CORONA ENVIRONMENTAL CONSULTING

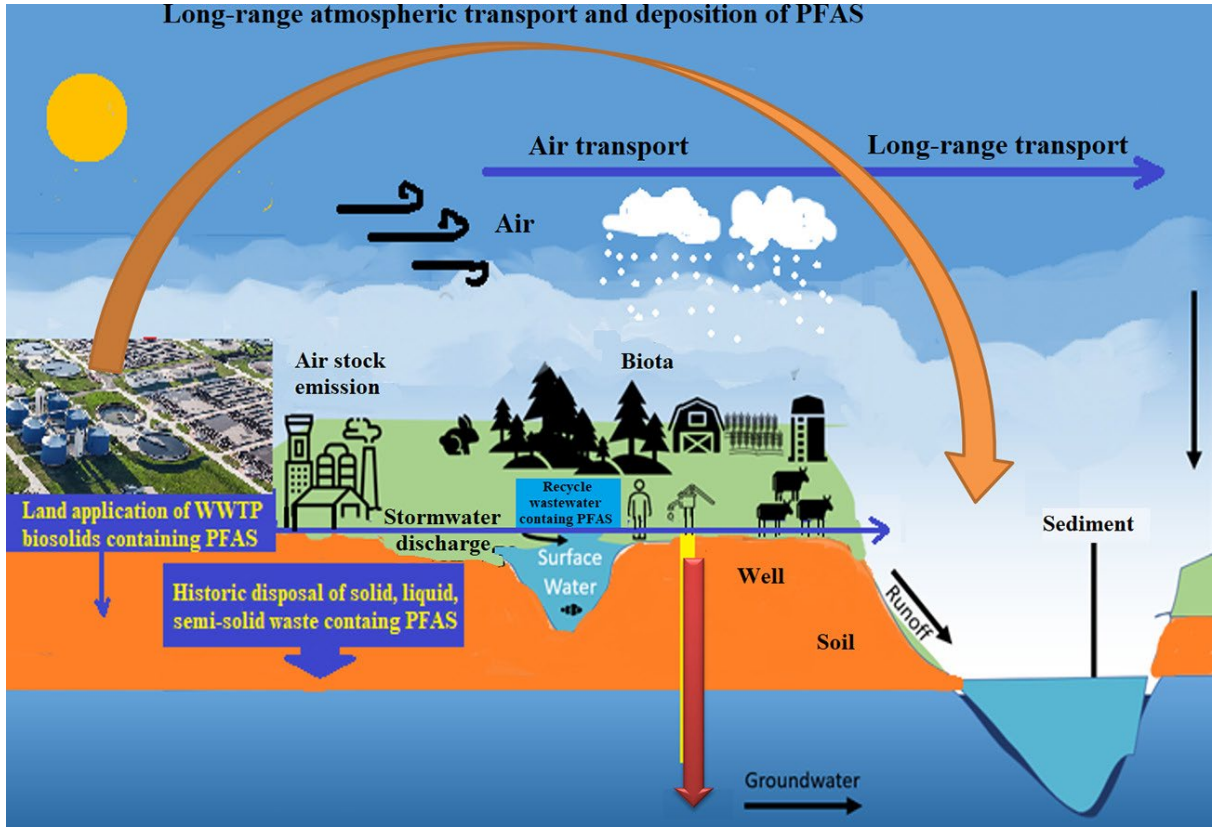
Poly- and perfluoroalkyl substances (PFAS): Latest Developments, Monitoring, and Treatment Strategies

