

Bioremediation of Perfluoroalkyl Substances

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Tote Study

In Situ Study

Additional Information



115th Fighter Wing Field Pilots

- Completed as a joint venture between Fixed Earth and ORIN.
- Two field studies in 2021/2022:
 - Treatment of highly impacted water ex-situ
 - Refinement of in-situ bioremediation methods
- Testing of ORIN's BAM product line to enhance microbe performance.
- Prior to field studies, site-specific microbes were acquired and tested in lab conditions.
- Testing of alternative methods to create aerobic conditions.





Case Study: Truck Flush Water

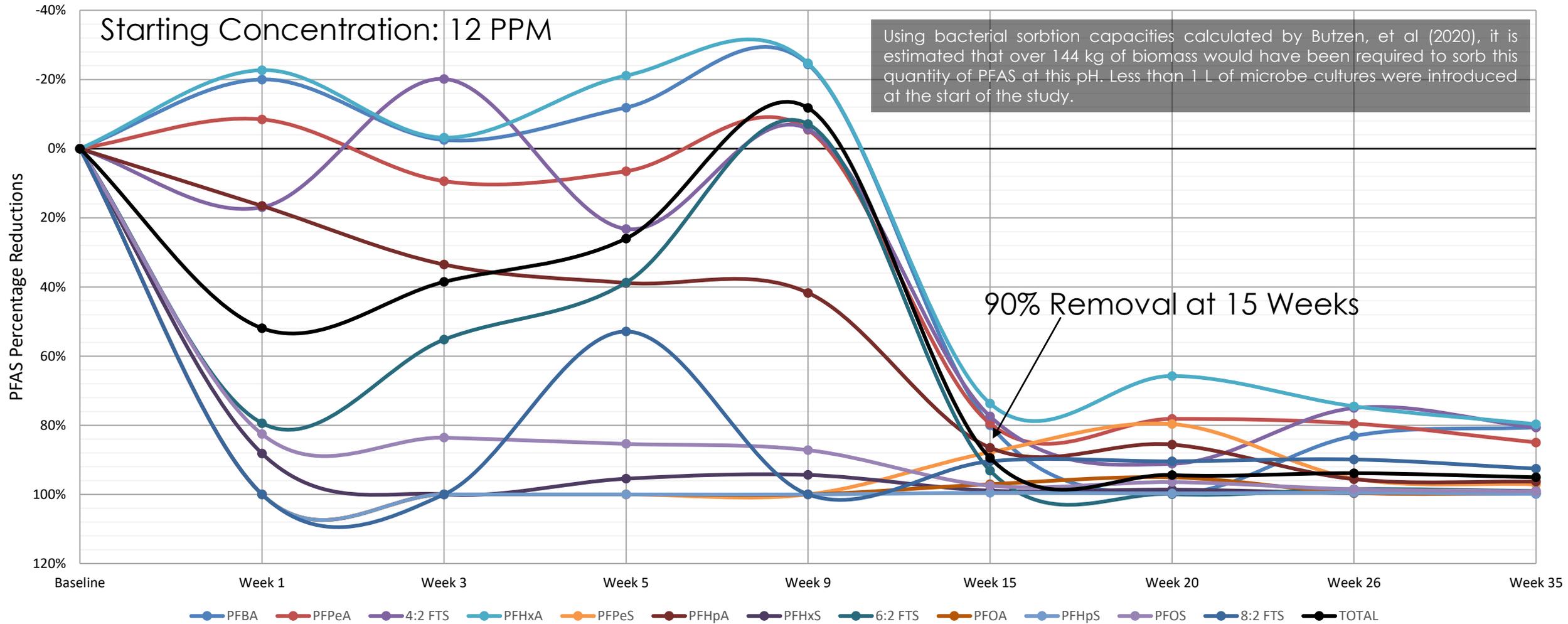
- Rinse water from flushing fire fighting trucks containing PFAS AFFF.
- Four plastic totes were treated.
- Total PFAS concentrations ranged from 7 to 33 ppm.
- Field pilot commenced in summer 2021 and was monitored for 35 weeks.

Case Study: Truck Flush Water

- Dosage consisted of BAM Ultra, PFAS degrading microbes, calcium peroxide, and air sparge
- Only one tote did not receive BAM Ultra to test microbes alone
 - Calcium peroxide for initial oxygen boost
 - Air sparge for sustained oxygen supplementation
- Aeration generated foam
 - Foam control was implemented

