Regenerable IX Resin for PFAS Treatment - *5 Years Later … What We've Learned…*

Montrose Environmental Group

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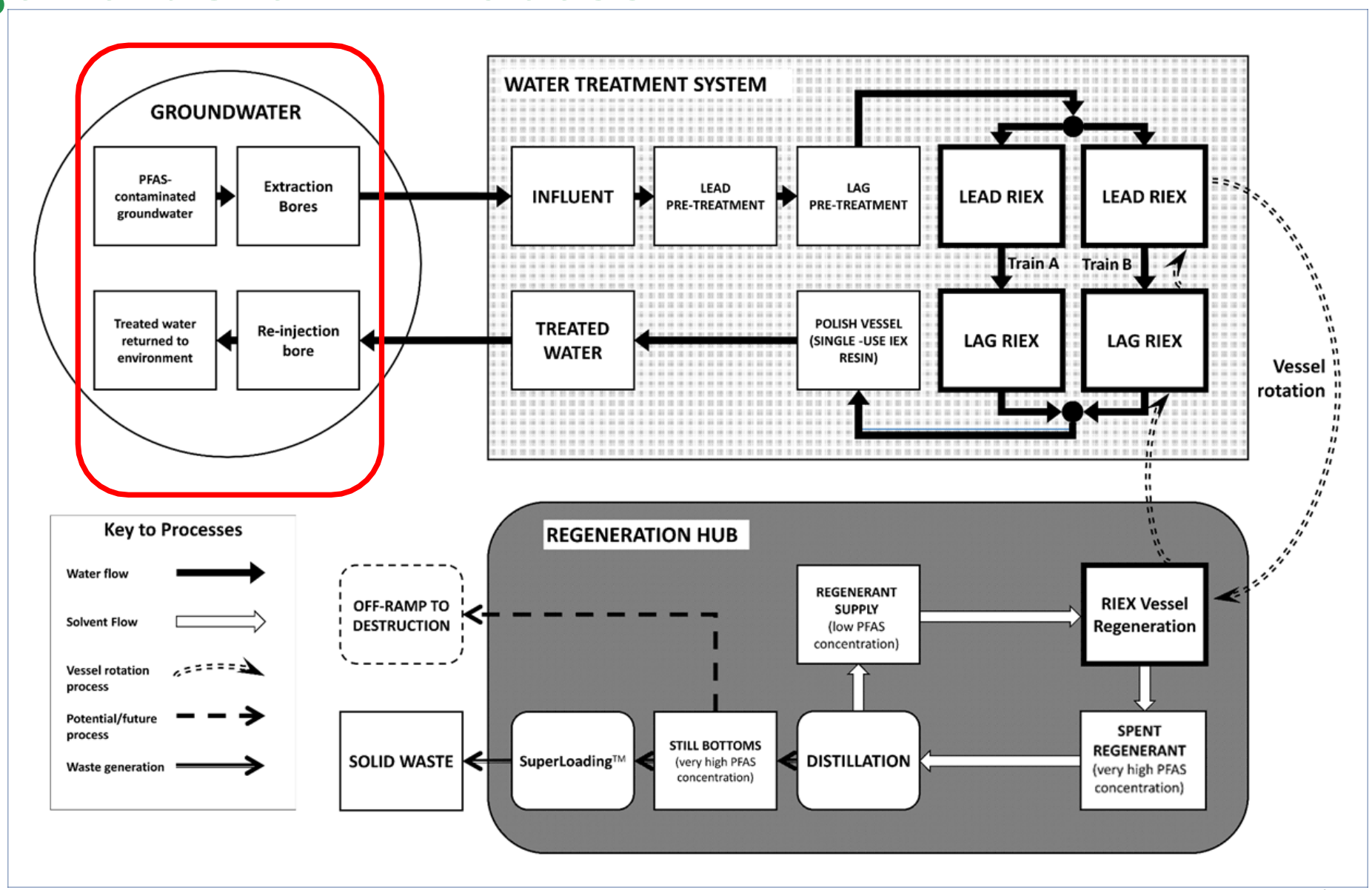
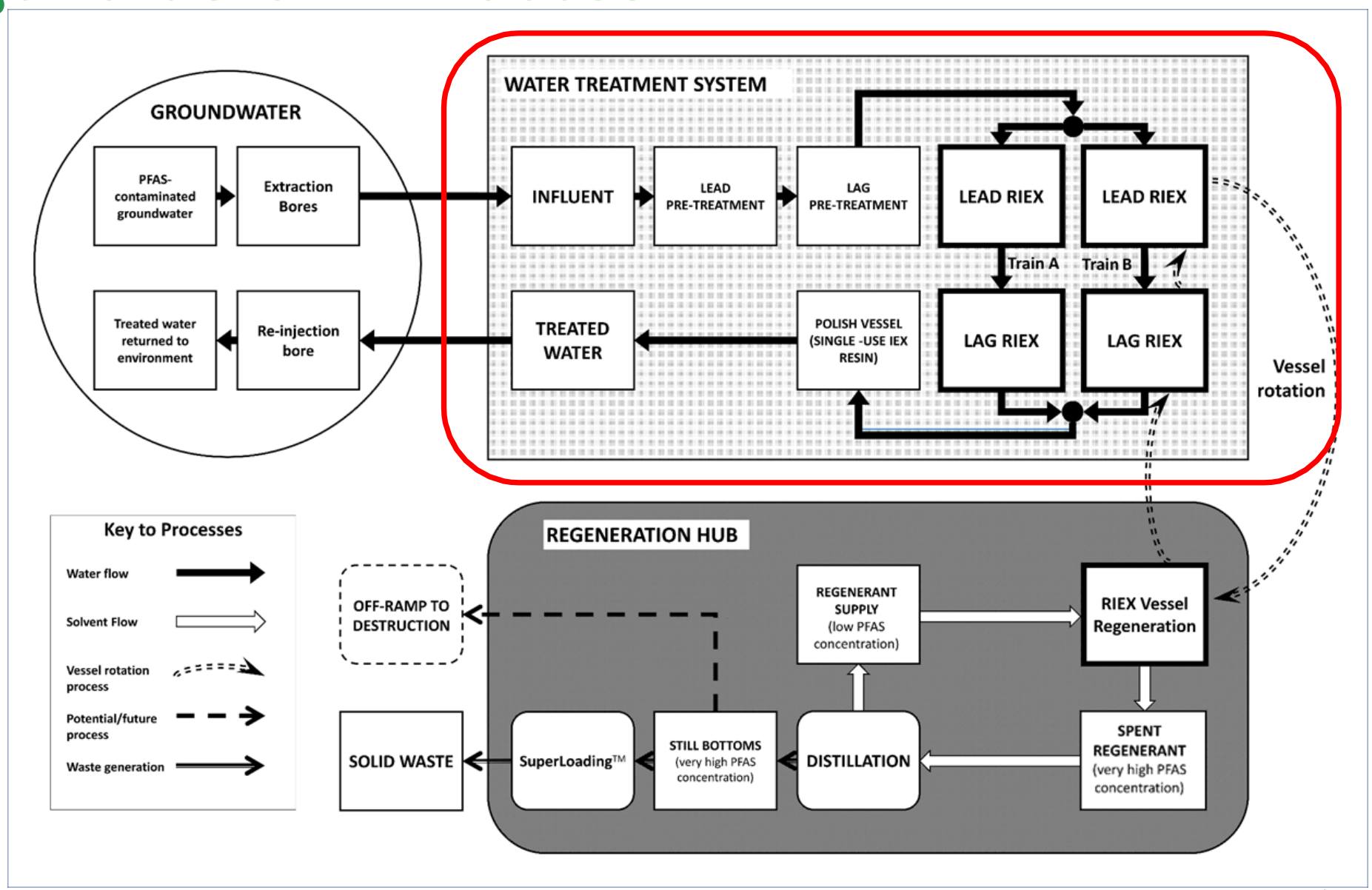
Agenda

