An Enhanced Approach to Groundwater Sampling

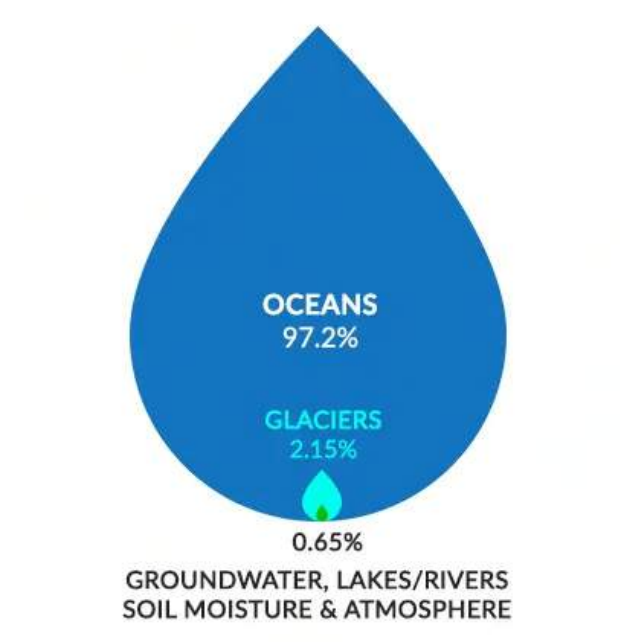
Groundwater and mass flux

February 12, 2025

Goedele Verreydt, co-founder
Marjan Joris, account manager & expert remediation

Future-proof groundwater monitoring solutions in uncertain and dynamic times

iFLUX – Why Groundwater?

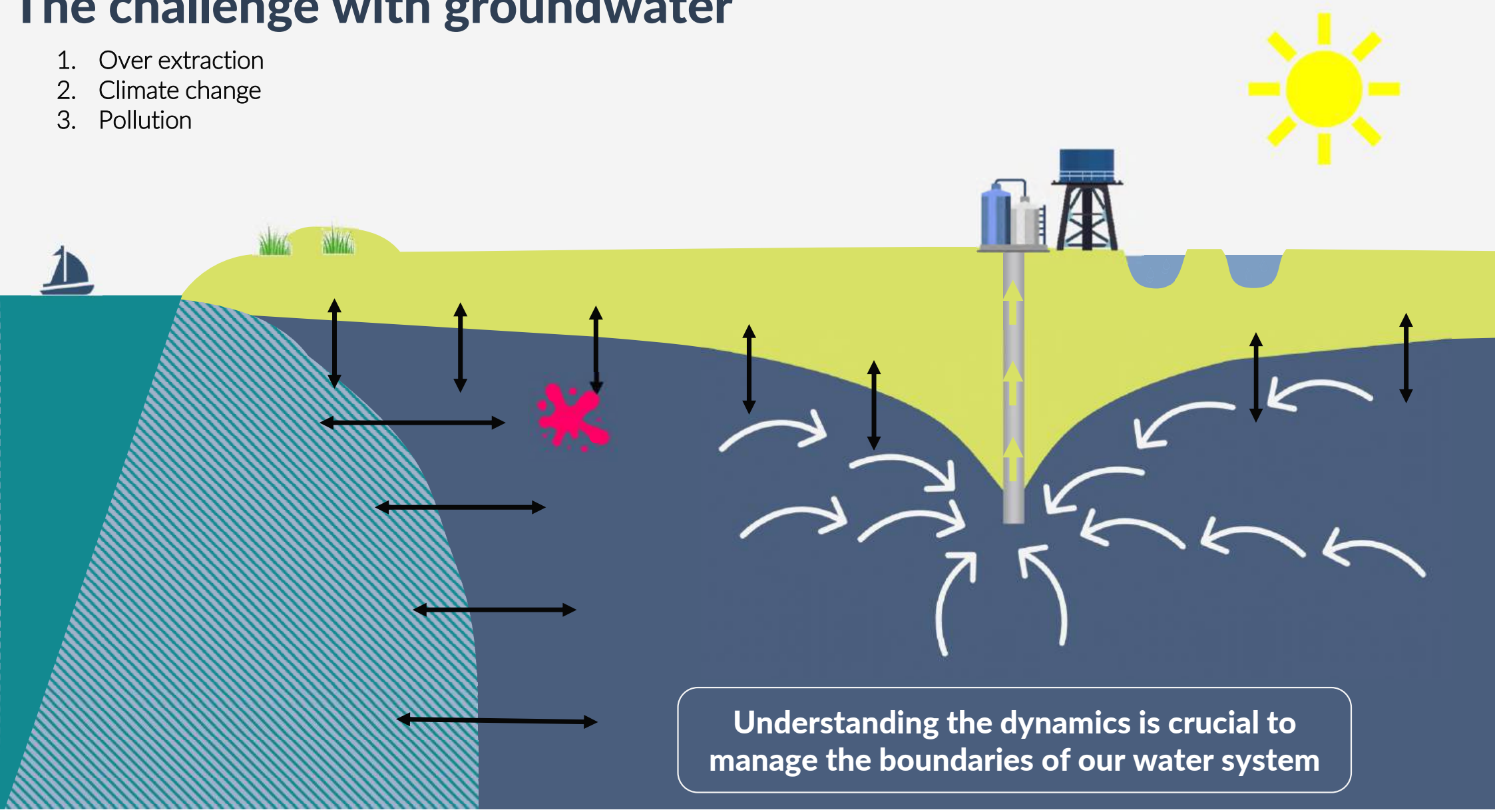


Only 0,65% of earth's water is freshwater. Groundwater makes up 99% of Earth's liquid fresh water

Groundwater is a precious natural resource, and its worth protecting

The challenge with groundwater

1. Over extraction
2. Climate change
3. Pollution



Understanding the dynamics is crucial to manage the boundaries of our water system

iFLUX

- Founded in 2017 as a spinoff of VITO and the University of Antwerp
- Deliver insights for data-driven groundwater management
- Design and operate innovative groundwater monitoring networks
- Patented groundwater flux sensing and sampling technologies

