BodemBreed forum

VERHOEVE
AURORA GROUP

ect2
Montrose Environmental Group

INHOUD

- Introductie
- Samenwerking Verhoeve – ECT2
- Project Swedavia Arlanda
    - Ontwerp en engineering
    - Bouw en installatie
- Results Project Swedavia Arlanda
- ECT2 waterzuiveringstechnieken

Wie zijn wij?

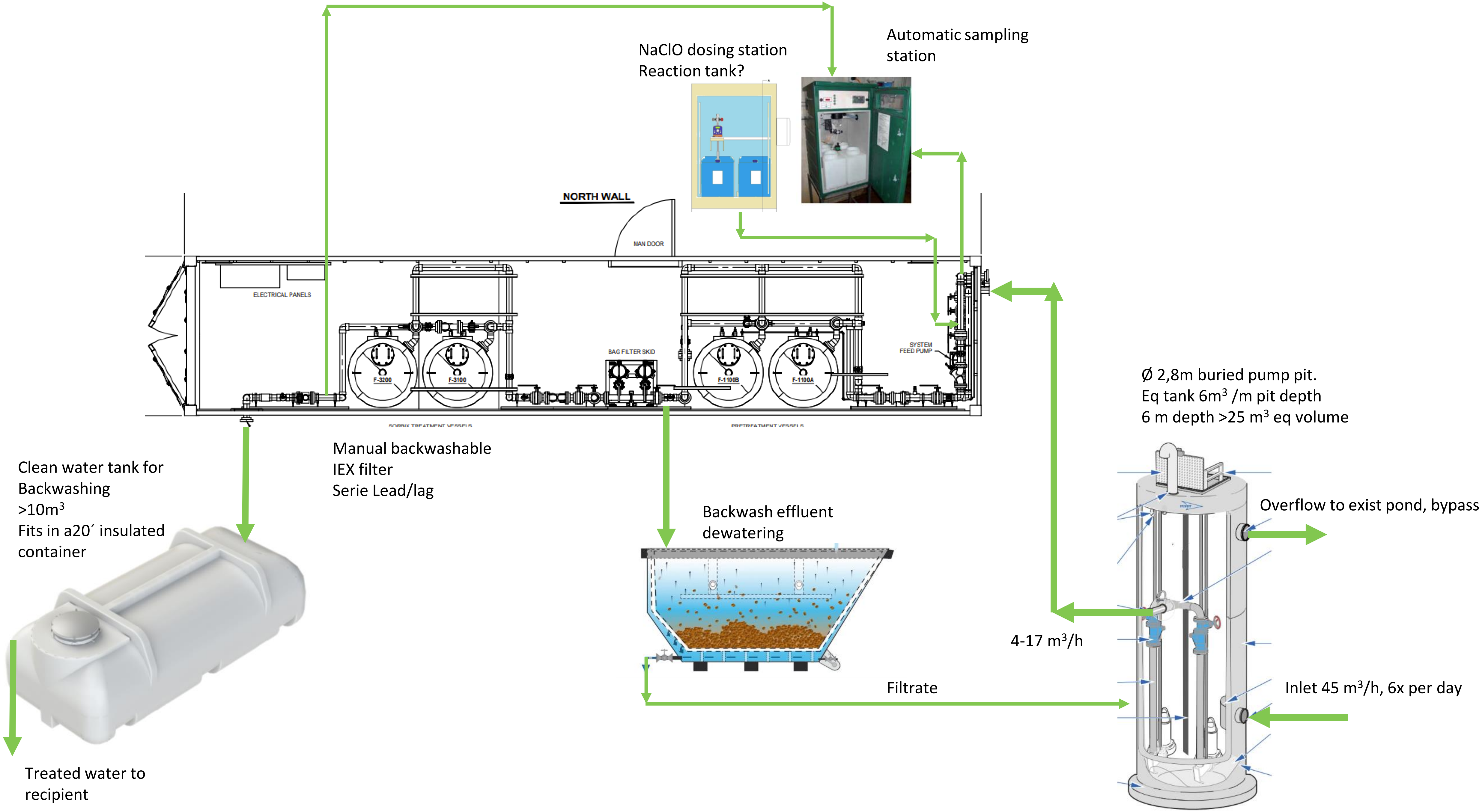
- Samenwerking ECT2 – Verhoeve ontstaan in 2020
- Doel: Opgedane kennis en ervaring PFAS-aanpak uit Amerika en Australië benutten in Europa
- Specifieke casus: Swedavia Arlanda (2023)
  - ECT2: ontwerp en exploitatie
  - Verhoeve: fabricage en installatie

Project Swedavia Arlanda

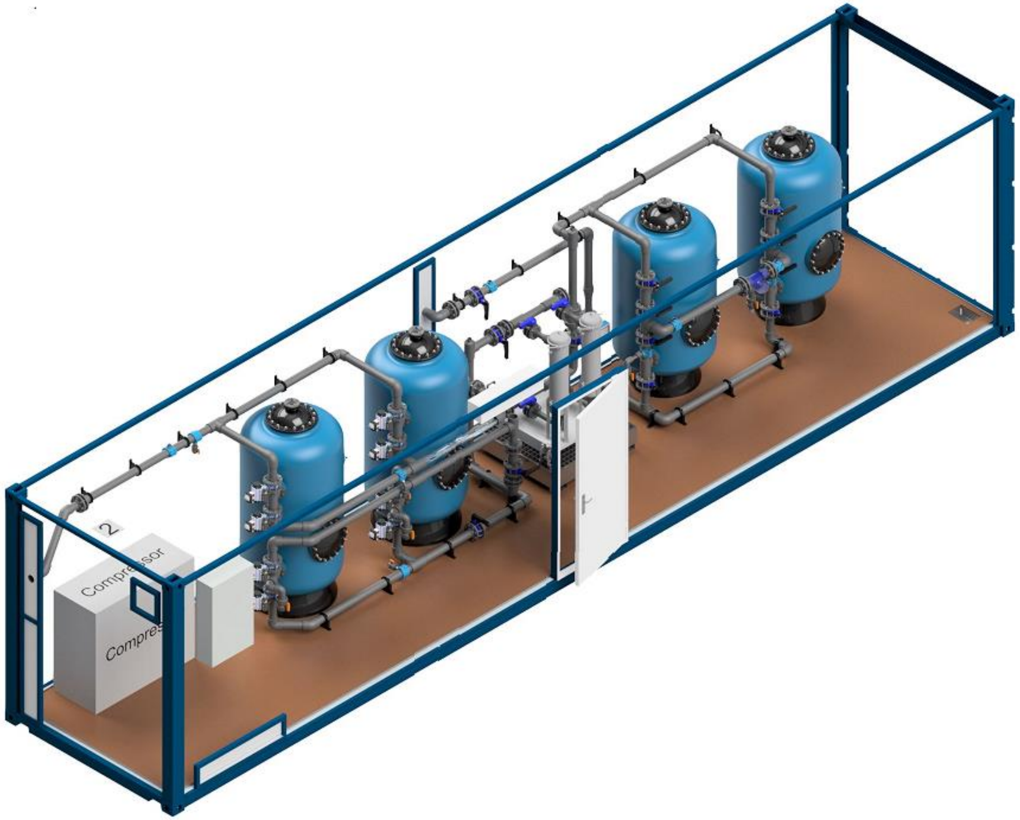
- Ontwerp: ECT2
- Fabricage: Verhoeve
- US M6 installatie naar Europese normen aangepast
- Ontwerpdebiet: 17 m^3/h
- Ontwerp en bouwperiode: 6 maanden
- Volledig geautomatiseerd
- Operationeel sinds: Sept 2023

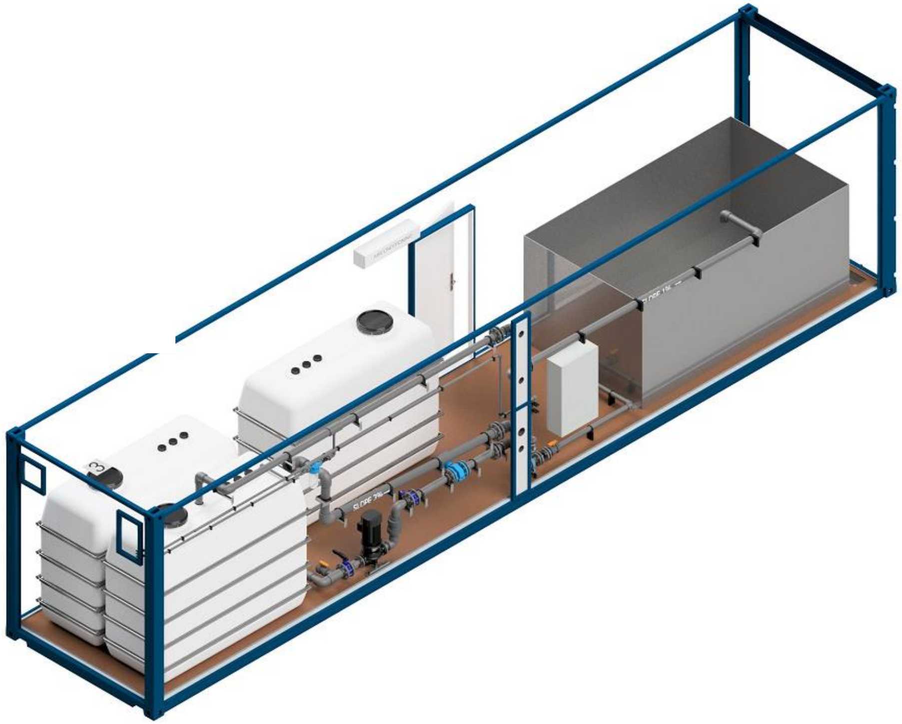
Engineering en bouwproces

- Componenten M6 unit aanpassen naar Europese norm
- Bouw conform Europese wet- en regelgeving

