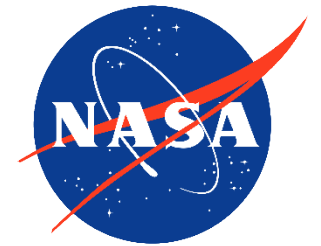


TETRA TECH



Mitigating PFAS in Streams

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May 10, 2023

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Presentation Overview

- PFAS Investigation in Seeps and Streams
- Seep Treatment
- Temporary Stream Treatment
- Conclusions & Recommendations

PFAS in Surface Water - Seep and Stream

- Per and polyfluoroalkyl substances (PFAS) have been detected in the natural waterways (streams and seeps) at the National Aeronautics and Space Administration (NASA) Wallops Flight Facility (WFF), Virginia.



- Samples were collected from the streams to determine if PFAS was present.
- PFAS was detected in water from seeps and in streams.
- Contributing source of PFAS were identified.
 - A hillside seeping water into the near by stream with high concentration of PFAS from Former Fire Training area (FFTA).
 - Effluent from the Wastewater Treatment Plant (WWTP) in a creek through outfall.
 - A series of seeps flowing into the streams

Seep Treatment



SeepSorber™



Seep Treatment

- A seep treatment system with the flow rate of approximately 1 gpm was designed and installed to mitigate and treat PFAS in the seep water before flowing into the stream.
 - Water is captured from the seep and directed into a Capture Box using natural methods.
 - From the Capture Box, the water flows through gravity to the Treatment Box.
 - The Treatment Box contains PFAS adsorption media.
 - The PFAS treated seep water is then discharged into the stream.

