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Interactive Dashboard Toolboxes with Coupled Data Based Mass Flux Models for High Resolution PFAS Conceptual Site Models

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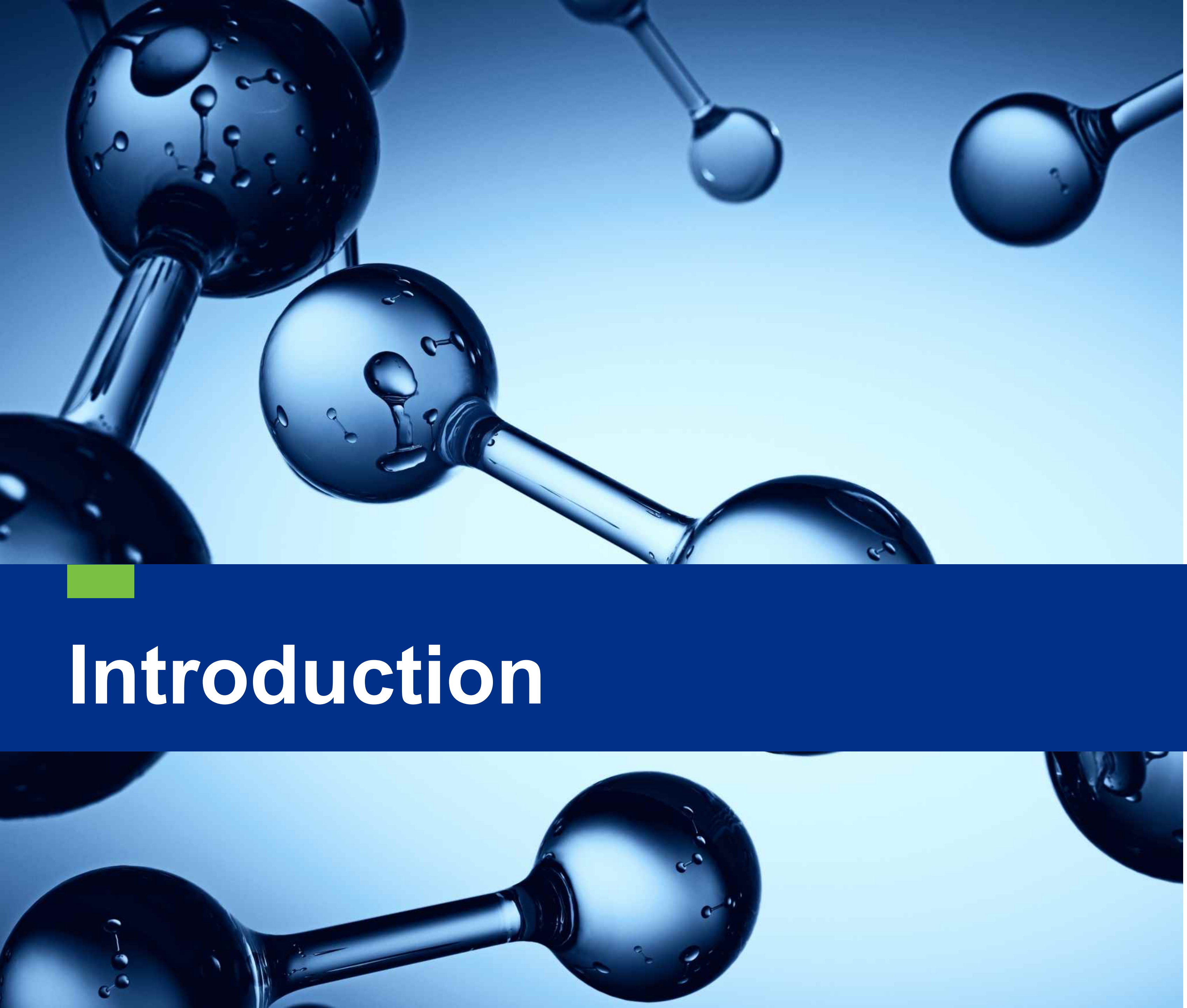
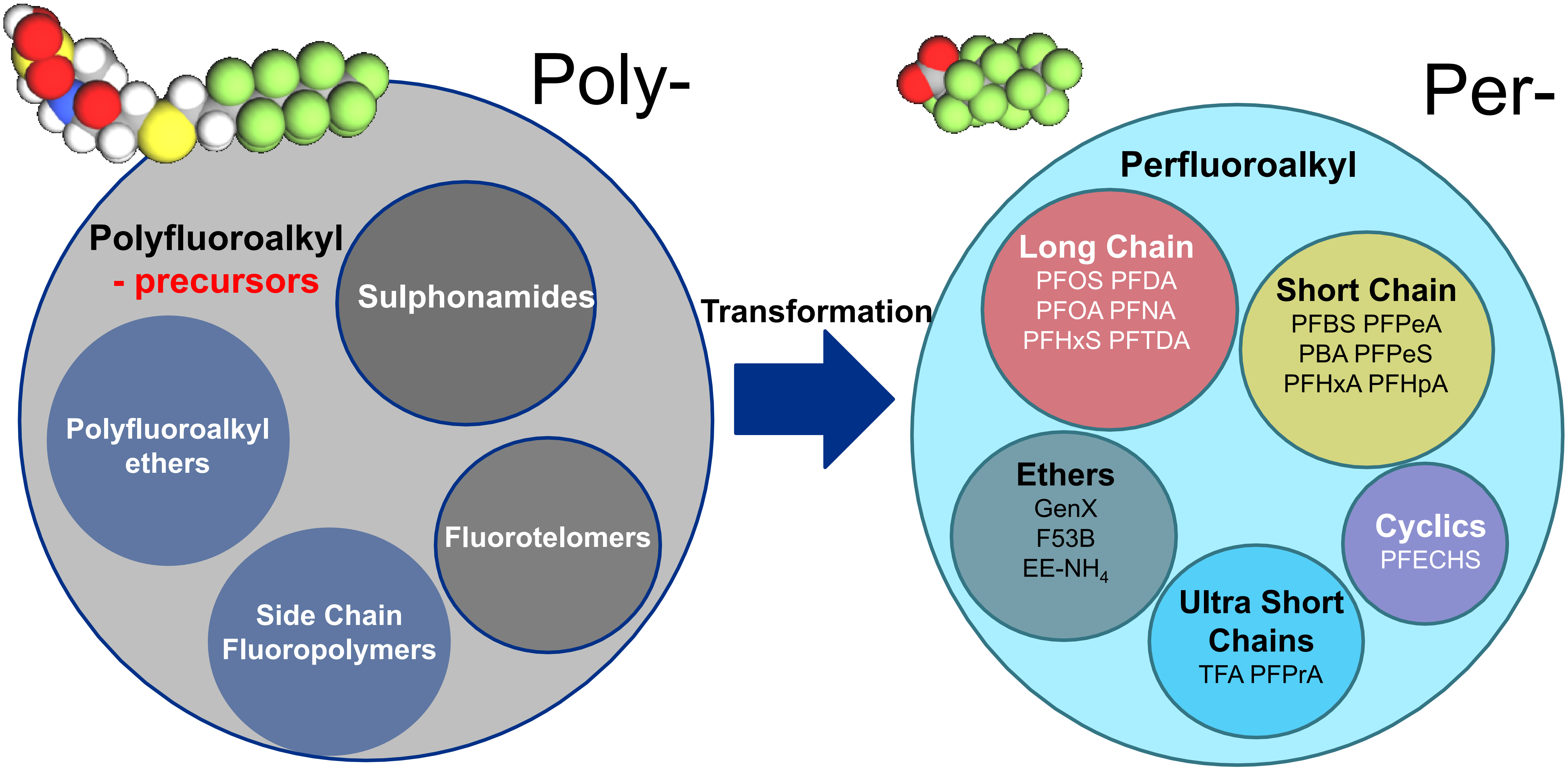
Overview

1. **Introduction**
   - PFAS Background
2. **HR-CSMs for PFAS**
   - Example of AFFF contaminated site
3. **Analytics Tools for HR-CSM**
   - Dashboard Tools Overview and Reasoning
   - Practical Analytics
   - Vadose Zone Leaching Models
   - Groundwater Plume Evaluation
   - 3D Visualization
4. **Demonstration**

