Project 1007 Update – 3M Settlement Work Groups

Rebecca Higgins, PG | East Metro Unit

Gary Krueger, PSS | East Metro Unit

December 15-16, 2020

Project 1007 Update

Background	Settlement Language & Context
Results To-Date	Surface Water, Sediment, Foam & Groundwater/Drinking Water
Risk Assessment	Human & Ecological Health
Modeling	Combined Surface Water & Groundwater Model
Drinking Water Protection: Long-Term Remedies	Multi-Benefit Well Analysis & ASR Evaluation
Drinking Water Protection: Interim Corrective Actions	Surface Water & Sediment

Background: 3M Settlement Language

- Under Priority 1 of the 3M Settlement, the MPCA *"shall conduct a source assessment and feasibility study regarding the role of the Valley Branch Water District's project known as Project 1007 in the conveyance of PFCs in the environment."*
- Other than site specific remedy implementation and temporary measures, *"the 3M Grant shall fund future projects that would have been payable under the SACO."*

Background: Project 1007 Context

Known Facts: 3M Oakdale Site and Washington County Landfill are primary sources of PFAS that feed into the system. The full extent of the corridor may be impacted by secondary sources from PFAS-impacted sediment and surface water.

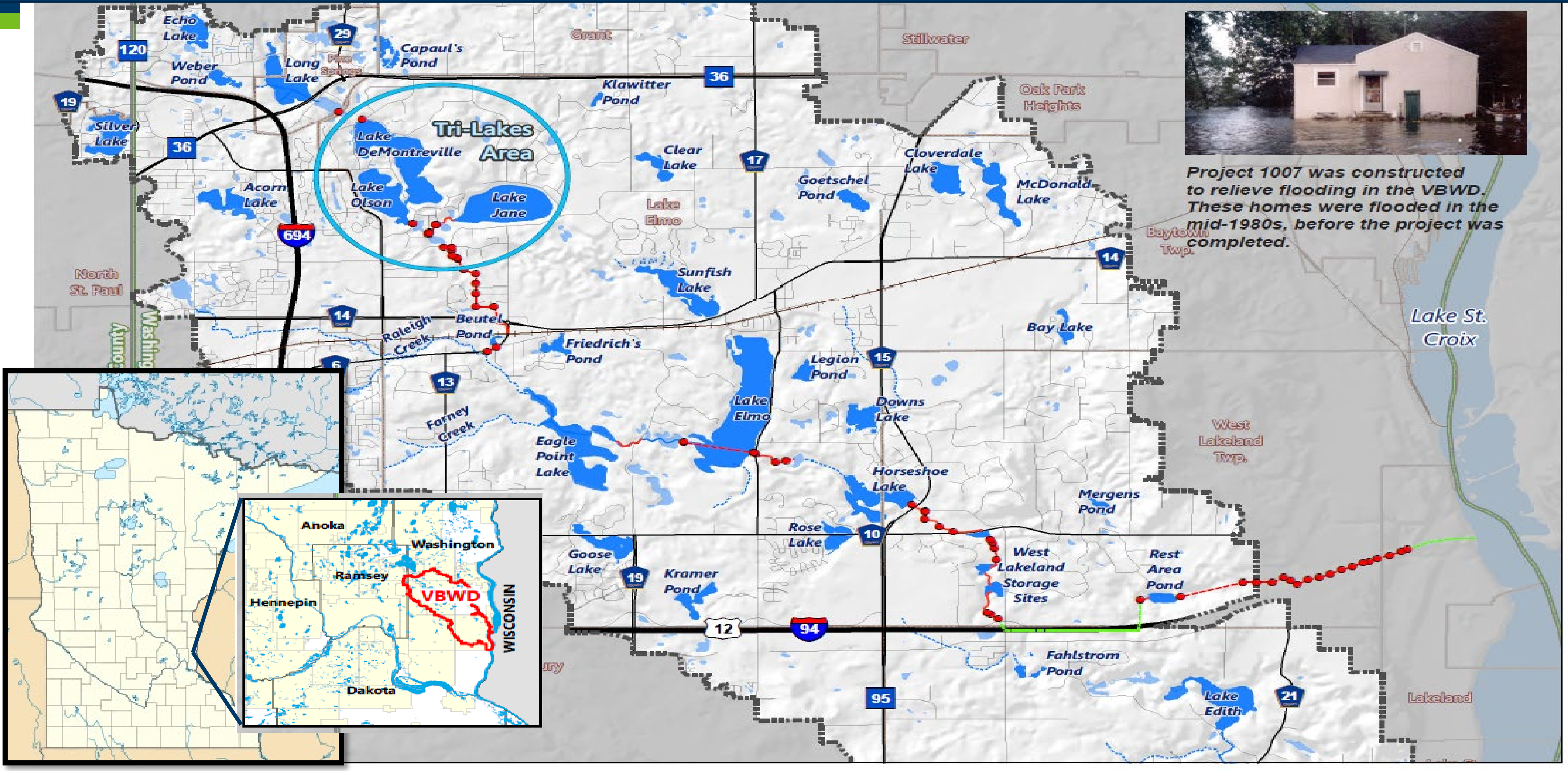
Why we are doing this work: to understand the complete picture of sources, pathways and risks to human and ecological health.

Goals: investigate the region for PFAS impacts to better understand how the contaminants move and what we can do about the multiple layers of complexities in this situation.