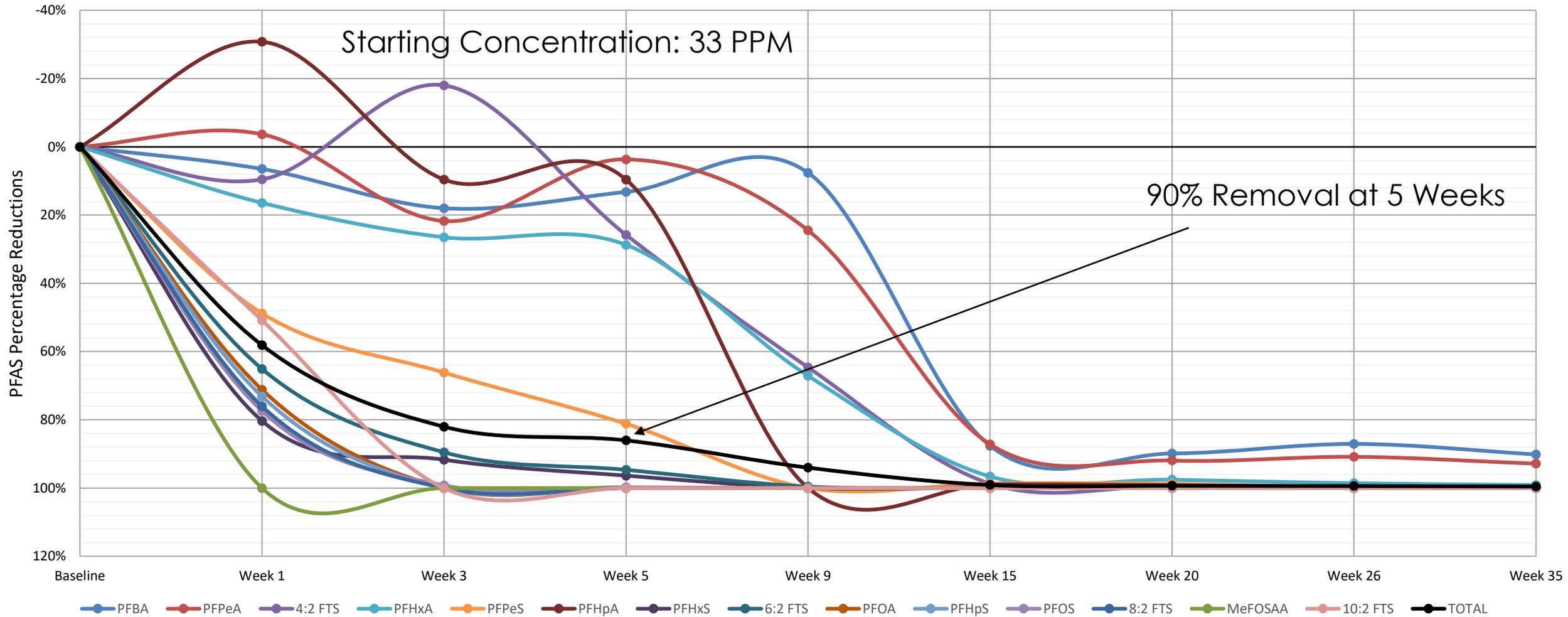


Tote 2 - PFAS Degrading Bacteria Alone



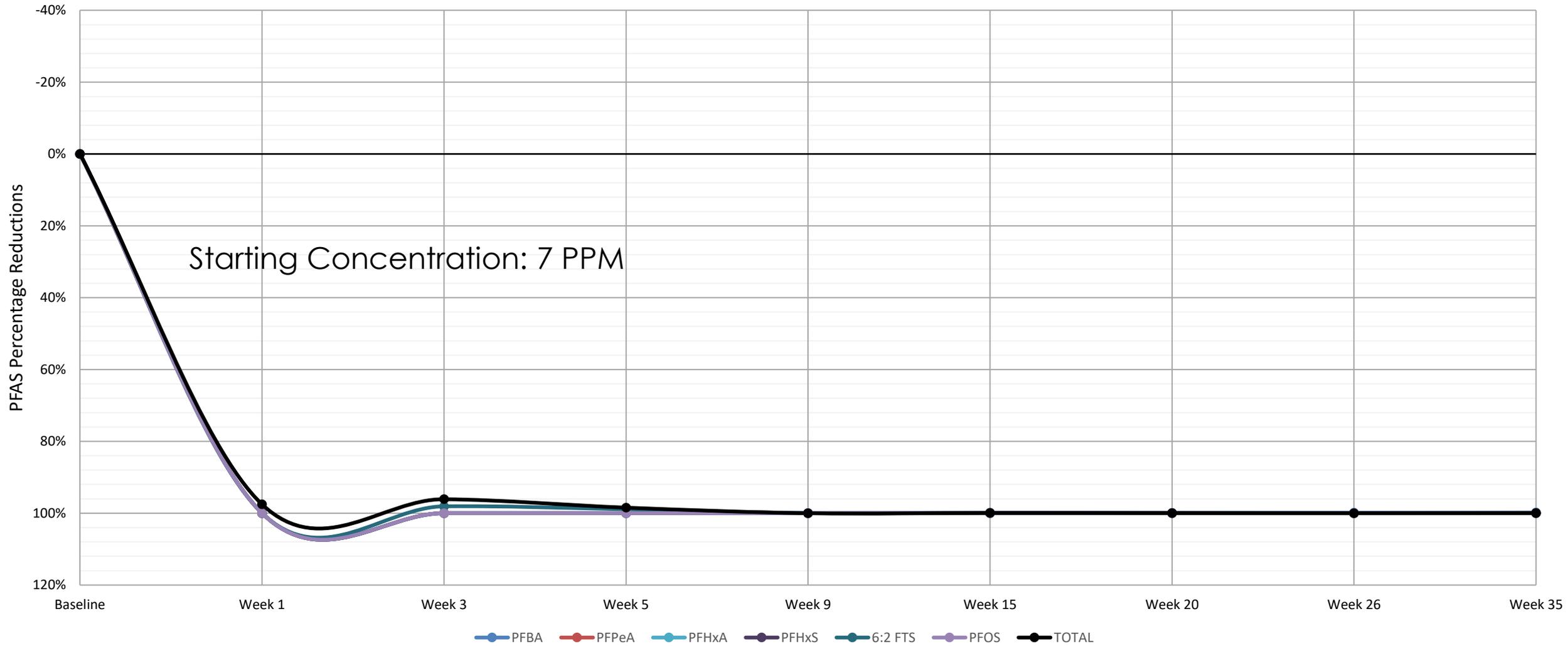
Tote 2 – Microbes Only – Percent Removal

