



Emerging Contaminants in the Waters of Cape Cod: Lessons Learned and Looking Ahead

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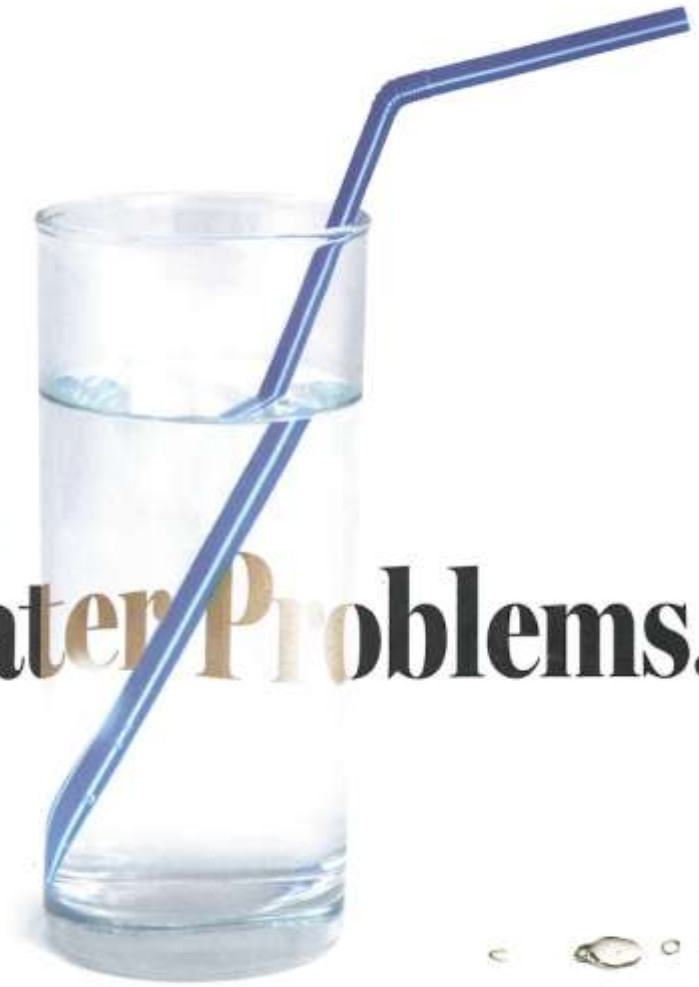
Today's presentation

- Contaminants of emerging concern
- Silent Spring Institute water quality research
- Lessons learned and looking ahead

THE CITGO SIGN'S ORIGIN STORY // AMATEUR DNA DETECTIVE ON THE CASE // BLIND DATE BETWEEN BEAUTIFUL PEOPLE

Globe Magazine

THE BOSTON GLOBE / AUGUST 7, 2016



Sunny Skies.
Sandy Beaches.

Big Water Problems.

In the aquifer and septic systems under Cape Cod's idyllic landscape lie deep environmental challenges. Here's why fixing them won't be easy.

BY BARBARA MORAN

The Cape's Big Drinking Water Problem

When you live on what's essentially a sandbar, pollution, septic systems, and political roadblocks add up to one tough challenge.

By Barbara Moran

2 August 2016

Contaminants of Emerging Concern

Contaminants

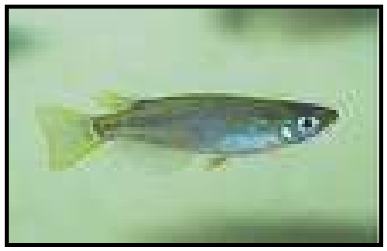
- Widely detected in drinking water, surface water, and groundwater

Emerging

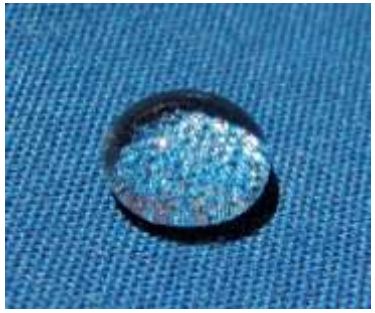
- Improved analytical capabilities can detect lower concentrations
- Not regulated in drinking water

Concern

- Hormone disruption in aquatic species
- Higher levels of exposure linked to human health effects, low dose effects unknown



Common sources of CECs



Examples of CECs

pharmaceuticals

antimicrobials

hormones

highly fluorinated chemicals

preservatives

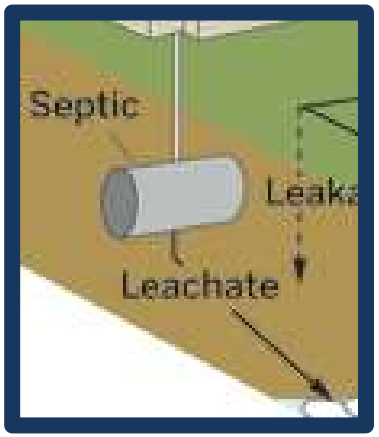
detergents

fragrances

flame retardants

artificial sweeteners

How do CECs get into the environment?

