CAPTURE

Innovative Integrated Framework for Sustainable Management of PFAS in Soil and Groundwater

Moving Beyond Concentration-Based Approaches

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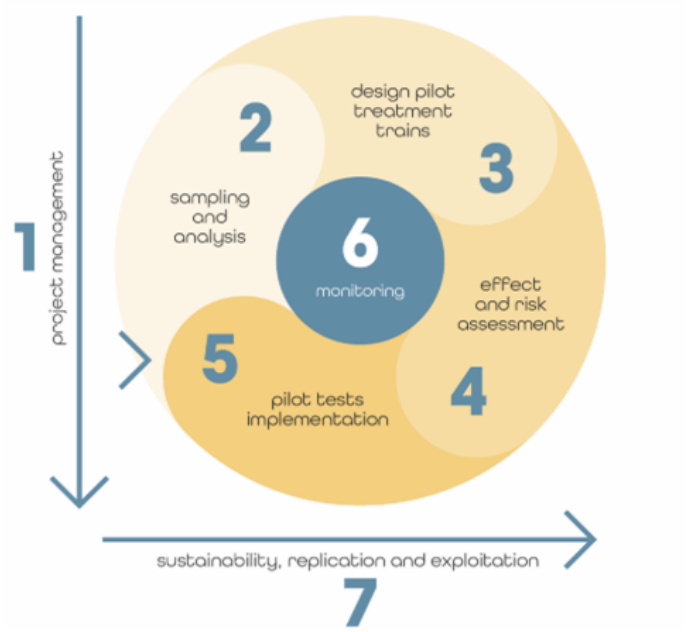
LIFE CAPTURE

- LIFE Project | Funded by the European LIFE Programme
- Collaboration of 8 partners
- Combining novel Analytical protocols for PFAS contamination with Technologies for sustainable Remediation
- Duration: 2022-10-01 – 2027-09-30



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Main Objective

- Demonstrate through concrete use cases how integrated tools improve sustainable PFAS management

Specific Objectives

- Broaden PFAS characterisation beyond target lists
- Improve exposure & risk assessment via flux-based monitoring
- Optimise remediation efficiency with tailored technology trains (e.g., foam fractionation for soils, advanced oxidation for water)
- Support regulators & site owners with pragmatic, science-based decision tools

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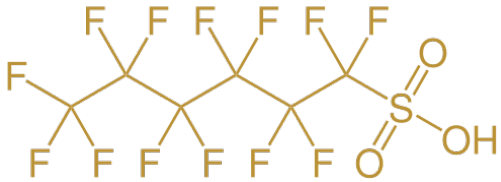
The PFAS Challenge



- Persistent, mobile, and toxic chemicals
- Widespread contamination of soil and groundwater
- Growing public concern and tightening EU regulations
- Improvements over conventional approaches (concentration-based)

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Innovative Nature of the Approach

- Integrated and operational framework
- Moves beyond conventional concentration-based assessment
- Combines:
  - Tiered analytical protocol
  - Flux-based groundwater monitoring
  - Pragmatic risk assessment for mixtures & unknowns
  - Innovative remediation technology trains

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Key Innovation 1 – PFASafe® Analytical Protocol (SGS)

- Robust tiered "menu" approach – choose analyses based on the problem

- **Tier 1**: Total PFAS screening (AOF/EOF → TOF)
- **Tier 2**: Expanded LC-MS/MS target analysis (including short- & USC PFAS)
- **Tier 3**: Suspect screening for unknowns & emerging compounds using HRMS (may include TOP assay)
- Major improvement: Overcomes limitations of narrow target-list methods

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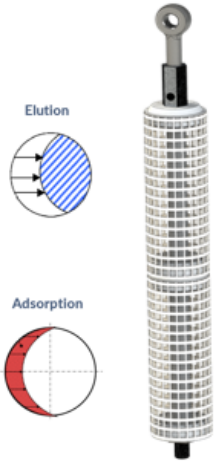
Key Innovation 2 – Flux-Based Monitoring

