Testing and Design of Advanced Treatment Facilities to Remove EDCs

2008 WEAU Mid-Year Conference

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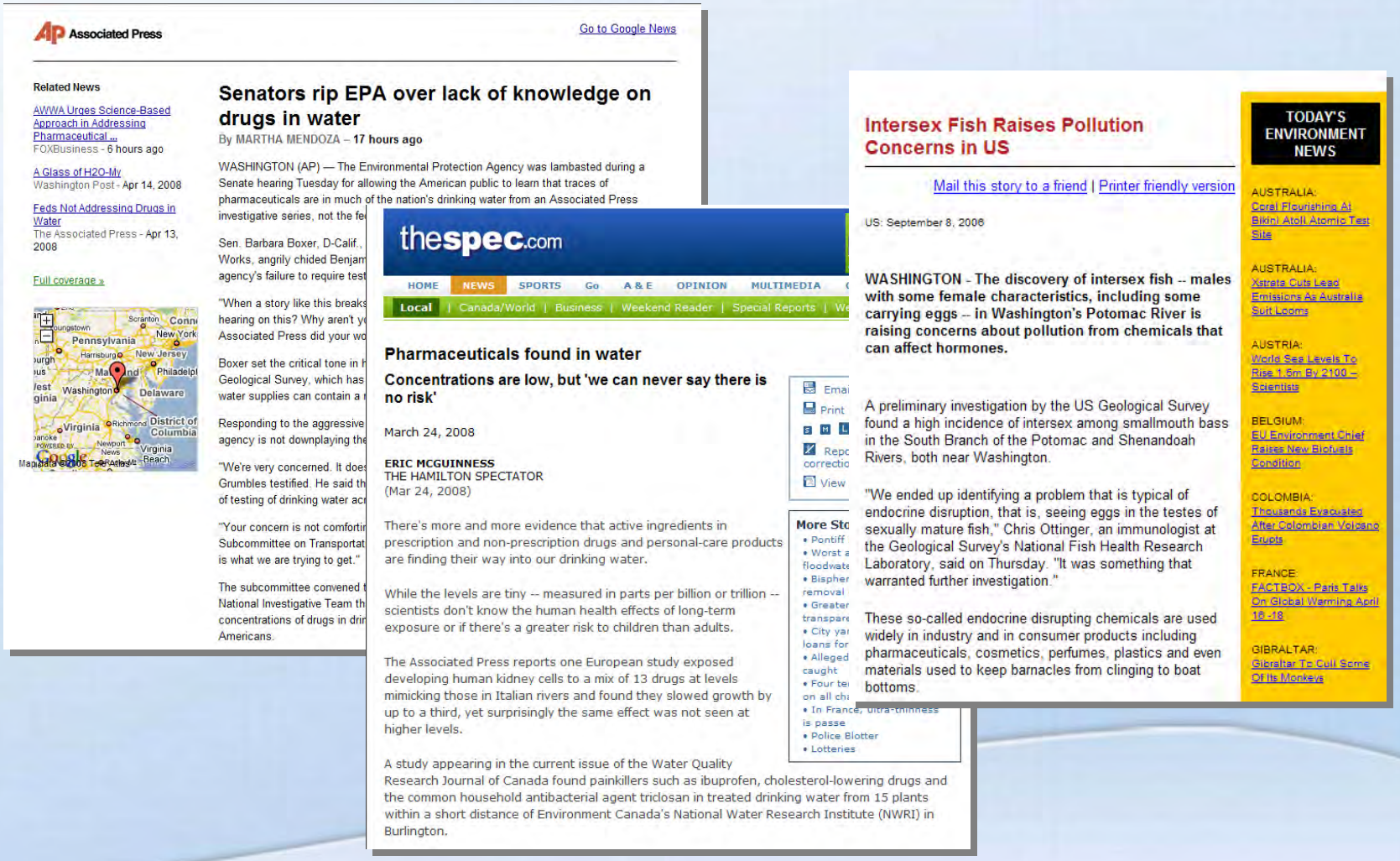
AP Story March 2008: Pharmaceuticals in Water



Associated Press

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Full coverage »

Senators rip EPA over lack of knowledge on drugs in water

By MARTHA MENDOZA – 17 hours ago

WASHINGTON (AP) — The Environmental Protection Agency was lambasted during a Senate hearing Tuesday for allowing the American public to learn that traces of pharmaceuticals are in much of the nation's drinking water from an Associated Press investigative series, not the fe

Sen. Barbara Boxer, D-Calif., Works, angrily chided Benjam agency's failure to require test

"When a story like this breaks hearing on this? Why aren't y Associated Press did your wo

Boxer set the critical tone in h Geological Survey, which has water supplies can contain a

Responding to the aggressive agency is not downplaying the

"We're very concerned. It does Grumbles testified. He said th of testing of drinking water acr

"Your concern is not comfortir Subcommittee on Transportat is what we are trying to get."

The subcommittee convened t National Investigative Team th concentrations of drugs in drir Americans.

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Pharmaceuticals found in water

Concentrations are low, but 'we can never say there is no risk'

March 24, 2008

ERIC MCGUINNESS
THE HAMILTON SPECTATOR
(Mar 24, 2008)

There's more and more evidence that active ingredients in prescription and non-prescription drugs and personal-care products are finding their way into our drinking water.

While the levels are tiny -- measured in parts per billion or trillion -- scientists don't know the human health effects of long-term exposure or if there's a greater risk to children than adults.

The Associated Press reports one European study exposed developing human kidney cells to a mix of 13 drugs at levels mimicking those in Italian rivers and found they slowed growth by up to a third, yet surprisingly the same effect was not seen at higher levels.

A study appearing in the current issue of the Water Quality Research Journal of Canada found painkillers such as ibuprofen, cholesterol-lowering drugs and the common household antibacterial agent triclosan in treated drinking water from 15 plants within a short distance of Environment Canada's National Water Research Institute (NWRI) in Burlington.

More Sto
• Pontiff
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• Lotteries

Intersex Fish Raises Pollution Concerns in US

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US: September 8, 2006

WASHINGTON - The discovery of intersex fish -- males with some female characteristics, including some carrying eggs -- in Washington's Potomac River is raising concerns about pollution from chemicals that can affect hormones.

A preliminary investigation by the US Geological Survey found a high incidence of intersex among smallmouth bass in the South Branch of the Potomac and Shenandoah Rivers, both near Washington.

"We ended up identifying a problem that is typical of endocrine disruption, that is, seeing eggs in the testes of sexually mature fish," Chris Ottinger, an immunologist at the Geological Survey's National Fish Health Research Laboratory, said on Thursday. "It was something that warranted further investigation."

These so-called endocrine disrupting chemicals are used widely in industry and in consumer products including pharmaceuticals, cosmetics, perfumes, plastics and even materials used to keep barnacles from clinging to boat bottoms.

