

Trace Organics as Organic Tracers

Alandra Kahl

Department of Chemical and Environmental Engineering
The University of Arizona, Tucson, AZ

Organization of the talk:



Background— AZ/Tucson water landscape

**Trace organics in wastewater—conventional
treatment and environmental fate**

Future work

Research motivations:

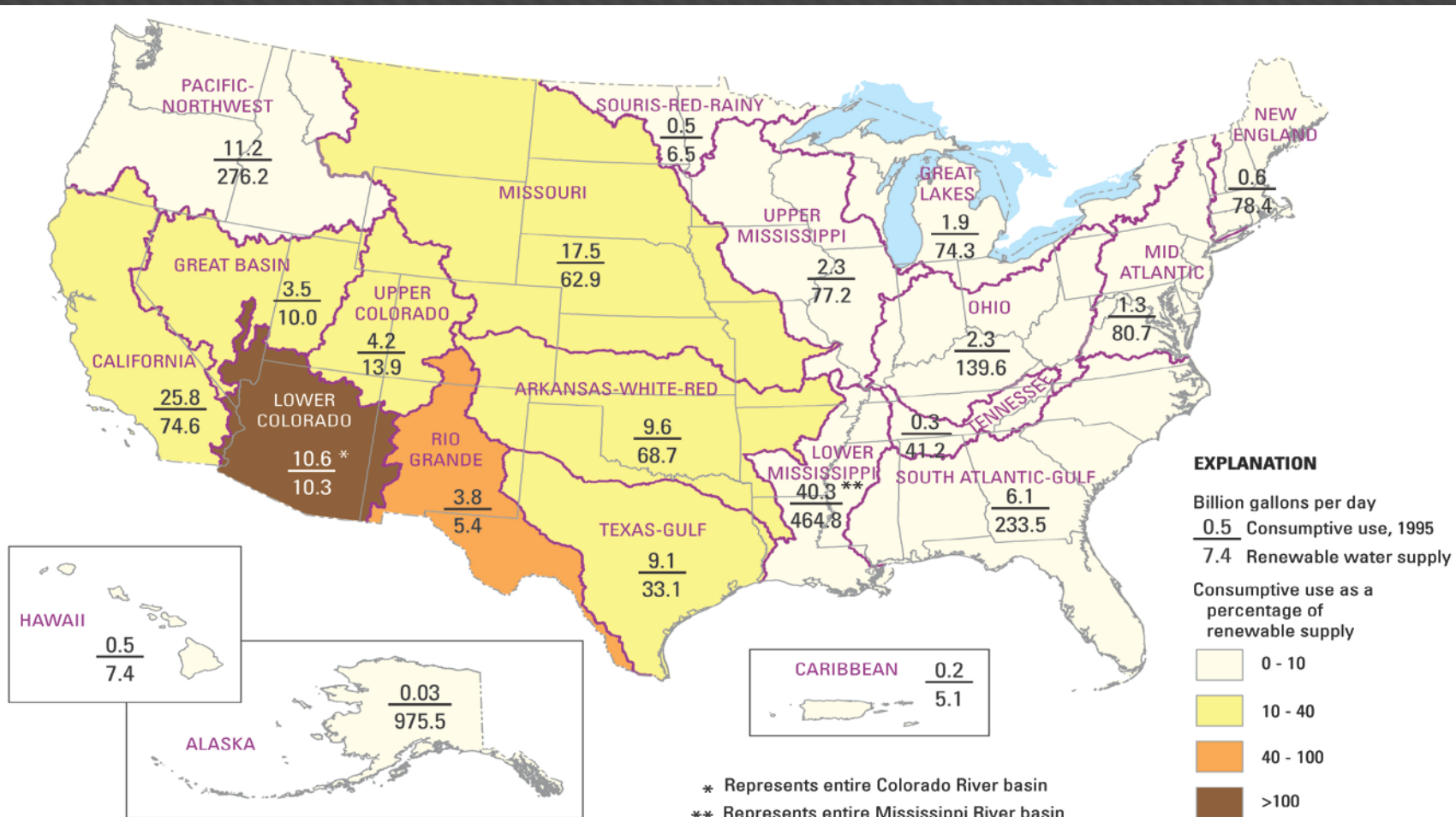
A western water story: Using research to tackle the problem of water scarcity and the challenges of water reuse.



