Emerging Contaminants in Drinking Water

Colin White, Manager
Emerging Contaminants Section
Ohio EPA Division of Drinking and Ground Waters

Ohio Environmental Protection Agency

How much water is in the water?

$H_2O \rightleftharpoons H^+ + OH^-$ $\quad K_w = 10^{-14} = \frac{\propto_{H^+} \propto_{OH^-}}{\propto_{H_2O}}$

$$\propto_{H_2O} = \lambda_{H_2O} X_{H_2O} \approx 1.0$$

Gamma=0.95-1.0

X is the mole fraction (concentration of water in water)

Where: $\propto_{OH^-} = \gamma_{OH^-}[OH^-]$ $\quad \propto_{H^+} = \gamma_{H^+}[H^+]$

Columbus: $X_{H_2O} = \frac{n_{H_2O}}{n_{total}} = \frac{n_{H_2O}}{n_{H_2O} + \sum n_i} = 0.9998$

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Problem

- Unregulated Contaminants
  - Contaminants that are suspected to be in drinking water and do not have health-based standards set under the SDWA
- Emerging Contaminants
- Contaminants of Emerging Concern (CECs)
  - Contaminants we know about but new data (occurrence, health, etc.) suggests we need to reconsider

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Challenges

- Lack of analytical methodologies, occurrence data and understand of health effects
- Lack of regulatory standards
- Undeveloped treatment technologies and best management practices
- New chemicals entering market each year
- 1000s chemicals considered emerging contaminants – priority?

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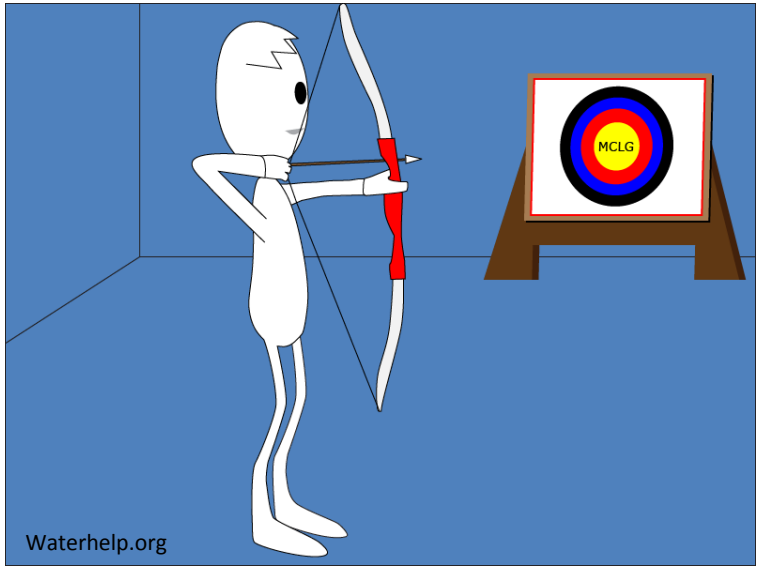
Review the Regulatory Terms

- MCLG (aspirational goal)
  - Determined for individual contaminant
  - No adverse health effects
  - Non-enforceable
- HAL
  - Non-enforceable, non-regulatory
  - Provide technical information
  - Several levels
- MCL
  - Health effects, technology, cost, and residual risk

EPA United States Environmental Protection Agency

2018 Edition of the Drinking Water Standards and Health Advisories Tables

The 2012 Drinking Water Standards and Health Advisories (DWSHA) Tables were amended March 2018 to fix typographical errors and add health advisories published after 2012.



Monitoring and Regulation

- MCLG, **MCL**, HAL
  - NPDWR
- US EPA Regulatory process
- CCL
  - UCMR
    - Monitoring and reporting of detects in CCR
- Regulatory determination

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Current Federal MCL Process

- SDWA guides selection
- CCL (dataset) minimum of 5 for regulatory determination
- Prerequisites to graduate:
  - Health effects
  - Occurrence
  - Sole judgement
- Qualification: Draft RD→Final RD→rulemaking process
- Graduate degree=NPDWR as MCL or TT
- Non-graduate diploma→UCMR or HA (often)

Analysis

Last update I was 13 years old.

Past CCLs 97/12, 104/12, 42/9, 50/10

Past RDs 1/4, 1/11, 0/9

Not just sensitive populations

Perchlorate: 1998→2005, 2011 RD→20xx?

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Current Federal Rulemaking Process

- Regulatory Determination trigger
  - Federal register
  - Public comment
  - Final rule
  - Regulation codified in CFR
- Legislation trigger
  - Congress
  - Presidential approval
  - Codify into USC

Analysis

2008 RD 2 identified perchlorate to study
- 2011 final RD for perchlorate
- Intent to regulate

2016-Strontium on similar path?

AWIA of 2018-Trump
- Amendments to SDWA

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UCMR scope

The 1996 Safe Drinking Water Act (SDWA) amendments require that once every five years EPA issue a new list of no more than 30 unregulated contaminants to be monitored by public water systems (PWSs).

System Size (# of people served)	10 List 1 Cyanotoxins	20 Additional List 1 Chemicals
Small Systems (25 – 10,000)	800 randomly selected surface water (SW) or ground water under the direct influence of surface water (GWUDI) systems	A different group of 800 randomly selected SW, GWUDI and ground water (GW) systems
Large Systems (10,001 and over)	All SW or GWUDI systems	All SW, GWUDI and GW systems

2018-AWIA

- Amends SDWA §1445
- Call upon US EPA to require PWSs serving between 3,300-10,000 to monitor
- Dependent lab capacity
- Authorizes 15 million each FY for monitoring, otherwise reauthorizes 10 million for each FY 2019-2021 UCMR monitoring.