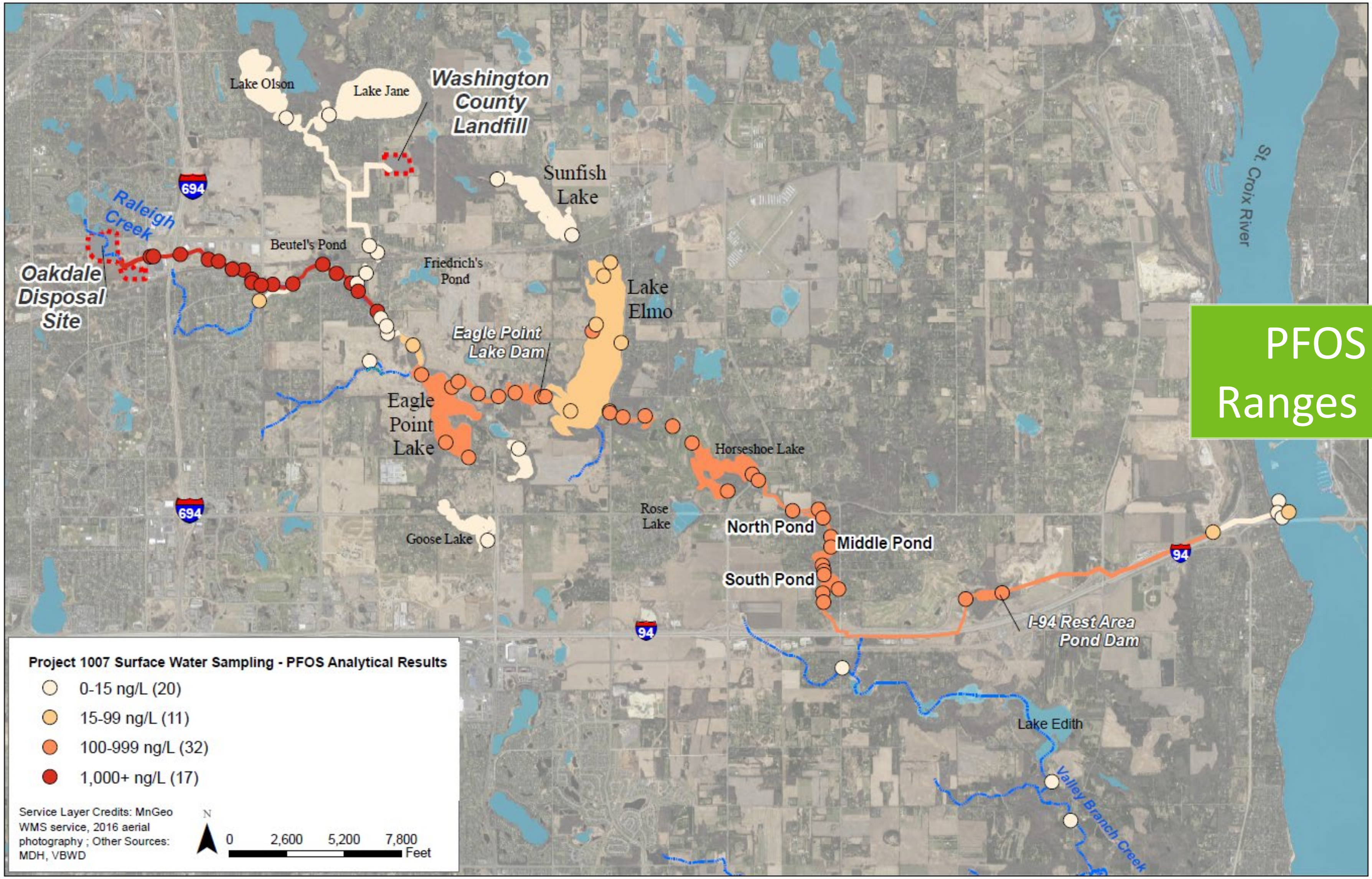
Key Goals

1. Determine nature of PFAS impacts to the varied media (i.e., groundwater/drinking water sources, surface water, soil and sediment) across a very complex system. A robust evaluation is necessary given the variability of the system to help identify those "secondary" sources of PFAS.
2. Determine where Human Health and Ecological value exceedances are encountered across the system in surface water, sediment and groundwater/drinking water sources.
3. Create a combined surface water and groundwater model that fully evaluates that interaction, and which will be a useful tool for looking at long-term cleanup options.
4. Identify and evaluate reasonable cost-effective mitigation measures, both short and long term, to address PFAS impacts to the environment; including ground water/drinking water source control, surface water treatment and sediment removal.
5. Evaluate utilizing Multi-benefit wells as a regional groundwater option to provide safe water for drinking or other purposes, while aiding in addressing the long-term groundwater impacts.

Project 1007 Location



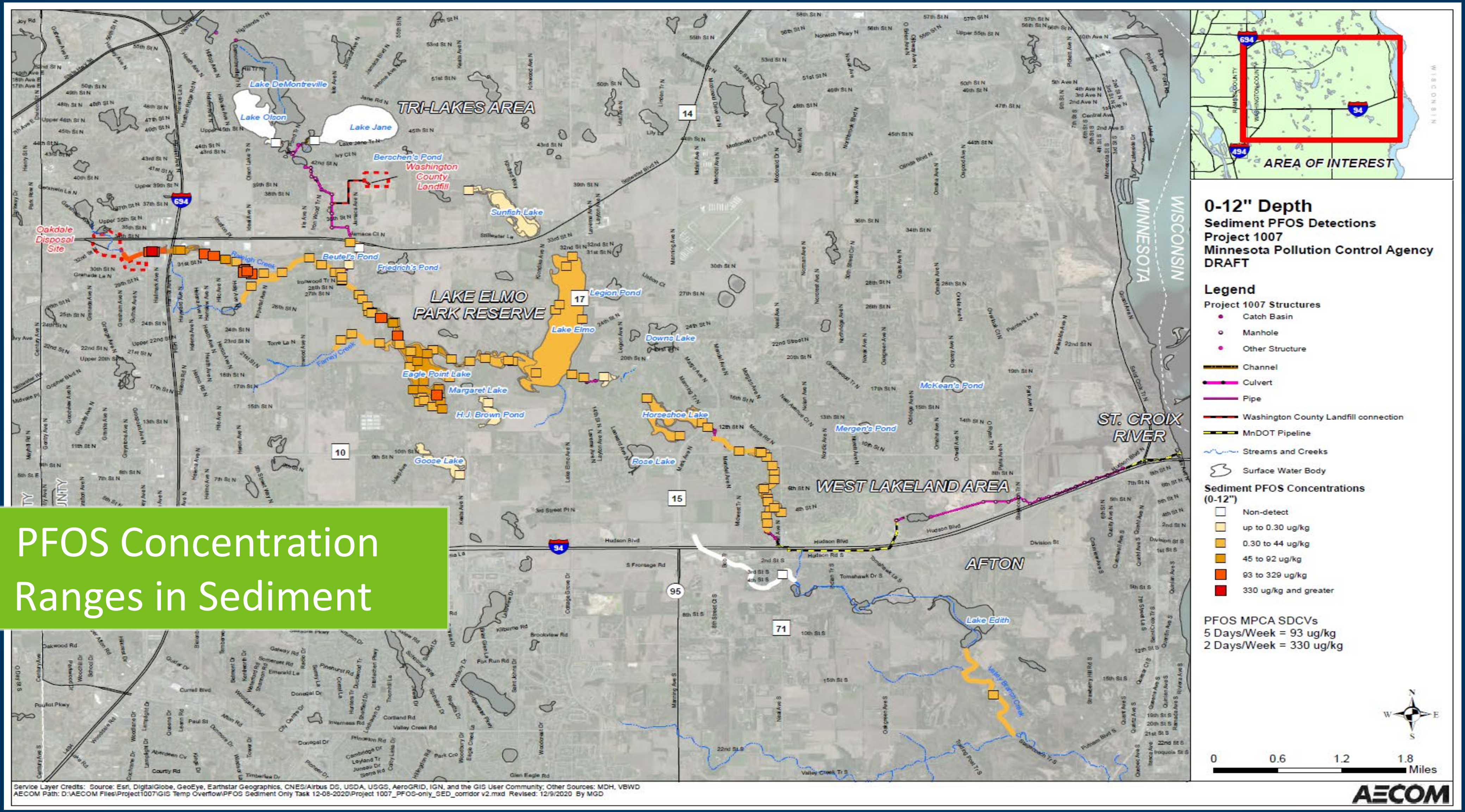
Results To-Date: Surface Water Impacts and New Surface Water Quality Criteria



PFOS Concentration Ranges in Surface Water

Site-Specific Water Quality Criteria 0.05 ng/L (ppt)

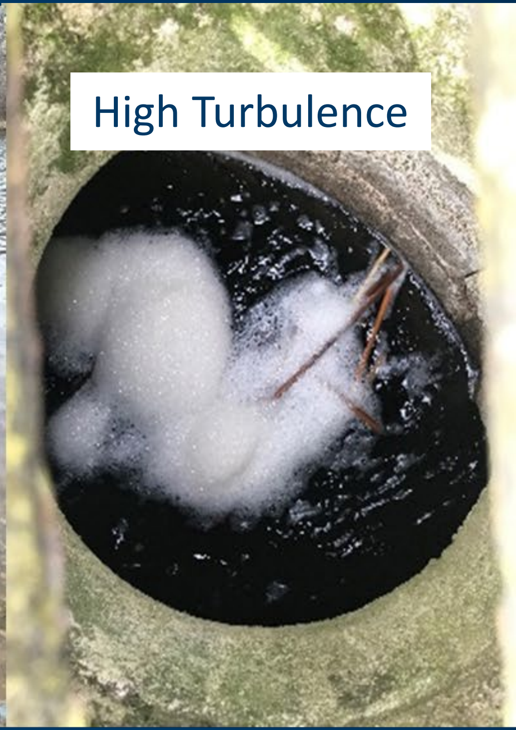
Results To-Date:
Sediment Impacts and Sediment Cleanup Values