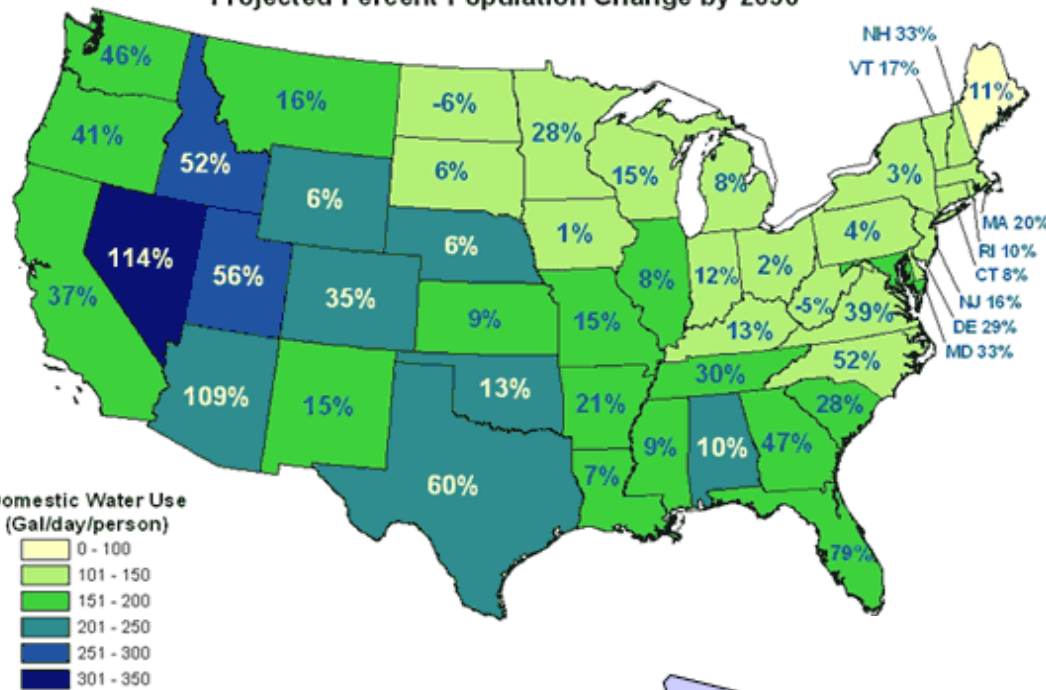


THE WORLD IS **GROWING**
AND WATER IS NEEDED FOR GROWTH

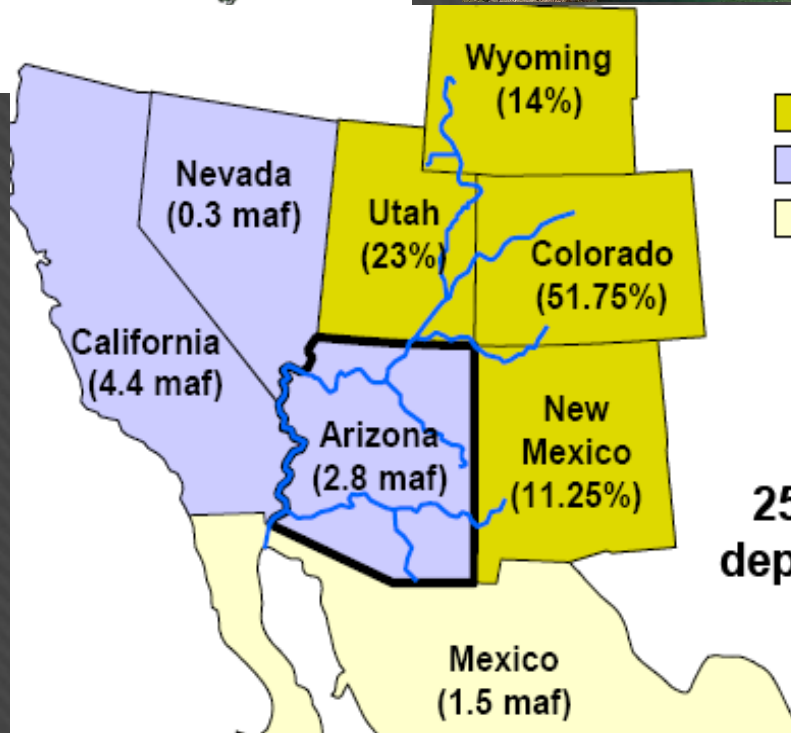
Is there a southwestern water supply problem?



Domestic Water Use in Gallons per Day per Person and Projected Percent Population Change by 2030