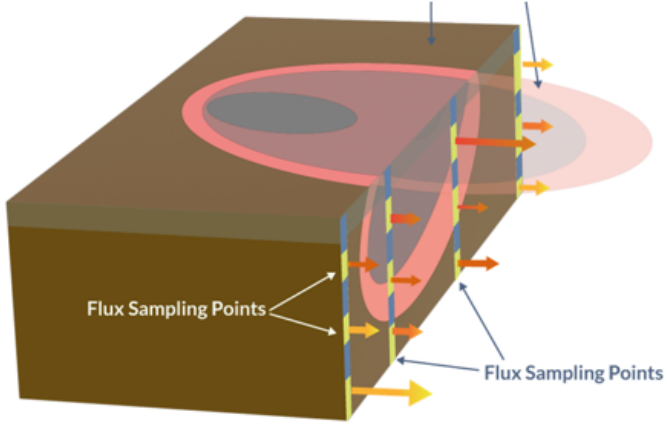
- Uses iFLUX Passive Samplers with advanced resins
- Provide time integrated results, including dynamics
- HORIZONTAL

Water-flux tells us how much groundwater is moving

Mass-flux tells us how much contamination is moving with the groundwater



On-site measurement of the transport of contaminants & groundwater

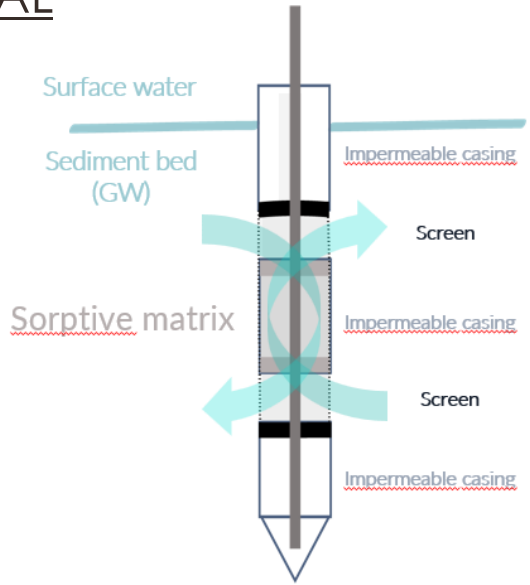


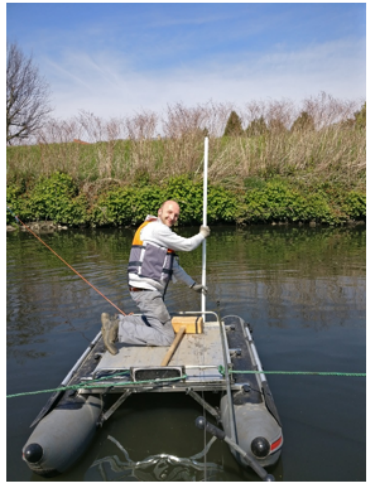
High resolution plume characterization => Less costly & more effective remediation

iFLUX

Key Innovation 2 – Flux-Based Monitoring

- Uses SBPFMs with advanced resins
- Provide time integrated results, including dynamics
- VERTICAL





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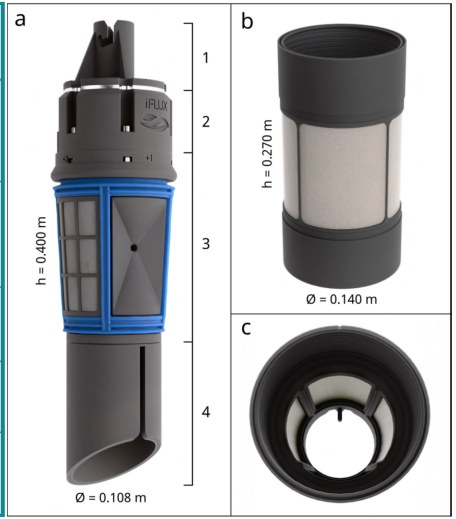
Key Innovation 2 – Flux-Based Monitoring

- Real-time monitoring of groundwater flow with iFLUX sensing solutions: continuous magnitude & direction of Darcy Flux