Jake Causey, PE

ILRWA Norther Conference 2022

Outline

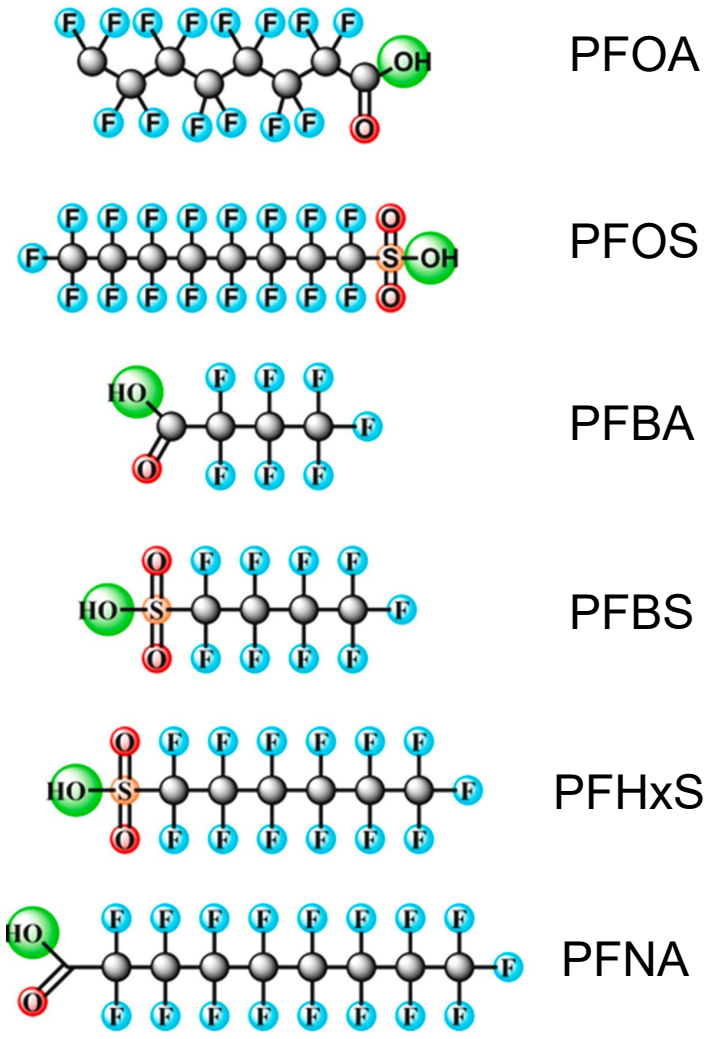
- PFAS – What, Where, and Why
- PFAS Timeline Highlights
- Illinois EPA PFAS Activities
- USEPA PFAS Update
- Analytical Methods
- UCMR 5
- Treatment Technologies