- Limited PFAS case studies
- Regenerable IX process overview
- Case study – RAAF Base
  - Treatment effectiveness
  - Resin capacity trends
  - Waste generated
  - Optimization
- Wrap up … What we've accomplished and what we've learned

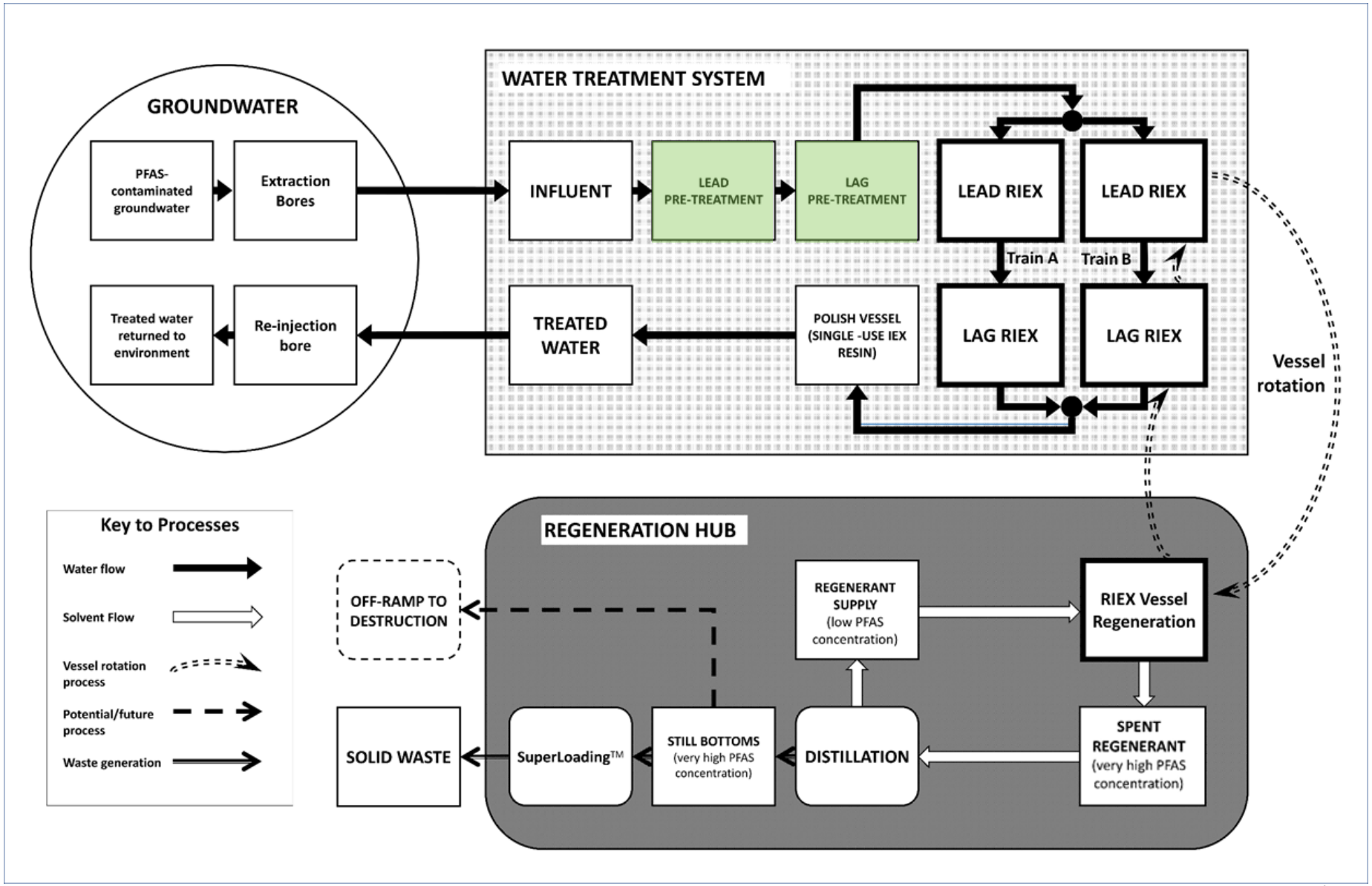
Regenerable IX Process



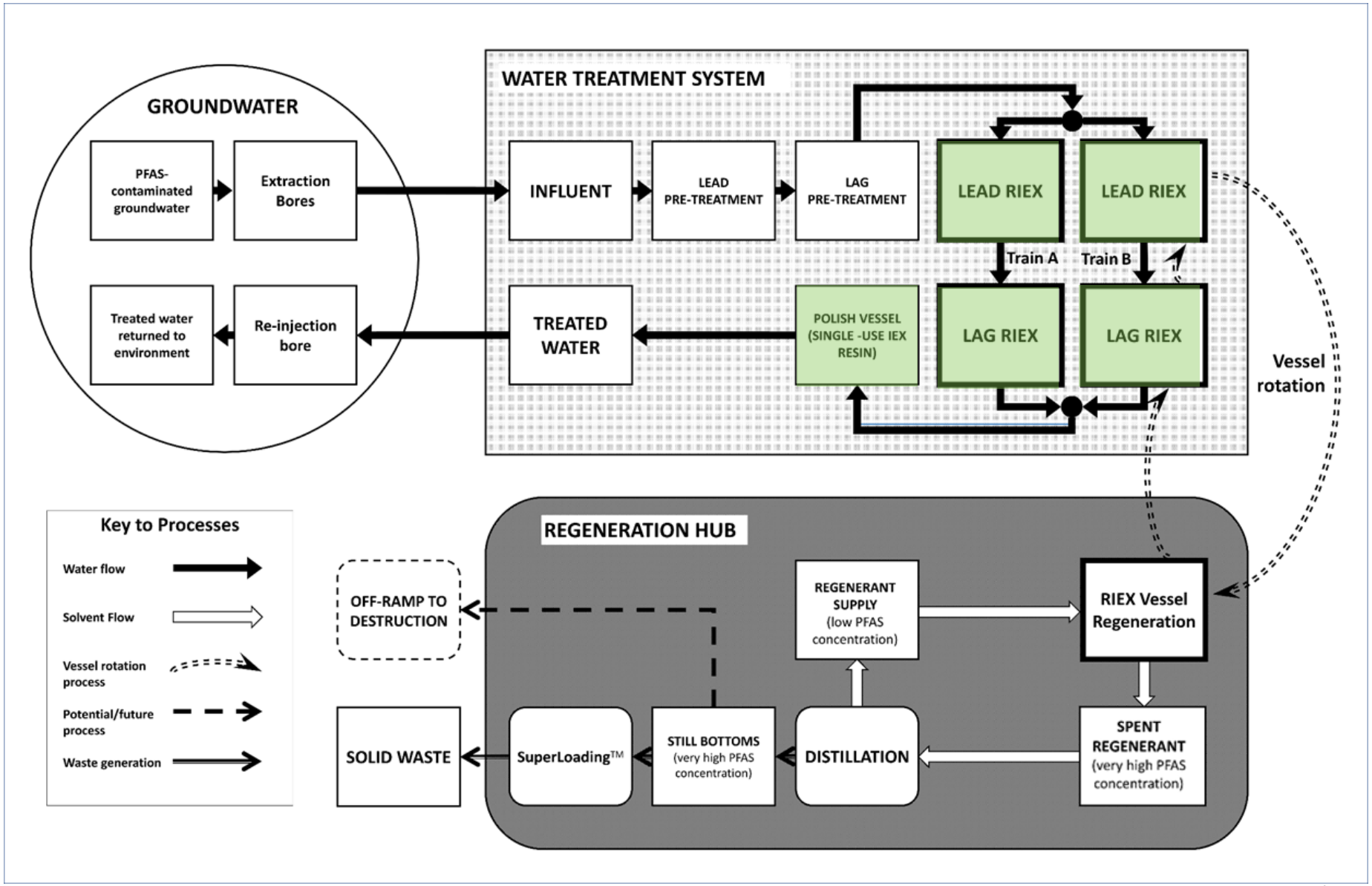