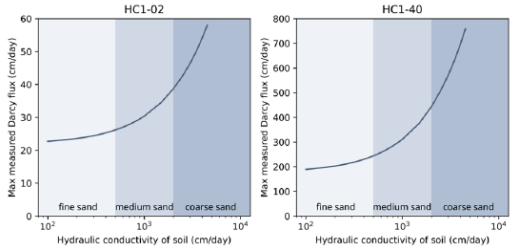
Performance

Parameter	HC1-02	HC1-40
Measurement Range Magnitude • Min • Max (cf. Graph)	• 0.1 cm/d • 20 to 60 cm/d	• 1.0 cm/d • 200 to 800 cm/d
Accuracy Magnitude (Maximum Error) • Lower Range • Higher Range	Flux (cm/d): • <15: ±0.5 cm/d • >15: ±5%	Flux (cm/d): • <30: ±4.0 cm/d • >30: ±15%
Accuracy Direction • RMSE	• ±5°	• ±5°
Smallest Detectable Change	• 0.1 cm/day	• 1.0 cm/day
Response time	Depends on setting datalogger & chosen network connectivity. Minimum response time: quasi real-time.	



- In new monitoring well (ø 15cm) with dedicated prepack filter
- Well installed manually up to 5m or deeper through pulse or sonic drilling
- In unconsolidated soils

Upper limit of measurable flux magnitude:



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- Real-time monitoring of groundwater flow: magnitude & direction of Darcy Flux

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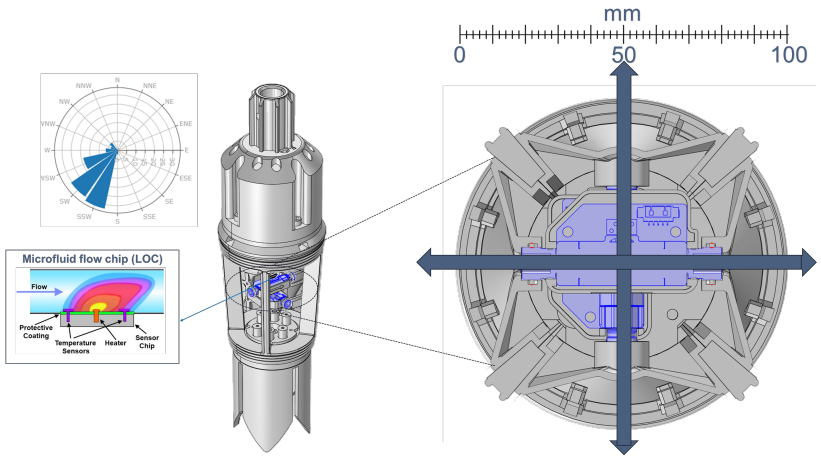
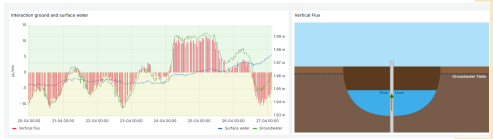
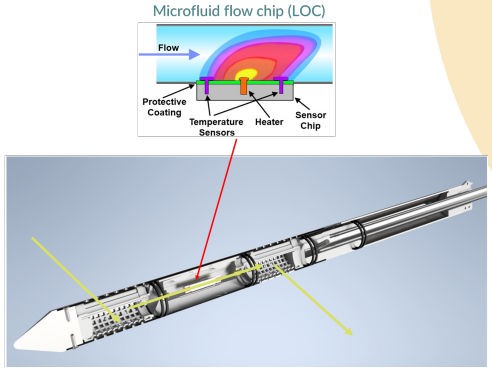


VERTICAL





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Summary – Improvements Over Existing Practice

Aspect	Conventional Practice	CAPTURE PFAS Approach
Analysis	Narrow target lists	Tiered PFASafe® (total + suspects)
Monitoring	Concentration only	Flux-based with high-sensitivity passive samplers
Remediation	Generic	Tailored technology trains
Risk Assessment	Limited for mixtures	Addresses mixtures & unknowns
Overall	Higher uncertainty & cost	More efficient & sustainable

