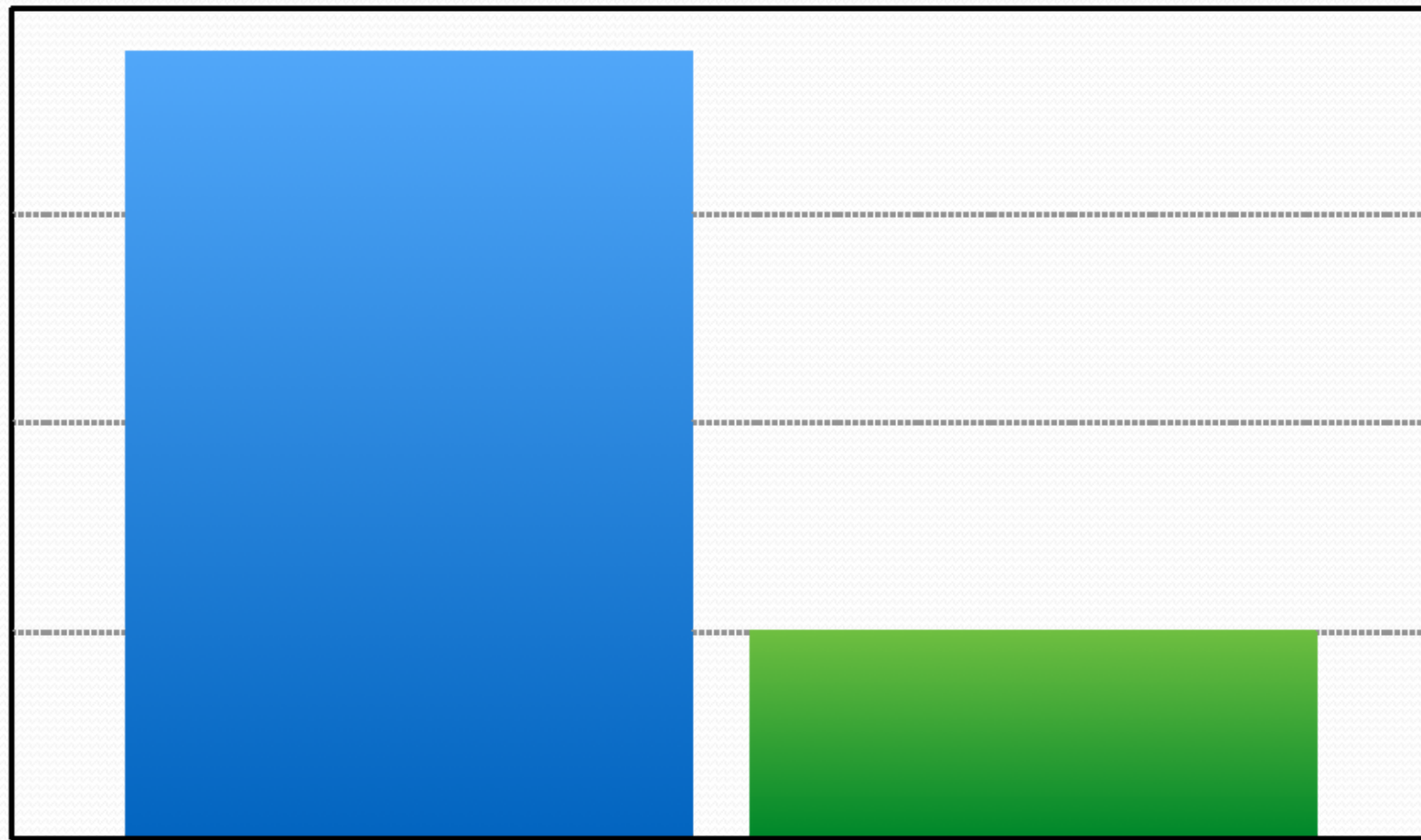
Gallons Of Water
160,000,000

120,000,000

80,000,000

40,000,000

0



Total Restroom Water Use

■ Before

■ After



Estimated Savings

1 million dollars
110 million gallons





New Water Efficient Restroom Products



High Efficiency Toilets

Replacement Options

- High efficiency commercial 1.28 gpf
- Dual flush Tank 0.5 / 0.95 gpf
- Single flush Tank 0.8 gpf
- New drain assist technologies