Regenerable IX Process



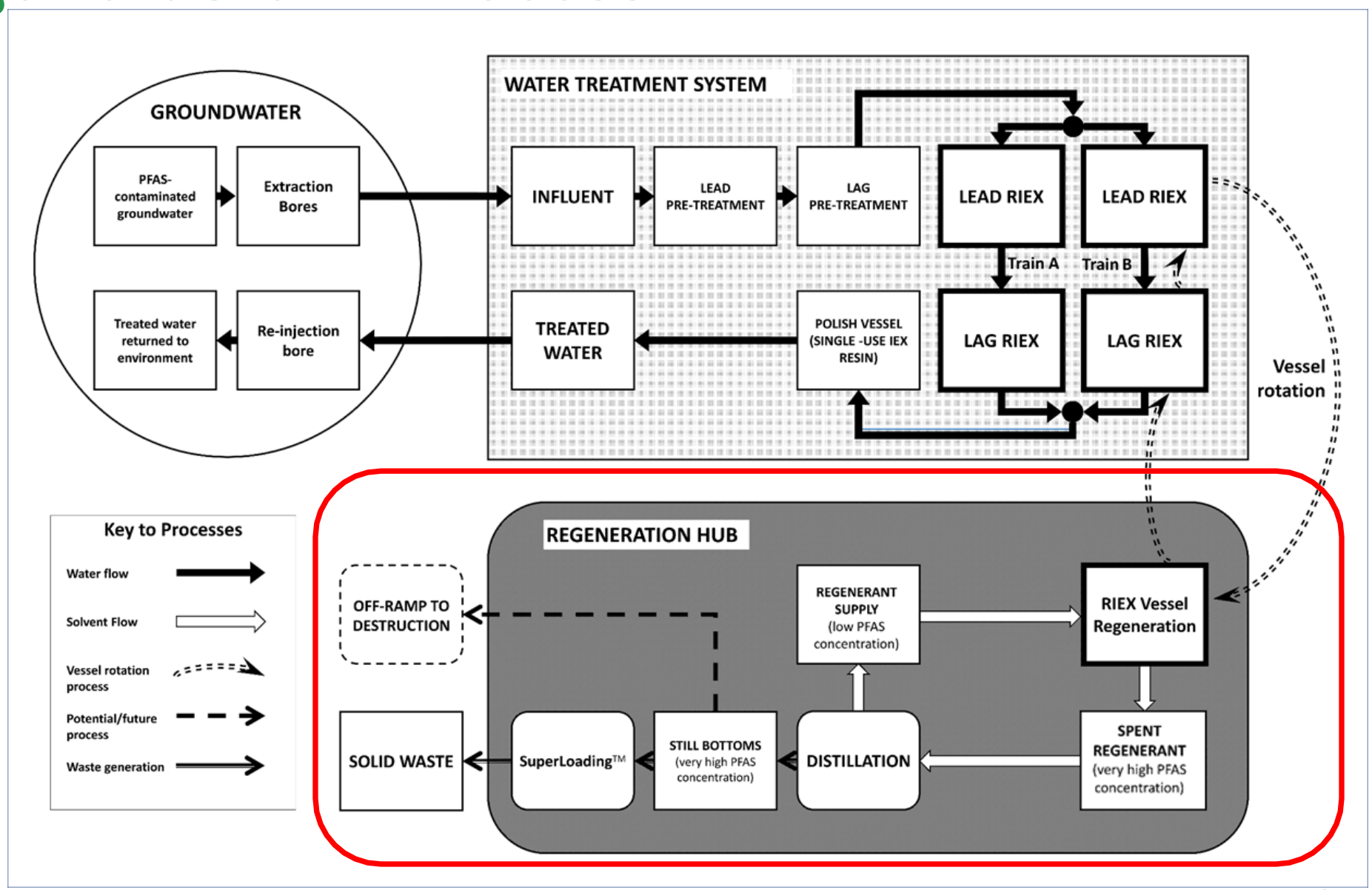
Stage 1: Pre-treatment



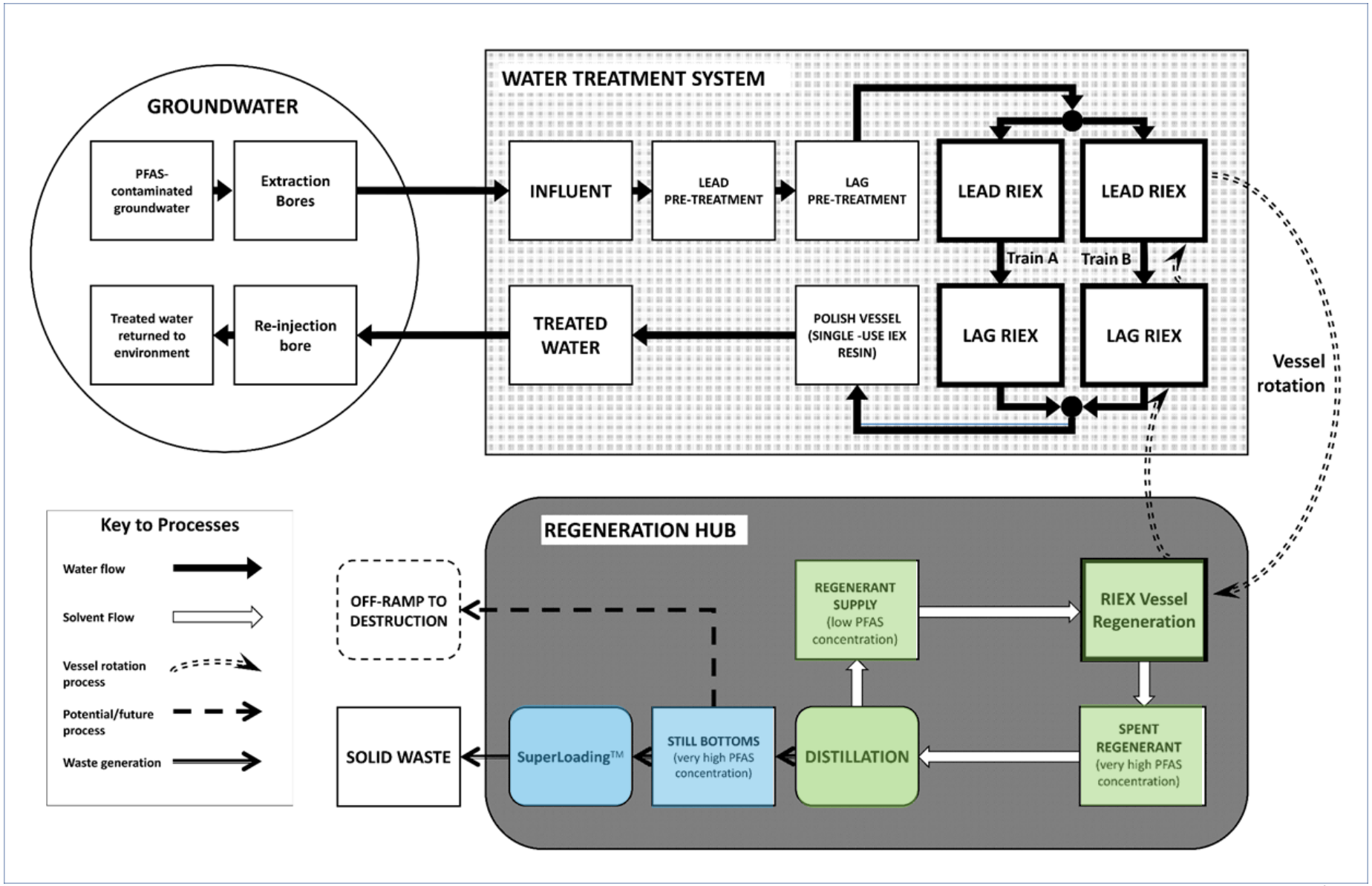
Stage 2: REIX Treatment



Regenerable IX Process



Stage 3: Resin Regeneration



Regenerable IX Hub-and-Spoke Model

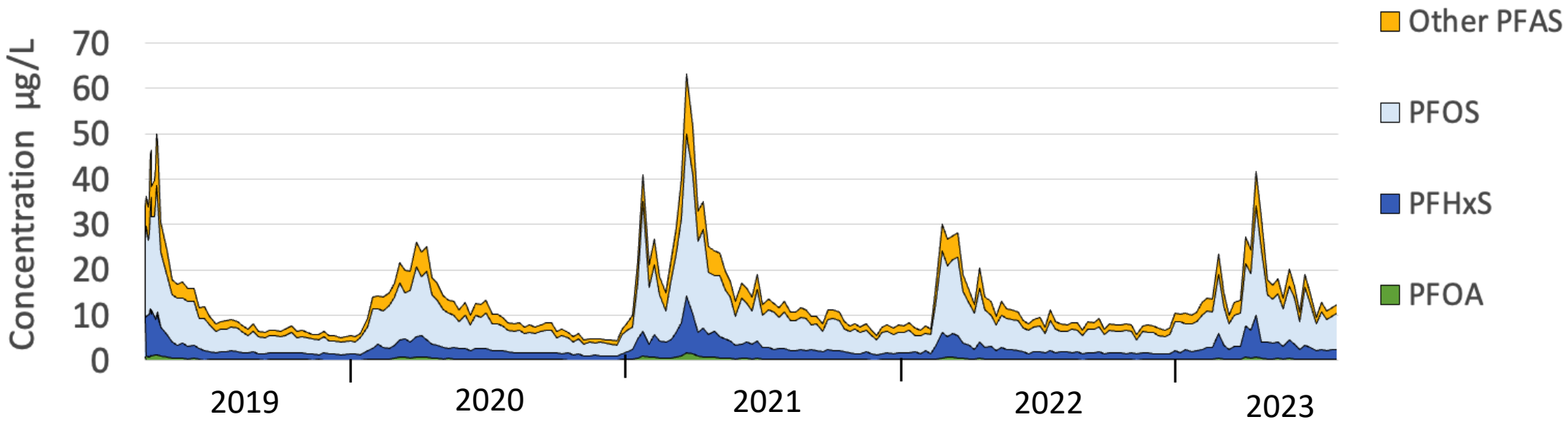
Transportable
Regenerable IX Vessel