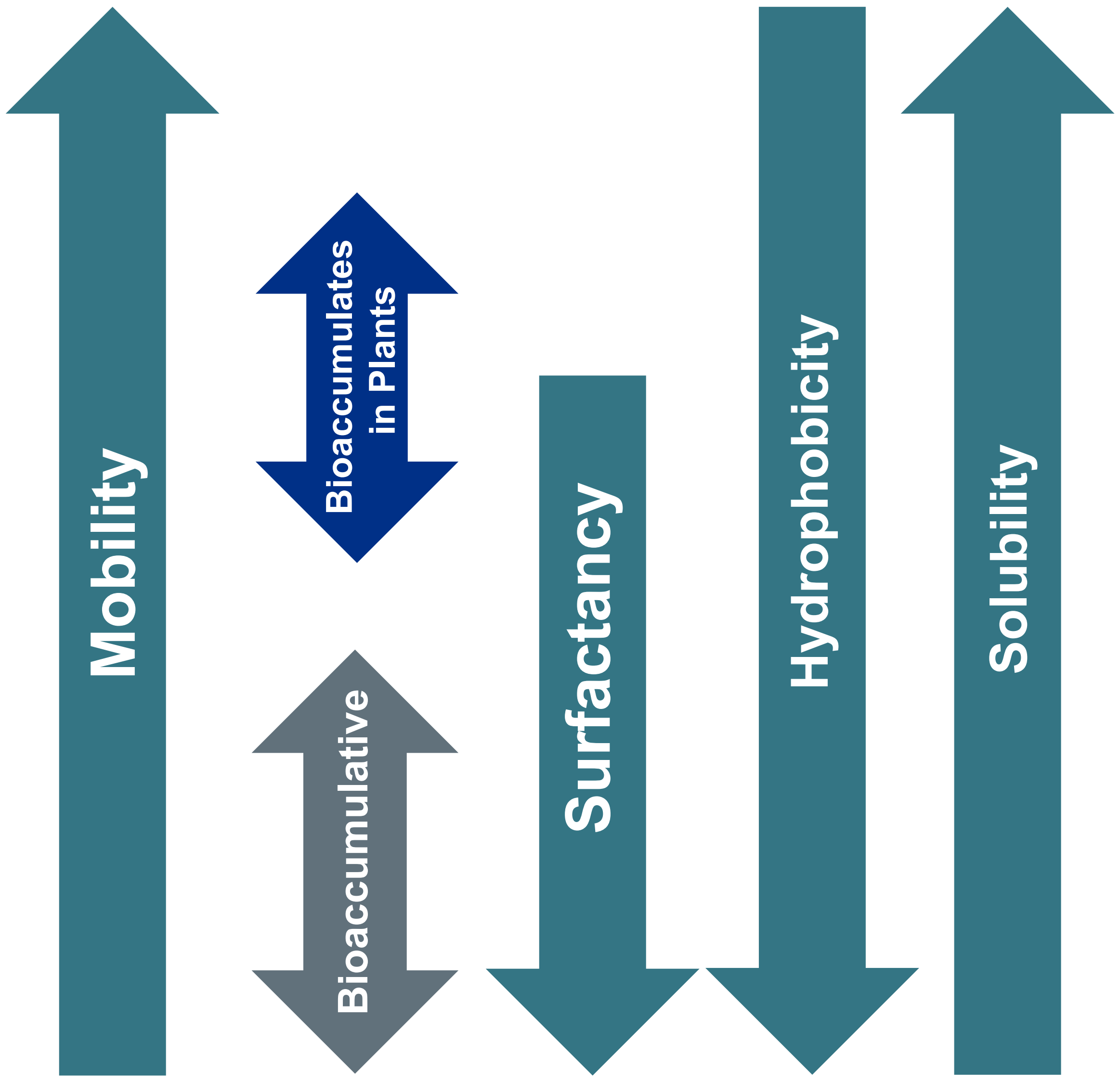


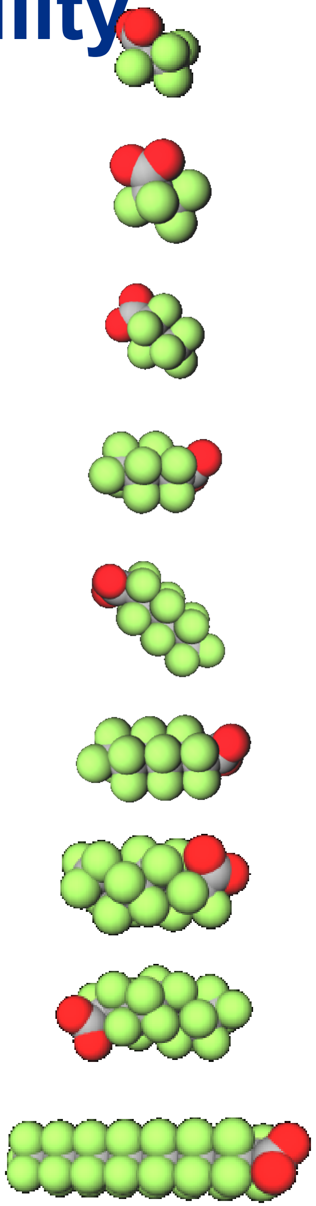
Introduction

1.1. PFAS Background - Categories



1.1. PFAS Background - Mobility





C2 Perfluoroethanoic acid (PFEA)

C3 Perfluoropropanoic acid (PFPrA)

C4 Perfluorobutanoic acid (PFBA)

C5 Perfluoropentanoic acid (PFPeA)

C6 Perfluorohexanoic acid (PFHxA)

C7 Perfluoroheptanoic acid (PFHpA)

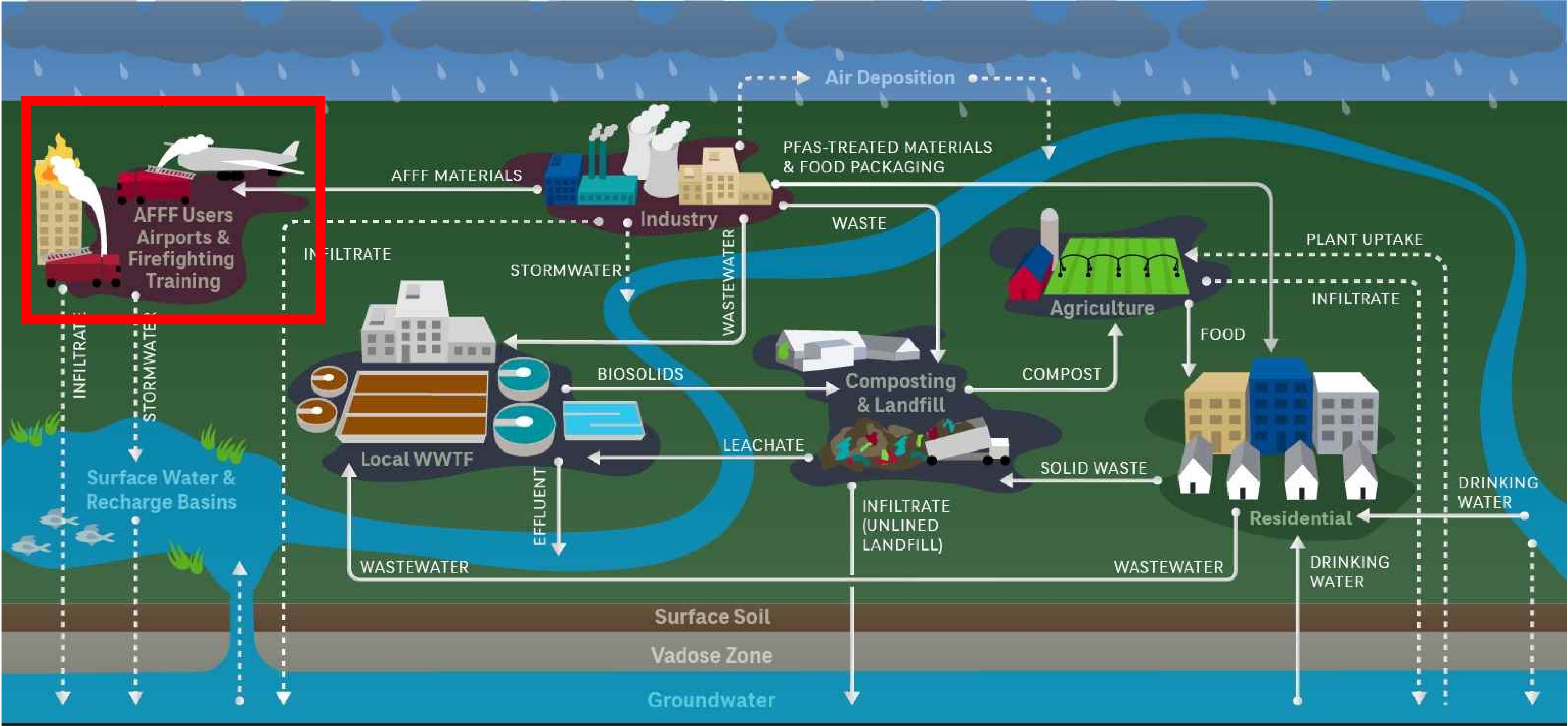
Short C4-C7

C8 Perfluorooctanoic acid (PFOA)