Tote 1 - BAM Ultra with PFAS Degrading Bacteria



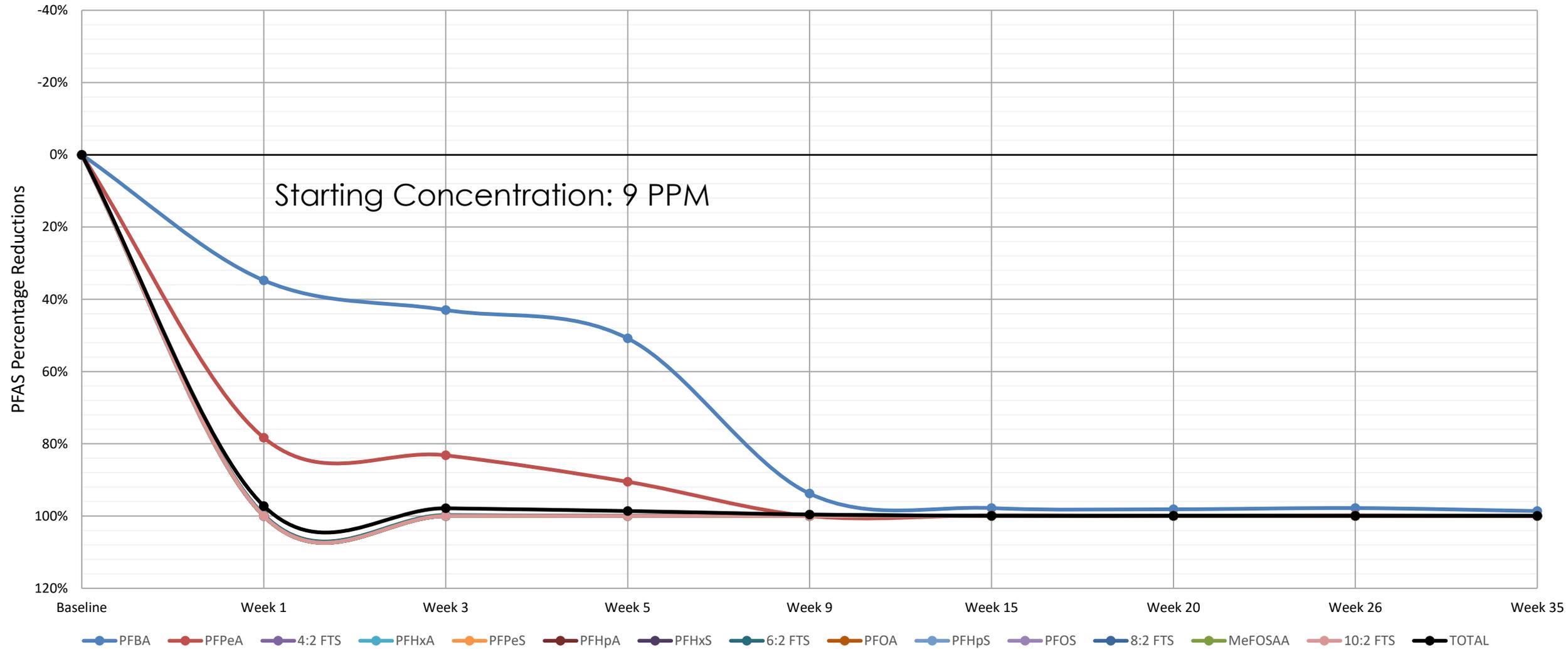
Tote 1 – BAM and Microbes – Percent Removal