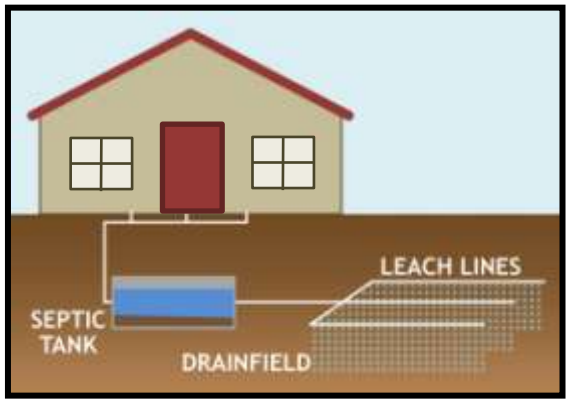


85% of Cape residences are served by septic systems

http://pubs.acs.org/cen/coverstory/86/8608cover.html

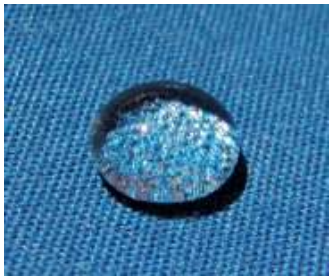
Wastewater treatment plants and septic systems do not fully remove CECs

- Removal depends on chemical properties:
  - Biodegradability
  - Hydrophobicity
  - Volatility
- Removal also depends on type of treatment



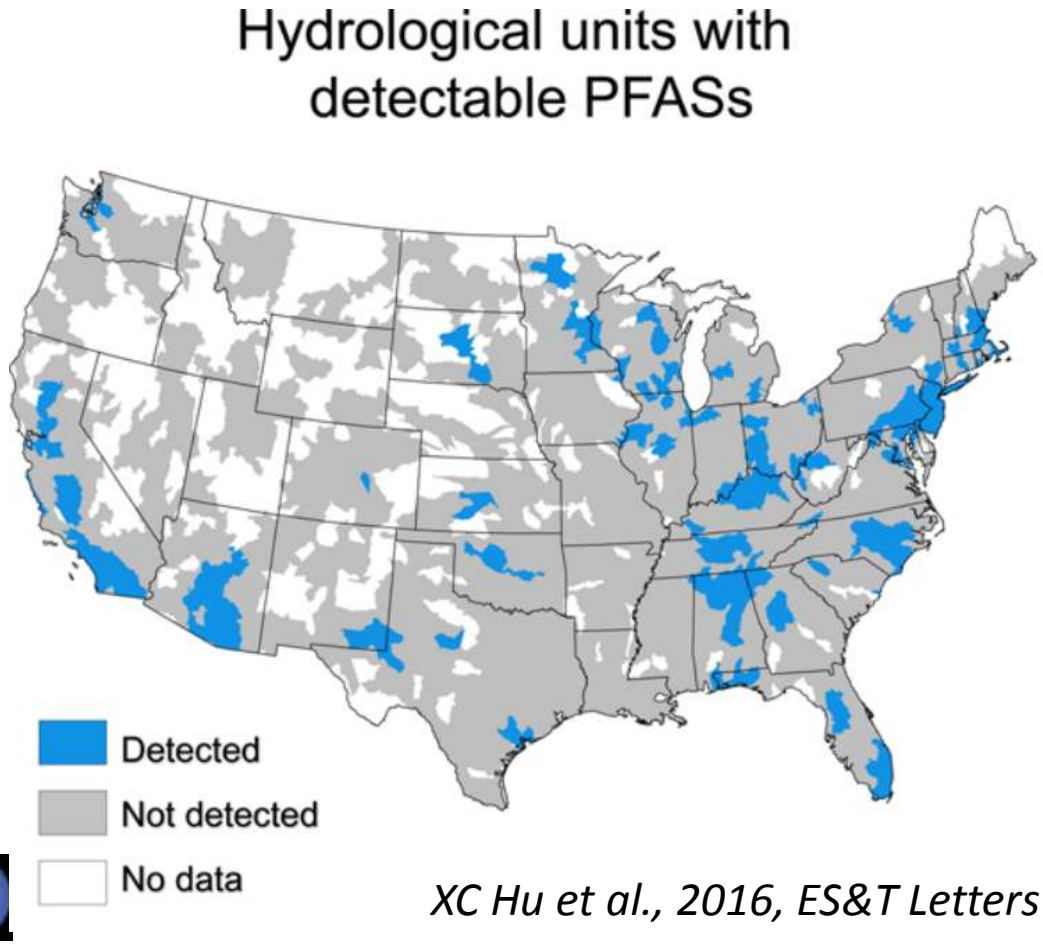
Per- and polyfluoroalkyl substances (PFASs, also called PFCs)