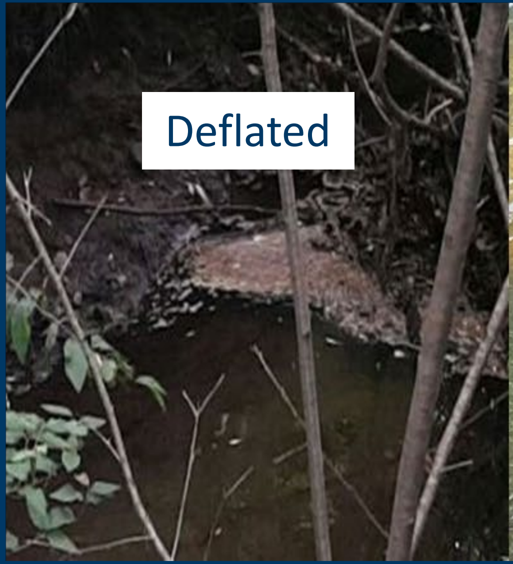


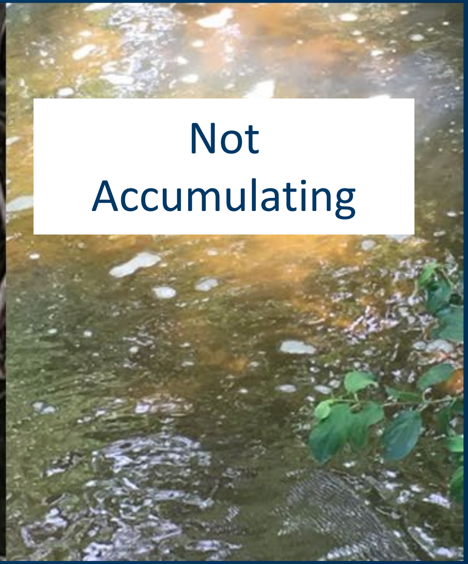
PFOS Concentration Ranges in Sediment

Example of Sediment Sinks: Immediately Downgradient of Oakdale Disposal Site

Results To-Date: Observed Foam Characteristics and Foam Concentrations

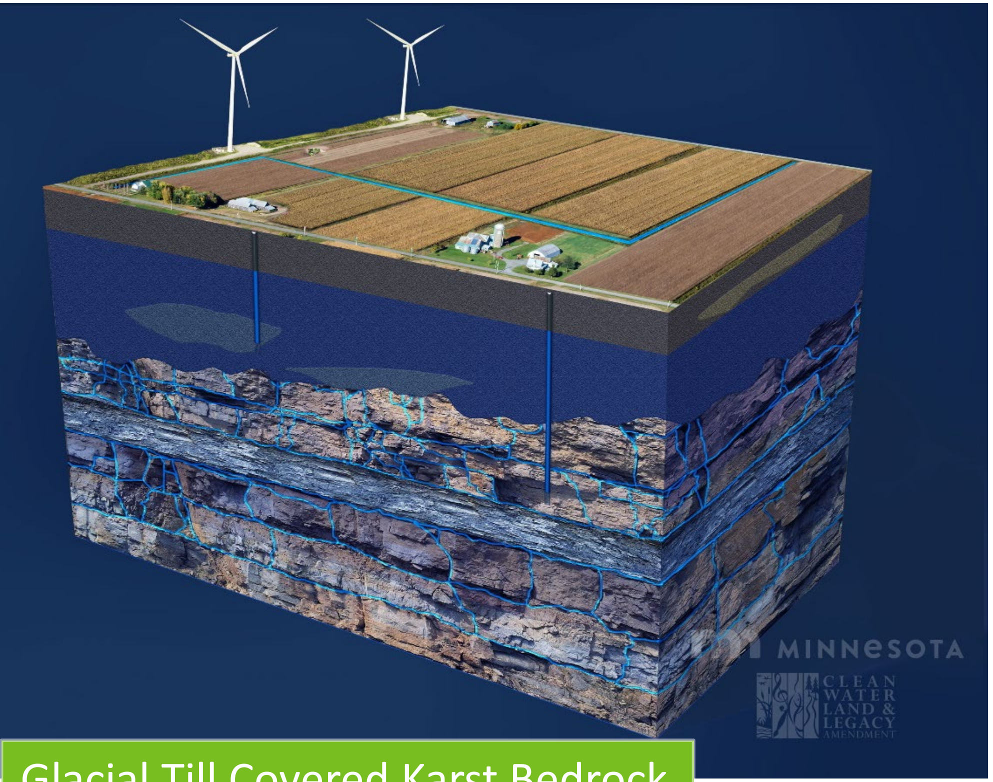




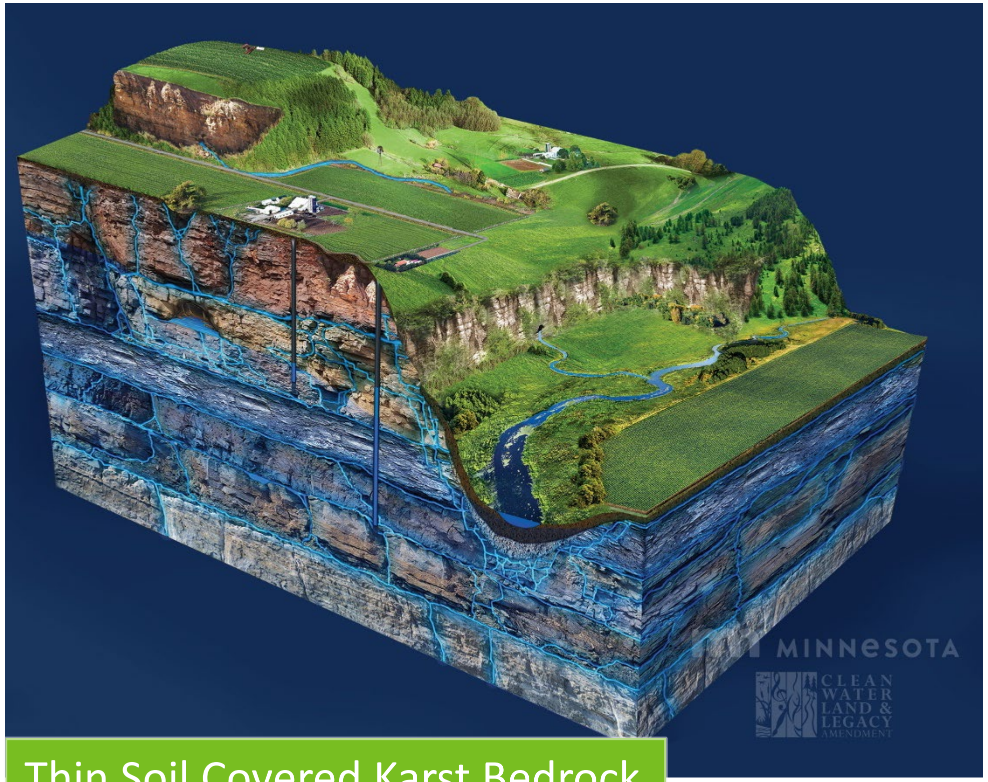


Regional Hydrologic Connections - Drinking Water Risks

By understanding PFAS characteristics and the concentrations in foam, surface water, sediment and groundwater, we can incorporate the physical setting to better understand drinking water risks.



