Emerging Contaminants – A Brief Overview of USGS Activities

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U.S. Department of the Interior
U.S. Geological Survey

USGS

- Our objective is to provide reliable, impartial and timely information needed by decision makers to more effectively manage our water resources and also to protect and enhance these resources for human health, aquatic health and environmental quality.

Which chemicals to measure?

- Mass produced/Quantities used.
- Manner used & release pathways.
- Anticipated environmental behavior.
- Health significance.
- Ability to measure.
- Potential as indicators/tracers.
- Stakeholder priorities.

How do we assure a representative measurement?

- Consistent field protocols
- Field Quality Assurance
- Laboratory QA
- Agregate QA datasets
- Interlab comparison & coordination

Collection of Pharmaceutical Data

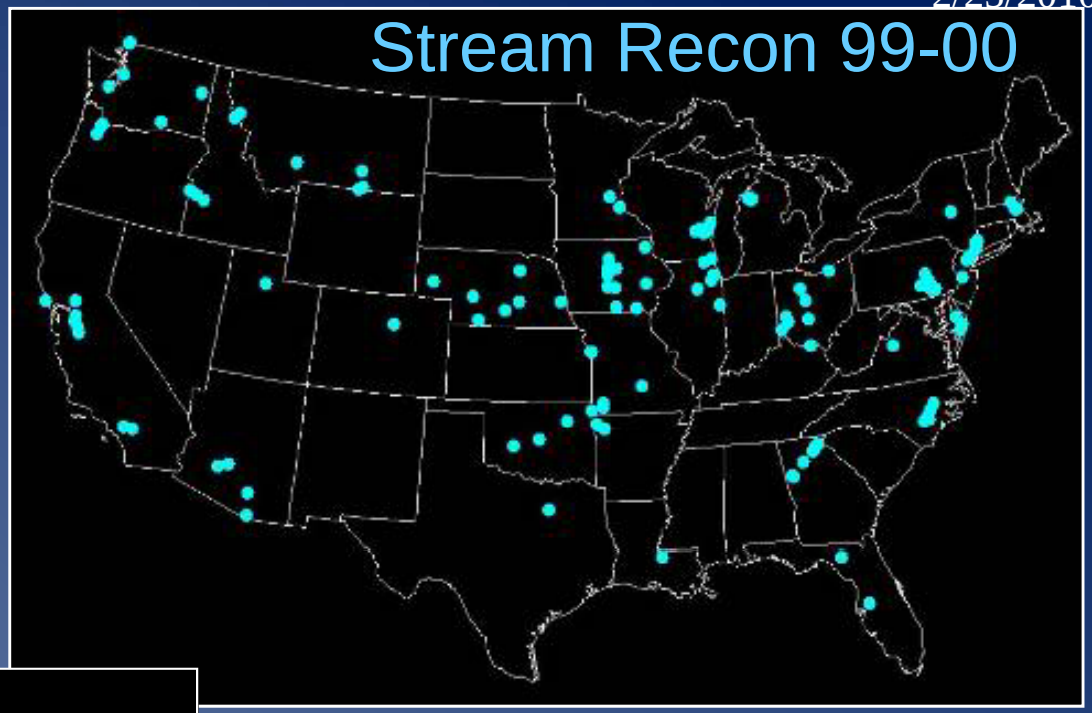
- USGS – National Field Manual for the Collection of Water-Quality Data
  - http://water.usgs.gov/owq/FieldManual/
- Chapter A5 – Sample Processing
  - 5.6.1.F – Wastewater, Pharmaceutical and Antibiotic Compounds

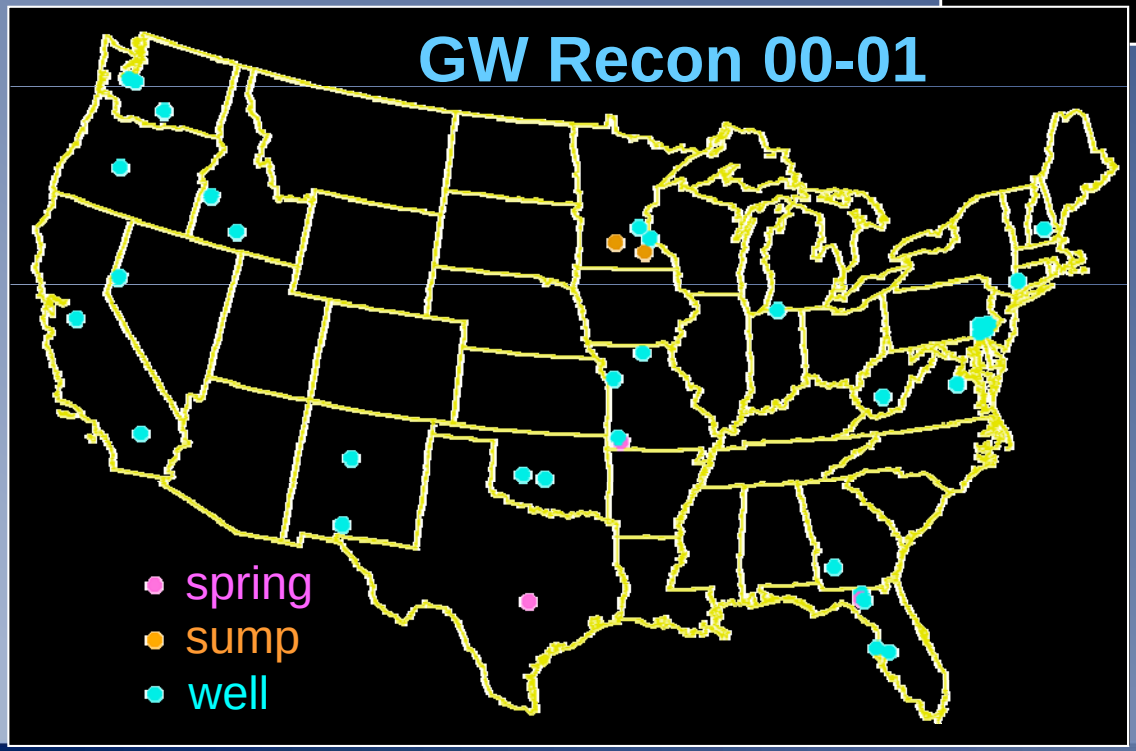
Care in Collection of Samples

- Safety is a must!
  - Wear protective gear
  - Be current on immunizations
- Prevent contamination
  - Avoid contact or consumption of products that contain target analytes, during collection and cleaning of equipment

Testing for Environmental Occurrence

Looking in Urban and Agricultural areas.