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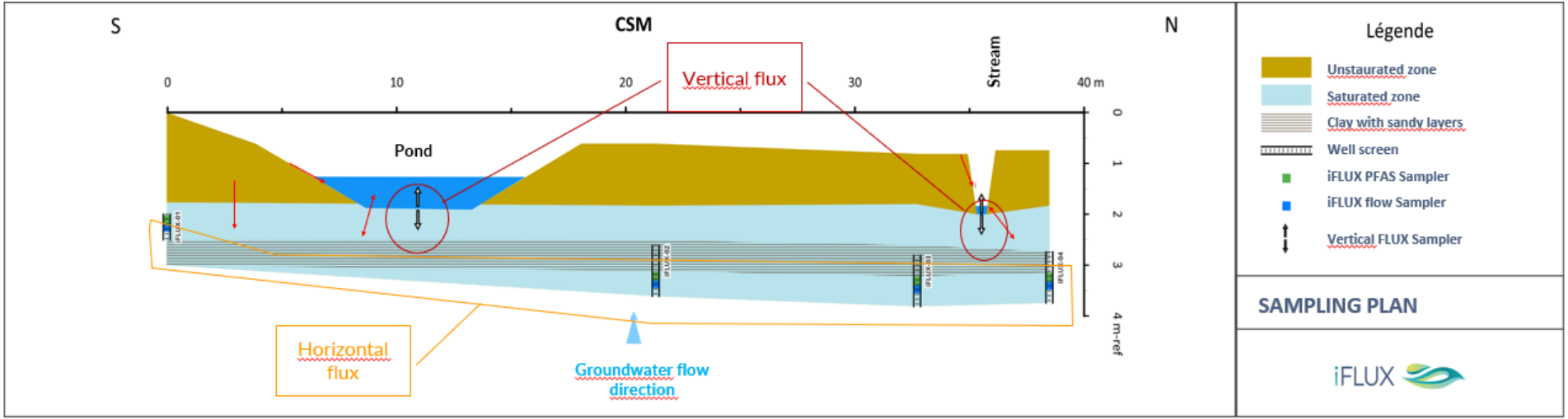
Case study:Dispersion risk due to diffuse soil contamination with PFAS (NL)

Conceptual Site Model



Case study:Dispersion risk due to diffuse soil contamination with PFAS (NL)

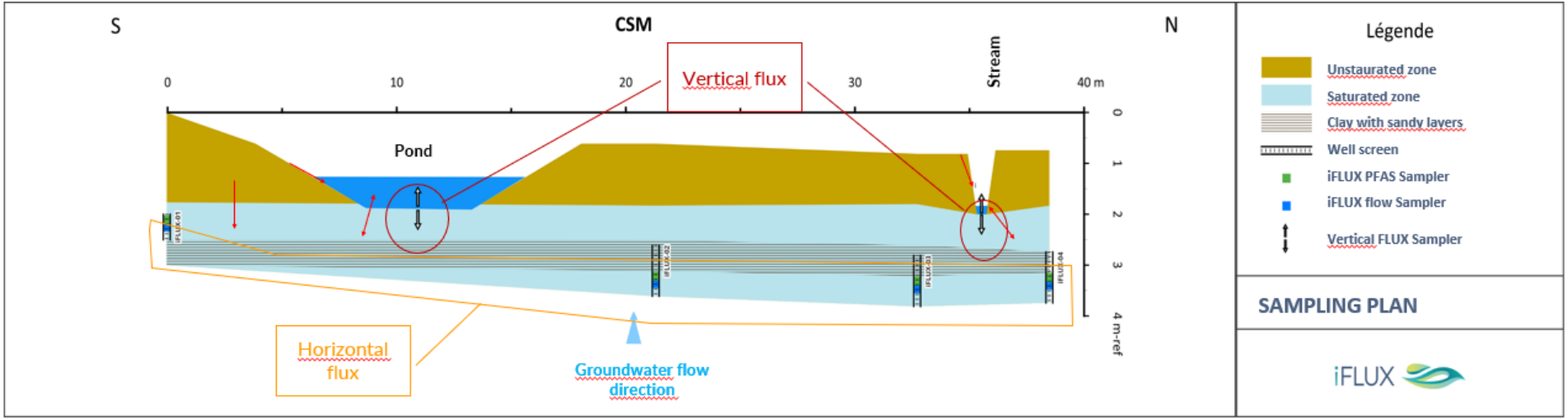
Diffuse soil contamination: Reuse of contaminated soil in renovation project

