GQ2019

Mass flux measurement in groundwater: application & practices

Dr. Goedele Verreydt
Founder & Technical Director of iFLUX

Universitè de Liège

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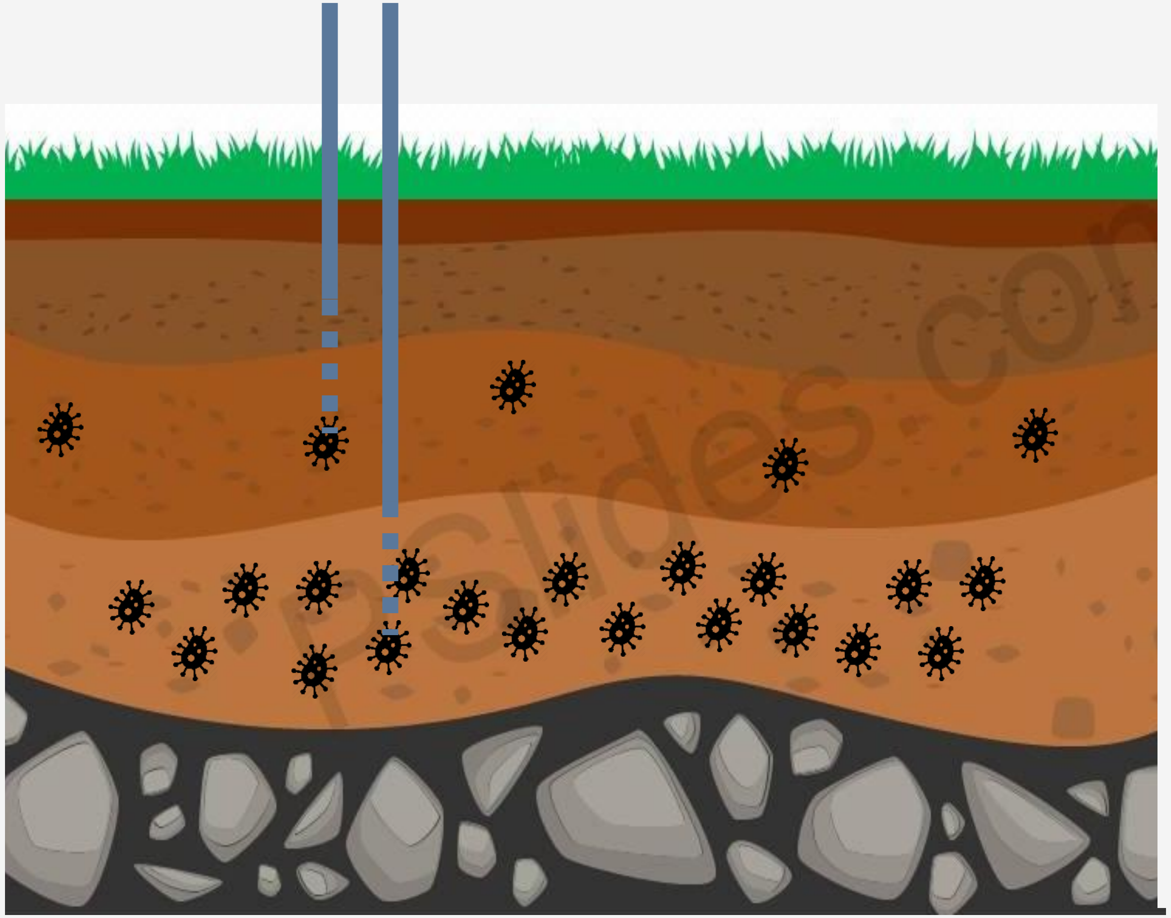
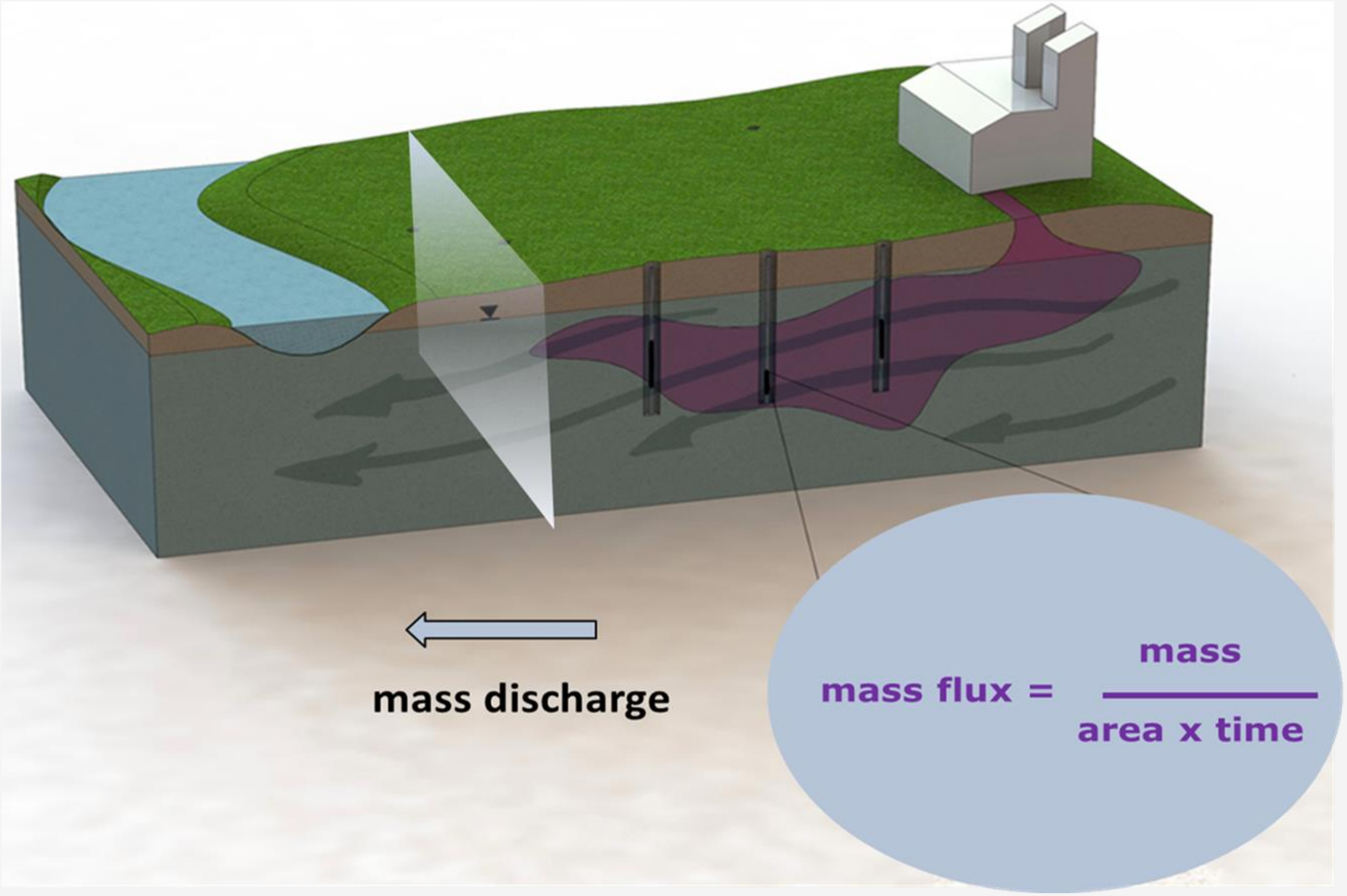
Dynamics of soil and groundwater pollution often is underestimated



