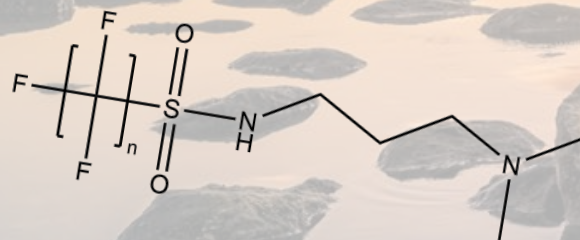
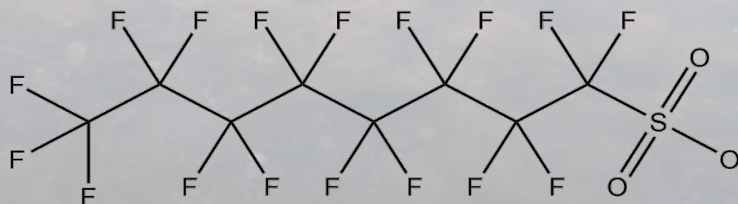
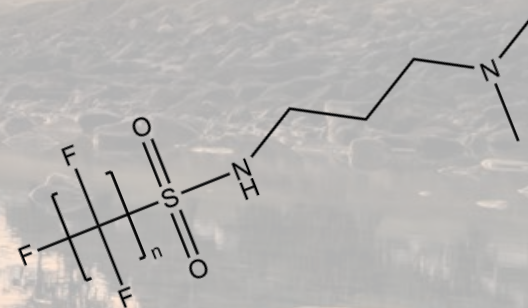


Concentrations of Per- and Polyfluoroalkyl Substances (PFAS) in Selected Brooks and Rivers in Massachusetts, 2020



A Collaborative Project by the
Department of Environmental Protection
&

U.S. Geological Survey - New England Water Science Center



What are PFAS compounds?

- Man-made (synthetic), mostly carbon and fluoride long-chained compounds
- Produced since the 1940's
- Consumer products
 - Food packaging
 - Nonstick, water repelling, stain resistant
 - Ski wax
- Fire-fighting foams
- Very persistent in the environment
- Adverse human and animal effects

Tokranov and others, 2021

Per- and Polyfluoroalkyl Substances (PFAS) in New Hampshire Soils and Biosolids

What Are PFAS?

Per- and polyfluoroalkyl substances (PFAS) are a diverse class of thousands of synthetic compounds that are used for a variety of industrial purposes and that can be found in consumer products such as food packaging, nonstick cooking surfaces, water- and stain-resistant fabrics, cosmetics, and water-repellent clothing (fig. 1; U.S. Environmental Protection Agency, 2018; Agency for Toxic Substances and Disease Registry, 2020). Many PFAS are frequently detected in the environment, including in soil, water, and air (fig. 2). Although some PFAS have been produced and used in products since the 1940s, they have only recently come under intense scrutiny for their potential link to adverse human health effects, including decreased response to vaccines, thyroid disease, and decreased birth weight (U.S. Environmental Protection Agency, 2018; Agency for Toxic Substances and Disease Registry, 2020).

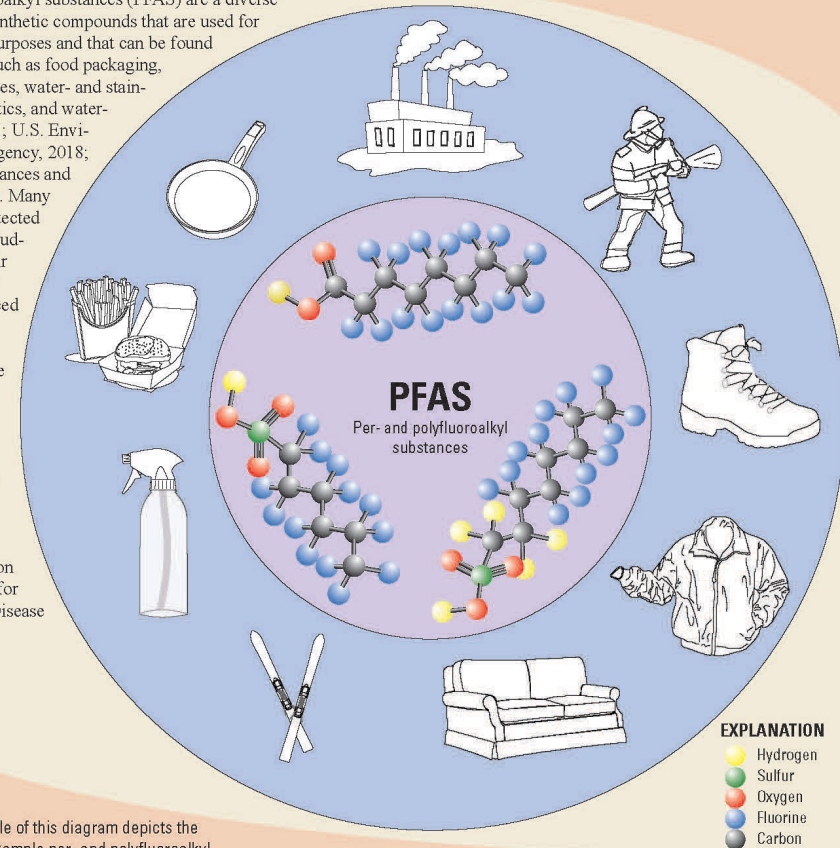


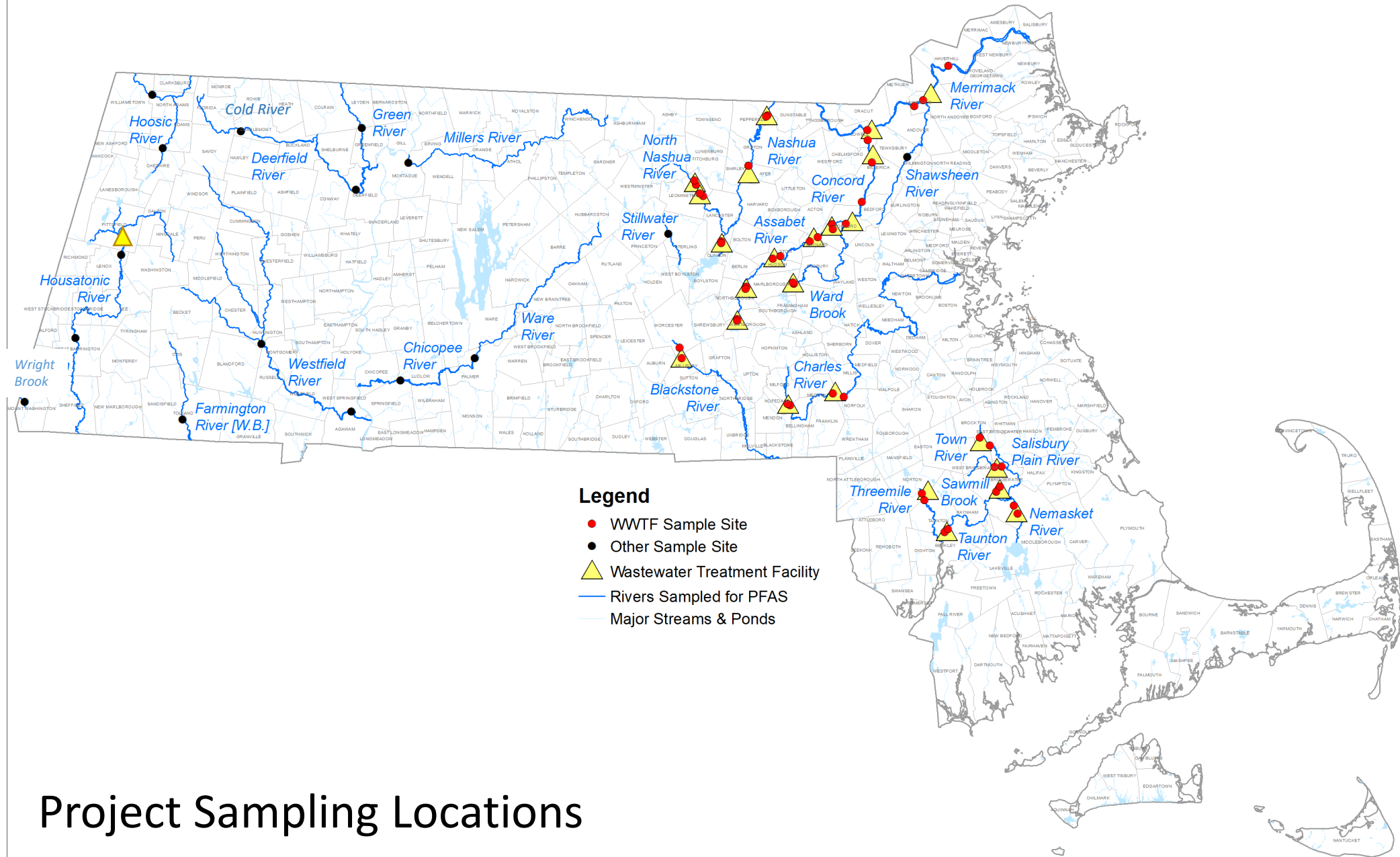
Figure 1. The inner circle of this diagram depicts the chemical structures of example per- and polyfluoroalkyl substances (PFAS): perfluorooctanoic acid (PFOA, top), perfluorohexanesulfonic acid (PFHxS, bottom left), and 6:2 fluorotelomer sulfonic acid (6:2 FTS, bottom right). Surrounding the PFAS compounds are depictions of products that might contain PFAS and of industry, which can produce or use PFAS. Line drawings in outer circle are from Pixabay.

Project Objectives

1. Characterize PFAS near WWTFs that discharge upstream of public water supply intakes.
 - 48 Sites: upstream/downstream of 24 WWTFs.
2. Characterize PFAS downstream of possible non-point or industrial sources (non-WWTF).
 - 9 Sites
3. Characterize background PFAS at locations with no known PFAS sources.
 - 7 sites