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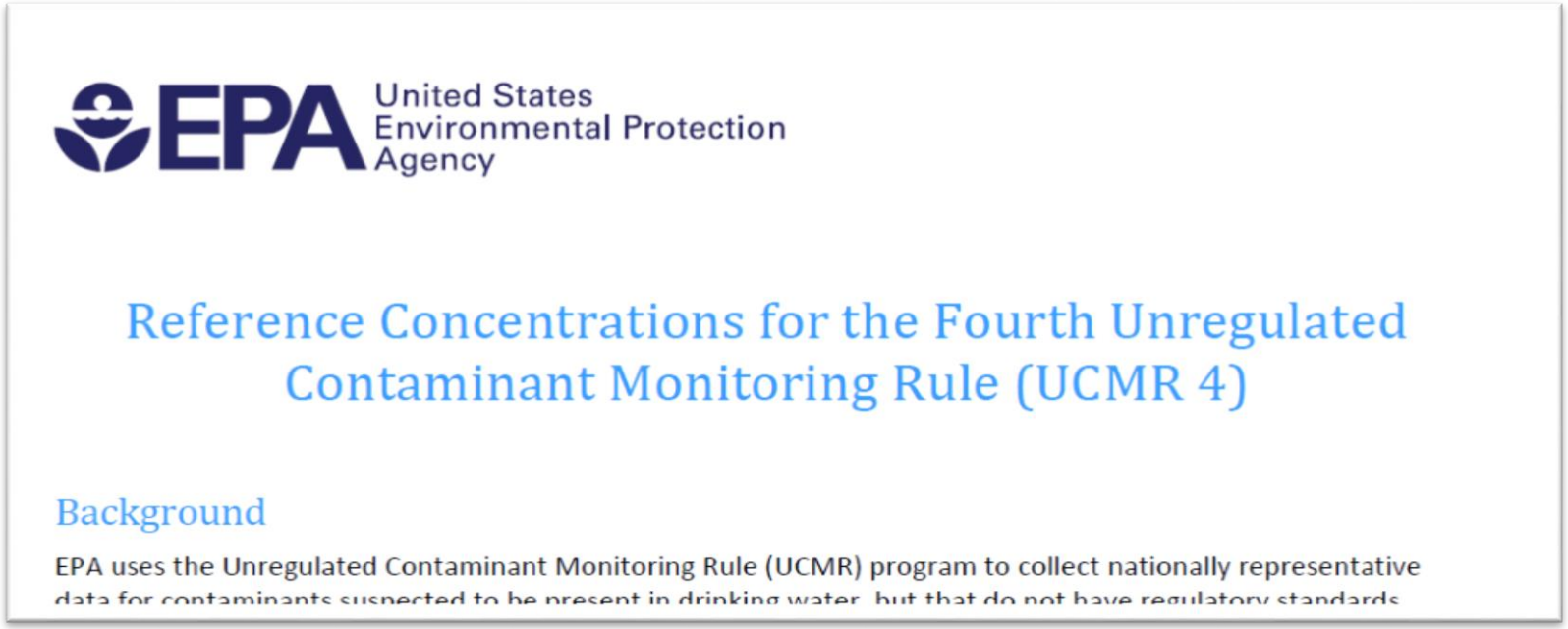
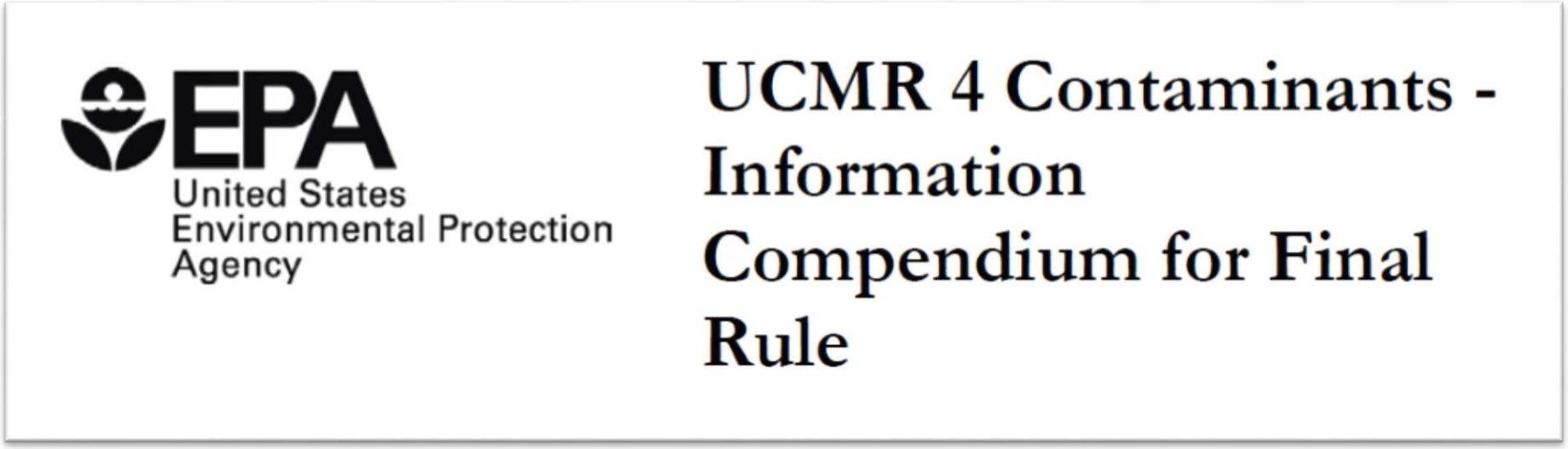
UCMR

- Reference Concentrations are health based
- UCMR4 Compendium
  - EPA 815-B-16-020





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UCMR Results

- UCMR_Sampling_Coordinator@epa.gov
- SDWARS4 instructions page 34-*"How to review Analytical Data submitted by the laboratory for Large PWS Accounts"*
  - *Notified via email in CDX*
  - *3 options: Hold, Approve, Return to Lab*
  - *60 days-auto approve*
  - *Contact lab*
- Small systems see page 7

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Emerging Contaminants

- Knowns and unknowns
  - Per- and Polyfluoroalkyl Substances (PFAS)
  - HABs, *Legionella*
  - [fill in the blank]
- Public interest and expectations have changed
- Drinking water on the front line

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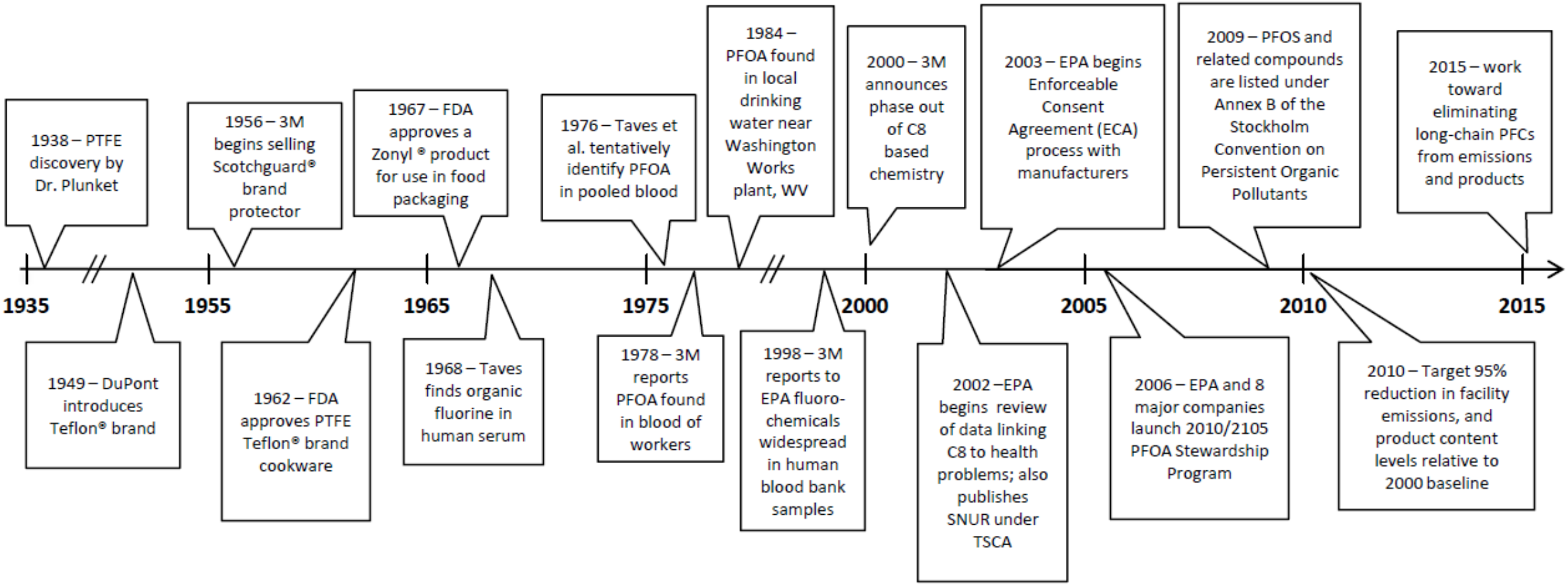
PFAS history