Leaching into groundwater, runoff into surface waters, and mobilization via the stream

Hypothesis: Risk of dispersion via groundwater, the pond and/or the stream

=> Quantify the flows to define appropriate measures for managing dispersion risk

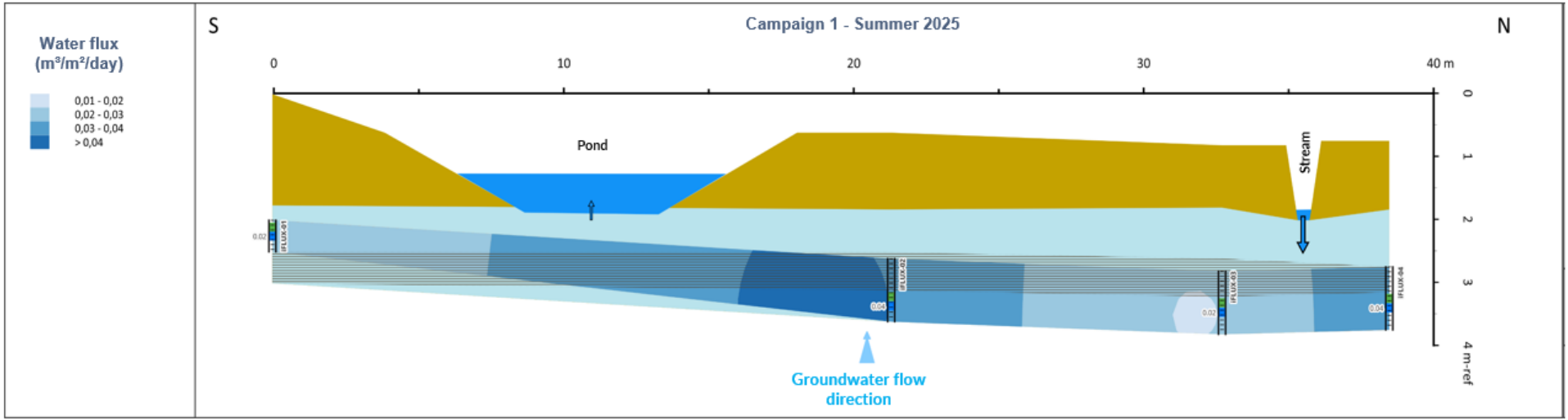
Conceptual Site Model



Case study:Dispersion risk due to diffuse soil contamination with PFAS (NL)

Campaign 1 (summer 2025) : Interpolation horizontal **groundwater flux**

Period 17 jul 2025 – 3 sept 2025 : 48 days



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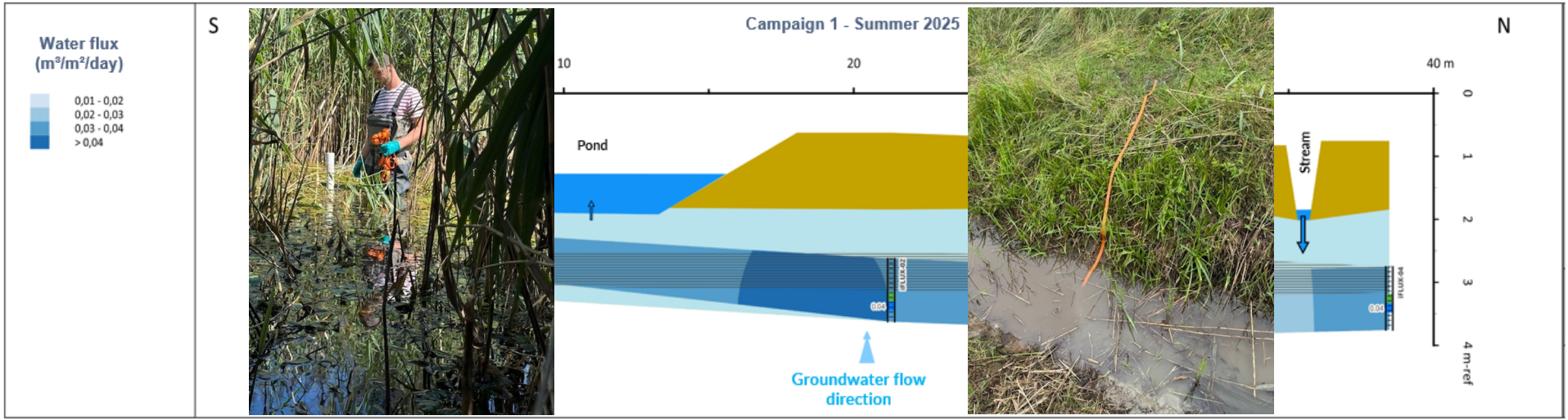