Glacial Till Covered Karst Bedrock

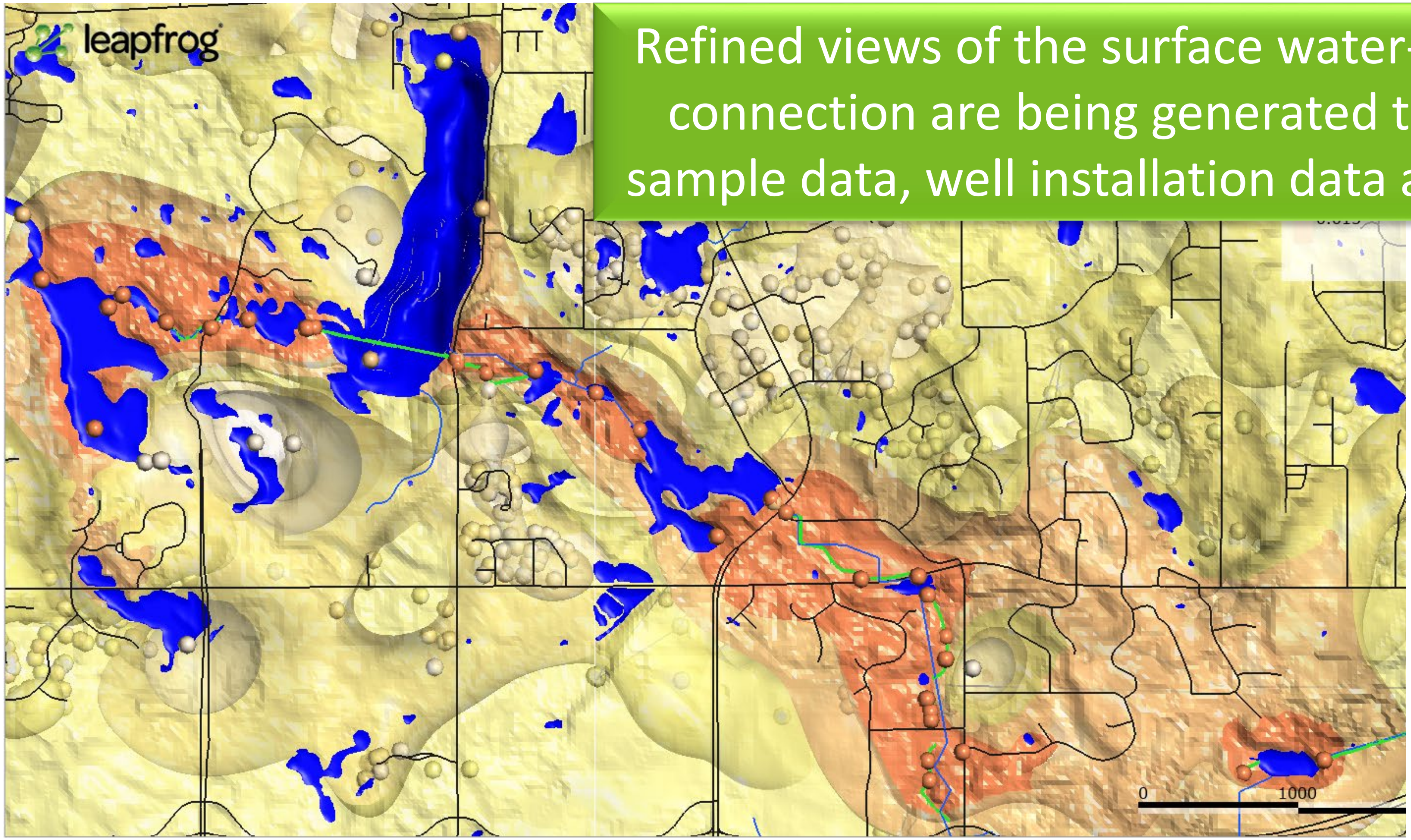


Thin Soil Covered Karst Bedrock

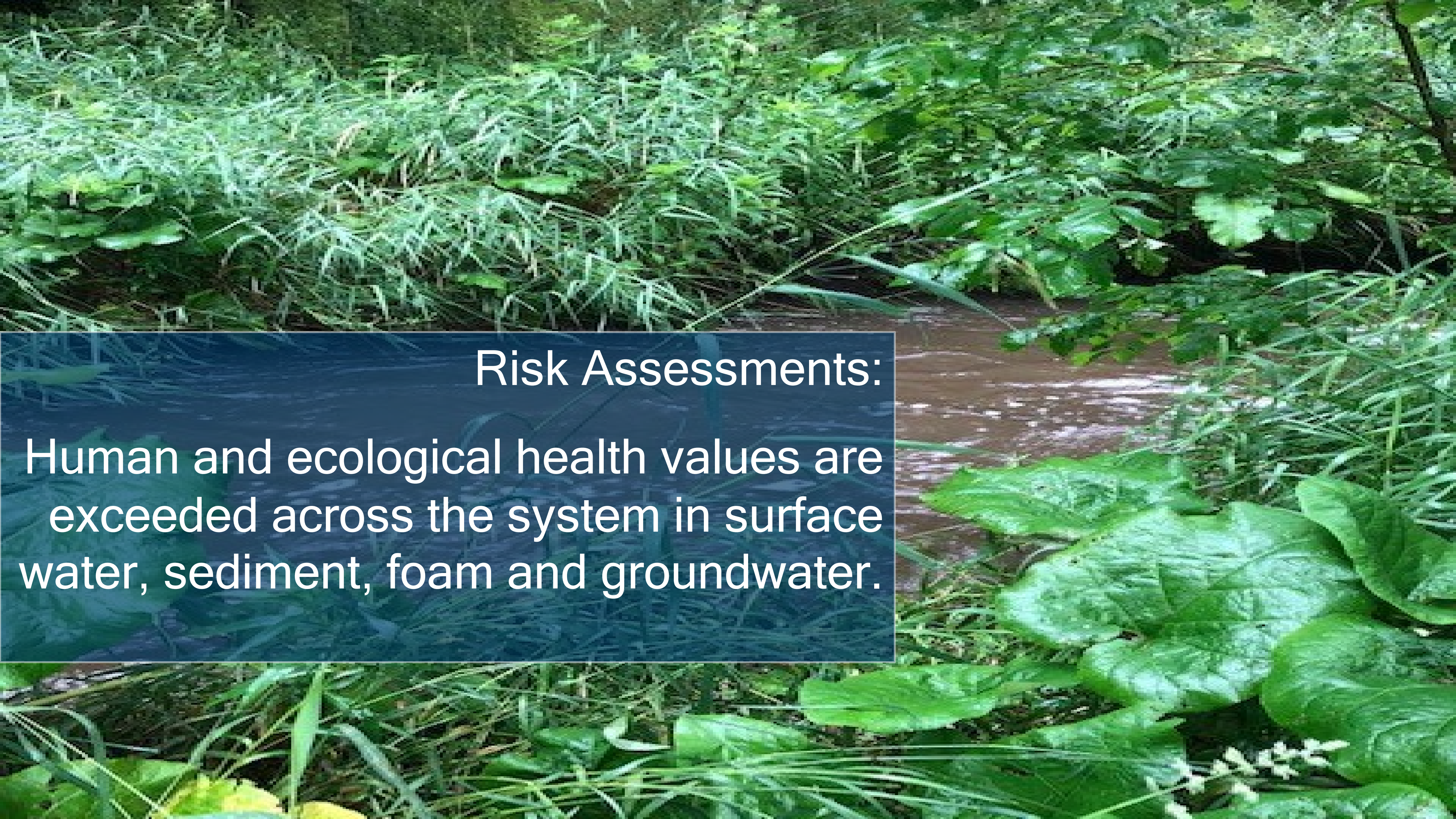
Understanding these physical and chemical relationships between foam, surface water, sediment and groundwater pathways is key to Project 1007 outcomes.

Vertical and horizontal movement across geologic features is a focus of the investigation.

Hydrologic Connections of Contaminants - Drinking Water Risks



Refined views of the surface water-groundwater connection are being generated through new sample data, well installation data and modeling.



Risk Assessments:

Human and ecological health values are exceeded across the system in surface water, sediment, foam and groundwater.