Lindstrom et al 2011

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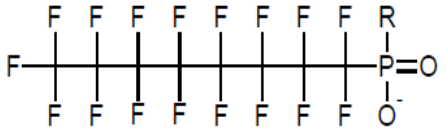
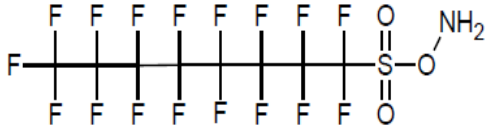
PFAS basics

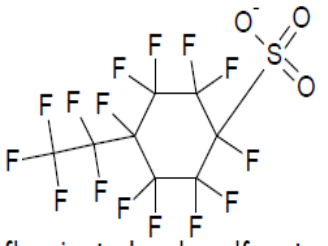
- Found in soil, sediment, air, ocean, rivers, lakes and ground water
  - Found in tissue and blood of humans, birds, fish worldwide
- AFFF
- Resistant
- Bioaccumulative
- Per- vs. Poly-
- UCMR3



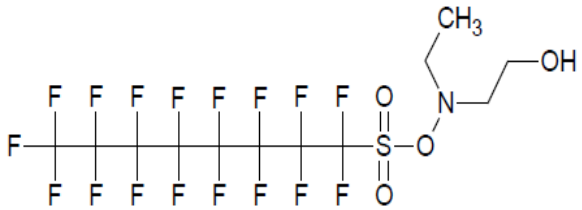
Perfluorophosphonic/phosphinic acids
(e.g., If R=OH then PFOPA
If R=C8 perfluoroalkane then 8:8 PFPi)



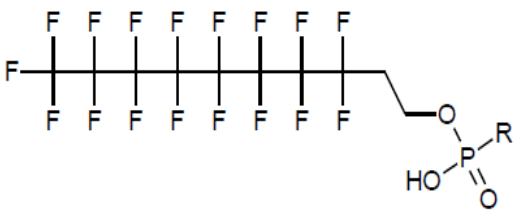
Perfluorosulfonamide
(e.g., FOSA)



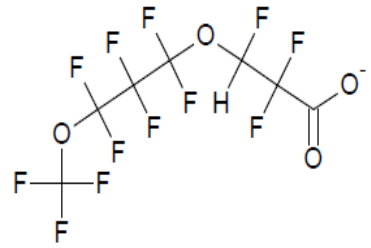
Perfluorinated cyclo sulfonates
(e.g., PFECHS)



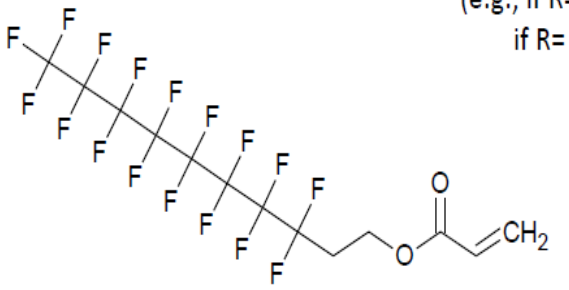
Perfluorosulfonamidoethanol
(e.g., N-EtFOSE)



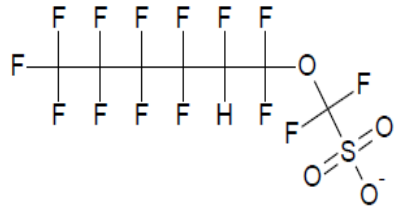
Fluorotelomer phosphate esters
(e.g., if R= OH then 8:2 monoPAP
if R= 8:2 FTO ester then 8:2 diPAP)



Polyfluorinated ether carboxylates
(e.g., 4,8-dioxa-3H-perfluorononanoate)

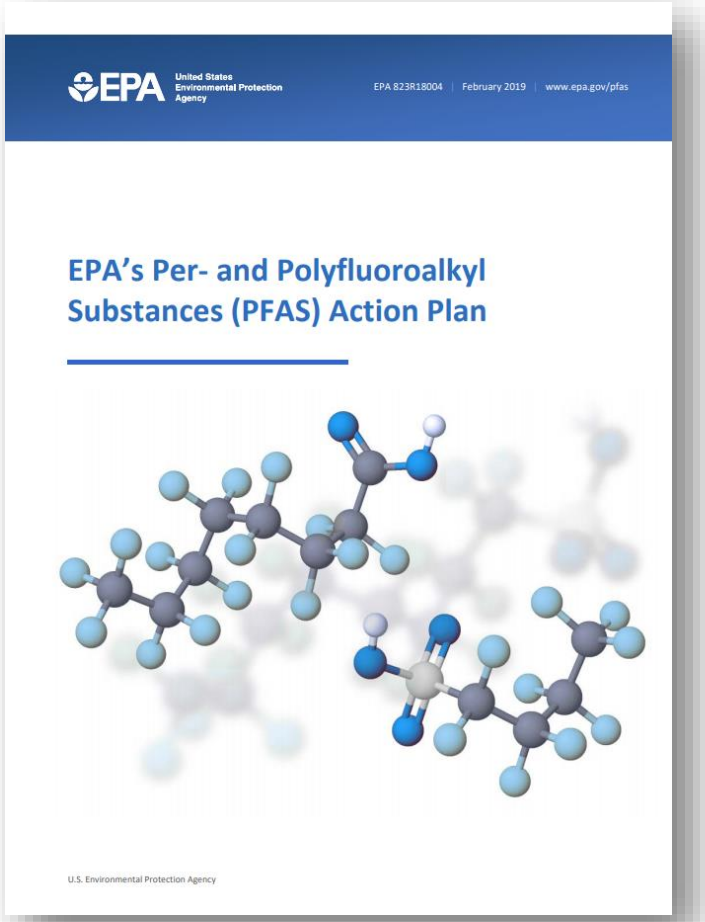


Polyfluorinated polymeric unit
(e.g., 1H,1H,2H,2H-perfluorodecyl acrylate)



Polyfluorinated ether sulfonates
(e.g., Perfluoro [hexyl ethyl ether sulfonate])

New Developments – February 2019



- Released 2/14/19
- Develop drinking water standard
- Designate PFOA/PFOS as hazardous substances
- Develop interim ground water clean-up recommendations
- Toxicity levels determined for GenX and PFBS

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U.S. EPA Action Plan

- **Drinking water:** EPA is moving forward with the MCL process outlined in the Safe Drinking Water Act for PFOA and PFOS—two of the most well-known and prevalent PFAS chemicals
- By the end of this year, EPA will propose a regulatory determination, which is the next step in the Safe Drinking Water Act process for establishing an MCL
- Continue to use enforcement tools and assist states
- Develop risk communication toolbox

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U.S. EPA Action Plan

- **Clean up:** EPA has already begun the regulatory development process for listing PFOA and PFOS as hazardous substances and will issue interim groundwater cleanup recommendations for sites contaminated with PFOA and PFOS. This important work will provide additional tools to help states and communities address existing contamination and enhance the ability to hold responsible parties accountable.