Are contaminants entering our aquatic environments ?

At what Levels?

In what Mixtures?

Human Waste Pathways

- WWTF
- CSOs
- ISDS
- Industrial Disch.
- Landfills
- Water Reuse

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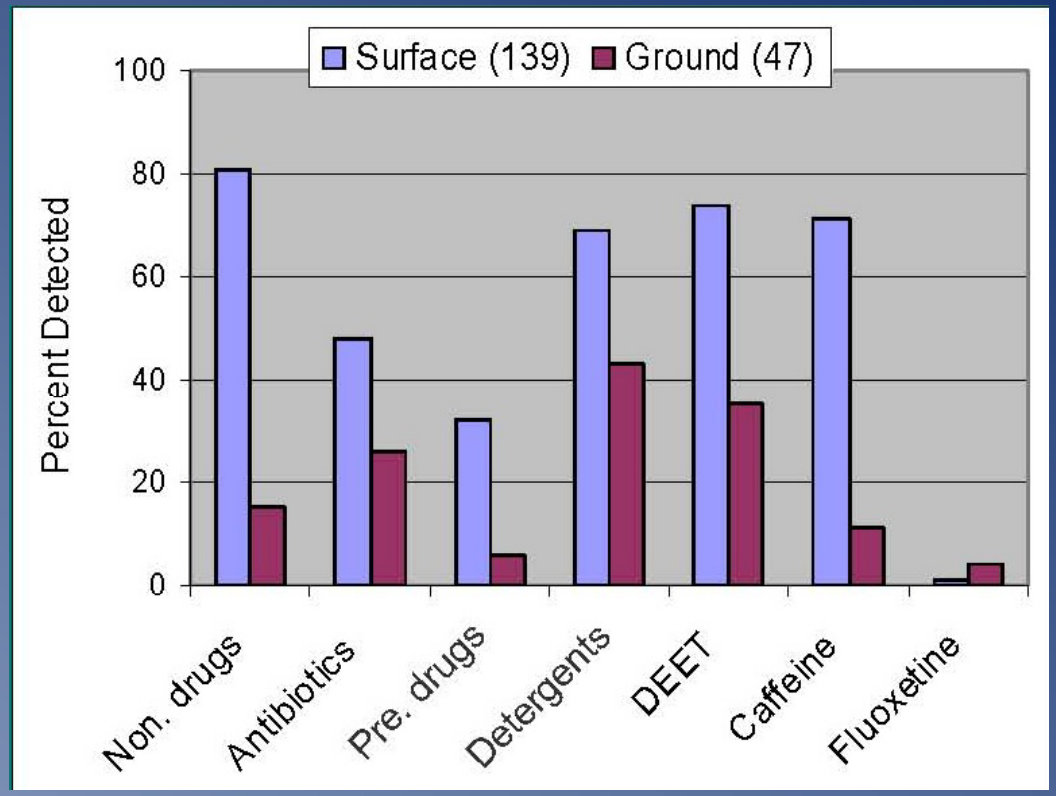
Are PPCP's entering our environment?

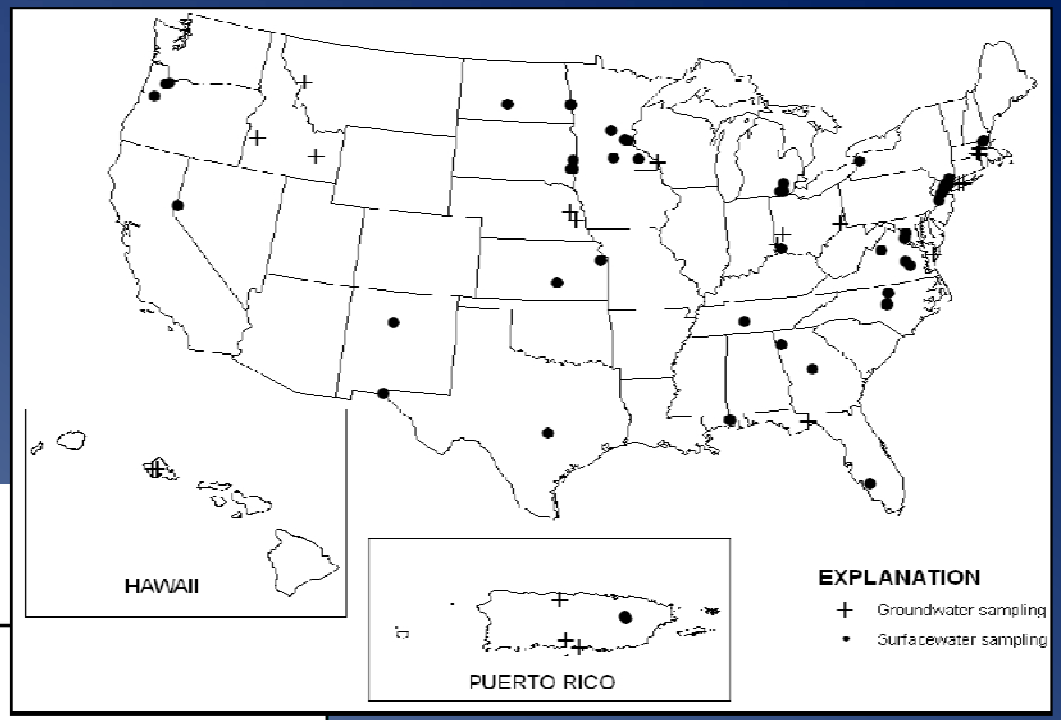
Results of National Stream and Groundwater Surveys