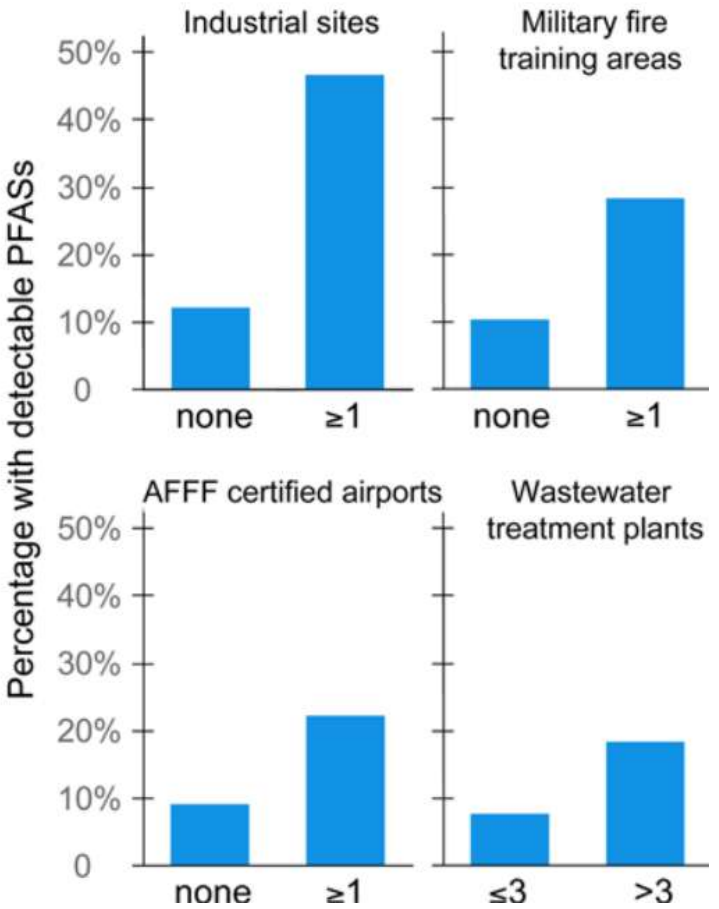
- Highly persistent
- Linked to cancer, developmental toxicity, immune suppression, and other health effects
- Non-stick, stain-resistant, and waterproof consumer products
- Firefighting foams for fuel fires (AFFF) are major source of groundwater contamination



Sources of PFASs to drinking water

Public water supplies near production facilities, military fire training areas, AFFF-certified airports, or WWTPs were 2 to 5 times more likely to have detectable PFASs in EPA's UCMR3 testing





XC Hu et al., 2016, ES&T Letters

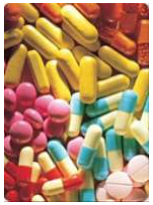
Silent Spring Institute Cape Cod water quality research

- Measure CECs in Cape Cod:
  - Public and private drinking water wells [1,2]
  - Groundwater [3]
  - Ponds [4]
  - Septic systems [3,5]
- Identify markers of CECs to predict wells with highest concentrations
- Inform Cape wastewater management and drinking water protection

[1] LA Schaider et al. *Science of the Total Environment,* 2014.
[2] LA Schaider et al. *Science of the Total Environment,* 2016.
[3] CH Swartz et al. *Environmental Science & Technology,* 2006.
[4] LJ Standley et al. *Environmental Toxicology & Chemistry,* 2008.
[5] RA Rudel et al. *Environmental Science & Technology,* 1998.