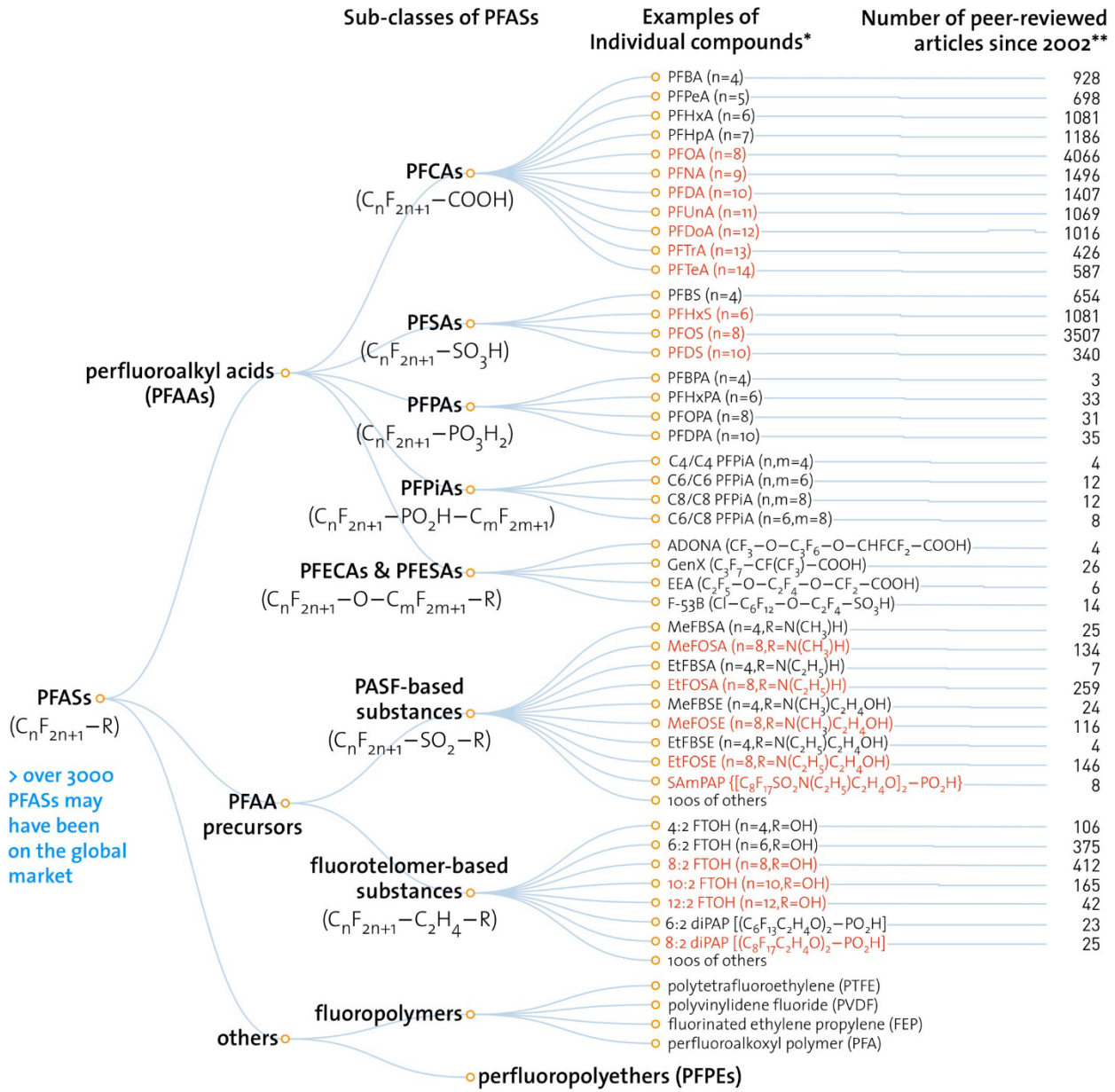
Sudarshan Kurwadkar, Jason Dane, Sushil R. Kanel, Mallikarjuna N. Nadagouda, Ryan W. Cawdrey, Balram Ambade, Garrett C. Struckhoff, Richard Wilkin, Per- and polyfluoroalkyl substances in water and wastewater: A critical review of their global occurrence and distribution, Science of The Total Environment, Volume 809, 2022,151003, ISSN 00489697,https://doi.org/10.1016/j.scitotenv.2021.151003.

What are PFAS?

- *Per-* and polyfluoroalkyl substances (PFAS) are a family of fluorinated organic compounds of anthropogenic origin.
- *PFAS* represent a diverse group of ≥ 4000 compounds (Sunderland et al., 2019).
- The highest number of PFAS and their precursors are used in the textile industry, followed by paper packaging and aftermarket consumer products (Glüge et al., 2020).
- PFOA and PFOS have been the most extensively produced and studied of these chemicals and are very persistent in the environment and in the human body – meaning they don't break down and they can accumulate over time.



Bentuo Xu, Shuai Liu, John L. Zhou, Chunmiao Zheng, Jin Weifeng, Bei Chen, Ting Zhang, Wenhui Qiu, PFAS and their substitutes in groundwater: Occurrence, transformation and remediation, Journal of Hazardous Materials, Volume 412, 2021,125159, ISSN 0304-3894, https://doi.org/10.1016/j.jhazmat.2021.125159.



* PFASs in **RED** are those that have been restricted under national/regional/global regulatory or voluntary frameworks, with or without specific exemptions (for details, see OECD (2015), Risk reduction approaches for PFASs. http://oe.cd/1AN).

** The numbers of articles (related to all aspects of research) were retrieved from SciFinder® on Nov. 1, 2016.

"Family tree" of PFASs, including examples of individual PFASs and the number of peer-reviewed articles on them since 2002.

Published in: Zhanyun Wang; Jamie C. DeWitt; Christopher P. Higgins; Ian T. Cousins; Environ. Sci. Technol. 2017, 51, 2508-2518.
DOI: 10.1021/acs.est.6b04806

Where are PFAS found?