The Colorado River Compact (1920s) & Population Demographics

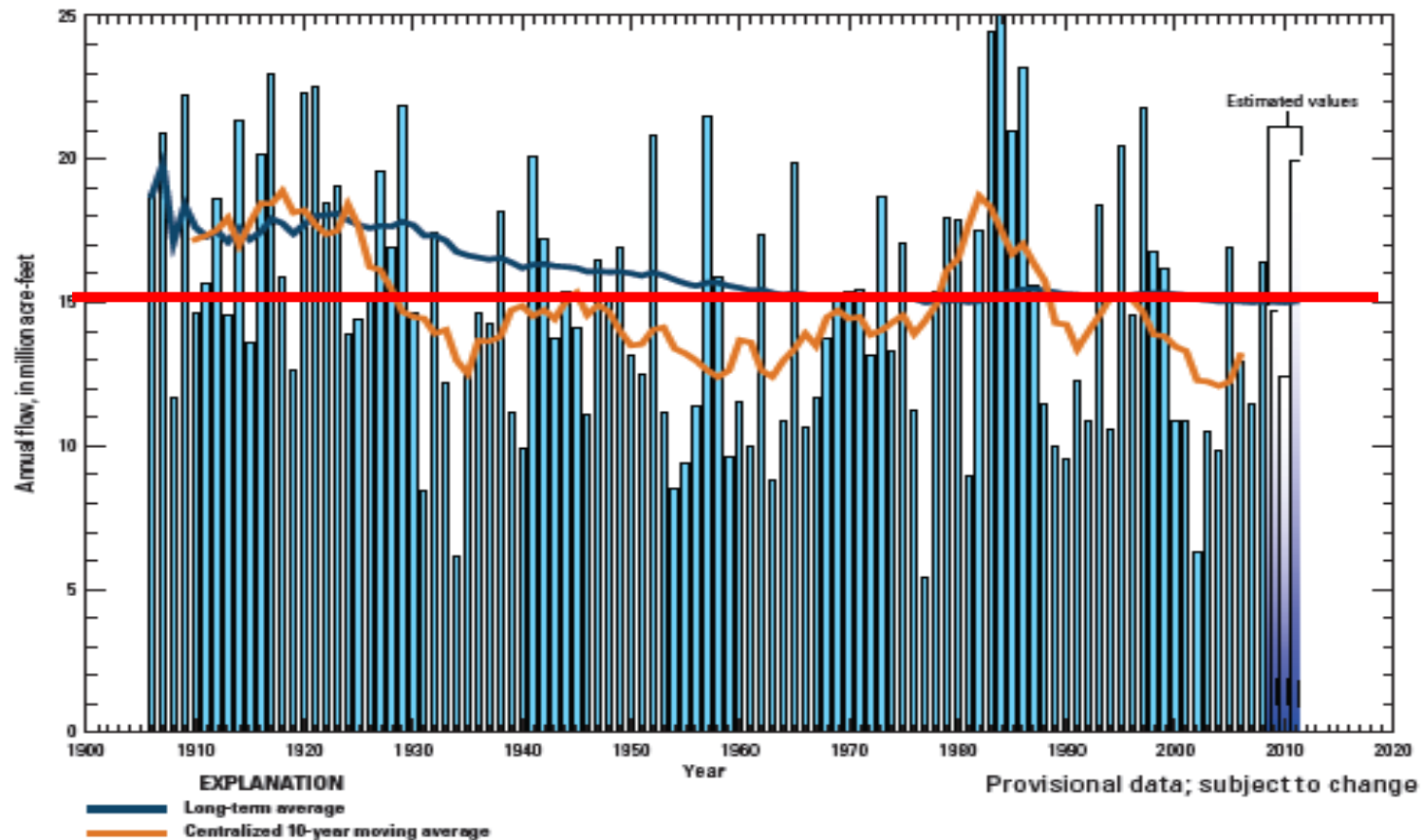


Upper Basin: 7.5 maf
Lower Basin: 7.5 maf
International: 1.5 maf
Total: 16.5 maf

25 million Americans depend on the Colorado River for supply

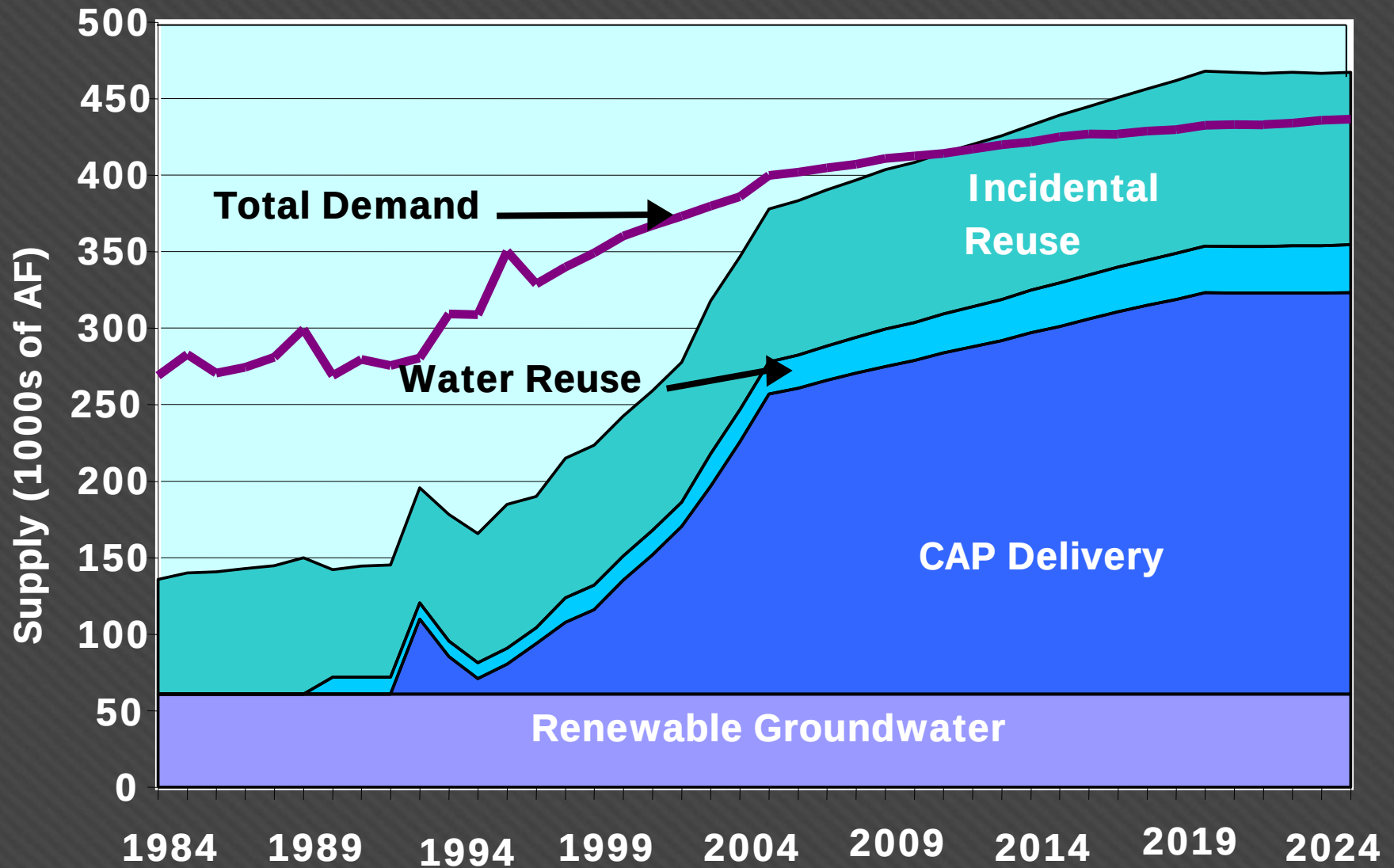
Naturalized flow on the Colorado River during the 20th Century