C9 **Perfluorononanoic acid (PFNA)**

C14 **Perfluorotetradecanoic acid (PFTeDA)**

Long >C8



PFAS Life Cycle

KEY

Human Transport

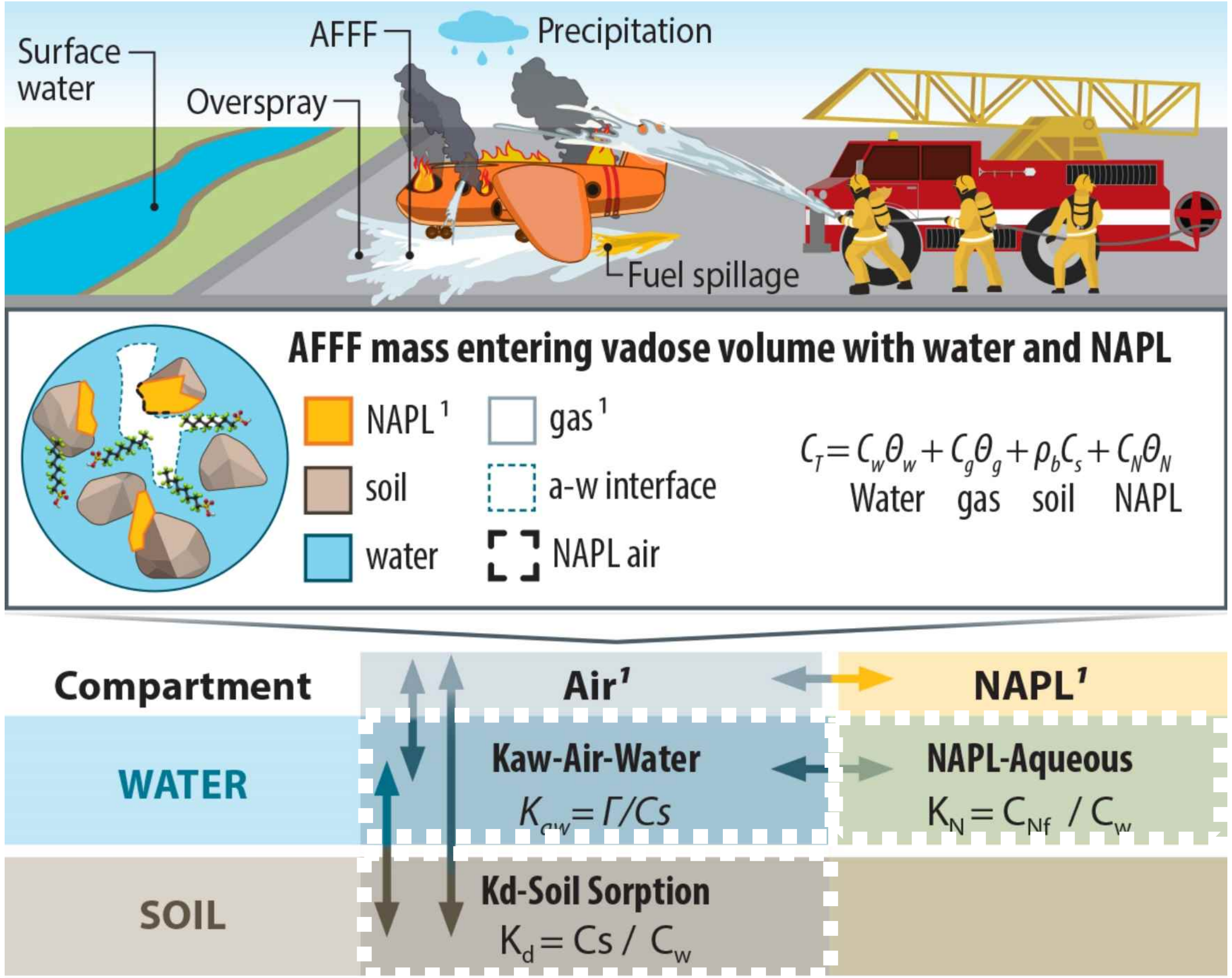
Environmental Migration

Primary sources

Secondary sources

1.1. AFFF Source Zones

1.1. PFAS Partitioning and Transport



$$M_{\Sigma\ PFAS\ mass\ total} = C_w\left(\theta_w + K_{dp} + K_{aw_c} + A_{aw} + K_N\theta_{NAPL}\right)$$

- Regulated PFAS are generally fluorosurfactants (amphiphiles)
- Surfactants accumulate on surfaces and at interfaces including:
  - Air: water / Solid: air / Solid: water / Aldair / NAPL: water
- PFAS can form highly stable assemblies/films on surfaces or at interfaces
- Amphiphilic PFAS have unique fate & transport properties

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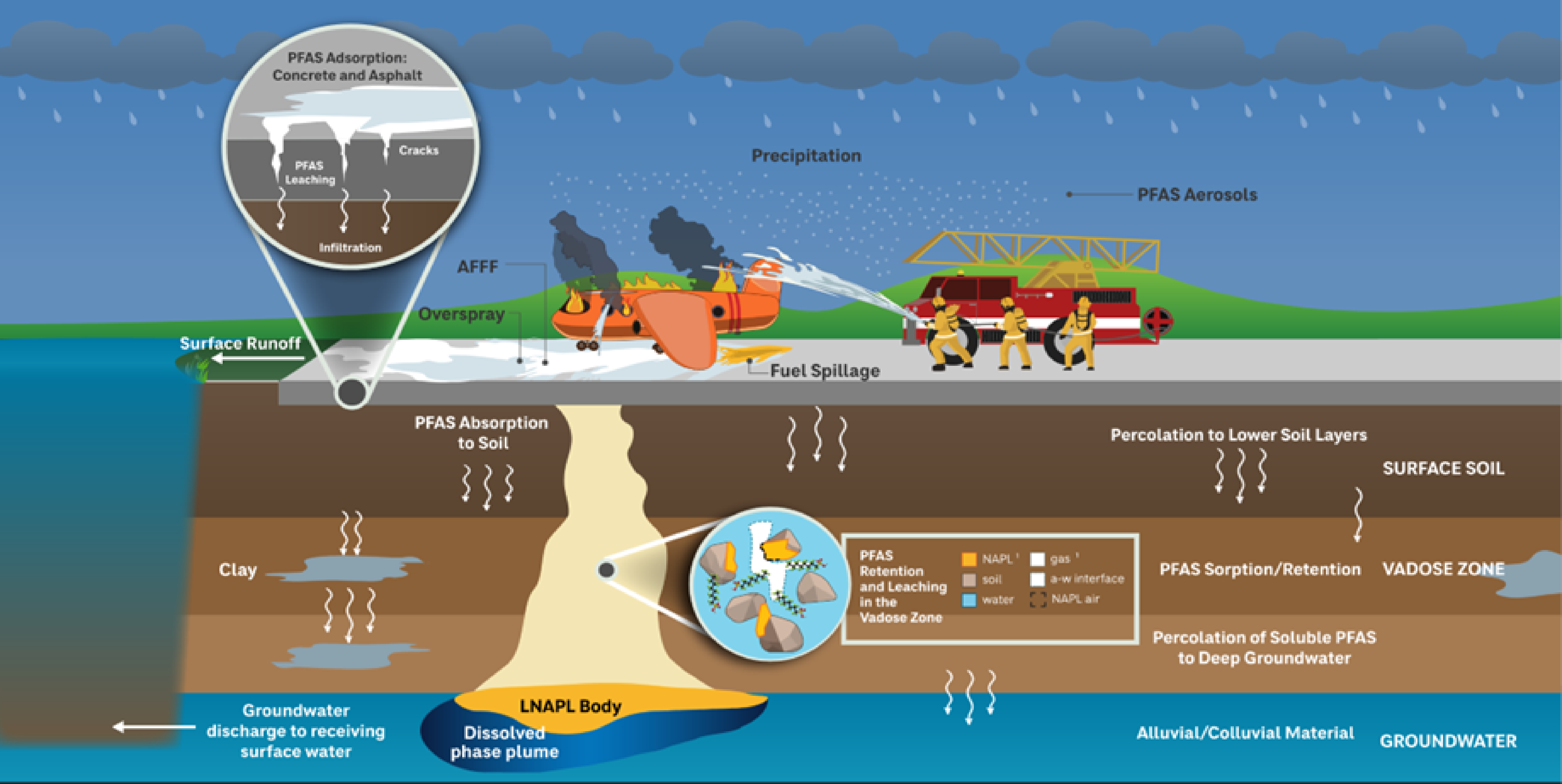
HR-CSM for PFAS Source Zones