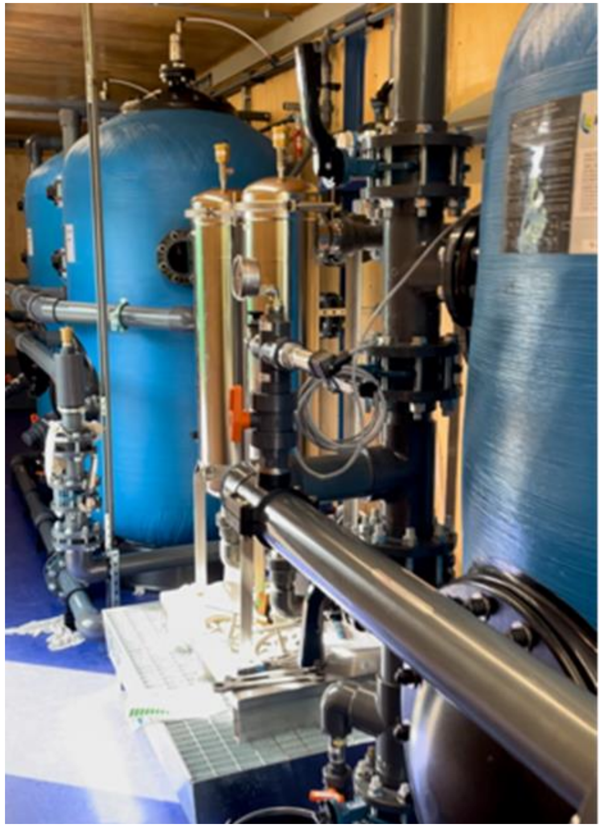

NaClO dosing station
Reaction tank?
Automatic sampling
station
NORTH WALL
MAN DOOR
ELECTRICAL PANELS
BAG FILTER SKID
F-3200
F-3100
F-1100B
F-1100A
SYSTEM
FEED PUMP
Ø 2,8m buried pump pit.
Eq tank 6m^3 /m pit depth
6 m depth >25 m^3 eq volume
Manual backwashable
IEX filter
Serie Lead/lag
Clean water tank for
Backwashing
>10m^3
Fits in a20´ insulated
container
Backwash effluent
dewatering
Overflow to exist pond, bypass
4-17 m^3/h
Filtrate
Inlet 45 m^3/h, 6x per day
Treated water to
recipient