Seep Treatment



SEEP

Capture Box

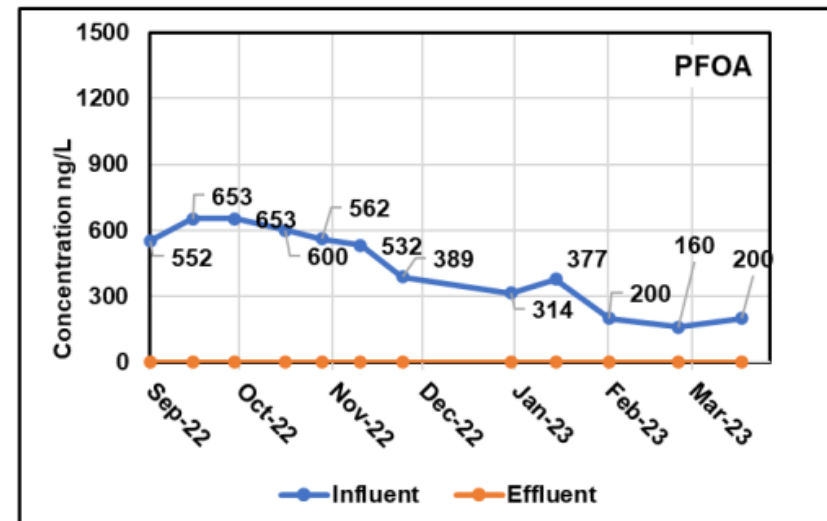
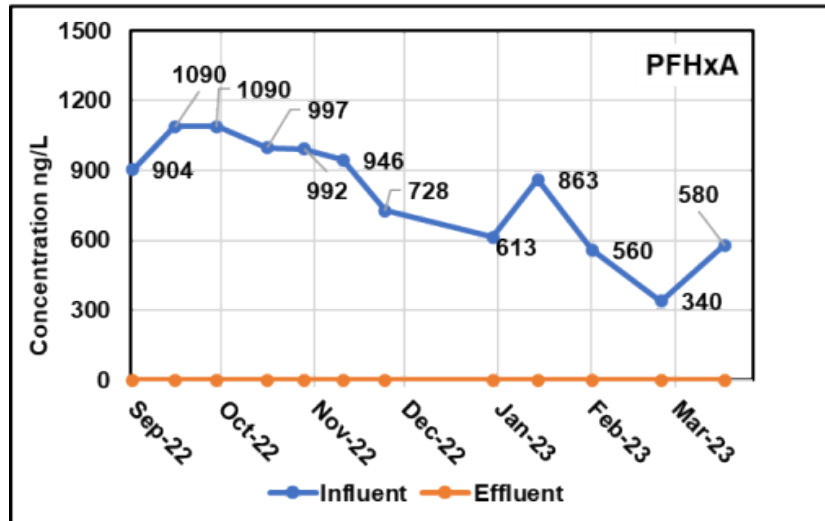
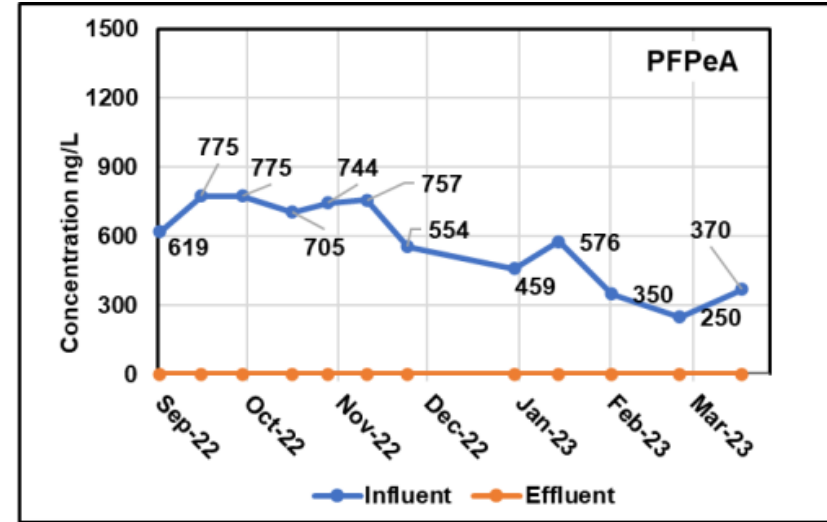
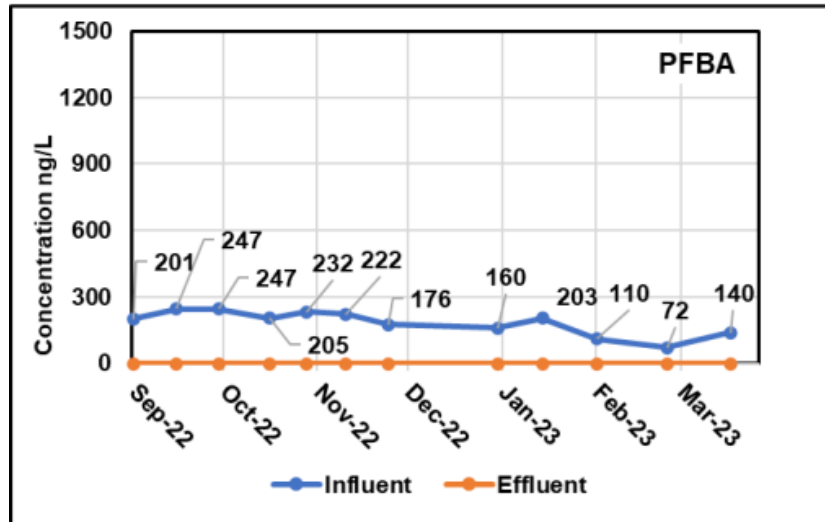