Tote 3 - BAM Ultra with PFAS Degrading Bacteria



Tote 3 – BAM and Microbes – Percent Removal

Tote 4 - BAM Ultra with PFAS Degrading Bacteria



Tote 4 – BAM and Microbes – Percent Removal

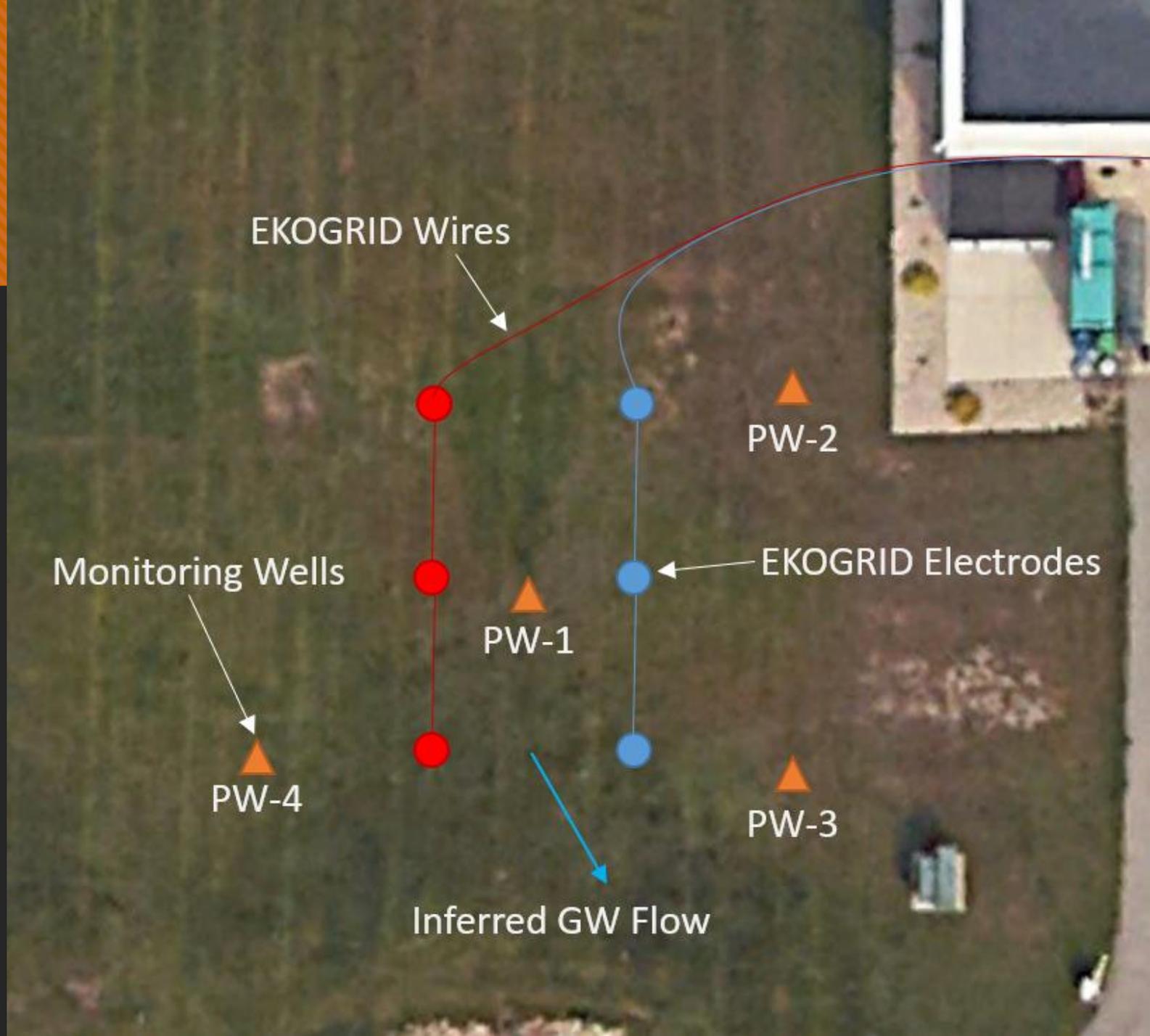
Pilot Scale In-Situ Treatment

- Small treatment area located adjacent to firefighting building where PFAS was known to occur in groundwater.
- Study commenced in late November 2021.
- Four monitoring wells were installed in treatment area to measure performance.
- Geoprobes were used to inject a mixture of BAM, site-specific microbes, and calcium peroxide over a 20 foot interval.
- 17 Injection points over a 1,600 square foot area with a 25 foot total depth.
- PFAS data has been monitored 1 year with rebound study in progress.
- Groundwater parameters (DO, pH, EC, temperature, etc.) are monitored weekly.
- Groundwater flows to the southeast.
- Aerobic conditions maintained through deployment of oxidation system by Signum Environmental (Calgary, AB).