- Reliable (real-time) data flows
- Accurate & action-driven insights

Trusted Customers

Jacobs, ARCADIS, ERM, Dow, Vitens, AECOM, TAUW, anteagroup

Trusted Partners

IMAGINE H2O, nicole, University of Antwerp, SGS, SoilLite, tersus environmental

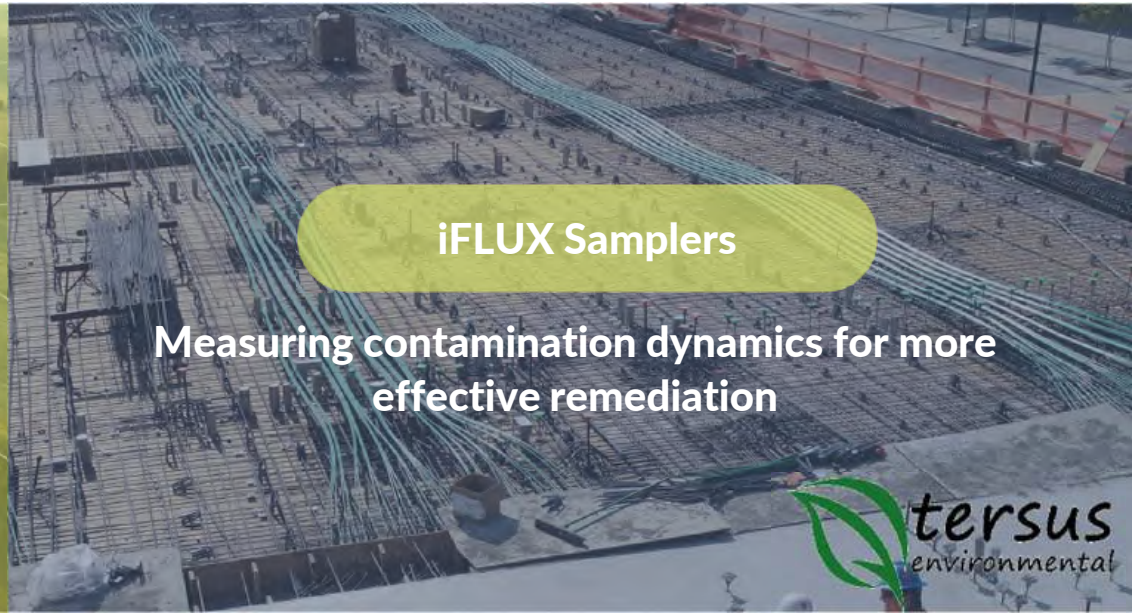
The iFLUX solutions

Insights for evidence-based groundwater management

Measure FLUX, understand dynamics

iFLUX Sensing Solutions

Monitoring networks for real-time insights into groundwater dynamics



iFLUX Samplers

Measuring contamination dynamics for more effective remediation

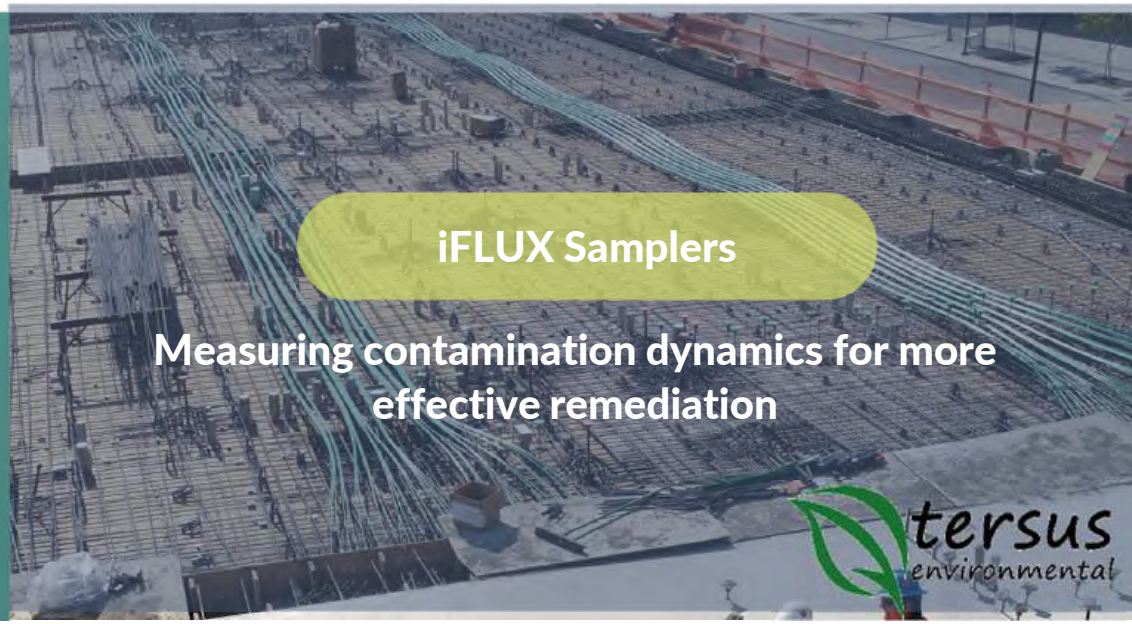
The iFLUX solutions

Insights for evidence-based groundwater management

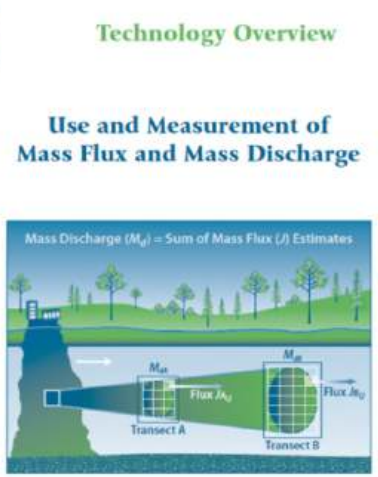
Measure FLUX, understand dynamics

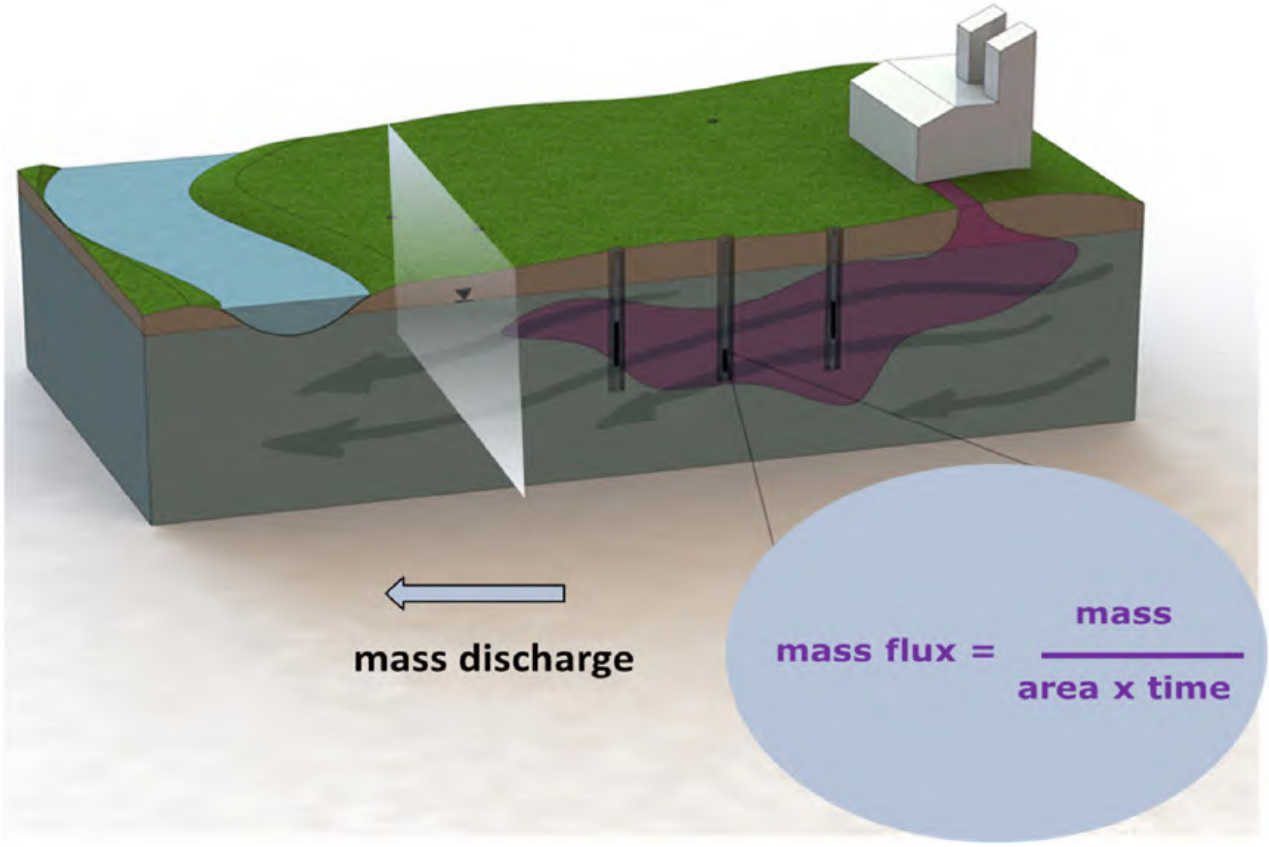
iFLUX Sensing Solutions

Monitoring networks for real-time insights into groundwater dynamics



Mass flux concept

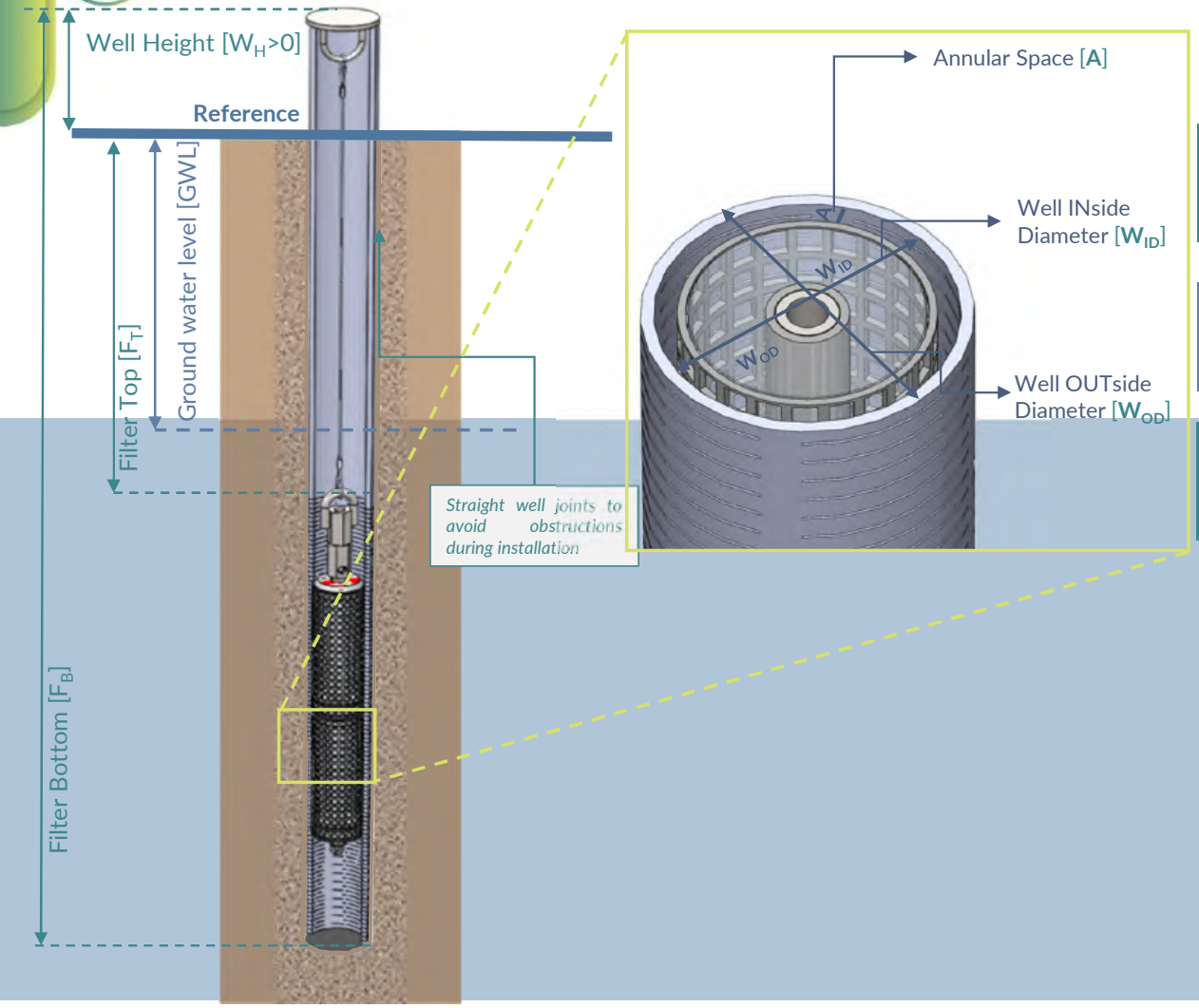




= Concentration (t)
x Darcy velocity
= C_t x q

ITRC (Interstate Technology & Regulatory Council). *Use and Measurement of Mass Flux and Mass Discharge* Washington, D.C.: Interstate Technology & Regulatory Council, Mass Flux Team www.itrcweb.org. *Published for the web by the Interstate Technology & Regulatory Council, June 2021*

iFLUX sampler: easy in use and reliable



Development well

Modular sampler adaptable to size of the well (1”-6”) and (multi)level

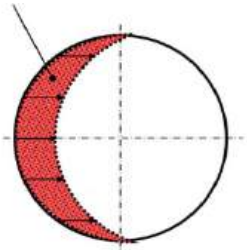
Optimal results: Correction flow field distortion

Verreydt et al._2014_Groundwater flow field distortion by monitoring wells and passive flux meters

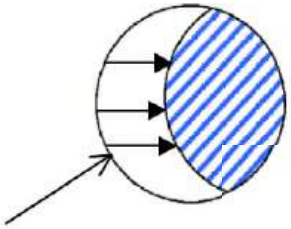
Contamination & Remediation

iFLUX samplers

Adsorption



Elution



iFLUX SGS