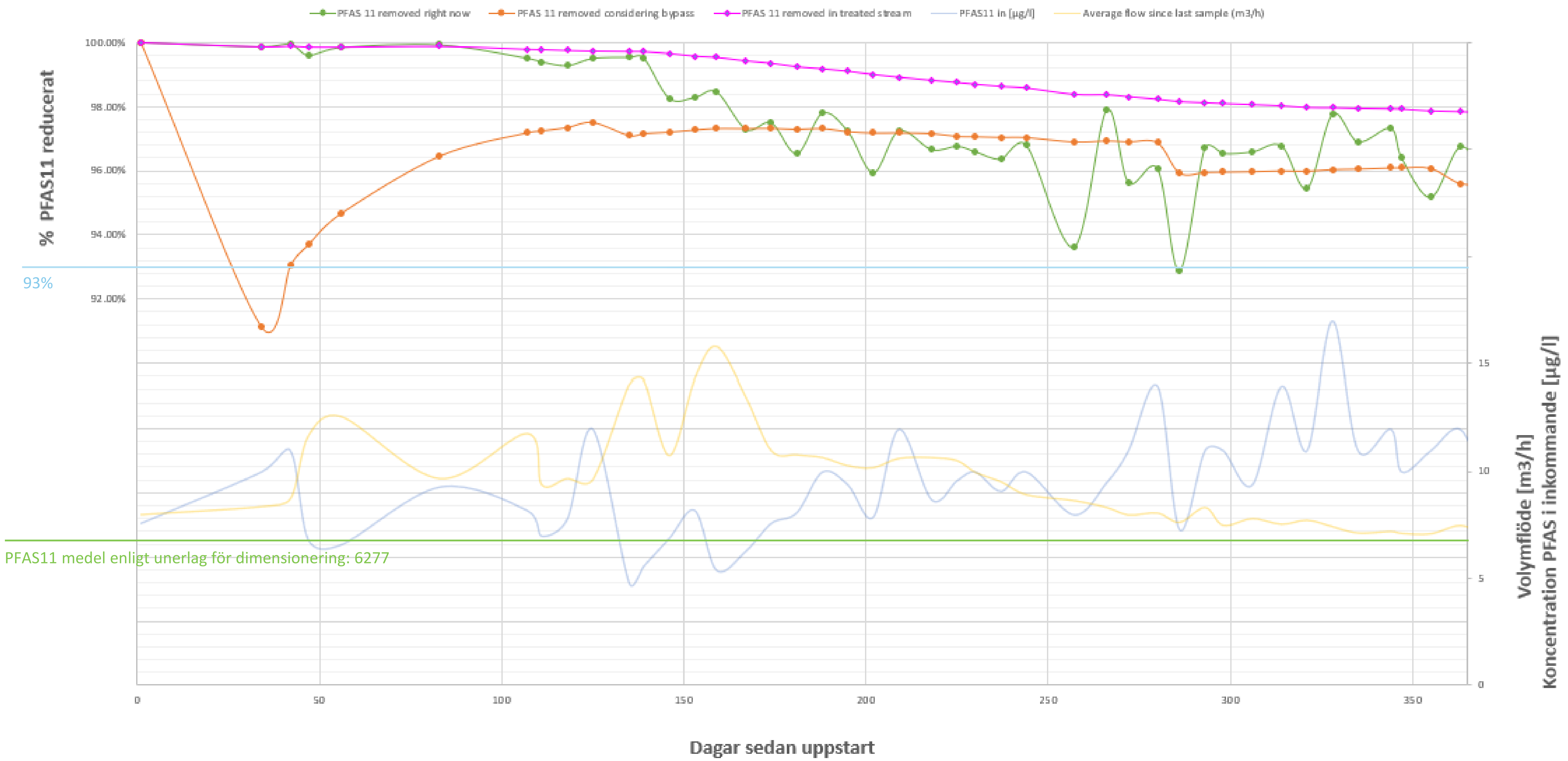
Van 2D naar 3D





Bouw en installatie



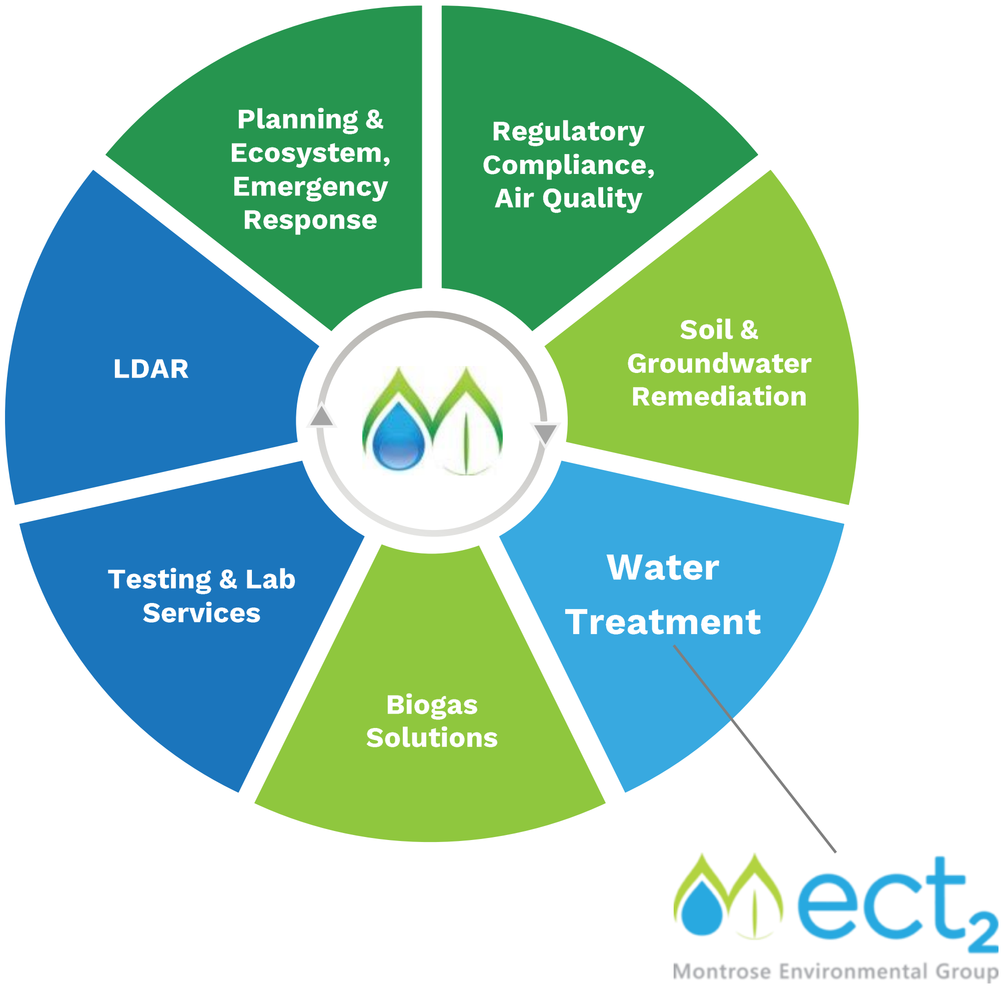


PFAS 11 removed right now
PFAS 11 removed considering bypass
PFAS 11 removed in treated stream
PFAS11 in [µg/l]
Average flow since last sample (m3/h)
% PFAS11 reducerat
100.00%
98.00%
96.00%
94.00%
93%
92.00%
PFAS11 medel enligt unerlag för dimensionering: 6277
Volymflöde [m3/h]
Konzentration PFAS i inkommande [µg/l]
15
10
5
0
0
50
100
150
200
250
300
350
Dagar sedan uppstart

ECT2: Emerging Compounds Treatment Technologies, Inc.

ECT2 is a solutions provider of cutting-edge technology solutions to remove emerging and difficult to treat contaminants, PFAS and 1,4-dioxane, from:

- **Investigation-derived waste**
- **Groundwater**
- **Surface Water**
- **Construction dewatering liquids**
- **Drinking water**
- **Wastewater**
- **Foam spills**
- **Landfill leachate**



ECT2 in the EU –
Status Update

- **5 employees in Sweden**
  - Engineering, project management, business development and administration
- **7 employees in Denmark**
  - Vandrensning acquired in 2023
  - Multiple projects in the nordics
  - EU leader in Leachate treatment for PFAS
- **1 employee in Belgium**
  - Developing opportunities for expansion in Benelux
  - Advancing central regen facility with private client
- **Treatability labs in Denmark and Sweden**
- **Revenue expected to double in 2024 and again in 2025**

State of Technology Development (ITRC) Treatment

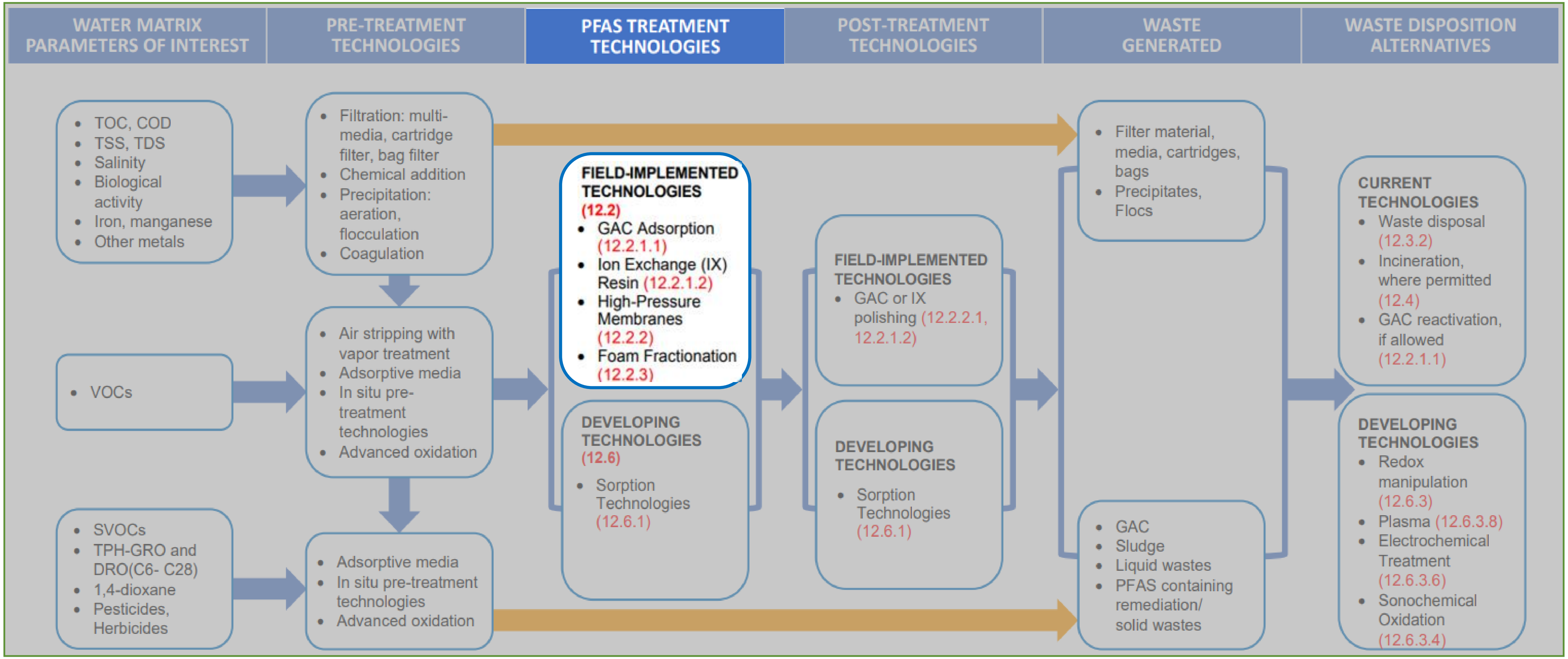
Field-Implemented Treatment Technologies:

- Granular Activated Carbon (GAC)
- Single-use Ion Exchange (IX) - SORBIX™ PURE
- Regenerable IX - SORBIX RePURE
- Foam fractionation - FOAM-X
- Reverse Osmosis (RO)

Limited Application or Developing Technologies:

- In-situ Remediation with Colloidal Carbon
- Precipitation
- Nanofiltration
- Destruction

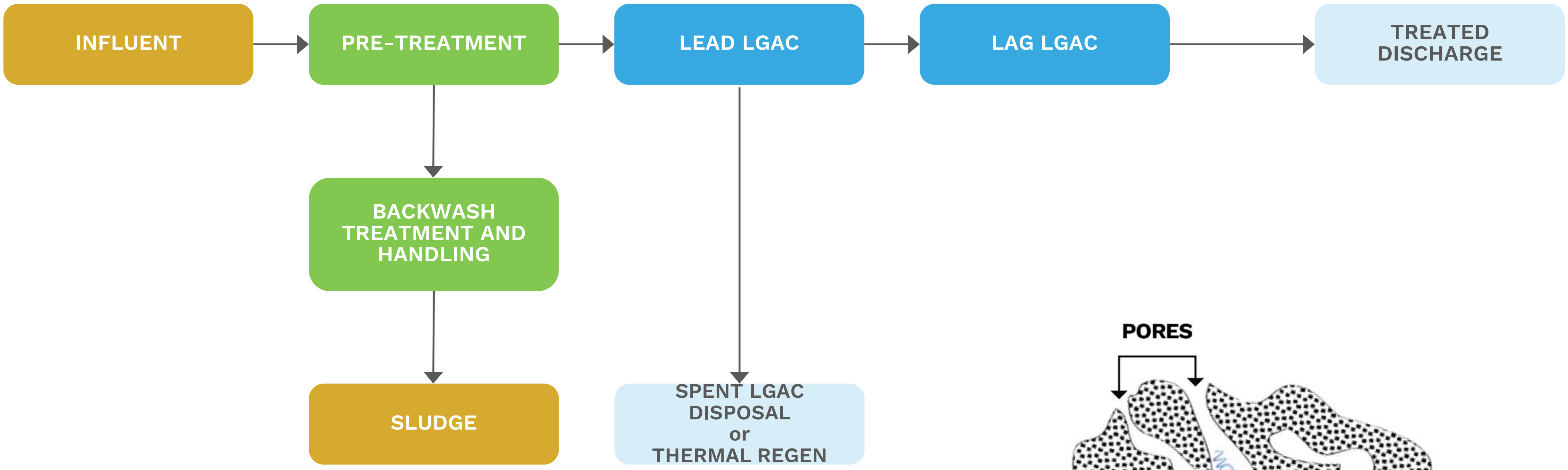
Integrated Water Treatment Solutions (from ITRC)