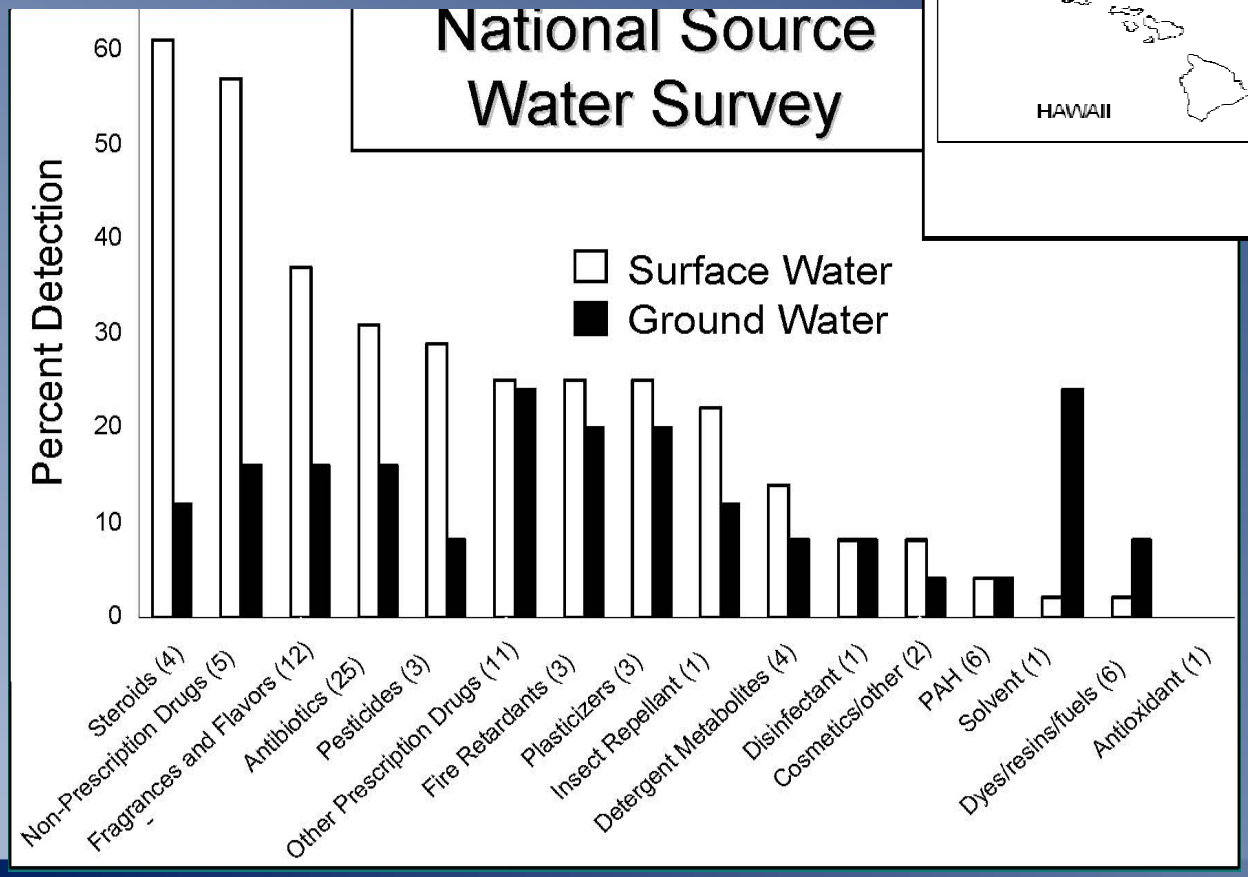
- Present in water at **sub-ppb concentrations**
- Present in **mixtures**
- Greater levels in streams than wells