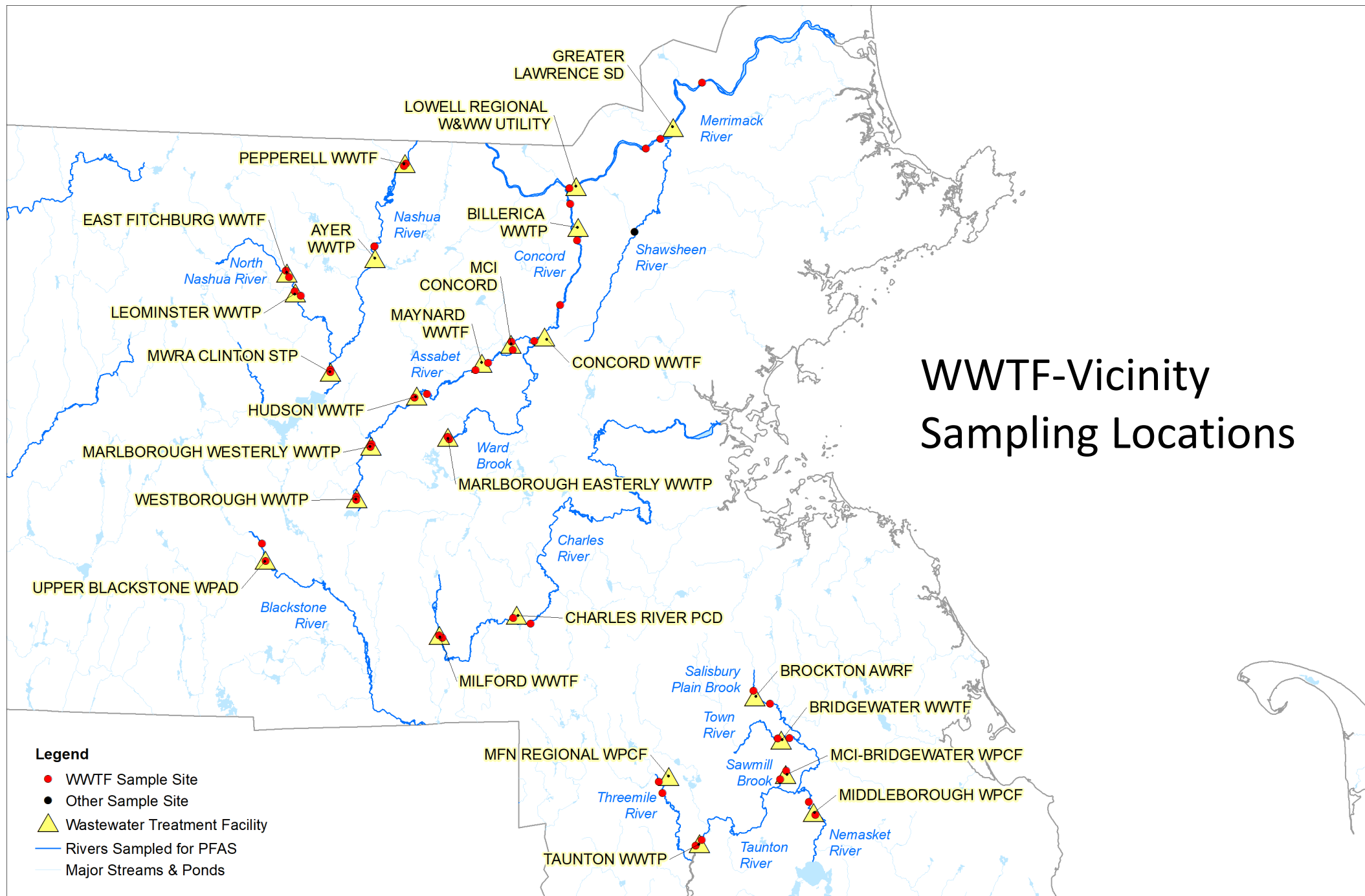


Westfield River



Project Sampling Locations

WWTF-Vicinity Sampling Locations



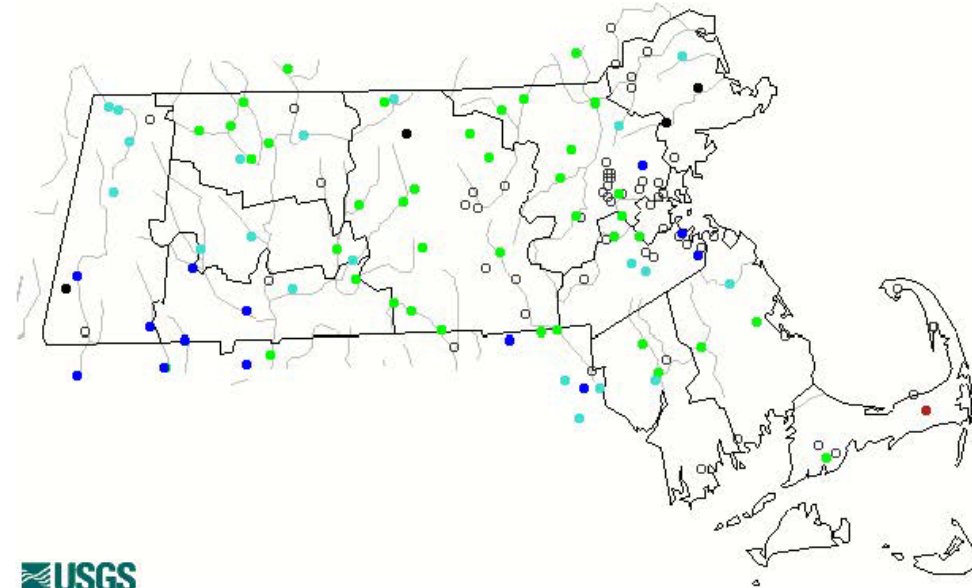
Quality Assurance Project Plan (QAPP):

- 3 rounds of samples – August to November 2020
- Monitor streamflow to optimize low-flow (baseflow) sample collection
- Deionized water blanks (6), replicates (22), and equipment blanks (23) (over 25% of the environmental samples)

Map of real-time streamflow compared to historical streamflow for the day of the year (Massachusetts)

Massachusetts or Water-Resources Regions

Tuesday, May 04, 2021 15:30ET



Search USGS streamgage

Choose a data retrieval option and select a location on the map

☐ List of all stations ☒ Single station ☐ Nearest stations ☐ Peak flow

Explanation - Percentile classes							
Low	<10 Much below normal	10-24 Below normal	25-75 Normal	76-90 Above normal	>90 Much above normal	High	Not-ranked

Sampling Methods:

Samples were collected by wading or from bridges (except for the Taunton - boat)

- Rivers <30 feet wide – centroid sample
- 30 to 60 ft wide – left, center, right composite sample
- >60 ft wide – Equal-width depth integrated sample (EWI)

Sawmill Brook
(upstream MCI Bridgewater)



Sample Collection:

- HDPE sampling equipment used (no Teflon)
- 250 ml HDPE bottles provided by Alpha Analytical
- Samples were unfiltered, no preservative added, and chilled
- Sampling equipment was rinsed with sample water prior to sample collection
- Lab Evaluation Procedure used by USGS to ensure lab proficiency



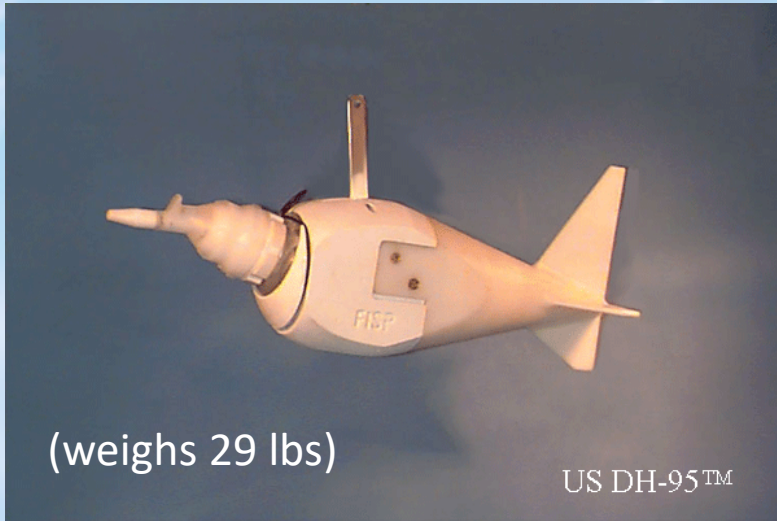
Handheld DH-81 suspended-sediment/water-quality sampler



Brendan Crowley - Assabet River
(downstream Westborough WWTF)



Suspended DH-95 sampler



Lower and raise by hand or using
bridgeboard

Guy Holzer
Chicopee River



Bridge board use



Alex Bissell

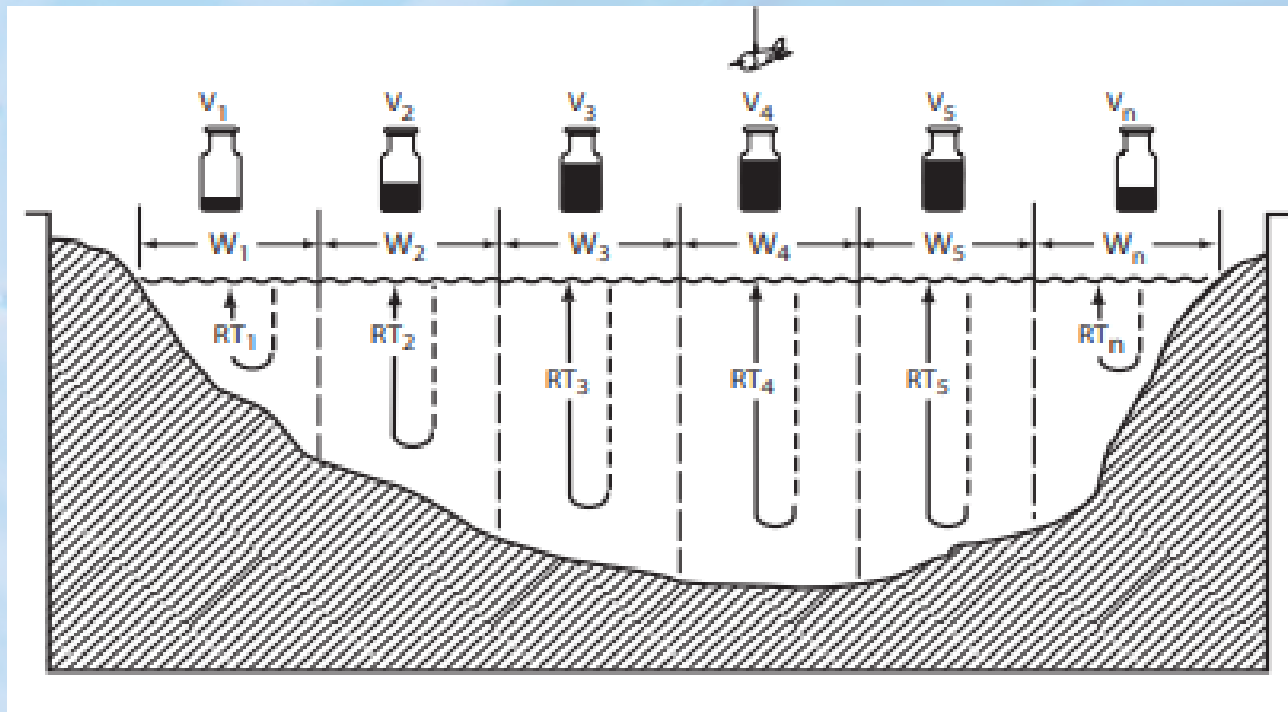


Alex Bissell and
Casey Beaudoin



Kyle Fronte
Merrimack River

Equal-width incremental sample



D-95 with crane
(64 lbs)

Samples were analyzed for 24 PFAS compounds by Alpha Analytical in Mansfield, MA

PFOA*	N-MeFOSAA	PFBA	PFOSA (FOSA)
PFOS*	N-EtFOSAA	PFDS	PFPeS
PFHxS*	8:2 FTS	PFDoA	PFPeA
PFHpA*	6:2 FTS	PFHpS	PFTA
PFDA*	4:2 FTS	PFHxA	PRTTrDA
PFNA*	PFBS	PFNS	PFUnA

* compounds currently regulated in MassDEP drinking water standard

MassDEP drinking water standard for PFAS6 is 20 ng/L
(Individually or the sum of the concentrations of the PFAS6)

Alpha Analytical

- Alpha Analytical analyzed PFAS using a modified version of EPA Method 537.1 with isotope dilution
- Analysis method included extraction of dissolved (liquid phase) and sediment-bound PFAS compounds
- Liquid chromatography–tandem mass spectrometry (LC-MS-MS)



* The use of brand names is for identification purposes only and does not imply endorsement by the United States Government

Observations: Data Quality Evaluation

- Little or no apparent red flags with respect to data validity.
- DIW and equipment blanks showed little/no detects, except for one common contaminant - Perfluorohexanoic acid (PFHxA).
- Sufficient duplicates were collected in each round and show good agreement.
- Most of the data qualifiers are “E” denoting an “estimated value” ($MDL < result < RL$) and not a technical data quality issue.