Cape Cod public and private wells

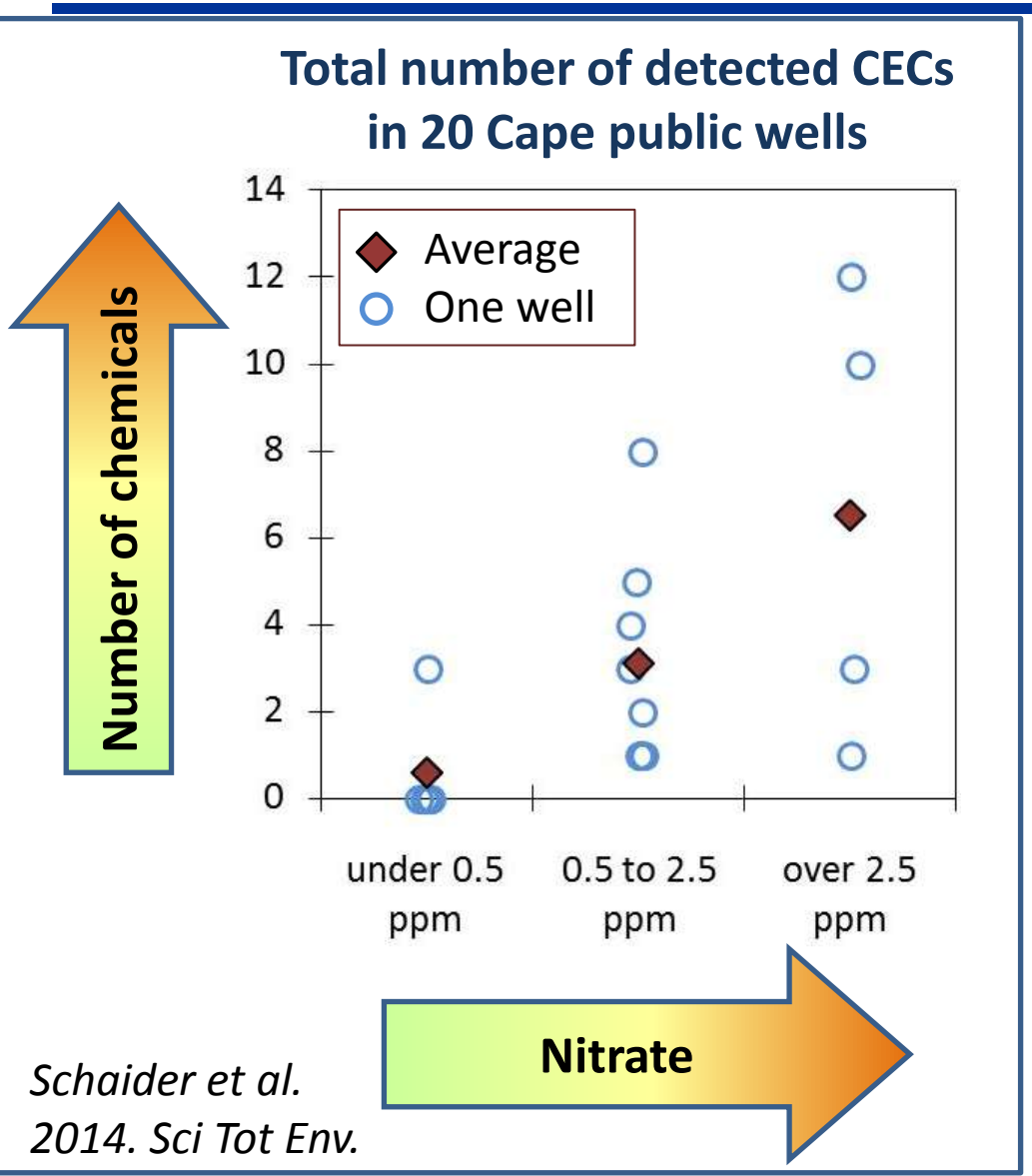
- Most frequently detected chemicals
  - Artificial sweetener (acesulfame)
  - Antibiotics (sulfamethoxazole, trimethoprim)
  - Anticonvulsants (carbamazepine, dilantin)
  - Flame retardants (TCEP, TEP)
  - Highly fluorinated chemicals (PFOS, PFBS)



- Typical concentrations: 1-10 parts per trillion (ng/L)
- Maximum concentrations for several pharmaceuticals among the highest in U.S.