Instrumental Record of 'Naturalized' Colorado River Flow at Lees Ferry near Page, Arizona



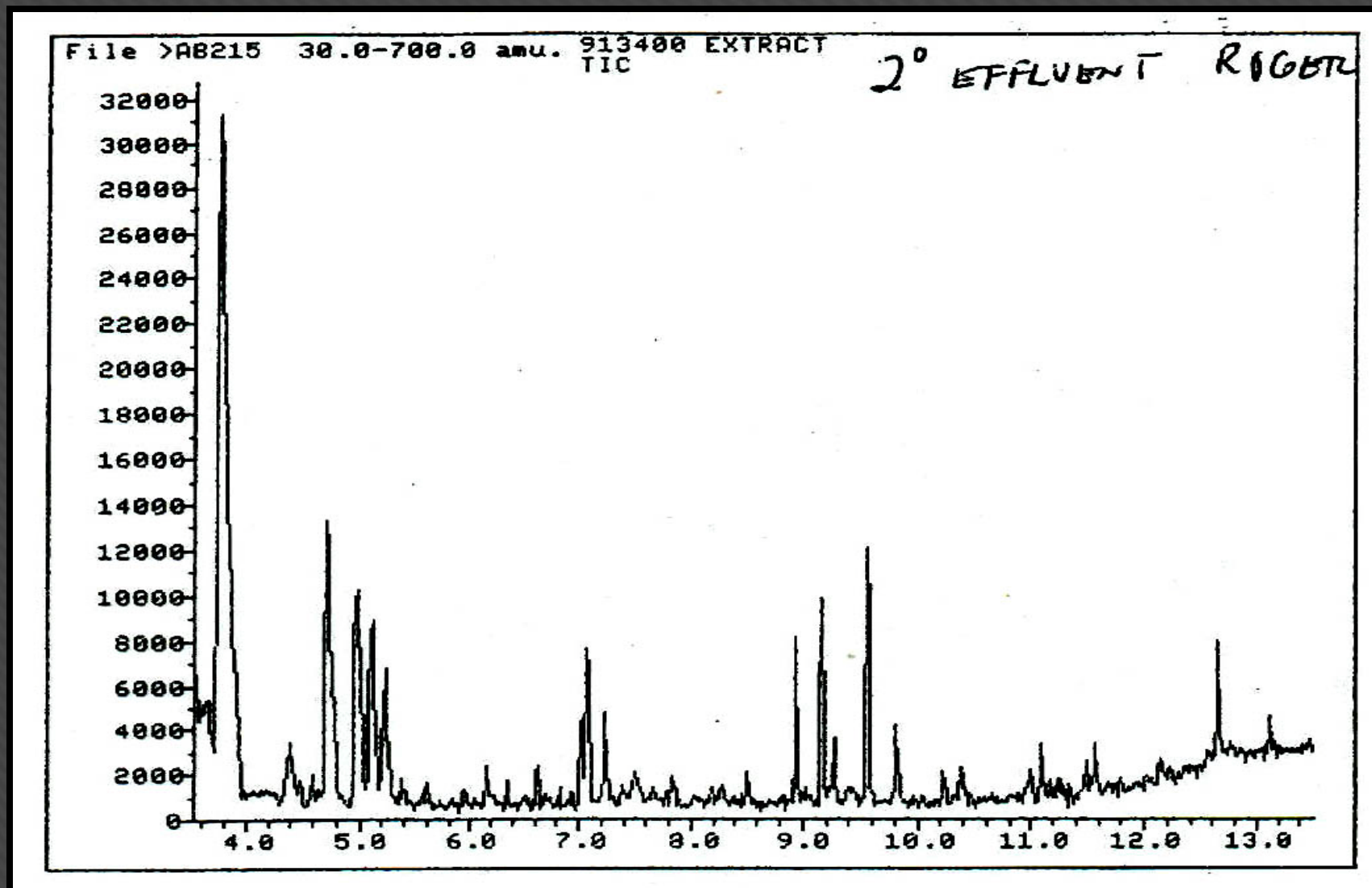
Arizona's Annual Water Budget

Water Source	Million Acre-Feet (maf) 1 maf ~ 1 km3	% of Total
SURFACE		
Colorado River	2.8	35.6 %
CAP	1.6	21%
On-River	1.2	16%
In-State Rivers	1.4	17.8%
Salt-Verde	1.0	13%
Gila & others	0.4	5%
GROUNDWATER		2.9
		36.8%
RECLAIMED WATER		0.77
		9.8%
Total		7.87



Water demand and supply in the Tucson Active Management Area

The Trouble with Water Reuse—What's in That Stuff?



