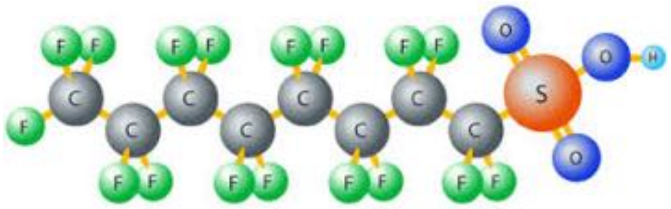
Get to Know Emerging Drinking Water Contaminants: PFAS Challenges and Solutions



Syracuse University – Environmental Finance Center

Smart Management for Small Water Systems

August 13, 2019

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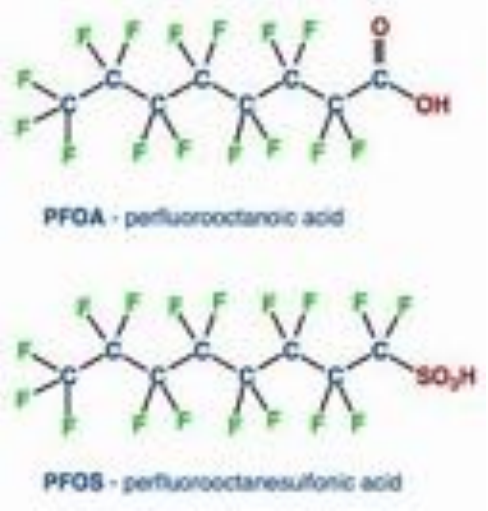
PFAS Challenges and Solutions
Presentation Overview

- **Recap: PFAS Background**
- **Existing Treatment Technologies**
- **Emerging Treatment Technologies**
- **Case Study: Portsmouth, NH**
- **Case Study: Devens, MA**
- **Questions**

PFAS Background

- Per- and Poly- Fluoroalkyl Substances are used in making fluoropolymer coatings
- Environmental Persistence
  - Resistant to:
    - Oil and Grease
    - Staining
    - Water
    - Heat
- Bioaccumulation
  - <1 week to 10 years
  - "Long" chain vs "short" chain



PFAS Background

So where is it? (In high concentrations)

- Airports
- Air Force Bases
- Naval Facilities
- Fire Fighting Academies
- Manufacturing Facilities

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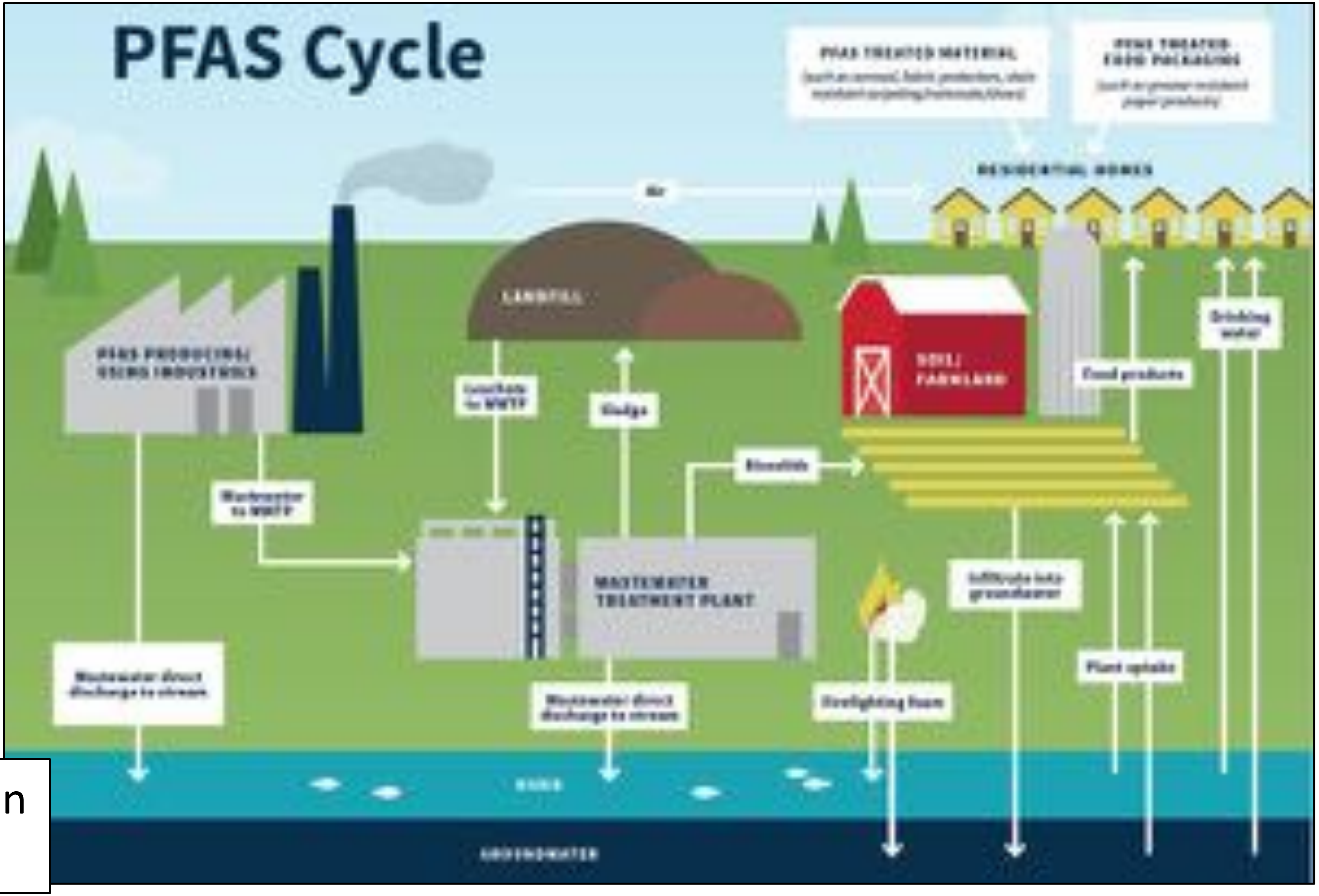
So where is it? (In lower concentrations)