TODAY'S ENVIRONMENT NEWS

AUSTRALIA:
Coral Flourishing At Bikini Atoll Atomic Test Site

AUSTRALIA:
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World Sea Levels To Rise 1.6m By 2100 – Scientists

BELGIUM:
EU Environment Chief Raises New Biofuels Condition

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Thousands Evacuated After Colombian Volcano Erupts

FRANCE:
FACTBOX - Paris Talks On Global Warming April 16 -18

GIBRALTAR:
Gibraltar To Cull Some Of Its Monkeys

SBWRD Is Concerned About the Possible Effects of EDCs on Downstream Fish

Brown Trout
(Salmo trutta)
Bonneville Cutthroat
(Oncorhynchus clarki)

Snyderville Basin Water Reclamation District

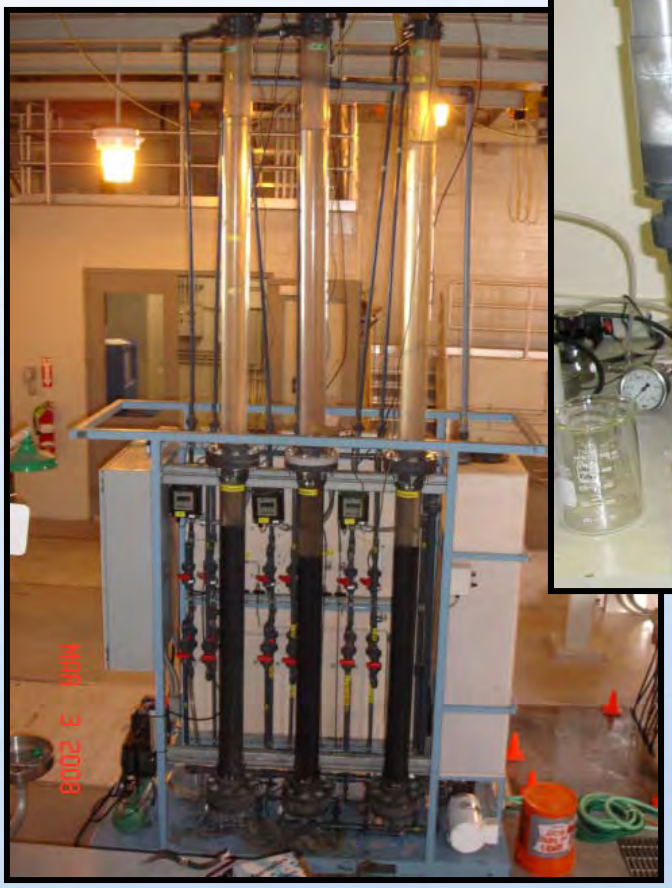
What Is SBWRD's Position Concerning EDC's?

- Currently there are no regulatory requirements to remove EDC's.
- The District has spent millions of dollars to improve water quality. It only makes sense to be proactive in addressing EDC's.
- The District has conducted pilot studies on how to remove EDC's.
- The District is working with the DWR Fisheries Experiment Station to conduct pathology studies of various species of fish to determine if estrogenicity is taking place.

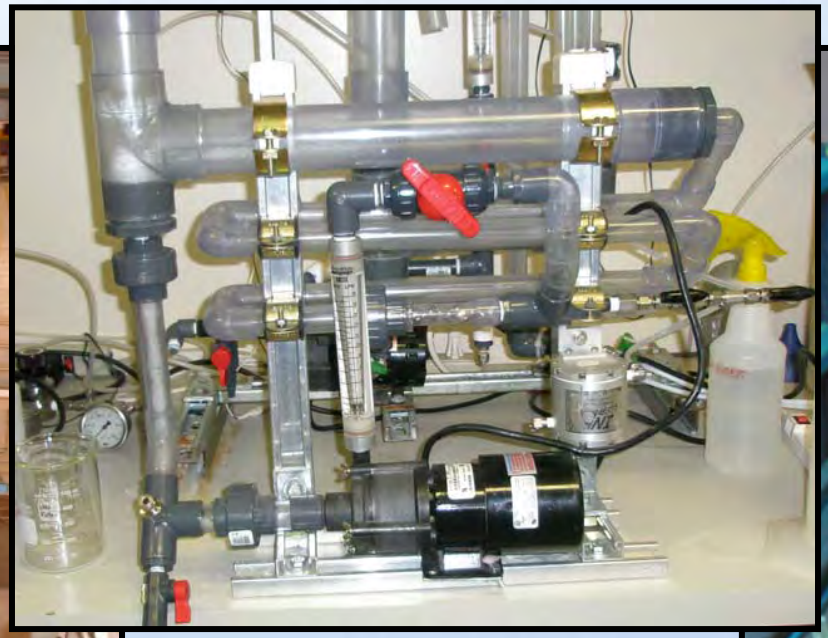
Michael Luers, SBWRD General Manager - WEAU Annual Conference, St. George, Utah, April 2008.

Design Project for East Canyon WRF in Park City, Utah

SBWRD Funded the Investigation of Three EDC Removal Technologies



GAC Filtration



Ozone/Peroxide

UV/Peroxide

Study Outcomes

- Three Technologies Tested Using ECWRF Effluent
- Developed Costs of Full-Scale Implementation
- Recommendation on Technology of Choice
- Identified a Potential Treatment Target for EDC Removal

Testing Methods and Results

Target EDC Analytes

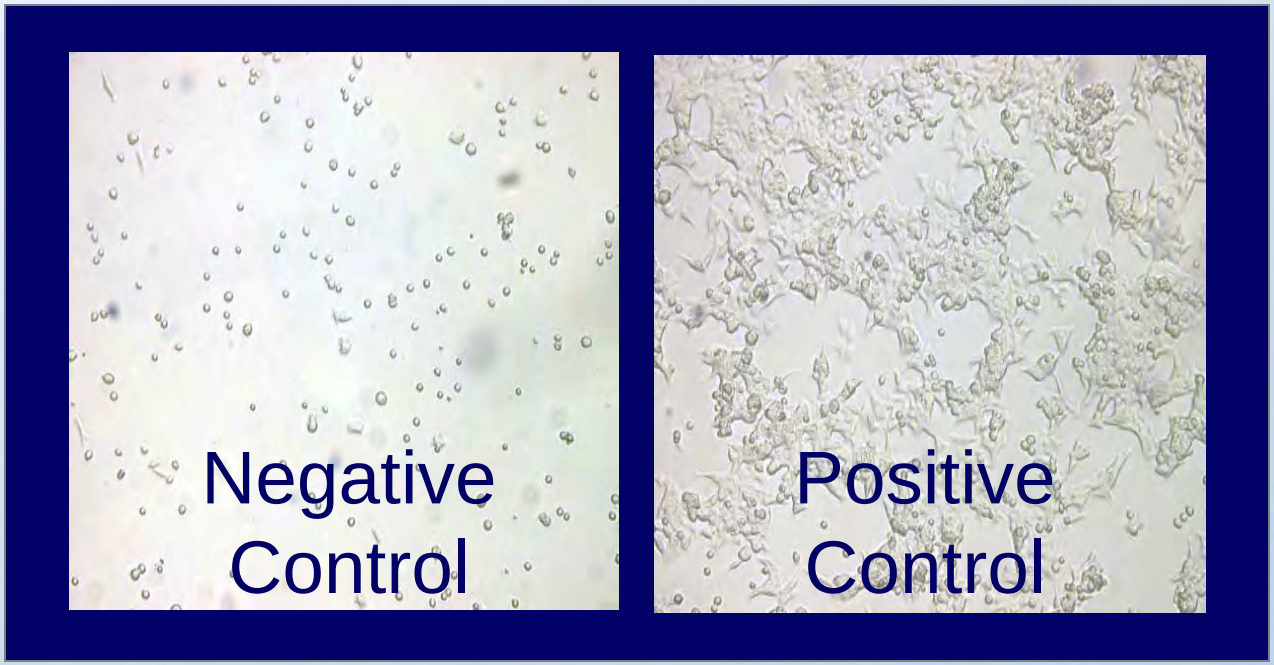
Carbamazepine	pharmaceutical (epilepsy, bipolar)
Estrone	natural hormone
Estradiol	natural hormone
Ethinyl Estradiol	synthetic hormone
Progesterone	natural hormone
Testosterone	natural hormone