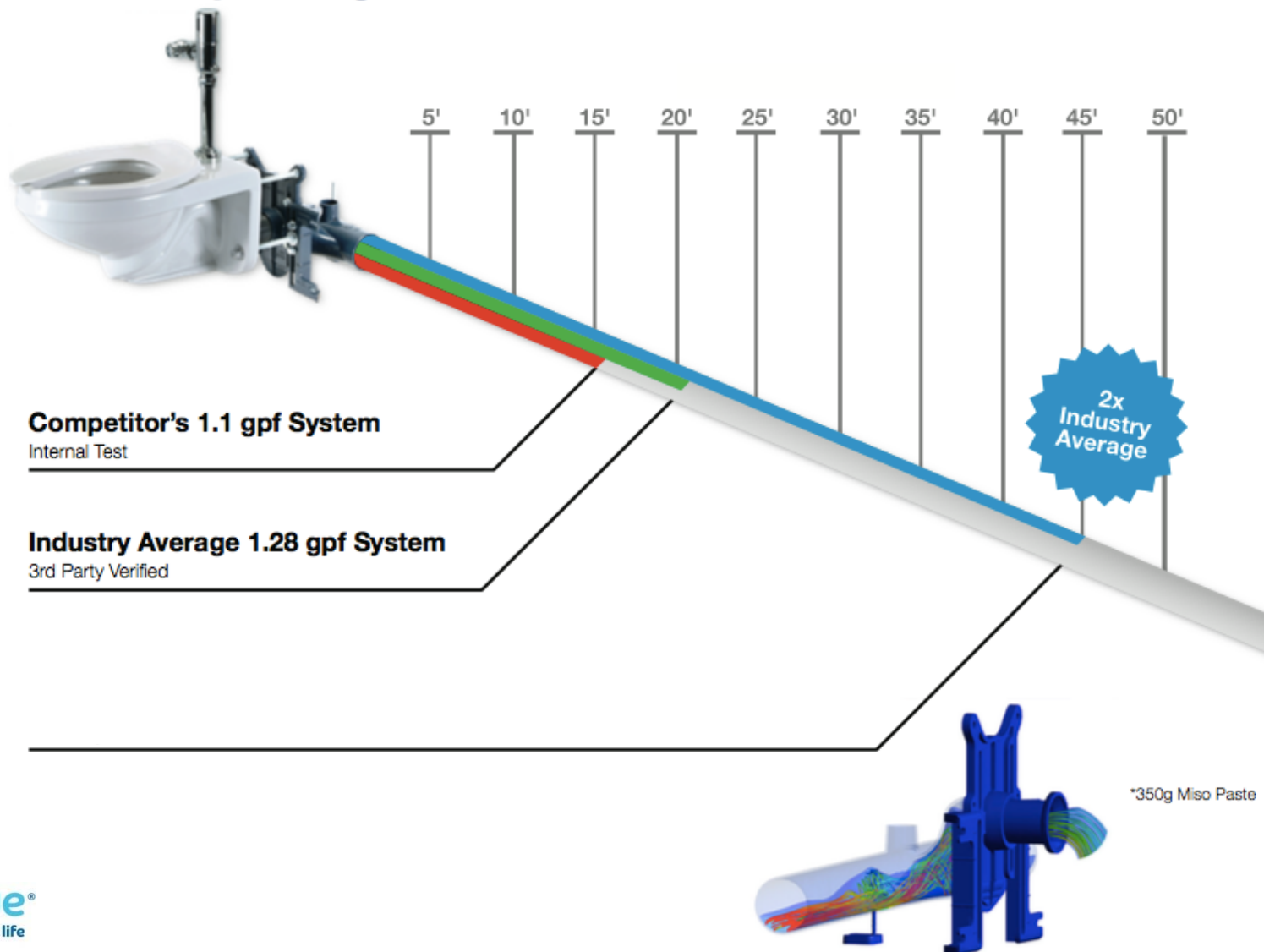
Retrofit Options

- Dual Flush Handles (up vs down)



High Efficiency Toilet and Carrier System

Modified Line Carry Testing*



Hand Sink Faucets

- Sensor operated
- Timed flow
- Manual operation



Faucet Flow Controllers

- Pre 1992: 4 gpm
- Post 1992: 2.2 gpm, 1.5 gpm, 1.0 gpm, 0.5 gpm
- Initial versions prone to scale, blockage, bacteria
- New silicon and design technologies