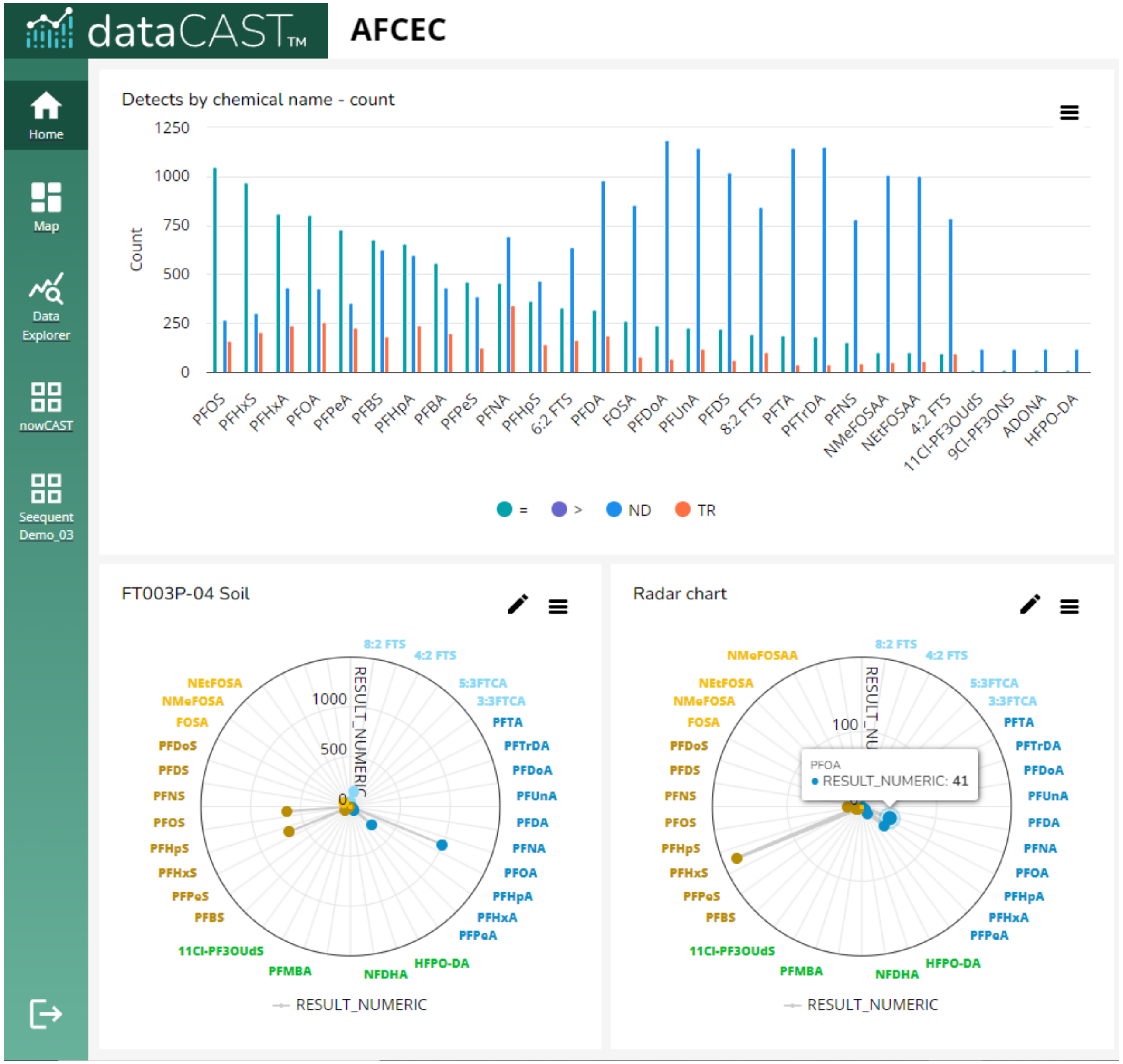
The Case for Dashboard Tools



PFAS Conceptual Site Model

2.1. Evaluation Needs for AFFF HR-CSM

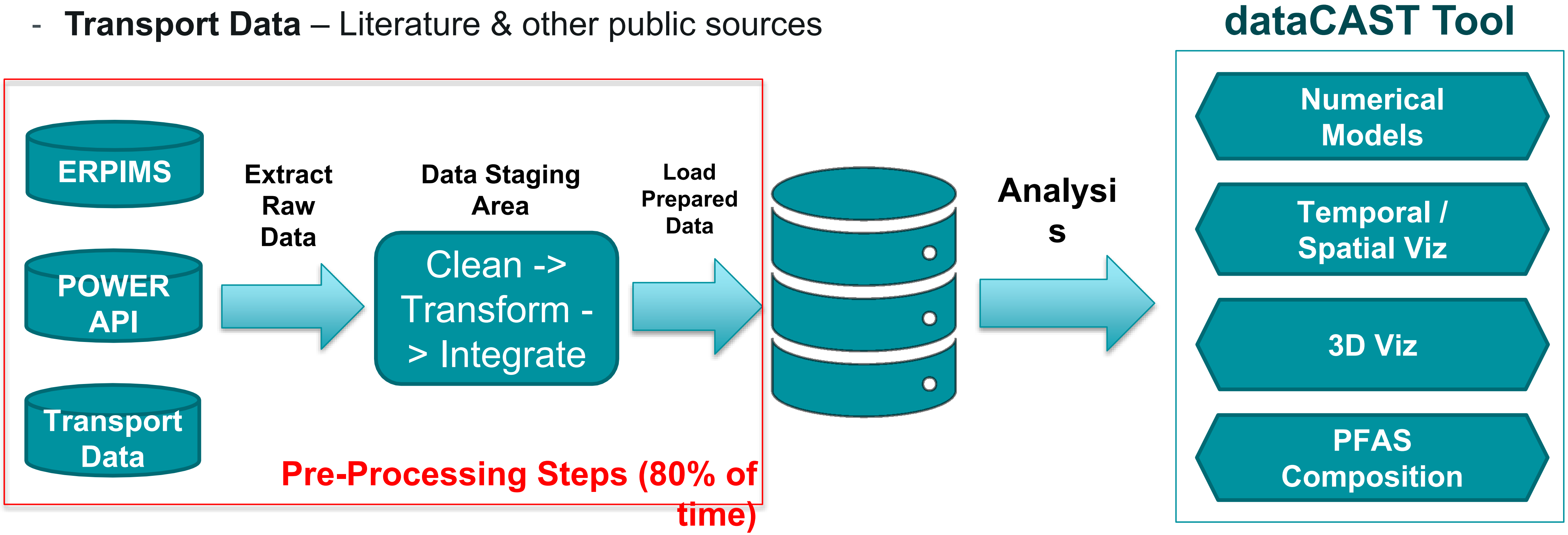
- **Why Dashboards? Convenient analysis of multiple data sources in one place**
  - Temporal trends in data
  - PFAS distributions
  - Concentration distributions
    - Kriging
    - Bar charts
    - Detect/non-detect analysis
  - Media Heterogeneity
    - 3-D modeling
  - Risk analysis
    - Flux models and analytical tools



Dashboarding Options and Implementation

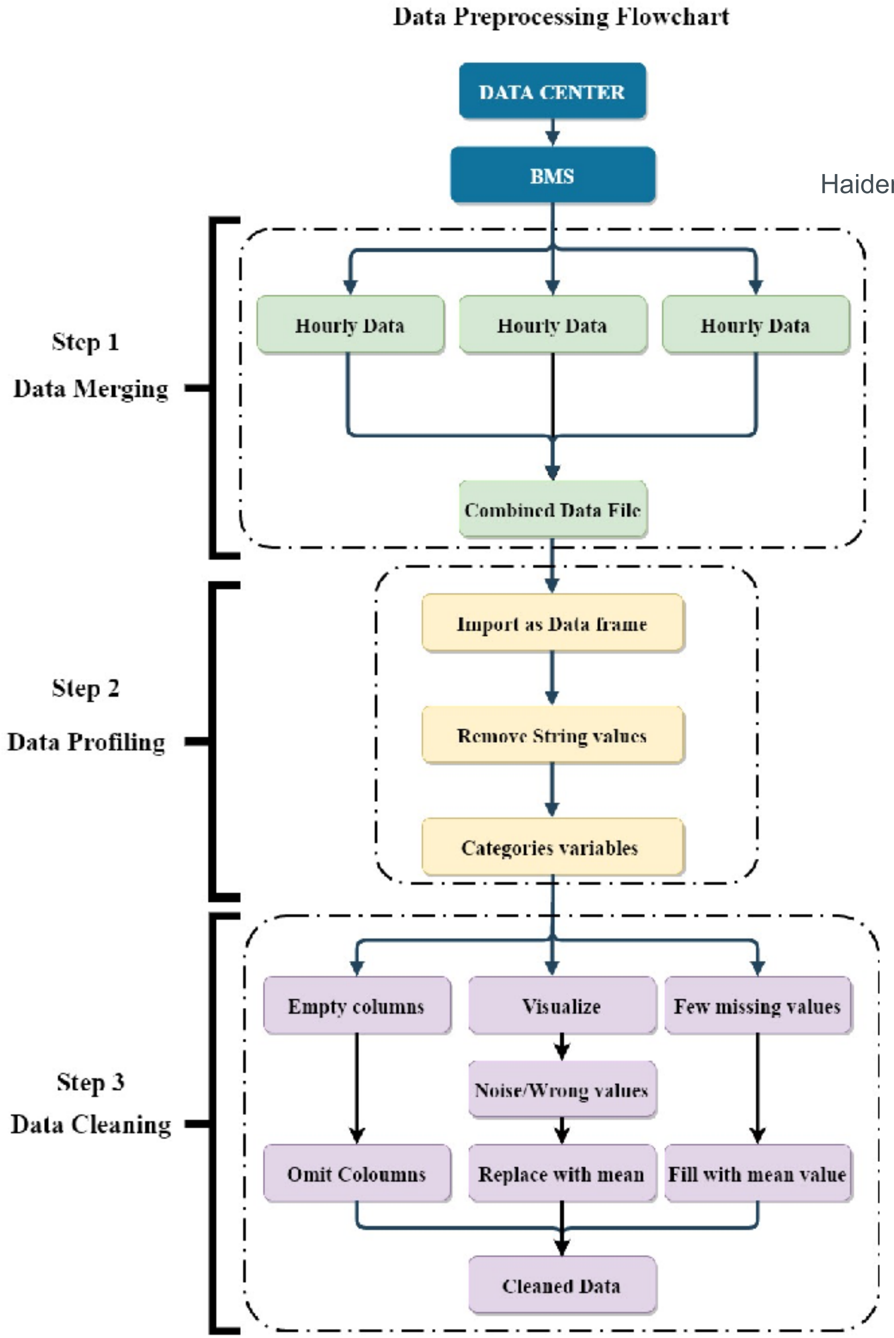
3.1. Dashboard Tools - Workflow

- **Significant effort developing data pipeline for advanced analytics**
  - **80:20 Rule – 80% of time spent on pre-processing; 20% on Analysis**
- **Involves Ingesting & standardizing multiple data sources**
  - **ERPIMS** – PFAS/Site Specific Data
  - **POWER API** – Agroclimatalogical Data
  - **Transport Data** – Literature & other public sources