Risk Assessment Example: Baseline Ecological Risk Assessment

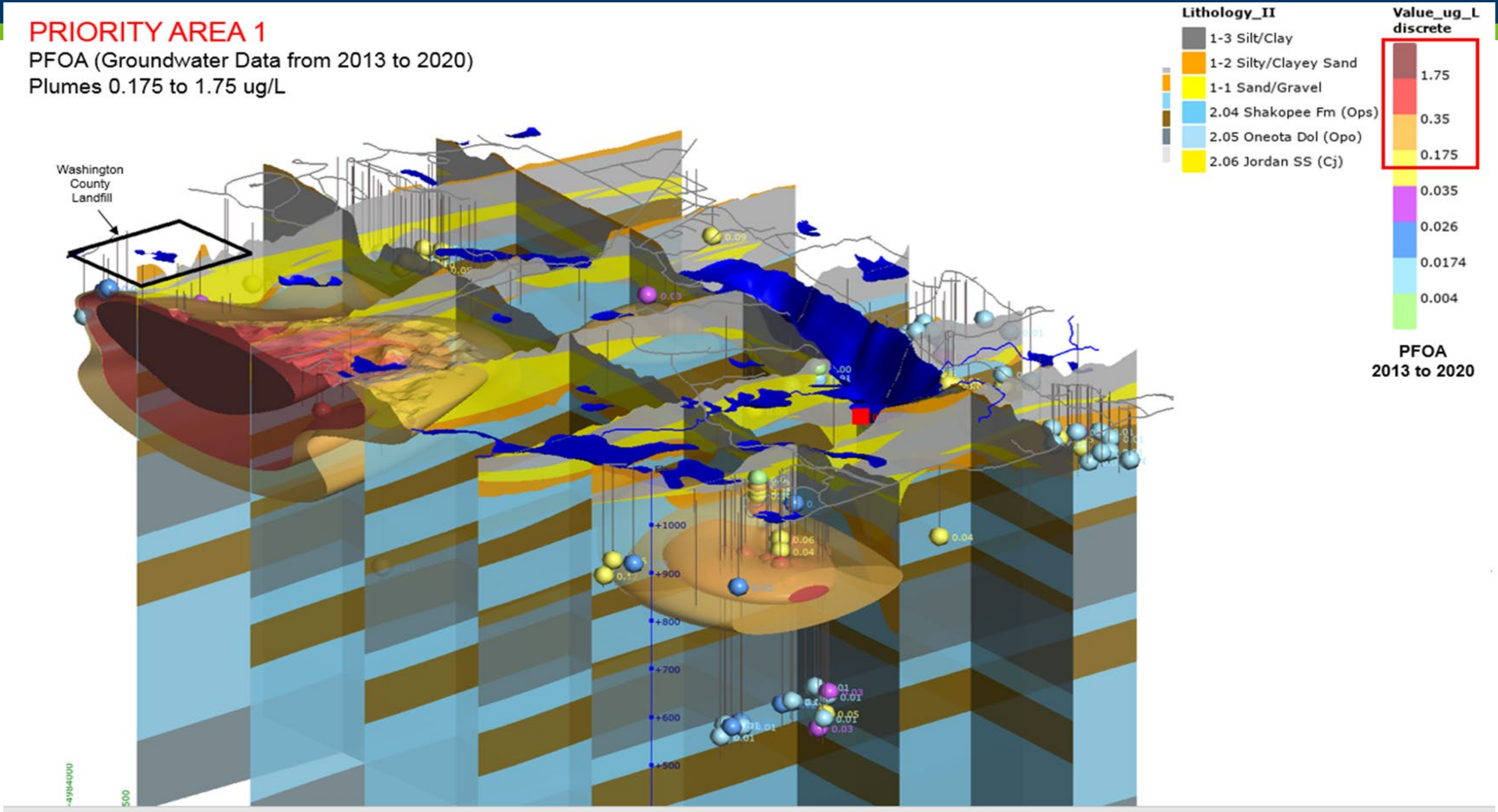
Assessment EndPoints

- Protection and maintenance of ecological communities at levels similar to those of nearby populations not exposed to PFAS.

Measure of Effects (respectively)

- Comparison of sediment, porewater, surface water and foam concentrations to direct toxicity screening levels.

Modeling update: Groundwater Plume Interpolation



Drinking Water Protection: Long-Term Remedies

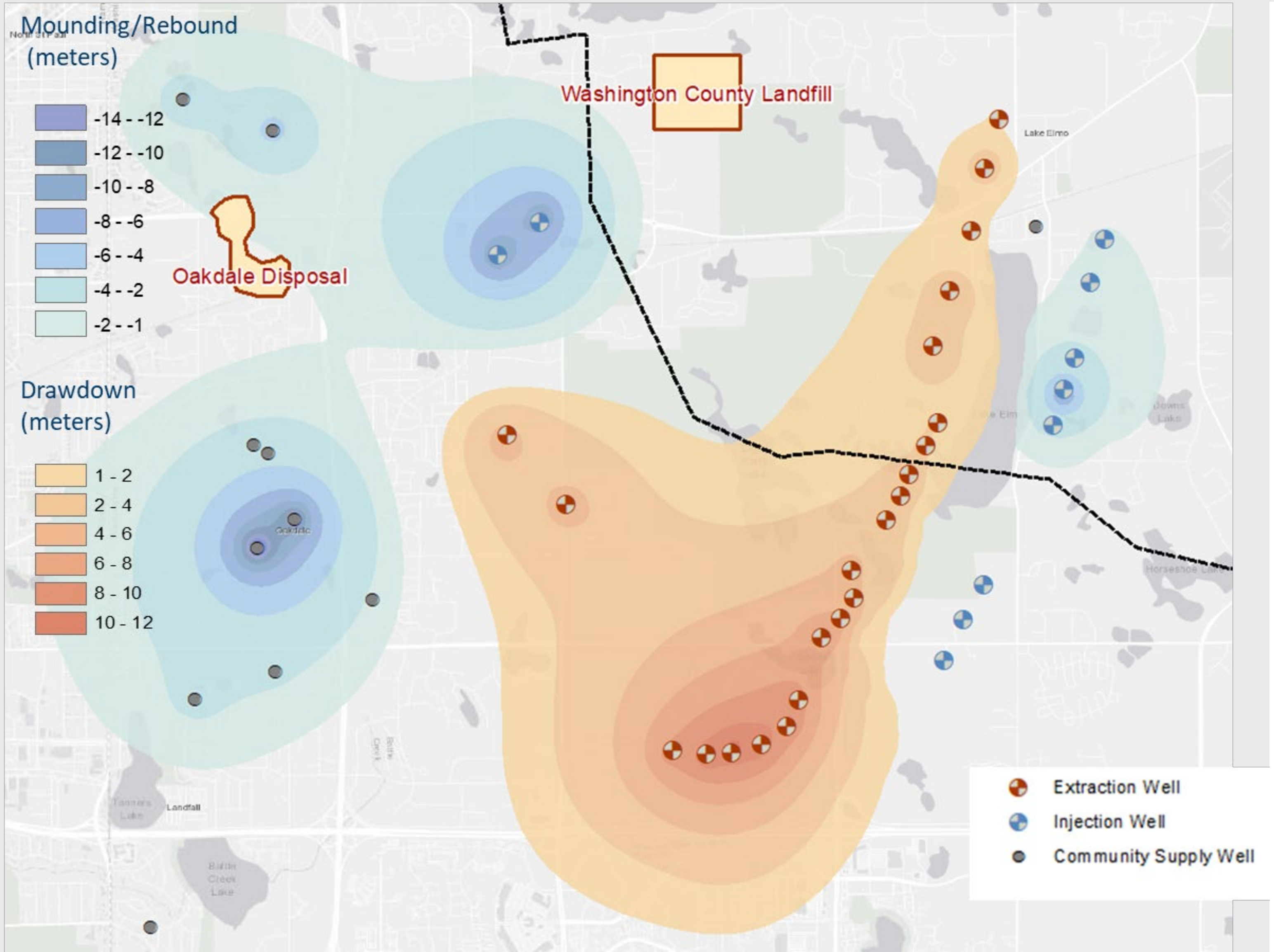
1. Clean-up drinking water foremost with the understanding surface water, sediment, and groundwater are interconnected with PFAS impacts.
   - Groundwater clean-up intended for the highest beneficial use which is potable water.
2. Use a holistic approach to a multi-faceted problem above and below ground.
   - Solving this problem begins with the most accessible pathway: surface water and sediment.
3. Address clean-up when and where possible using demonstrated technologies like GAC, while considering innovative approaches to cleanup solutions for other media, like SAFF and DE-FLUORO.
   - A pragmatic approach to clean-up is being pursued for this emerging contaminant using innovative solutions.

Multi-Benefit Well Considerations

Multi-benefit wells may be an option for consideration in the regional groundwater options to provide safe water while aiding in addressing long-term groundwater impacts.

Multi-benefit wells are bedrock wells that serve multiple functions and benefit both long-term municipal drinking water supply demands while controlling large, regional groundwater plumes, ultimately providing alternatives for demand and PFAS removals.

Multi-Benefit Well Conceptualization



- Multi-benefit extraction wells for PFAS capture, treatment, and reuse are being evaluated
- Offset cumulative impacts to groundwater and lake levels
- PFAS capture volume could account for more than half the 2040 groundwater demand
- PFAS removal from groundwater is active and accelerated