Schaider et al. 2014, Schaider et al. 2016, *Sci Tot Env*

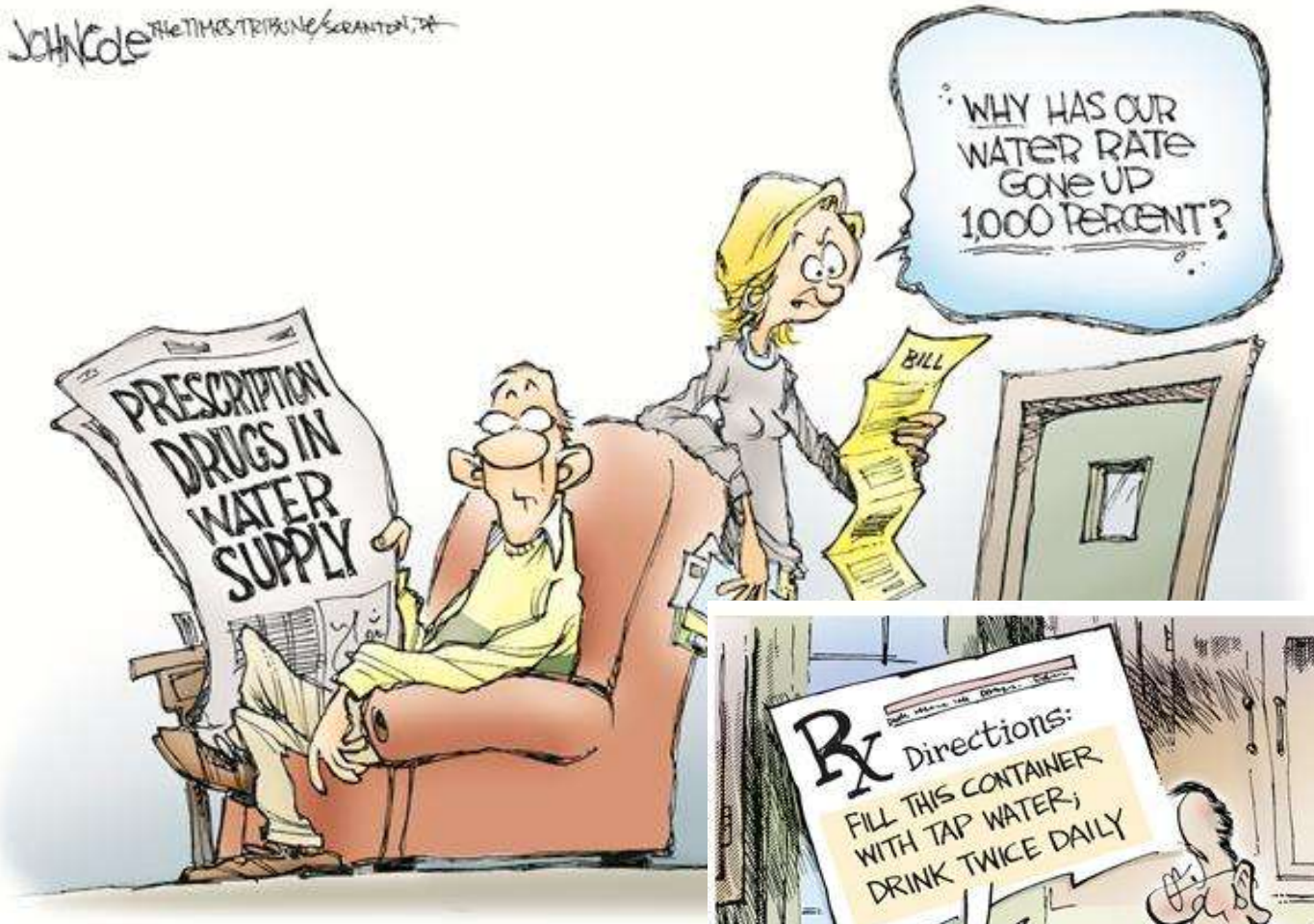
Nitrate is a marker of CECs



Schaider et al. 2014. Sci Tot Env.

Other markers

- ✔ Residential land development
  - Within Zone 2
  - Within 500-m radius
- ✔ Boron (in wastewater)
- ✔ Well depth (inverse)



http://www.politicalcartoons.com

Do CECs in drinking water pose a health concern?

Magnitude of exposures (what is a part per trillion?)

- Therapeutic doses >> pharmaceuticals in drinking water
- Exposures through product usage may be much higher
- Current drinking water standards in µg/L not ng/L