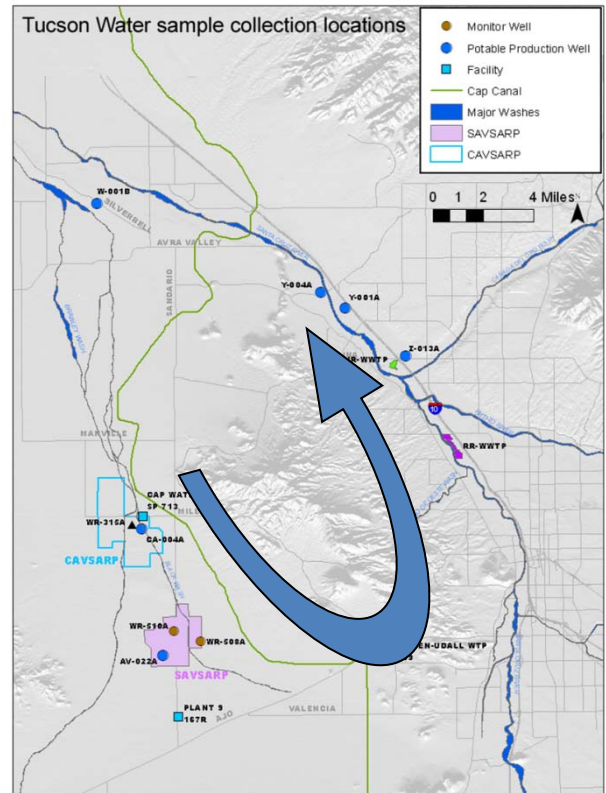
Tucson, a great place to study the fate of trace organics in the environment