Multi-Benefit and Injection Wells

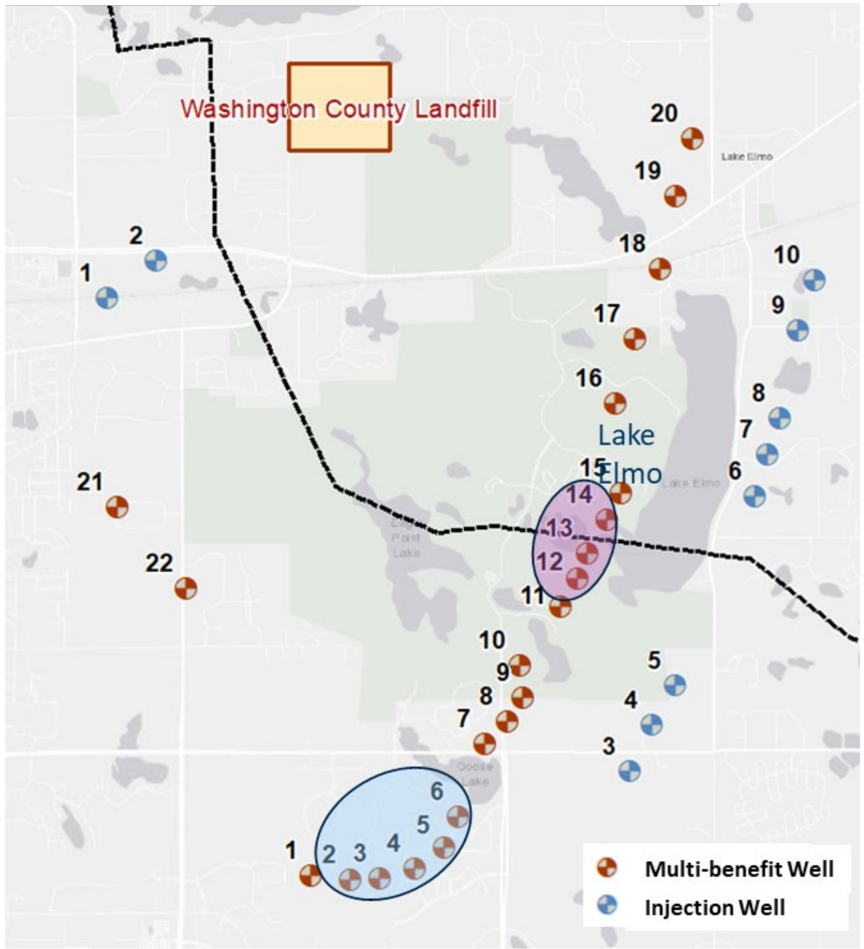
Combined Extraction Rate: 10,550 gpm (67% total ADD)

Total Extraction (gpm)	2040 ADD (gpm)		Total Injection (gpm)
	Oakdale	Lake Elmo	
10,550	2,125	1,411	7,014

Well ID	Rate (gpm)	Drawdown (m)		Available Head (m)		t of Available Head	
		Prairie Du Chien	Jordan Sandstone	Prairie Du Chien	Jordan Sandston e	Prairie Du Chien	Jordan Sandstone
1	400	9	9	22	67	41	13
2	400	11	11	20	66	57	17
3	400	12	12	19	65	62	18
4	400	12	12	18	65	65	18
5	400	10	10	17	65	58	16
6	550	10	10	17	64	57	15
7	550	8	8	17	64	46	13
8	400	6	7	33	64	19	10
9	400	4	5	44	63	9	7
10	500	4	5	19	62	24	8
11	500	2	3	25	58	10	4
12	500	2	3	0	57	0	5
13	550	2	2	0	57	0	4
14	600	2	2	0	57	0	4
15	500	2	2	19	57	10	4
16	400	3	3	11	57	26	6
17	500	3	3	11	57	27	6
18	600	1	2	27	57	5	3
19	550	3	4	18	58	17	7
20	550	1	1	13	48	6	2
21	500	6	6	37	75	16	8
22	400	6	6	33	72	19	8

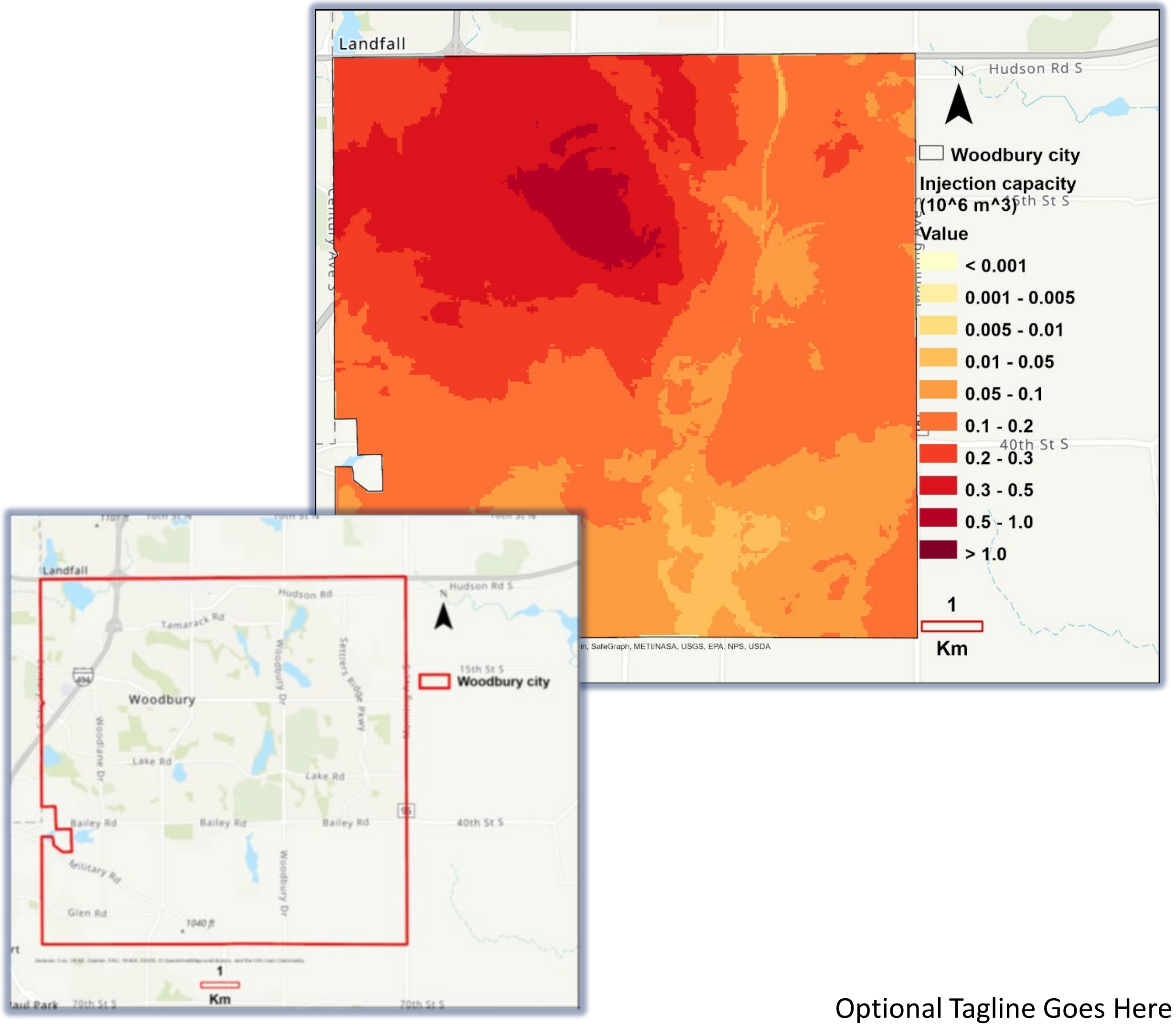
Exceeds 50% available head (Prairie Du Chien) [wells 2–6]

Prairie Du Chien not present [wells 12–14]



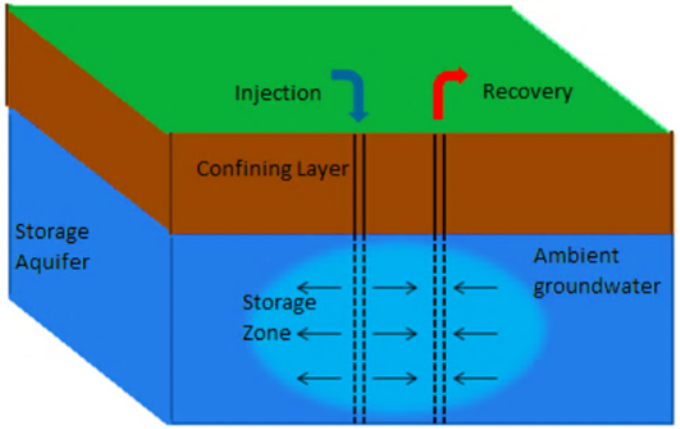
- 7000 gpm is approximately 14 million cubic meter / year
- Our first order estimation shows that the required amount may be injected with about 10 wells by choosing high Injection Capacity areas

Woodbury Managed Aquifer Recharge - ASR Example



Why do we need to estimate injection capacity?