- Car washes
- Biosolids
- Septic systems
- Landfills
- Food



Michigan EGLE

PFOS & PFOA in Public Drinking Water

ewg.org

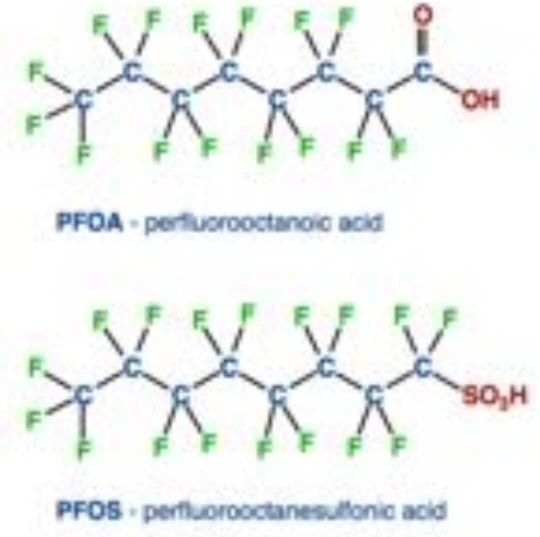
Structural Makeup

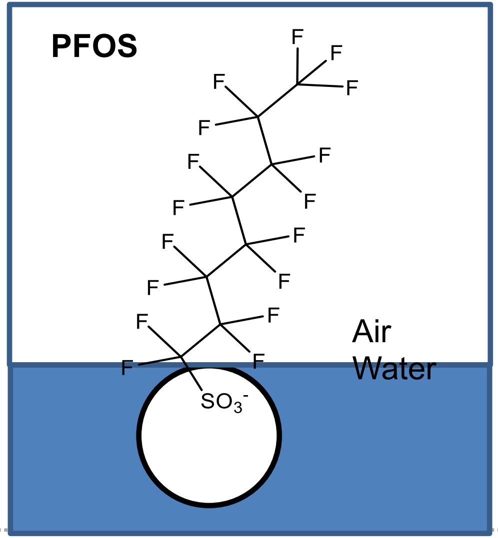
- Anionic Perfluorinated Alkyl Acids (Terminal, NO BREAKDOWN)
  - Negatively charged
  - Low vapor pressure
  - Water soluble

PFAAs generally act as surfactants with tail in the air and head in water

Perfluorinated TAIL

Anionic HEAD



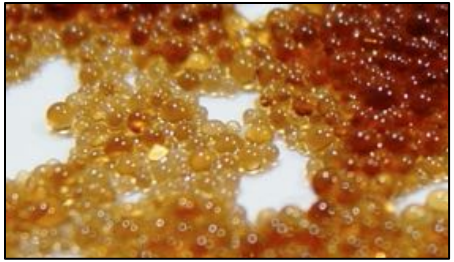


Drinking Water Technologies

- Granular Activated Carbon
  - Advantages – cost effective, several systems in use, PFAS can be transported offsite for destruction
  - Disadvantages – may be costly to changeout for short chain breakthrough, footprint/building height

Drinking Water Technologies

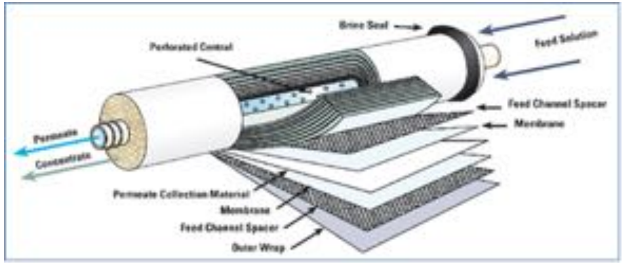
- Ion Exchange Resins



  - Advantages – custom designed treatment, long service life, smaller vessels required
  - Disadvantages – expensive if single use, newer technology with limited data

Drinking Water Technologies

- Membranes



  - Advantages – >99% removals
  - Disadvantages – waste stream, high capital and O&M costs, expertise required to operate system

Unsuccessful Treatment Technologies

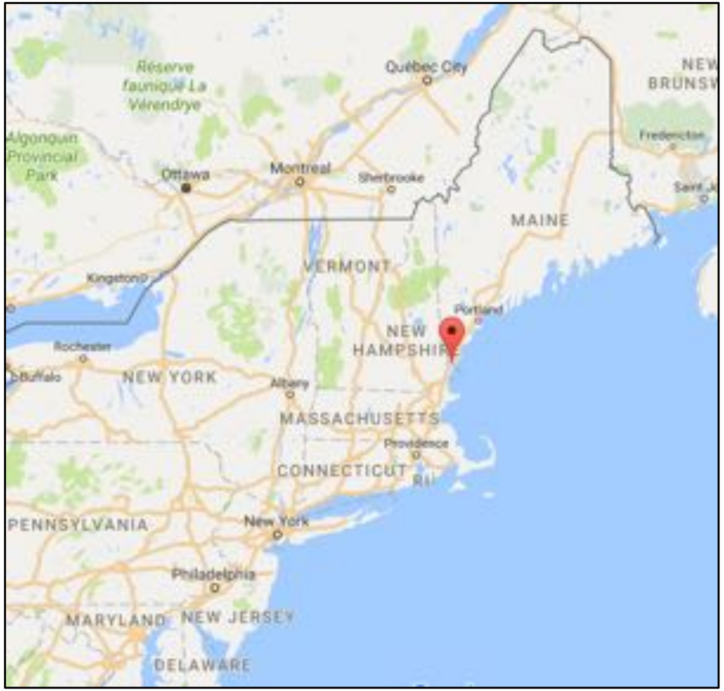
- Aeration
- Coagulation/Flocculation/Sedimentation
- Conventional Rapid Filtration
- Conventional Oxidation

Emerging Technologies

- Reducing C-F chain length
  - Electrochemical Oxidation
  - Plasma Treatment

- Concentrating PFAS solutions
  - Ozofractionation

Case Study: Former Pease Air Force Base



- Portsmouth, NH
- Shut down in 1991
- Airport with split use between commercial flights and Air National Guard
- Expanding office space with some light industrial, college buildings, golf course, restaurants, day care centers

Previous Ground Water Contamination

- VOCs plumes (TCE/PCE) found around Haven Well
- A WTP constructed in the mid 1980's to treat for VOCs
- 1990 site remediation started under CERCLA
- Due to low demand (base closure) and steadily improving GW quality, WTP never activated, equipment removed in 2013

Pease Well Is Shut Down After Unregulated Contaminant Discovered

By SAM EVANS-BROWN • MAY 22, 2014

Tweet Share Google+ Email

May 2014

Article published May 22, 2014

Contaminated well shut down at Pease Tradeport

PORTSMOUTH — A well that serves the Pease International Tradeport has been shut down after testing positive for a chemical contaminant, according to the state Department of Environmental Services.