Analytical packages & individual compounds

WATERFLUX
Traceralcohols

BTEX-N-S-MTBE
Benzene
Toluene
Ethylbenzene
O-Xylene
M-,p-Xylenes
Naphtalene
Styrene
MTBE

MINERAL OILS
Fraction C-10 – C-12
Fraction C-12 – C-20
Fraction C-20 – C-30
Fraction C-30 – C-40
Mineral oils (GC)

CHLORINATED SOLVENTS
Dichloromethane
1,1-Dichloroethane
1,2-Dichloroethane
Cis-1,2-dichloroethene
Trans-1,2-dichloroethene
Trichloromethane
Trichloroethene
1,1,1-Trichloroethane
1,1,2-Trichloroethane
Tetrachloromethane
Tetrachloroethene
Vinylchloride

CHLOROTULUENES
2-Chlorotoluene
4-Chlorotoluene

TRIMETHYBENZENES
1,2,3-trimethylbenzene
1,2,4-trimethylbenzene
1,3,5-trimethylbenzene

POLYAROMATIC HYDROCARBONS
Napthalene
Acenapthylene
Acenaphtene
Fluorene
Fenanthrene
Anthracene
Fluoranthene
Pyrene
Benzo(a)anthracene
Chrysene
Benzo(b)fluoranthene
Benzo(k)fluoranthene
Benzo(a)pyrene
Dibenzo(ah)anthracene
Benzo(ghi)perylene
Indeno(123cd)pyrene

POLYCHLORINATED BIPHENYLS
PCB 28
PCB 52
PCB 101
PCB 118
PCB 138
PCB 153
PCB 180

Collaborative third-party labo
SGS

VOLATILE ORGANIC COMPOUNDS SPECIFIC
1,1,1,2-Tetrachloroethane
1,1,2-Trichloro-1,2,2-trifluorethane
1,1-Dichloroethene
1,1-Dichloropropane
1,1-Dichloropropene
1,2,3-Trichloropropane
1,2-Dibromoethane
1,2-Dichloropropane
1,3-Dichloropropane
2,2-Dichloropropane
2,3-Dichloropropene
2-Chloro-1,3-butadiene
2-Ethyltoluene
3-Chloro-1-propene (allylchloride)
3-Ethyltoluene
4-Ethyltoluene
Bromobenzene
Bromochloromethane
Bromodichloromethane
Bromomethane
Chloroethane
cis-1,3-Dichloropropene
Cumene
Dibromochloromethane
Dibromomethane
Diisopropylether
ETBE (Ethyl tert-butyl ether)
Ethylether
Hexachlorobutadiene
Iodomethane
TAME (Tert-Amyl Methyl Ether)
trans-1,3-Dichloro-propene
Tribromomethane (Bromoform)
Trichloromonofluor-methane