Hand Sink Faucet:



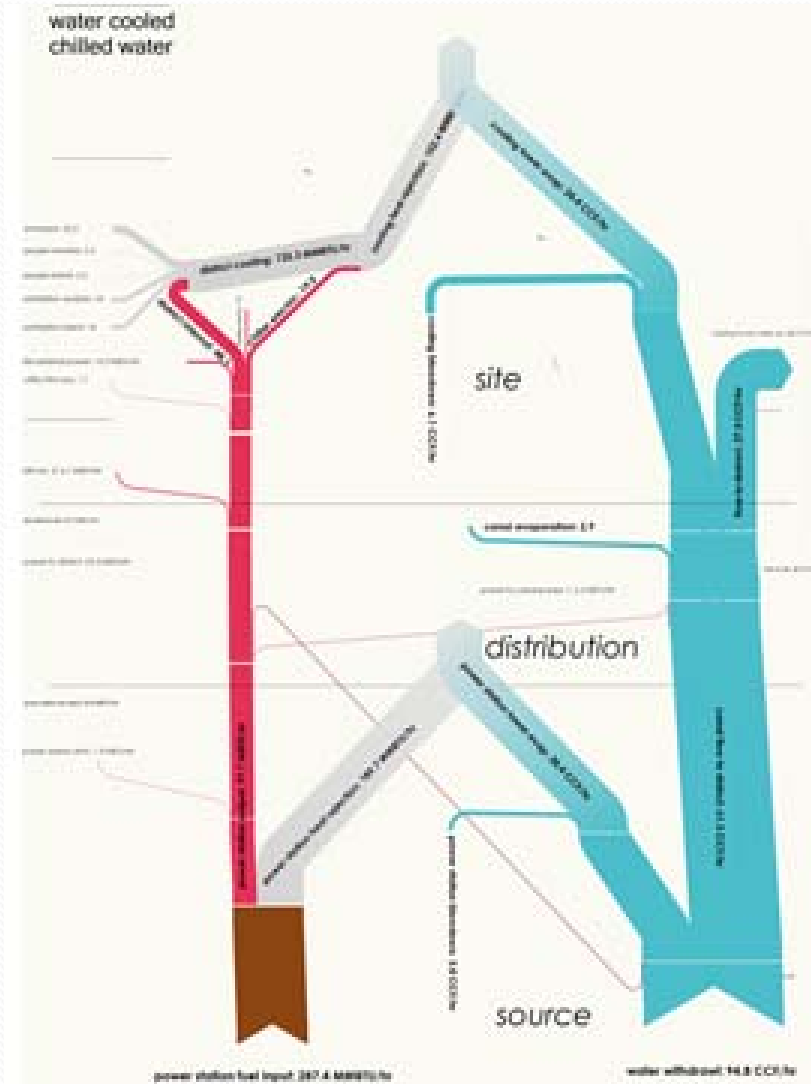
One minute of use





Cooling

UA CAMPUS SOURCE AND SITE WATER

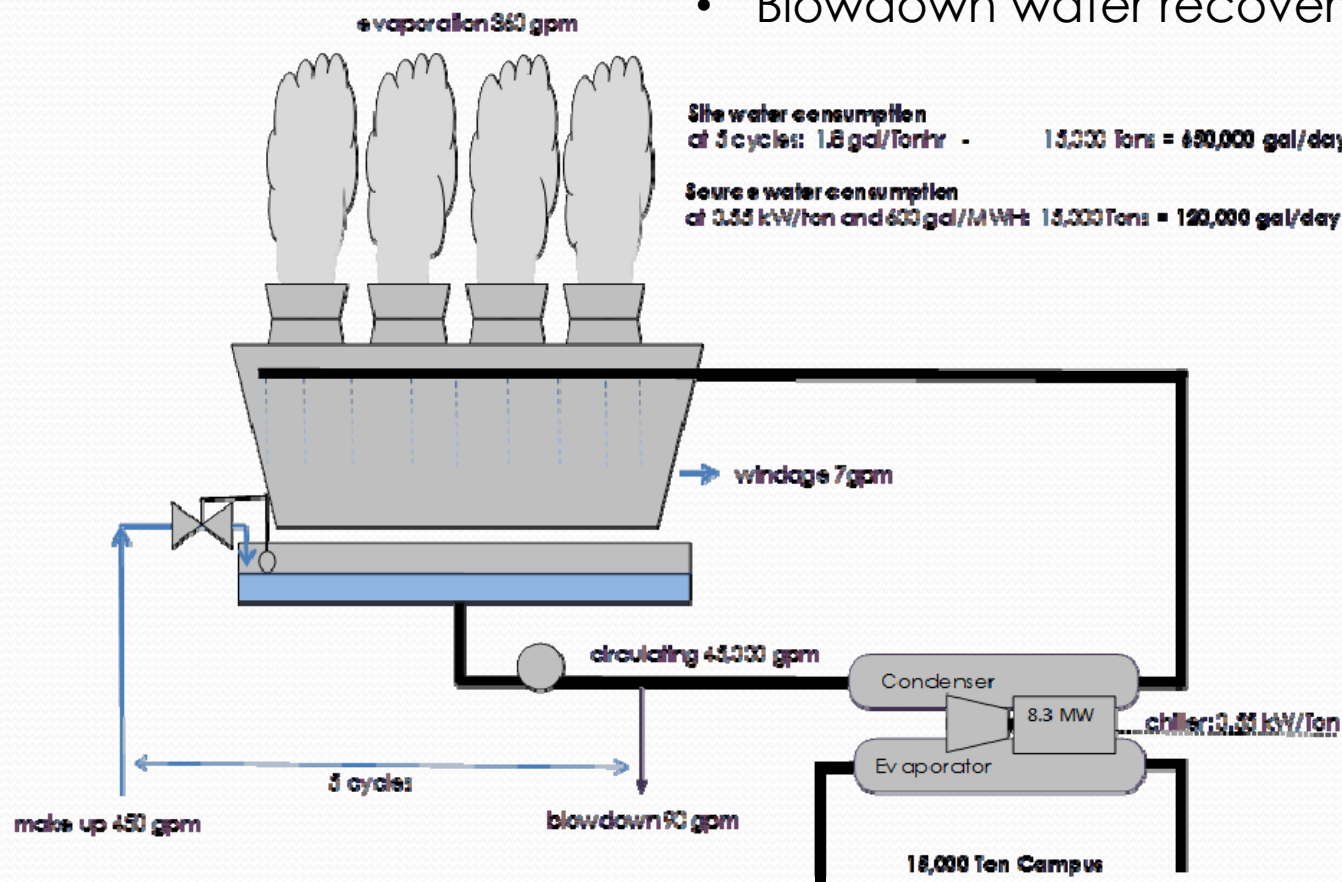