USGS Method 2 – APCI Positive Ion Mode Only

E-Screen Bioassay

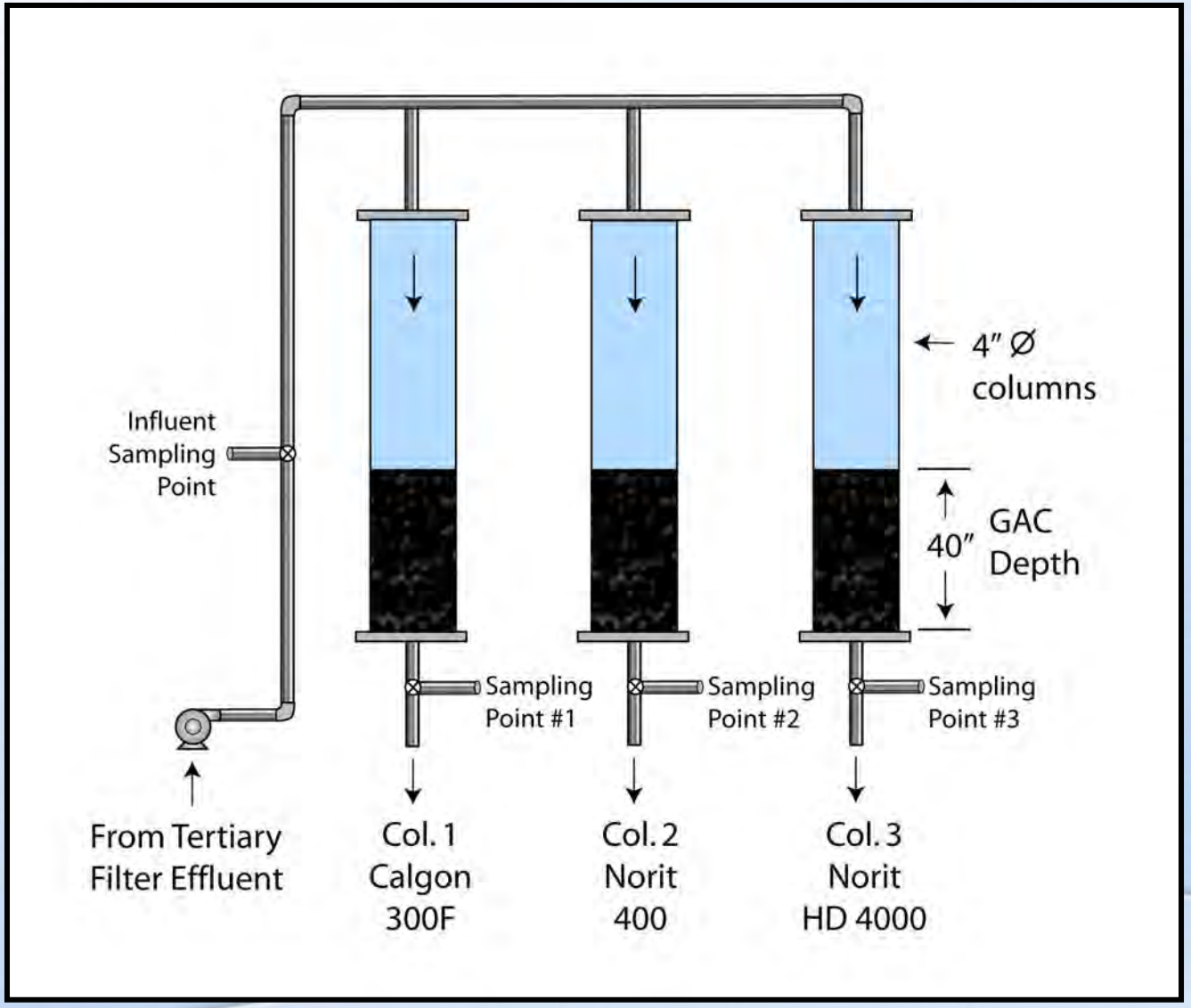
Breast cancer cell line, growth response to estrogen

Reported as Estradiol equivalents (MRL = 0.030 ppt)



Sample Collection

GAC Sorption Pilot-Scale Apparatus



GAC Sorption Pilot-Scale Apparatus

GAC Filtration Reduced EDC Concentrations in ECWRF Effluent

Carbamazepine	Hits	Min	Max	Avg
Plant Eff	6	40	146	95
Column 1	4	5.1	12	7.9
Column 2	3	20	37	27
Column 3	4	5.0	19	10
Estradiol	**Hits**	**Min**	**Max**	**Avg**
Plant Eff	3	1.6	2.2	1.8

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Ethinyl Estradiol	Hits	Conc.		
Plant Eff	1	13		
Column 1	1	2.6		
Column 2	1	4.5		
Column 3	1	3.0		
E-Screen	**PE**	**C1**	**C2**	**C3**
Estradiol Equivalents	0.77	<0.03	<0.03	<0.03