HEAVY METALS
Cadmium
Chromium
Copper
Lead
Nickel
Zinc

METAL SPECIFIC
Calcium
Iron
Potassium
Magnesium
Manganese
Sodium

NUTRIENT CATIONIC
Ammonium - N

HEAVY METAL SPECIFI
Mercury
Arsenic

NUTRIENT ANIONIC
Nitrate-N
Sulfate

DIOXANE
1,4-Dioxane

PFAS
Perfluorohexanoic acid (PFHxA)
Perfluoroheptanoic acid (PFHpA)
Perfluorooctanoic acid (PFOA)
Perfluorononanoic acid (PFNA)
Perfluorodecanoic acid (PFDA)
Perfluoroundecanoic acid (PFUnDA)
Perfluorododecanoic acid (PFDoDA)
Perfluorobutanesulfonic acid (PFBS)
Perfluorohexanesulfonic acid (PFHxS)
Perfluorooctanesulfonic acid (PFOS)
Perfluorooctanesulfo - namide (PFOSA)
Perfluorobutanoic acid (PFBA)
Perfluorotridecanoic acid (PFTrDA)
Perfluorotetradecanoic acid (PFTeDA)
Perfluorohexadecanoic acid (PFHxDA)
Perfluorooctadecanoic acid (PFOcDA)
Perfluoroheptanesulfonic acid (PFHpS)
Perfluorononanesulfonic acid (PFNS)
Perfluorodecanesulfonic acid (PFDS)
Perfluoroundecanesul-fonic acid (PFUnDS)
Perfluorododecanesul-fonic acid (PFDoDS)
Perfluorotridecanesul-fonic acid (PFTrDS)
4:2 Fluorotelomer sulfonate (4:2 FTS)
6:2 Fluorotelomer sulfonate (6:2 FTS)
8:2 Fluorotelomer sulfonate (8:2 FTS)
10:2 Fluorotelomer sulfonate (10:2 FTS)
Perfluoro-3,6-dioxaheptanoic acid (PHFO-DA)
N-ethyl perfluorooctanesulfonamide (N-EtFOSA)
N-methyl perfluorooctanesulfon-amidoacetic acid (N-MeFOSAA)
N-ethyl perfluorooctane-sulfonamidoacetic acid (N-EtFOSAA)
Perfluorohexanesulfonic acid (PFHxSA)
8:2 Polyfluoroalkyl phosphate diester (8:2 DiPAP)
6:2 Polyfluoroalkyl phosphate diester (6:2 DiPAP)
Mixed 6:2/8:2 Polyfluoroal-kyl phosphate diester (6:2/8:2 DiPAP)
9-Chlorohexadecafluoro-3-oxanonane-1-sulfonic acid (9 ClPF3ONS)
11-Chlorohexadecafluoro-3-oxaundecane-1-sulfonic acid (11 ClPF3UdS)

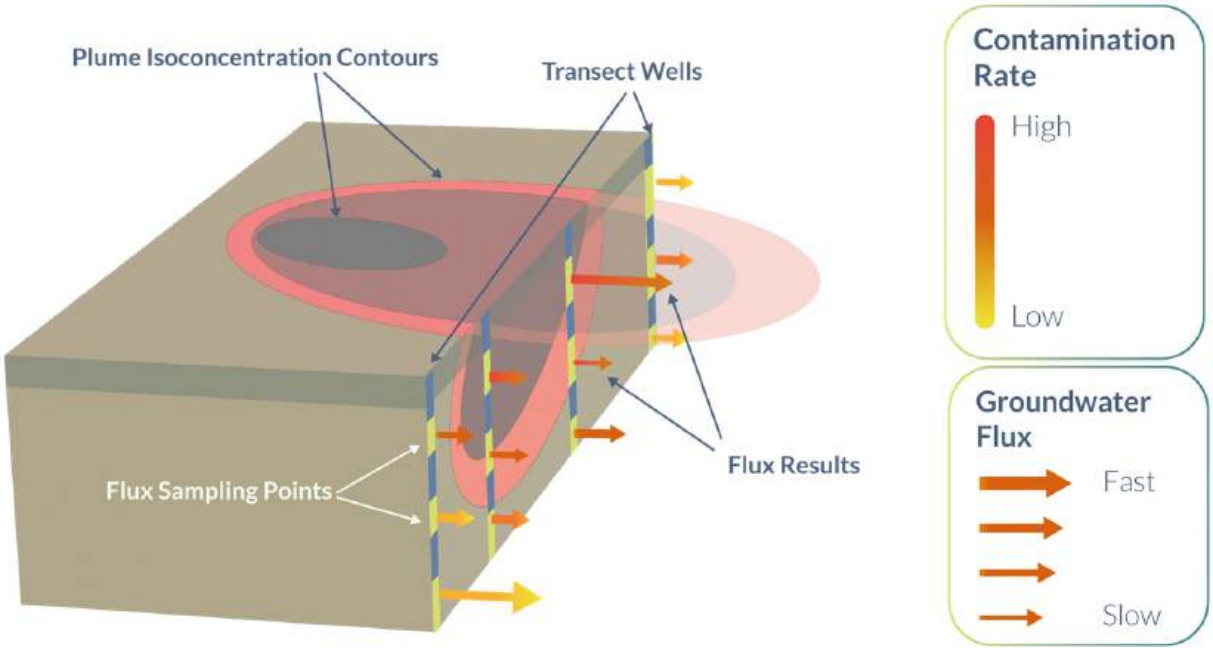
iFLUX

For more details, please visit
www.iFLUX.be

How to build your monitoring plan

Where to measure what & when

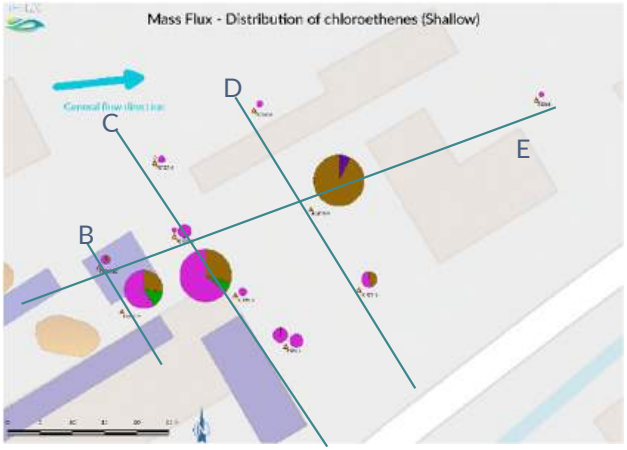
Monitoring plan : objectives

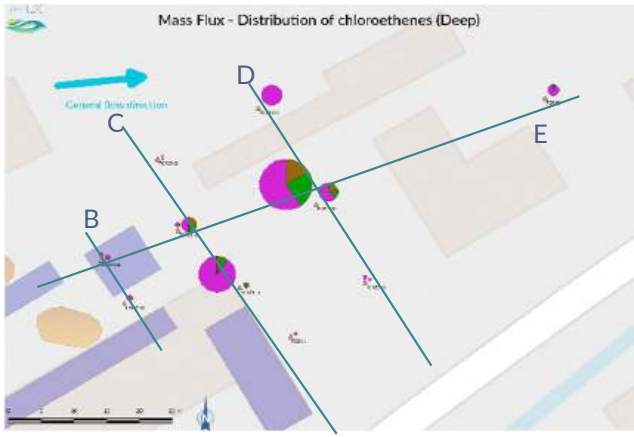


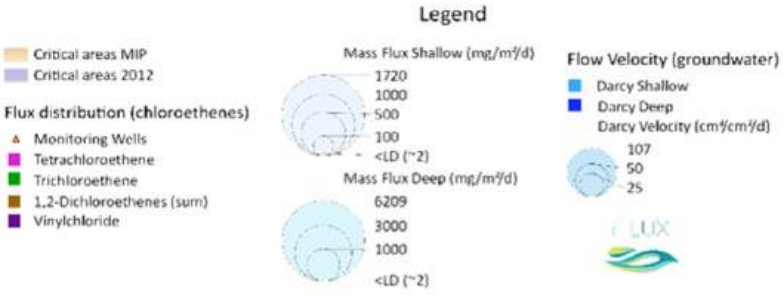
- Determine mass discharge & exposure risk
- Preferential pathways
- Understand dynamics
- Design, follow up & adjust remedial actions