LARGEST SINGLE USER: COOLING TOWER

WATER USE

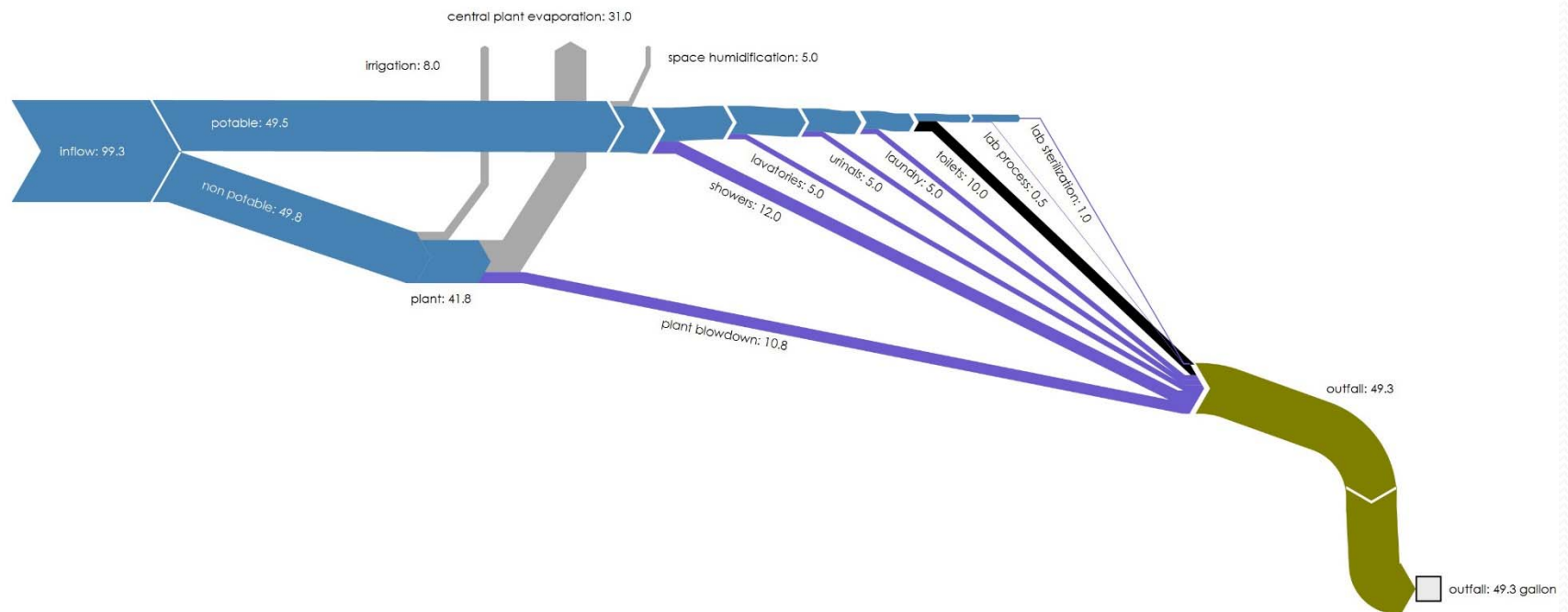
Cooling Tower Conservation Measures
Campus Efficiency Improvements