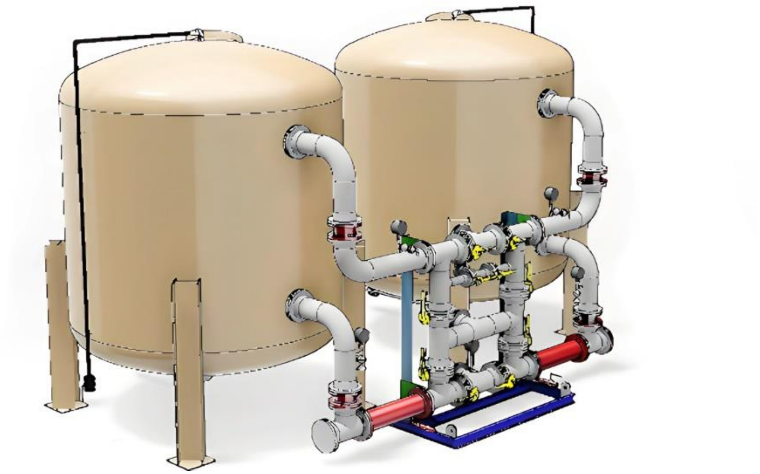


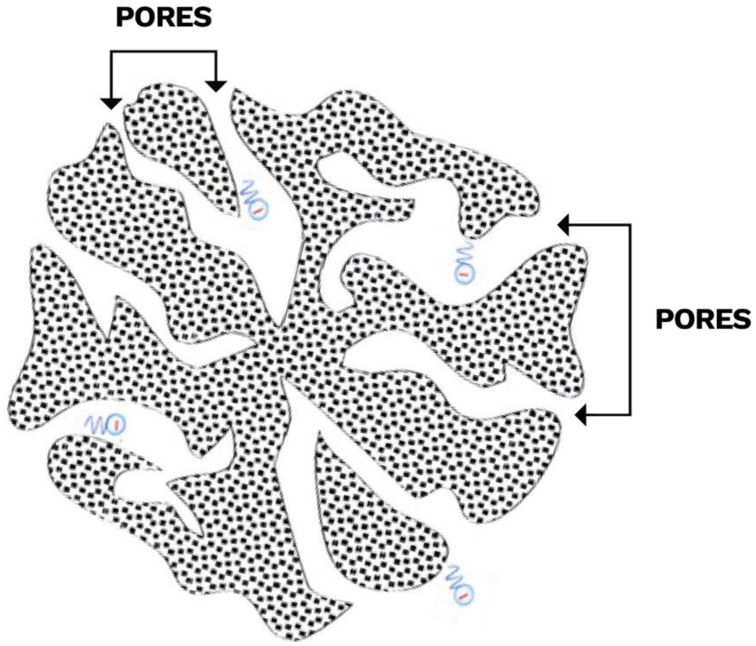
LEGEND
- Water Path
- Waste Path
- (12.2.1.1) Section reference

Printed from: Interstate Technology & Regulatory Council (ITRC). 2023. *PFAS Technical and Regulatory Guidance Document and Fact Sheets PFAS-1*. Washington, D.C.: Interstate Technology & Regulatory Council, PFAS Team. https://pfas-1.itrcweb.org/.

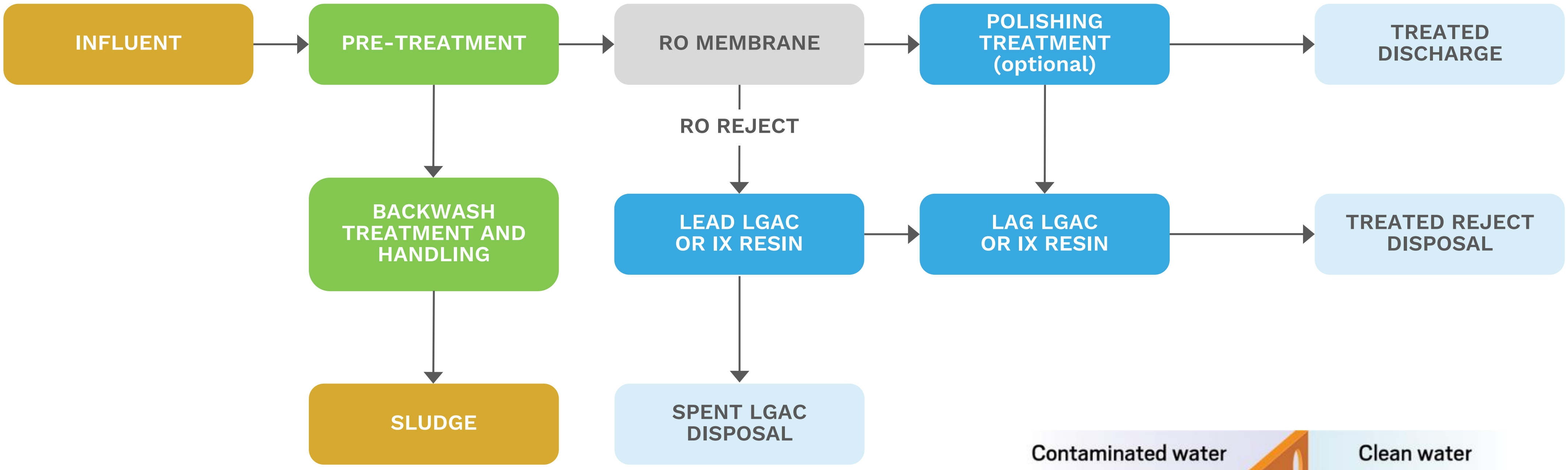
How Does GAC Remove PFAS?

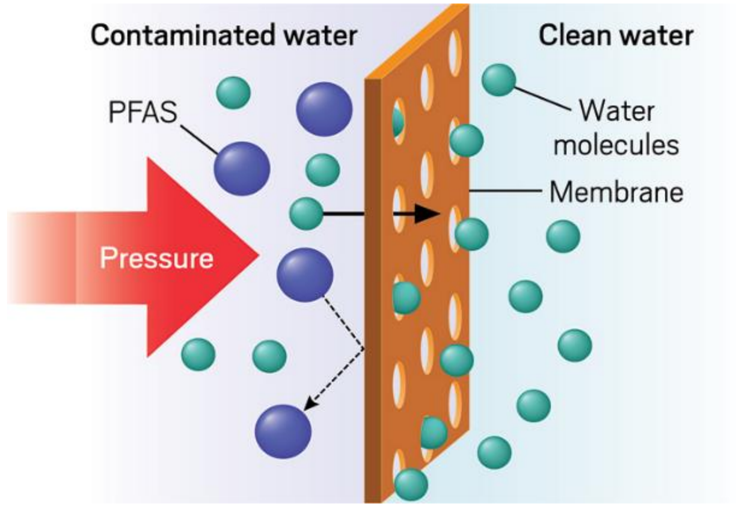




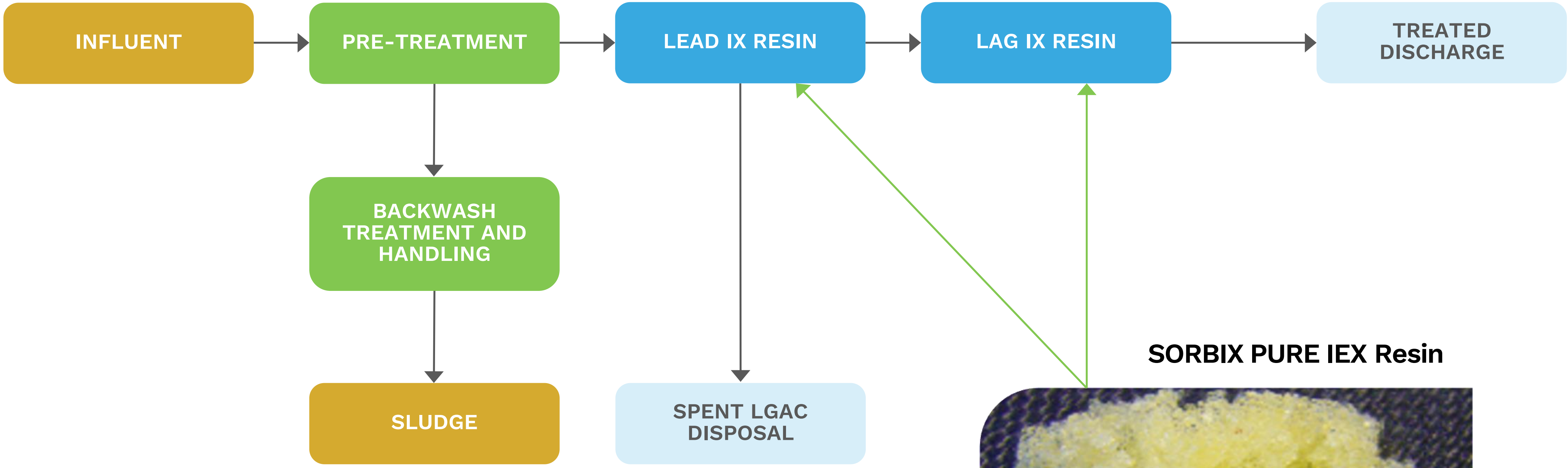


How Does RO Remove PFAS?