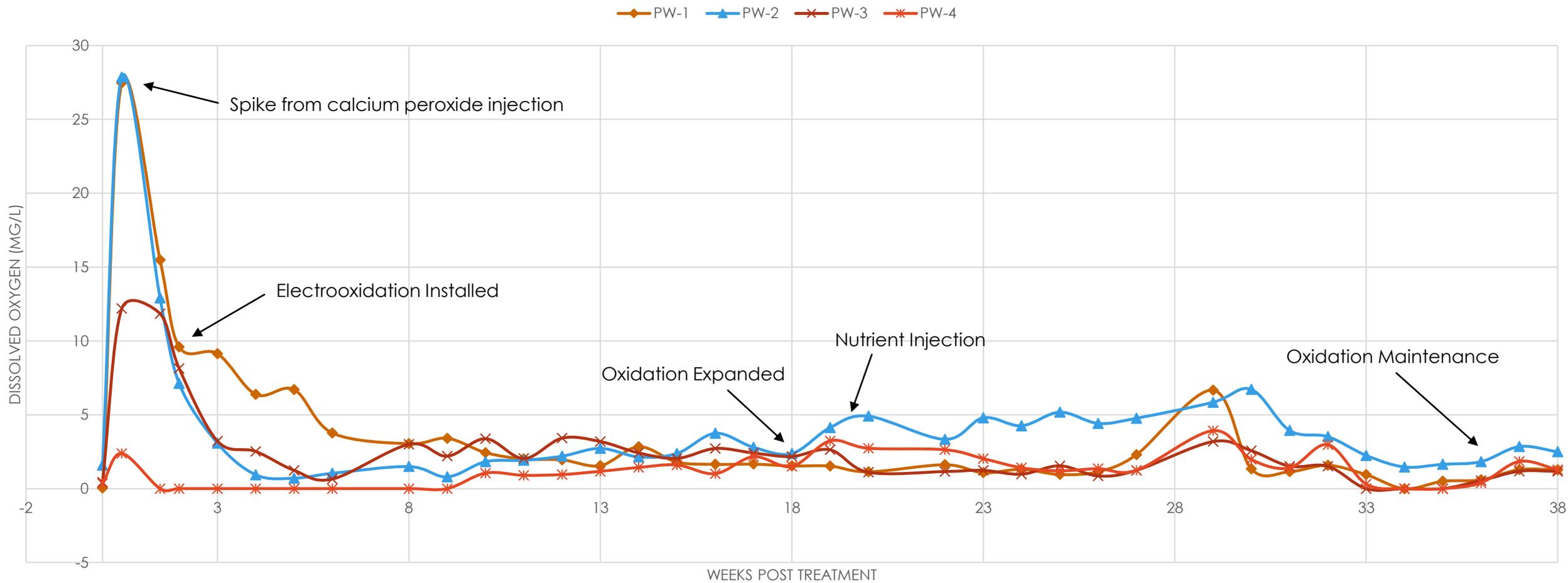


Site Configuration

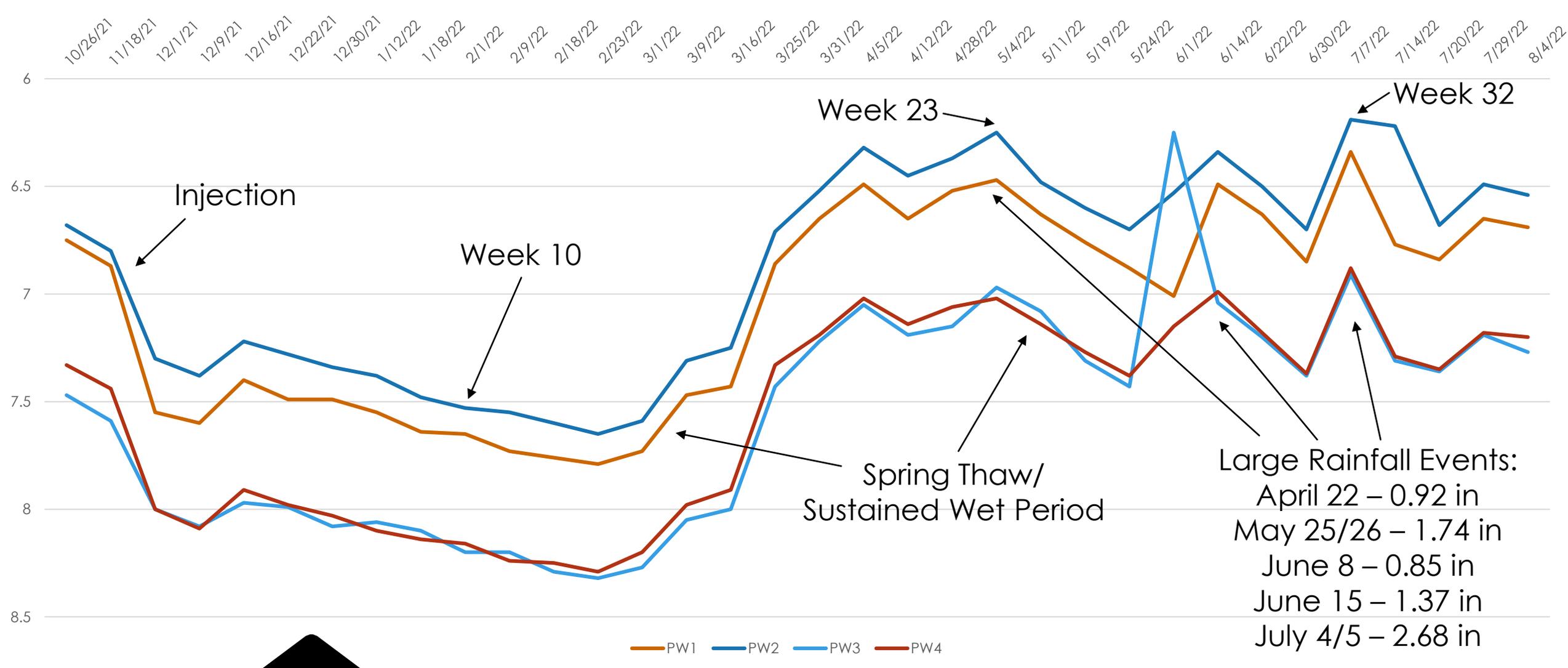
- Two weeks following the injection an electrooxidation unit was installed to maintain elevated dissolved oxygen in the treatment area.
- Electrooxidation is a technology that uses alternating square-wave direct current to generate oxygen from groundwater.
- 10-16 volts are utilized, electrodes and wires are flush with ground, minimizing impacts to airport operations.
- Elevated oxygen is observed in PW-1 and PW-3 and has maintained biological activity in these areas.
- PW-2 and PW-4 returned to anaerobic conditions after the initial injection and minimal biological activity has been observed.