Gail L. Carlson, Skylar Tupper, Ski wax use contributes to environmental contamination by per- and polyfluoroalkyl substances, Chemosphere, Volume 261, 2020,128078, ISSN 0045-6535, https://doi.org/10.1016/j.chemosphere.2020.128078.

Why are PFAS important?

- Increased cholesterol levels
- Small decreases in infant birth weights
- Changes in liver enzymes
- Decreased vaccine response in children
- Increased risk of kidney or testicular cancer
- Increased risk of high blood pressure or pre-eclampsia in pregnant women

CDC

ATSDR
AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY

PFAS Timeline Highlights

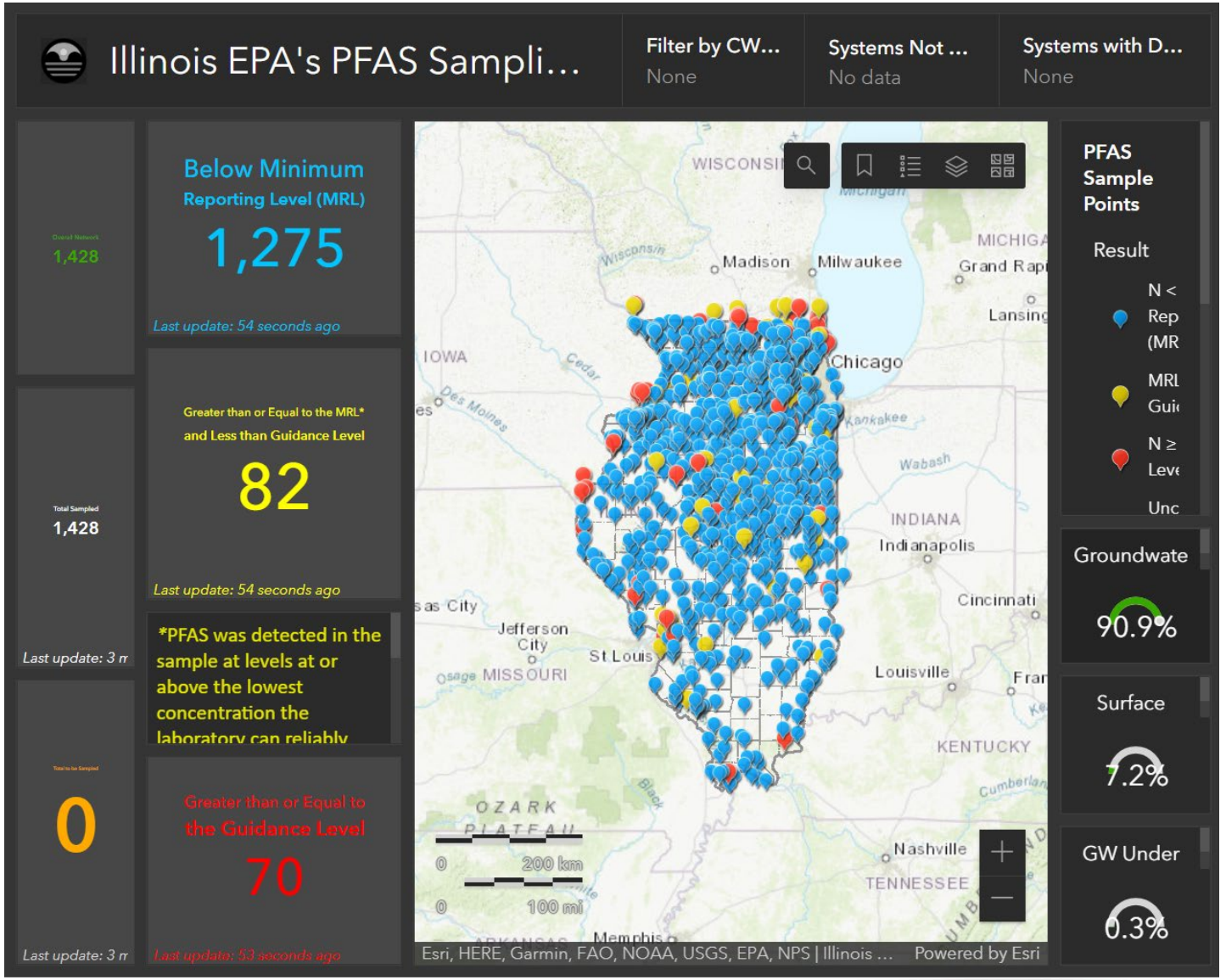
- 1950's – PFOS & PFOA, Teflon, Scotchgard, AFFF
- 1980's – Human exposure concerns begin
- 1990's – Parkersburg, WV Lawsuit (DuPont - PFOA)
- 2000's – PFOS & PFOA phase-out initiated; provisional drinking water advisory PFOS 200 ppt & PFOA 400 ppt; EPA Method 537 released
- 2010's – UCMR 3 Included six PFAS targets; Cape Fear river; revised advisory PFOS+PFOA 70 ppt; EPA Method 537.1 released
- 2020's – EPA Method 533 Support for UCMR 5, regulatory determination for PFOS & PFOA, revised (interim) health advisory PFOS 20 ppq, PFOA 4 ppq