Outfall and Stream

Seep Treatment Box

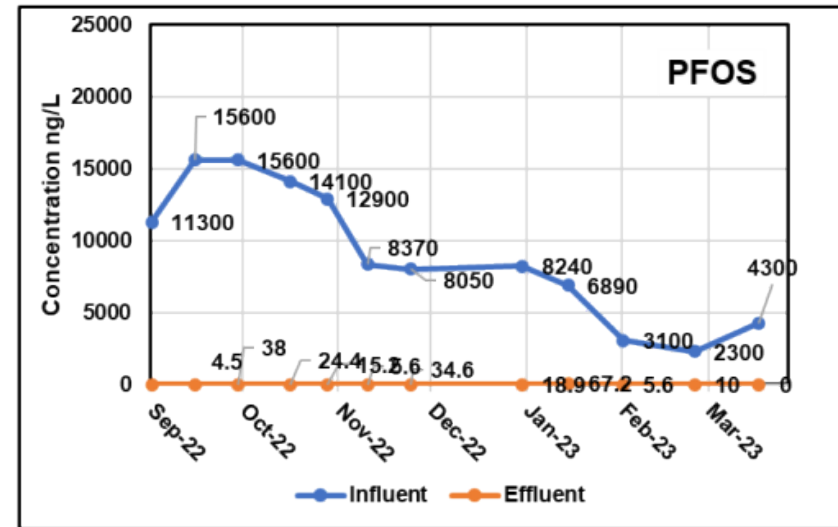
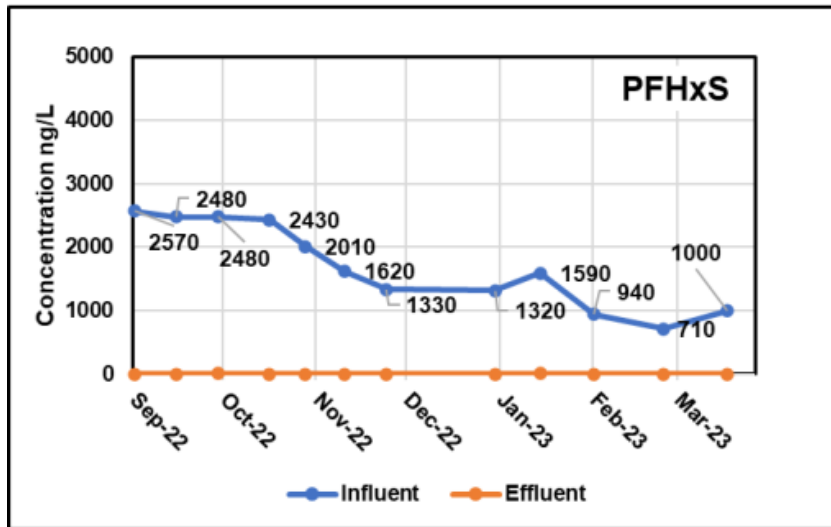
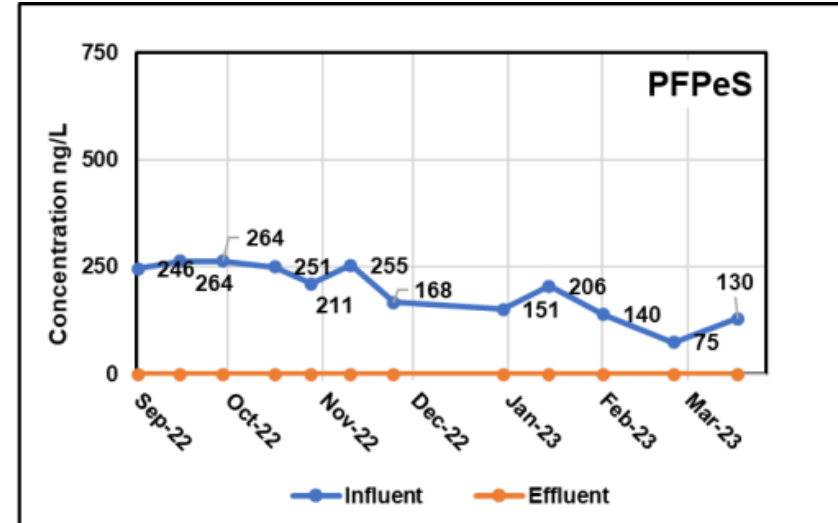
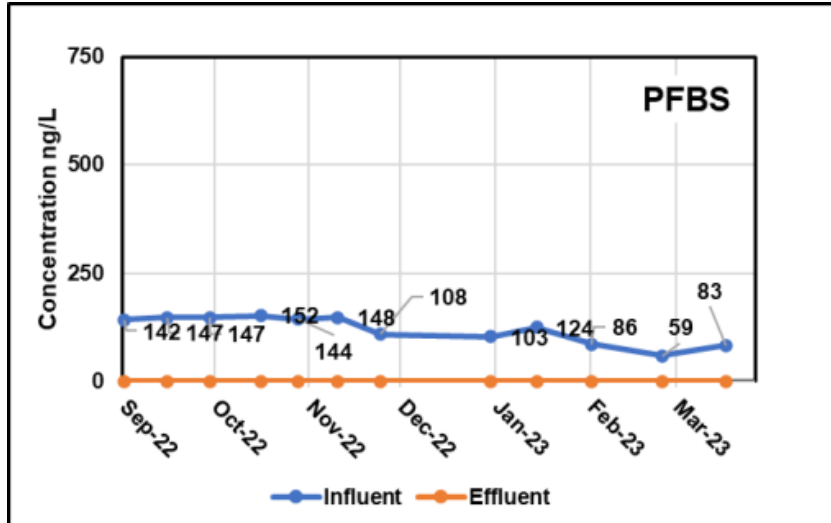