Nevertheless, CECs in drinking water do raise concerns

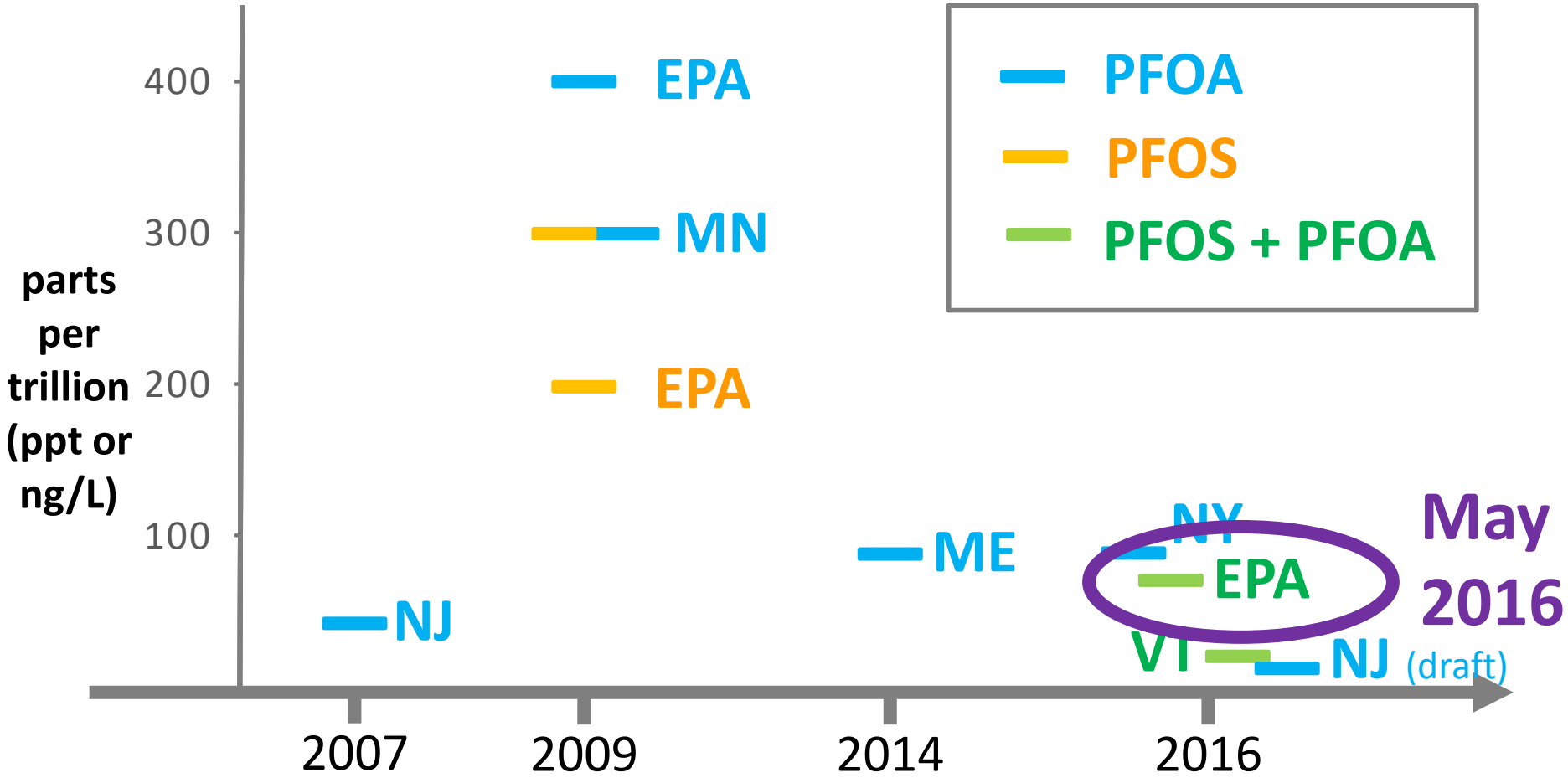
- Drugs are potent, intended for specific conditions, and can have side effects, and sensitivities vary
- Potential synergistic effects of chemical mixtures
- Our understanding of health effects is evolving