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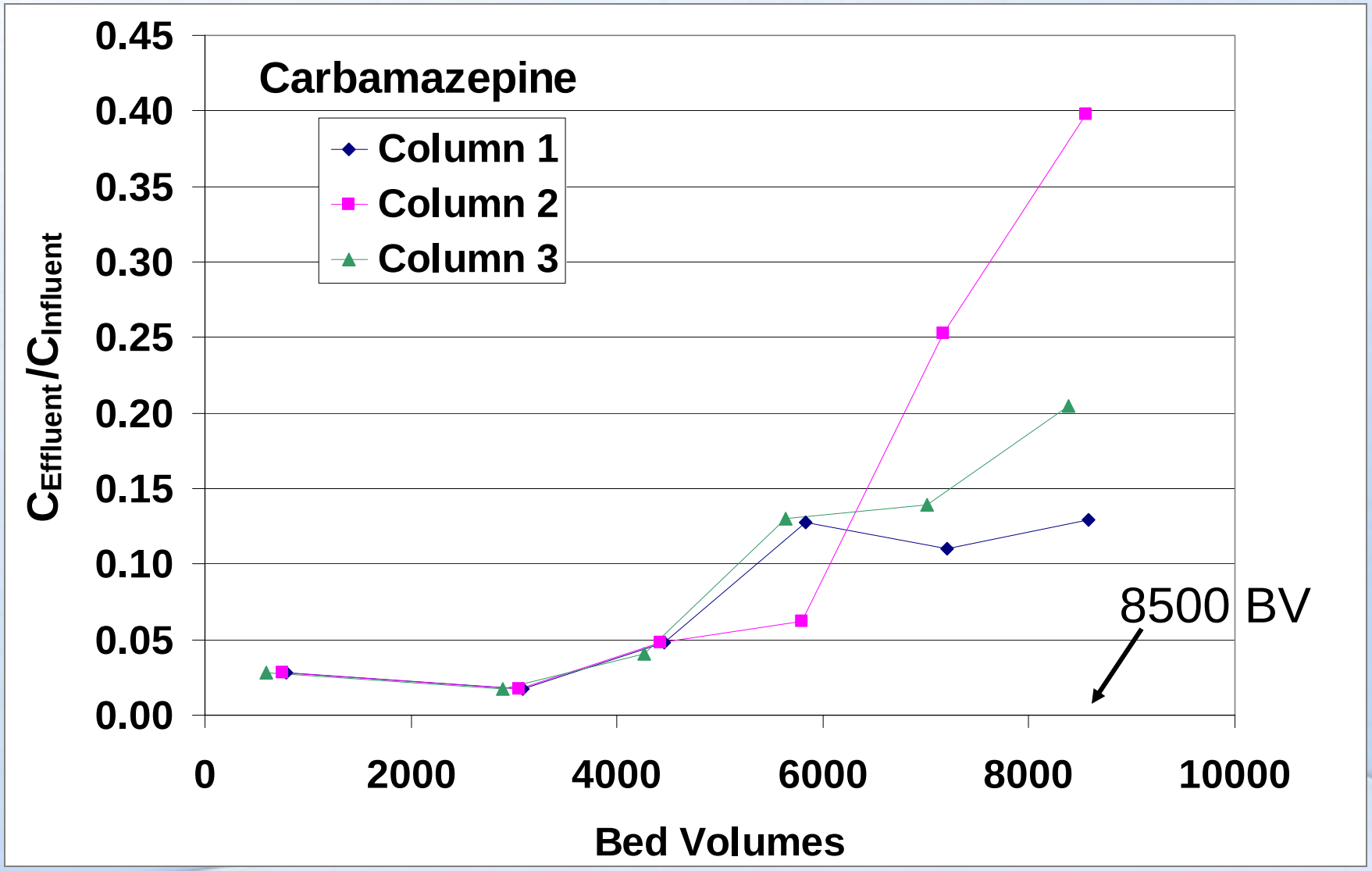
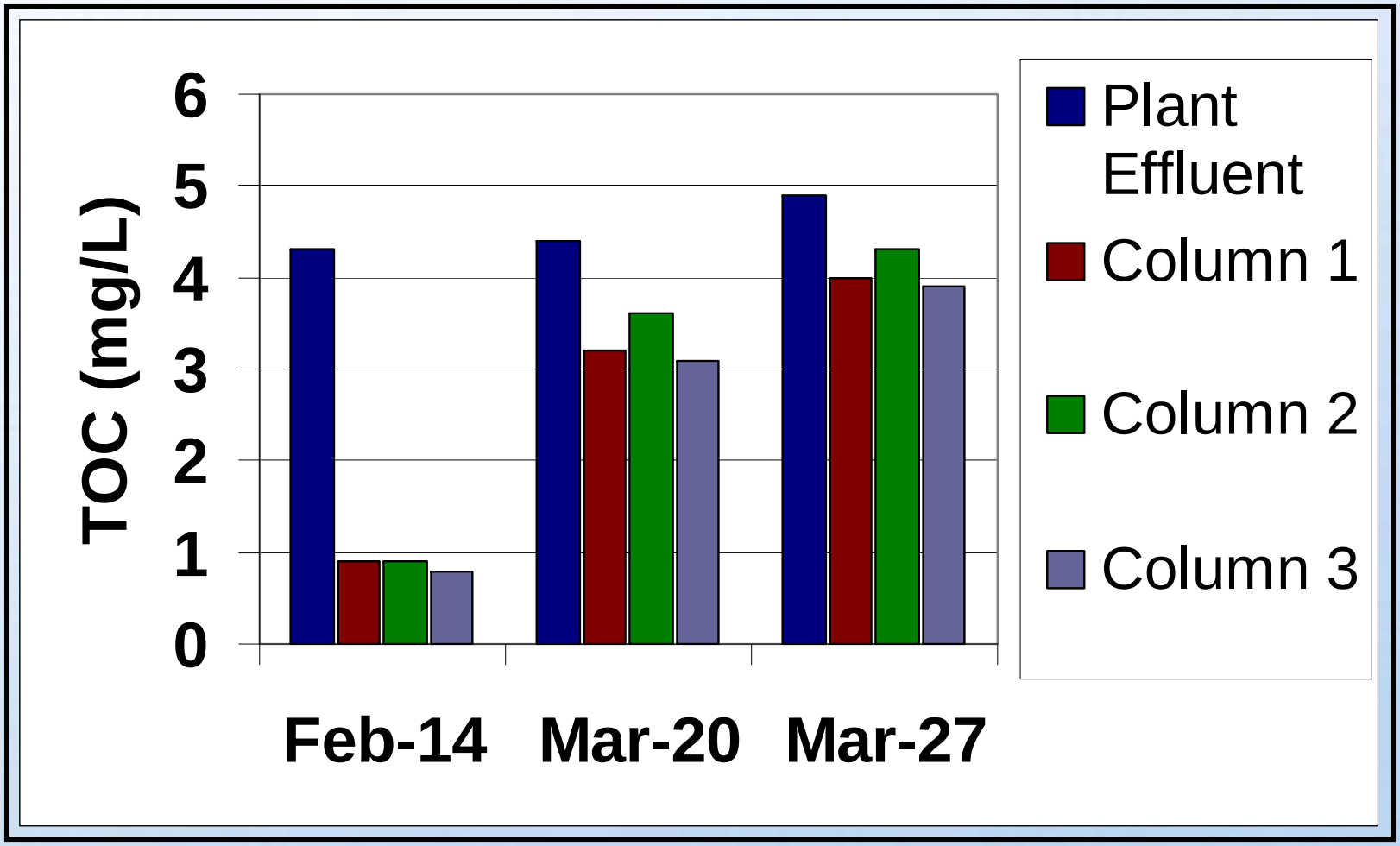
Carbamazepine: A Tracer for Estimating GAC Bed Life