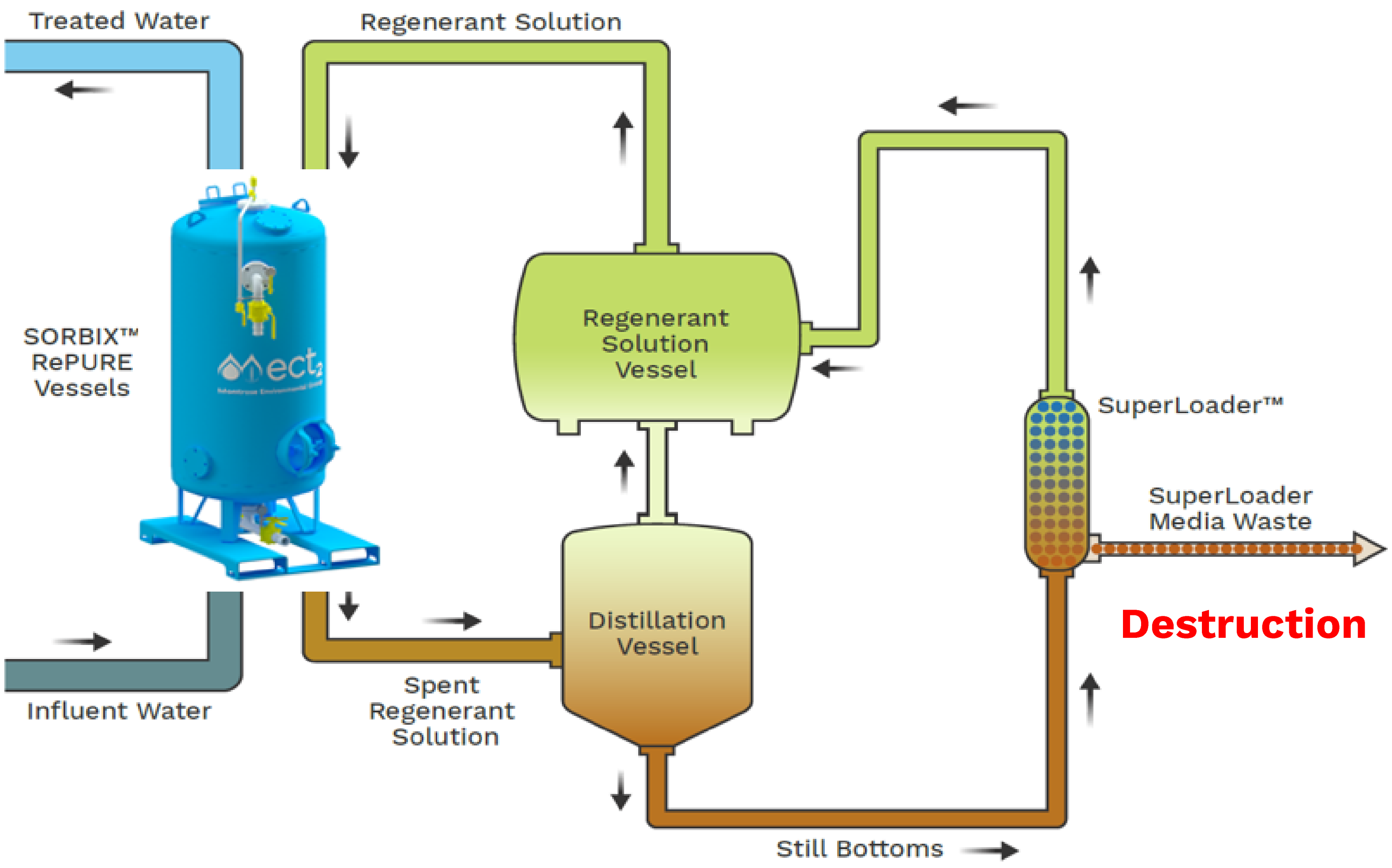


Single-Use IEX Resin Process Flow



SORBIX PURE IEX Resin

SORBIX RePURE IX Resin Regeneration Technology Concentrates PFAS Waste



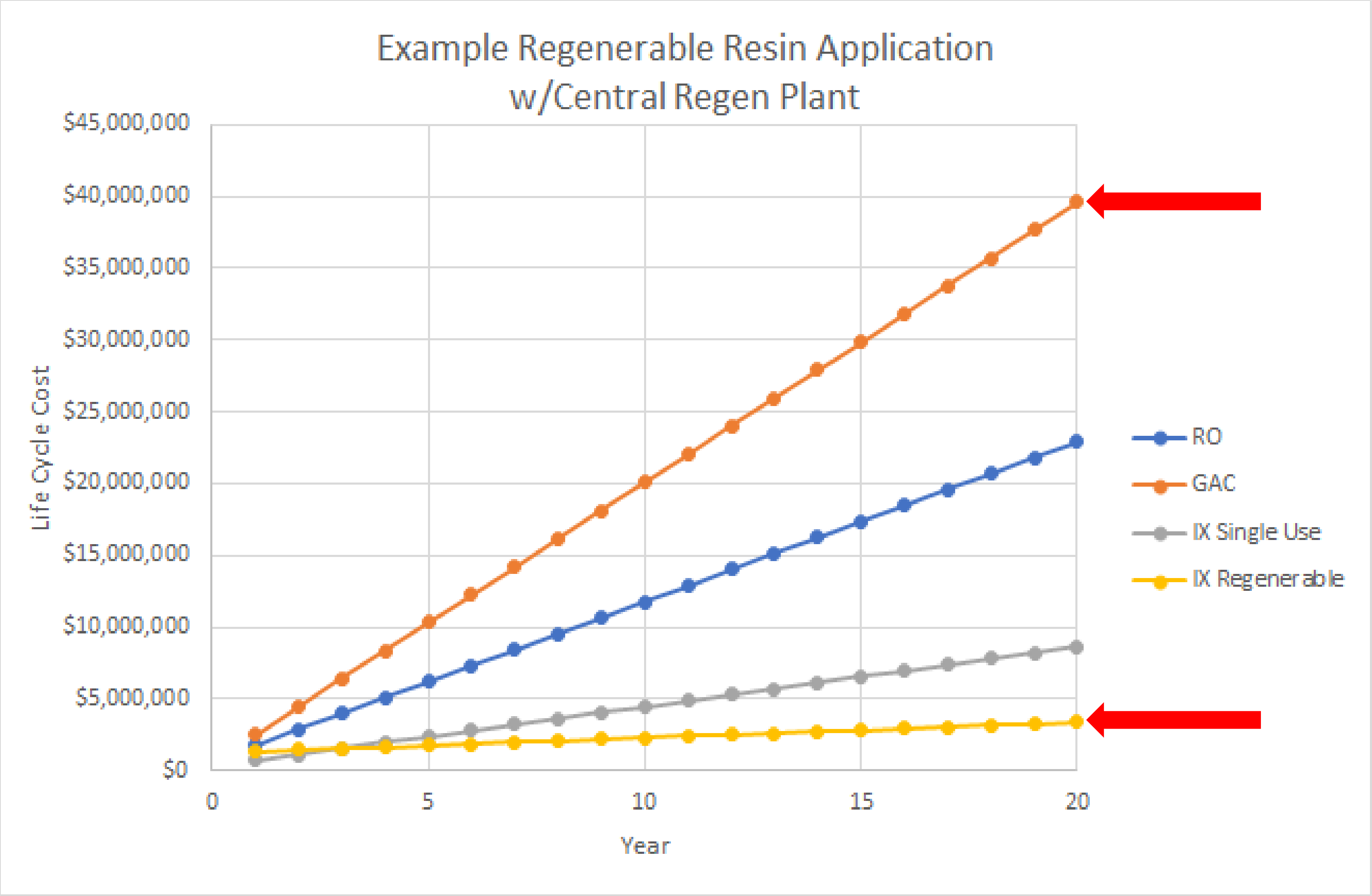
>99%
Less waste generation with RePURE

67%
Reduction in treatment system size

50%
Reduction in lifecycle costs

Lifecycle Cost Comparison – Multiple Treatment Systems

- Three PFAS remediation systems – 200 GPM
- The 3 IX systems share 1 central regen plant
- Total influent PFAS concentration = 100 µg/l
- Treatment objective: PFOS + PFOA < 70 ng/l
- Client wants to minimize waste transport off site



Montrose Experience

Montrose has built **the largest PFAS system in the world** (with RO, GAC and SORBIX RePURE Ion Exchange resin) and has successfully treated billions of gallons of water in the US, Europe and Australia.