Seep Treatment Charts



The seep treatment system continues to treat PFAS in water before discharging to stream.

Seep Treatment Charts

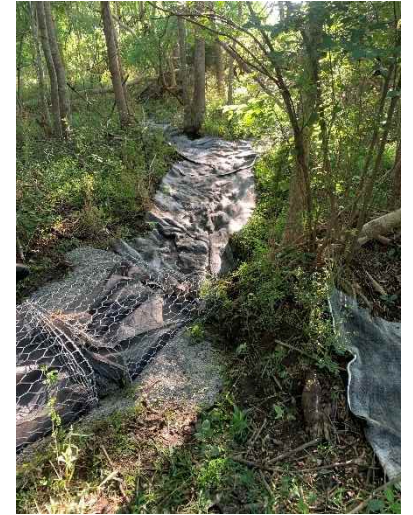


The seep treatment system continues to treat PFAS in water before discharging to stream.

Temporary Stream Treatment



Temporary Measure for Stream Treatments



Stream Treatment

- Multiple contributing sources of PFAS in the stream
 - Seeps (point source)
 - Groundwater
- Mitigation of PFAS into the stream
 - Install Temporary Stream Treatment
 - Evaluate and Design Permanent Treatment System
 - Install Permanent Treatment System
- Temporary treatment system allows for
 - Capturing and treatment of PFAS in the stream
 - Ease of construction
 - Minimal impact to the environment.

Temporary Stream Treatment

- The temporary treatment system consist of:
 - A series of gabion baskets filled with a treatment media (FLUORO-SORB®) for PFAS adsorption
 - Mats with embedded PFAS treatment media
 - An isolating media to seal off the bottom and sides of the channel to help prevent short circuiting around the treatment media
 - Pea gravel used to filter sediments and debris
 - Existing rocks and sandbags to help channel the water flow and secure the treatment equipment and material