Mass flux concept



https://www.itrcweb.org/GuidanceDocuments/MASSFLUX1.pdf

iFLUX technology

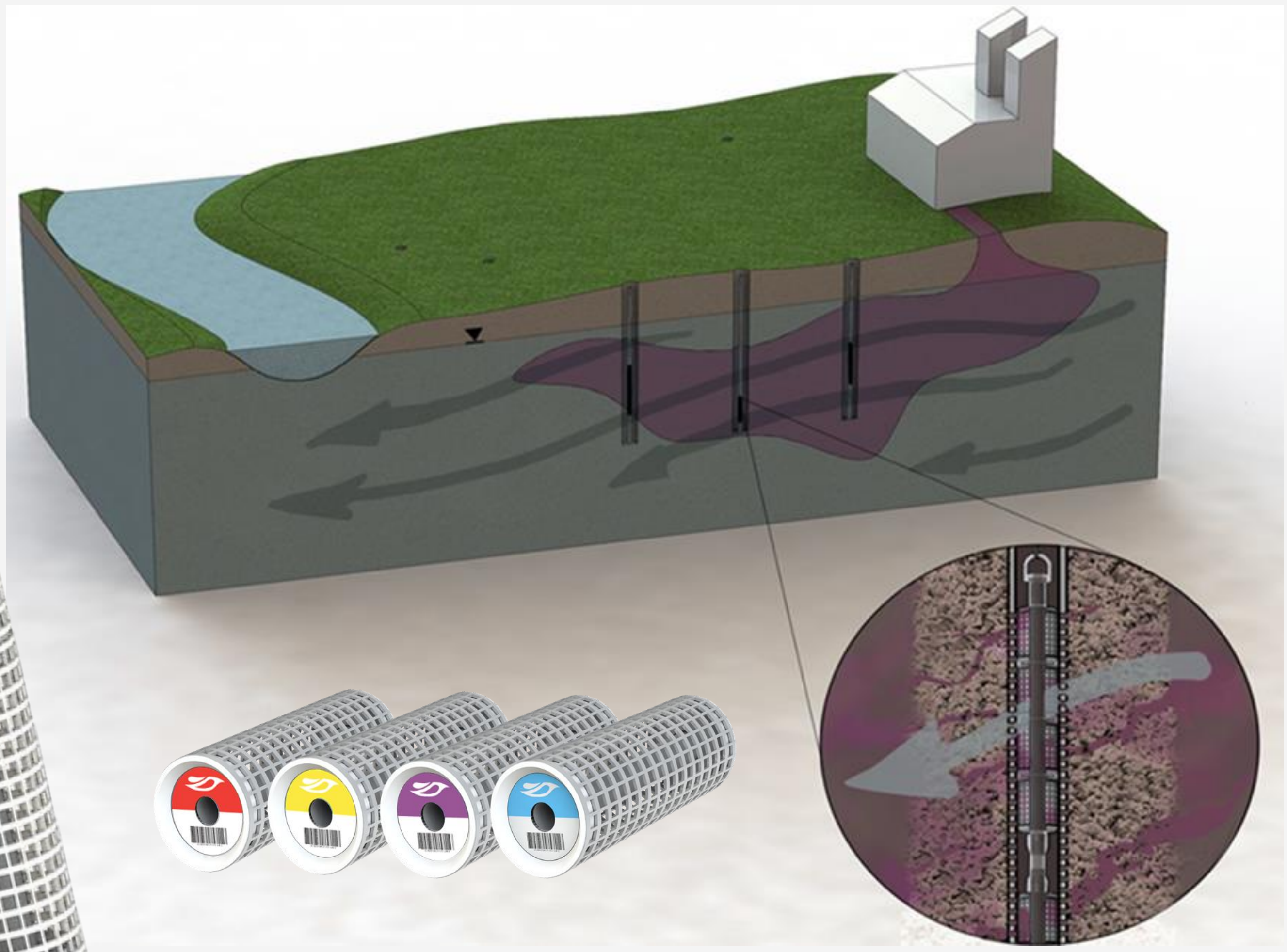
We are able to perform a direct flux measurement