Regenerable IX Case Study

RAAF Base, AU

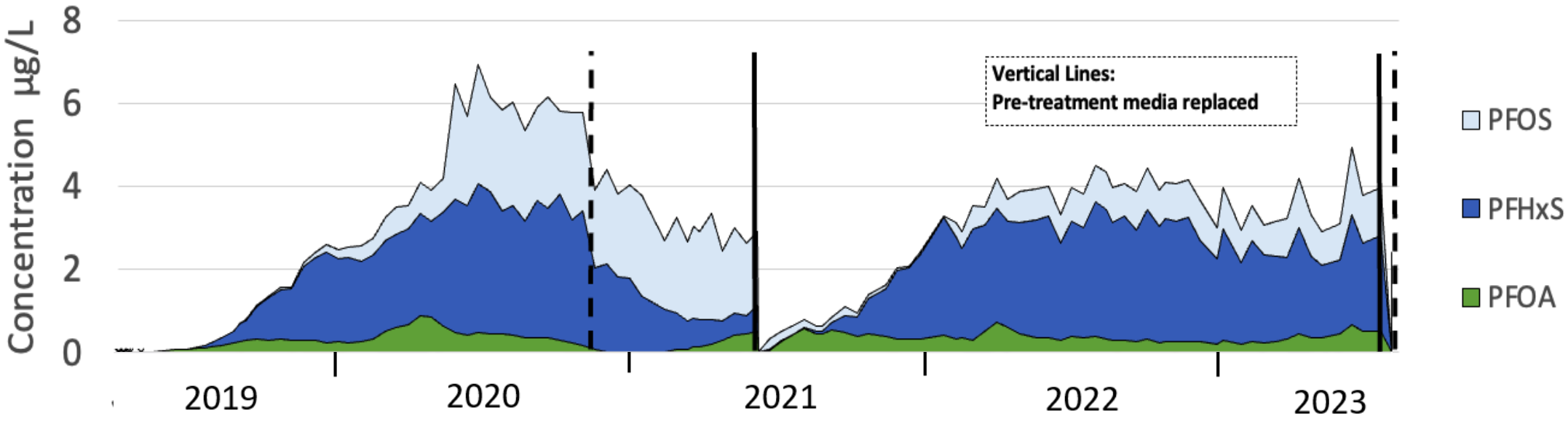
- Legacy AFFF-impacted groundwater
- 12.6 L/s (200 gpm) treatment since 2019
- Influent: ΣPFAS up to 60 µg/L; mean: 14 µg/L
- Treatment criteria: Australian HBGVs
  - PFOS + PFHxS 0.07 µg/L
  - PFOA 0.56 µg/L
- 26 regenerations
- 22+ kg of PFAS removed