Aquifer storage and recovery (ASR)

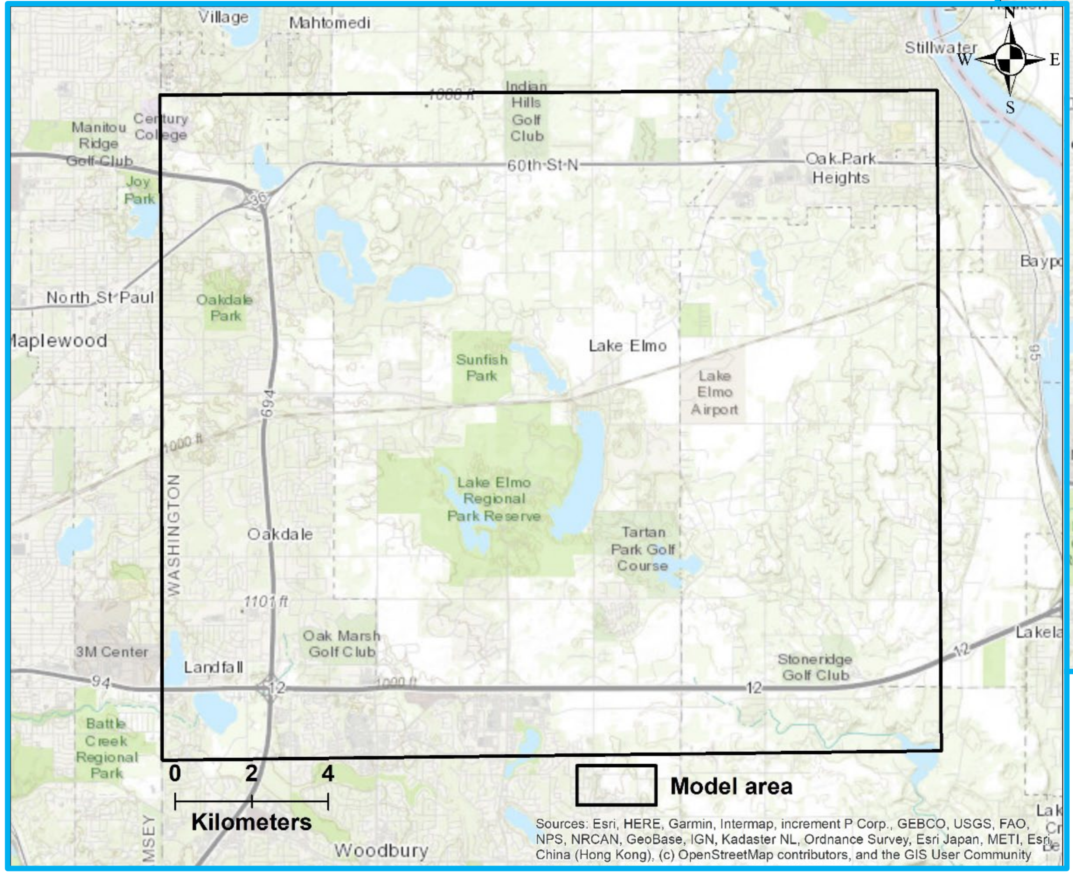


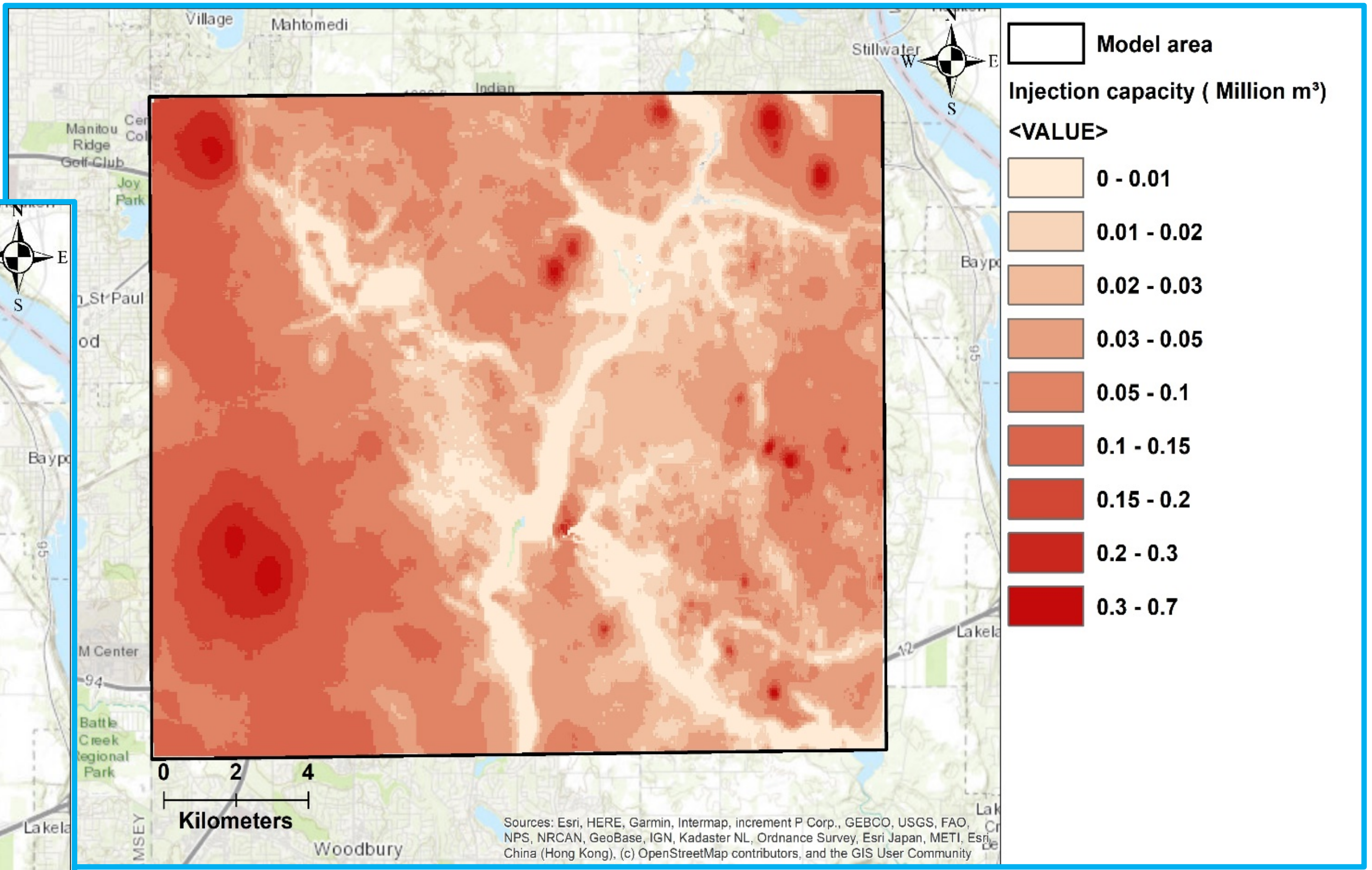
Source: RESTORE group

- ASR is one type of MAR. It is a process of water banking via wells during periods of excess availability and later use in the period of scarcity.
- To consider ASR, we first need to understand how much we can inject.