Pond: Role of vegetation (evapotranspiration)

Stream: Infiltration due to lower groundwater level in summer

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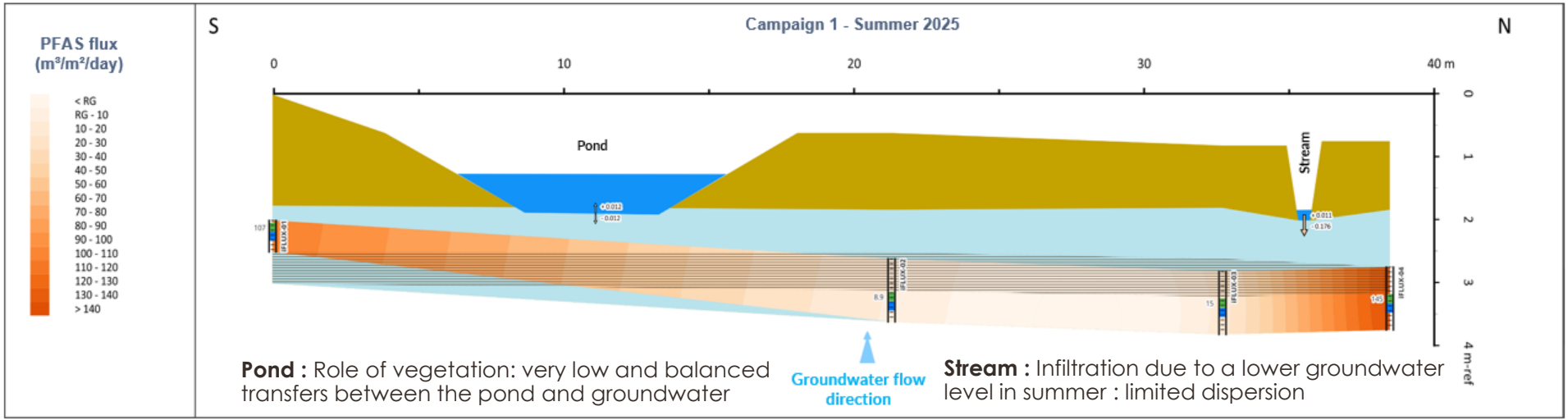


Pond : Role of vegetation: very low and balanced transfers between the pond and groundwater

Groundwater flow direction

Stream : Infiltration due to a lower groundwater level in summer : limited dispersion