Drinking water regulations

We tend to think of drinking water standards as bright red lines…

…but determining standards is complex and our knowledge is evolving

What is safe? Evolution of state and federal PFOS and PFOA guidelines



CAPE COD TIMES

Hyannis residents warned about water quality

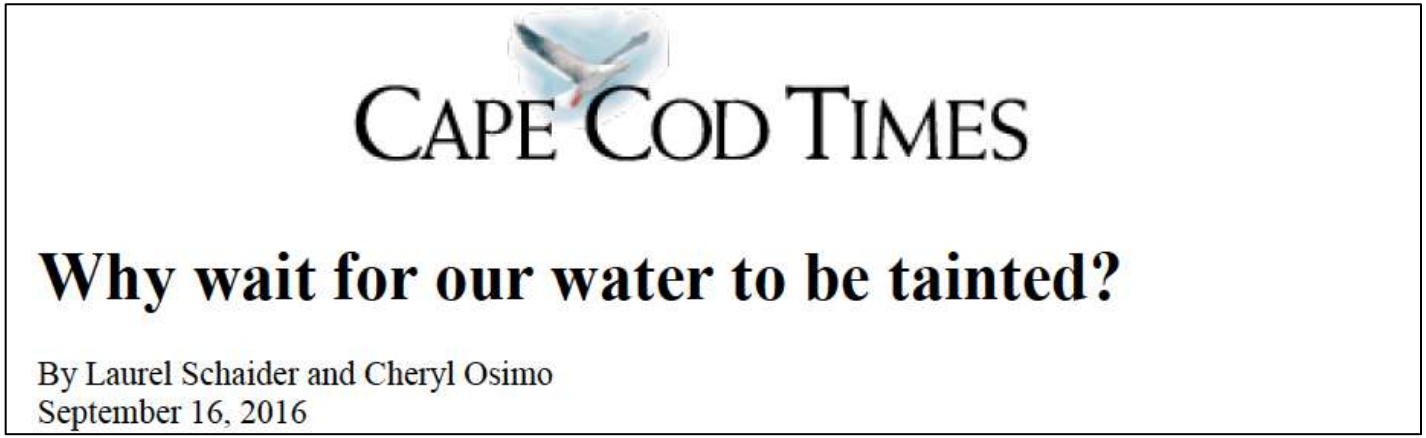
Posted May. 24, 2016 at 3:05 PM

HYANNIS — Barnstable officials are recommending that pregnant women, nursing mothers and infants in Hyannis not drink or cook with well water until further notice after a federal agency changed thresholds for two contaminants in the drinking water.

On Thursday, the U.S. Environmental Protection Agency changed its advisory level for perfluorinated compounds, known as PFOS and PFOAs, from 0.2 micrograms per liter and 0.4 micrograms per liter to 0.07 micrograms per liter for both.

The change put a well at the Mary Dunn well field above the new contaminant limit, according to Daniel Santos, director of the town's Department of Public Works.

Lessons learned and looking ahead



CAPE COD TIMES

Why wait for our water to be tainted?

By Laurel Schaider and Cheryl Osimo
September 16, 2016

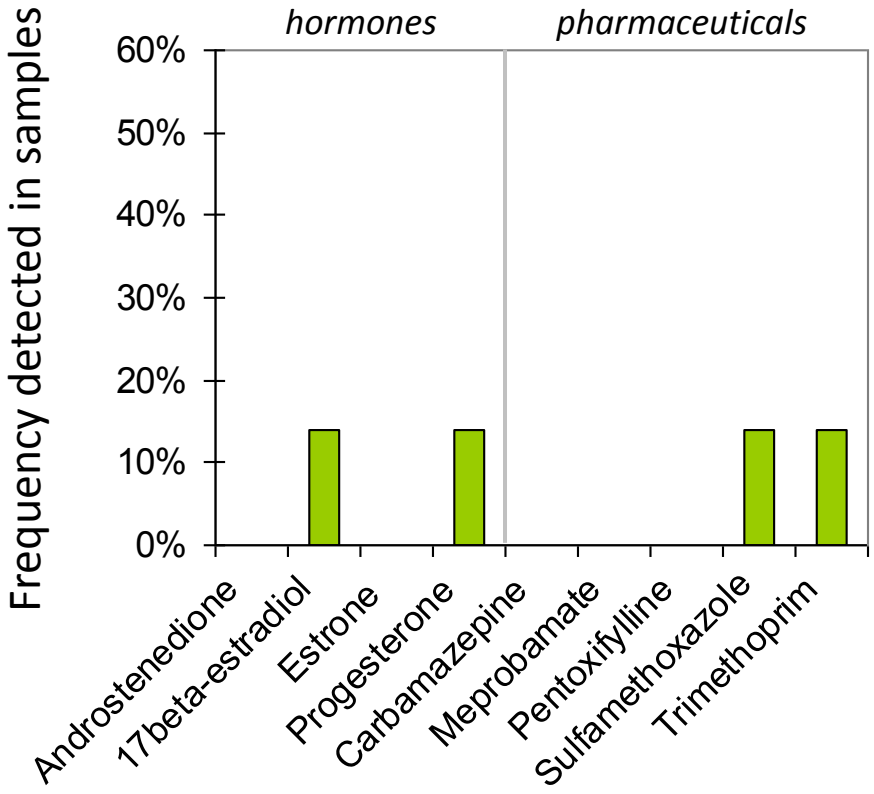
"Even without exceeding health guidelines, who wants landfill leachate, firefighter foams or wastewater in their drinking water?"