Local and Federal Legislative Delegation

March 18, 2015 - Senator Shaheen addresses Pease PFC contamination to U.S. Air Force

2016 – Governor (now Senator) Hassan meets with Testing for Pease representatives

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Technical Response Team Forms

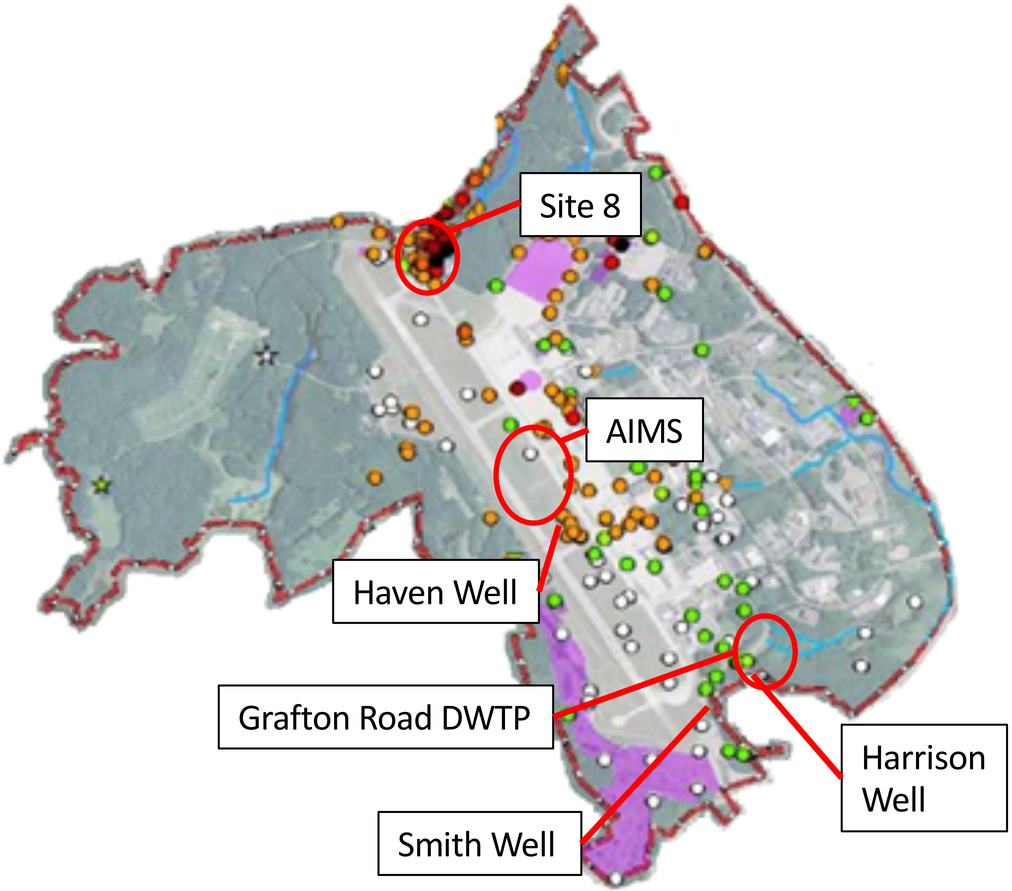
- **Weekly meetings (initially) either in-person or via teleconference:**
  - City of Portsmouth Staff
    - City consultants
  - Pease Development Authority
  - Environmental Protection Agency
  - New Hampshire Department of Environmental Services
    - Waste Division
    - Drinking Water and Groundwater Bureau
  - Air Force Civil Engineering
    - Air Force Consultants
  - New Hampshire Health and Human Services
  - Agency for Toxic Substances and Disease Registry (ATSDR)
  - Others, depending on topic

Public Involvement:

- Presentations to Portsmouth City Council
- Haven Well Community Advisory Board
  - 14 public meetings in 2014
- Blood Testing
  - March 31st, 2015 – Public Meeting where NHHS Announces Protocol for Pease Blood Testing
  - Three public meetings announcing blood test results
- ATSDR Community Assistance Panel
  - Formed in 2016 to address long-term health concerns
- Pease Restoration Advisory Board
  - Reestablished in 2016

Former Pease Air Force Base

- Three treatment systems
  - Site 8 (remediation)
  - AIMS (remediation)
  - Grafton Road (drinking water)

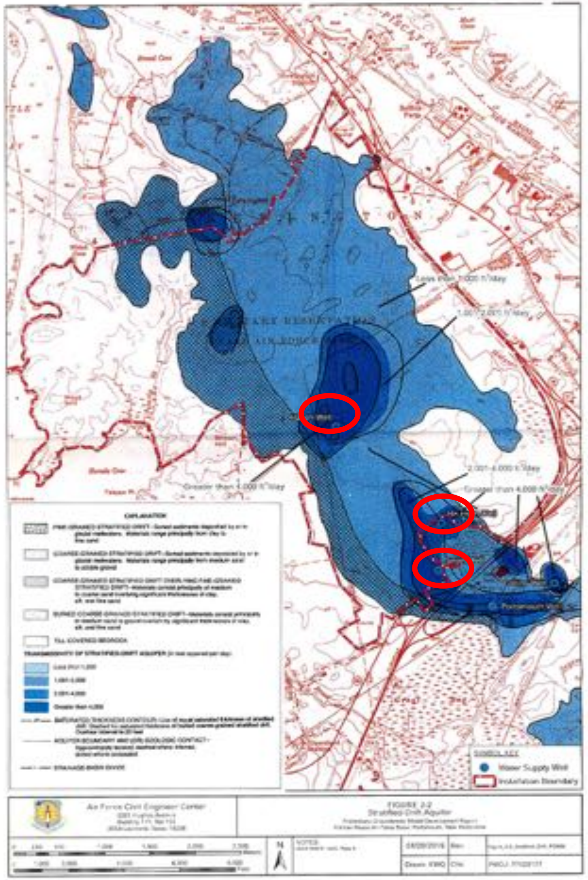


Drinking Water Sources

Initial Haven Well sample came back at 2.5 μg/L

Well	Flow Rate (gpm)	PFOA+PFOS (μg/L)
Harrison	286	0.029
Smith	343	0.012
Haven	534	1.495