Influent Concentrations to WTP



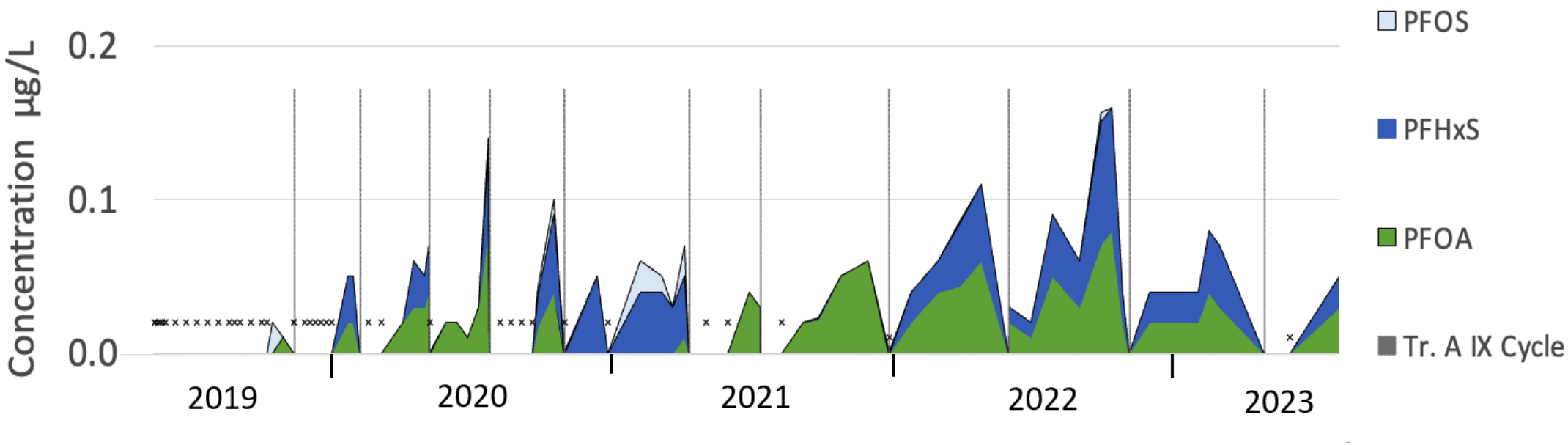
High influent concentrations → Consider regenerable resin

Influent Concentrations to REIX System



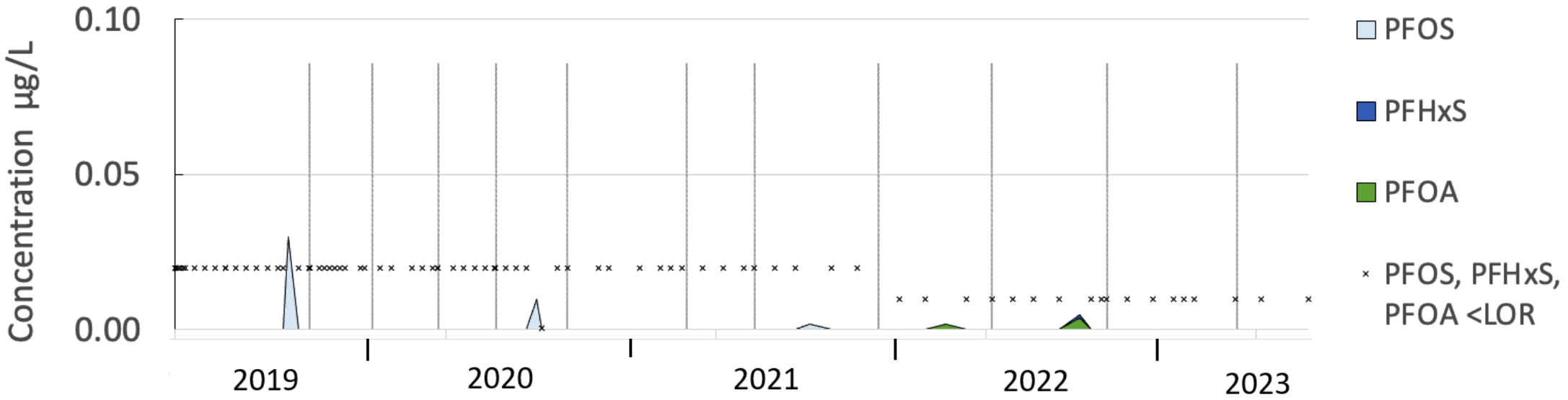
Pre-treatment removes some PFAS – goal is to protect the resin