IEPA PFAS Health-Based Guidance Level

PFAS Analyte	Acronym	Health-Based Guidance Level (ng/L)	Minimum Reporting Level (ng/L)
Perfluorobutanesulfonic acid	PFBS	2,100	2
Perfluorohexanesulfonic acid	PFHxS	140	2
Perfluorononanoic acid	PFNA	21	2
Perfluorooctanesulfonic acid	PFOS	14	2
Perfluorooctanoic acid	PFOA	2	2
Perfluorohexanoic acid	PFHxA	560,000	2
Hexafluoropropylene oxide dimer acid	GenX	21	2

IEPA PFAS Monitoring

- Development and promulgation of maximum contaminant level (MCL) standards in Illinois for certain PFAS
- Samples will be analyzed using U.S. EPA Method 537.1
- If PFAS are detected, the Illinois EPA will return to collect a confirmation sample at the distribution system entry point(s)
- Based on the results of the confirmation sampling, additional evaluation or actions may be necessary to protect human health and the environment



EPA SENDS PFAS DRINKING WATER REGULATION TO OMB FOR REVIEW

October 7, 2022 Stephanie Schlea Off Drinking Water Headlines

Yesterday (October 6), the U.S. Environmental Protection Agency (EPA) sent the proposed rule to regulate PFOA and PFOS in drinking water to the Office of Management and Budget (OMB) for review. In February of this year, after a re-evaluation in accordance with Biden-Harris administration executive orders, EPA announced that the Agency would move forward with actions on the final Regulatory Determinations for PFOA and PFOS, solidifying the Agency's decision to regulate the two PFAS under a National Primary Drinking Water Regulation. It is unclear how long OMB will review the proposal, but EPA has stated on multiple occasions that the Agency intends to publish the proposal by the end of the year.

Latest News on USEPA PFAS Regulatory Development

Relevant Drinking Water Analytical Methods

Method	Description	MRL	Cost/Sample
EPA 537.1	18 PFAS Compounds	2 ppt	~$250
EPA 533	25 PFAS Compounds	2 ppt	~$350
Eurofins L402	45 PFAS Compounds; In-house method	2 ppt	~$450
Eurofins 75PFAS	75 PFAS Compounds; In-house method	2 ppt	~$1050

UCMR 5 (Jan '23 – Dec '25)