Aerial View

Santa Cruz
River

Recharge
Basins

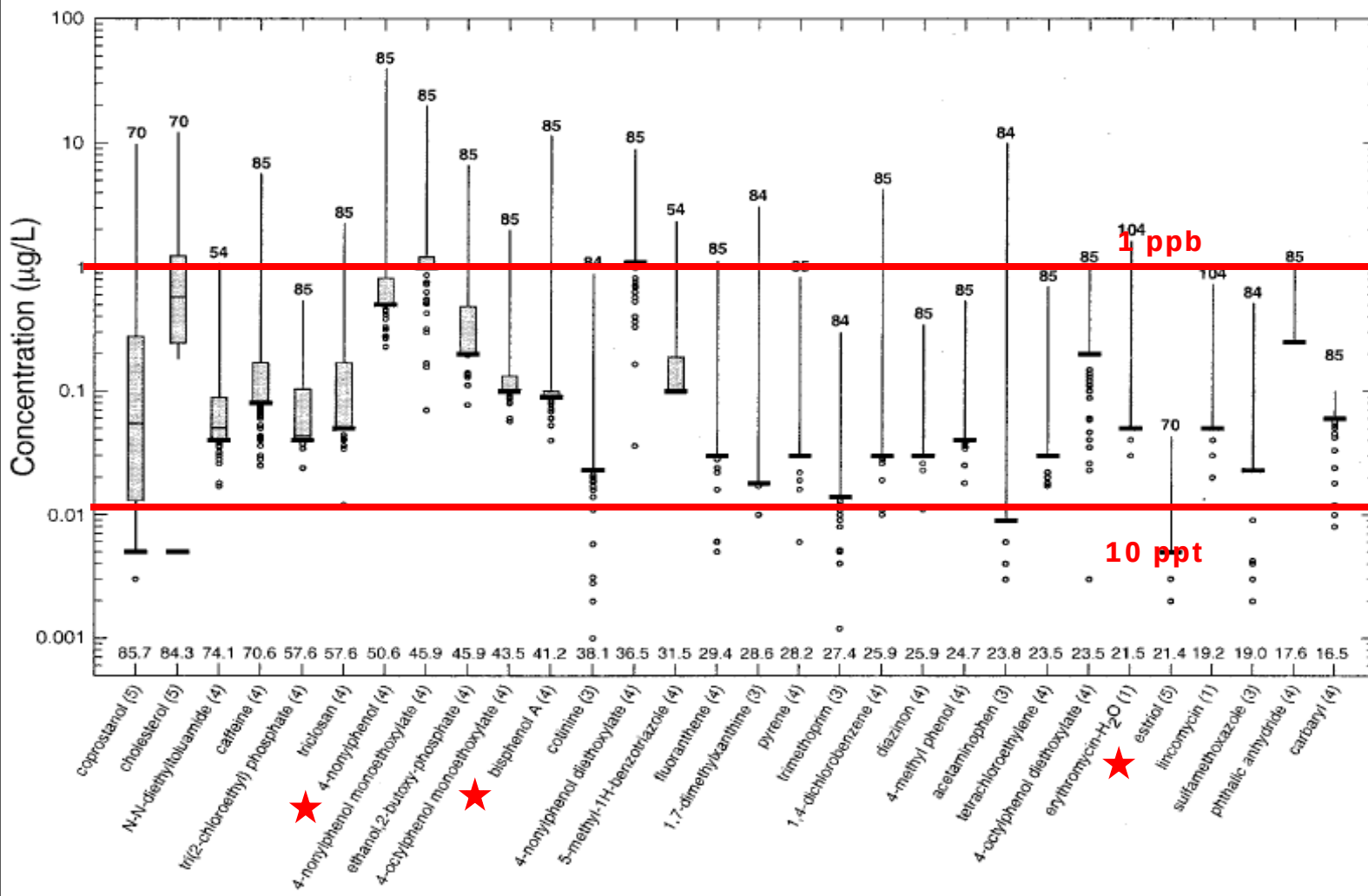
RRWWTP



Trace Organics in United States Surface Waters



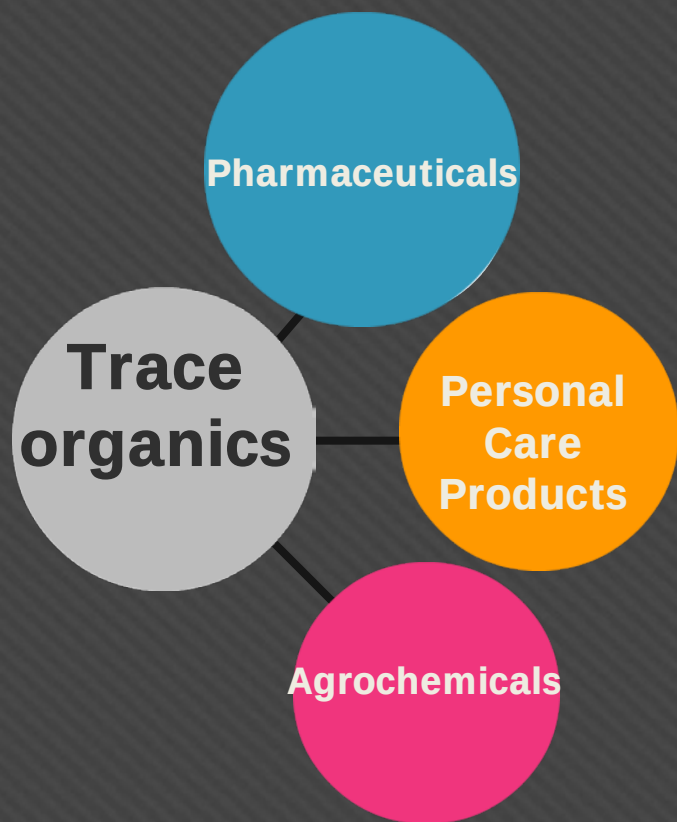
Waters



**3815
Citations**

Kolpin et al,
2002: The first
paper detailing
trace organic
impacts on
water sources
in the US.

Trace organics: Origin in the water supply



35.2%

Of American consumers flush unused prescription drugs down the toilet or sink



\$8000

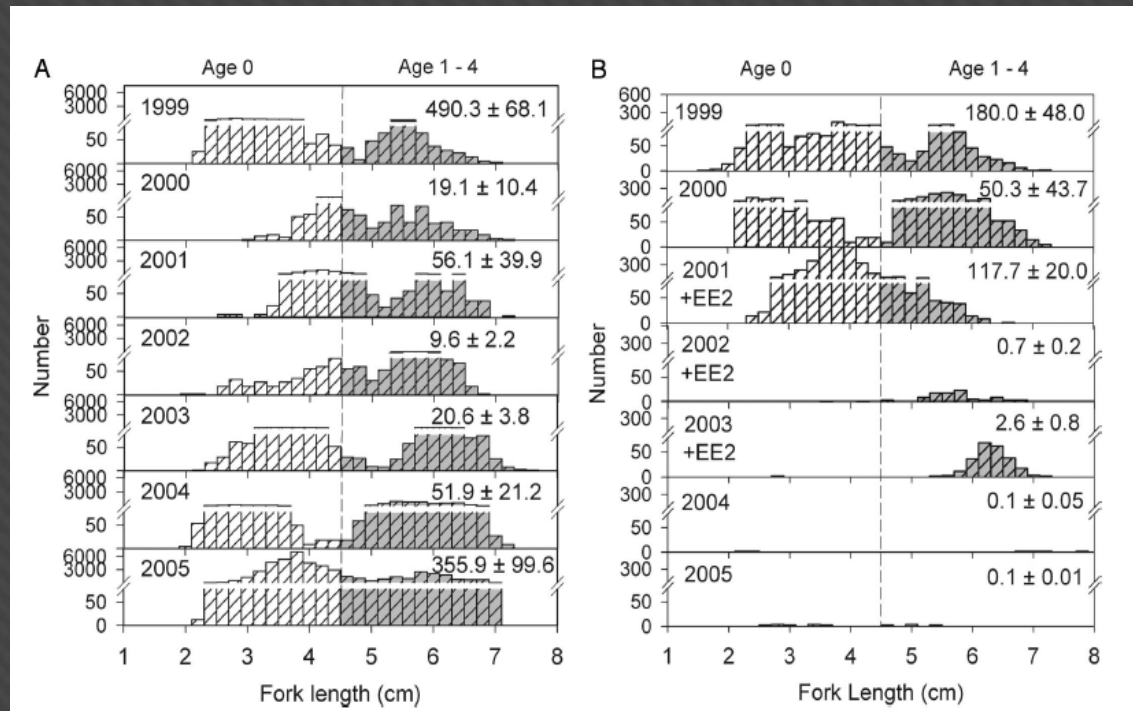
Cost of the average takeback program per pharmacy.



80%

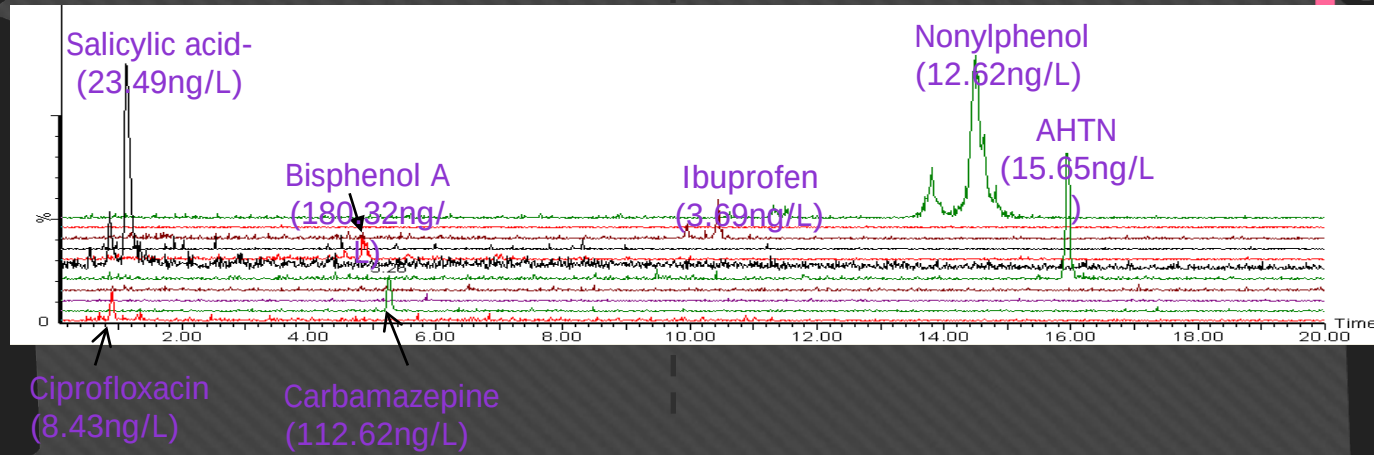
Of streams tested in a 2002 reconnaissance were positive for trace organics