**Results of
Per- and Polyfluoroalkyl Substances (PFAS)
in Selected Brooks and Rivers
in Massachusetts, 2020**

Richard Chase, MassDEP



Observations: Environmental Data Results

- PFAS detected in all 27 rivers sampled
- Number of PFAS analytes detected at each location (of 24 tested):
 - Average: 10 compounds
 - Range: 2 - 16 compounds
 - Max # of detections: Shawsheen River (16 PFAS)
 - Concentration range for individual PFAS analytes ND - 109 ng/L
- Highest individual compound values observed:
 - North Nashua River (East Fitchburg) – PFBS concentration 109 ng/L
 - Sawmill Brook (MCI Bridgewater) – PFPeA concentration 106 ng/L

Analyte short name	Percent of samples with results >MDL	Number of detections	Minimum (ng/L)	Median (ng/L)	Mean (ng/L)	Maximum (ng/L)
PFHxA	100	192	0.34	9.3	13	91
PFOA *	99	191	0.24	7.5	8.7	42
PFOS *	95	183	0.52	6.3	6.9	55
PFHpA *	95	182	0.24	3.3	4.1	19
PFPeA	95	182	0.44	10.8	14.4	106
PFBA	94	180	0.43	4.9	6.7	54
PFBS	90	173	0.33	4.0	8.0	109
PFHxS *	88	169	0.4	2.5	3.1	26
PFNA *	87	167	0.29	1.3	1.6	10
PFDA *	65	124	0.28	0.64	0.86	4.7
PFPeS	64	123	0.24	0.43	0.53	2.9
PFUnA	21	40	0.24	0.36	0.53	1.8
6:2 FTS	13	25	1.3	3.0	4.61	18
N-MeFOSAA	5	10	0.68	0.74	0.87	1.5
PFTA	5	10	0.23	0.26	0.28	0.37
N-EtFOSAA	5	9	0.82	0.95	1.17	2.3
PFTTrDA	2	3	0.31	0.35	1.01	2.3
PFDoA	1	1	0.56	0.56	0.56	0.56
PFHpS	1	1	1.6	1.6	1.6	1.6

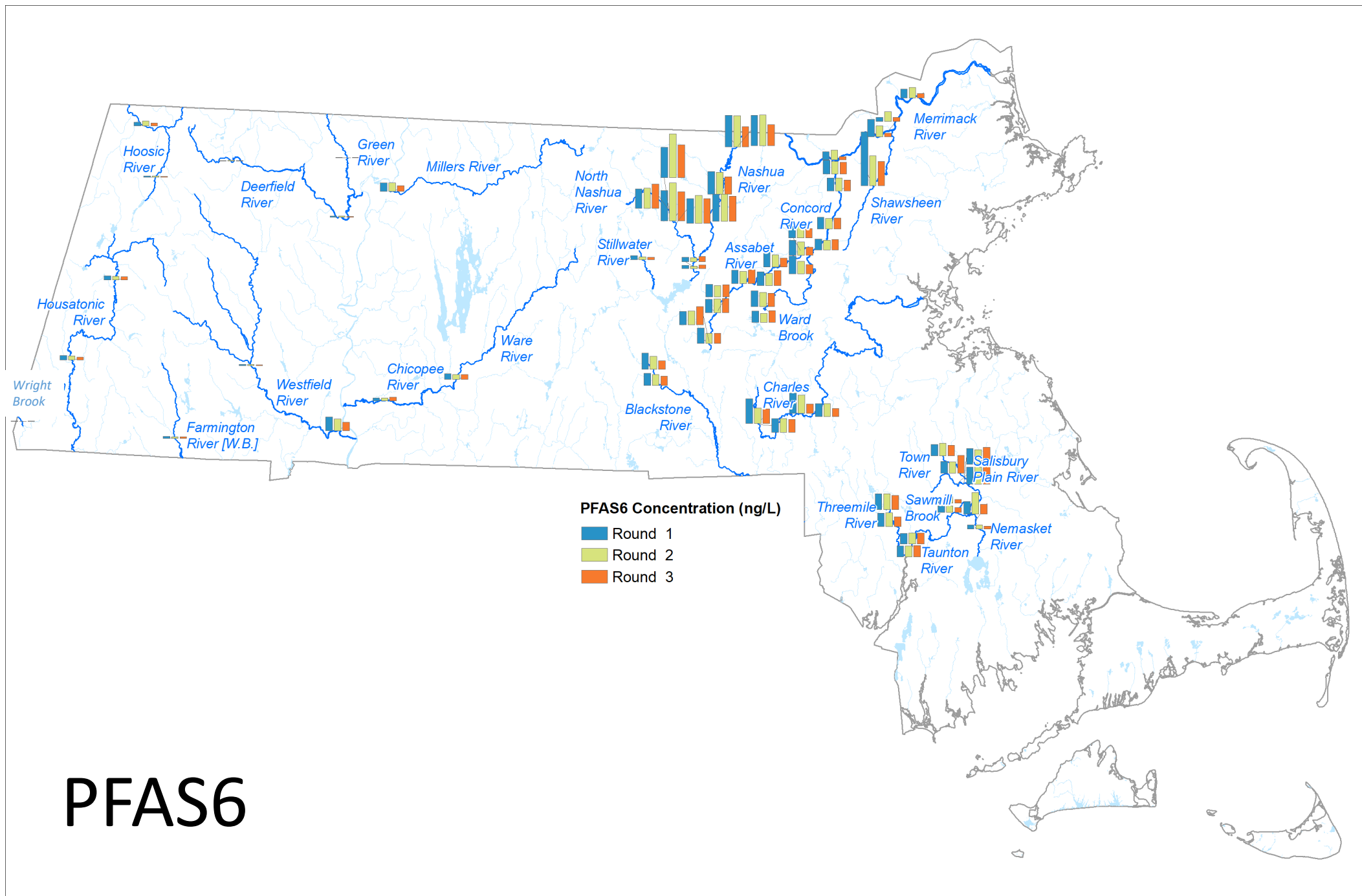
1) Not detected in any of the samples: 8:2FTS, 4:2FTS, PFDS, PFNS, and PFOSA 2) *=**PFAS6**

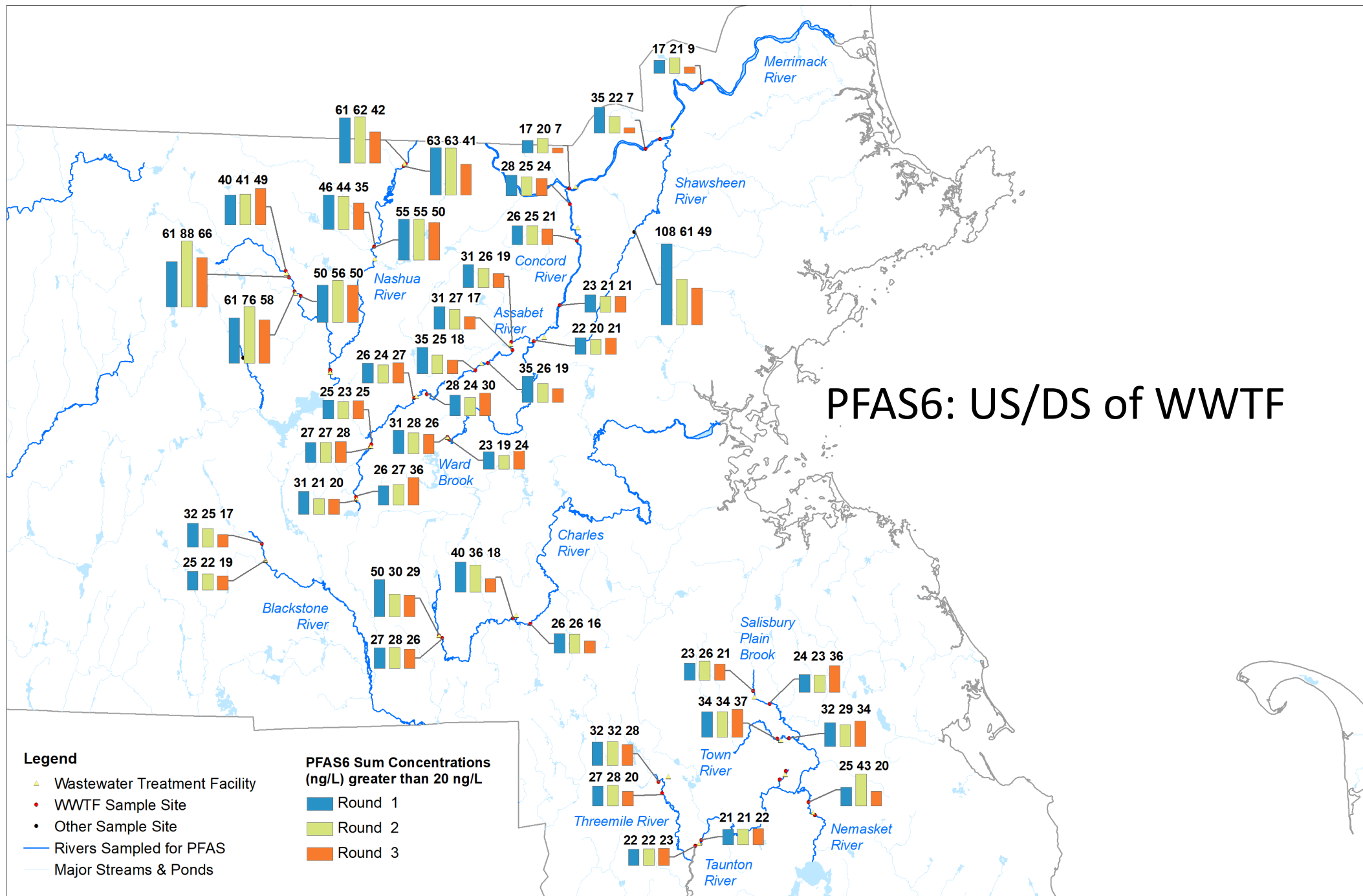
Observations: PFAS6 Results

- Concentration range for individual PFAS6 analytes only (all sites): **ND-55 ng/l (PFOS was max in the Shawsheen)**
- Concentration range for [sumPFAS6] (all sites): **ND-108 ng/l**
- # of sites (of 64 total) with [sumPFAS6] concentrations greater than 20 ng/l: **43 sites**

PFAS6 = PFOA + PFOS + PFHpA + PFHxS + PFNA + PFDA

PFAS6



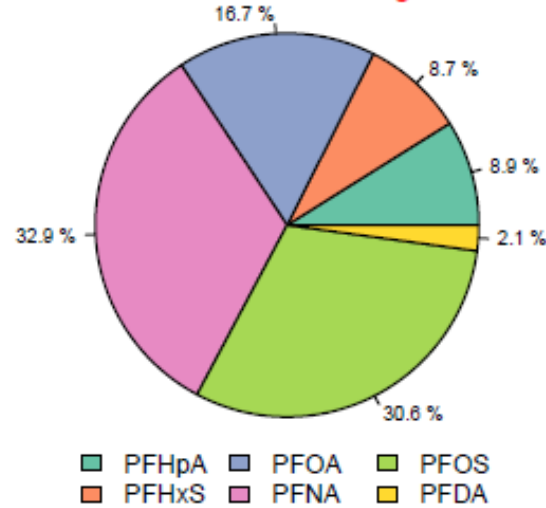


Examples:

Changes in % composition of PFAS6 for each sampling round from Upstream (UP) to Downstream (DS) of a Wastewater Treatment Facility