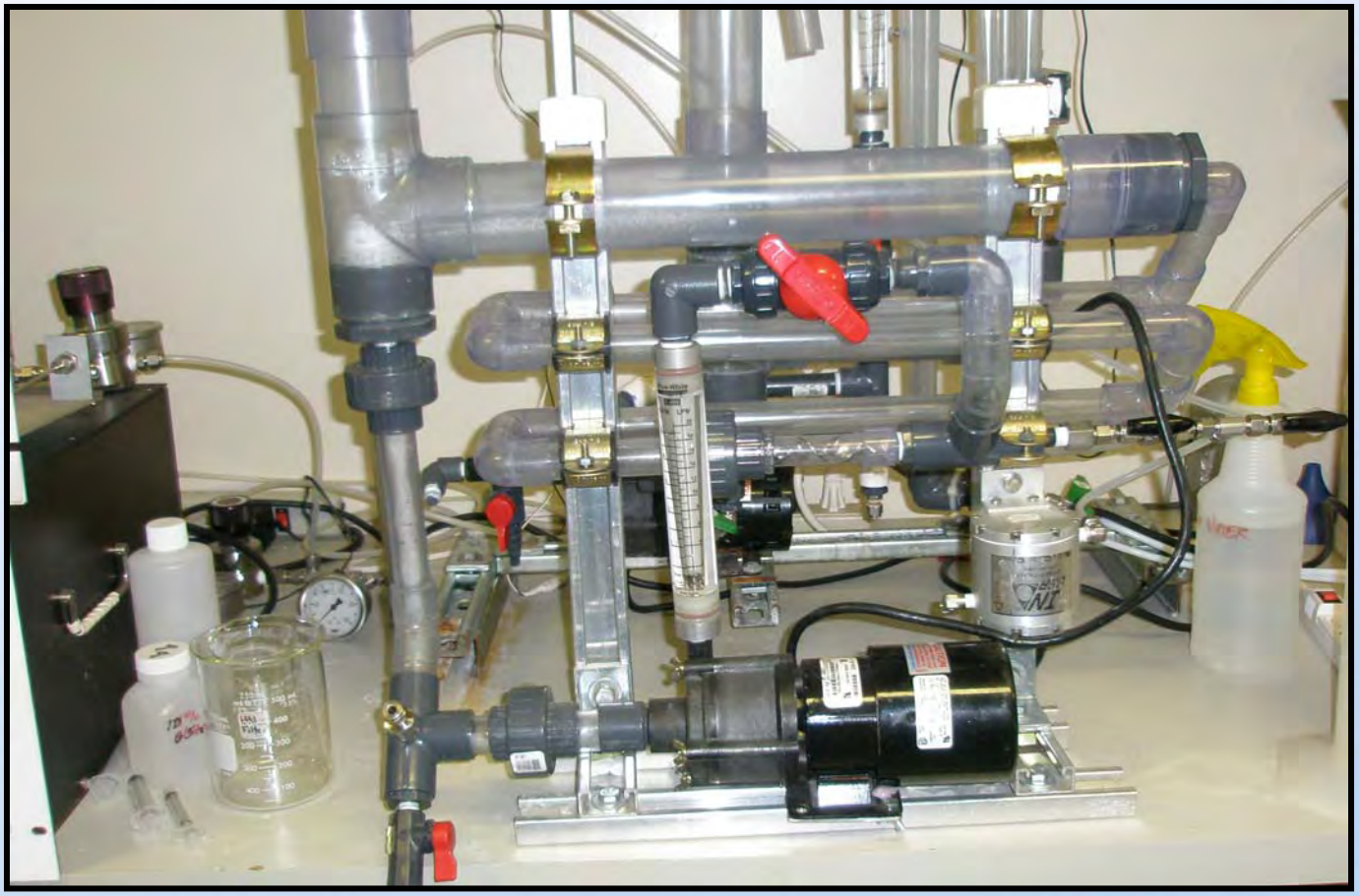


GAC Treatment Improved Water Quality



TOC as a surrogate for real time filter performance?

Ozone Bench-Scale Apparatus

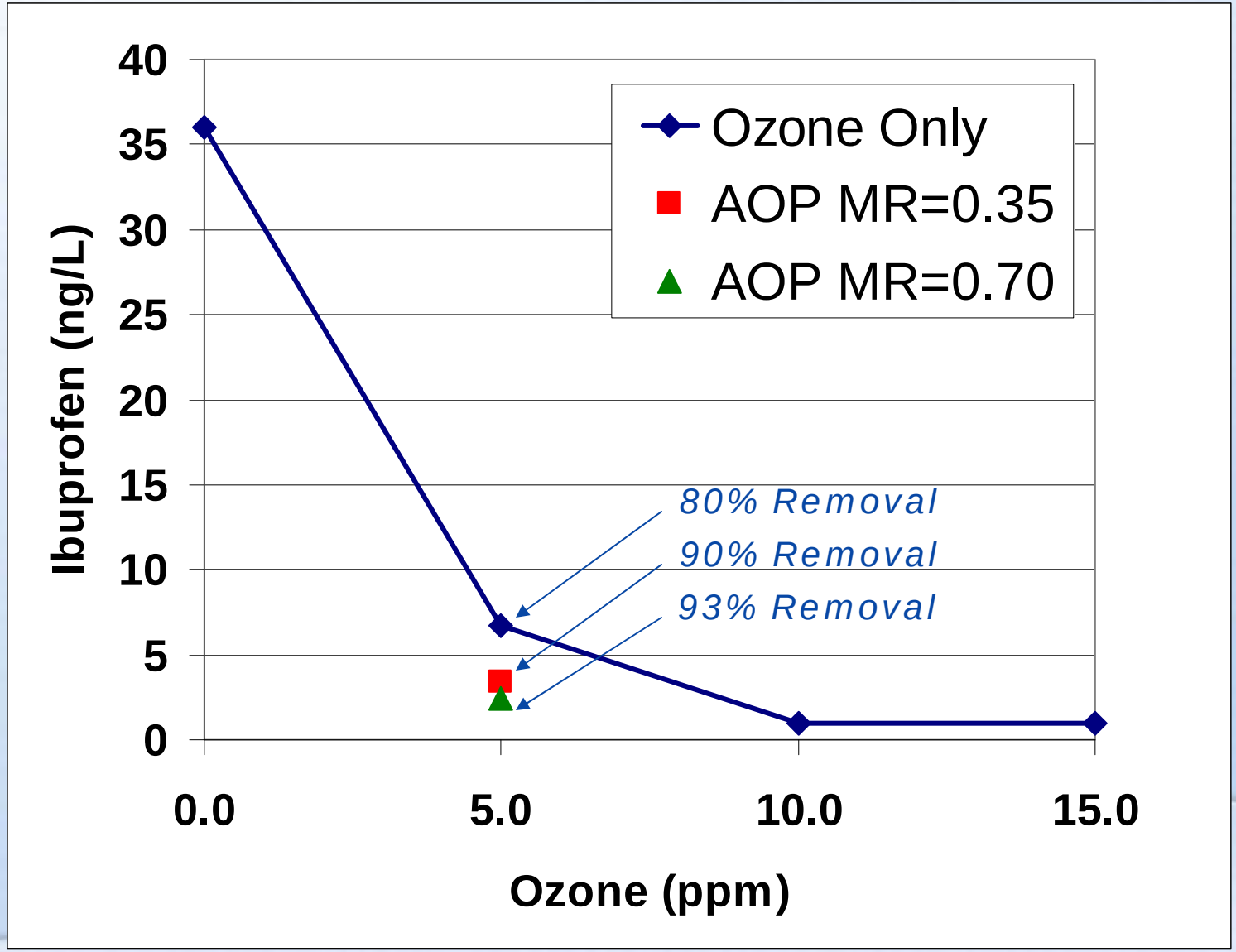


Courtesy of Applied Process Technology, Inc.