Average PFOA+PFOS concentrations, Harrison and Smith: 2016-2017, Haven: 2016



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Existing Facility

GAC Piloting – Harrison and Smith

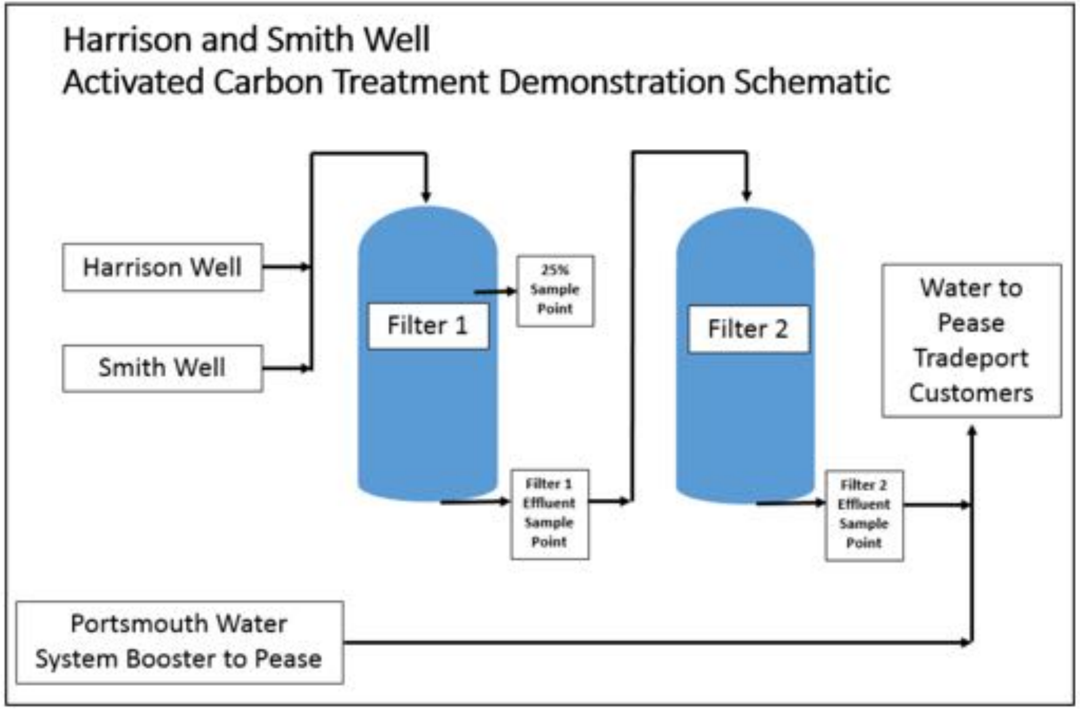
- Purpose – monitor GAC effects on pH
  - Potential issues with orthophosphate effectiveness

Demonstration Study

Purpose

- Test GAC effectiveness on Pease (Harrison and Smith) water
- Test new media
- Further research treatment alternatives
- Evolving regulations
- Design of permanent facility

Demonstration Filter Schematic



GAC Filter Installation

Demonstration Filter Results

(September 2016 – present)

- 35 months of operation, ~425,000,000 gallons treated (82,000 BV)
  - GAC works well for low levels of PFOA/PFOS
- Media in PV2 replaced March 2018, All media replaced in November 2018
- Most recent sampling event (July 8, 2019 - 79,000,000 gallons/15,000 BV):
  - PFHpA at 50% sample port of PV1
  - PFOA at 50% sample port of PV1
  - PFBS at 50% sample port of PV1
  - PFHxS at 50% sample port of PV1
  - PFOS at 50% sample port of PV1
  - PFPeA at 100% sample port of PV1
  - PFHxA at 100% sample port of PV1
  - PFBA at 100% sample port of PV2
- Concentrations near detection limits are difficult to trend

Objectives of Haven Well Pilot Test

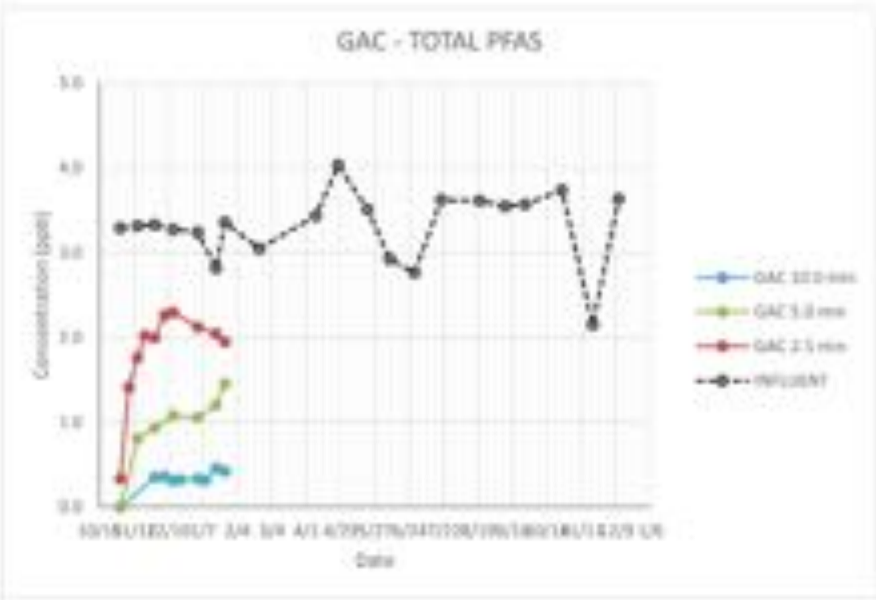
(November 2017 – December 2018)

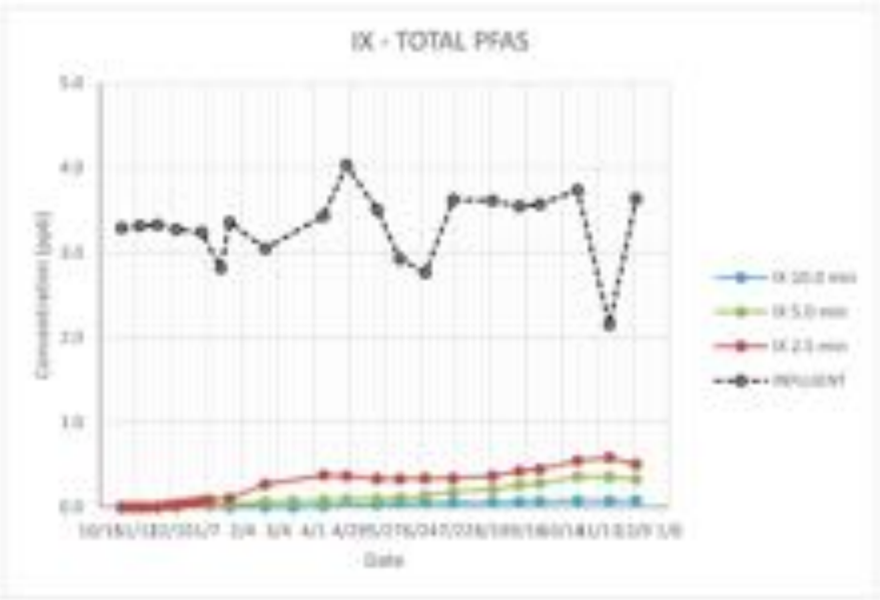
- Uncertain if GAC would perform well for significantly higher levels of PFAS.
- Compare the ability of media to remove PFAS from the Haven Well
  - IX Resin = ECT's SORBIX LC1
  - GAC = Calgon's F400
- Confirm design parameters and system sizing to be used in the preparation of the full-scale treatment system technology evaluation.
- Select PFAS-removal technology for full-scale implementation based on lifecycle cost comparison and risk