Monitoring plan

Objectives en detail of campaign

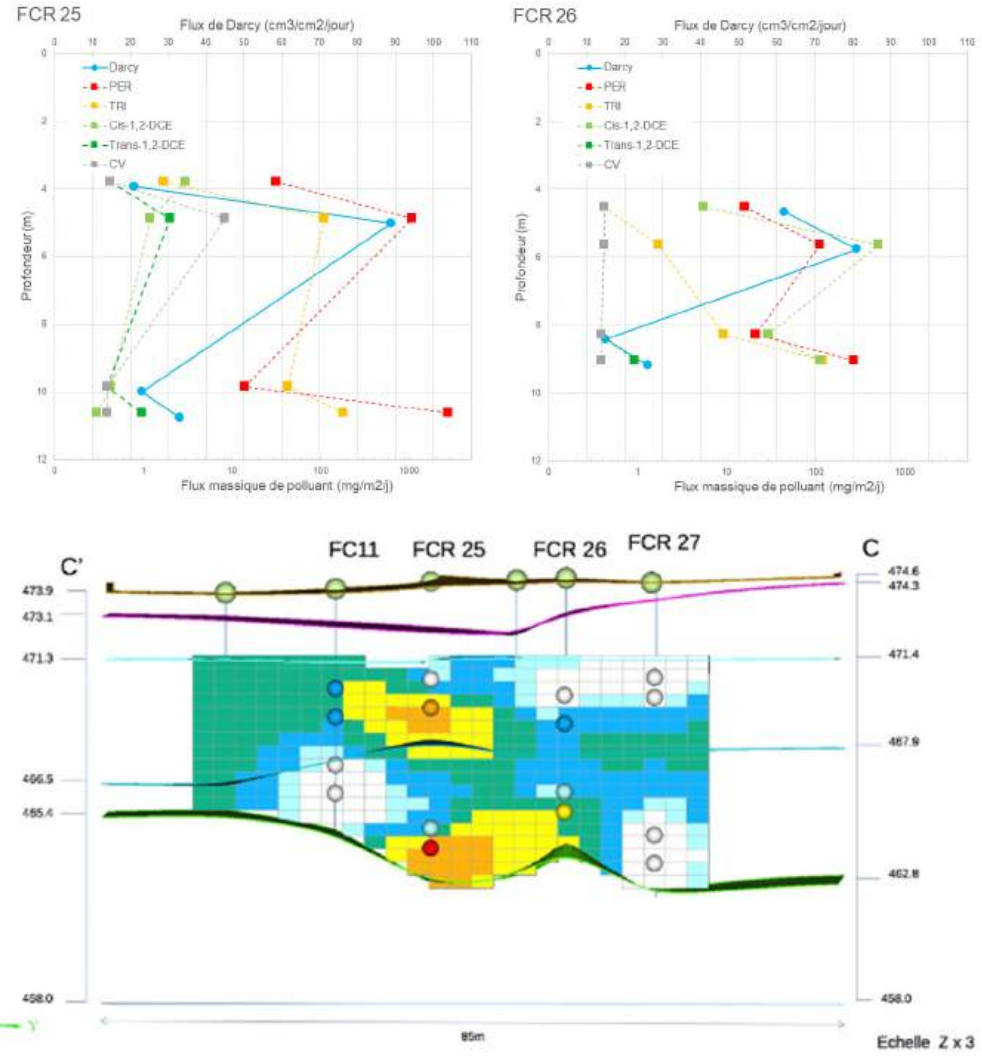






Quantify mass discharge

Determine source zones and preferential pathways



Site specific information

Infrastructure & activities

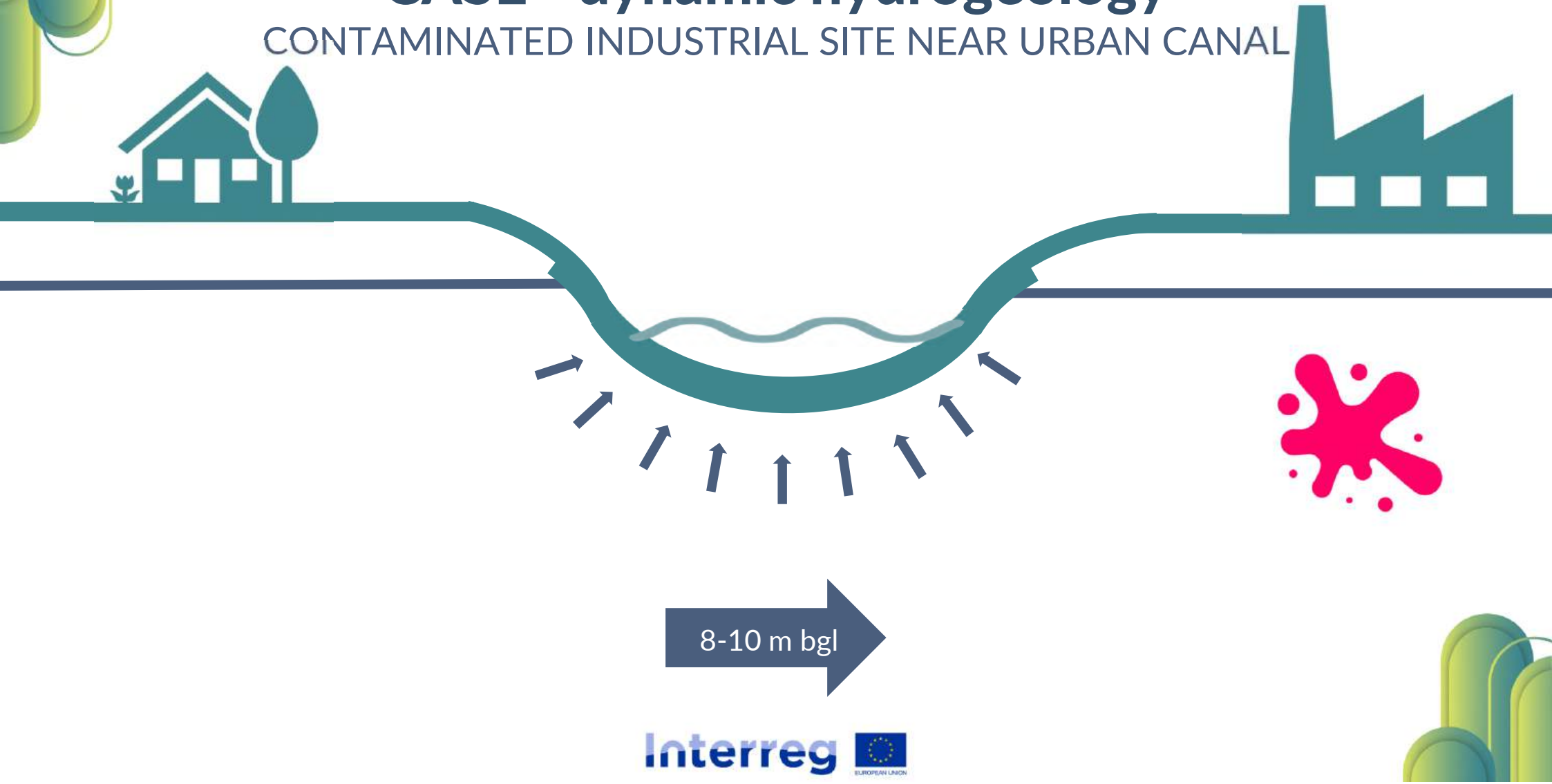
- Dyke