- Increase Cycles through water treatment
- Blowdown water recovery – nanofiltration



UA CAMPUS WATER FLOW DIAGRAM

campus water flow



CITY OF TUCSON RECLAIMED WATER SYSTEM

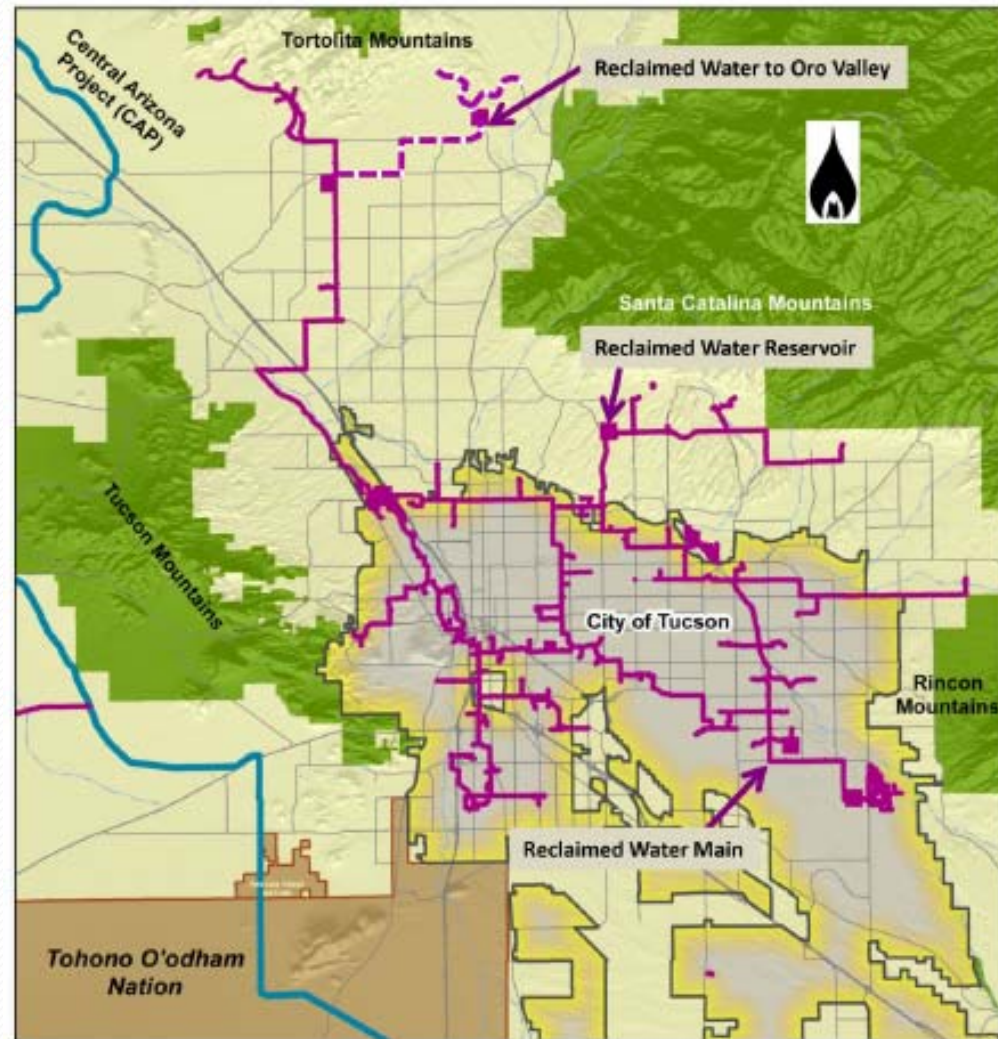
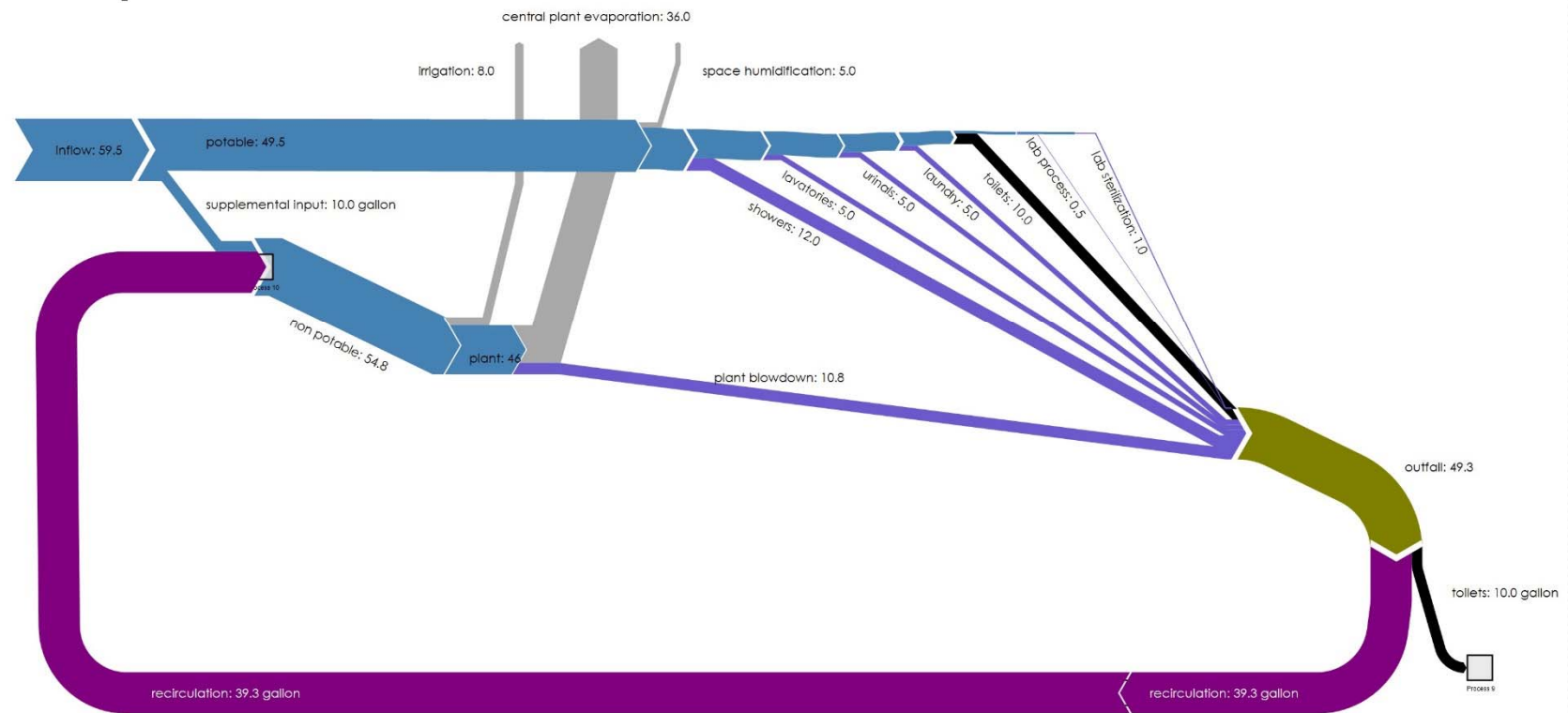