Effluent from Lead IX Vessel



Concentrations < 200 ppt after first lead RIEX vessel

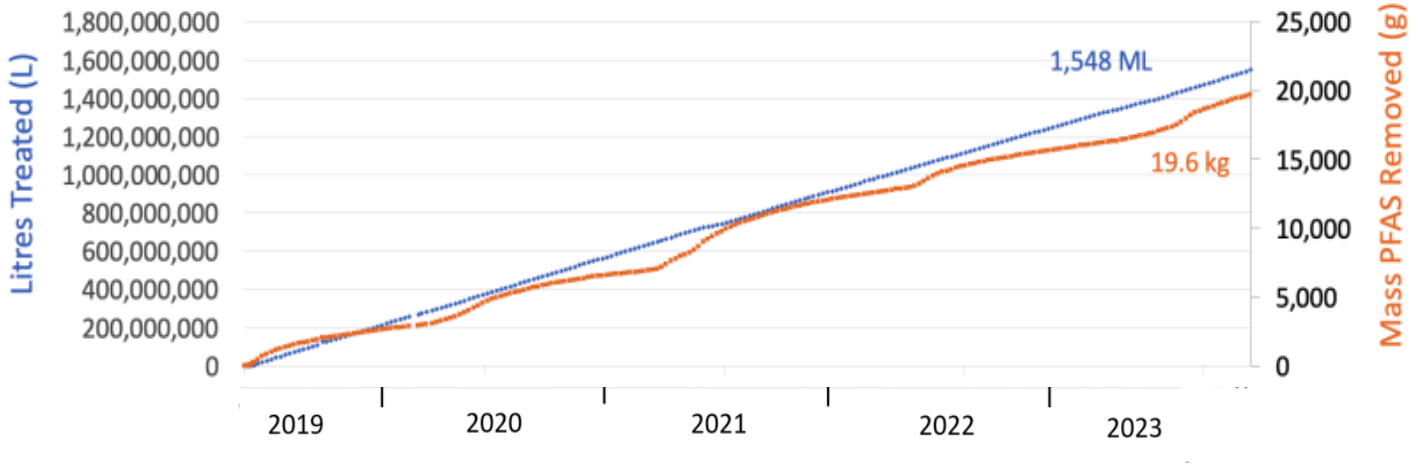
Effluent from Lag Vessel

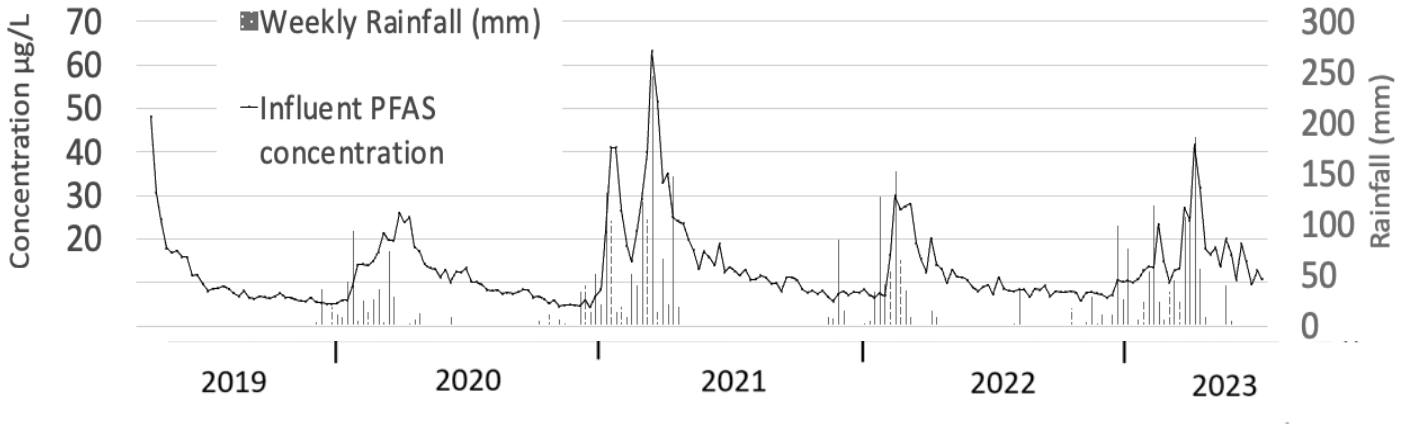


Consistent: 100% compliance with treatment objective; nearly non-detect in all sampling events

Consistent Performa

- Volume water treated
- PFAS removal
  - Pre-treatment media
  - Hydrogeological areas of greater concentration
  - Seasonal variation