Gabion

Sealing media

Mat

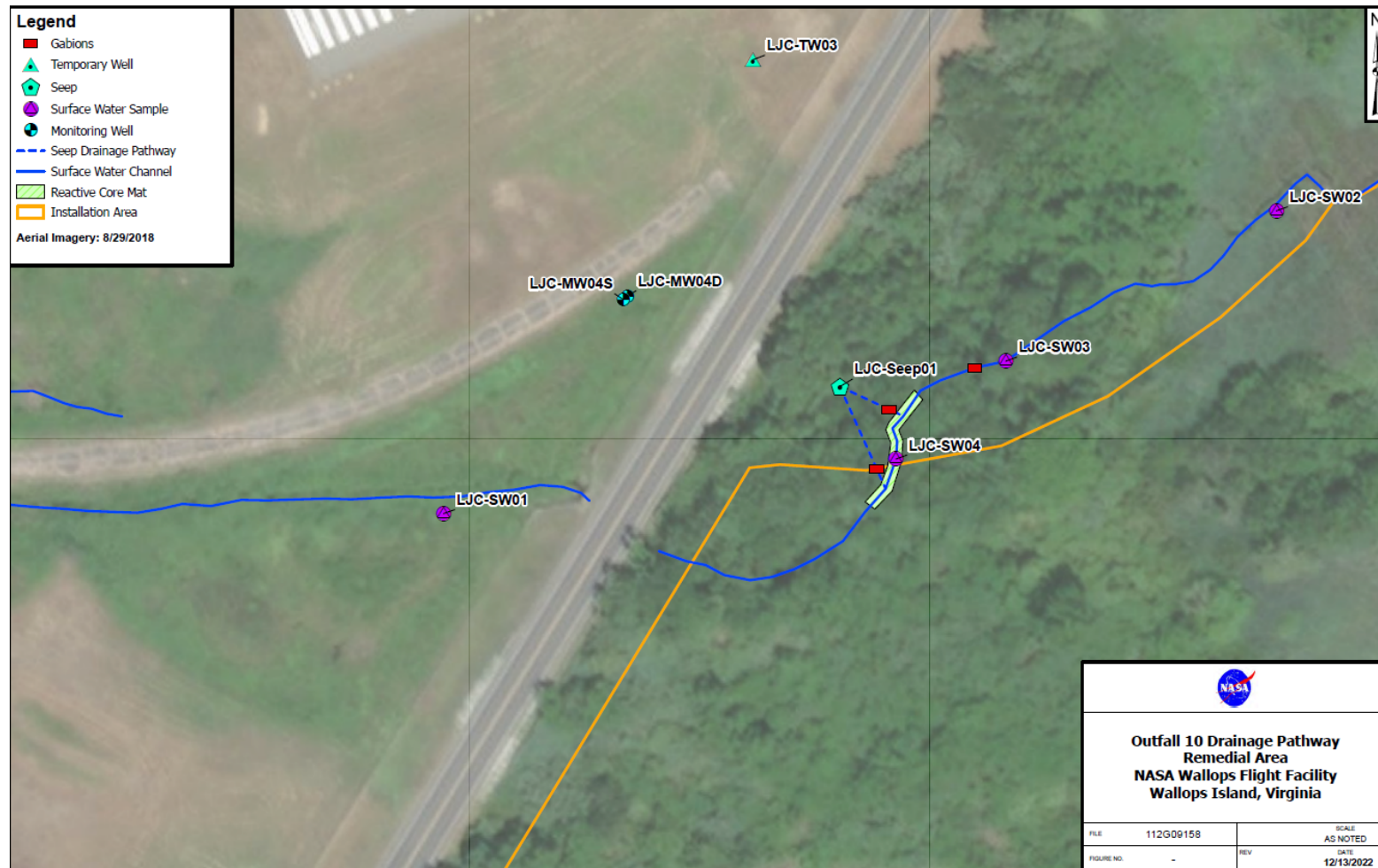


Stream Treatment

- The primary purpose of the mat is to treat the groundwater flowing into the stream through the stream bed.
- System is designed to allow stream water to pass through only the treatment media and prevent short circuiting around the treatment area.