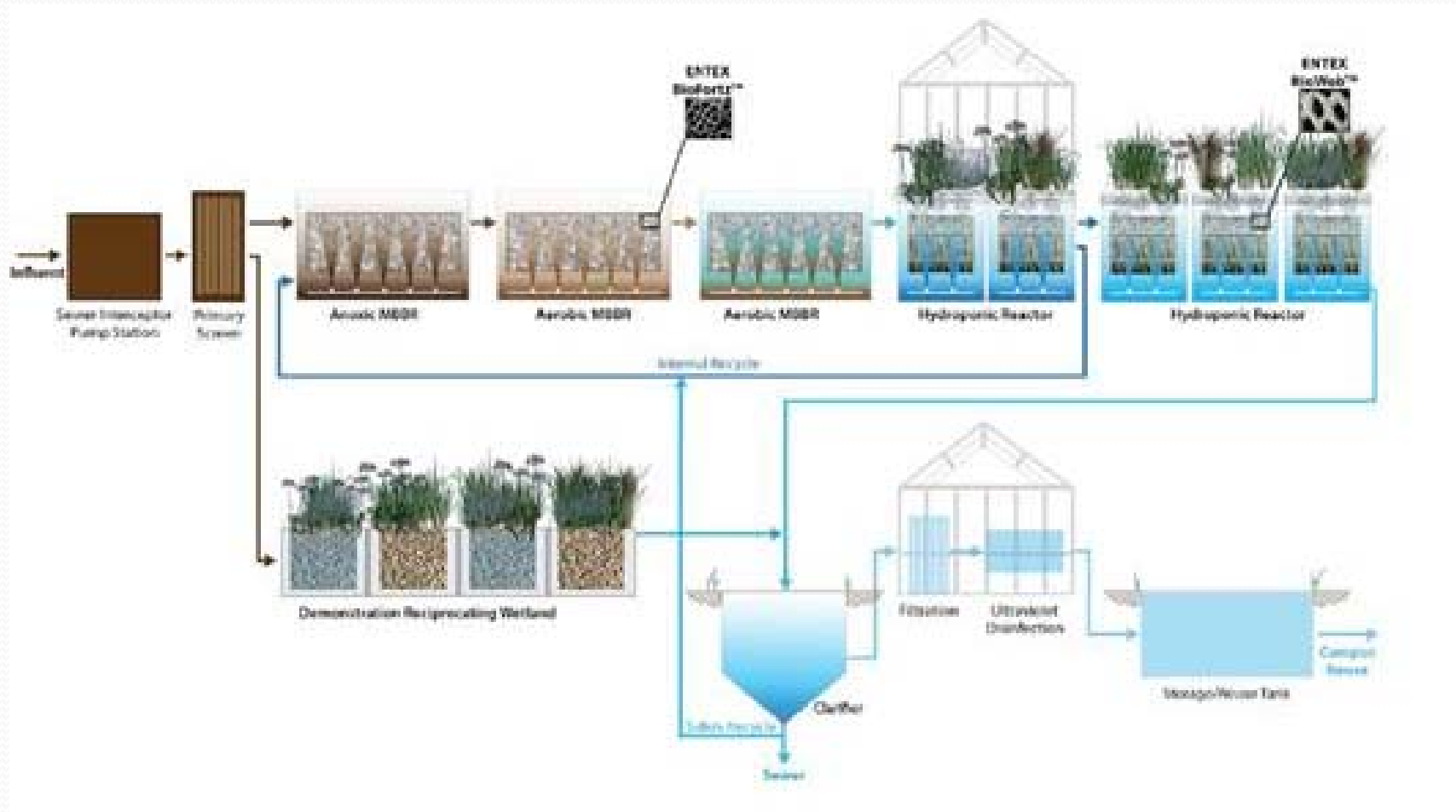
Figure ES-1. The Reclaimed Water System (RWS)

CONSERVATION OPPORTUNITY: RECLAIMED WATER FOR COOLING TOWER WATER USE

campus water flow with local water reclamation



AN INTERESTING ALTERNATIVE: DISTRIBUTED WATER RECOVERY (toilet to tower)





Seen from above, the WaterHub system looks like an attractive botanical garden, with lush beds of native and tropical plants.

WATER PRODUCTION AND USE AT THE UNIVERSITY OF ARIZONA

THANK
YOU