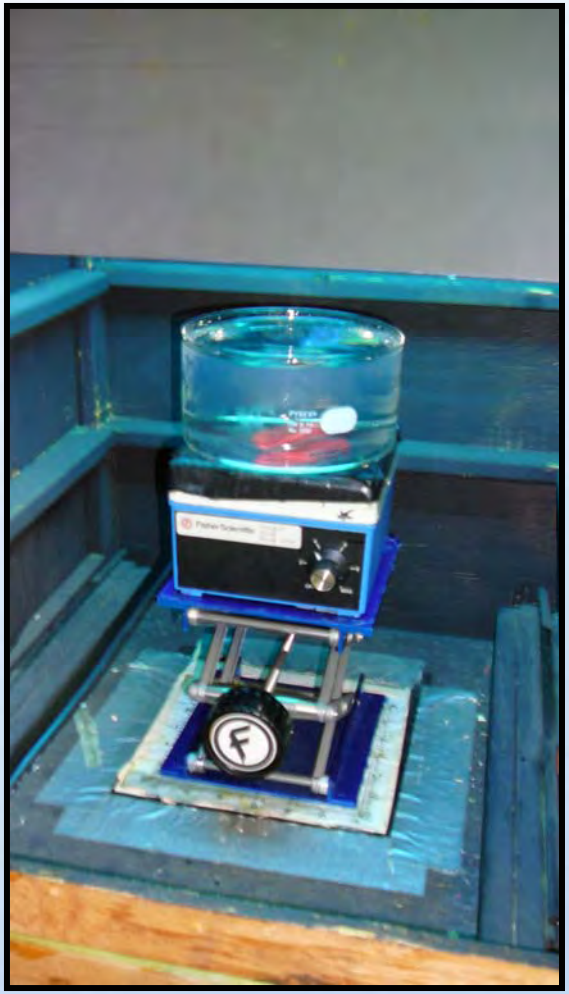
Ozone Treatment Effective for EDC/PPCP Removal

Constituent	Plant Eff Conc (ng/L)	Conc after O_3 (5 ppm)
Estradiol Equivalents	0.92	<0.10
Gemifibrozil	116	<1.0
Ibuprofen	36	6.7
Triclosan	13	<5.0
Caffeine	45	<3.0
Fluoxetine	20	<1.0
Sulfamethoxazole	524	<1.0
Trimethoprim	76	<1.0
	#/100mL	
E. Coli.	12000	<1