Potential harm of trace organics



In 2008, the research group of Karen Kidd dosed a small lake in Canada with a synthetic estrogen at the levels commonly discharged by wastewater treatment plants. The fish population collapsed in the second year, due to the lack of functional males for reproduction.

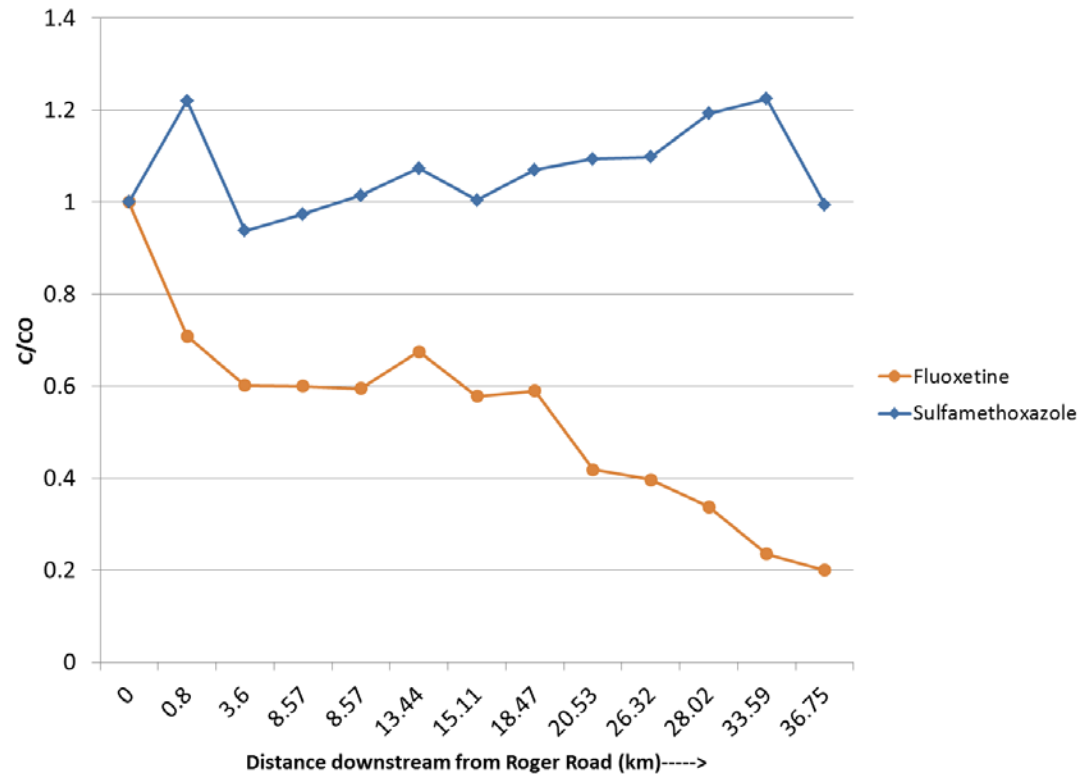
Analysis of Central Arizona Project water



We must find cost effective solutions to conserve and reuse water, as our supply is finite.

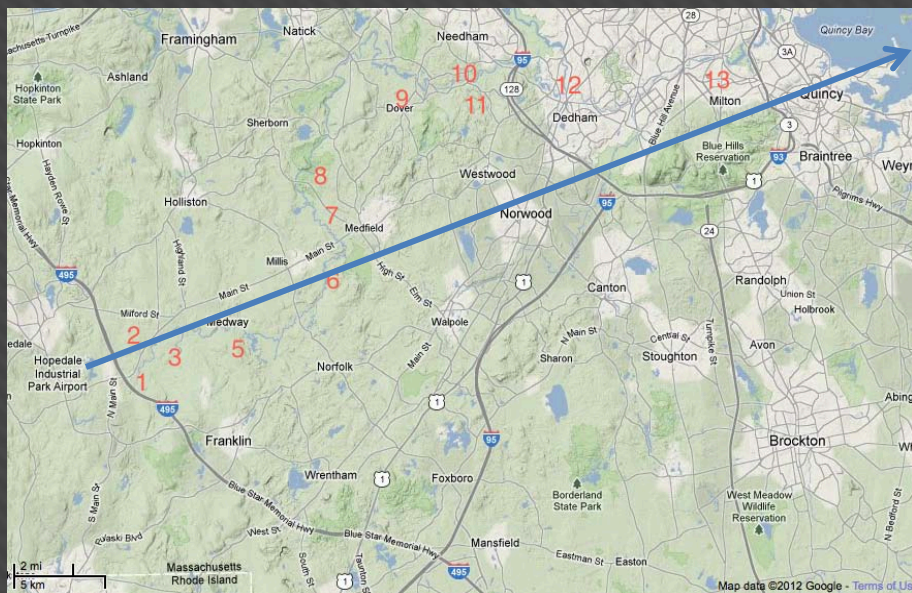
Communicating and interpreting results helps us to share what we have found, even at low concentrations. We can then look for compound specific trends. Some compounds can be harmful at very low levels, which we know from others working in life science.