Kolpin and others, 2002; Barnes and others, 2008

PPCPs in Source Waters

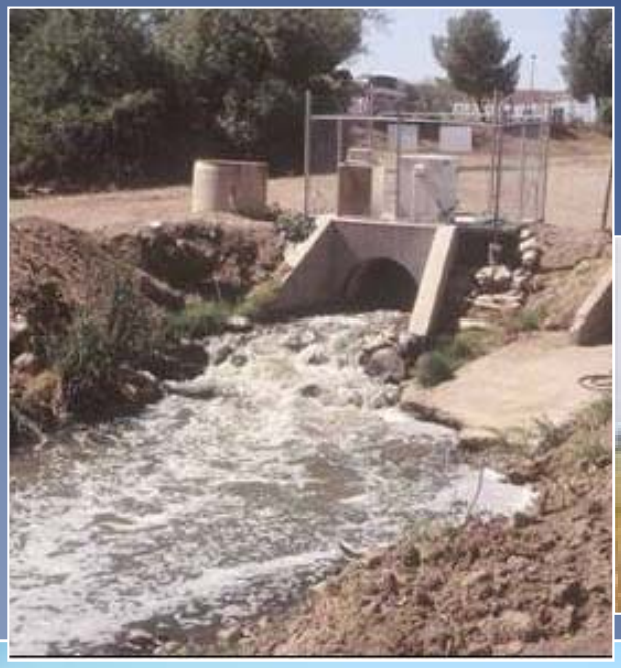




Focazio and others, 2008

Source Characterization Studies

Liquid and
Solid Waste



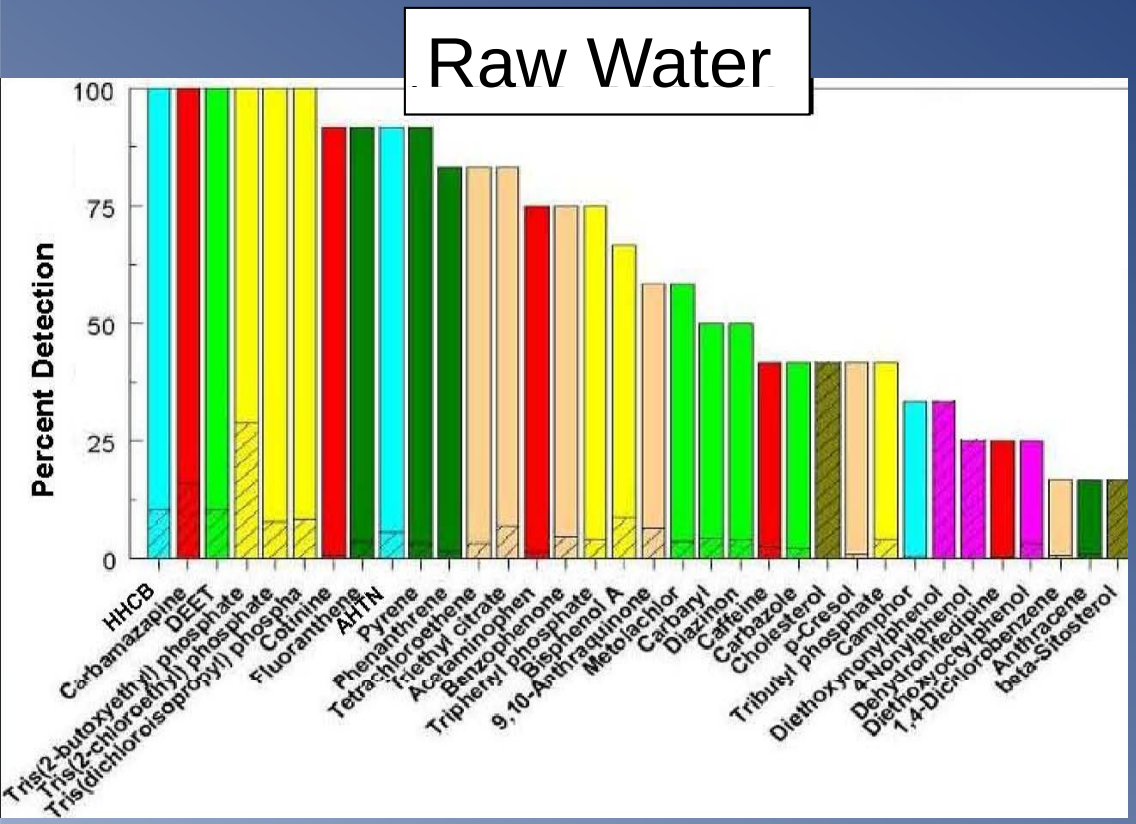
Stackelberg and others, 2004

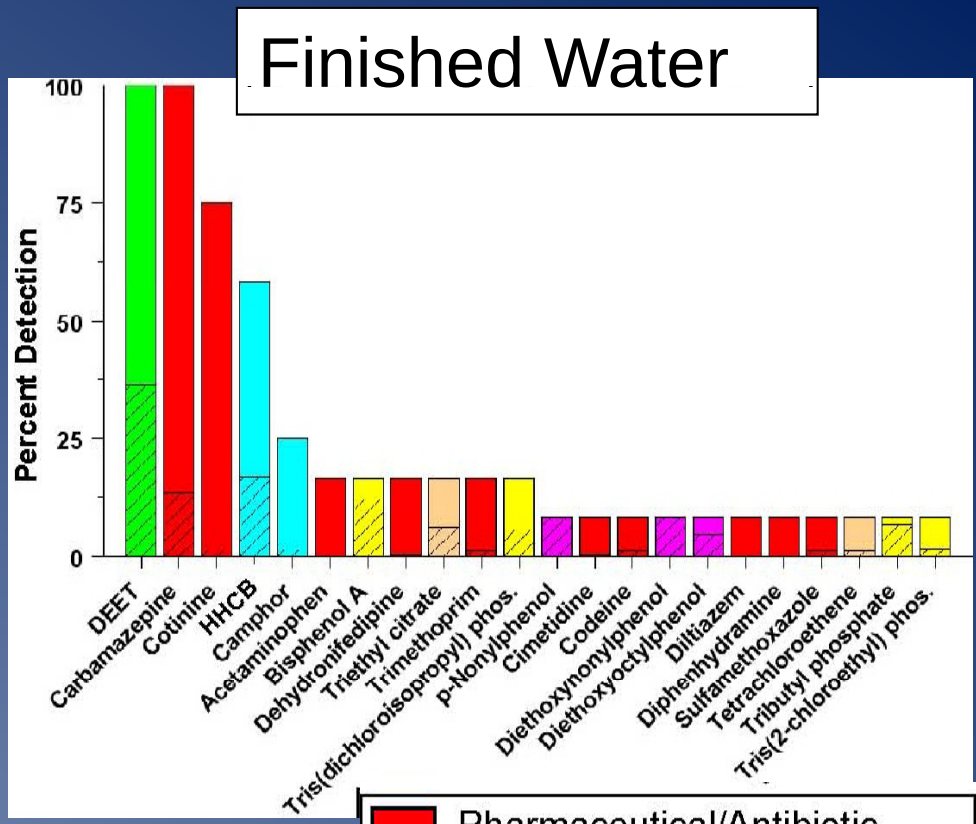
- Conventional drinking-water plant
- Samples collected from the stream and from selected locations within the plant
- 106 organic wastewater-related compounds
- Samples collected over 4 consecutive weeks, November-December 2001
- Low-flow sampling only, not assumed to be representative of high flows

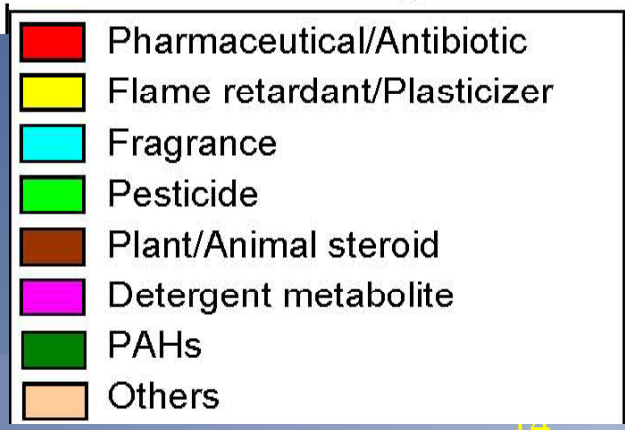
Stackelberg and others, 2007

- Same plant as previous study in 2001
- Collection of time-composited samples at each treatment step to account for retention
- Solids samples for the evaluation of adsorptive processes in removing OCs
- Samples collected over 3-week period, July-August 2003