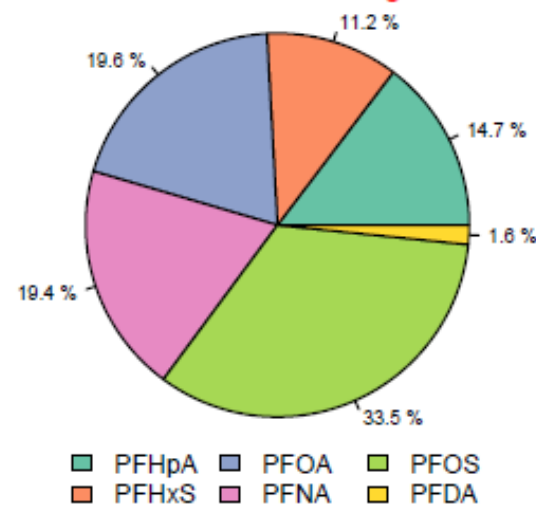
Assabet River
WESTBORO US
(17-Aug-20) Round 1

Total PFAS6: 30.7 ng/L



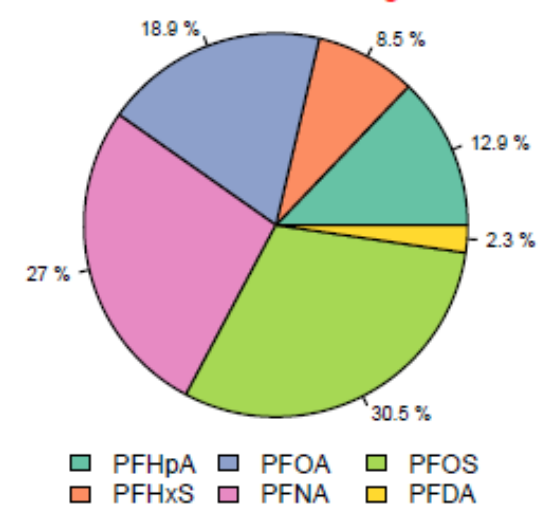
Assabet River
WESTBORO US
(22-Sep-20) Round 2

Total PFAS6: 20.8 ng/L



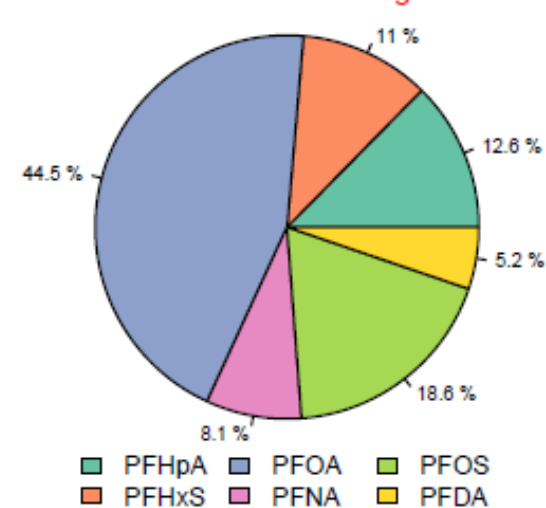
Assabet River
WESTBORO US
(28-Oct-20) Round 3

Total PFAS6: 20.2 ng/L



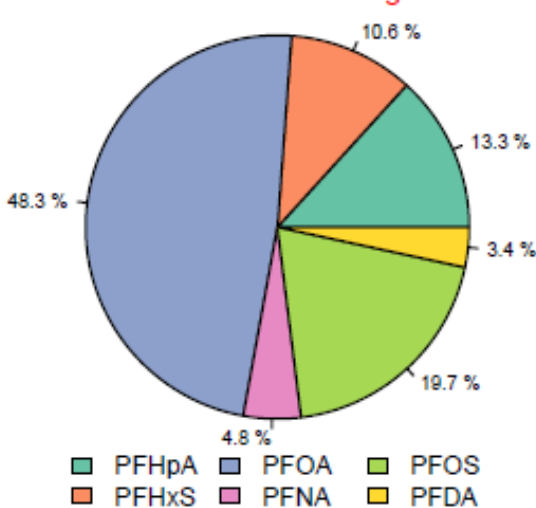
Assabet River
WESTBORO DS
(17-Aug-20) Round 1

Total PFAS6: 26.1 ng/L



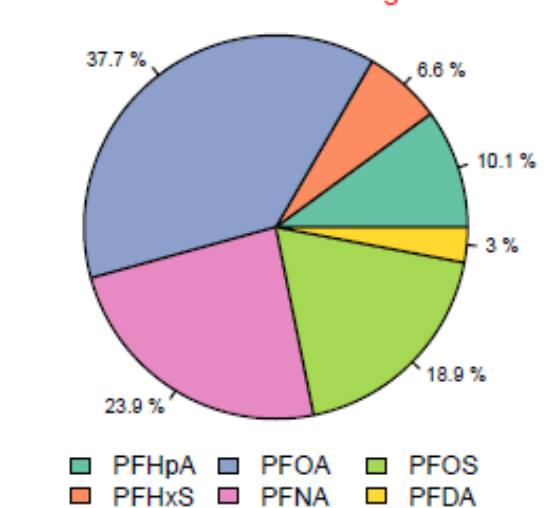
Assabet River
WESTBORO DS
(22-Sep-20) Round 2