Ozone/Peroxide Improved Removal of Ibuprofen

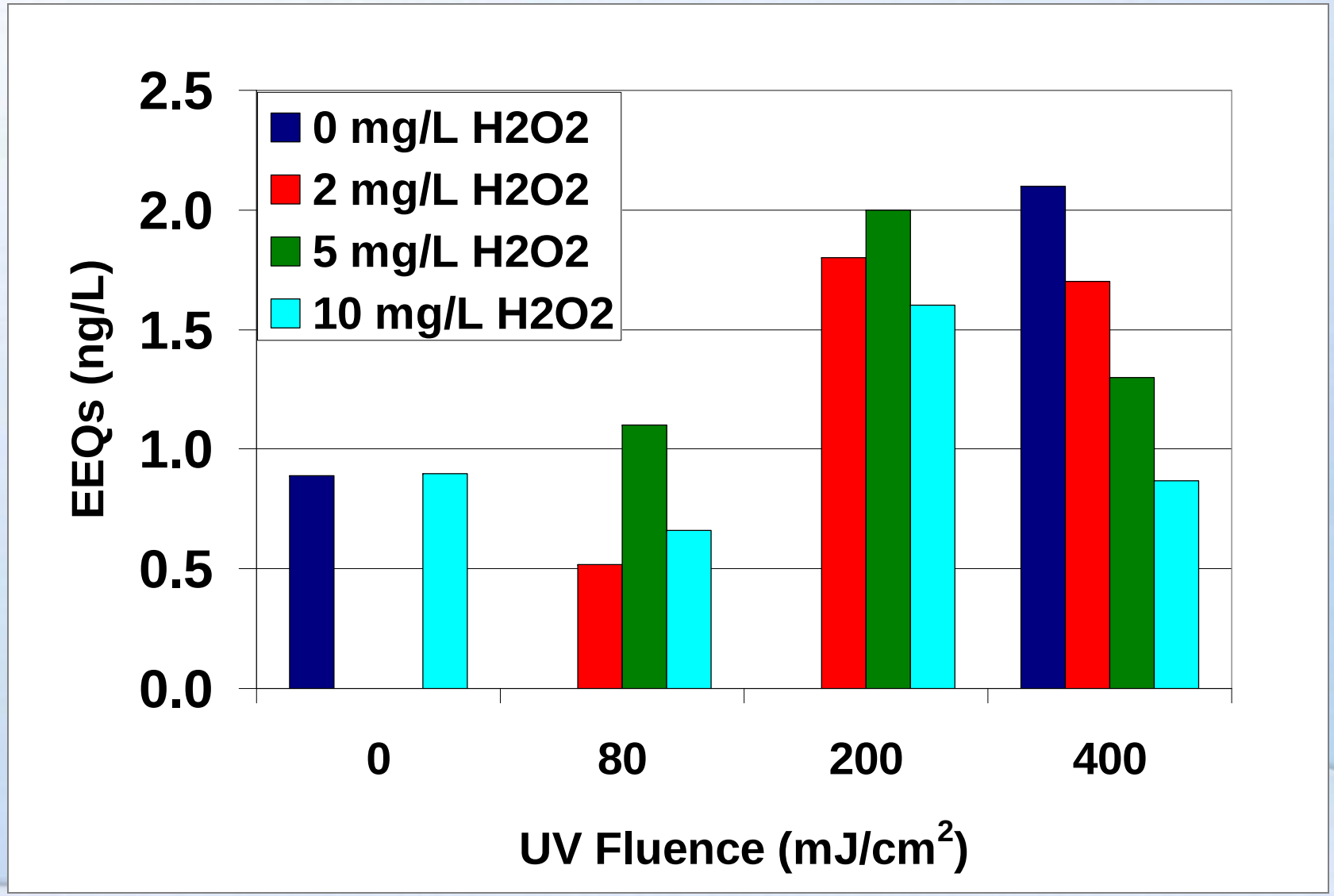


UV Bench-Scale Apparatus

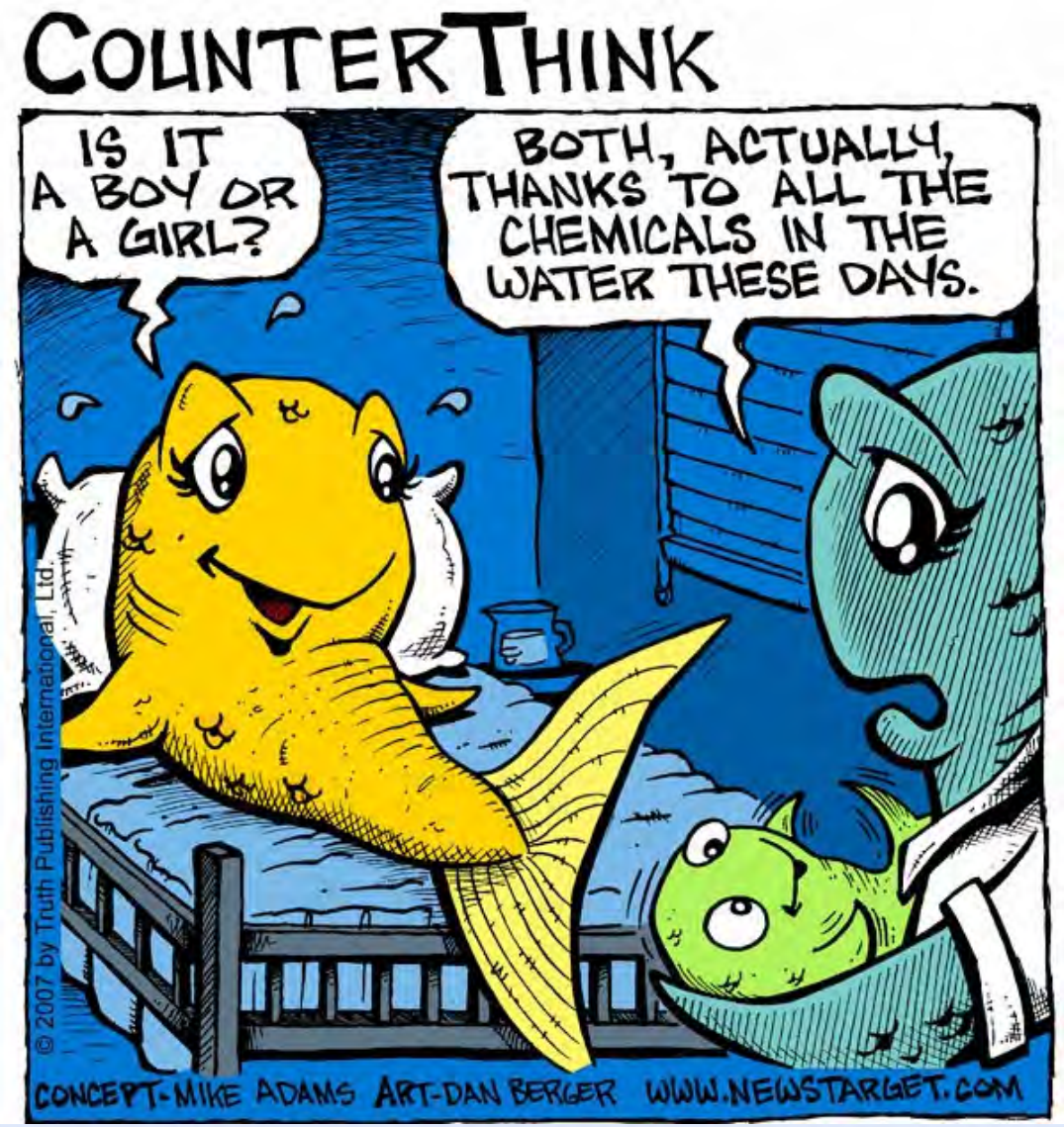


Courtesy of Duke University Research Group

UV/Peroxide: A Trend of EEQ Removal Seen at Highest UV Fluence



Costs and Recommendation



Cost Estimate Development

Assumptions:

Build new 7.2 mgd facility (AADF only)