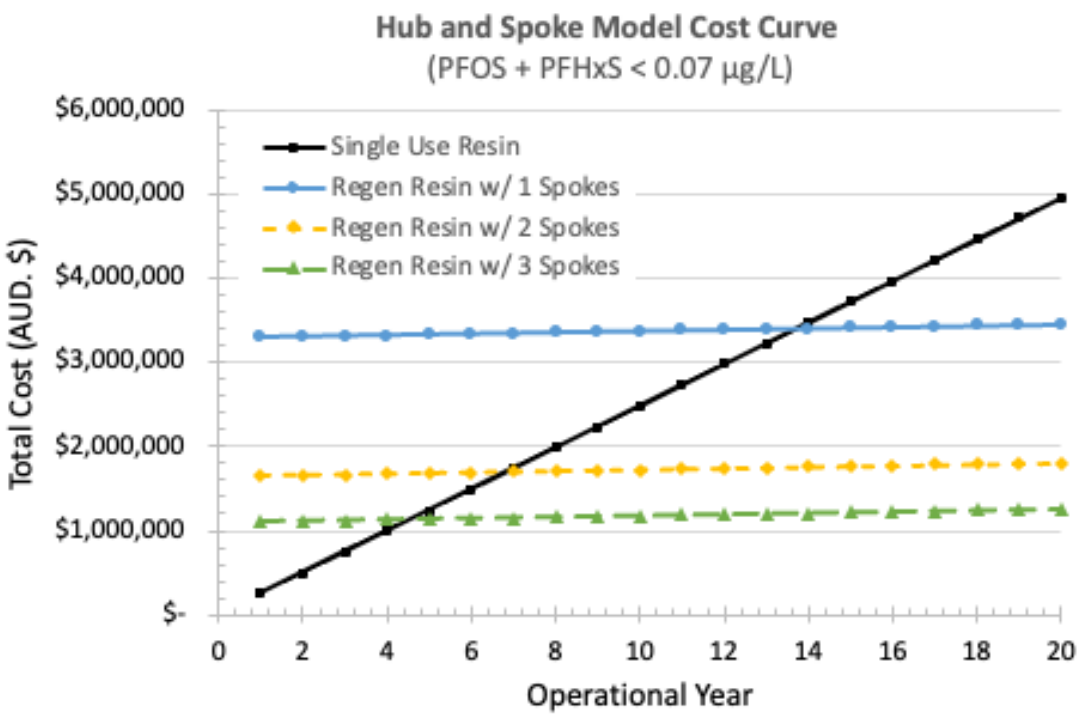


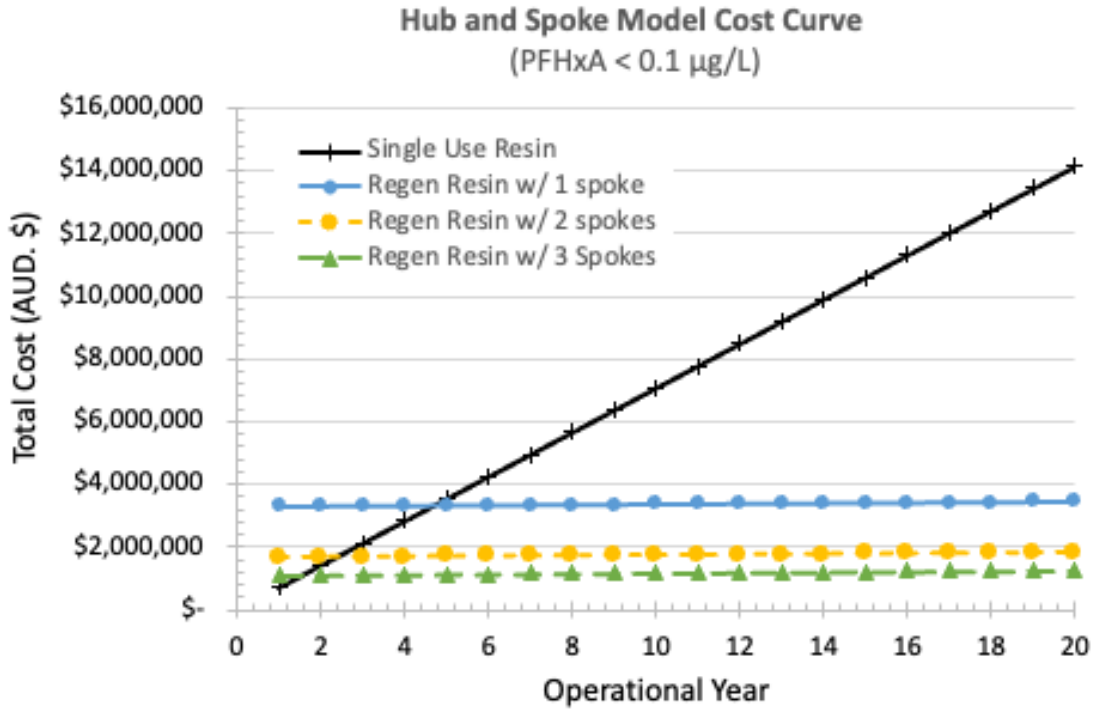
Regeneration Efficiency

- No obvious media degradation
- No increased regeneration frequency
- Consistent PFAS mass recovered

Criteria	5–Cycle Average	5-Cycle Standard Deviation
Treatment Days	245	56
Volume Water Treated (ML)	128	26
PFAS Removed (g)	330	112
PFAS Recovered (g)	369	173
Mass Balance (removed-recovered)	-39	77

Economics of Regeneration

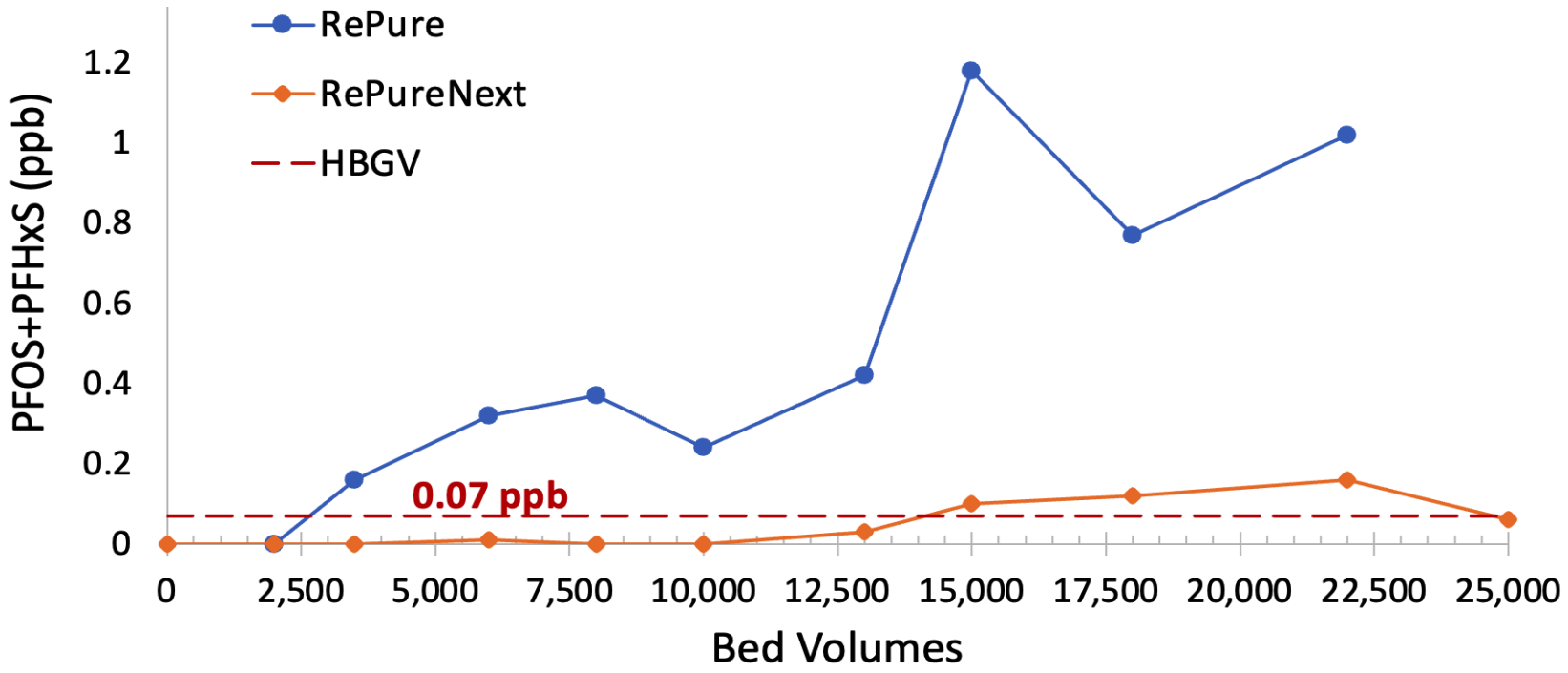




- **Increased CAPEX: recouped with OPEX savings.**
- **RIEX: future proof for future treatment objectives.**

Optimization Efforts Continue

New media evaluation



2.7x capacity with RePureNext for carboxylates;
>4x capacity for HBGV PFAS of interest

Investigation efforts

Microplastics

Are we putting microplastics into the environment by with technology involving large vessels of plastic media?

FIG. 2 Water Sampling Apparatus for Pressurized Systems

ASTM D8332-20
Standard Practice for Collection of Water Samples with High, Medium, or Low Suspended Solids for Identification and Quantification of Microplastic Particles and Fibers