Total PFAS6: 27.3 ng/L



Assabet River
WESTBORO DS
(28-Oct-20) Round 3

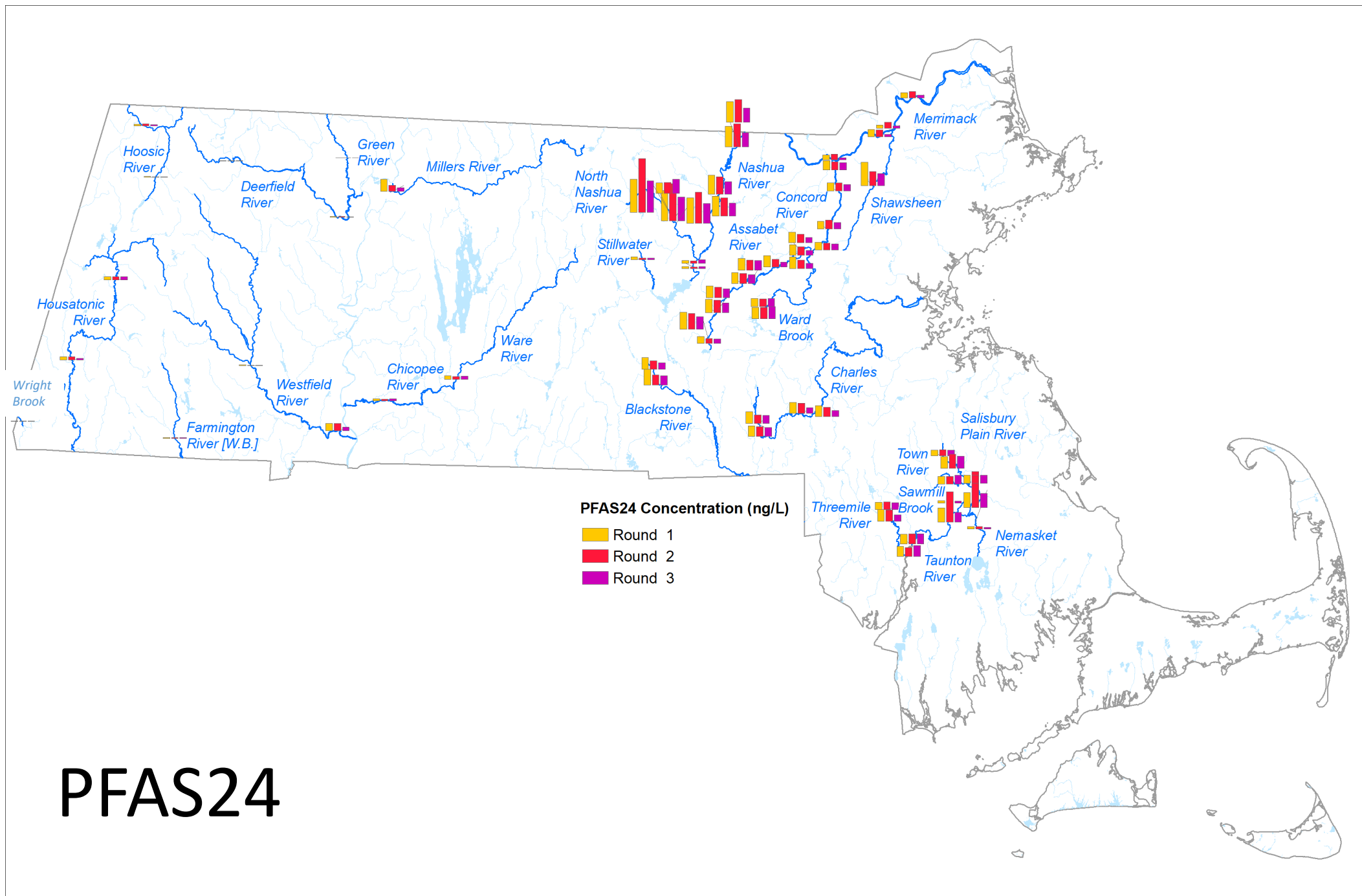
Total PFAS6: 36.4 ng/L



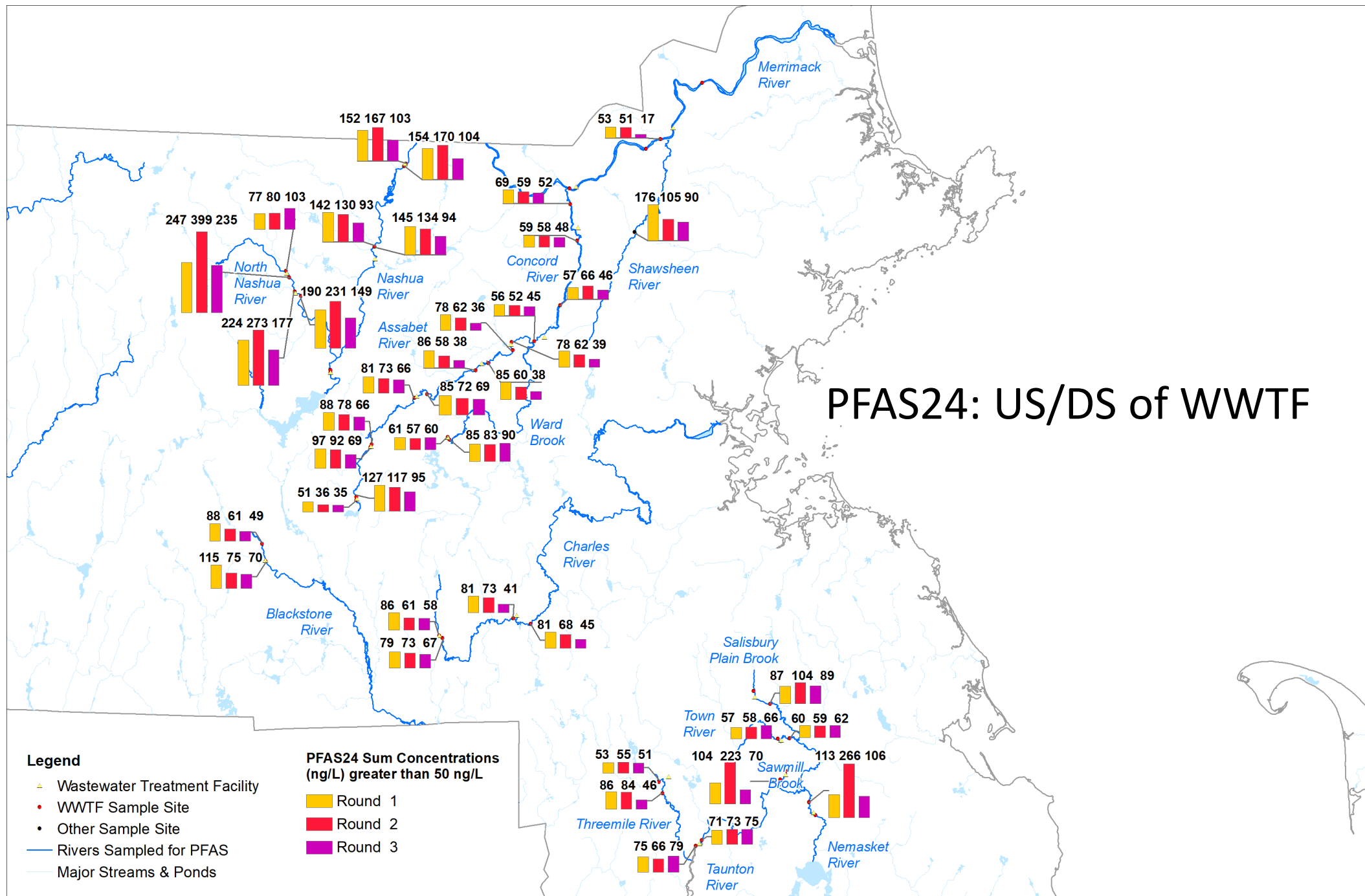
Observations: PFAS24 Results

- Concentration range for [sum of 24 compounds] (all sites): **0.3-399 ng/l**
- Of the 64 sites, PFAS24 concentrations greater than 50 ng/L detected at 41 of the 64 sites sampled
- Waterbodies generally showing higher PFAS total [sum24] concentrations (>~50 ng/l):
 - Assabet River
 - Sewage Brook
 - Concord River
 - Nashua River (**maximum [sum24] observed= 399 ng/l, DS of E. Fitchburg**)
 - Blackstone River
 - Charles River
 - Three Mile River
 - Sawmill Brook
 - Nemasket River
 - Salisbury Plain River
 - Town River
 - Taunton River
 - Millers River
 - Shawsheen River (**maximum [PFAS6] observed= 108 ng/l**)
 - Westfield River