3.1. Dashboard Tools - Reasoning

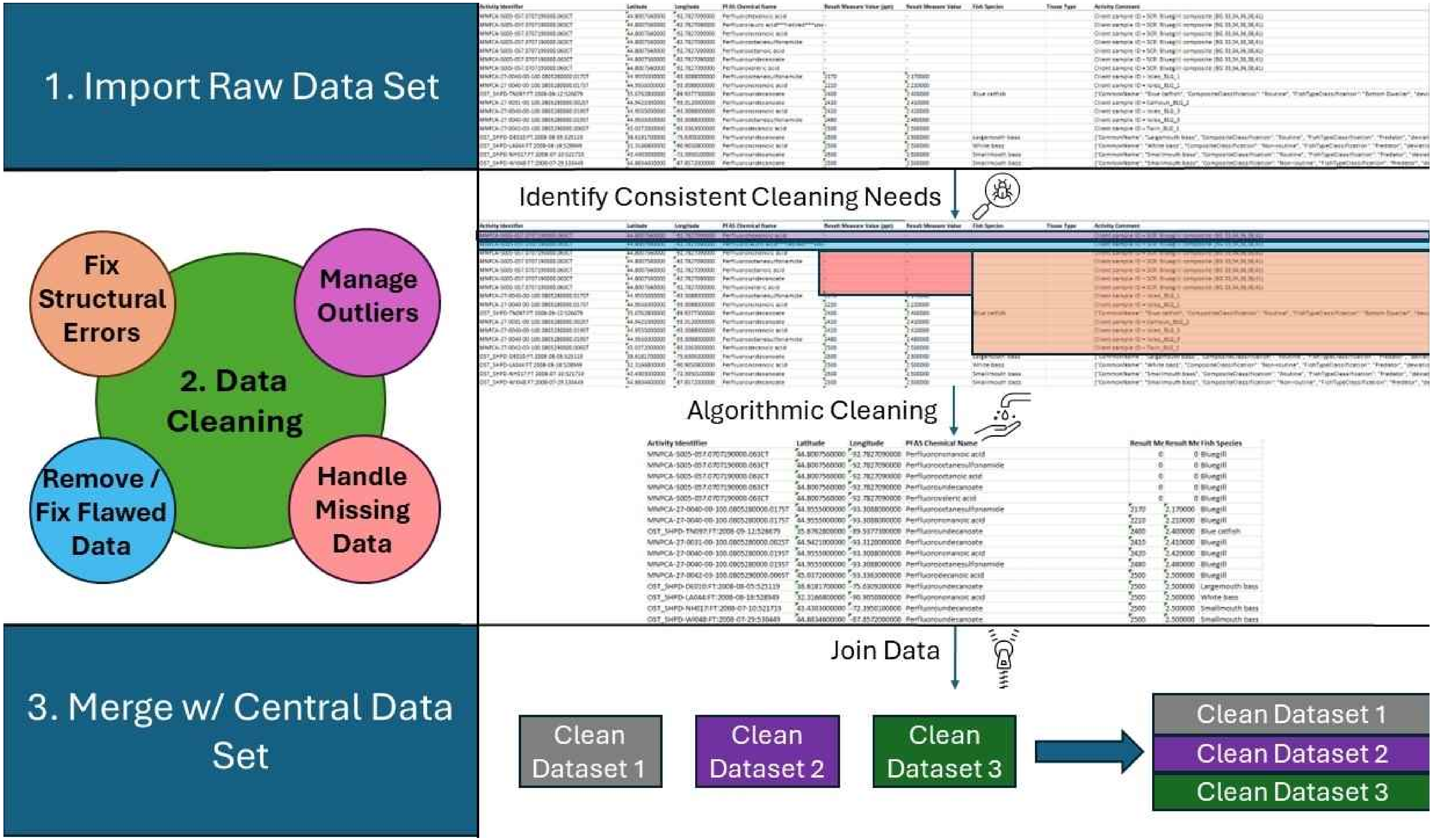
- **Implementation of dashboard tools requires automating preprocessing**
  - 80 % of the time in most applications
- **Allows for users to focus on analysis & decision making**
- **3 major steps**
  - Figure out the data scheme
  - Create algorithms to import/export data to a central repository
  - Test and validate



Haider et al 2020[1]

[1]Haider, S. N.; Zhao, Q.; Meran, B. K. Automated Data Cleaning for Data Centers: A Case Study. In *2020 39th Chinese Control Conference (CCC)*; IEEE: Shenyang, China, 2020; pp 3227–3232. https://doi.org/10.23919/CCC50068.2020.9189357.

3.1. Dashboard Tools – Data Cleaning



3.1. Dashboard Tools - Options

Open Source

- Pros: Customizable and flexible
- Cons: Labor-intensive startup, programming, **internal deployment**

Proprietary

- Pros: No programming knowledge, out of the box
- Cons: Pay for service, inflexible, **internal deployment**

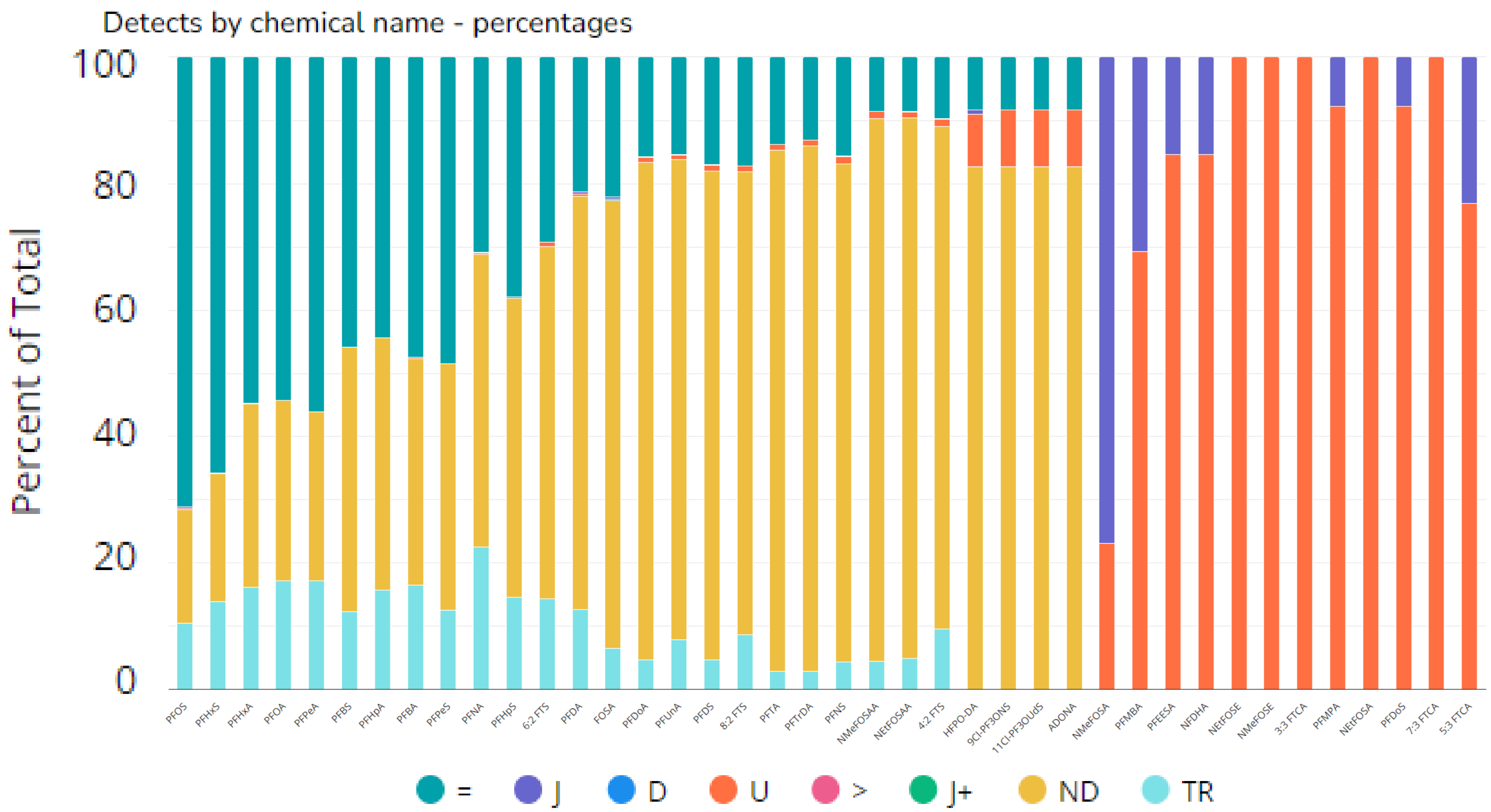
DataCast

- Pros: Customizable and flexible out of the box; deployment managed by 3rd party
- Cons: CDM Smith/Trinnex Proprietary

	Maturity	Simplicity	Adaptability	Focus	Language Support	Capital Cost	Labor Cost
Streamlit	C	A	C	Dashboard	Python	$	$$
Dash	A	B-	A	Dashboard	Python, R	$	$$$
Shiny	A	B+	B	Dashboard	Python, R	$	$$
PowerBI	A	A	C	Dashboard and Data Management	Python, R	$$$	$
DataCast	A	A	A	Dashboard and Data Management	Python	$$$	$