Patented and validated

Captures 90% of all pollution types

Accurate measurement of speed and direction

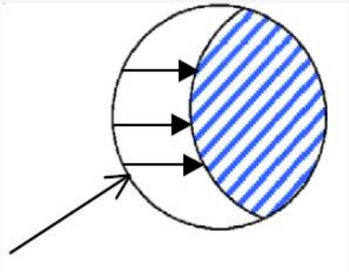
Potential cost reduction up to 30%



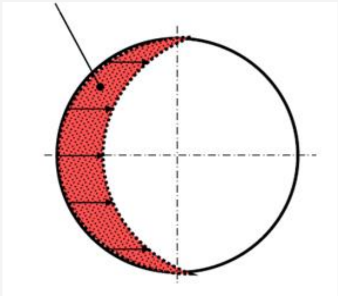
PRINCIPLES

Mass flux calculation

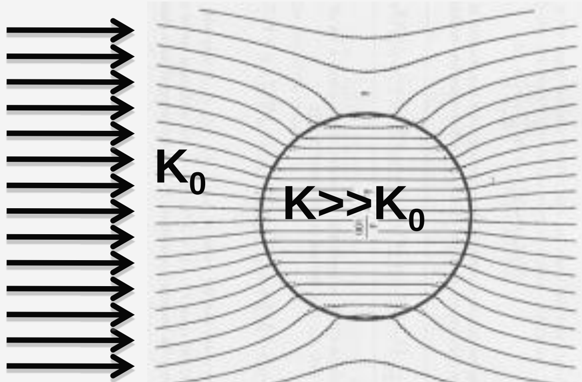
Tracer eluted to the right



Sorbed contaminant



1. Tracer desorbs from passive flux meter over time to get Flow (Q)



Groundwater Flowlines

2. Contaminant adsorbed onto passive flux meter over time to get Mass flux (J)

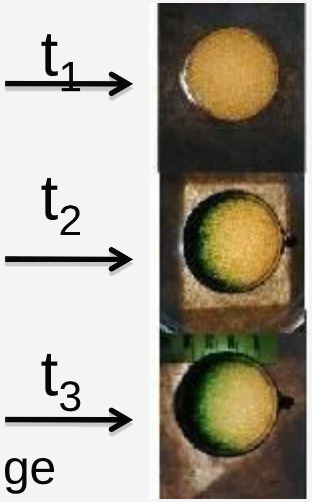


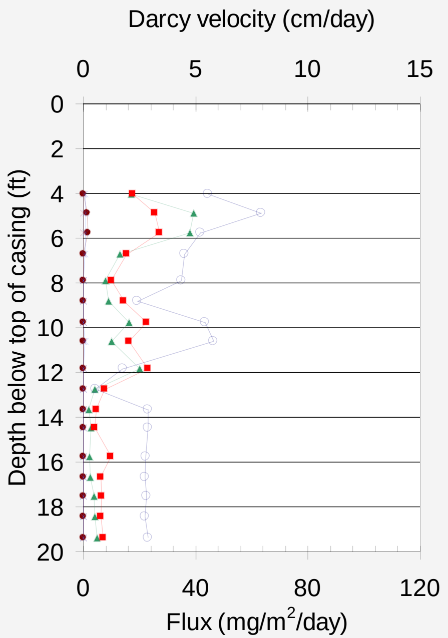
Photo: Dye intercepted in a cartridge

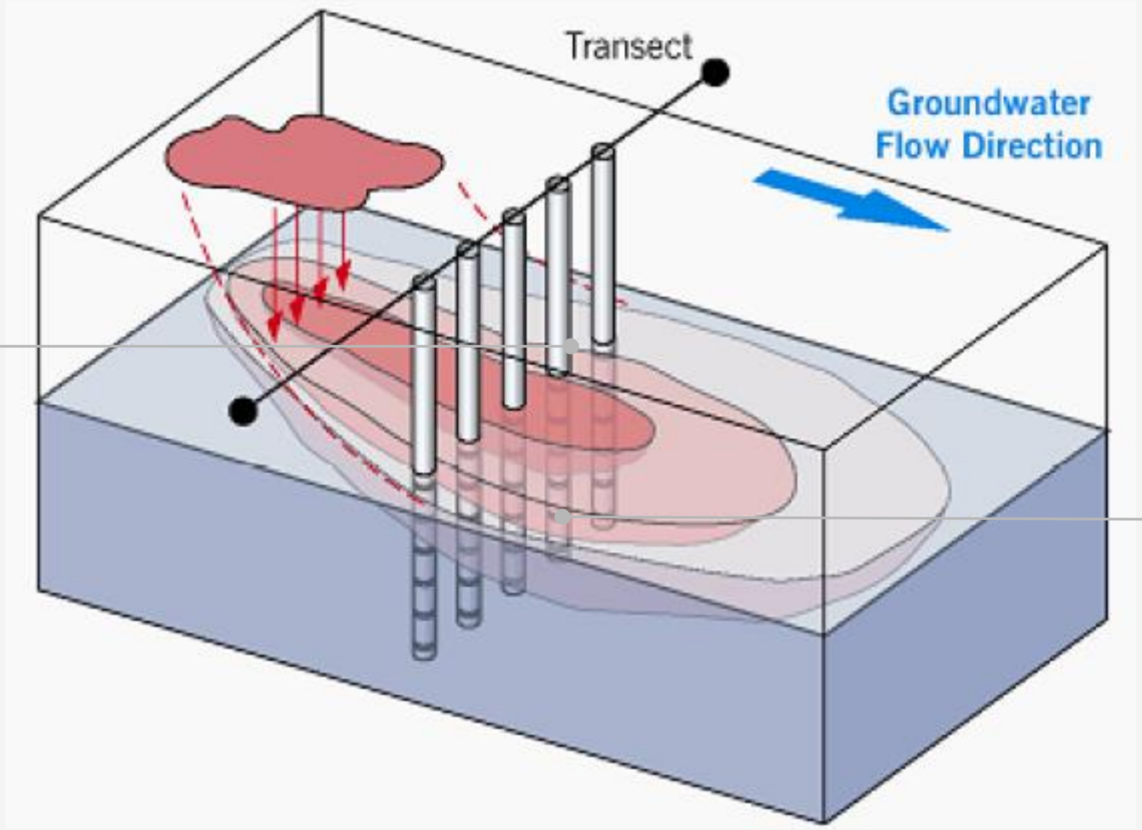
Flux results

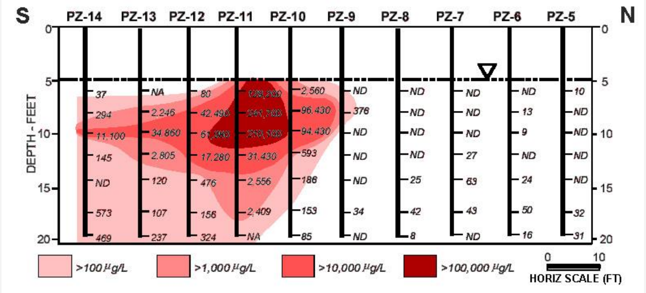
End report with interpreted and analyzed flux results.

Well depth graph

Each sampler location delivers accurate flux results for each depth



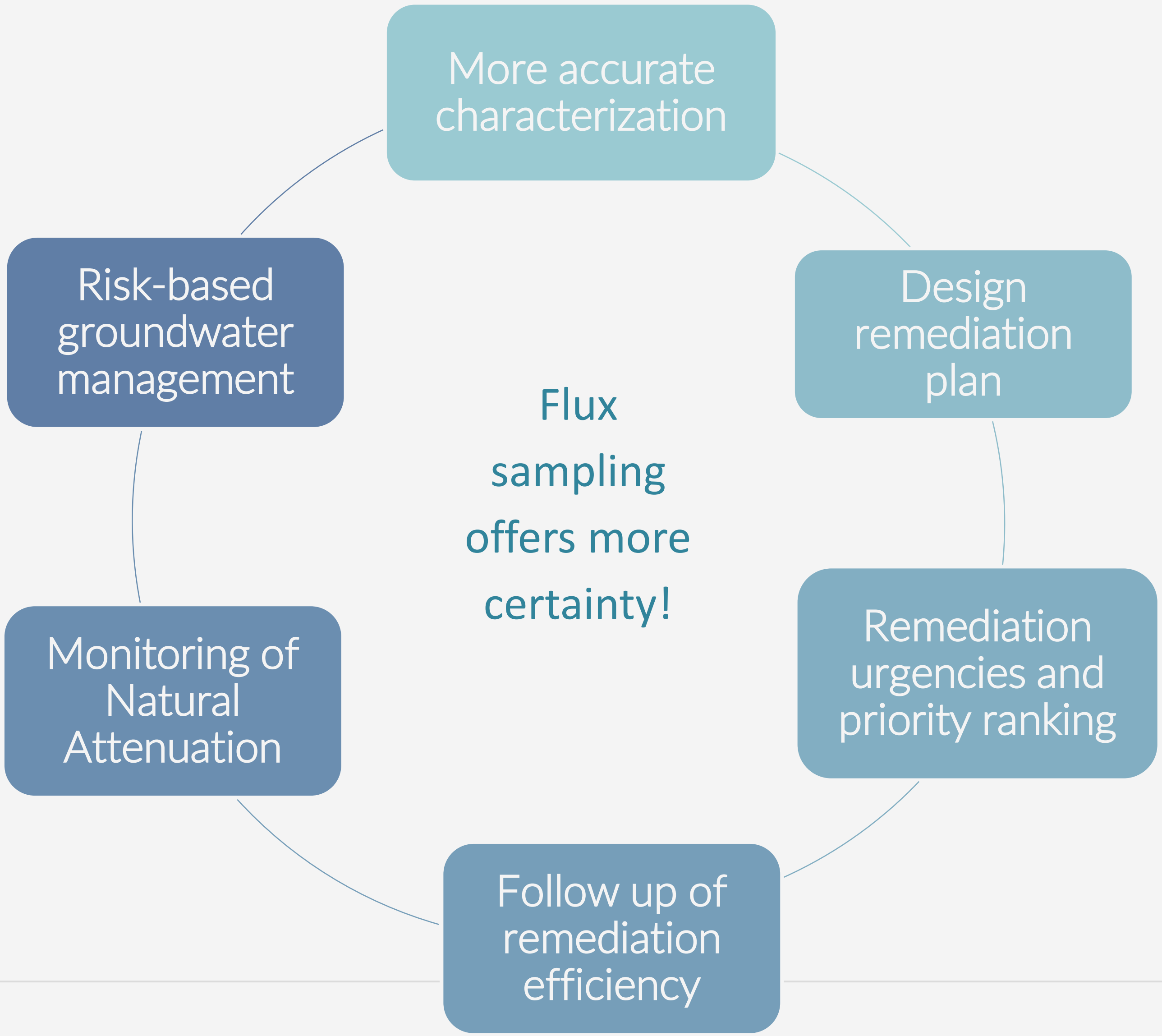




Control plane

Interpolation technique to calculate and visualize spreading of groundwater and pollution

When to apply flux measurements?



iFLUX case studies

iFLUX Project

iFLUX offers an integrated solution in close cooperation with the Environmental Consultant to guarantee accurate flux results.
A typical project includes 4 milestones.

1 – Field design

Based on preliminary site investigation and customer input, a detailed monitoring campaign is developed.

2 – Sampler installation on site

An authorized field team will guarantee a precise installation of the selected iFLUX samplers on site.

3 – Retrieval and lab analysis

After retrieval, dedicated transport from site to our partner laboratory is taken care of. A certified lab analysis will provide us the raw flux data measured.

4 – Data analysis and reporting

Validated flow field distortion calculations deliver detailed and reliable flux data in the aquifer. Our end report contains comprehensible graphs and maps of the designated field.