- 10,311 public water systems participating nationally

EPA Method 533 (PFAS monitored under UCMR 3 are in **bold**)			
1H, 1H, 2H, 2H-perfluorodecane sulfonic acid (8:2 FTS)	9-chlorohexadecafluoro-3-oxanone-1-sulfonic acid (9Cl-PF3ONS)	4,8-dioxa-3H-perfluorononanoic acid (ADONA)	Perfluorohexanoic acid (PFHxA)
1H, 1H, 2H, 2H-perfluorohexane sulfonic acid (4:2 FTS)	Perfluorobutanoic acid (PFBA)	Hexafluoropropylene oxide dimer acid (HFPO-DA) (GenX)	**Perfluorohexanesulfonic acid (PFHxS)**
1H, 1H, 2H, 2H-perfluorooctane sulfonic acid (6:2 FTS)	Perfluoroheptanesulfonic acid (PFHpS)	**Perfluorobutanesulfonic acid (PFBS)**	**Perfluorononanoic acid (PFNA)**
Nonafluoro-3,6-dioxaheptanoic acid (NFDHA)	Perfluoropentanesulfonic acid (PFPeS)	Perfluorodecanoic acid (PFDA)	**Perfluorooctanesulfonic acid (PFOS)**
Perfluoro (2-ethoxyethane) sulfonic acid (PFEESA)	Perfluoropentanoic acid (PFPeA)	Perfluorododecanoic acid (PFDoA)	**Perfluorooctanoic acid (PFOA)**
Perfluoro-3-methoxypropanoic acid (PFMPA)	11-chloroeicosafluoro-3-oxaundecane-1-sulfonic acid (11Cl-PF3OUdS)	**Perfluoroheptanoic acid (PFHpA)**	Perfluoroundecanoic acid (PFUnA)
Perfluoro-4-methoxybutanoic acid (PFMBA)			
PFAS Analytes Unique to EPA Method 537.1			
N-ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA)	N-methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA)	Perfluorotetradecanoic acid (PFTA)	Perfluorotridecanoic acid (PFTrDA)
EPA Method 200.7 or Alternate SM 3120 B or ASTM D1976-20			
Lithium			

PFAS Treatment Technologies

- Granular Activated Carbon
- Ion Exchange
- Reverse Osmosis

GAC vs IX

GAC

- Effective removal of PFAS
- Lower media cost
- Lower headloss (energy cost)
- Treat co-occurring contaminants
- Lower sensitivity to TSS, Fe, & Mn fouling
- Less impact from competing ions such as sulfate

IX

- Effective removal of PFAS
- Lower capital cost
- Smaller footprint
- Does not have nitrate sloughing issues
- Less impact from competing organics such as TOC

Example Equipment Comparison

Parameter	Units	IX	GAC
Treatment train			
Number	#	1	2
Contactor	# in series/train	2	2
Media			
Product		PFAS-specific SBA-IX-NR	12x40 mesh, bituminous coal
Bed diameter	ft	10	10
Bed depth	ft	~5	~8
Flow rate	gpm	600	600
EBCT			
Contactor	min	~2.0	~10.0
Total	min	~4.0	~20.0
HLR	gpm/ft^2	~7.6	~3.8
Budgetary Cost for Equipment:		$630,000	$880,000

CORONA ENVIRONMENTAL CONSULTING

GAC & IX Equipment Example

Media Replacement Cost

- IX media can cost ~4-5x higher than GAC media cost
- Evaluate the bed-life. How long will it last before I have to replace it
- Modeling, Bench (RSSCTs), & Pilot-scale testing is used to inform the bed-life
- Pilot-testing will provide the most accurate information for comparison

Media	Estimated Breakthrough Time for PFOA in Bed Volumes	
	RL	60% of Influent Concentration
Granular Activated Carbon		
F400	54,000*	51,000*
AV1240LDX	41,400	40,800
AV1240CB	40,500	32,700
AV1240PFAS	33,900	31,800
Ion-Exchange Resin		
PSR2 Plus	675,000*	610,000*
SIR-110-HP	520,000*	490,000*
PFCR-2	500,000*	460,000*
PFA694E	380,500	350,800

What Should I be Doing?

- Planning & Preparing for
  - Risk Communications with customers
  - Monitoring for PFAS if not performed yet including UCMR 5
  - Release of draft MCLs for PFOA and PFOS by the end of the year
- After Draft MCLs are Released by USEPA
  - Evaluate alternatives to meet the new MCLs including treatment evaluations for impacted sources
  - Consider future PFAS regulations to come with UCMR 5 results

Questions

Jonathan “Jake” Causey, PE
Senior Water Quality & Treatment Engineer

(P) 781-753-6666 ext 117
(M) 225-603-4169
jcausey@coronaenv.com