Removal in Treatment, NJ Facility





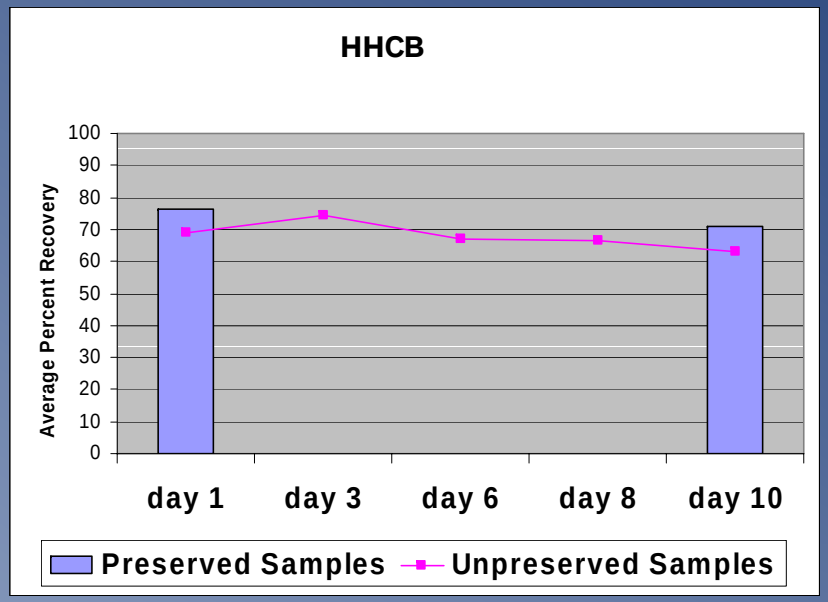


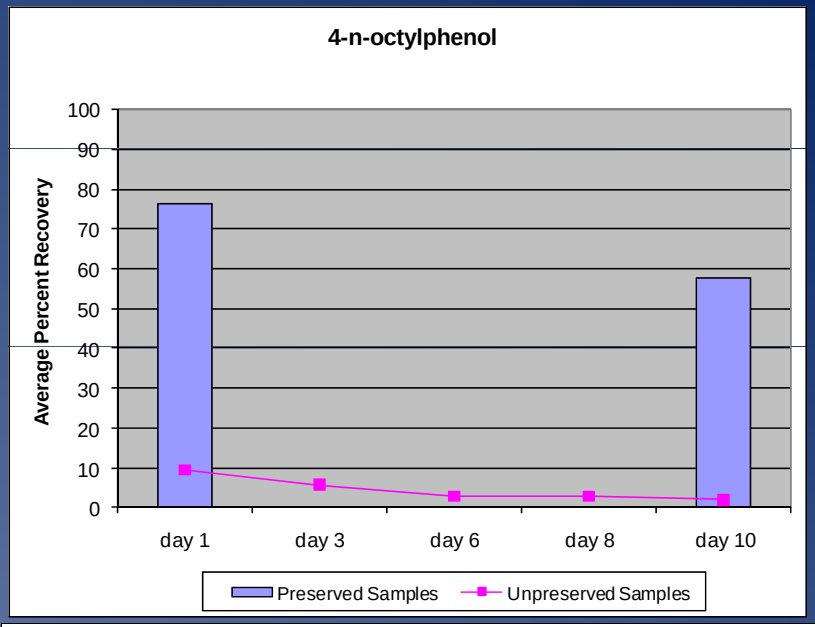
Levels Generally reduced by Treatment with GAC Filters