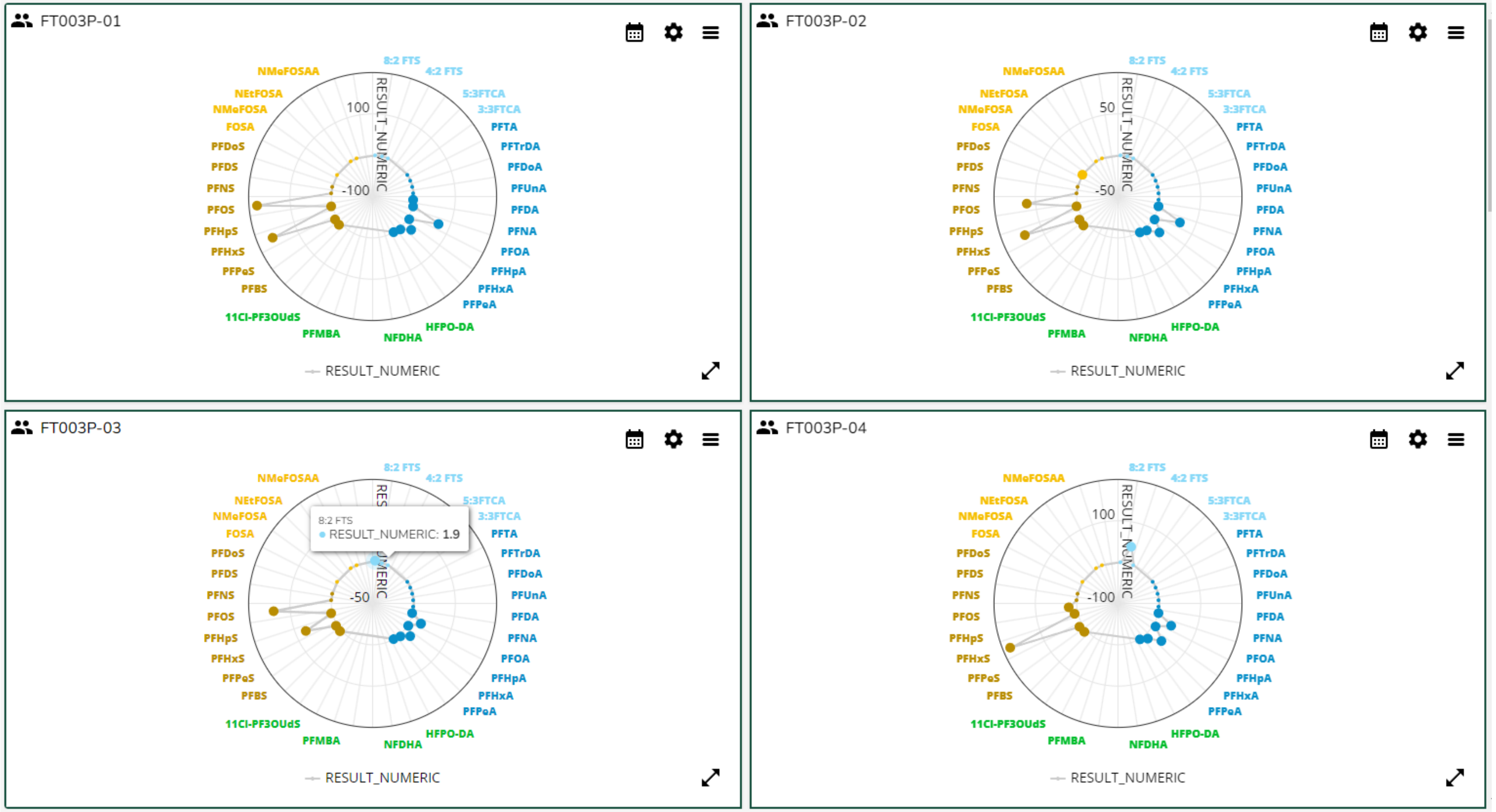
3.1. Analysis Tools - Detections

- **Goal:** Determine what PFAS are likely to present
- **Tool:** Detect Percentages



3.2. Analysis Tools – PFAS Distributions

- **Goal:** Determine types of PFAS present
- **Tool:** Distribution chart of 1633 components

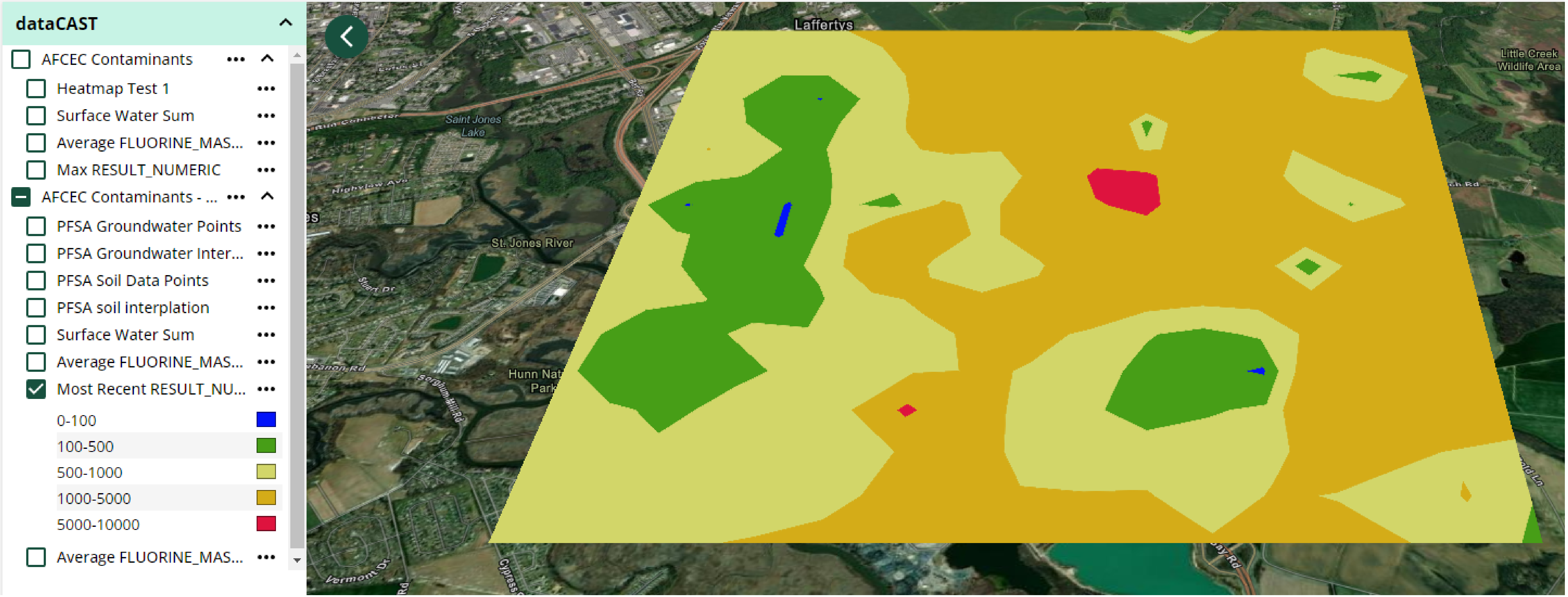


3.2. Analysis Tools – Mapping Values

- **Goal:** Determine general locations of high detects
- **Tool:** General mapped values with color bars