DISSOLVED OXYGEN CONCENTRATIONS

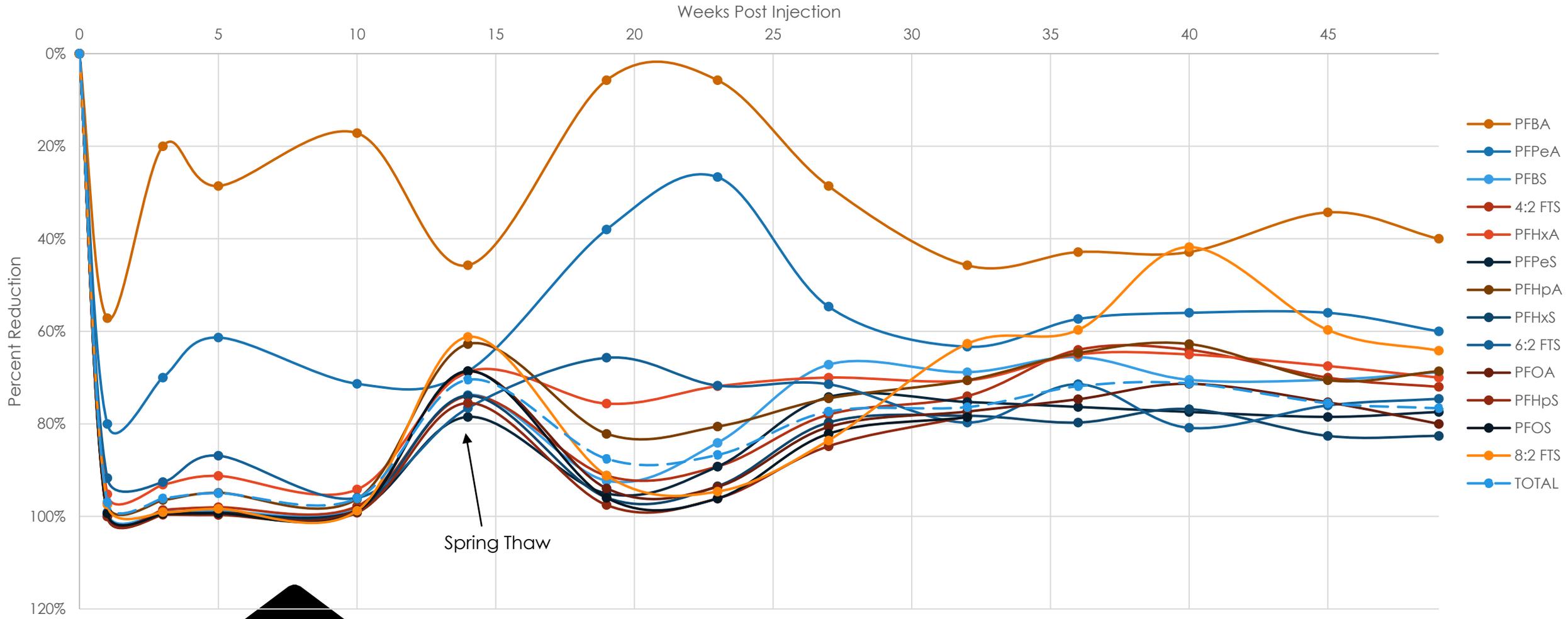


Dissolved Oxygen Monitoring Data



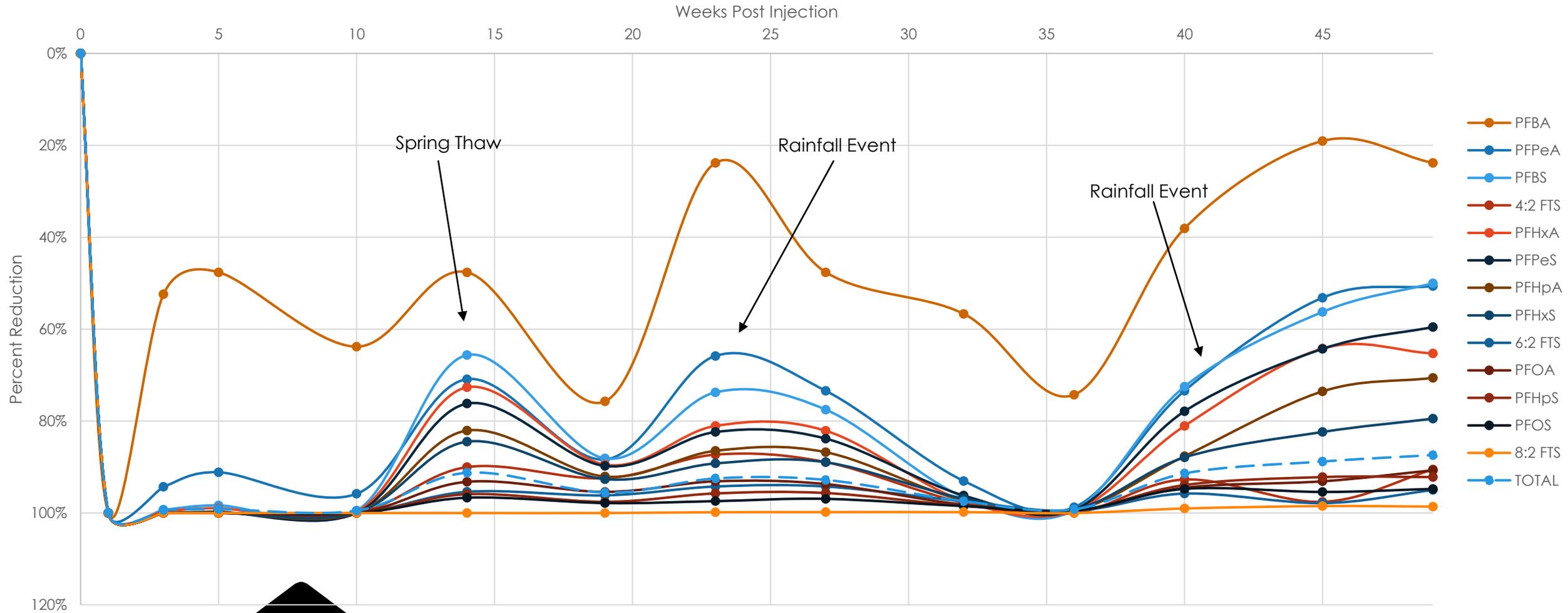
Depth to Groundwater (ft)