The results are consistent, replicable, and <u>below</u> regulatory standards.

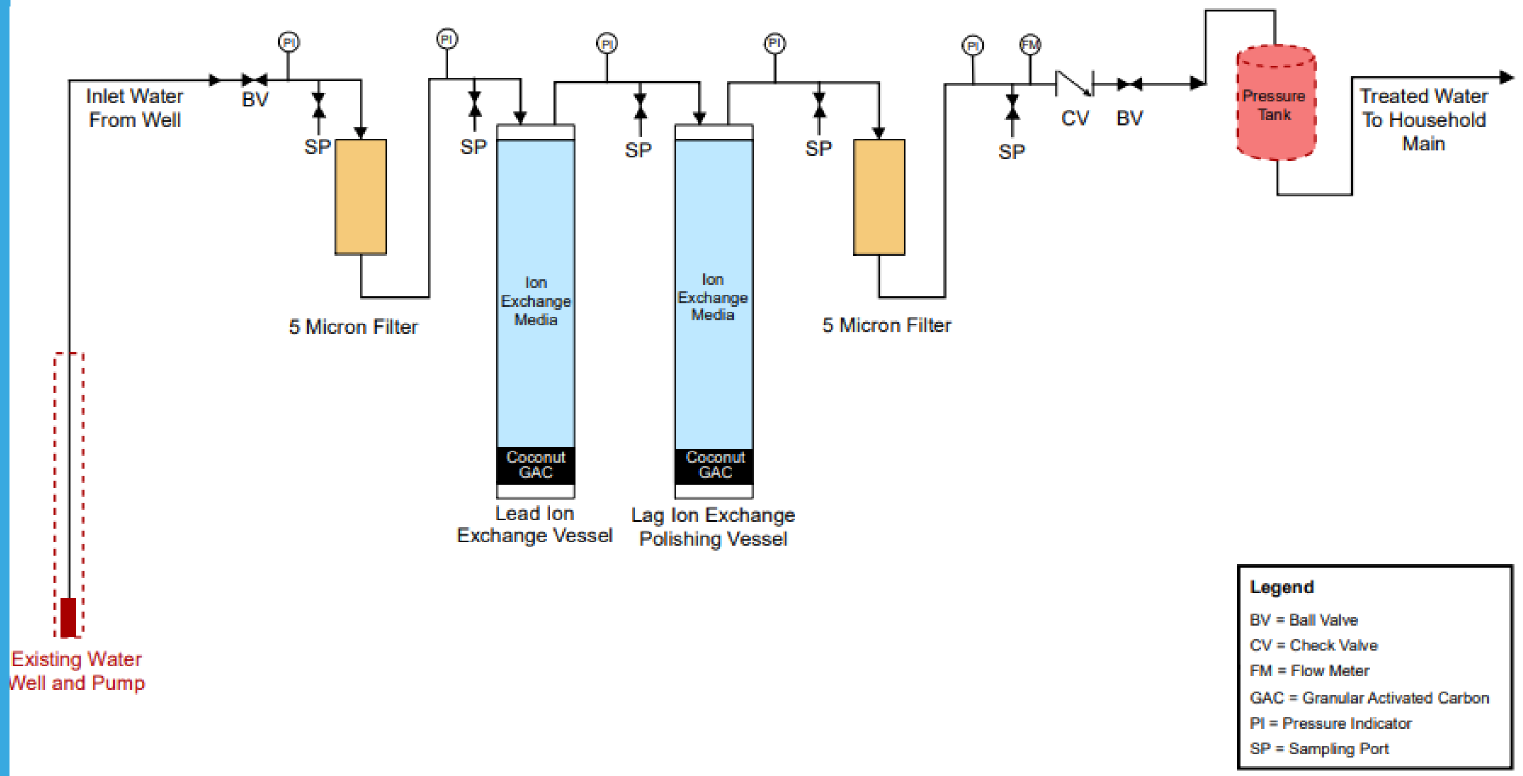
Drinking Water

Things to consider if you must produce drinking water on you site:

1. Available Space
2. Flow rate
3. Drinking water treatment objectives (including non-PFAS)

What are your options if you need to produce drinking water at your facility?

1. Point of Entry Treatment System (POET)



Drinking Water

Things to consider if you must produce drinking water on you site:

1. Available Space
2. Flow rate
3. Drinking water treatment objectives (including non-PFAS)

What are your options if you need to produce drinking water at your facility?

1. Point of Entry Treatment System (POET)
2. High Flow Rate Treatment System

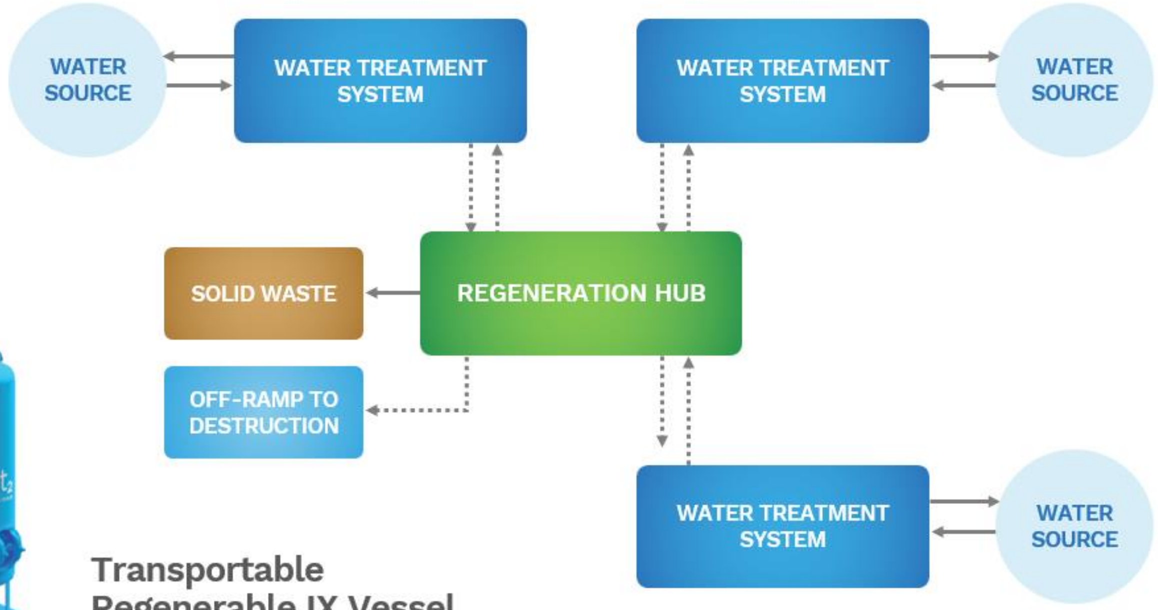
Groundwater Remediation

Things to consider:

1. Flow & Contamination Dependent
2. Estimated time to complete remediation (temporary or permanent)
3. One hot spot or multiple hot spots
4. Location – Indoor/Outdoor, Hazardous Classification
5. Waste disposal options

FOAM Frac

I. Regenerable IX Hub-and-Spoke Model



Transportable Regenerable IX Vessel

High Flow

Med Flow Transportable

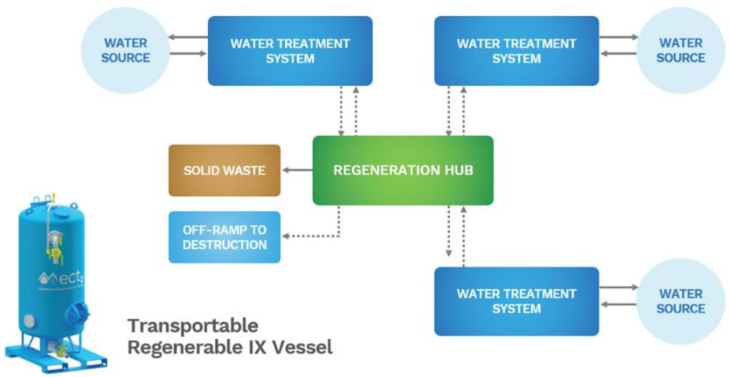
Low Flow

Case Study: Regenerable IX Treatment System for PFAS

RAAF Williamtown, AU

- Legacy AFFF-impacted groundwater
- 200 gpm treatment operational since 2019
- Influent: Total PFAS 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
- 19+ kg of PFAS removed