Site	:	Chemical plant
Location	:	Harbour area
Contamination type	:	Aromatic hydrocarbons

Chemical Plant

Topic: contaminant migration risk

- Industrial chemical plant active since the 1970s
- Refinement and distillation of petroleum hydrocarbons, production of solvents and additives
- Located in an industrial harbour area
- Subsurface: heterogeneous sediments, with drainage ditches and mechanical dewatering

Case: Chemical plant

Situation

- Source area 1: BTEX, TPH, (MTBE)
- Source area 2: MTBE, (TPH, BTEX)

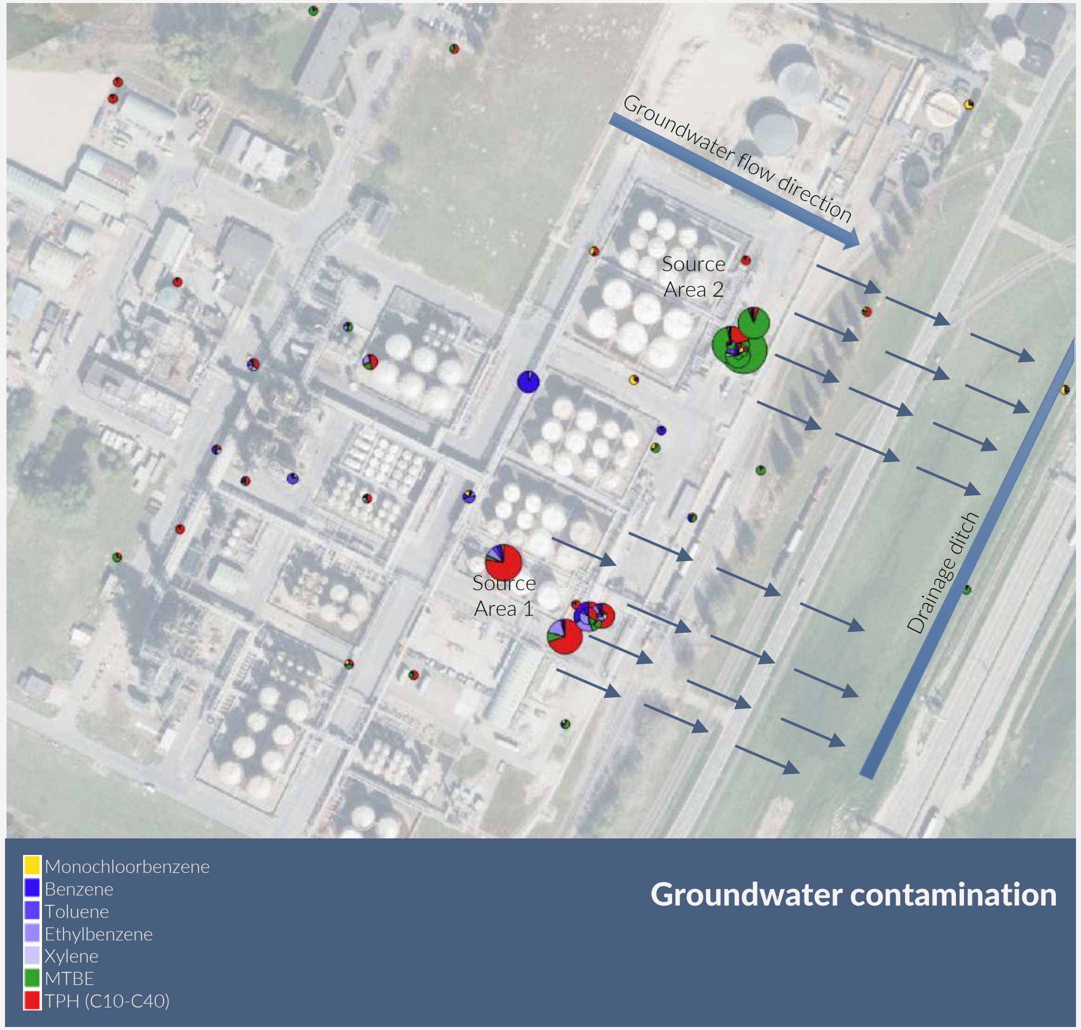
- No current human health risk

- Migration risk towards a down gradient located drainage ditch, which is discharged via pumping in the nearby river

- Ongoing source remediation – pilot scale:
    - Source area 1: In-situ Chemical Oxidation (ISCO)
    - Source area 2: Vapor Enhanced Recovery (VER)

- Plume control: traditional monitoring

- Geology: heterogeneous alluvial deposits with large variations in permeability and composition (coarse sand, fine sands, clay, peat, …)



Case: Chemical plant

Problem

1. Preferential pathways

Are there preferential pathways driving contaminant migration? 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 the contamination migrating? Will this be impacted by other effects (sorption, degradation, back-diffusion, ...)?

4. Optimized mitigation

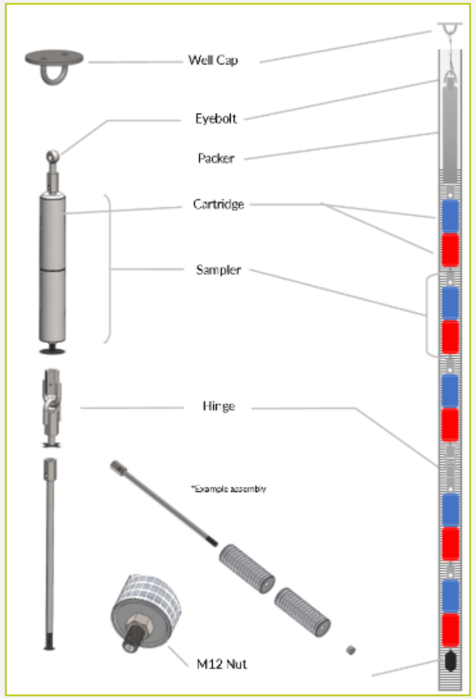
If remedial actions are required, how can they be optimized and become highly efficient?