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U.S. EPA Action Plan

- **Enforcement:** EPA will use available enforcement tools to address PFAS exposure in the environment and assist states in enforcement activities.

- **Monitoring:** EPA will propose to include PFAS in nationwide drinking water monitoring under the next Unregulated Contaminant Monitoring Program. The agency will also consider PFAS chemicals for listing in the Toxics Release Inventory to help the agency identify where these chemicals are being released.

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U.S. EPA Action Plan

- **Research:** EPA will develop new analytical methods so that more PFAS chemicals can be detected in drinking water, in soil, and in groundwater. These efforts will improve our ability to monitor and assess potential risks. EPA's research efforts also include developing new technologies and treatment options to remove PFAS from drinking water at contaminated sites.

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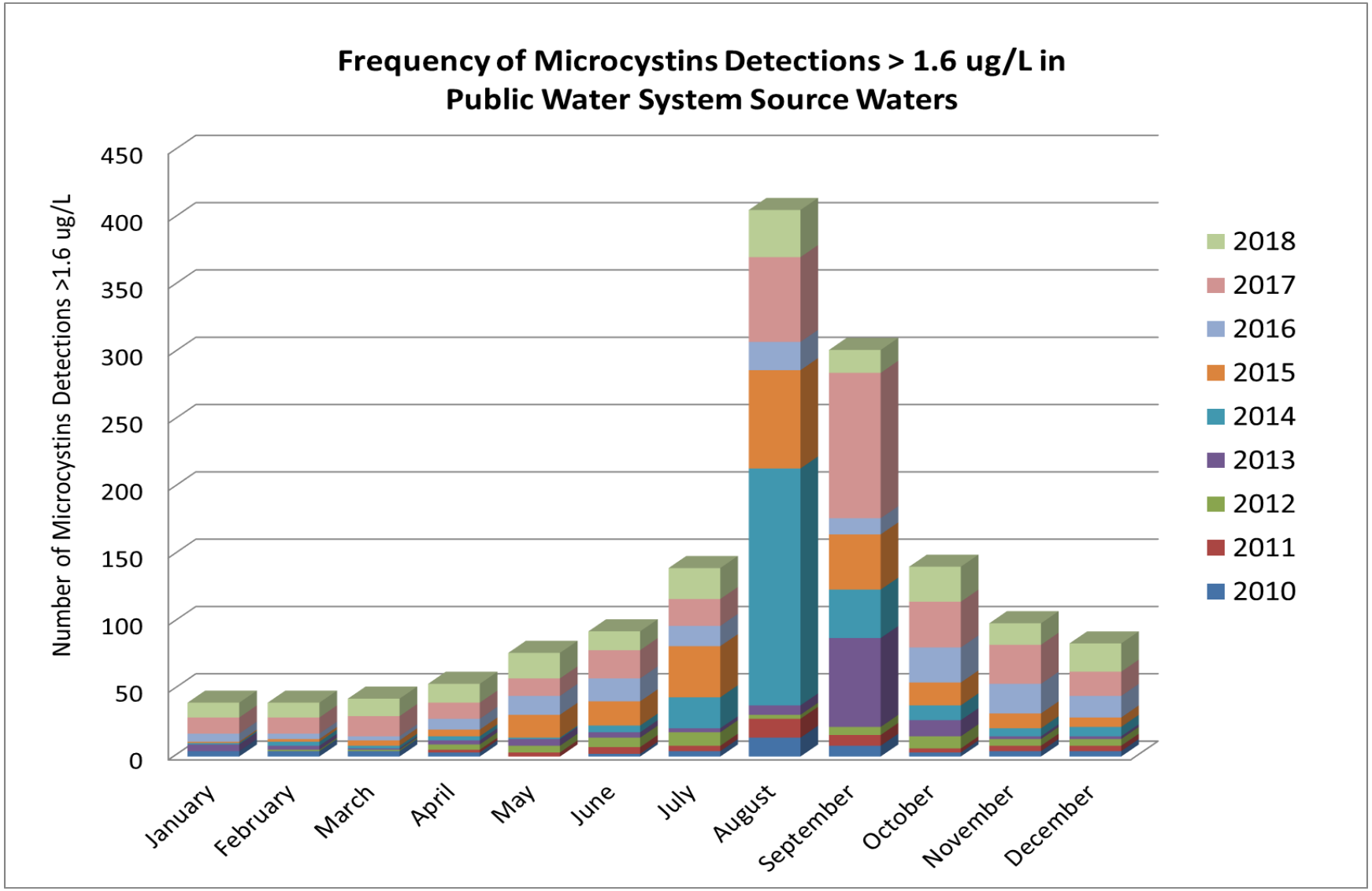
PWS HAB Review



- Source water microcystins detected at 41 Public Water Systems (PWS).
- Four finished water microcystins detections and first finished water cylindrospermopsin detection.

No Advisories.

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Anatoxin-a and UCMR4

- 12 Ohio PWSs had 20 UCMR4 anatoxin-a detections (range 0.05- 4.0 ug/L)
  - All samples with detections analyzed by same UCMR 4 lab
  - All samples well below Ohio EPA drinking water threshold of 20 ug/L

- PWS notified Ohio EPA of 4.0 ug/L anatoxin-a detection before UCMR data was approved and available to Ohio EPA
  - Ohio EPA conducted repeat raw and finished water anatoxin-a sampling and also submitted archived samples collected that same week for analysis.
  - All repeat and archived samples were non-detect for anatoxin-a (used different UCMR4 lab).

- Ohio EPA raised concerns regarding sample analysis with USEPA and conducted joint inquiry with reporting lab.
  - After detailed review, lab invalidated majority of anatoxin-a positive results
  - Only 4 trace anatoxin-a detections at 3 Ohio water systems were not invalidated
  - Lab modified their anatoxin-a sample analysis method

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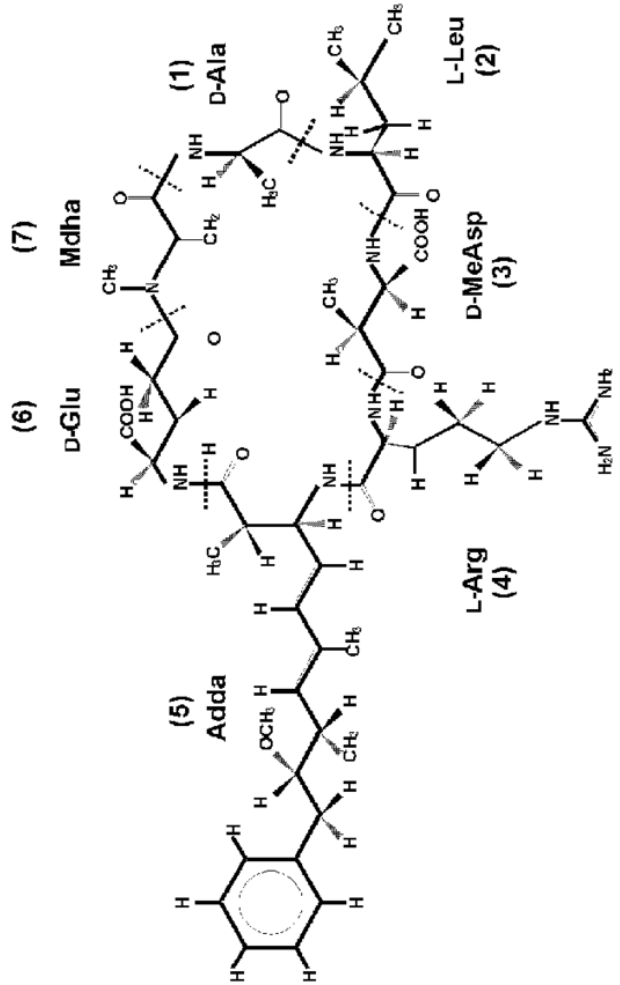
Cyanotoxins and UCMR