Haven Pilot Setup

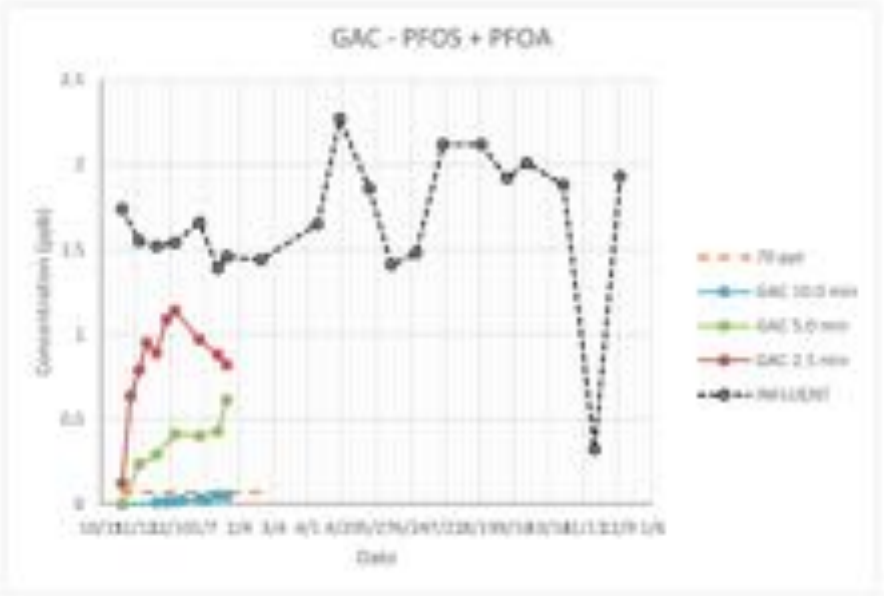
- Fabricated dual sided pilot skid for side-by-side testing: IX Resin vs. GAC
  - Each side:
    - Design flowrate of 112 gpd
    - 4 columns in series, 2.5-min EBCT each
    - 1.25-inch column diameter
    - 30-inch media bed height
- Sampled & analyzed for 23 PFAS compounds out of each column