PW-1 Baseline to 49 Weeks Post Injection



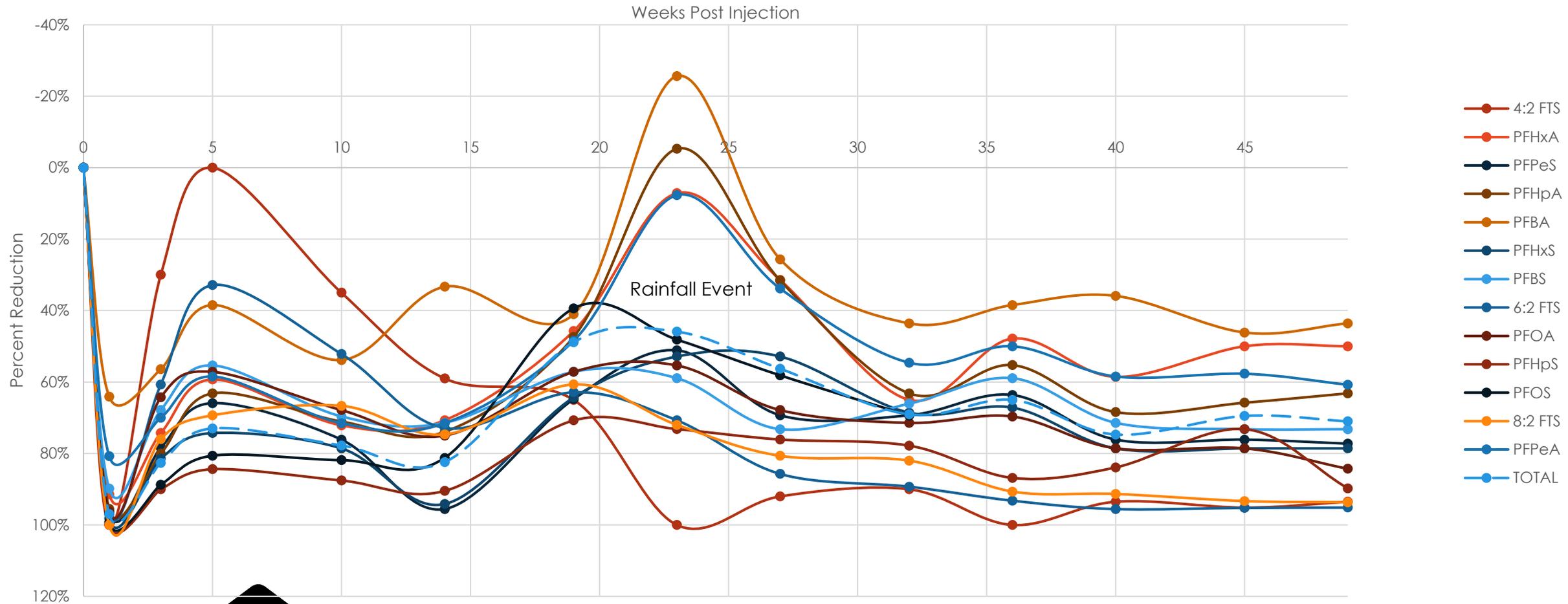
Center Well PW-1 PFAS Monitoring Data

PW-3 Baseline to 49 Weeks Post Injection



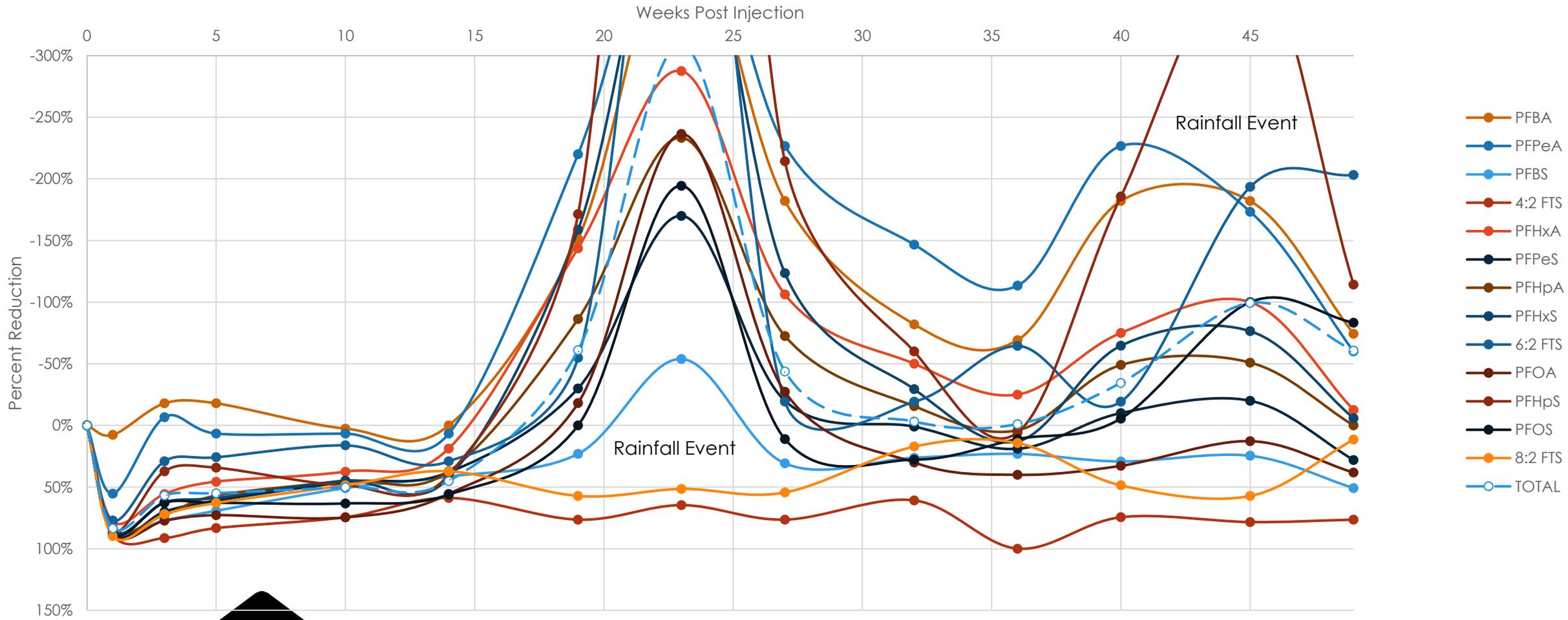
Down Gradient PW-3 PFAS Monitoring Data

PW-2 Baseline to 49 Weeks Post Injection

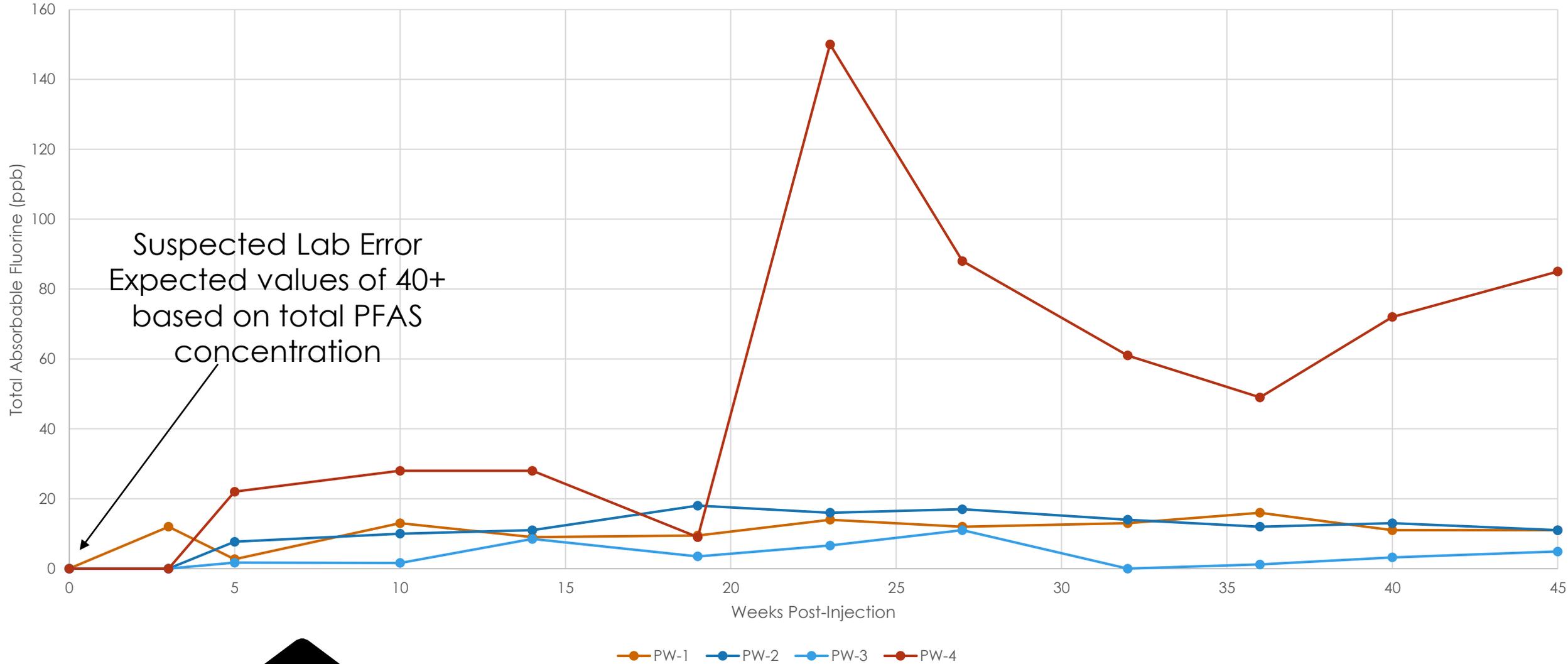


Side Gradient PW-2 PFAS Monitoring Data

PW-4 Baseline to 49 Weeks Post Injection



Up Gradient PW-4 PFAS Monitoring Data



Total Absorbable Fluorine Data

Announcing Onur Solutions, a Fixed Earth Innovations and ORIN Technologies joint venture to expand our PFAS destruction technologies.



Further Questions?

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