- water flux
- mass flux

Hydrogeology

External influence

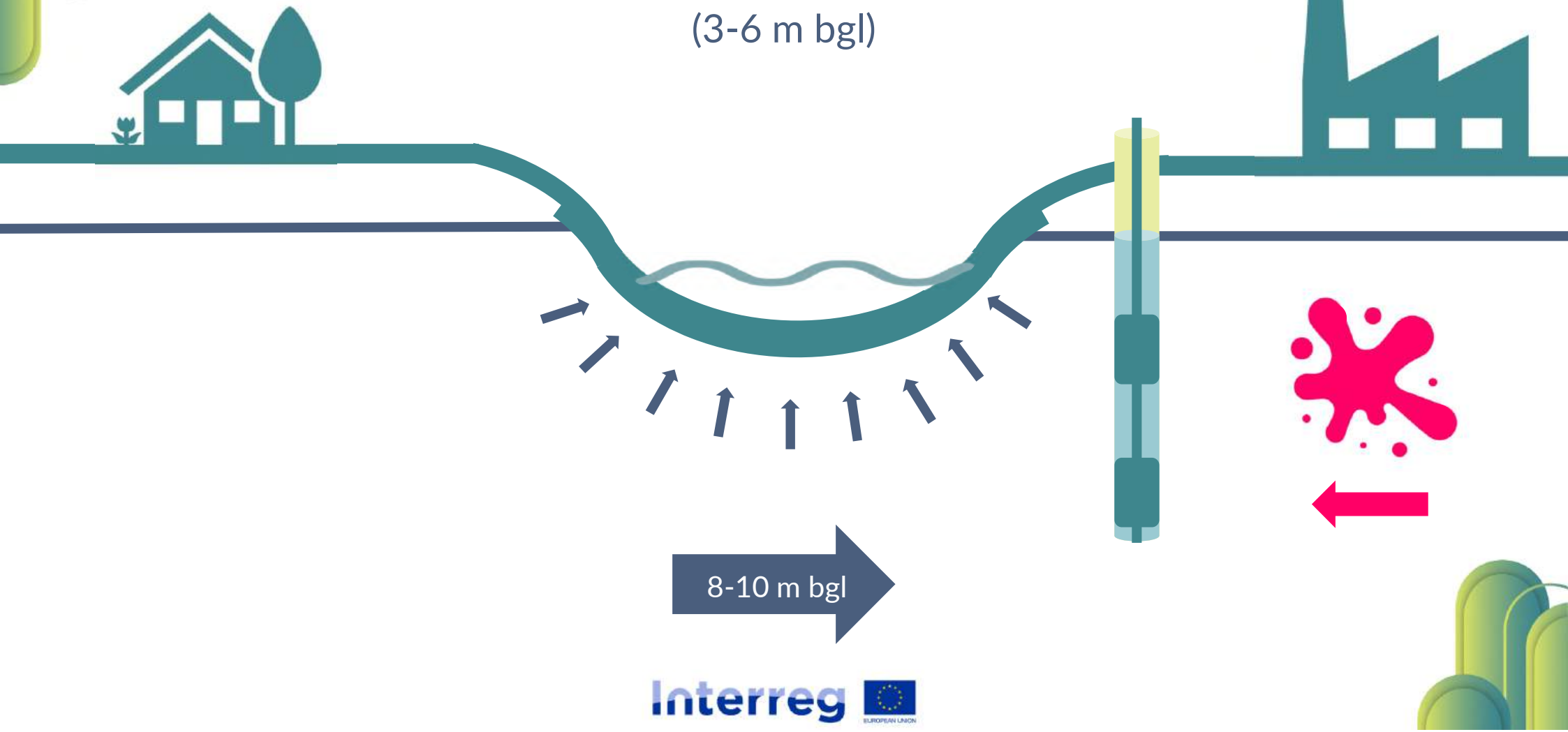
CASE - dynamic hydrogeology

CONTAMINATED INDUSTRIAL SITE NEAR URBAN CANAL

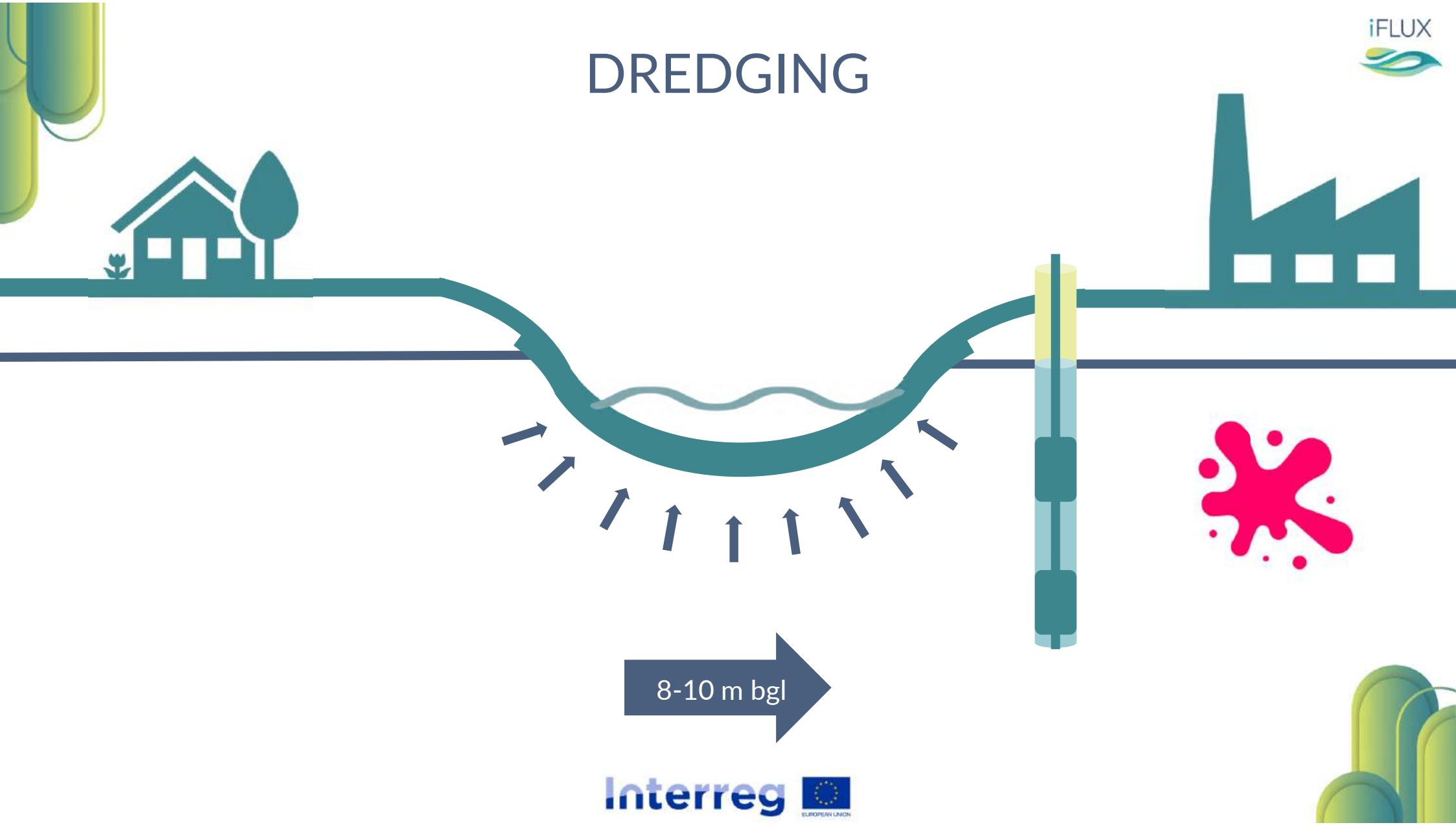


FLUX MEASUREMENTS **BEFORE** DREDGING

SHALLOW GROUNDWATER
(3-6 m bgl)