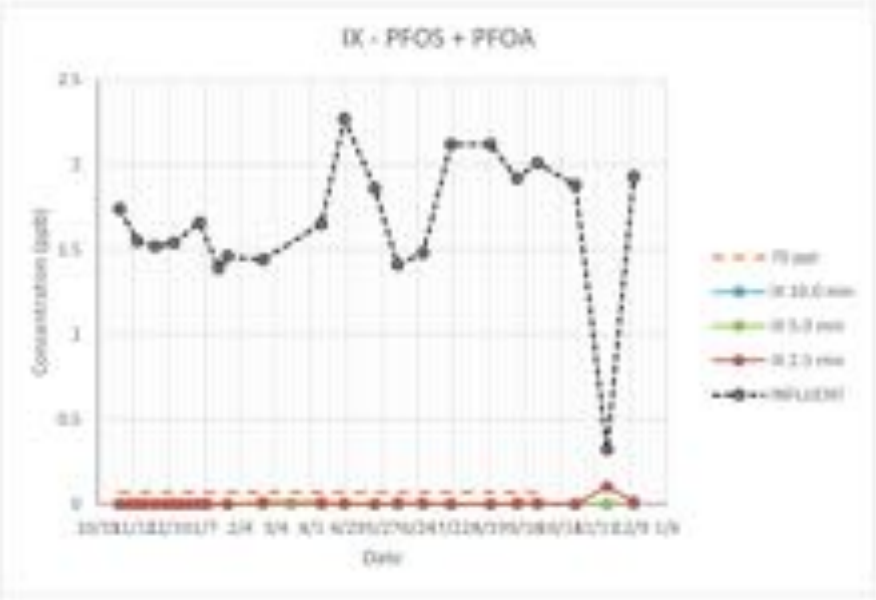
Haven Pilot Results



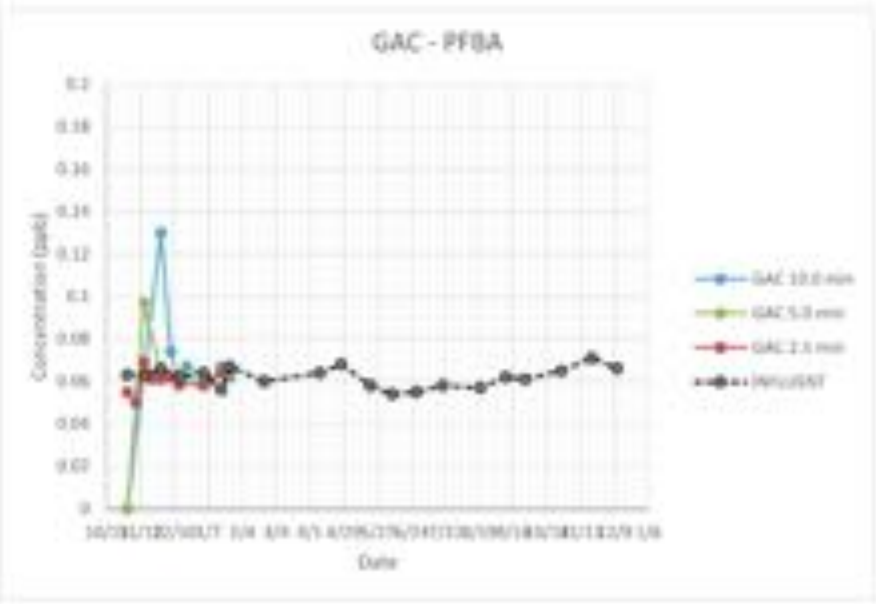


Haven Pilot Results





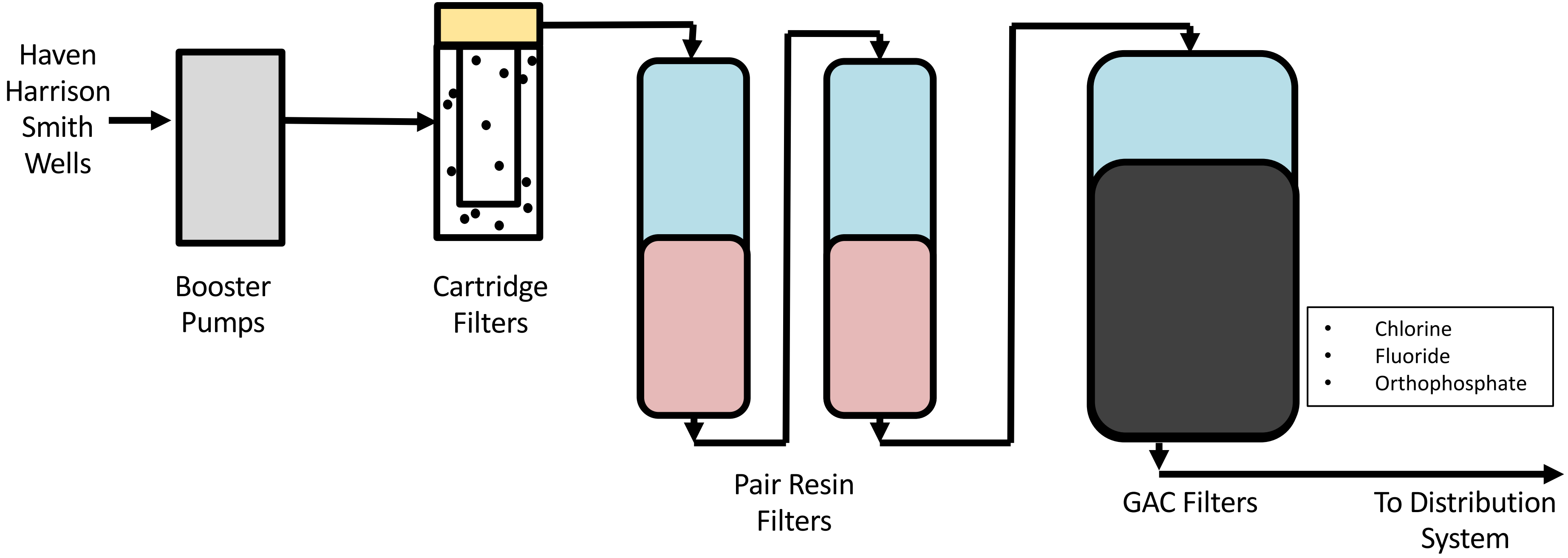
Haven Pilot Results



Haven Pilot Conclusions

- Resin significantly outperforms GAC when raw water PFAS concentrations are high
- Resin removed short chain compounds better than GAC
- As regulations move PFAS limits lower, the advantages of resin over GAC goes up

Grafton Road Water Facility Process Schematic
New Treatment System



Twenty Year Present Worth Analysis
Grafton Road Drinking Water Treatment Plant

Treatment Option	Construction Cost		Operations Costs		Present Worth Cost (20 year, 4%)
	Vessels and Media	Credits*	Annual Media Cost	Increase Electrical Cost Due to Additional Headloss	
GAC Only Treatment	$2,140,000	-	$304,000	-	$6,271,000
Resin in Parallel and GAC in Series	$2,430,000	-	$91,300	$2,000	$3,898,000
Resin in Series and GAC in Parallel	$2,625,000	$(910,000)	$99,300	$8,000	$3,173,000

* Credits associated with reduction in building footprint and elimination of backwash supply and recycle tanks

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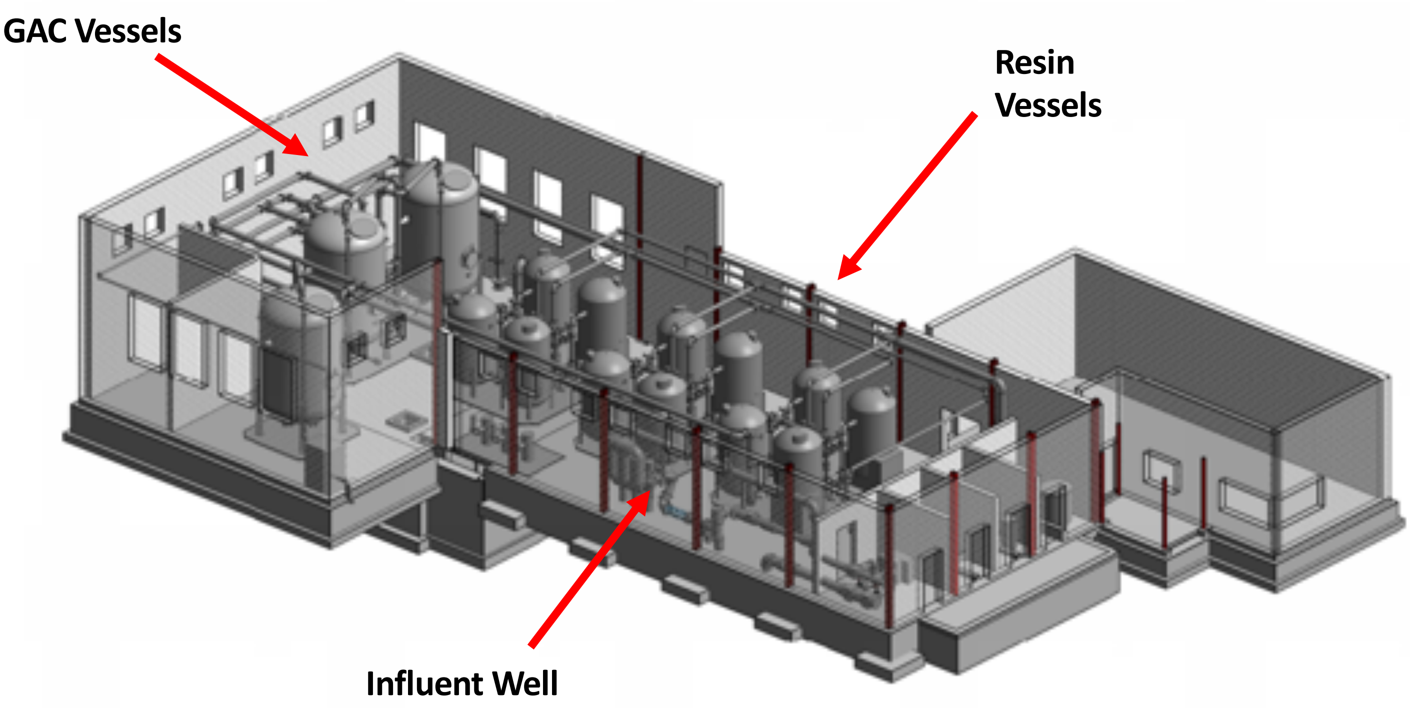
Proposed Final Layout



Case Study: Former US Army Base Fort Devens

- Devens, MA
- Base shut down in 1996
- Majority overseen by MassDevelopment
- Expanding office space with some light industrial, college buildings, golf course, restaurants