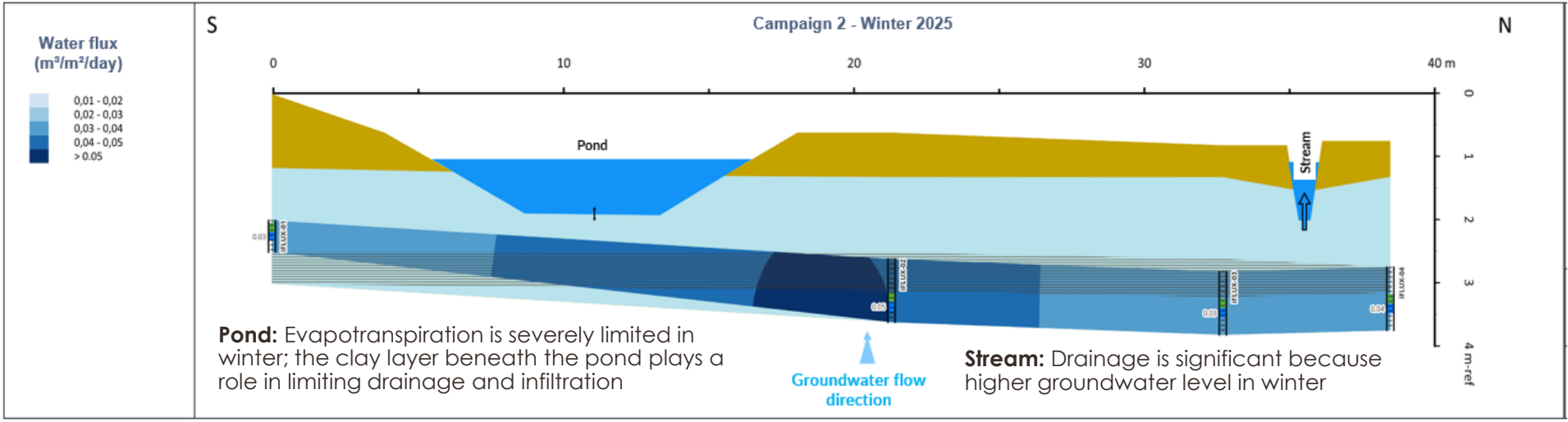
→ **no action required**

→ **no action required**

Case study:Dispersion risk due to diffuse soil contamination with PFAS (NL)

Campaign 2 (winter) : Interpolation horizontal **groundwater flux**

Period 17 dec 2025 – 12 feb 2026 : 57 days



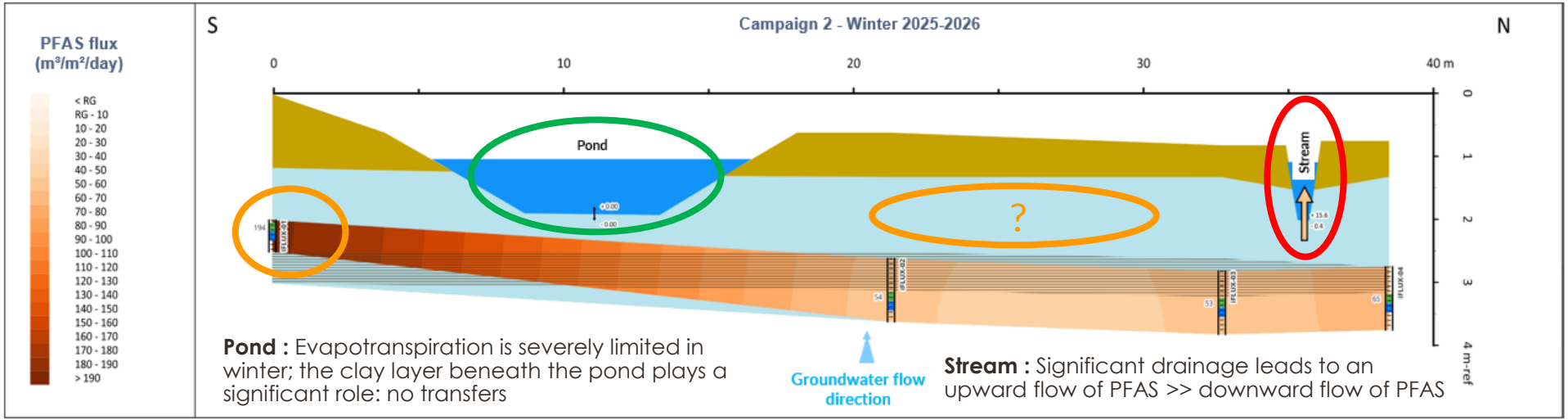
Case study:Dispersion risk due to diffuse soil contamination with PFAS (NL)