Trace organics and water travel

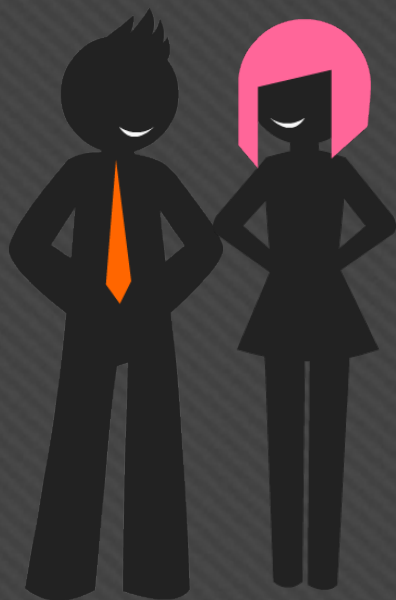


There are trace organics present in our river system. Some persist, and some are attenuated downstream during travel. Possible mechanisms for persistence include resistance to biodegradation and hydrophobicity.

Trace organics and water travel



In Boston, where the time of travel is much longer, we can investigate the effects of distance and greater moisture on chemicals of concern. Longer travel times have the potential to mitigate trace organics which may appear to persist in smaller basins.



The properties of the contaminants in question, including hydrophobicity, biodegradation and photolysis provide evidence for mechanisms of persistence and removal in natural systems.

Compound	1-C/CO	Log D _{ow}	Log K _d	k _b (L/g-d)	K _{oh} (10 ⁹) L/mol/s
Carbamazepine	0.01	2.67	1.96	0	8.02 (±1.90)
DEET	0.45	1.96	1.96	11.5	7.51 (±0.07)
Fluoxetine	0.81	1.57	3.05	980	9.6(±0.8)
Iopromide	0.58	-3.24	1	2	3.30
Primidone	0	-0.81	1.5	0	6.7
Sucralose	0.09	0.23	1.5	0	1.50 (±0.01)
Sulfamethoxazole	0	-0.33	2.4	0.05	5.82 (±1.99)
TCEP	0.11	0.48	1.5	0	0.56(±0.02)
Trimethoprim	0.53	0.28	2.35	0.6	8.92(± 0.22)

And we don't know everything.

Some Information



Essentially Nothing Known

sensitivity of analytical chemical methods	fate of compounds during conventional and advanced w/w treatment	persistence and transport in the environment	health effects and risk management	determinants of societal preferences relative to cost and risk
--	---	--	--	---



“...the EPA has failed to protect the public from potentially dangerous exposures to pharmaceuticals in drinking water.”

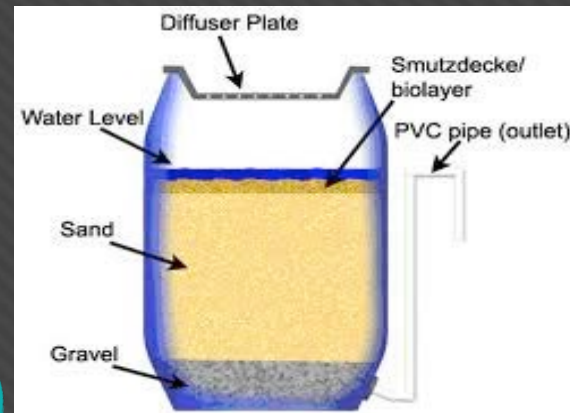
Barbara Boxer (April 21, 2008)

Future work



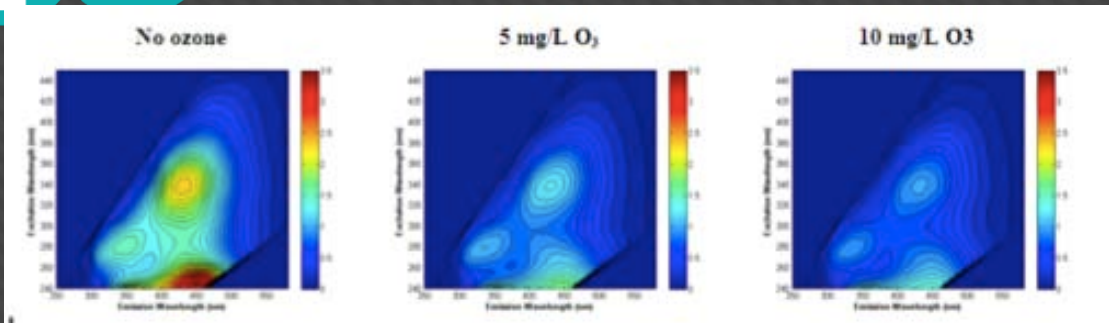
Building on current research

Development of comprehensive models as well as use of surrogate parameters such as fluorescence to better monitor transport of trace contaminants.



Construction of small scale model systems to investigate processes

Exploring existing water sources to find new ways of analysis and treatment





Acknowledgements



- ✓ Dr. Bob Arnold
- ✓ Dr. Shane Snyder
- ✓ Dr. Kim Ogden
- ✓ Dr. Leif Abrell
- ✓ Dr. David Quanrud



THANK YOU!

QUESTIONS?



www.che.arizona.edu



alandrak@email.arizona.edu



724-678-1817

Phone : 724-678-1817