- Please notify Ohio EPA immediately of any UCMR cyanotoxin detections
- When possible, pair Ohio EPA compliance cyanotoxin sampling with UCMR4 cyanotoxin sampling
- Ohio EPA response to UCMR cyanotoxin detections will be outlined in 2019 PWS HAB Response Strategy
- Ohio EPA usage of UCMR data for advisories



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Lab Reporting Change

- OAC Rules 3745-89-08 effective October 1, 2018 require new timelines for reporting HAB results:
  - All detections of microcystins, all results of microcystins collected in response to an exceedance of the microcystins action level, and all results of cyanobacteria screening that indicate the potential for production of cylindrospermopsin, saxitoxins or anatoxin-a must be reported to Ohio EPA by the **end of the next business day after the result was obtained**.
  - All other results for microcystins analyses must be reported by the **10th day following analysis**.

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Microcystins MDL Study Requirement

- Annual MDL study must be completed by end of each calendar year, regardless of the previous year's date MDL was established.

Effective immediately, Public Water Systems may choose to perform this study any time between January 1 and December 31.

- Recommended that MDL study be completed and submitted to Division of Environmental Services by May 1 of each year.

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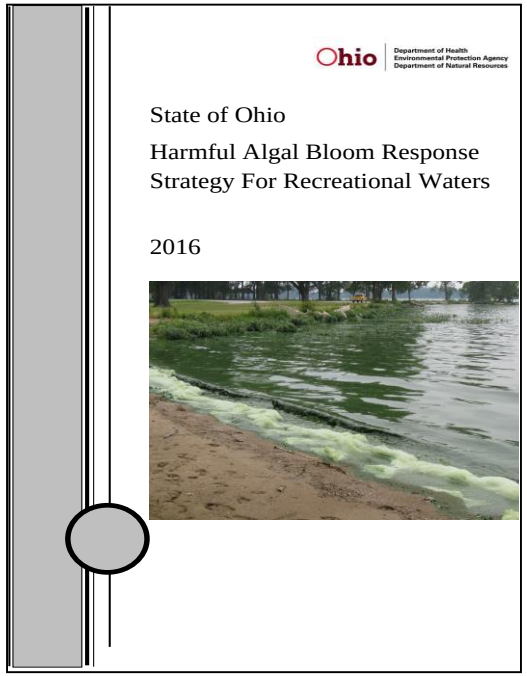
Ohio HAB Response Strategy for Recreational Waters

- Multi-agency effort
  - Ohio EPA, ODNR, ODH
  - Public waters focus
  - Numeric thresholds
  - Advisory language and signage
  - Sampling guidance



- OEPA Recreational Waters: http://epa.ohio.gov/portals/35/hab/HABResponseStrategy.pdf
- Draft USEPA Recreational Guidance: https://www.epa.gov/wqc/microbial-pathogenrecreational-water-quality-criteria
- Revised World Health Organization HAB Guidance (Spring 2019)

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Cyanotoxin Thresholds for Recreational Waters

Threshold (µg/L)	Microcystins*	Anatoxin-a	Cylindrospermopsin	Saxitoxins*
Informational Sign	<6	<80	<5	<0.8
Recreational Public Health Advisory	6	80	5	0.8
Elevated Recreational Public Health Advisory	20	300	20	3

- Cyanotoxin thresholds are based on incidental ingestion only, for example while swimming or bathing (primary contact)
- Animals (livestock and dogs) may be more sensitive to cyanotoxins
- Symptoms associated with dermal contact (skin rash) are not associated with these suite of cyanotoxins

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Signage for Recreational Waters

- **General Informational Sign**
  - Posted at all State Park beaches and boat ramps
  - Consider including at waters with a history of HABs
  - Download at www.ohioalgaeinfo.com

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Signage for Recreational Advisories

Public Health Advisory

Microcystins 6-20 ug/L

Elevated Public Health Advisory

Microcystins >20 ug/L

Download at [www.*ohioalgaeinfo.com*](http://www.ohioalgaeinfo.com)

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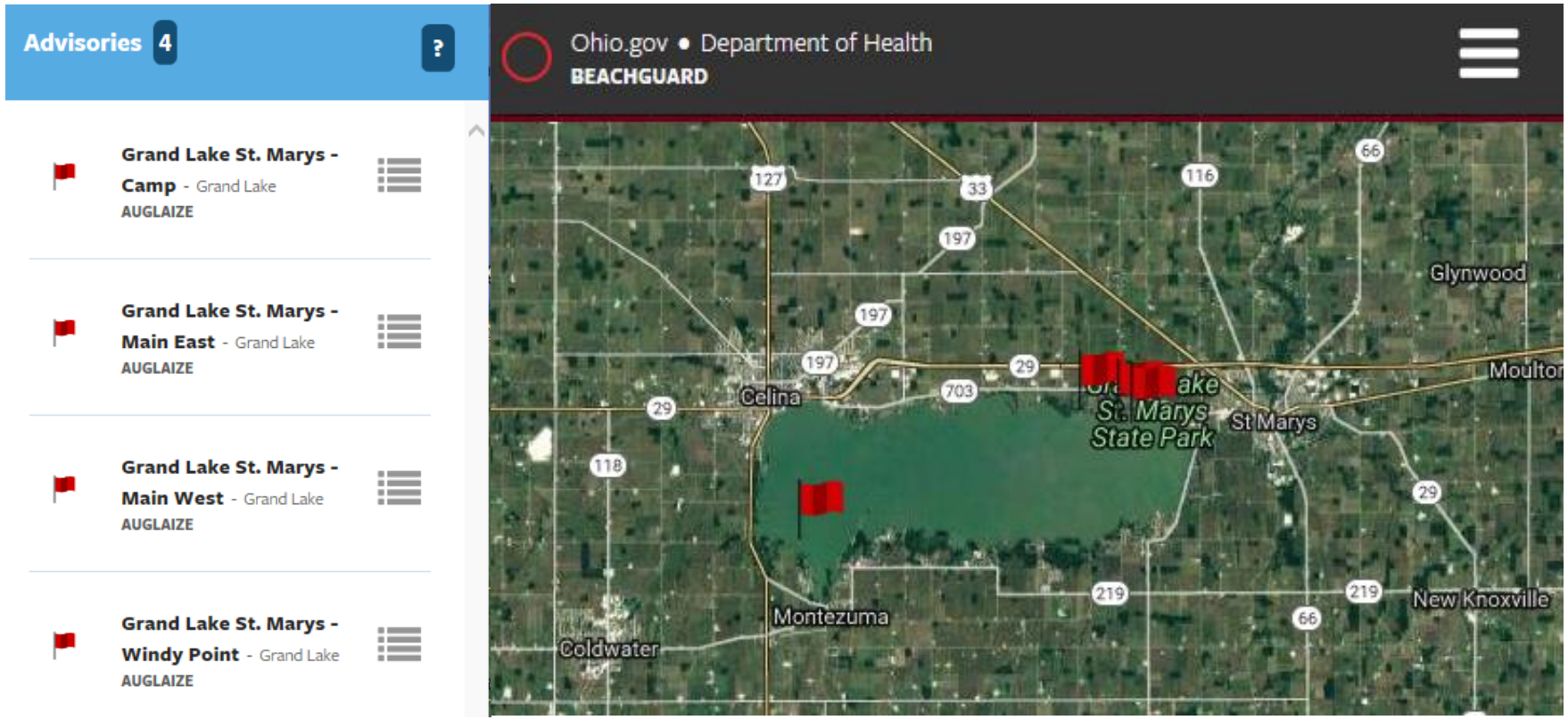
BeachGuard Website for Recreational Advisories