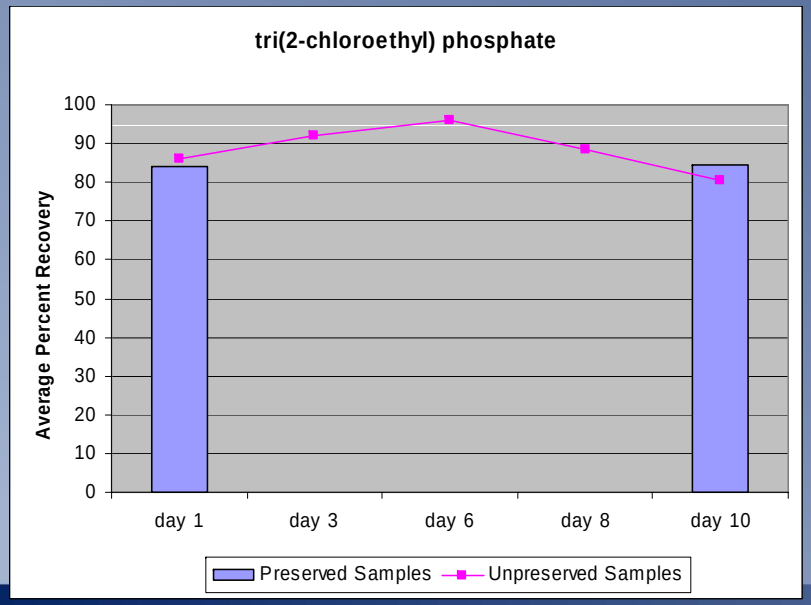
Stackelberg and others, 2004 & 2007

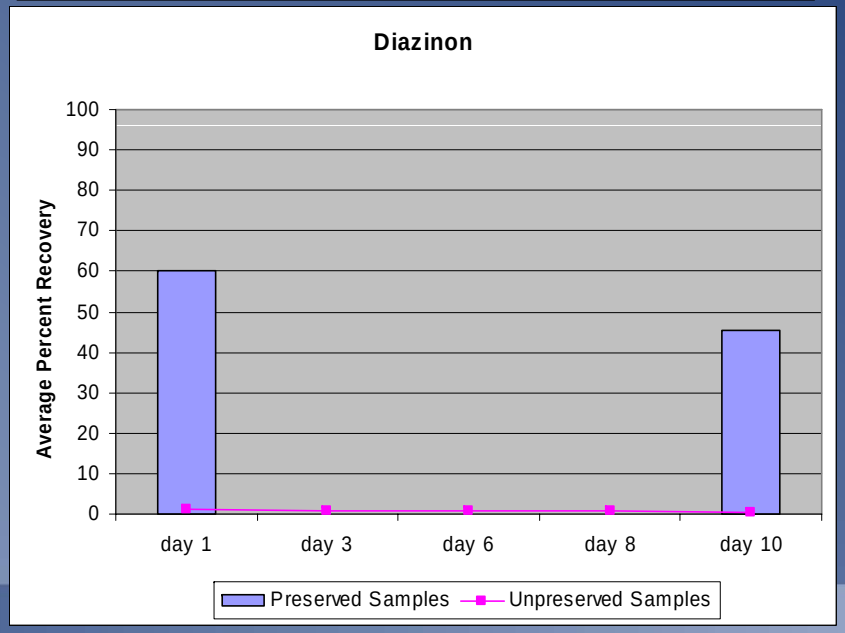
USGS

Stability in Chlorinated Water









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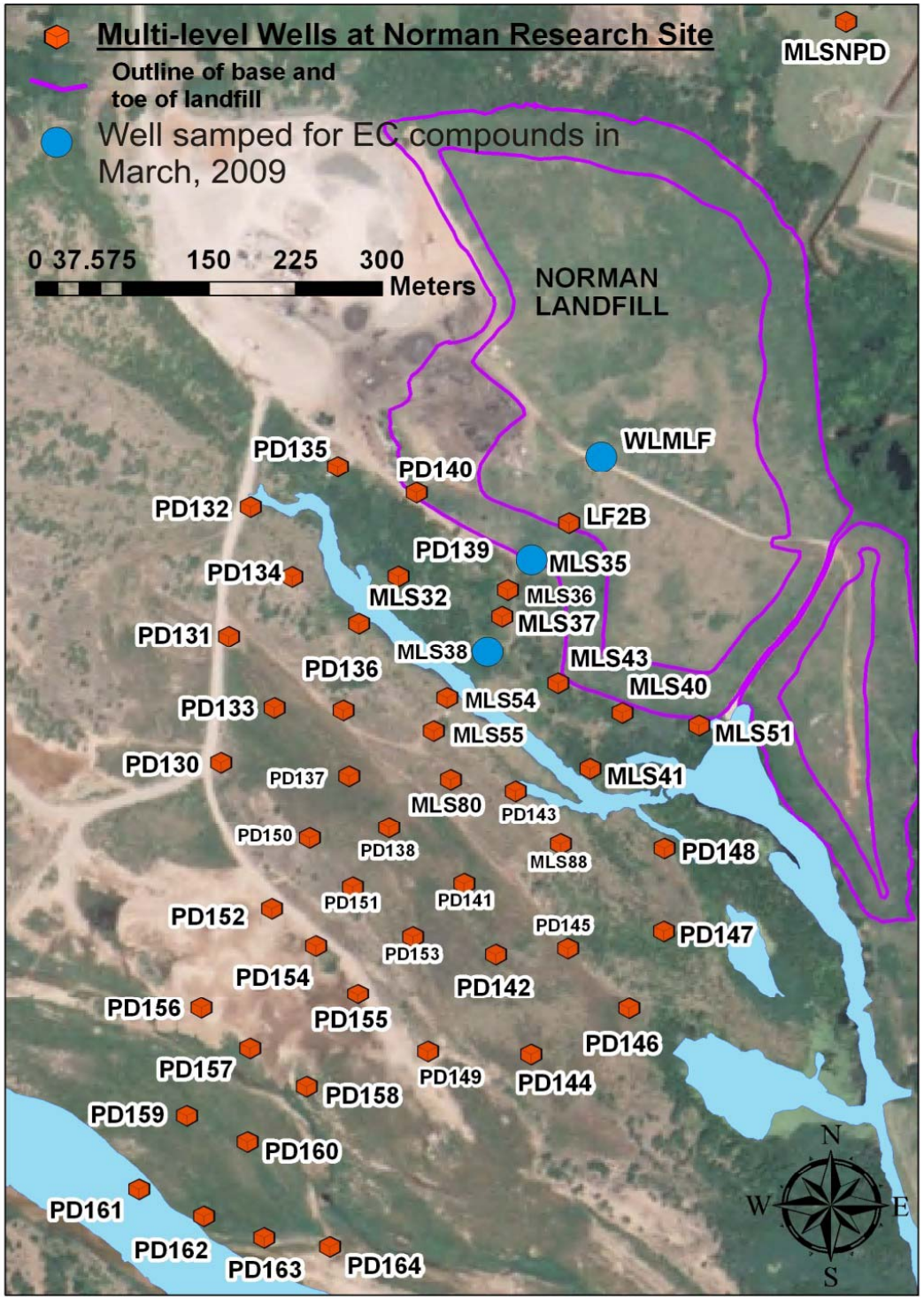
From Gibs and others, 2007