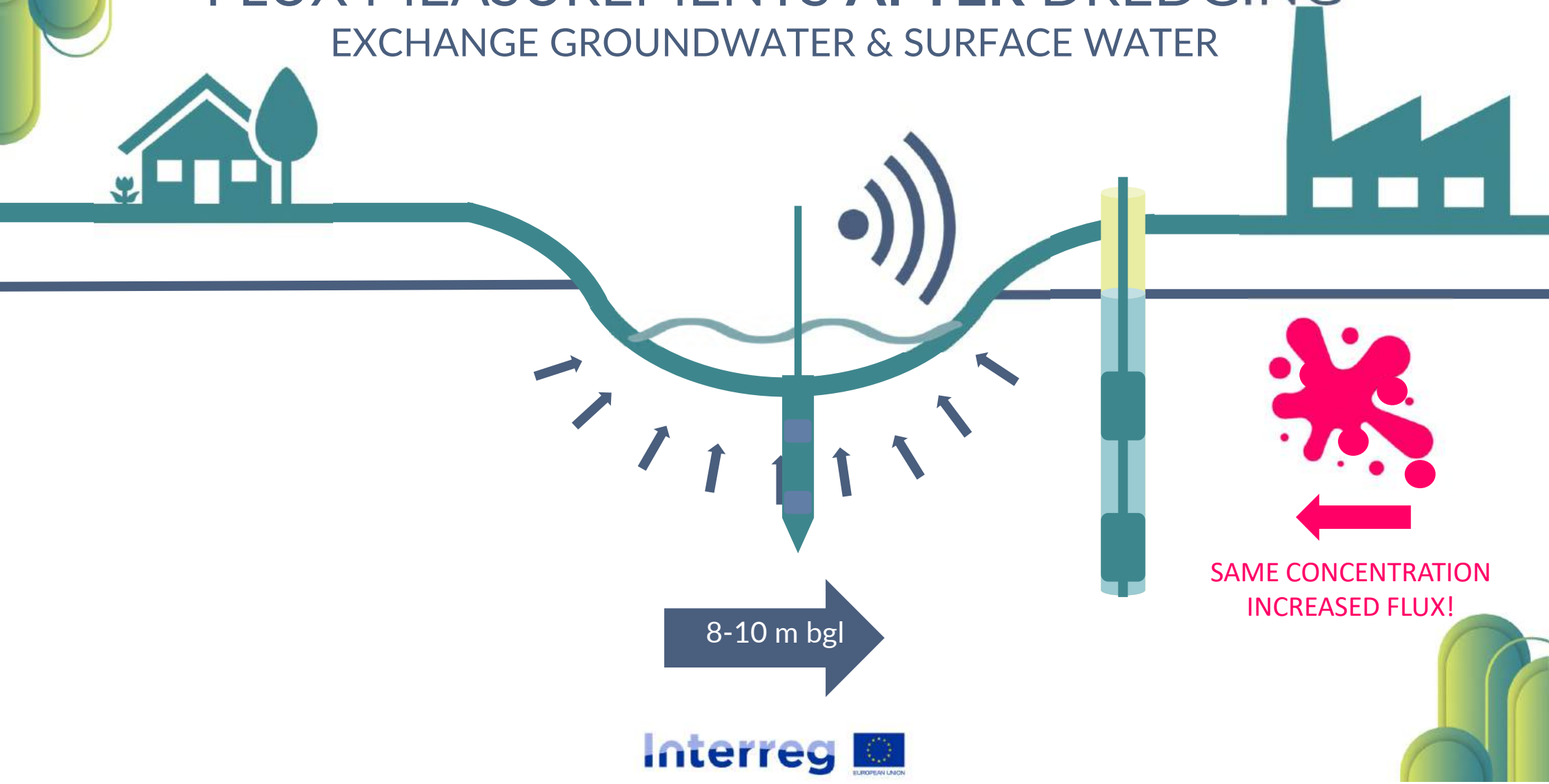


DREDGING



FLUX MEASUREMENTS **AFTER** DREDGING

EXCHANGE GROUNDWATER & SURFACE WATER

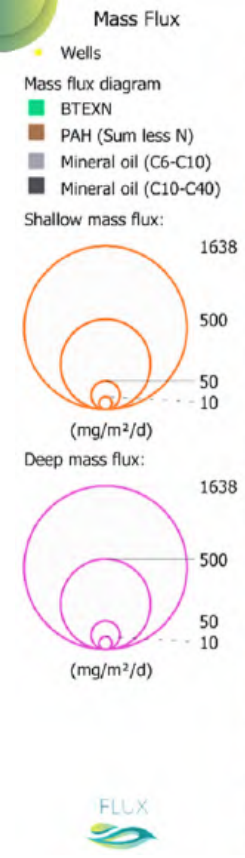


iFLUX

Interreg

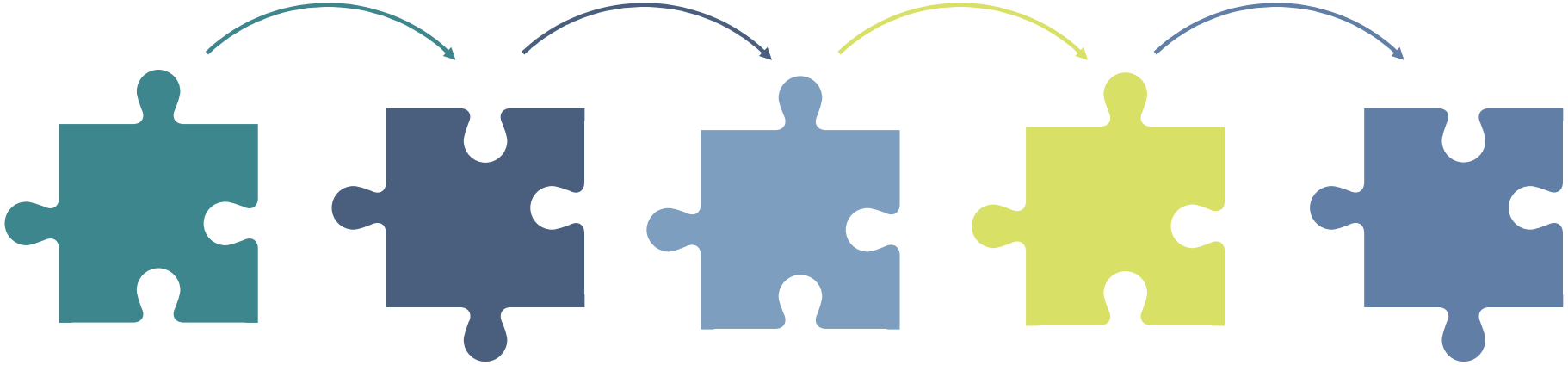
Results horizontal flux samplers

Increased flux after dredging



When to Apply Mass Flux Measurements?

Solutions – answering some basic questions



1. Preferential pathways

Are there preferential pathways?
If so, where are they located?

2. Contaminant mass

How much contamination is migrating? Is this a relevant mass to be considered a migration risk?

3. Migration rate

How fast is groundwater or contaminant migrating? Will this be impacted by other effects?

4. Optimized Mitigation

What can be mitigation measures (attenuation, NBS, ..) If remedial actions are required, how can they be optimized and become highly effective?