- E. coli and cyanobacteria warnings, advisories, and monitoring data throughout Ohio

http://publicapps.odh.ohio.gov/beachguardpublic/

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Lake Erie HAB Bulletins

Lake Erie Harmful Algal Bloom Bulletin

31 August, 2017, Bulletin 15

Due to the upcoming federal holiday, the next bulletin will be issued on Tuesday, September 5.

The *Microcystis* cyanobacteria bloom continues in the western basin, extending north along the Michigan coast and east along the Ohio coast toward the islands. Observed winds since Monday (8/28-30) caused mixing that reduced surface concentrations previously visible along the Ontario coast. Scum is present along the Michigan coast and Maumee Bay, corresponding with areas of dark red in Figure 1. Measured toxin concentrations exceed the public health recreation threshold in the northwest portion of Maumee Bay, where it is most dense (appearing green from a boat).

Forecast winds (5-21kn) today through Monday (8/31-9/4) may promote mixing, reducing surface concentrations of *Microcystis*. Winds may promote the northwesterly transport of *Microcystis* today through Monday (8/31-9/4) towards the Michigan coast.

Please check Ohio EPA's site on harmful algal blooms for safety information. http://epa.ohio.gov/habalgae.aspx. Keep your pets and yourself out of the water in areas where scum is forming. NOAA's GLERL provides additional HAB data: https://www.glerl.noaa.gov/res/HABs_and_Hypoxia. The persistent cyanobacteria bloom in Sandusky Bay continues. No other blooms are evident in the central and eastern basins. -Keeney, Davis

The images below are "GeoPDF". To see the longitude and latitude under your cursor, select "Tools > Analyze > Geospatial Location Tool".

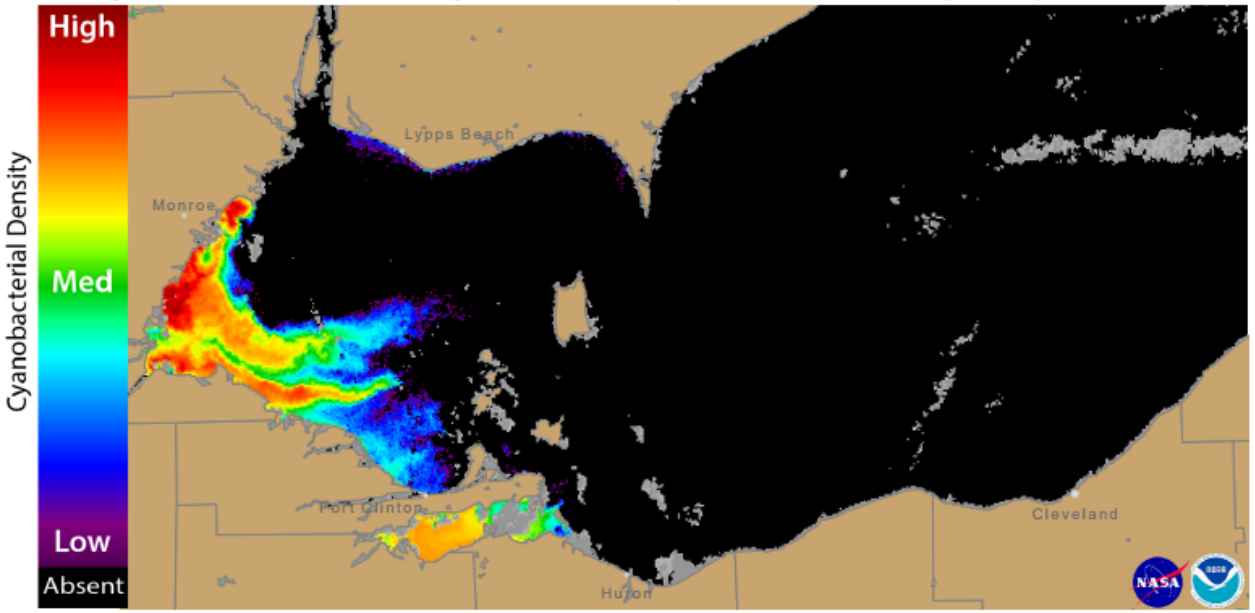

Figure 1. Cyanobacterial Index from modified Copernicus Sentinel 3 data collected 30 August, 2017 at 11:55 EST. Grey indicates clouds or missing data. The estimated threshold for cyanobacteria detection is 20,000 cells/mL.

- Experimental NOAA data product beginning 2009
  - MERIS
- Operational NOAA product since 2017
  - MODIS – Terra, Aqua
  - OLCI – Sentinel 3 (CI product)
- Confirmed cyanobacteria and microcystins with lake sampling
- Captures spatial and temporal scale of Lake Erie HABs
- Inform impairment determination in 2018 Integrated Report