Case: Chemical plant

Monitoring plan

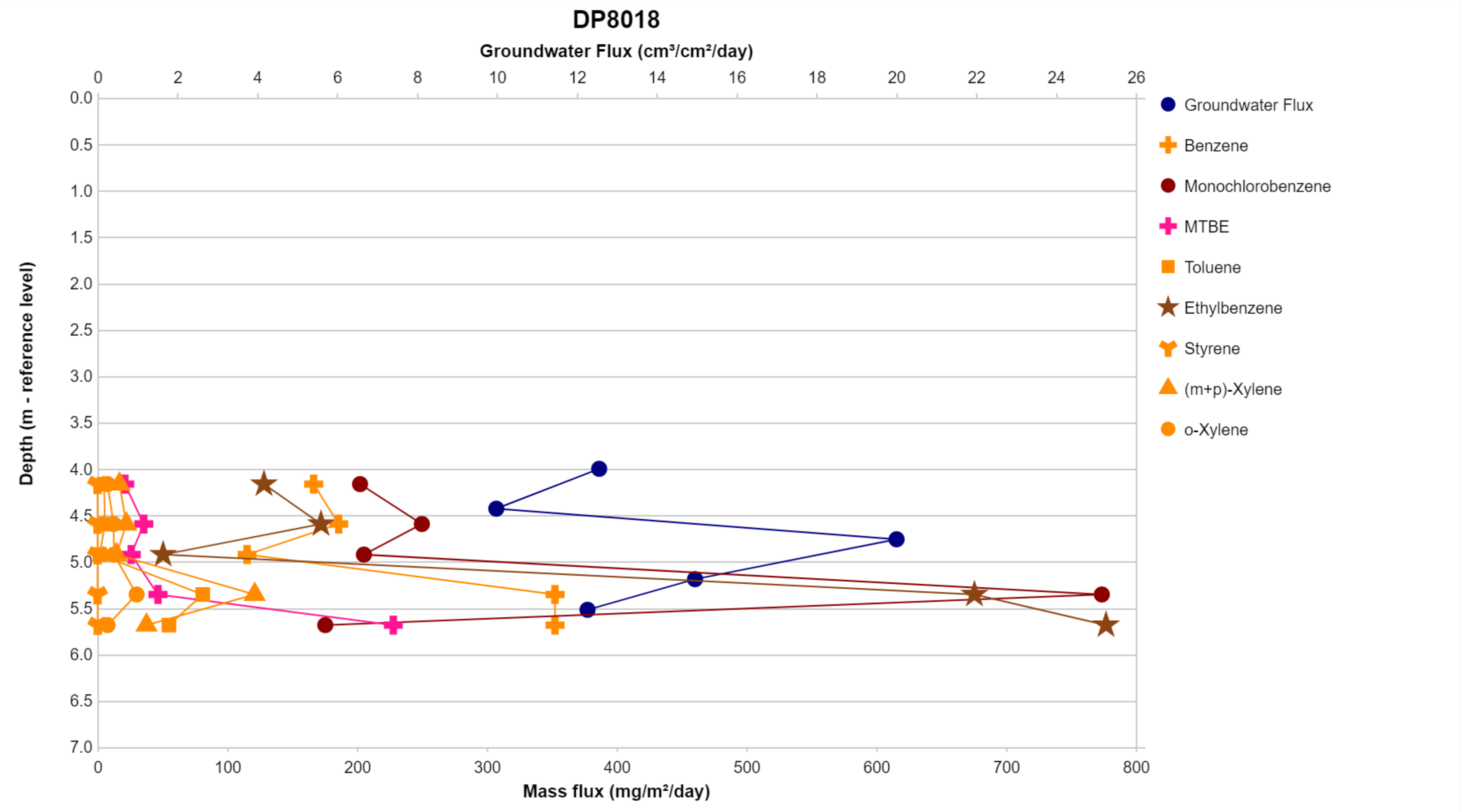
Available infrastructure/data:
- 9 monitoring wells with detailed borehole description at the downgradient site border
- 5 MIPs downgradient of source area 1

iFlux sampling setup:
- Installation of 5 iFlux samplers (5 X groundwater flux + VOC flux sampler) in 6 selected monitoring wells (screens at different depth intervals)
- Exposure time: 4 weeks



Case: Chemical plant

Graphs



Case: Chemical plant

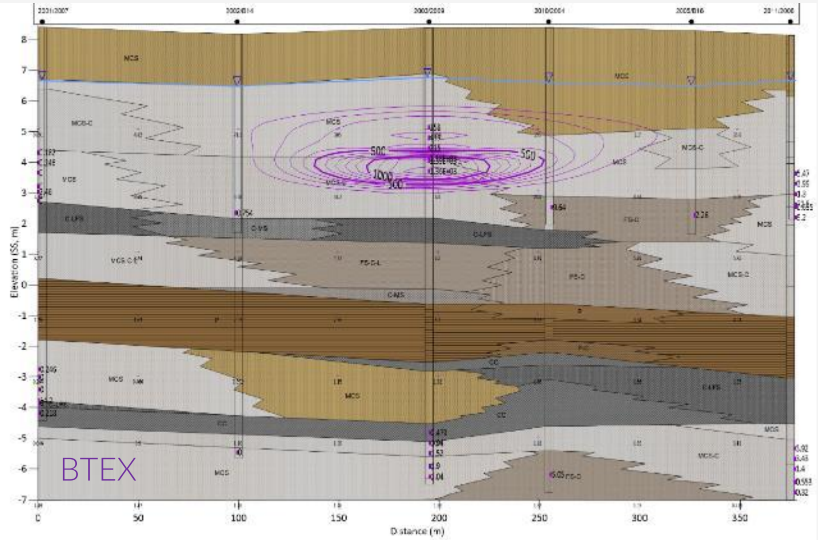
Contaminant flux (extrapolated contours) at the down gradient site border