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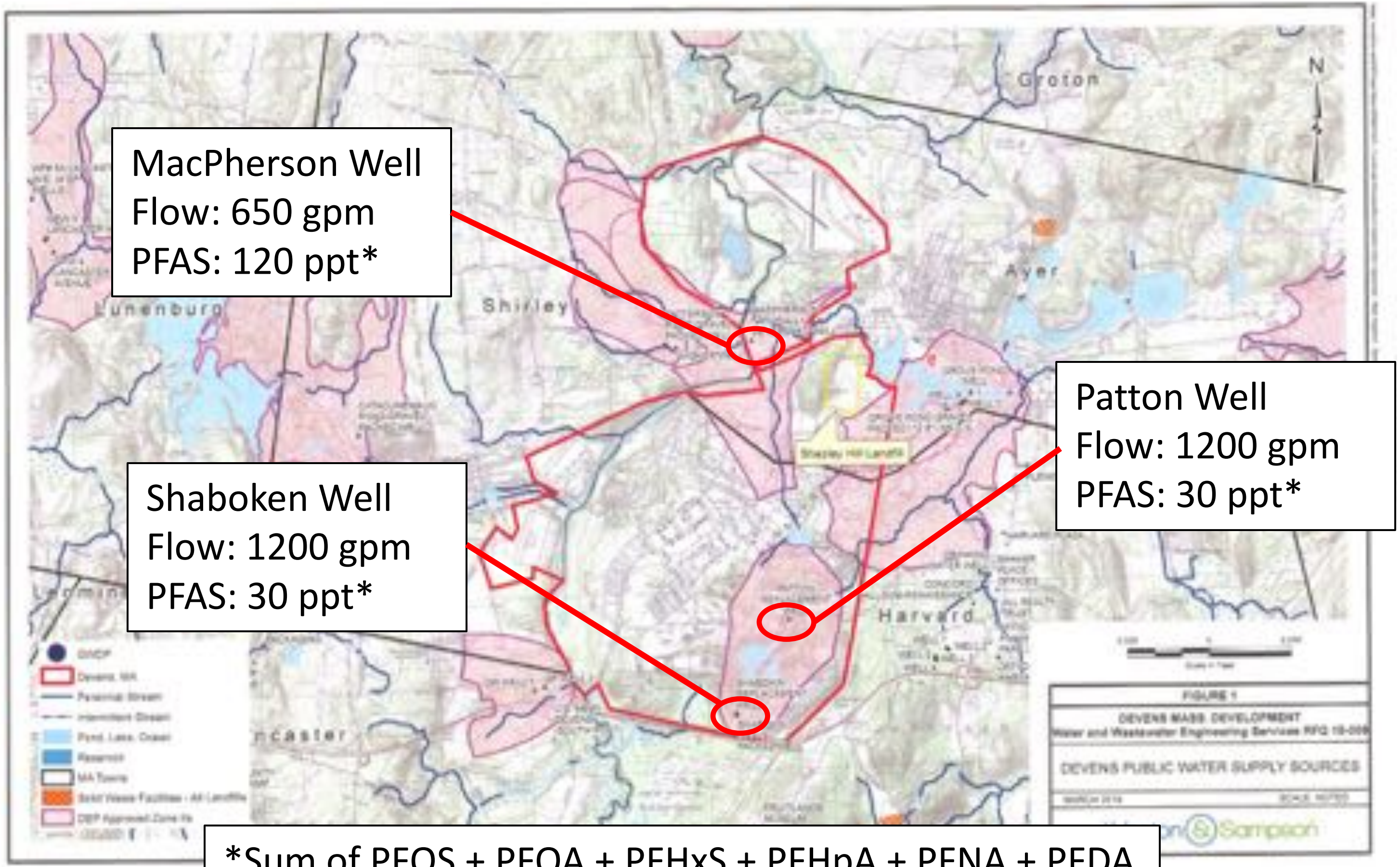


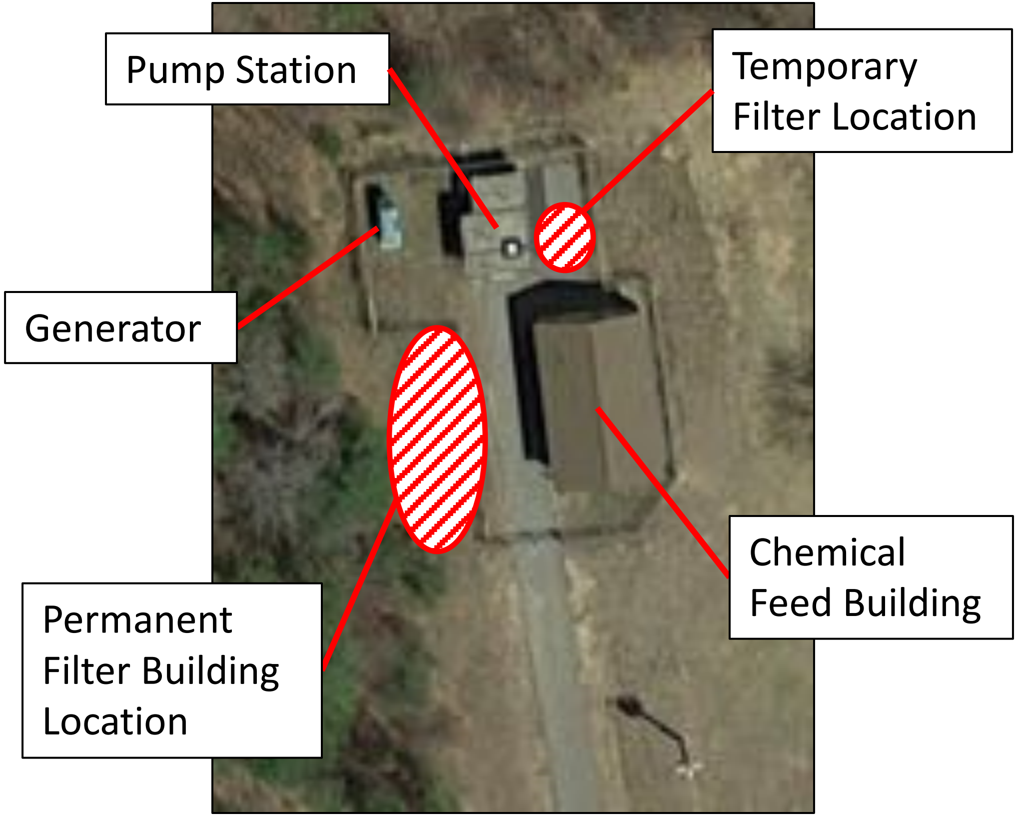
*Sum of PFOS + PFOA + PFHxS + PFHpA + PFNA + PFDA

MassDEP PFAS Guidelines

- May 2016 – EPA Health Advisory
  - **70 ppt (PFOS + PFOA)**
- June 2018 – Office of Research and Standards Guideline (ORSG)
  - 70 ppt (PFOS + PFOA **+ PFHxS + PFHpA + PFNA**)
- April 2019 – GW-1 Standard
  - **20 ppt** (PFOS + PFOA + PFHxS + PFHpA + PFNA **+ PFDA**)