1007 Aquifer Storage and Recovery – Injection Capacity

We extended and applied the methodology to the Lake Elmo area





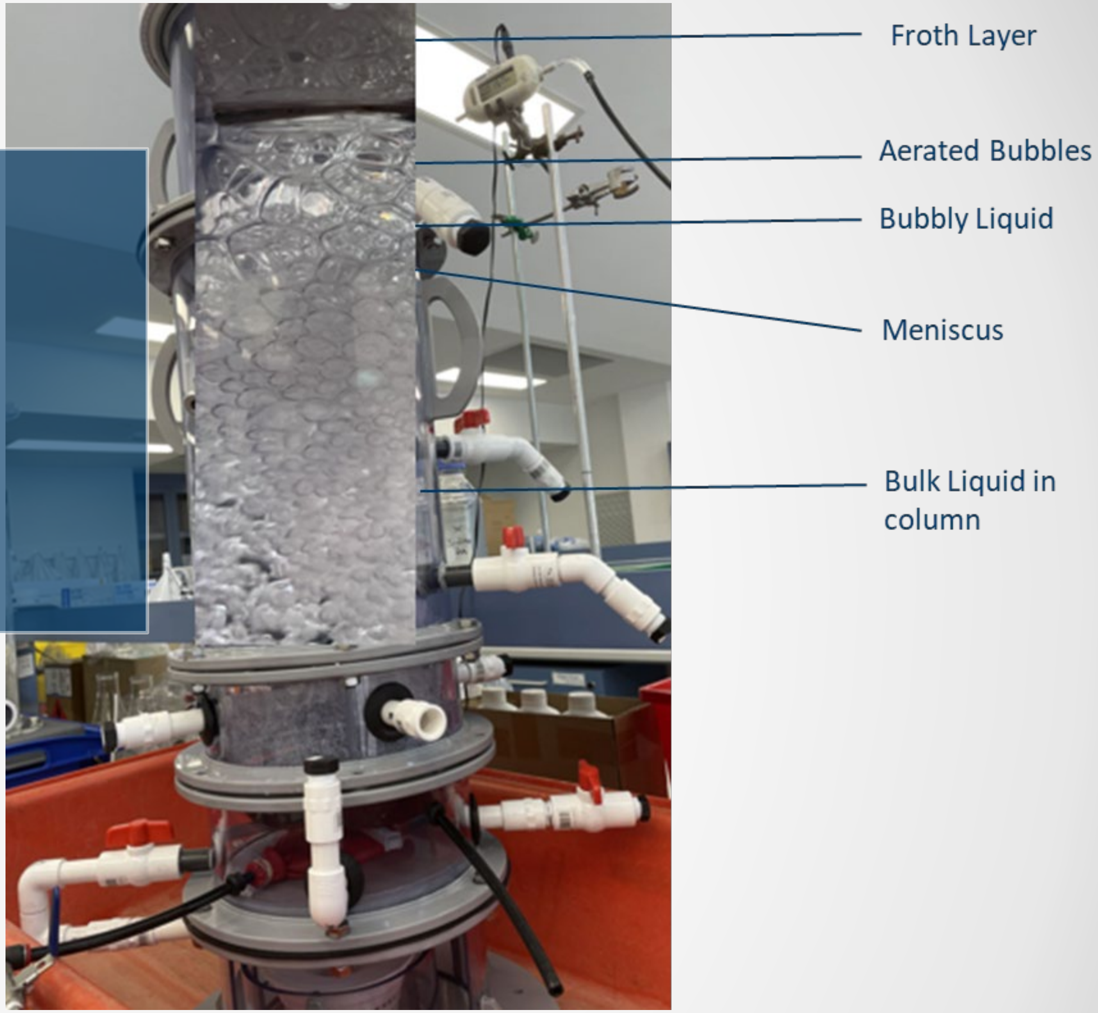
Interim Corrective Actions

Bench-Scale Lab Testing In-Progress Surface Activated Foam Fractionation

Preliminary SAFF bench-scale results from 7 batches of 15L surface water samples:

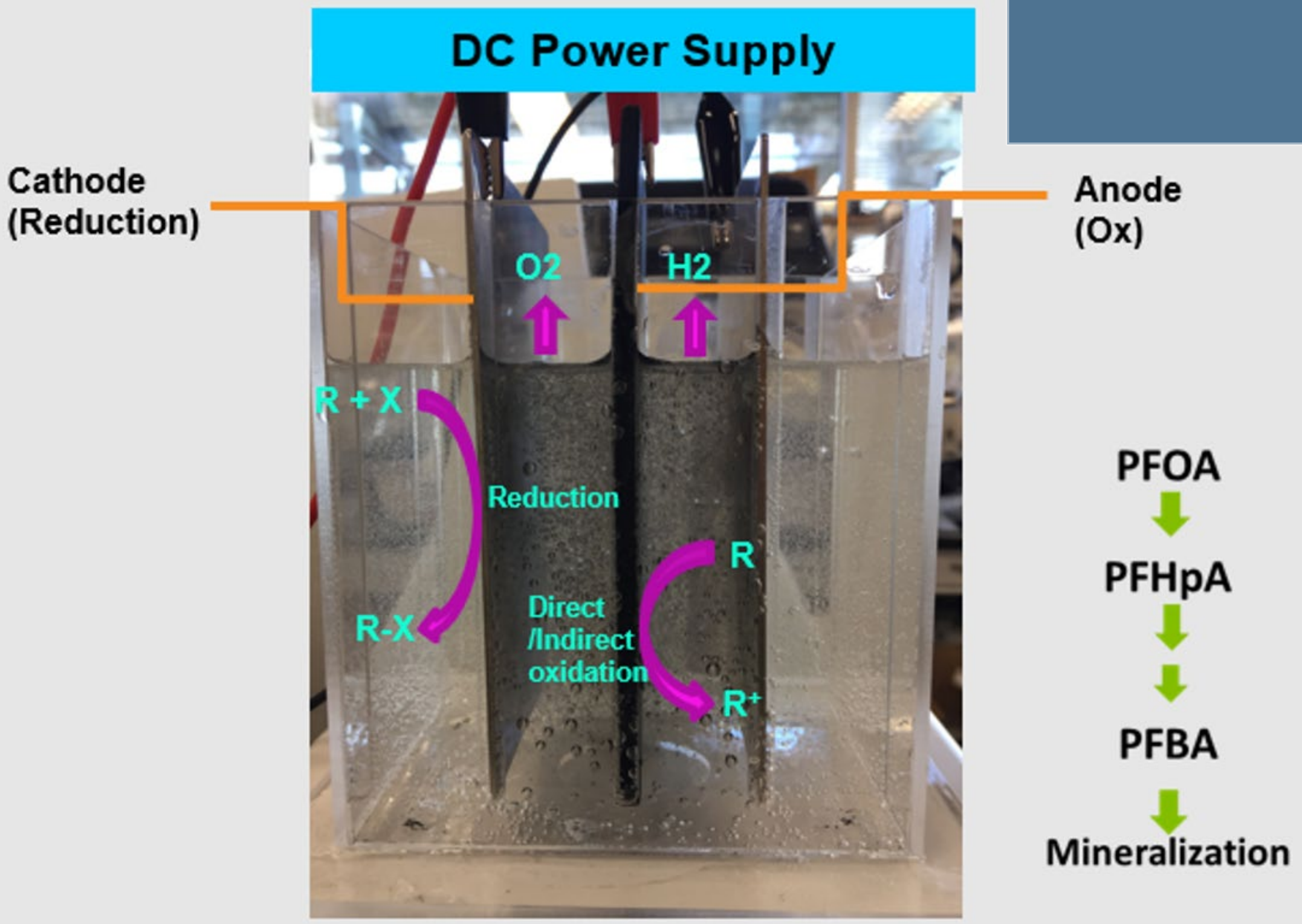
Total Bulk PFAS Removal: 79-85% in primary treatment

Treated down to 1-10ppt PFOA, 5-10ppt PFOS



High-Performance SAFF Apparatus showing aeration & bubbly Liquid zone.

Bench-Scale Lab Testing In-Progress Electrochemical Oxidation – DE-FLUORO™



Hyper-concentrate from SAFF system at Oakey Air Force Base in Oakey, Australia, with similar PFAS signature is on its way to AECOM DE-FLUORO™ lab in Texas for this test.

Timeline for Next Steps

Source Assessment Work

- On-Going
- Complete Assessment over next 1-2 years
- Complete Modeling and start Interim Corrective Actions over 1-3 years

Feasibility Study

- Starting in ~1-1.5 years
- Addresses Project 1007 Regional Long-Term Cleanup Options

Cleanup

- Years to Decades
- Cleanup will be shown by evidence of acceptable decreases and stability across multiple media and regional-scale impacts

5 Key Take-Aways

1. PFAS impacts are present in many forms across this complex system, presenting numerous challenges. A robust evaluation of the variability of the system itself and PFAS inputs into that system is on-going.
2. Human and Ecological Health Value and environmental value exceedances are encountered across the system in surface water, sediment and groundwater.
3. Surface water cleanup options are being pursued; we expect to consider sediment cleanup in targeted areas in the coming year.
4. A combined surface water and groundwater model is being created that will be a useful tool for looking at long-term cleanup options.
5. Multi-benefit wells may be an option for consideration in the regional groundwater options to provide safe water for drinking or other purposes, while aiding in addressing the long-term groundwater impacts.

Thank you

Rebecca Higgins, PG, MPCA

Rebecca.Higgins@state.mn.us

Gary Krueger, PSS, MPCA

Gary.Krueger@state.mn.us