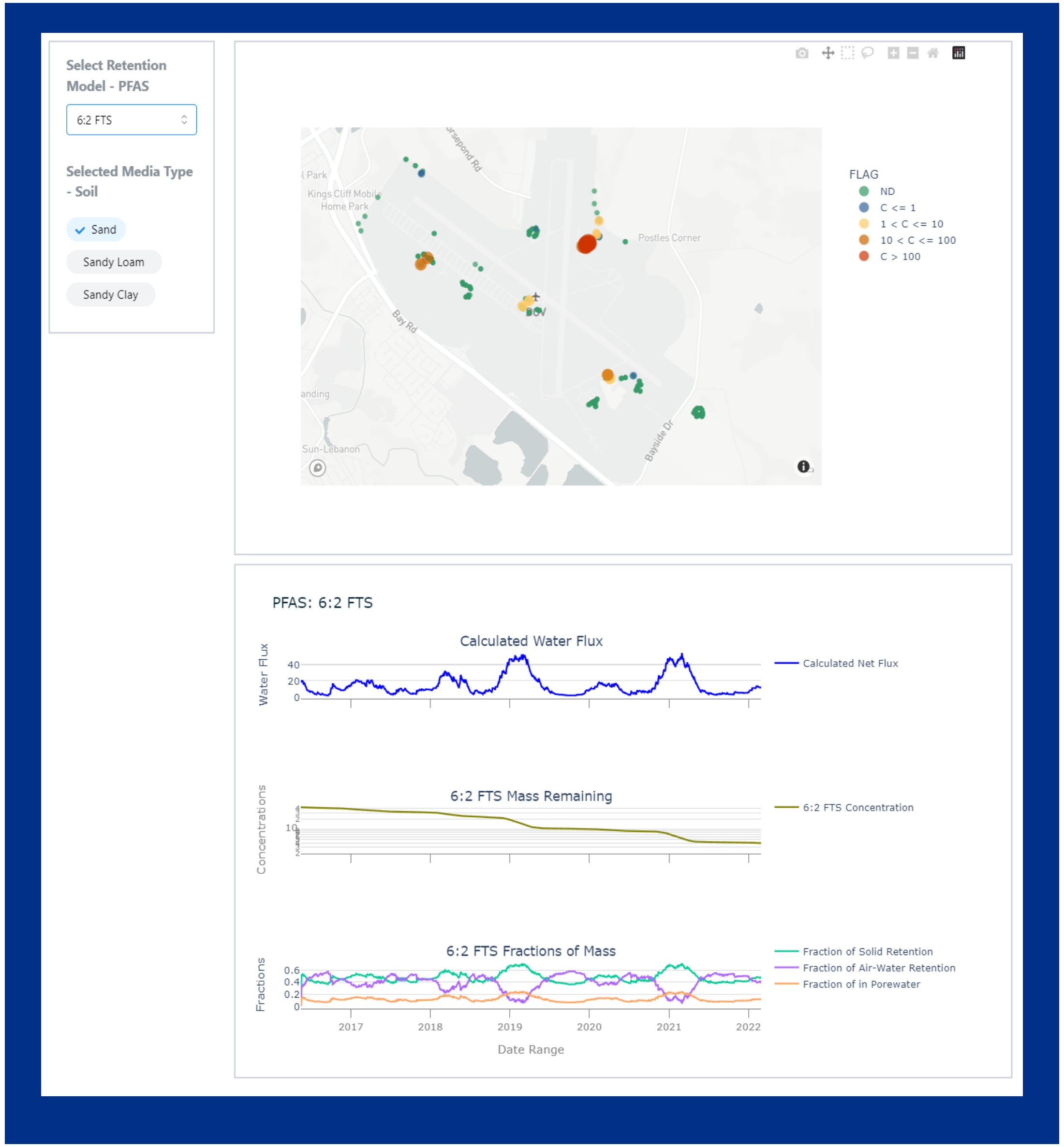
3.3. Analysis Tools – Mapping Plume extents

- **Goal:** Determine nature and extent of contamination
- **Tool:** Plume analysis via interpolation

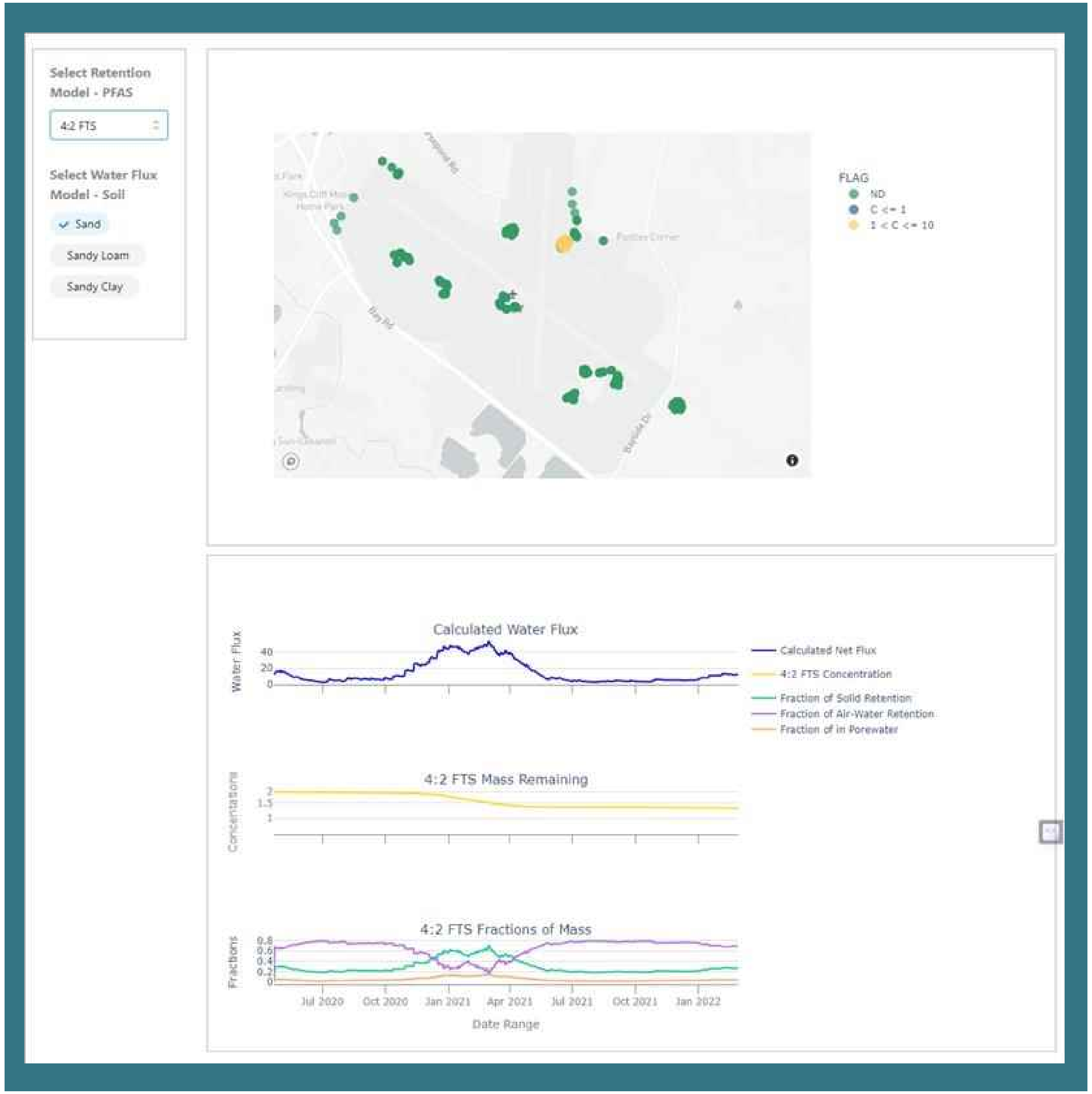


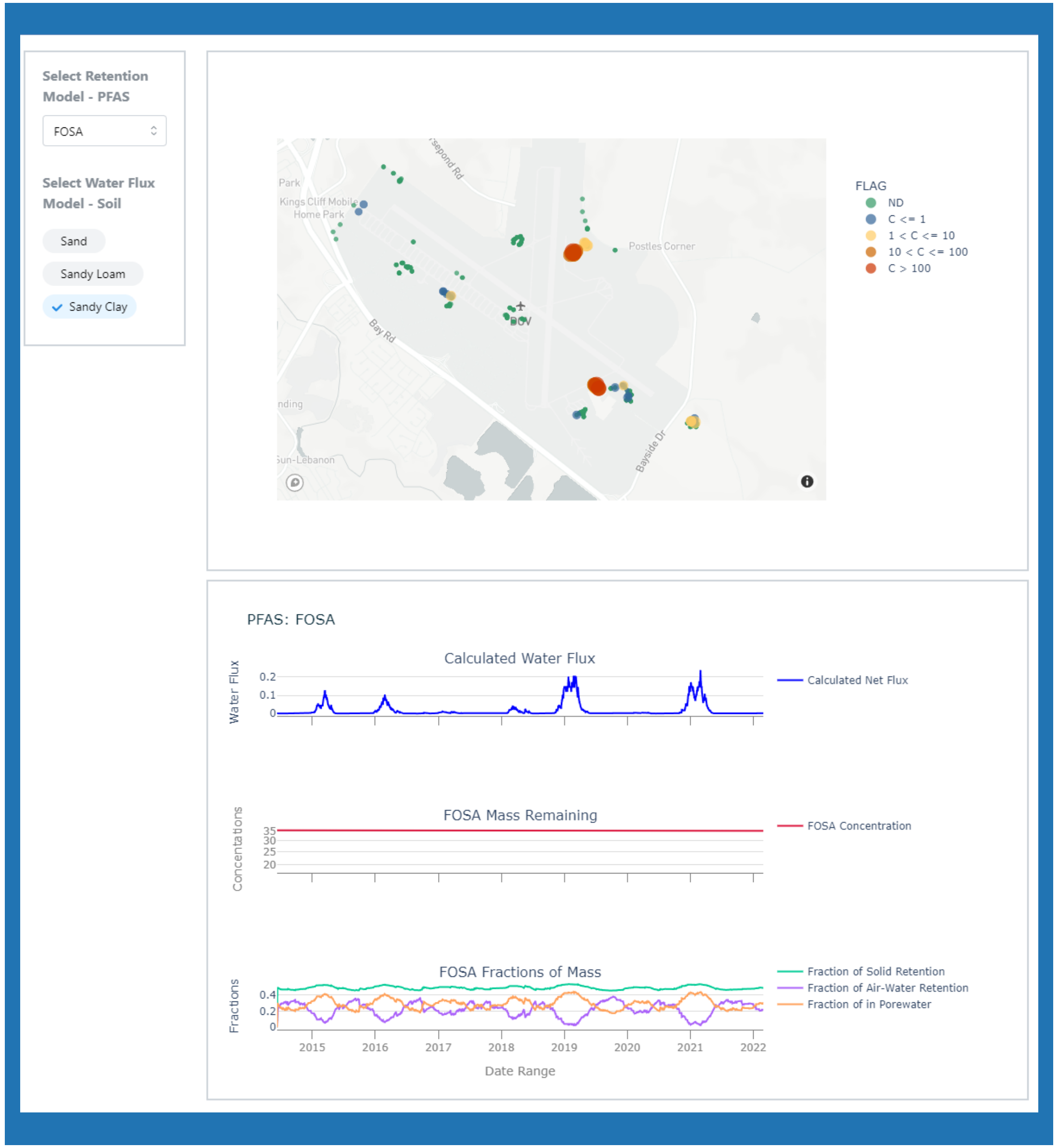
3.4. Risk Analysis – Leaching Model

- **Goal**: Determine leachability of PFAS from source zones to the underlying aquifer
- **Tool**: Simplified, data-based model running in real time