I. Regenerable IX Hub-and-Spoke Model

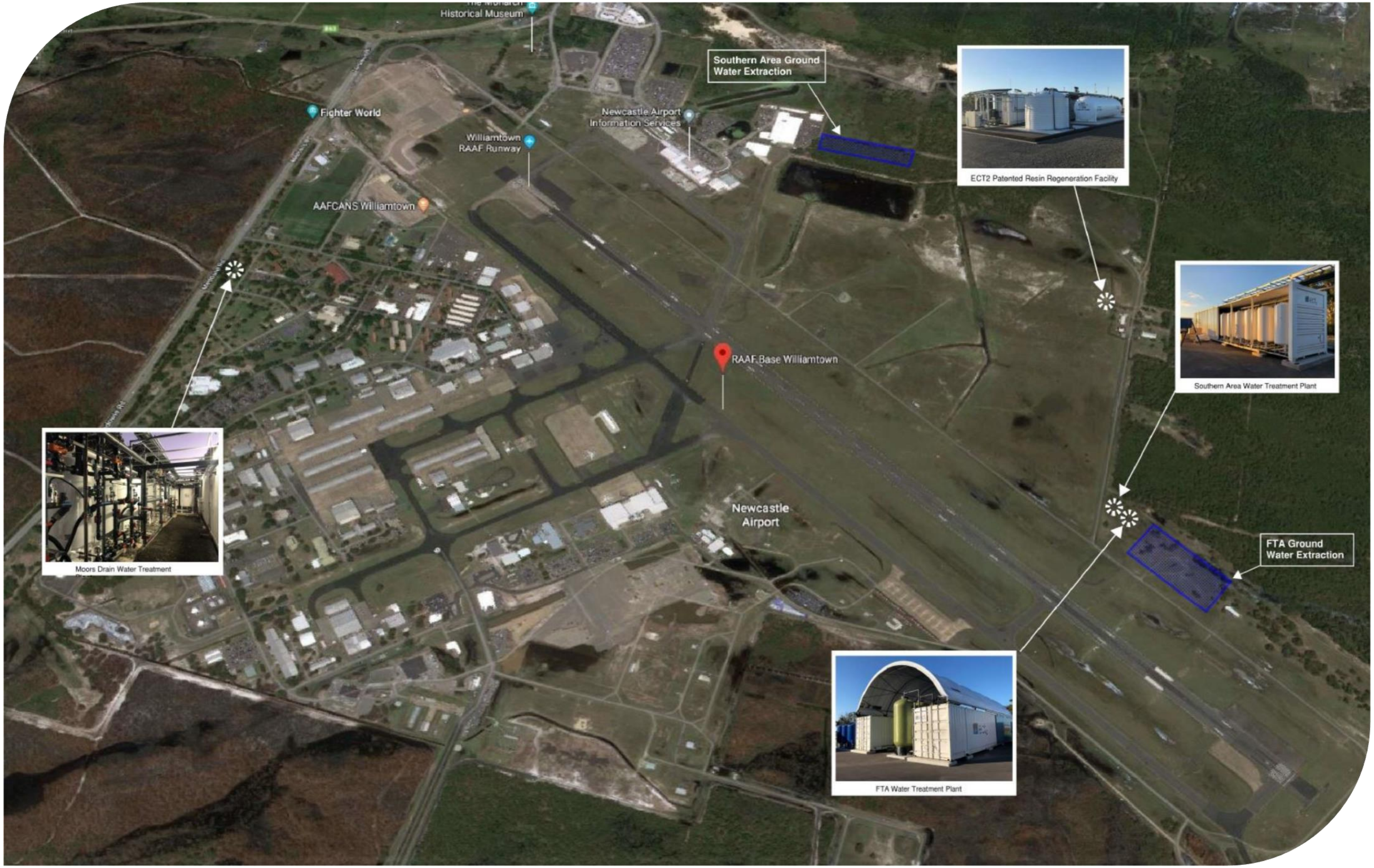


SORBIX RePURE Full Scale Systems Williamtown Australia Case Study

Opportunity:
- RAAF Base Williamtown
- Multiple PFAS hot spots
- Contamination migrating offsite in groundwater and
  surface water

Challenge:
- Construction on an active Air Base
- Different water sources:
  - Surface runoff, Fire Training Area, Groundwater Plume
- Minimize waste generation

Solution:
- (3) 200 GPM Treatment Systems
- (1) Central Regen System
- ND effluent since first system start-up in June 2017


Historical Museum
Fighter World
Williamtown
RAAF Runway
AAFCANS Williamtown
Newcastle Airport
Information Services
Southern Area Ground
Water Extraction
ECT2 Patented Resin Regeneration Facility
Southern Area Water Treatment Plant
RAAF Base Williamtown
Newcastle
Airport
FTA Ground
Water Extraction
FTA Water Treatment Plant
Moors Drain Water Treatment

Technology Comparison

	Foam Fractionation	Reverse Osmosis	GAC	Single Use IX	Regenerable IX
Treatment Mechanism	Adsorption to bubbles	Membrane	Adsorption	Adsorption and ion exchange	Adsorption and ion exchange
State of Development	Field-Implemented	Field-Implemented	Field-Implemented	Field-Implemented	Field-Implemented
Ideal PFAS Concentration Range	Low ppt and up	Low ppt and up	Low ppt and up	Very low ppt and up	>10 ppb (much lower if regen system shared)
Operating Scale (to date)	Up to 1 MGD (700 GPM)	Up to 10s MGD	Up to 10s MGD	Up to 10s MGD	Up to 10s MGD
Ability to treat long-chains	Excellent				
Ability to treat mid-chains	Good	Excellent	Good	Excellent	Excellent
Ability to treat short-chains	Poor for PFBA PFBS achievable with surfactant addition	Good to excellent	Poor	Good	Good to Excellent
Ability to treat ultra short-chains	Not tested	Good to excellent	Not applicable	Good Extremely low BV capacity	The only option

Technology Comparison

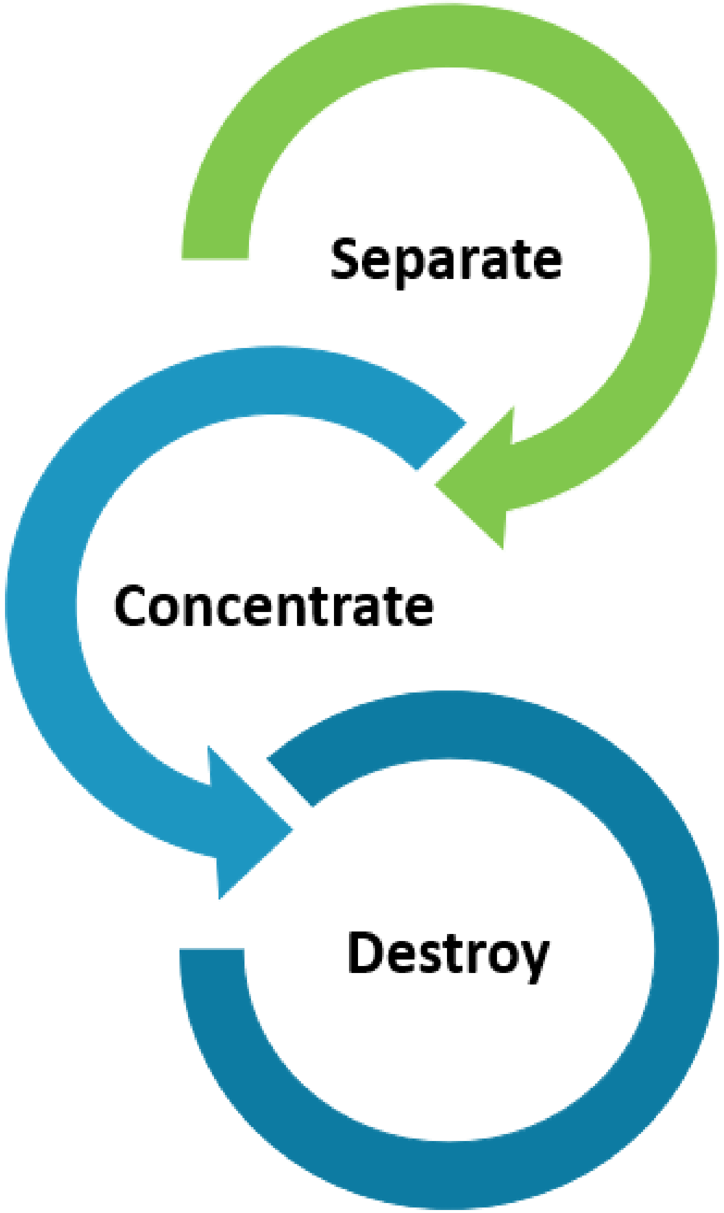
	Foam Fractionation	Reverse Osmosis	GAC	Single Use IX	Regenerable IX
Ideal Water Types	Low to high TDS; low to high TOC	Higher	Low to moderate TDS; Variable TDS	Low TDS; Low to moderate TDS	Low TDS; Low to moderate TDS
Typical Hydraulic Retention Time/Empty Bed Contact Time (EBCT)	20 min	N/A	10 min	2 - 3 min	4 - 5 min
System Footprint	Medium to Large	Medium	Large	Small	Medium
Typical Pretreatment	Usually none	Sand, UF, and/or Cartridge Filter	Sand or Cartridge Filters	Sand or GAC, Cartridge Filters	Sand or GAC, Cartridge Filters
Operational Considerations	Foaming capacity is highly variable, site specific		May need pretreatment to TSS	May need pretreatment to TSS	May need pretreatment to TSS; Uses organic solvent (ethanol or methanol)