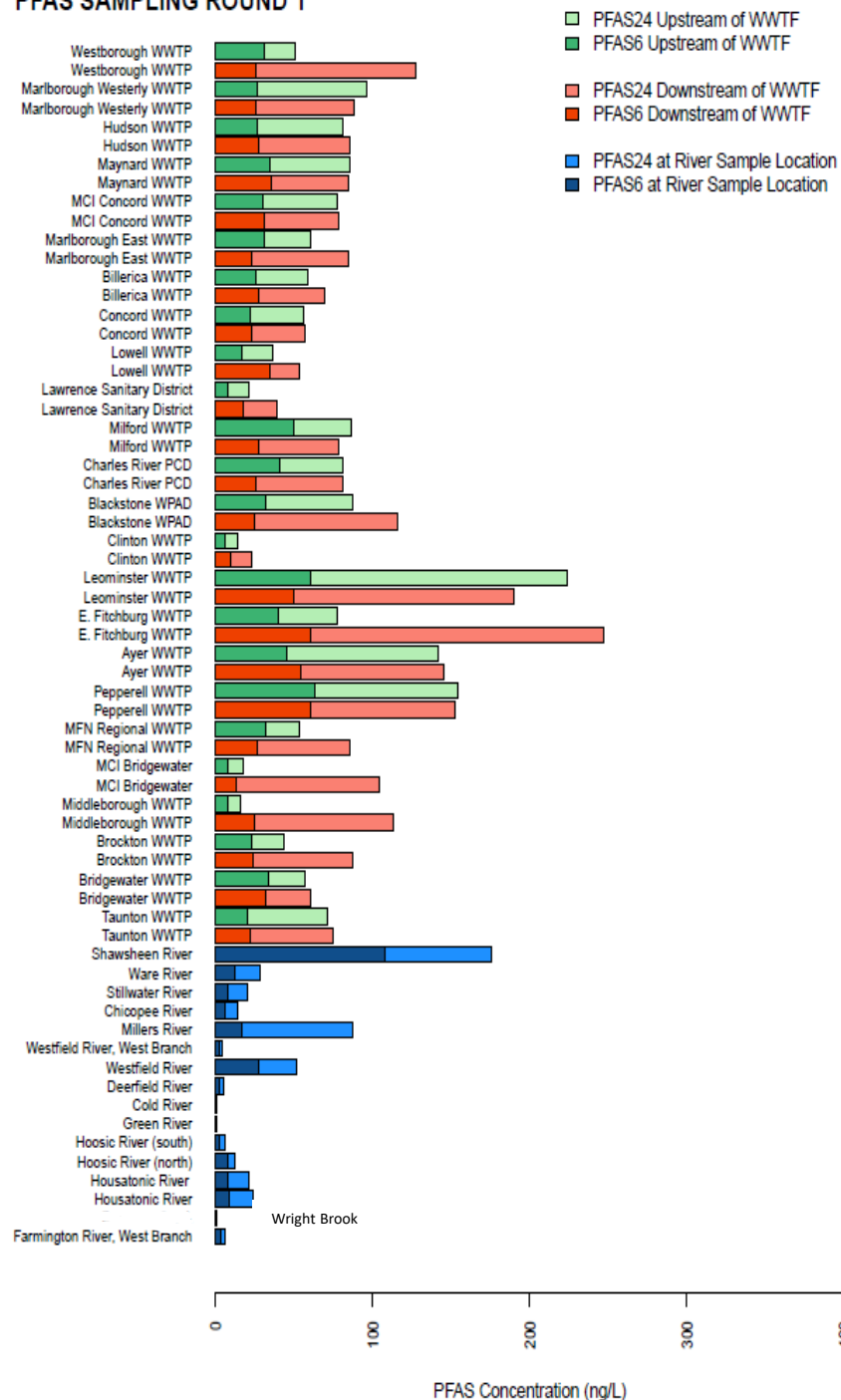
PFAS24



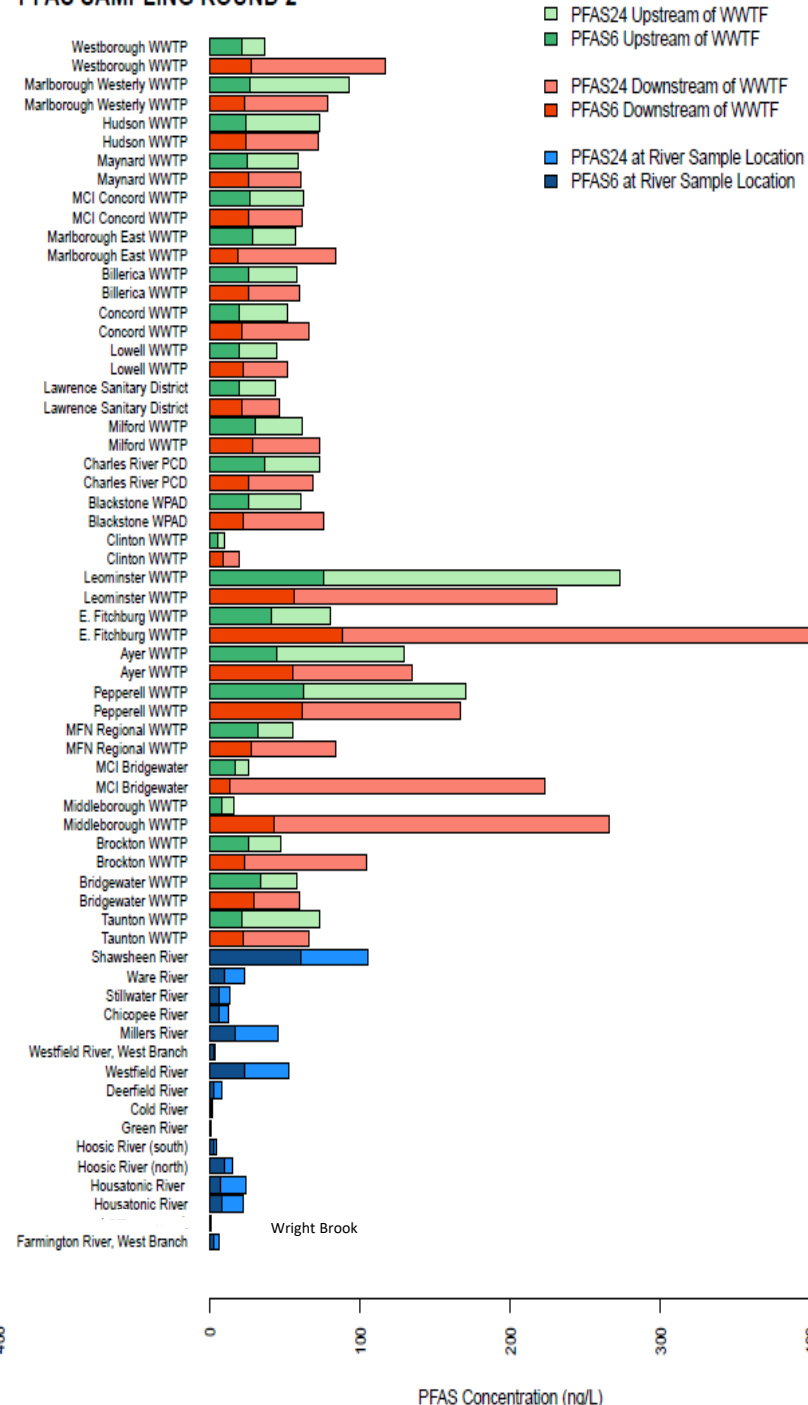
PFAS24: US/DS of WWTF



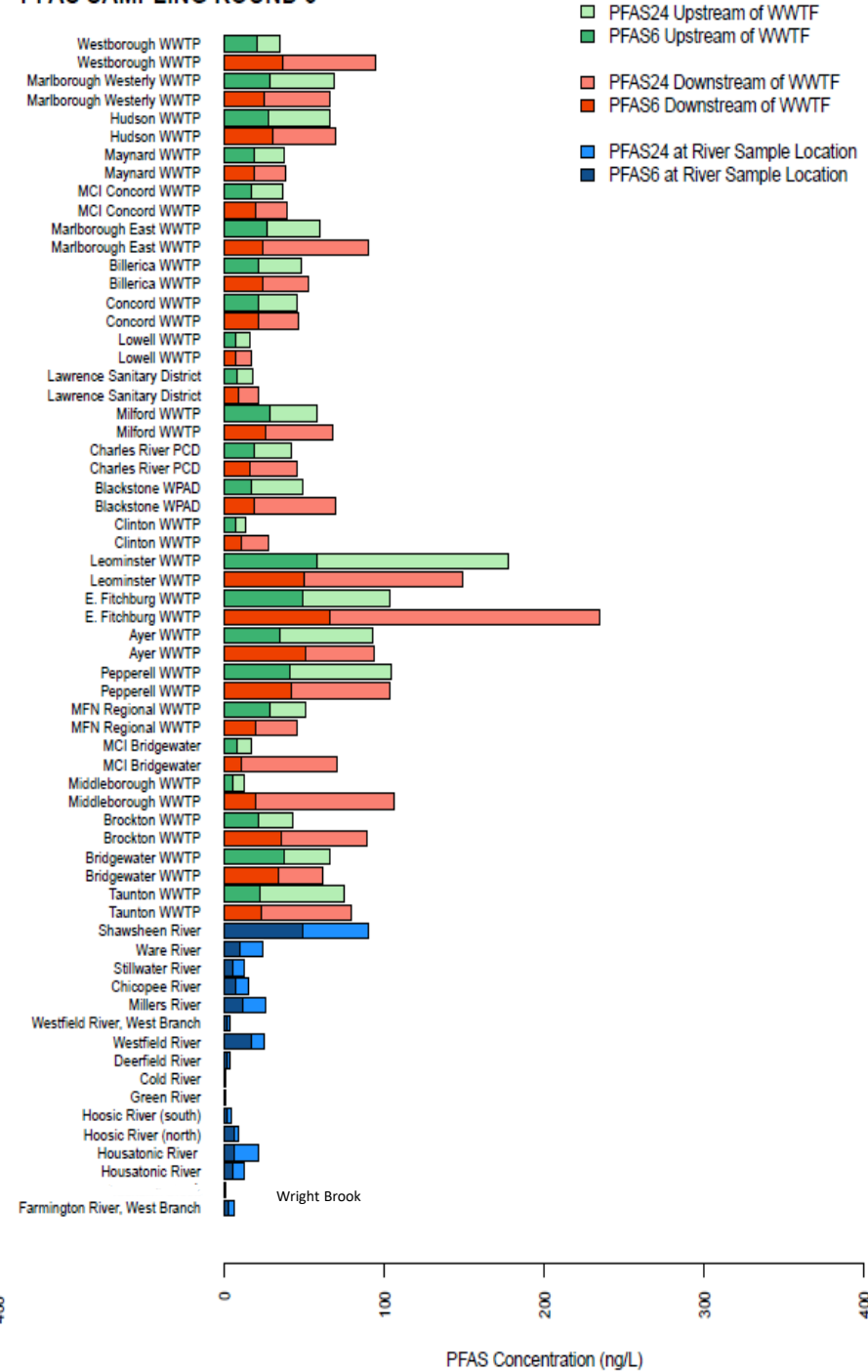
PFAS SAMPLING ROUND 1



PFAS SAMPLING ROUND 2



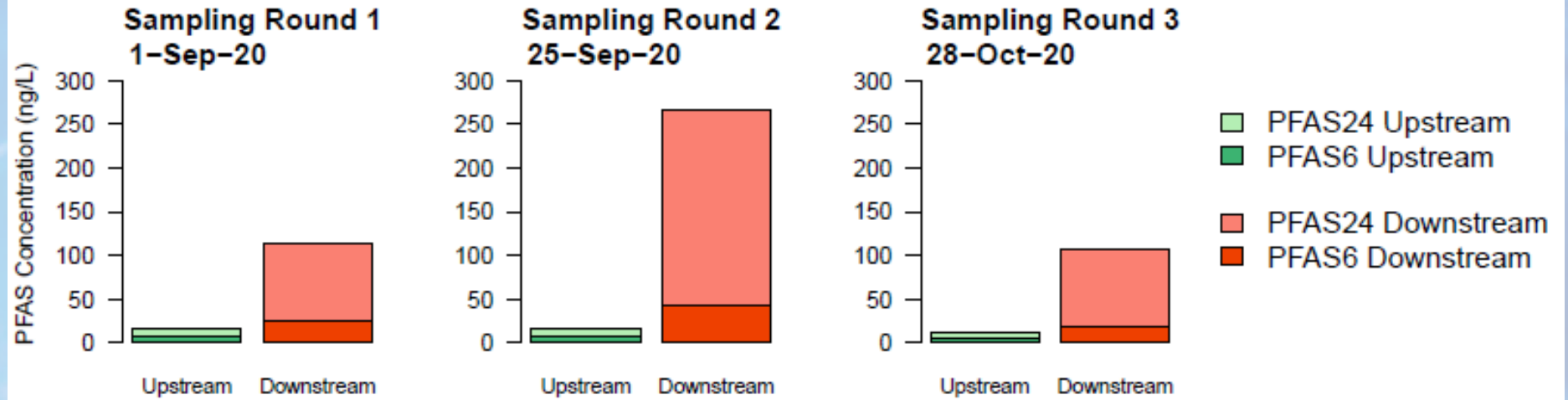
PFAS SAMPLING ROUND 3



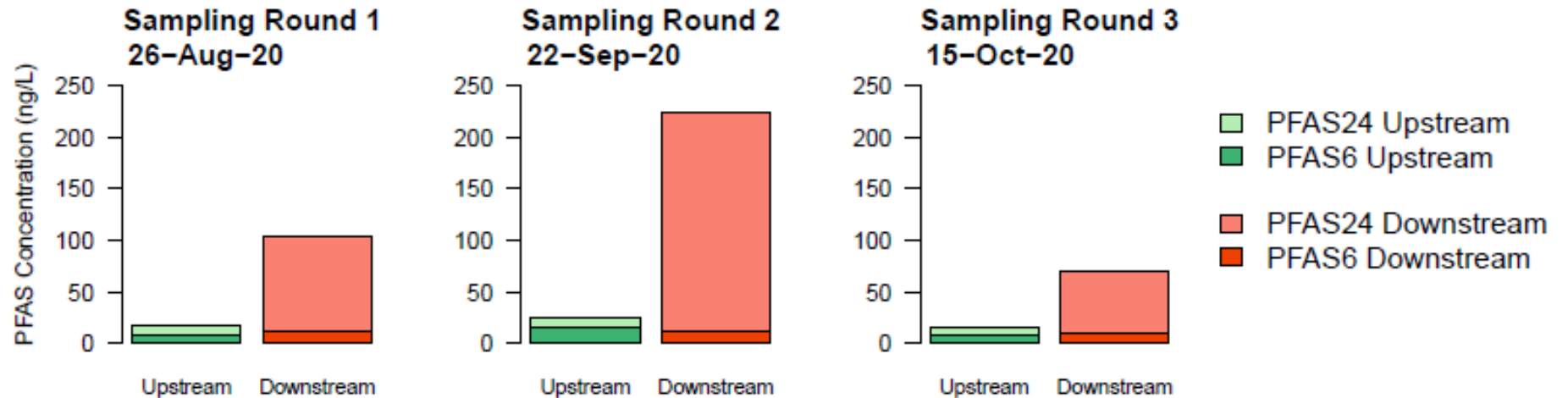
Examples:

Relatively low upstream PFAS24 concentrations compared to downstream of discharge

Middleborough WWTP

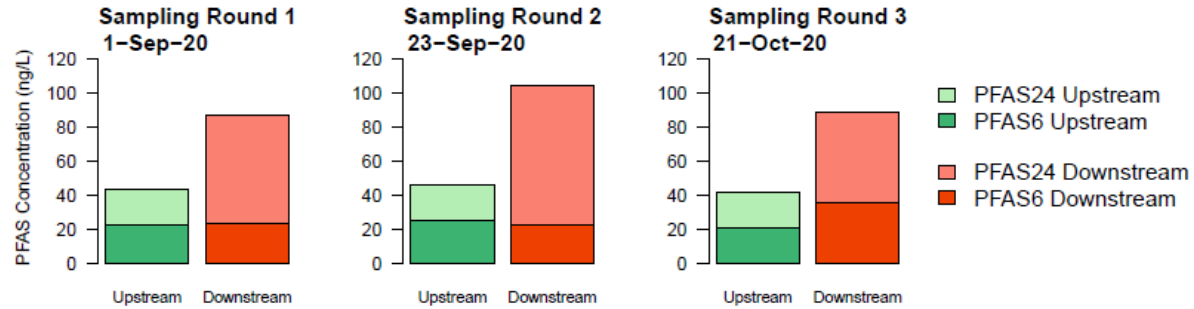


MCI Bridgewater

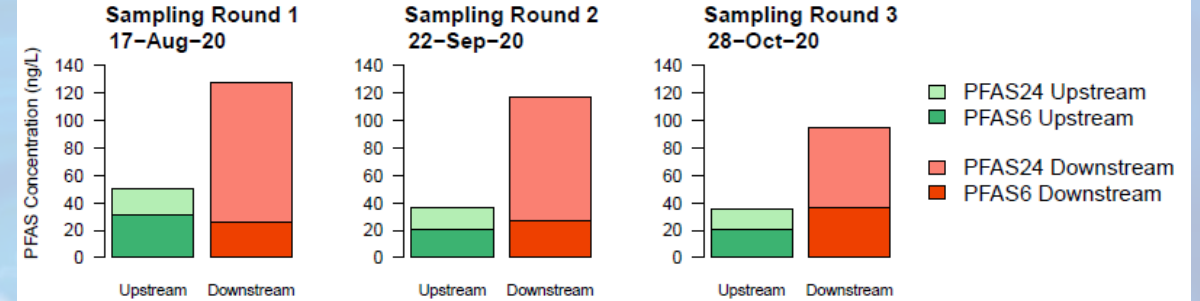


Examples: Significant increases in [PFAS24] from upstream to downstream of discharge