3.4. Risk Analysis – Leaching Model Other Displays





3.4. Risk Analysis – Leaching Model

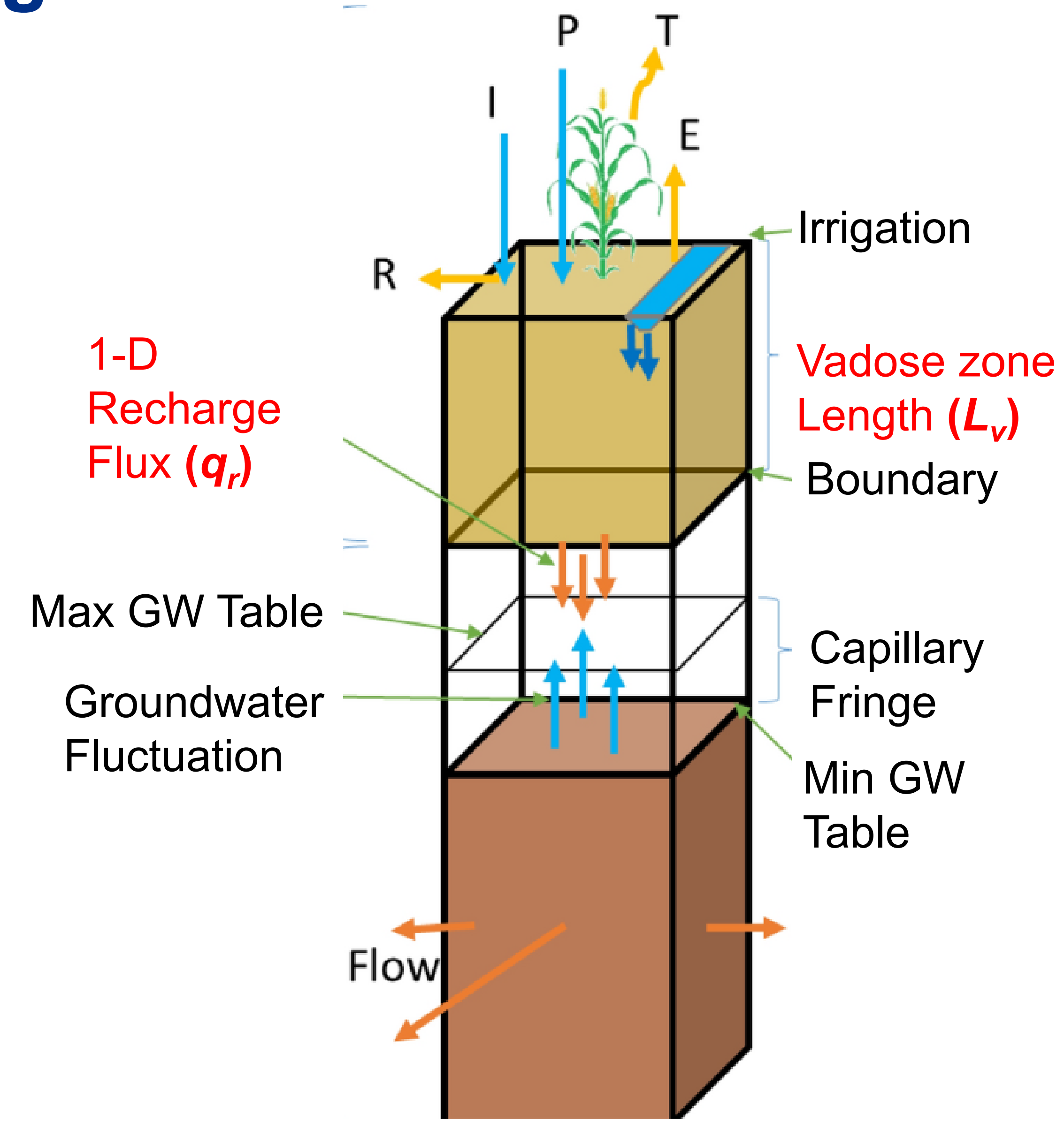
C_T = Total PFAS Conc.

C_p = Mobile porewater Conc

$$R = 1 + \frac{K_d \rho_b}{\theta_w} + \frac{K_{ia} A_{aw}}{\theta_w}$$

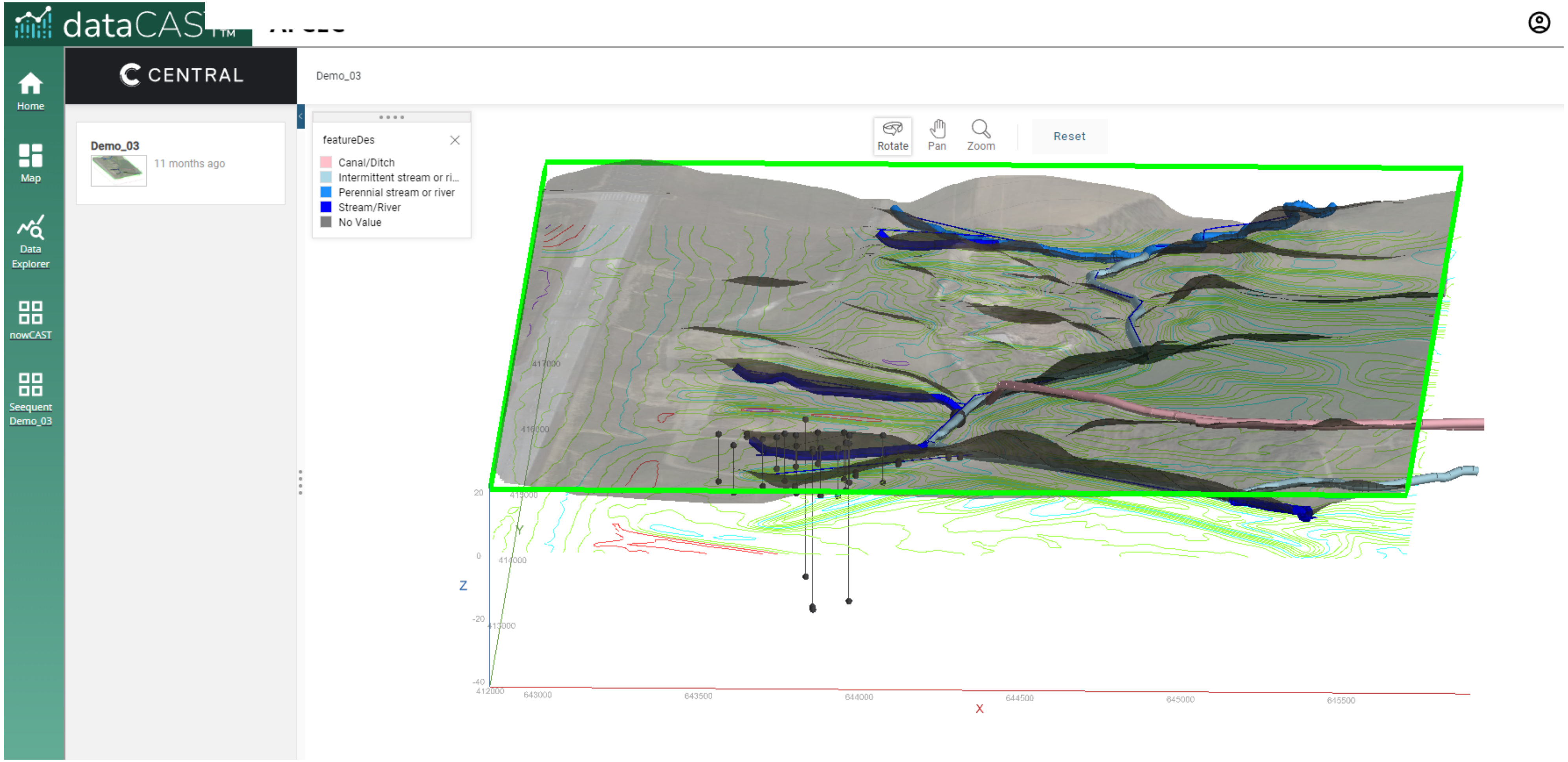
$$C_T = C_p \frac{\theta_w}{\rho_b} R$$

- **Real time sensor and satellite data feeds into model**
- **Requires integration of multiple data libraries**



3.5. 3-D Visualization

- **Goal:** Determine effects of heterogeneity and contextualize the site
- **Tool:** 3-D Viz with Leapfrog embedded in DataCast



Demonstration

https://trinnex.cloud/datacast/map

Thank you!

To learn more, contact:

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