Campaign 2 (winter) : Interpolation horizontal **PFAS flux**

Period 17 dec 2025 – 12 feb 2026 : 57 days

To the south and in between (above the clay layer): increased leaching due to rising groundwater levels

→ **requires monitoring.**



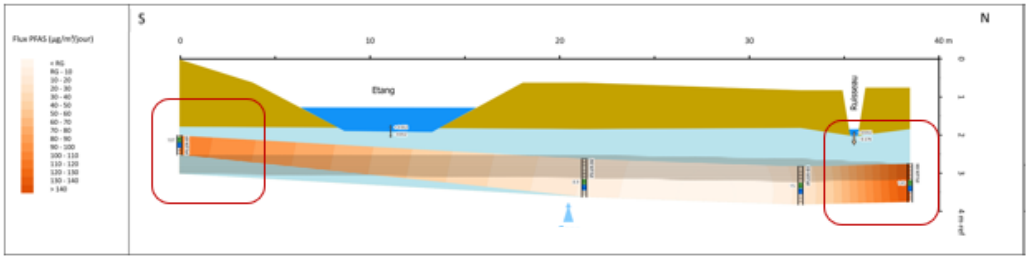
Pond : Evapotranspiration is severely limited in winter; the clay layer beneath the pond plays a significant role: no transfers

→ **no action required**

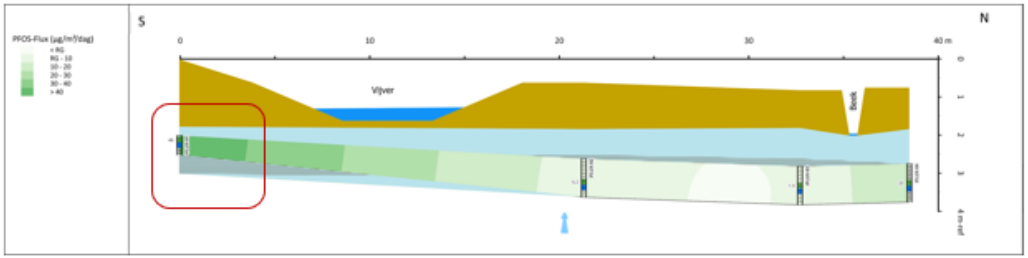
Stream : Significant drainage leads to an upward flow of PFAS >> downward flow of PFAS

→ **a proven risk (~3 mg/m²/year).**

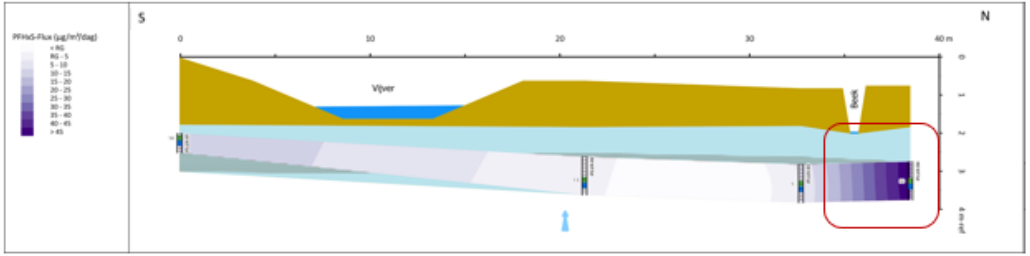
Case study:Dispersion risk due to diffuse soil contamination with PFAS (NL)



PFAS (total)



PFHxS in South



PFOS in Nord

Multi-sources

Conclusion (General)

- CAPTURE PFAS delivers a practical, innovative, and integrated solution
- Social/Regulatory: Addresses public concern and tightening EU standards
- Focus on sustainable remediation (minimise secondary waste & energy)
- Lowers long-term costs
- Ready for broader implementation across Europe (replication)
- Supports regulators, site owners, and communities with reliable data & sustainable solutions

Conclusion (Specific)

- Reduces uncertainty in source characterisation
- Provides direct insight into PFAS mass transport (**FLUX**)
- Better decision-making for sustainable PFAS management
- Better exposure assessment and targeted remediation design than concentration data alone

CAPTURE

Thank you

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