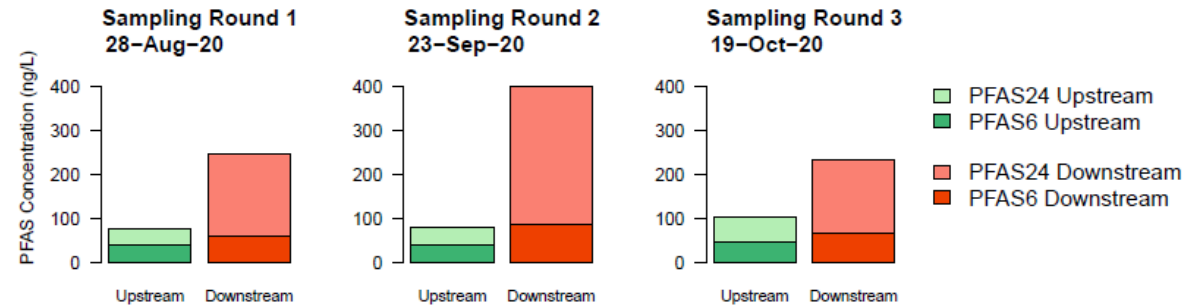
Brockton WWTP



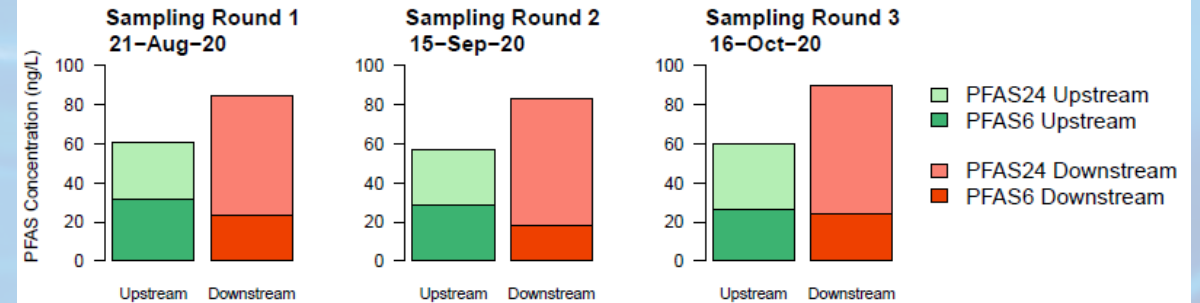
Westborough WWTP



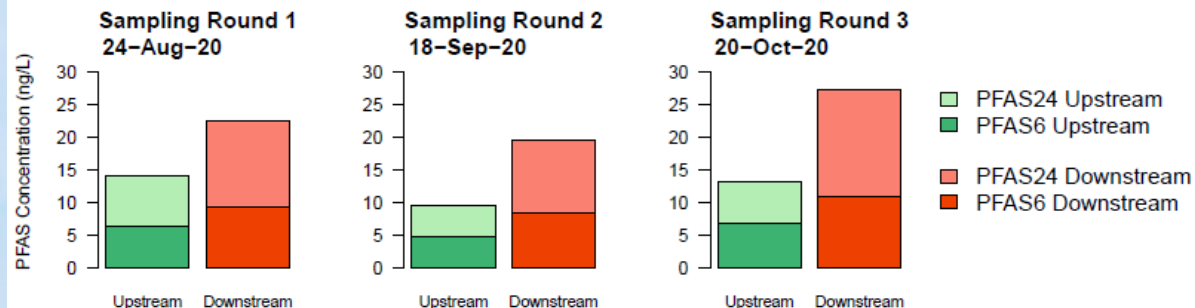
E. Fitchburg WWTP



Marlborough East WWTP

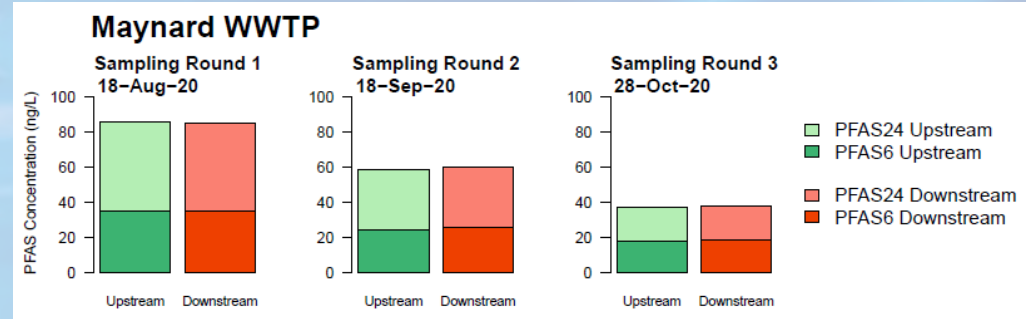
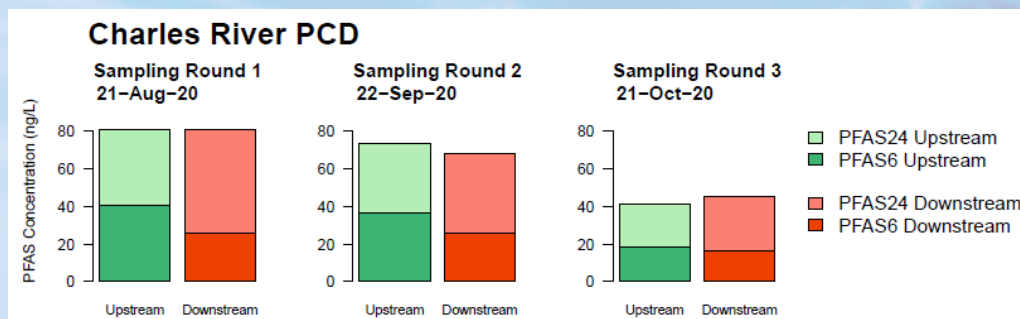
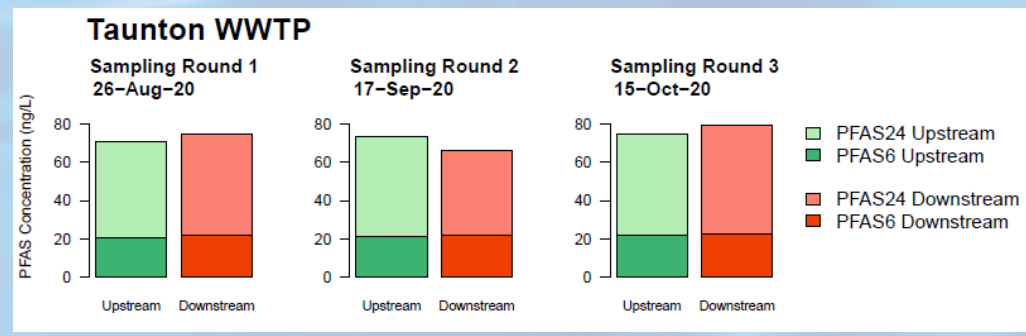
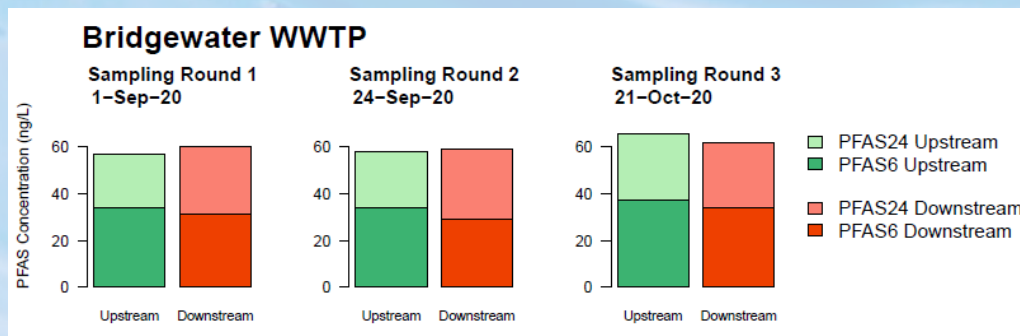
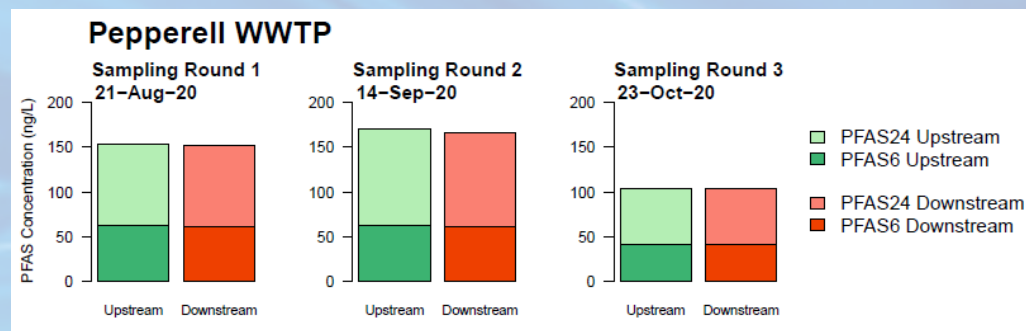
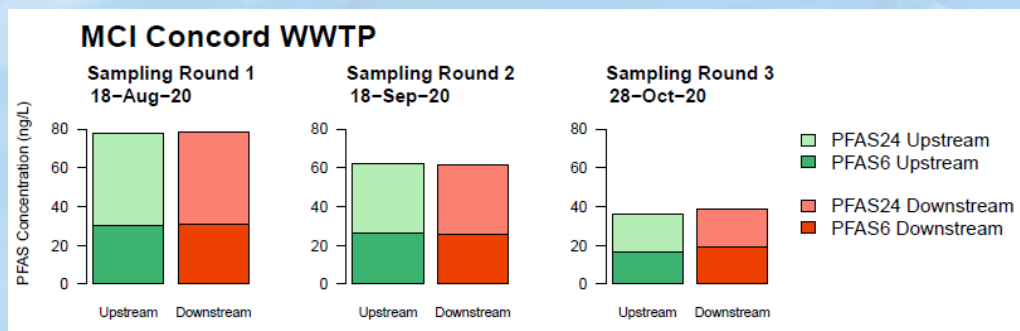
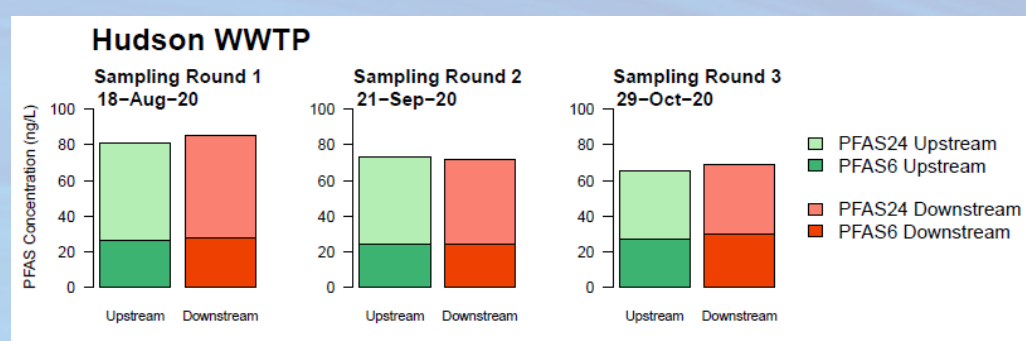
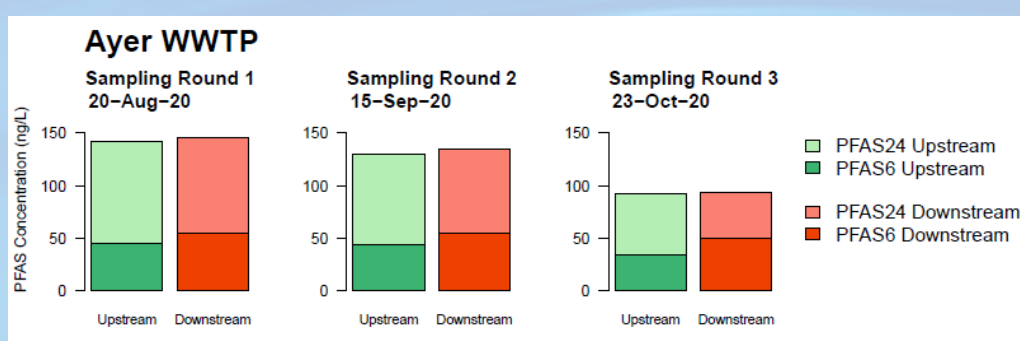