MacPherson Well

- Well capacity: 650 gpm
- PFAS: ~120-130 ppt
- Temporary Design
  - Single 10’ GAC vessel
  - 400 gpm (10 min EBCT)
  - Insulated stick built structure (installed at later date)

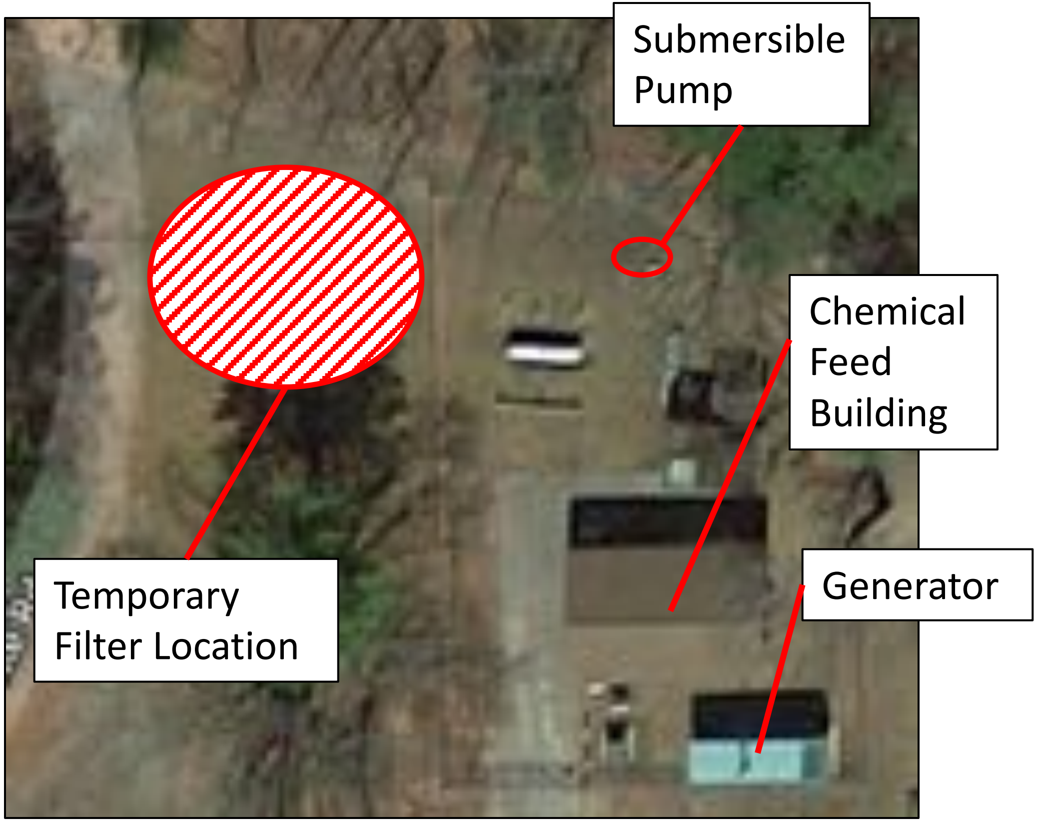


MacPherson Well Temporary Filter

~4 months from initial meeting with DEP to startup to distribution system

Shaboken Well

- Well capacity: 1,200 gpm
- PFAS ~30-40 ppt
- Temporary Design
  - Two pair 12' GAC vessels
  - Up to 900 gpm (10 min EBCT)
  - Insulated membrane structure (installed at later date)



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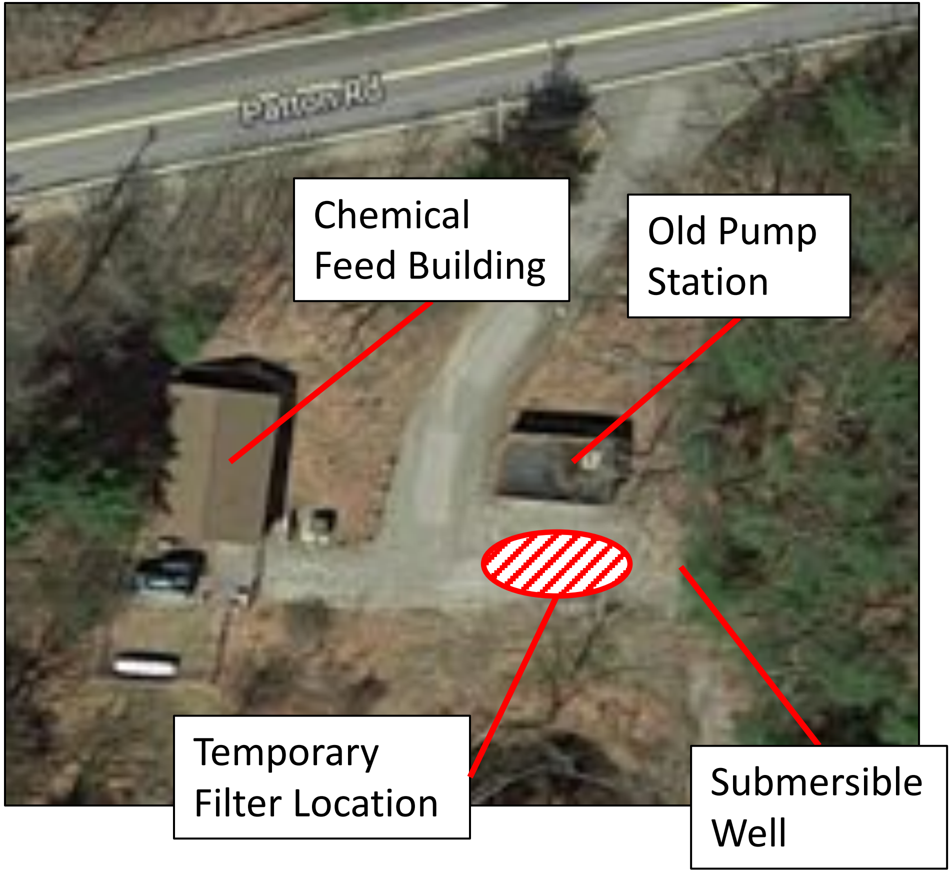
Shaboken Well Temporary Filters

Patton Well

- Well Capacity: 1,200 gpm
- PFAS ~30-40 ppt
- Temporary Design
  - Three 4' diameter resin filters
  - 200 gpm each (parallel flow)
  - Insulated storage container



Useful Websites

ITRC FACT SHEETS
https://pfas-1.itrcweb.org/fact-sheets/

EPA PFAS Webpage
https://www.epa.gov/pfas

Northeastern University PFAS Project
https://pfasproject.com/

Questions?

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