Stream Treatment Location (Outfall 10)



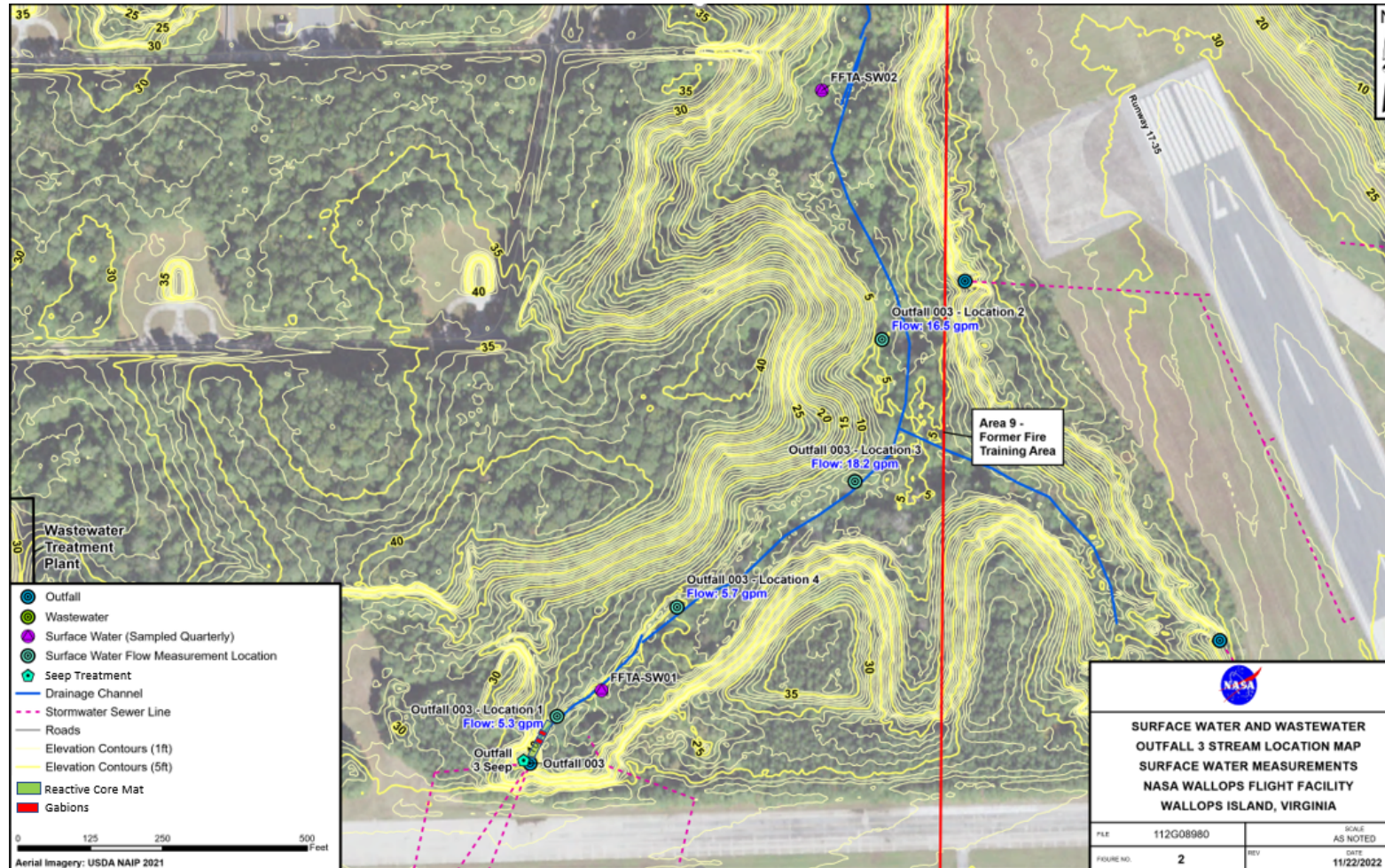
Temporary Stream Treatment System Installed at Outfall 10 Stream at NASA WFF facility.