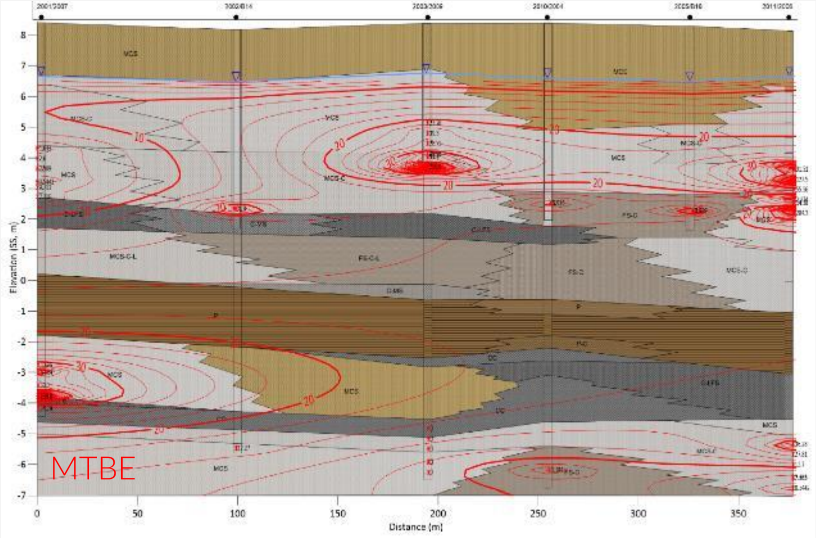
Conclusion 1:

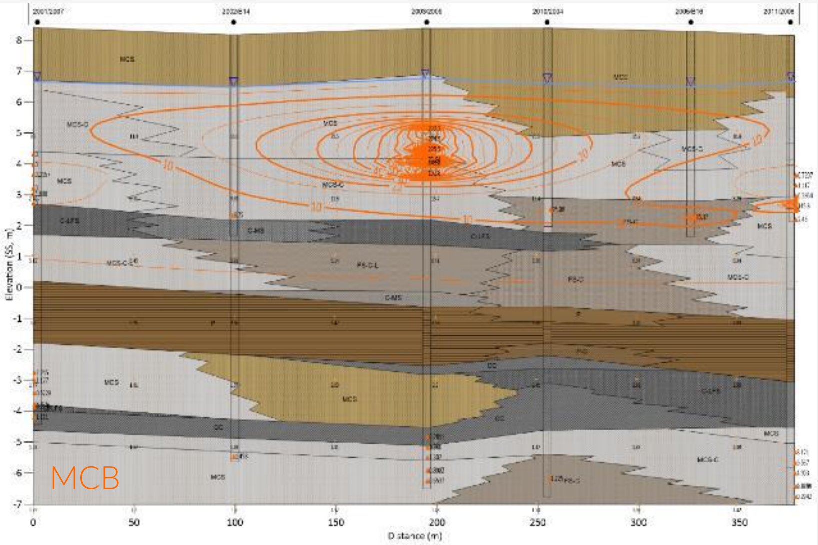
Preferential pathways in the highly permeable layers

Conclusion 2:

Relevant contaminant fluxes at site border
(in total almost 340 g/day, at an average concentration of 407 µg/l)







Parameter	Calculated mass load from flux measurements for total site border cross-section
Groundwater	836 m^3/day (305.000 m^3/y)
BTEX	210 g/day (77 kg/y)
MTBE	86 g/day (31 kg/y)
MCB	38 g/day (14 kg/y)

Case: Chemical plant

Contaminant flux and mass distribution (MIP) at the down gradient site border

Conclusion 3:

Large masses of contamination present in low permeable layers, potential sources for back-diffusion

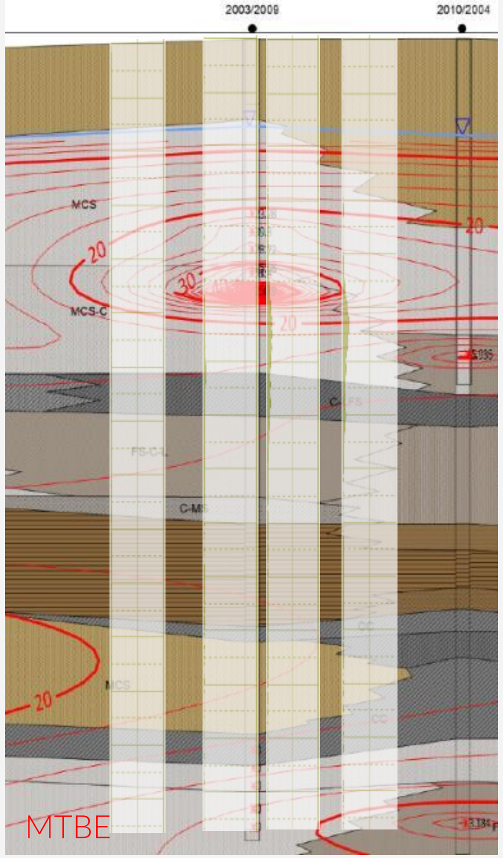
Conclusion 4:

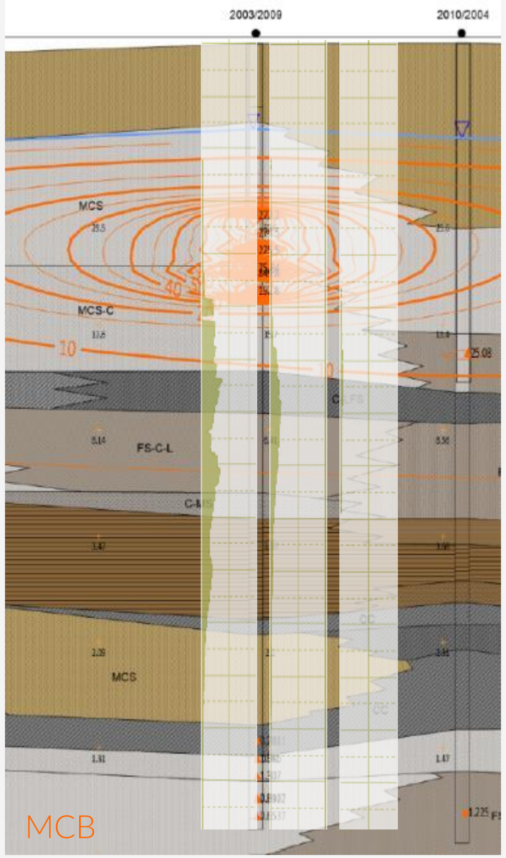
Sorption potential (Kd) differentiates contaminant mass distribution:

- low Kd, the contaminant is preferentially present in a soluble phase in the groundwater
- higher Kd more mass absorbed on the soil matrix

- Kd: MTBE < Benzene < Toluene < Xylene < MCB < Ethylbenzene

- Contaminant mass in low permeability, high sorbtion soil / Contaminant mass in high permeability, low sorbtion soil: MTBE <<<< Benzene, Toluene < (MCB) < Xylene, Ethylbenzene





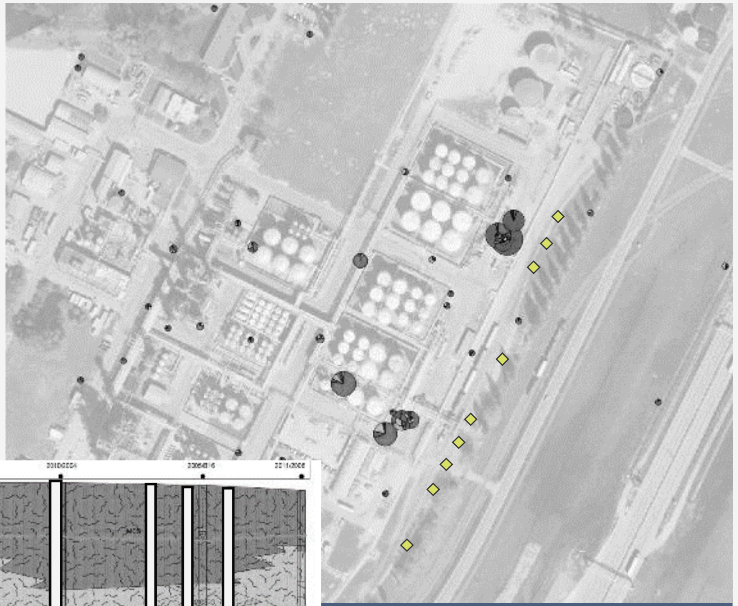
Case: Chemical plant

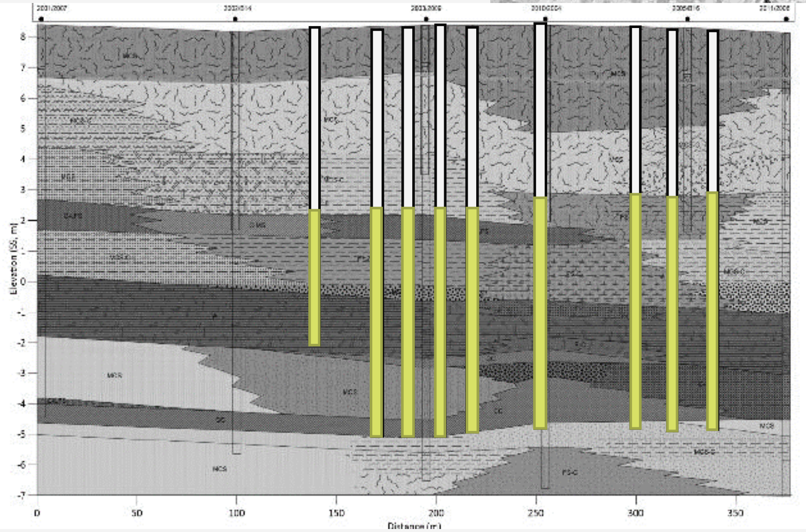
iFlux added value

GAIN
Finished one year earlier
40% cheaper

Without flux information:

- Focus on layers with high contaminant mass
- Abstraction from long screens
- Result: high pumping rate, low yield, limited effect on migration





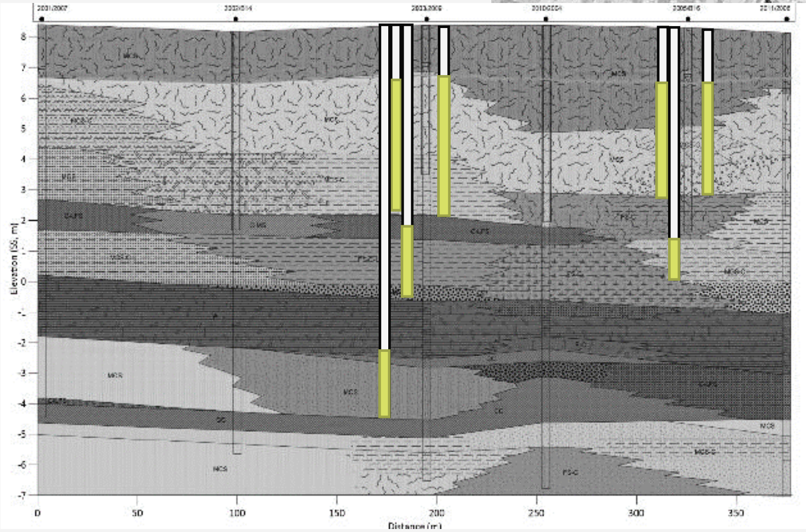
Hydraulic barrier

Numbers:

- Duration: 3 +2 years
- 50 m^3/h
- 780.000 euro

With flux information:

- Focus on layers with high contaminant flux
- Abstraction from short well placed screens
- Result: low pumping rate, high yield, strong effect on migration



Hydraulic barrier

Numbers:

- Duration: 3 + 1 year
- 20 m^3/h
- 485.000 euro

Vision

From soil remediation to smart water grid