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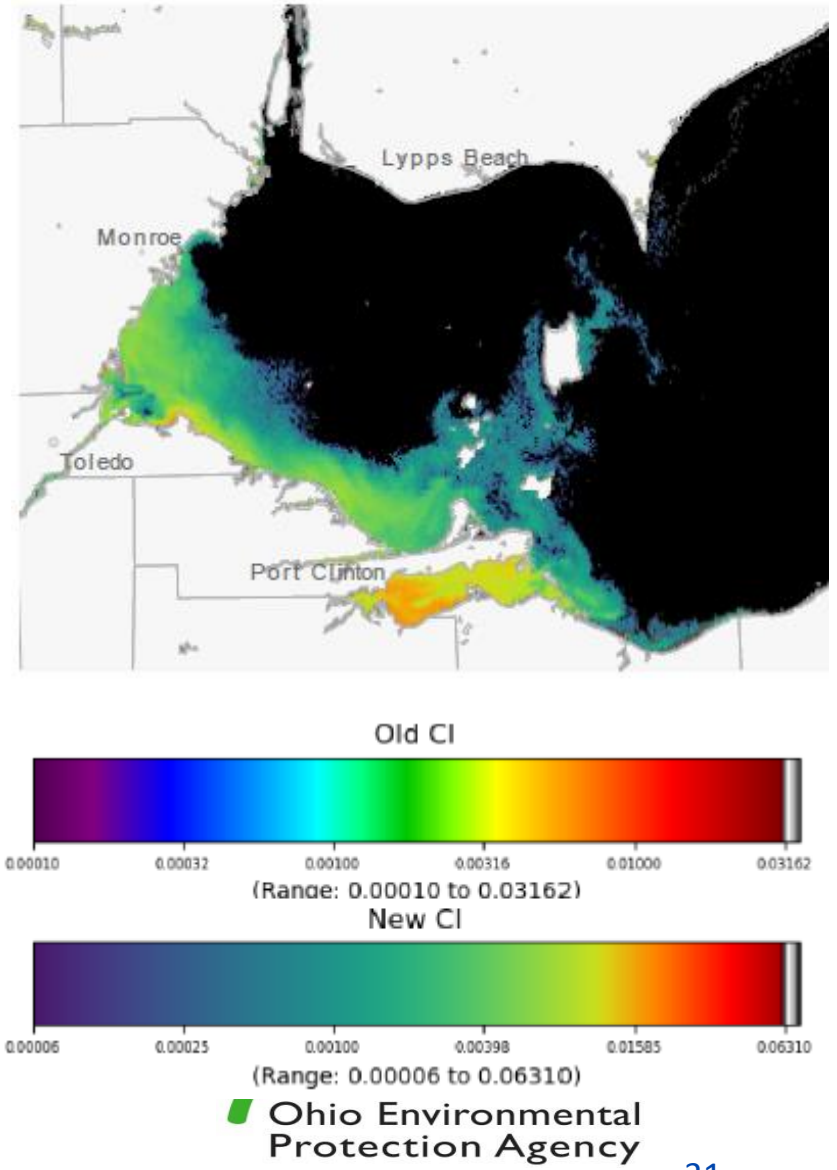
https://tidesandcurrents.noaa.gov/hab/lakeerie.html

Satellite Imagery – Inland Lakes

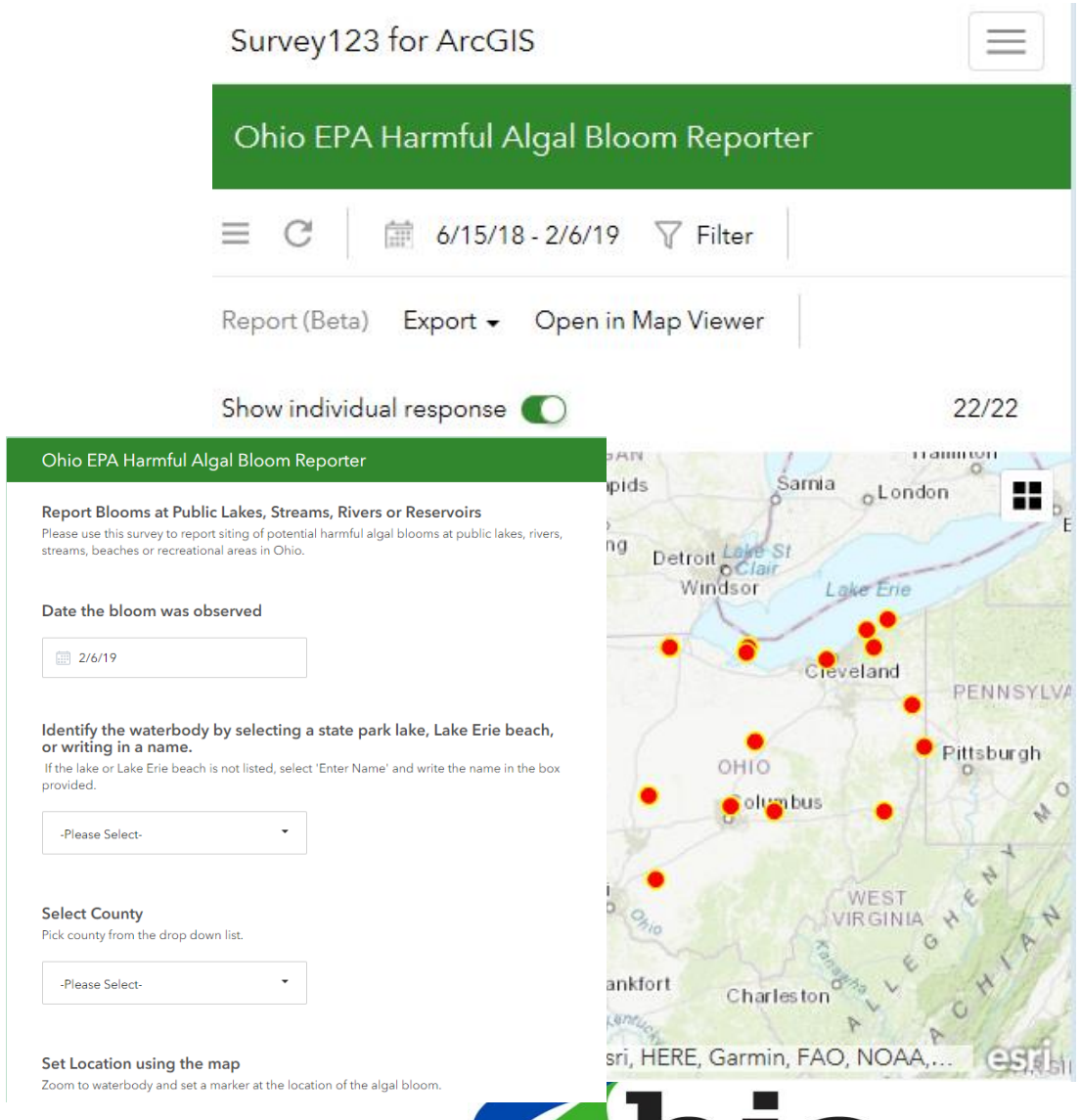
- 2018 Summary
  - Near weekly reports (email)
  - Streamlined summary
  - Include zip file of individual maps for report
  - Received citizen requests for updated maps

- 2019 Updates
  - New color ramp expected in NOAA products (consistent with Lake Erie HAB bulletins)
  - CyAN Android app planned release prior summer season and data password protected through fiscal year
    - CyAN data product is composite over 7 days with max detection



HAB Bloom Reports

- Launched webform (managed by OEPA-GIS)
- Bloom reports are routed through HABmailbox@epa.ohio.gov
- Issues?
  - Duplicate reports
- Possible updates for 2019
  - Special report form for state agencies
  - Remove paper form from website