Norman, OK Landfill – Research Site



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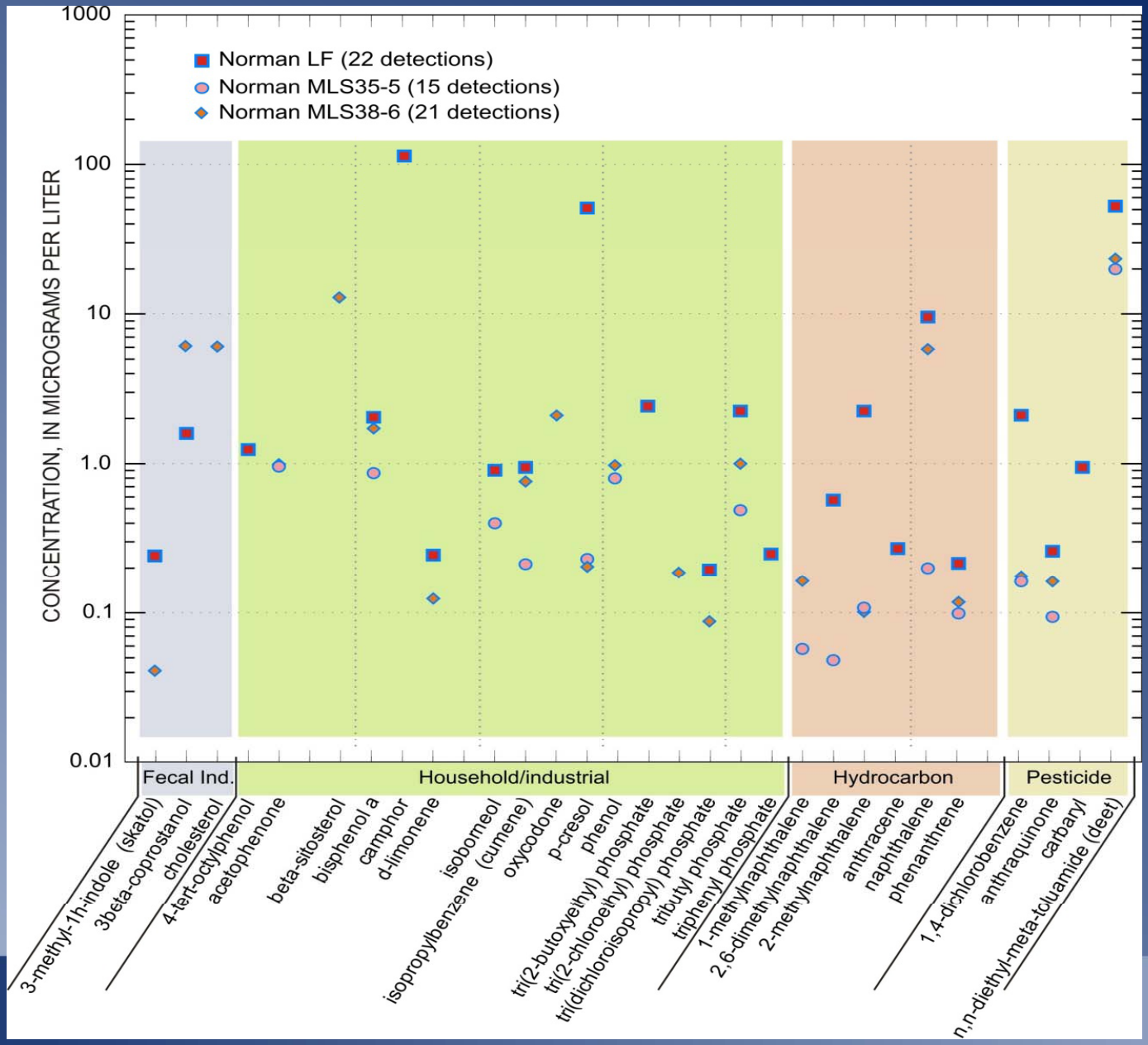
Norman, OK Landfill

- Closed in 1985, unlined, municipal landfill
- EC samples in 2000 and 2009
- ECs detected in all wells
- Well in Landfill, greatest concentrations
- Wells downgradient, concentrations of compounds not detected in the landfill well

2009 results from Norman, OK Landfill Research Site



USGS, 2009

OK Landfill Work

- Recently sampled around and in active landfill
- Lined
- Preliminary data are similar to the data from the unlined, older, closed landfill

Texas Emerging Contaminant Work

- Dallas Area study – Mick Baldys, Fort Worth

USGS Toxics Program

http://toxics.usgs.gov/regional/emc/index.html

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http://toxics.usgs.gov/regional/emc/index.html

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Toxic Substances Hydrology Program

Research Projects - Emerging Contaminants

Emerging Contaminants In the Environment

Emerging Contaminants | Methods Development | Environmental Occurrence | Source Pathways | Transport and Fate | Ecological Effects

Research is documenting with increasing frequency that many chemical and microbial constituents that have not historically been considered as contaminants are present in the environment on a global scale. These "emerging contaminants" are commonly derived from municipal, agricultural, and industrial wastewater sources and pathways. These newly recognized contaminants represent a shift in traditional thinking as many are produced industrially yet are dispersed to the environment from domestic, commercial, and industrial uses.

The major goal of the **Emerging Contaminants Project** is to provide information on these compounds for evaluation of their potential threat to environmental and human health. To accomplish this goal, the research activities of this project are to: (1) develop **analytical methods** to measure chemicals and microorganisms or their genes in a variety of matrices (e.g. water, sediment, waste) down to trace levels, (2) determine the **environmental occurrence** of these potential contaminants, (3) characterize the myriad of **sources and source pathways** that determine contaminant release to the environment, (4) define and quantify processes that determine their **transport and fate** through the environment, and (5) identify potential **ecologic effects** from exposure to these chemicals or microorganisms. Project research on emerging contaminants is being conducted within these five areas. The following links provide more detailed information.

1. Analytical Methods Development
2. Environmental Occurrence
3. Sources and Source Pathways
4. Transport and Fate
5. Ecological Effects

"Emerging contaminants" can be broadly defined as any synthetic or naturally occurring chemical or any microorganism that is not commonly monitored in the environment but has the potential to enter the environment and cause known or suspected adverse ecological and (or) human health effects. In some cases, release of emerging chemical or microbial contaminants to the environment has likely occurred for a long time, but may not have been recognized until new detection methods were developed. In other cases, synthesis of new chemicals or changes in use and disposal of existing chemicals can create new sources of emerging contaminants.

Emerging Contaminant Headlines

- Tackling Fish Endocrine Disruption
- Measuring Antidepressants, Fungicides, and Insecticides in the Environment
- Detergents in Streams May Just Disappear
- Emerging Contaminants Targeted in a Reconnaissance of Ground Water and Untreated Drinking-Water Sources

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Crosscutting Topics
- Agricultural Chemicals
- Contaminant Occurrence
- Contaminant Plumes
- Contaminant Transport (GW)
- Contaminant Transport (SW)
- Geophysical Characterization
- Methods
- Models
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New Publications

Upcoming Publications

- Fate of trace organic compounds during vadose zone soil treatment in an onsite wastewater system: Conn, K.E., Siegrist, R.L., Barber, L.B., and Meyer, M.T., Environmental Toxicology and Chemistry (IN PRESS).
- WhatÕs in your floodwater?: Kolpin, D.W., and Hornbuckle, K., *in* Mutel, C.F., ed., A Watershed Year--Anatomy of the Iowa Floods of 2008, Iowa City, University of Iowa Press (IN PRESS).