Clinton WWTP



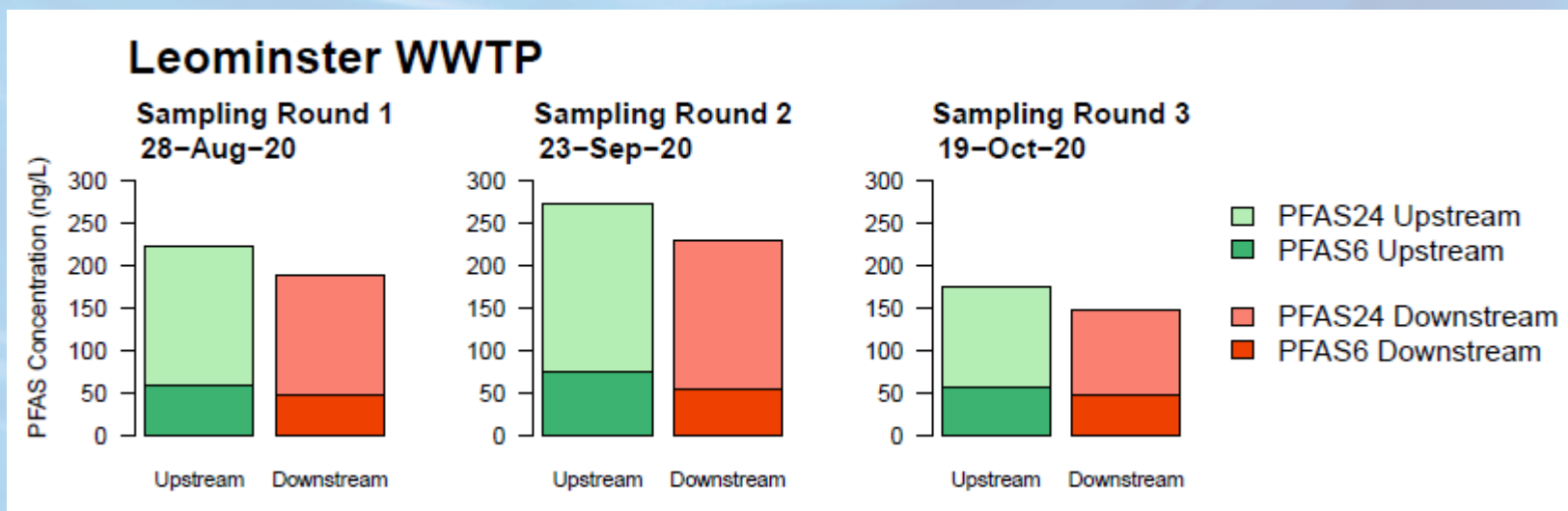
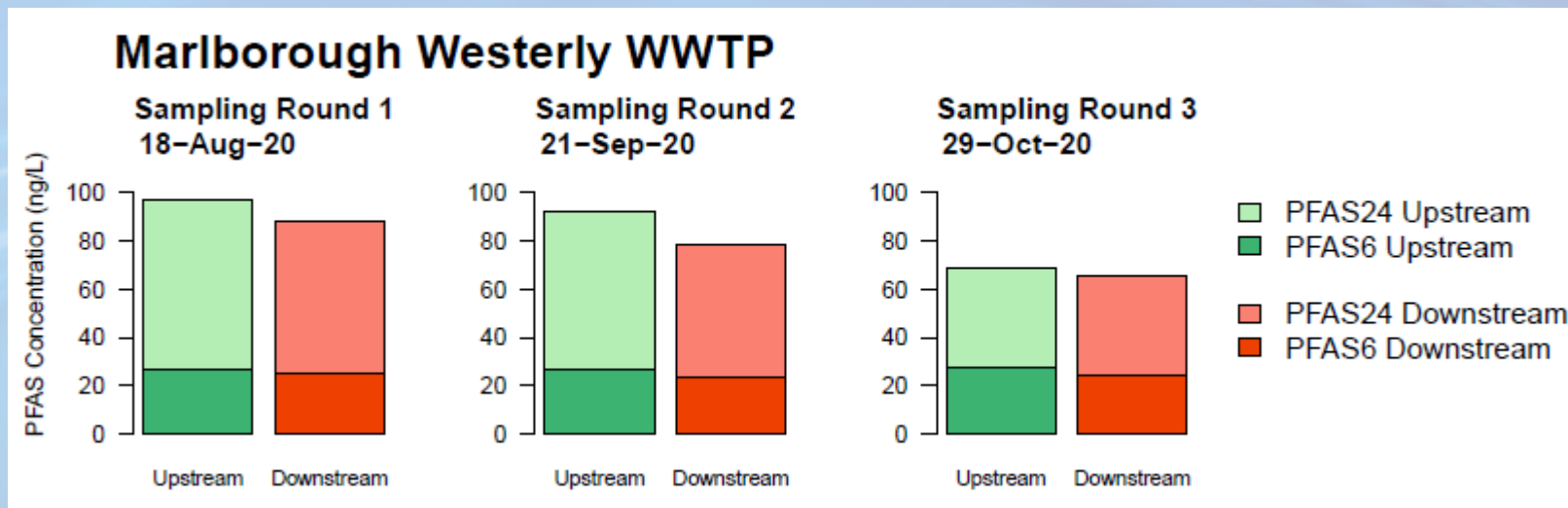
Examples:

Similar and elevated upstream and downstream [PFAS24]



Examples:

Possible dilution of
UPS [PFAS24]
resulting in lower
levels DNS
(inconclusive)



Summary & MA PFAS Standards and Requirements (2021):

(<https://www.mass.gov/info-details/per-and-polyfluoroalkyl-substances-pfas>)

- **Surface Water** (including primary contact, fish consumption, aquatic life):
 - none
- **Drinking Water:**
 - PFAS6 < 20 ng/L (Individually or the sum of the concentrations of the PFAS6)
 - PFAS testing for PWS required
 - [STORY MAP: PFAS in drinking water supplies in massachusetts](#)
- **Wastewater Discharge Permits:**
 - no numerical limits; quarterly monitoring of influent, effluent and sludge required
- **Biosolids:**
 - No numerical limits; quarterly monitoring of residuals that have an Approval of Suitability (AOS) is required
- **Contaminated Sites (MCP):**
 - Reportable Concentrations (RCs) and Reportable Quantities (RQs) under the MCP for groundwater and soils

PFAS6 Results: Drinking Water from Concord, Merrimack & Taunton Rivers

Public Water Supply	River	Population	Raw Water PFAS6 (ppt)	Finished Water PFAS6 (ppt)	Closest Upstream WWTF	Range of Upstream River PFAS6 (ppt)
Billerica	Concord	40,243	NA	3.04 on 4/1/21 (QC pending) 7.46 on 4/22/21 (QC pending)	Concord (Concord River)	21.0 – 23.4
Tewksbury	Merrimack	31,044	8.31 on 11/14/19 6.65 on 1/28/20	3.36 on 11/14/19 3.34 on 1/28/20	Lowell (Merrimack River)	7.1 – 34.6
Methuen	Merrimack	50,706	Not needed	ND on 11/25/19	Lowell (Merrimack River)	7.1 – 34.6
Lawrence	Merrimack	80,162	5.95 on 11/18/19 6.11 on 1/2/20 6.95 on 2/18/20	6.01 on 11/18/19 2.99 on 1/2/20 6.88 on 2/18/20	Lowell (Merrimack River)	7.1 – 34.6
Andover	Merrimack	33,201	11.7 on 11/4/19	3.68 on 11/4/19	Lowell (Merrimack River)	7.1 – 34.6
Lowell	Merrimack	106,519	11.5 (PFOS/PFOA) on 8/13/19 5.6 on 11/13/19 2.5 on 3/3/20	7.4 (PFOS/PFOA) on 8/13/19 2.9 on 11/13/19 Est. detects only on 3/3/20	Pepperell (Nashua River)	40.8 – 61.8
Aquarion	Taunton	93,810	NA	ND on 11/24/20	Taunton (Taunton River)	21.8 – 23.0

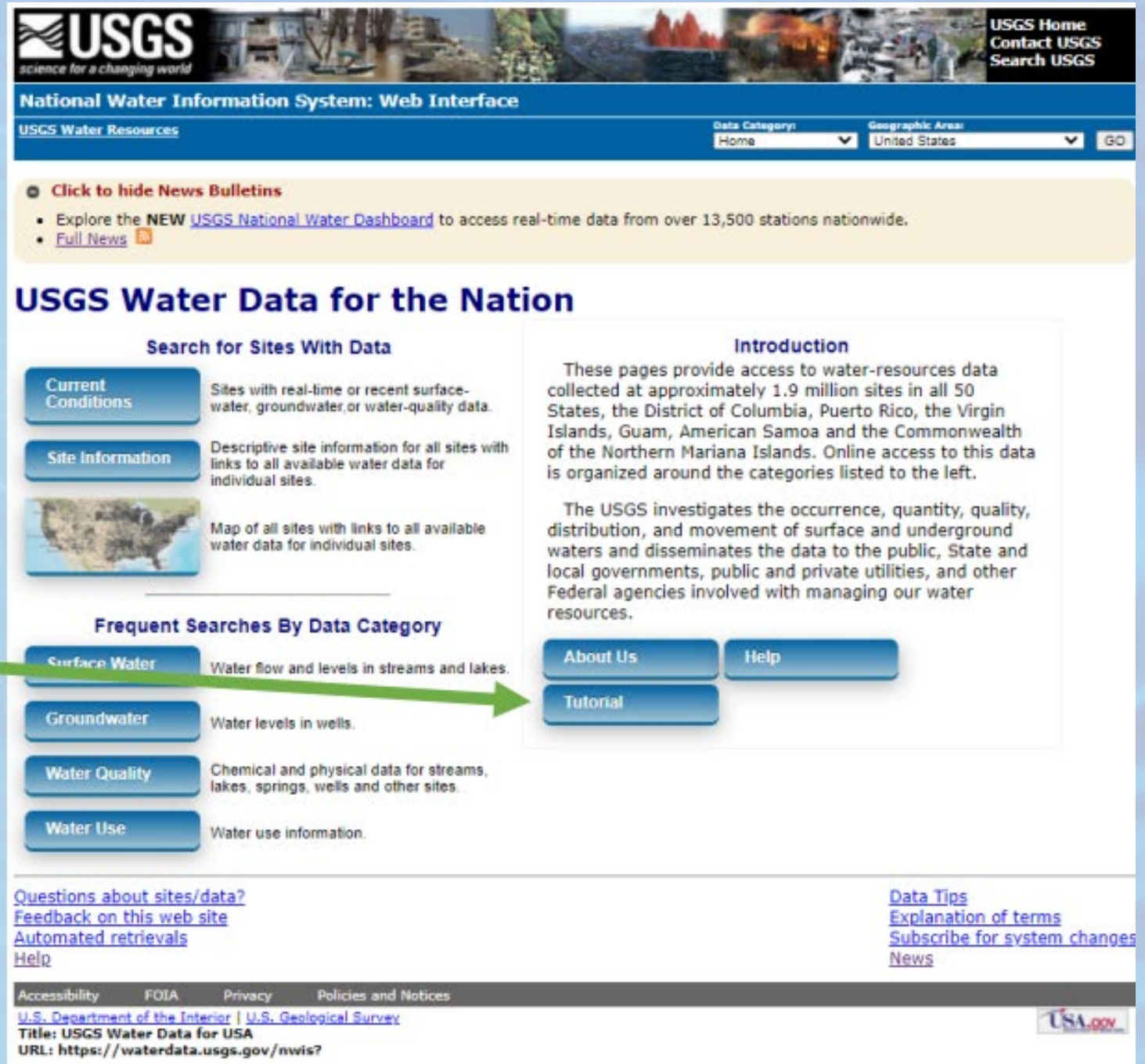
Recent and Pending Actions

- USGS data publication (NWIS): June 2021
- Presentation to wastewater facilities: June 2021
- Presentation to selected watershed groups: 6/30/2021
- USGS data report & release: Fall 2021
 - Separate errata issued in 2022 (report only) and 2023 (report and data release)
- DEP Planning for additional studies and actions: On-going
 - PFAS in fish tissue and water (lakes and rivers): 2022/2023
 - Wastewater PFAS study: influent, effluent, solids, ambient (upstream/downstream), and selected points in some of the collection systems

Data available USGS National Water Information System (NWIS)

waterdata.usgs.gov/nwis

Tutorials



USGS
science for a changing world

National Water Information System: Web Interface

USGS Water Resources

Data Category: Home Geographic Area: United States GO

Click to hide News Bulletins


- Explore the **NEW** [USGS National Water Dashboard](#) to access real-time data from over 13,500 stations nationwide.
- [Full News](#)

USGS Water Data for the Nation

Search for Sites With Data

Current Conditions Sites with real-time or recent surface-water, groundwater, or water-quality data.

Site Information Descriptive site information for all sites with links to all available water data for individual sites.

 Map of all sites with links to all available water data for individual sites.

Frequent Searches By Data Category

Surface Water Water flow and levels in streams and lakes.

Groundwater Water levels in wells.

Water Quality Chemical and physical data for streams, lakes, springs, wells and other sites.

Water Use Water use information.

Introduction

These pages provide access to water-resources data collected at approximately 1.9 million sites in all 50 States, the District of Columbia, Puerto Rico, the Virgin Islands, Guam, American Samoa and the Commonwealth of the Northern Mariana Islands. Online access to this data is organized around the categories listed to the left.

The USGS investigates the occurrence, quantity, quality, distribution, and movement of surface and underground waters and disseminates the data to the public, State and local governments, public and private utilities, and other Federal agencies involved with managing our water resources.


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Tutorial

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Accessibility FOIA Privacy Policies and Notices
U.S. Department of the Interior | U.S. Geological Survey
Title: USGS Water Data for USA
URL: <https://waterdata.usgs.gov/nwis/>



Thank you!

Questions?

Project-Related:

- Richard Carey, richard.carey@mass.gov
- Richard Chase, richard.f.chase@mass.gov

PFAS, NWIS and Other USGS Work:

- Jennifer Savoie, jsavoie@usgs.gov
- Denise Argue, dmargue@usgs.gov