5. Proof and quantification of biodegradation

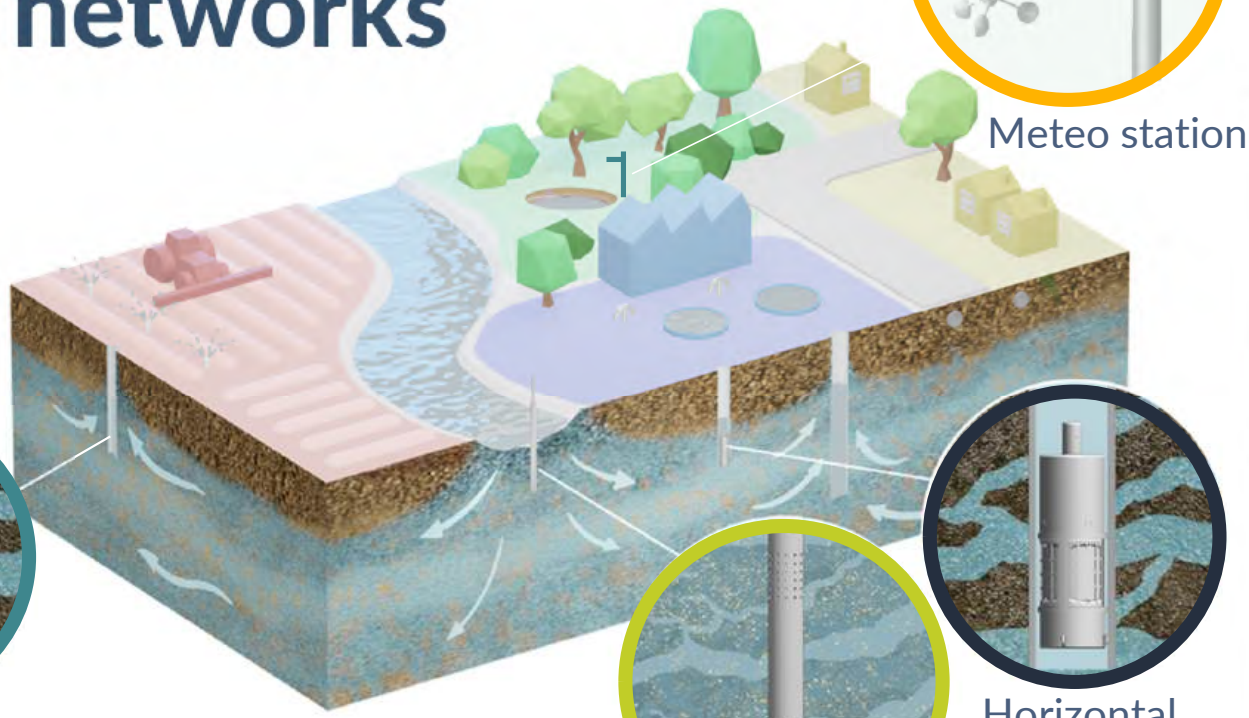
Is biological degradation occurring. What is degradation rate?

The iFLUX solutions

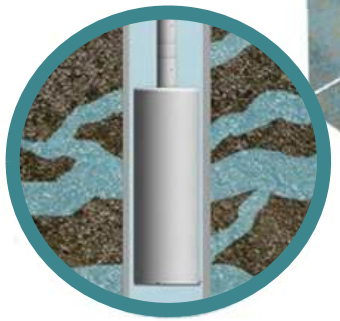
Insights for evidence-based groundwater management

Measure FLUX, understand dynamics

Real-time groundwater sensor networks



Meteo station

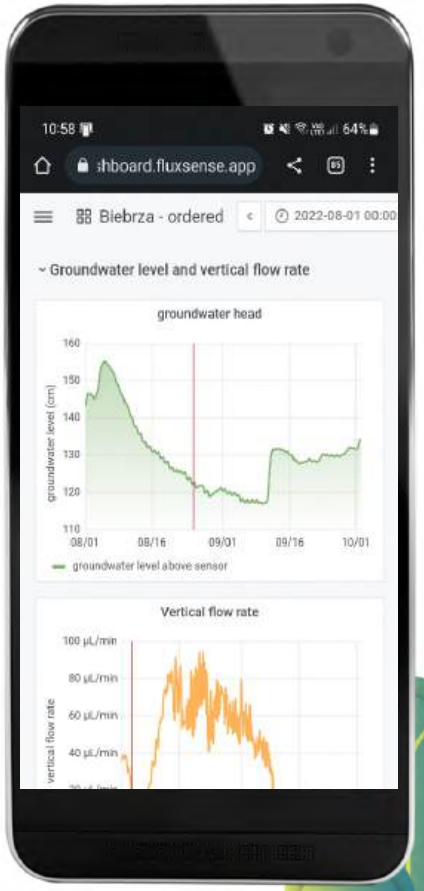


Quality or level sensor

Vertical sensor probe

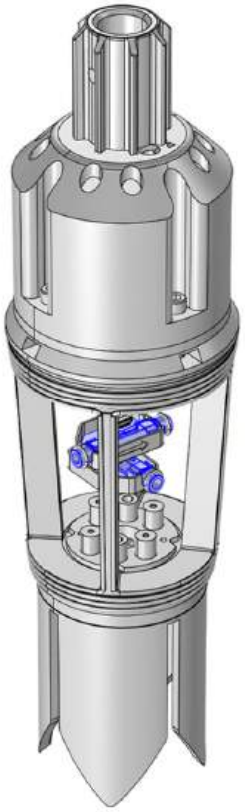
Horizontal sensor probe

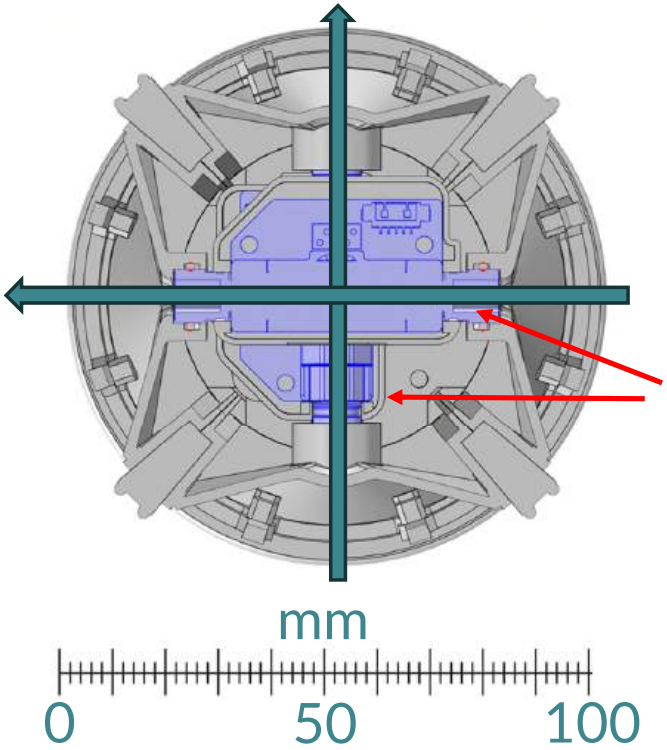
Real-time data

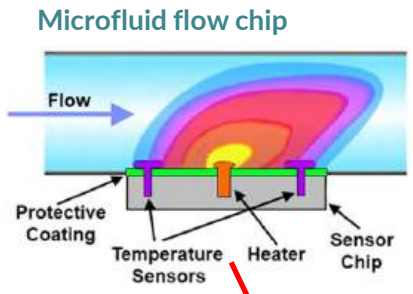


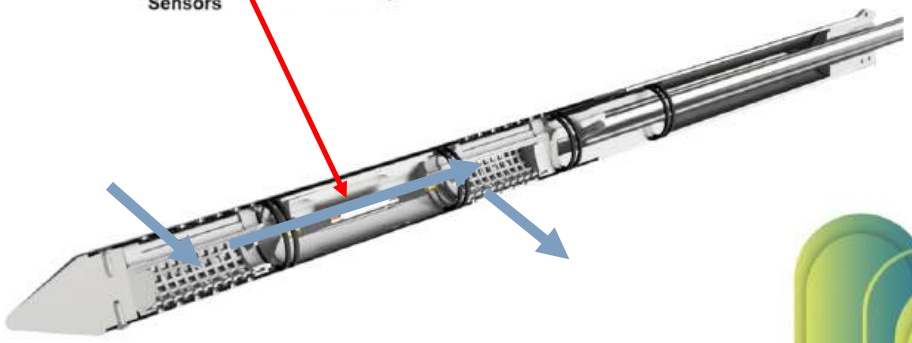
iFLUX's unique sensor:

real-time groundwater velocity speed & direction











Sensing Solutions - Usage Case *(video)*

tersus environmental

david.alden@tersusenv.com

www.tersusenv.com

iFLUX

marjan@iflux.be

www.iFLUX.be