Newly Published

- Antidepressant pharmaceuticals in two U.S. effluent-impacted streams--Occurrence and fate in water and sediment, and selective uptake in fish neural tissue: Schultz, M.M., Furlong, E.T., Kolpin, D.W., Werner, S.L., Schoenfuss, H.L., Barber, L.B., Blazer, V.S., Norris, D.O., and Vajda, A.M., 2010, Environmental Science and Technology, doi:10.1021/es9022706 (Advanced Web release).
- Comparing wastewater chemicals, indicator bacteria concentrations, and bacterial pathogen genes as fecal pollution indicators: Haack, S.K., Duris, J.W., Fogarty, L.R., Kolpin, D.W., Focazio, M.J., Furlong, E.T., and Meyer, M.T., 2009, Journal of Environmental Quality, v. 38, no. 1, p. 248-258, doi:10.2134/jeq2008.0173.
- Contaminants of emerging concern--Introduction to a featured collection: Battaglin, W.A., and Kolpin, D.W., 2009, JAWRA Journal of the American Water Resources Association, v. 45, no. 1, p. 1-3, doi:10.1111/j.1752-1688.2008.00299.x.
- Biodegradation of 17β-estradiol, estrone and testosterone in stream sediments: Bradley, P.M., Barber, L.B., Chapelle, F.H., Gray, J.L., Kolpin, D.W., and McMahon, P.B., 2009, Environmental Science and Technology, v. 43, no. 6, p. 1902-1910, doi:10.1021/es802797j.
- The occurrence of antibiotics in an urban watershed--From wastewater to drinking water: Watkinson, A.J., Murby, E.J., Kolpin, D.W., and Costanzo, S.D., 2009, Science of the Total Environment, v. 407, no. 8, p. 2,711-2,723, doi:10.1016/j.scitotenv.2008.11.059.
- Predator avoidance performance of larval fathead minnows (*Pimephales promelas*) following short-term exposure to estrogen mixtures: McGee, M.R., Julius, M.L., Vajda, A.M., Norris, D.O., Barber, L.B., and Schoenfuss, H.L., 2009, Aquatic Toxicology, v. 91, no. 4, p. 355-361, doi:10.1016/j.aquatox.2008.12.002.
- Waste-indicator and pharmaceutical compounds in landfill-leachate-affected ground water near Elkhart, Indiana, 2000-2002: Buszka, P.M., Yeskis, D.J., Kolpin, D.W., Furlong, E.T., Zaugg, S.D., and Meyer, M.T., 2009, Bulletin of Environmental Contamination and Toxicology, v. 82, no. 6, p. 653-659, doi:10.1007/s00128-009-9702-z.
- Fate of sulfamethoxazole, 4-nonyphenol, and 17β-estradiol in groundwater contaminated by wastewater treatment plant effluent: Barber, L.B., Keefe, S.H., LeBlanc, D.R., Bradley, P.M., Chapelle, F.H., Meyer, M.T., Loftin, K.A., Kolpin, D.W., and Rubio, F., 2009, Environmental Science and Technology, v. 43, no. 13, p. 4843-4850, doi:10.1021/es803292v.
- Reproductive health of bass in the Potomac, USA drainage--Part 2. Seasonal occurrence of persistent and emerging organic contaminants: Alvarez, D.A., Cranor, W.L., Perkins, S.D., Schroeder, V., Iwanowicz, L.R., Clark, R.C., Guy, C.P., Pinkney, A., Blazer, V.S., and Mullican, J.E., 2009, Environmental Toxicology and Chemistry, v. 28, no. 5, p. 1084-1095, doi:10.1897/08-417.1.
- Gene and antigen markers of Shiga-toxin producing *E. coli* from Michigan and Indiana river water--Occurrence and relation to recreational water quality criteria: Duris, J.W., Haack, S.K., and Fogarty, L.R., 2009, Journal of Environmental Quality, v. 38, no. 5, p. 1878-1886, doi:10.2134/jeq2008.0225.
- Reproductive health of bass in the Potomac, USA, drainage--Part 1. Exploring the effects of proximity to wastewater treatment plant discharge: Iwanowicz, L.R., Blazer, V.S., Guy, C.P., Pinkney, A.E., Mullican, J., and A., A.D., 2009, Environmental Toxicology and Chemistry, v. 28, no. 5, p. 1072-1083, doi:10.1897/08-433.1.
- Antidepressants at environmentally relevant concentrations affect predator avoidance behavior of larval fathead minnows (*Pimephales promelas*): Painter, M.M., Buerkley, M.A., Julius, M.L., Vajda, A.M., Norris, D.O., Barber, L.B., Furlong, E.T., Schultz, M.M., and Schoenfuss, H.L., 2009, Environmental Toxicology and Chemistry, v. 28, no. 12, p. 2677-2684, doi:10.1897/08-556.1.
- Occurrence and removal of pharmaceutically active compounds in sewage treatment plants with different technologies: Ying, G.G., Kookana, R.S., and Kolpin, D.W., 2009, Journal of Environmental Monitoring, v. 11, no. 8, p. 1498-1505, doi:10.1039/b904548a.

Select Information on Emerging Contaminant Research Outside the Toxic Substances Hydrology Program

- Endocrine Disruptor Research, Contaminant Biology Program, USGS
- Pharmaceuticals and Personal Care Products (PPCPs), U.S. Environmental Protection Agency

Removals of ECs in WWTP

A Multi-Disciplinary Approach to the removal of Emerging Contaminants in Wastwater Treatment Plant in New York State (2003-2004)

Phillips and others, 2008, Clearwaters, Fall 2008, p 48-59

http://nywea.org/clearwaters/08-3-fall/08-RemovalOfEmergingContaminants.pdf

Stackelberg and others

- 2004 Science of the Total Environment 329:99-113
  - Persistence of pharmaceutical compounds and other organic wastewater contaminants in a conventional drinking-water-treatment plant
- 2007 Science of the Total Environment 377:255-272
  - Efficiency of conventional drinking-water-treatment processes in removal of pharmaceutical and other organic compounds

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Many others I have probably forgotten to mention…..

Field expertise in 50 Water Science Center Offices.

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