Stream Treatment (Outfall 10)

PFAS	Event 1 (10/12/22)		Event 2 (01/26/23)	
	LJC-SW01 (Upstream, 0.25 miles) (ng/L)	LJC SW03 (Downstream, 50 ft) (ng/L)	LJC-SW01 (Upstream, 0.25 miles) (ng/L)	LJC SW03 (Downstream, 50 ft) (ng/L)
PFBA	12.4	14.5	14.0	17.0
PFPeA	29.6	33.7	33.0	44.0
PFHxA	23.2	26.9	27.0	36.0
PFHpA	26.8	28.9	28.0	34.0
PFOA	23.6	26.5	27.0	26.0
PFNA	7.5	8.8	9.1	9.0
PFBS	0	2.1	1.8	3.5
PFPeS	0	2.6	2.2	3.9
PFHxS	25.3	38.8	31.0	87.0
PFOS	115.0	174.0	93.0	260.0

- Post treatment system sampling events saw an increase in the concentration of PFAS downstream of the stream treatment
- Additional PFAS may be entering the stream downgradient of the temporary treatment. This may be due to groundwater to surface water migration pathway
- Additional stream sampling and evaluation is ongoing

Stream Treatment Location (Outfall 3)



Temporary Stream Treatment System Installed at Outfall 3 Stream at NASA WFF facility.

Stream Treatment (Outfall 3)

PFAS	Event 1 (10/12/22)			Event 2 (01/26/23)		
	FFTA SW06 (Upstream, 50 ft) (ng/L)	FFTA -SW01 (Downstream, 100 ft) (ng/L)	FFTA-SE02 (Downstream, 1 mile) (ng/L)	FFTA SW06 (Upstream, 50 ft) (ng/L)	FFTA -SW01 (Downstream, 100 ft) (ng/L)	FFTA-SE02 (Downstream, 1 mile) (ng/L)
PFBA	22.6	32.3	40.1	18.0	11.0	25.0
PFPeA	63.8	87.6	131.0	45.0	32.0	83.0
PFHxA	82.4	114	117.0	65.0	39.0	74.0
PFHpA	56.0	66.3	85.2	30.0	18.0	48.0
PFOA	44.0	54.0	78.0	27.0	16.0	43.0
PFNA	11.6	11.5	24.3	5.8	4.2	14.0
PFBS	12.9	20.4	11.8	11.0	7.8	7.3
PFPeS	20.5	24.4	15.3	17.0	8.1	7.7
PFHxS	170.0	219.0	171.0	170.0	83.0	89.0
PFOS	1150.0	1780.0	1010.0	680.0	310.0	280.0

- PFAS concentrations downstream of stream treatment have varying levels of effectiveness
- Additional PFAS may be entering the stream downgradient of the temporary treatment. This may be due to groundwater to surface water migration pathway
- Additional stream sampling and evaluation is ongoing

Recommendation

- Develop Treatment Alternative for each outfall based on:
 - Ground survey to provide more precise elevation information to determine the feasibility of passive options
 - Applicable permitting requirements in wetlands and floodplains
- Determine best locations of treatment systems
- Additional Data Needs
 - Topographical survey of proposed collection and treatment areas
 - Field delineated Aquatic Resources Survey (Wetlands)
 - Detailed utilities information
 - Additional stream flow measurements
 - Additional surface water analytical data (water quality data that could affect treatment design)
 - Characterize groundwater-surface water interface
 - Hydraulic testing

Conclusion

- Passive seep and stream treatment systems provide
 - Ability to capture and passively treat PFAS contaminated surface water
 - Minimal impact on the environment
 - Greater effectiveness at low flows and treatment of point sources
 - Minimal equipment required
 - Low installation and operational costs
- Full scale stream treatment systems are being designed based on treatability testing

Thank You! Questions?