Vendor quotes for equipment

$250/ sq ft. building cost

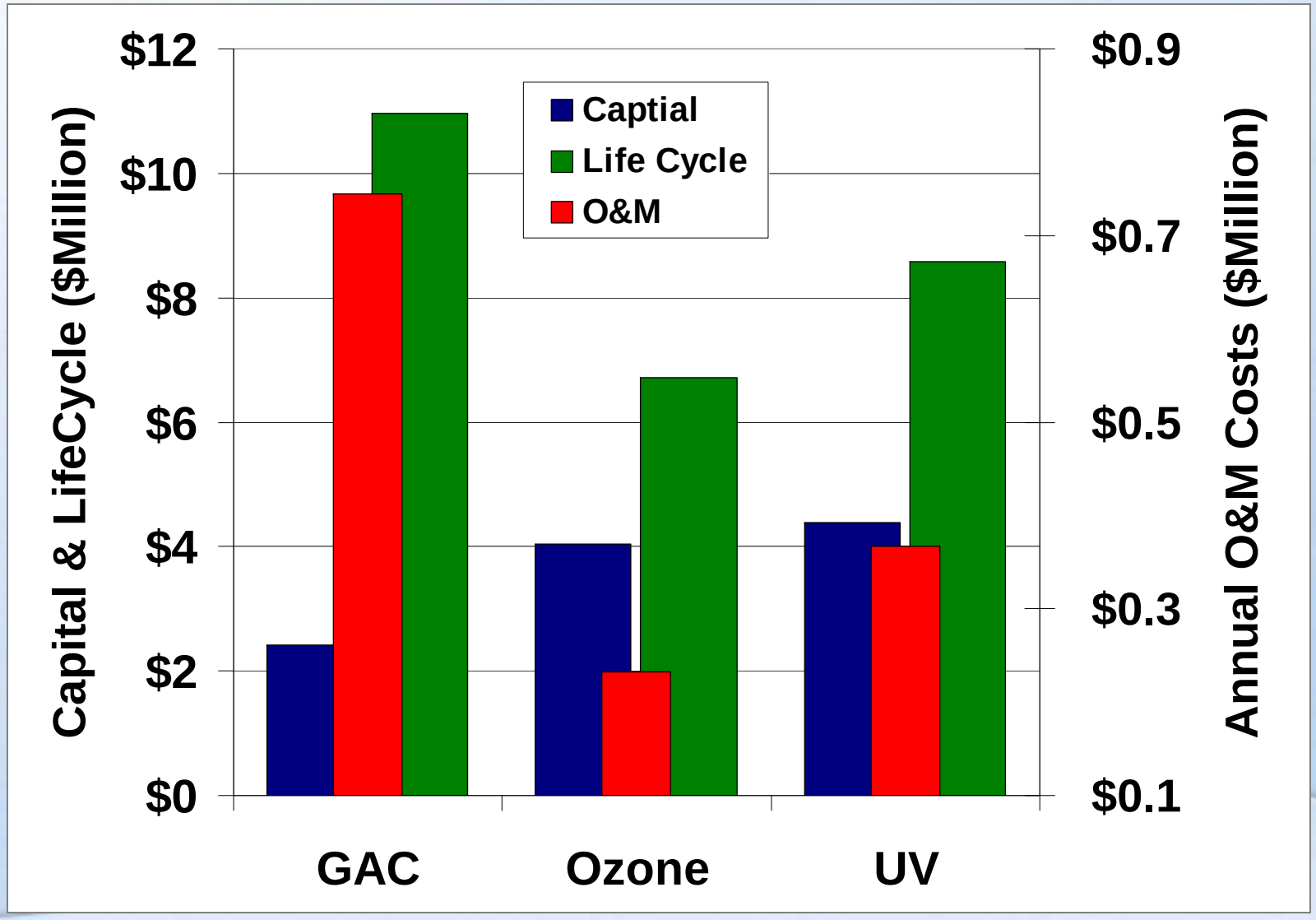
6% interest rate for 20 yr PW

GAC: 2 exchanges per year @ $350K

Ozone: 5ppm with H_2O_2, no CT basin

UV: 400mJ/cm^2 low pressure lamps

Ozone Treatment of EDCs is the Most Economical Alternative



Advanced Oxidation with Ozone Recommended as Technology of Choice

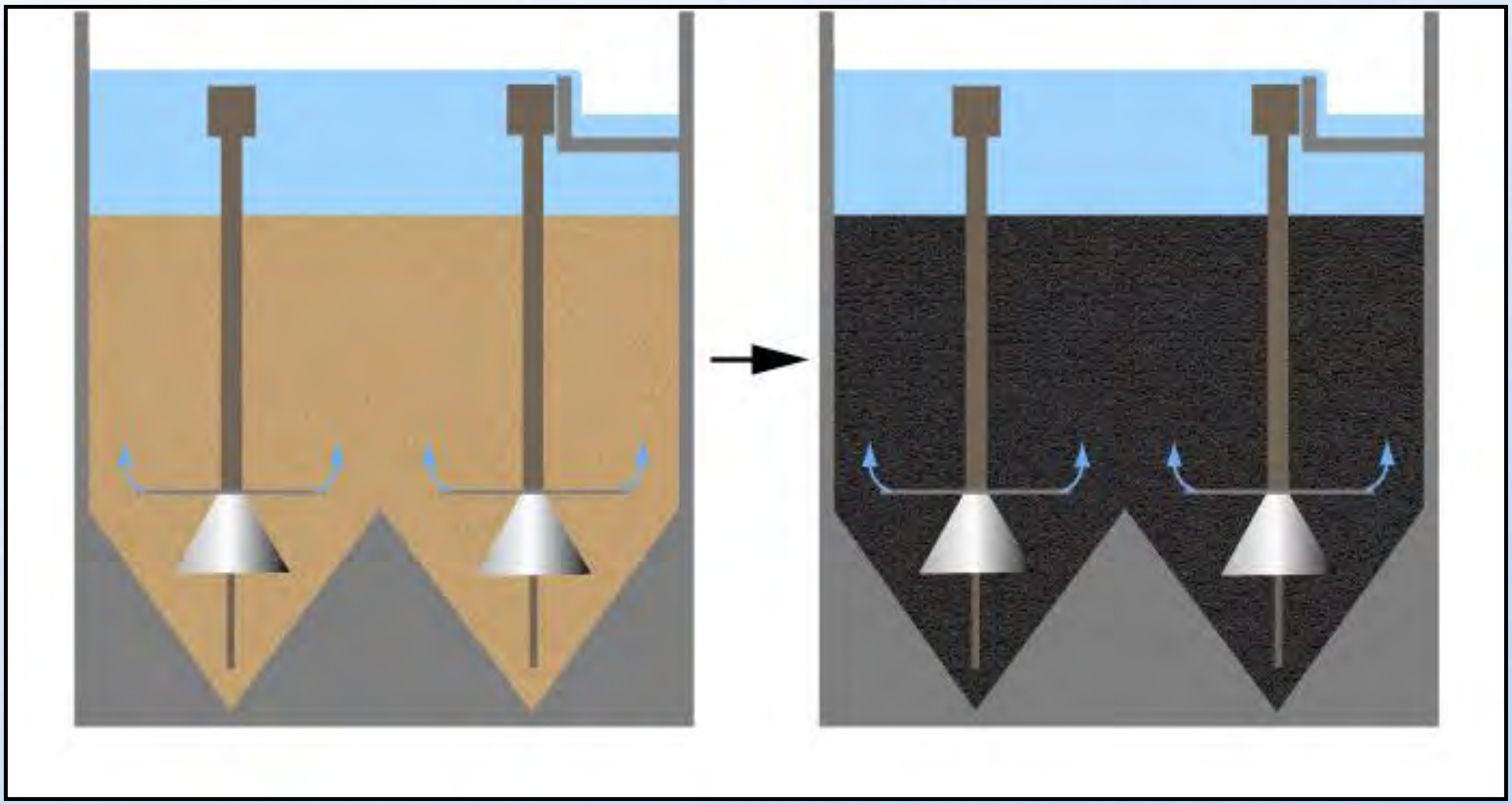
Advantages:

- **Lowest cost alternative based on 20 year PW**
- **Greater flexibility in treatment**
  - **Effective for a wide variety of chemicals**
  - **Vary the dose and/or add peroxide**

Disadvantages:

- **Highest Capital Cost & Oxidation Byproducts**

EDC Removal Using Existing Infrastructure



Existing Granular Media Filter (Parkson Dynasand)

GAC Contactor

Determine a Treatment Target

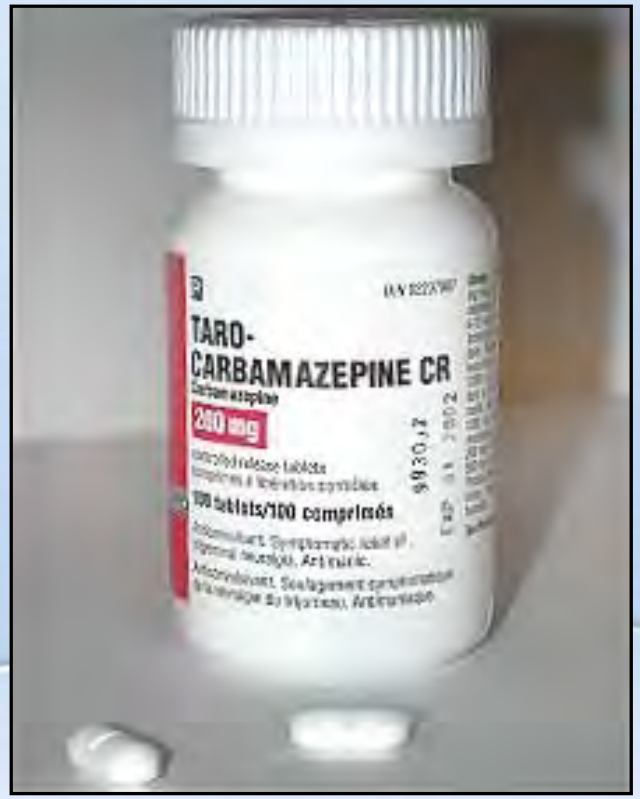
Source: National Drinking Water Clearing House, *On Tap*, Winter 2003.

What Should the Treatment Target be in the Absence of a Permit?

Determined environmentally safe level for two most common constituents:

Estrogen Activity

Carbamazepine



Carbamazepine is Not Suitable for Use as a Treatment Target

Published Ecotoxicity Values:

- **Acute Toxicity (EC_{50}) – 15 to 60 ppm**

  (Jos *et al*, 2003., Ferrari *et al*, 2006., & Kim *et al*, 2007.)

- **Chronic Toxicity (LOEC) – 1 ppb**

  (Triebskorn *et al*, 2003.)

ECWRF Highest Observed Conc. – 146 ppt

(10 times lower than LOEC)

A Reduction of Estrogenic Activity may be the best Treatment Target

Published Values for Measurable Effects:

- **Estrogenic Activity – 1 to 4 ppt**

  Observed Effects: Vitellogenin, Intersex, Feminization

  (Purdom *et al*, 1994., Snyder *et al*, 2003., & Fent *et al*, 2006.)

- **ECWRF Highest Observed Conc. – 1.2 ppt**

  Average Conc. 0.8 ppt

- **Treatment Target: Estrogenic Activity of less than 1 ppt**

  E-Screen Bioassay

Conclusions

- GAC Filtration and Ozone Oxidation were effective at reducing EDCs in ECWRF effluent
- Ozone/Peroxide advanced oxidation most economical treatment technology
- Best available treatment target is an estrogenic activity of 1.0 ppt or less

Future Research

Phase II: Assess Impacts on Downstream Fish

Sex Ratio Investigation and Sentinel Study

Questions?

For more info visit: http://www.sbwrd.com

Snyderville Basin Water Reclamation District

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