Technology Comparison

	Foam Fractionation	Reverse Osmosis	GAC	Single Use IX	Regenerable IX
CapEx and OPEX Considerations	Energy costs drive economics	Energy costs Reject stream treatment	Large vessels More frequent media change outs with short-chain PFAS	Smaller vessels, longer media life Better performance for treatment to ND levels	Lowest lifecycle cost for high concentrations, multiple sites and short/ultra short chain treatment
Waste Generated	Liquid Media treatment, landfill, deep well	Continuous reject stream that needs further treatment	Solid Incinerated, landfilled or offsite Regeneration	Solid Incinerated or Landfill	Regenerated Solid or liquid
Waste Quantities Generated	Small	Very Large	Large	Low	Negligible

To Recap...

- Many things to consider when evaluating your PFAS treatment options
- There is no “one-size-fits-all” solution for PFAS – can include GAC, IX, RO, Foam Frac
- Current process is:
    - Separate
    - Concentrate
    - Dispose/Destroy



ECT2 in the EU

Projects and capabilities

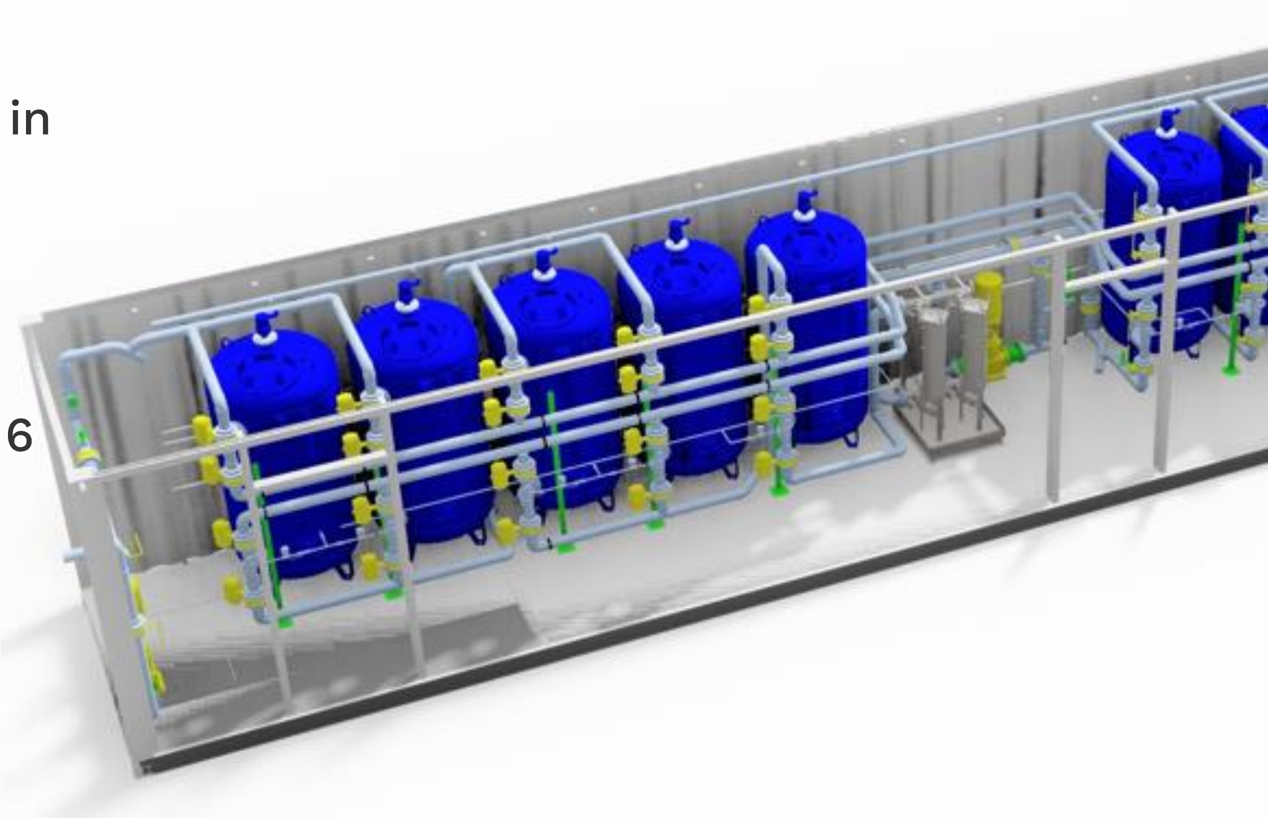
2024

Montrose Environmental Group

Jan 2024

M6 units for rapid deployment in the EU

- EU rental fleet will standardize around M6 design / sizing
- Appropriate for flow rates we are seeing in the EU
- First build underway for Swedavia Visby airport
- Offer submitted to industrial client for M6 groundwater treatment solution



Refinery Case Study

Opportunity

ECT2 was approached by a remote refinery in Alaska that had found PFAS in their wastewater stream. The refinery's wastewater discharge permit and associated ordinances administered by the local city government required that industrial users adhere to a total PFAS limit of <70 nanograms per liter (ng/L) for wastewater discharged to the local city government wastewater utility. More specifically, the sum of 12 PFAS compounds must be less than 70 ng/L to comply with the City ordinance. The presence of PFAS compounds in wastewater is a common problem faced by any industry that manufacturers, utilizes, or receives PFAS, particularly as the EPA increasingly looks to identify and regulate PFAS sources upstream from municipal wastewater treatment plants (WWTPs). Due to the remote location of this site, and the presence of other (i.e., non-PFAS) contaminants in the waste stream, this project required a team of experts that could react quickly to enable the refinery to meet their compliance goals.

Challenge

The primary challenge was to provide a wastewater treatment system, within a compressed timeframe, that could effectively treat the waste stream and allow the refinery to meet the refinery's discharge limit. This challenge was compounded by the presence of co-contaminants in the waste stream, the remote location of the project site, and the need for a system capable of operating in an extreme climate. The client also desired that the efficacy of any proposed treatment approach be demonstrated in the field at a pilot scale before proceeding to full-scale design and construction, and that the full-scale system be mobile, and flexible in terms of flow rates and operation configuration.

Solution

ECT2 designed and delivered a SORBIX™ L Series PFAS treatment system for the initial pilot study. The system was comprised of two media vessels, one container granular activated carbon (GAC), and the other with SORBIX™ PURE ion exchange (IX) media, arranged in a lead-lag configuration and capable of treating at a 3-5 gallons per minute (gpm) flow rate. The pilot system operated for a period of three weeks. While influent concentrations were in the order of 300 to 425 ng/L, treated effluent had a maximum concentration of 1.8 ng/L – well below the refinery's discharge limit. Removal was 99.5 to 100 percent effective in all cases tested and PFAS was reduced to below the 70 ng/L limit, and in most cases, reduced to non-detect. With the pilot study having demonstrated the efficacy of the proposed treatment approach, the client requested that ECT2 design and install a full-scale mobile system.
Within three months of client authorization, ECT2 designed, constructed, delivered and commissioned a SORBIX™ M Series, a full-scale system capable of operating at between 35-70 gpm. The system was housed in a weatherproofed and insulated 20-foot Conex box (suitable for Alaskan winters), and included variable frequency drives for flow rate flexibility, back-washable sand filtration and GAC pre-treatment to address co-contaminants, SORBIX™ ion exchange media treatment to address PFAS, and integration of controls with the refinery's existing treatment system. ECT2 was able to design a construct a system that could easily be configured in a variety of ways, or at different locations, while also offering a process that could be run in parallel, series, or have each vessel operated independently.
Since system startup, the treatment system has been very effective in treatment PFAS to non-detect levels and allowed the refinery to meet its discharge compliance goals.