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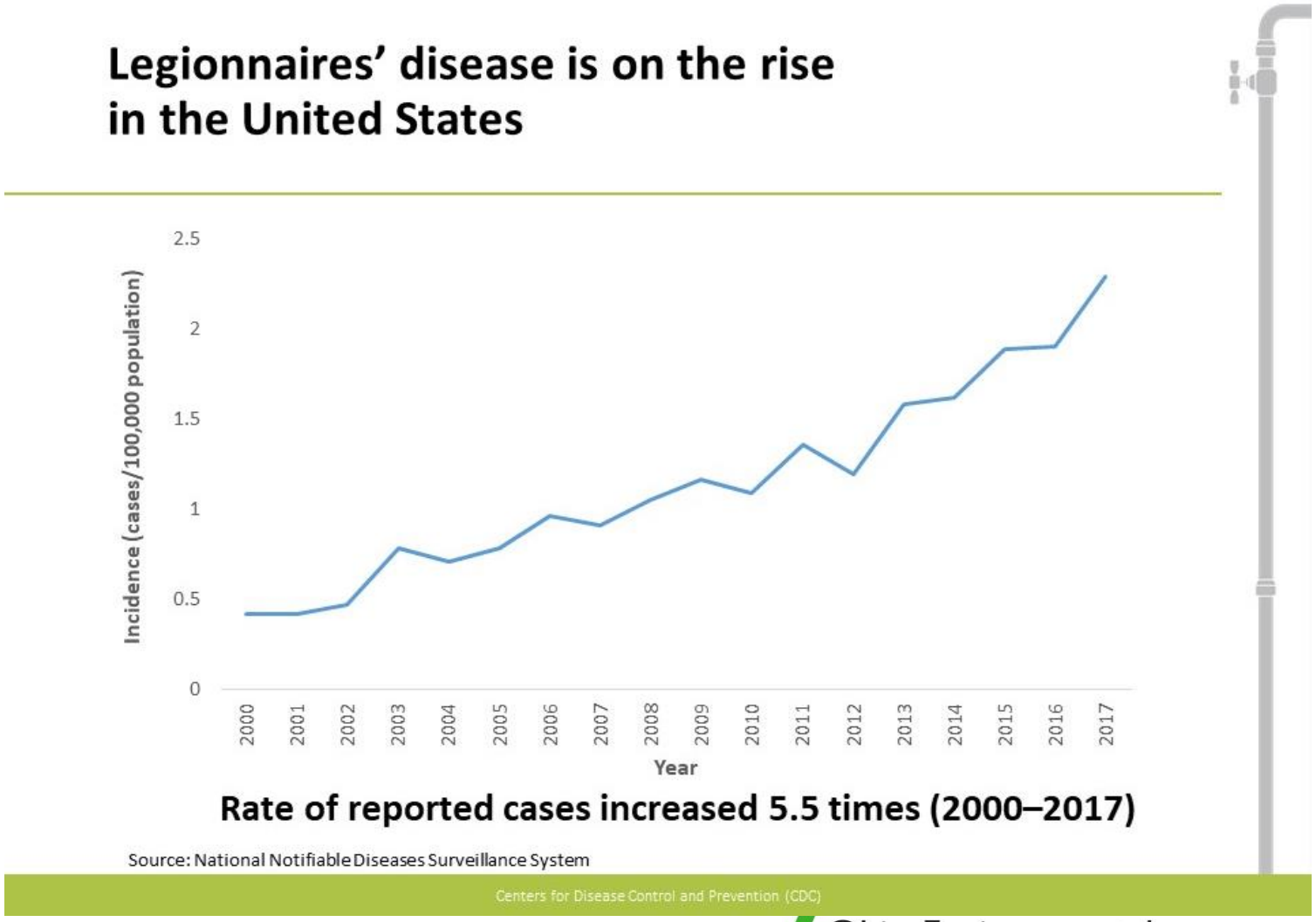
Legionella

- Bacteria (amoeba)
- Exposure
  - Premise plumbing
  - Cooling towers
- Treatment Technique
  - SDWA→SWTR
- Disinfectant residuals
- Illinois VA

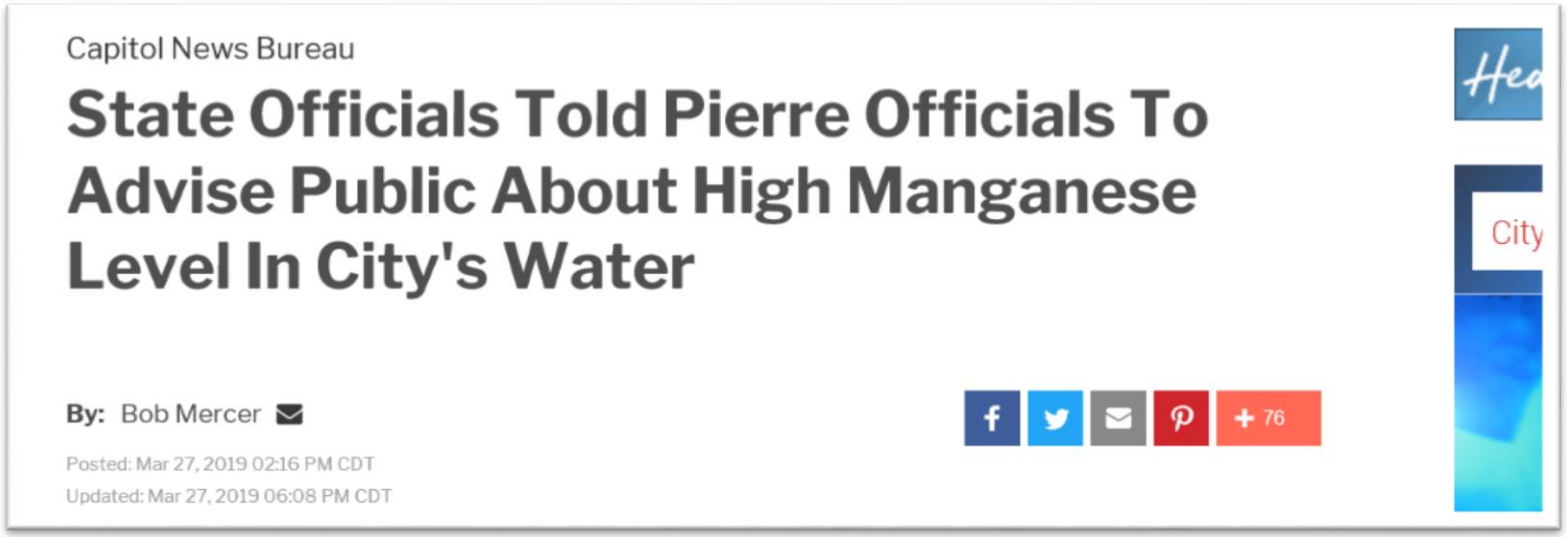


Manganese

- UCMR4
- Aesthetic
- Complexation
- US EPA HAL
  - Acute and chronic
- Sequestration

Central Iowa town's residents warned not to drink water after high levels of manganese discovered

Anna Spoerre and Tyler J Davis, Des Moines Register Published 2:43 p.m. CT March 6, 2019 | Updated 5:00 p.m. CT March 7, 2019



Capitol News Bureau

State Officials Told Pierre Officials To Advise Public About High Manganese Level In City's Water

By: Bob Mercer

Posted: Mar 27, 2019 02:16 PM CDT

Updated: Mar 27, 2019 06:08 PM CDT

+ 76

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Risk Assessment and Communication

- Risk assessment-determination
  - Toxicology studies
  - *in silico*
  - Statistics
    - Goal=Conservative
- One part per trillion
  - AKA 1 nanogram per liter
    - 1 ng is 0.000000001 mg (1 mg is half a mosquito)
    - 1 second in 32,000 years

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How low can you go?

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Response in Ohio

- Initial efforts focused on protecting drinking water
- Formed Emerging Contaminants Section
- Evaluating existing authorities
- Coordinating with U.S. EPA and stakeholder groups on national policy
- Communicating with researchers for method development, treatment technologies and best management practices
- Ohio EPA's laboratory can now provide PFAS analysis

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THANK YOU

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