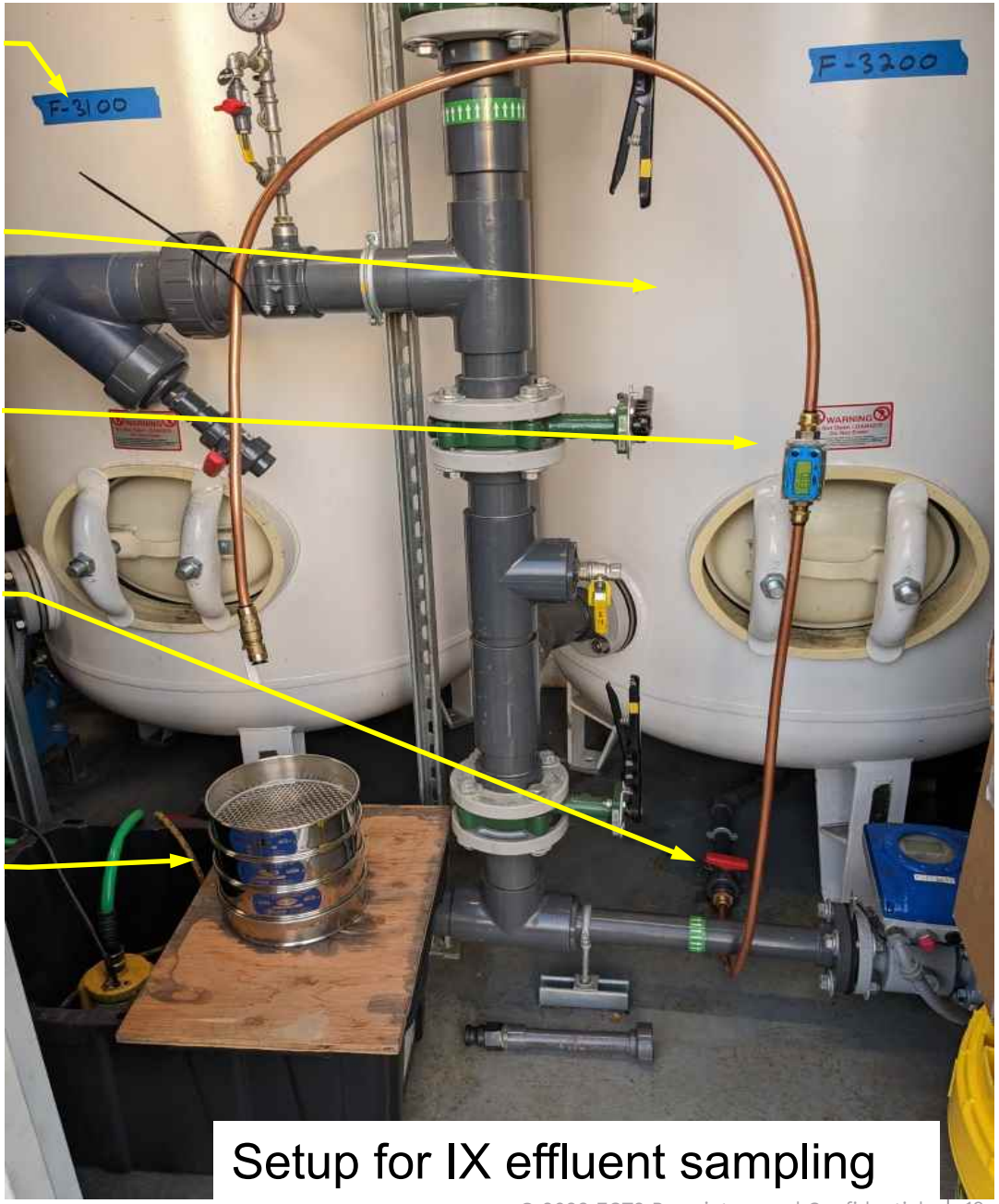
Lead IX Vessel F-3100

Lag IX Vessel F-3200

Flow Meter

Sample from drain

Sieves



Setup for IX effluent sampling

Investigation efforts

Microplastics

Criteria	AU (Site #1)	US (Site #2 / Lab #1)	US (Site #2 / Lab #2)
Microplastic count (microplastics/L)	Inf = 27 / Eff = 34	0.6 / 0	1.1 / 1.0
Sample collected	Grab	ASTM 8332-20	
Analysis performed	Microscopy/LDIR	PLM/Raman	Microscopy/LDIR
Plastics identified	No polystyrenic / PMMA		
Resin sample match	No	N/A	No

Findings do not suggest MP contribution to the environment from two IEX treatment locations

What We've Accomplished:

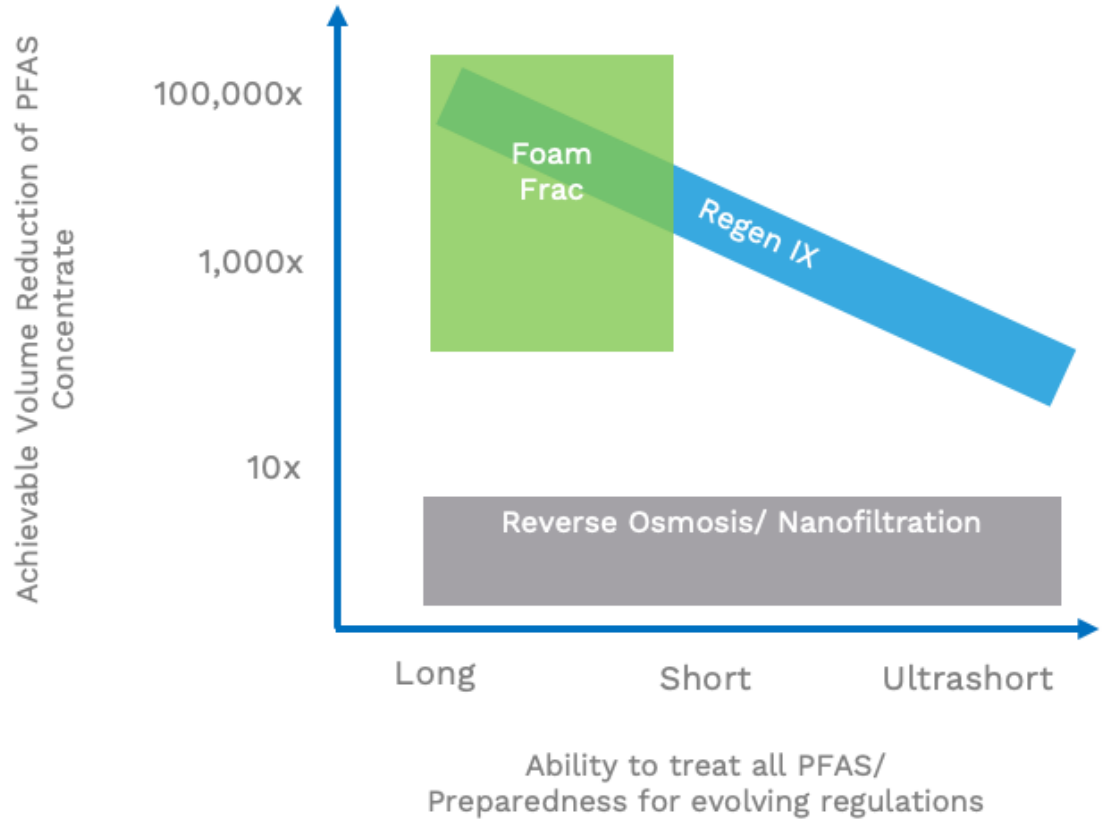
5 years full-time operation	**1.8GL** Treated	**100% HBGVs** compliance	26 regens performed	**22+ kg** PFAS removed

- Higher concentrations; longer treatment times; bundled locations
- Ancillary Benefits
  - ESG metrics
  - reduced future liability
  - waste minimization

What We've Learned

- Consistently works (PFAS removal and resin regeneration)
- Not a silver bullet for all situations
- Accurate design parameters
- Optimization must continue
- Microplastic evaluation completed

- Future-proof
  - Tightening regulations
  - Off-ramp for destruction



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