Identify vulnerable sources

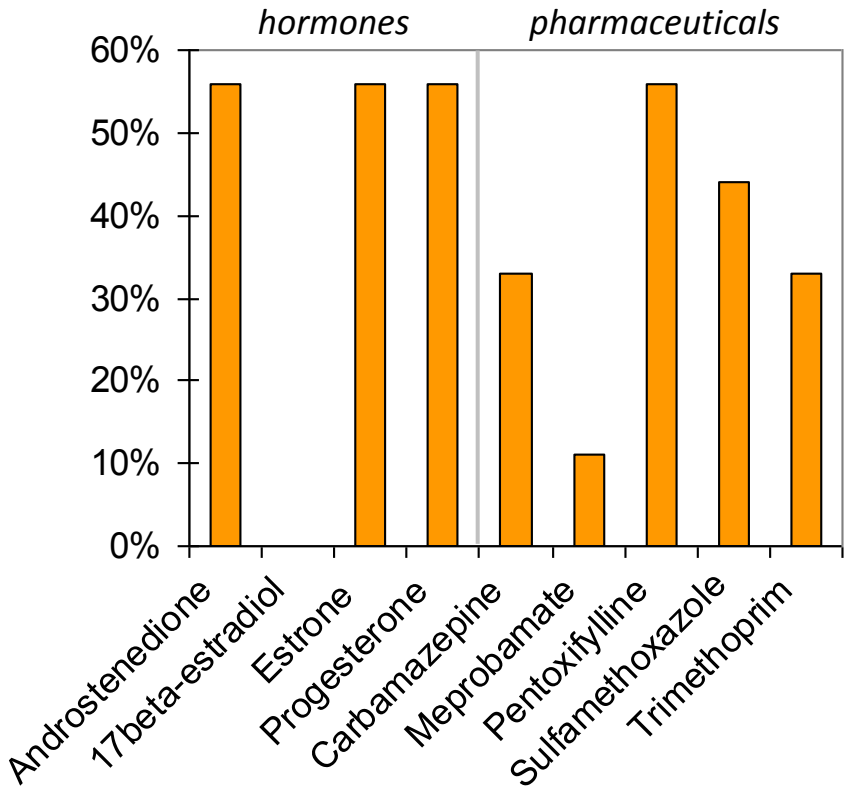
- Many wells with PFASs, pharmaceuticals, or other CECs have other signs of pollution
  - Perchlorate or VOCs
  - Plumes from landfills
  - Dense development or elevated nitrate
- Research studies can provide useful data
  - SSI 2010 public wells study found PFASs in Hyannis wells
- Reduce reliance or prioritize water quality monitoring in most vulnerable wells

Preserving open land protects water quality

3 low residential density ponds
(7 samples)



3 high residential density ponds
(9 samples)



Standley et al., ET&C, 2008

Ibuprofen detected, not shown on graphs

Integrating CECs into nutrient management

- Evaluate nutrient reduction strategies
  - Where does the treatment occur?
  - What types of CECs could be removed?
  - How effective is CEC removal?
- Additional research needed to evaluate removal

http://www.capecodcommission.org/resources/waterresources/BRT_Status_20121115.pdf

What can I do?

- Support local efforts to protect open areas
- Reduce reliance on harmful household chemicals
- Don’t flush hazardous chemicals or dump on ground
- Maintain your septic system
- Learn where your water comes from and consider filtering tap water
- Support consumer and regulatory action to improve safety of chemicals in products

DetoxMe
Smartphone app

Acknowledgements

- Silent Spring Institute research team
- Participating well owners, public water suppliers, volunteers
- Massachusetts Environmental Trust, foundations and private donors, and other funders

MASSACHUSETTS ENVIRONMENTAL TRUST

www.silentspring.org/water

Water Research

Pharmaceuticals, hormones, and consumer product chemicals are showing up in drinking water throughout the U.S. Our wastewater and our drinking water are connected through the same water cycle. How can we safely treat and dispose of our waste without damaging our drinking water quality?

To protect Cape Cod's coastal marine sanctuary, wastewater is disposed on land, primarily in septic systems. These systems allow pollutants to seep through porous soils, often reaching shallow drinking water wells. Silent Spring Institute is undertaking a number of initiatives aimed at understanding the role that polluted water may play in the disproportionately high levels of breast cancer on Cape Cod.

Drinking water for Cape Cod residents comes from a sole-source aquifer. Because the Cape has a shallow water table and sandy,

RELATED CONTENT

Press Release

Drugs and other contaminants found in private drinking wells on Cape Cod

Contaminants pervasive in Cape Cod's drinking water supply, Silent Spring Institute finds

RELATED SCIENTIFIC RESOURCES

Scientific Article or Summary

Septic systems as sources of organic wastewater compounds in domestic drinking water wells in a shallow sand and gravel aquifer.

Historical reconstruction of wastewater and land use impacts to groundwater used for public drinking water: exposure assessment using chemical data and GIS

Identification of alkylphenols and