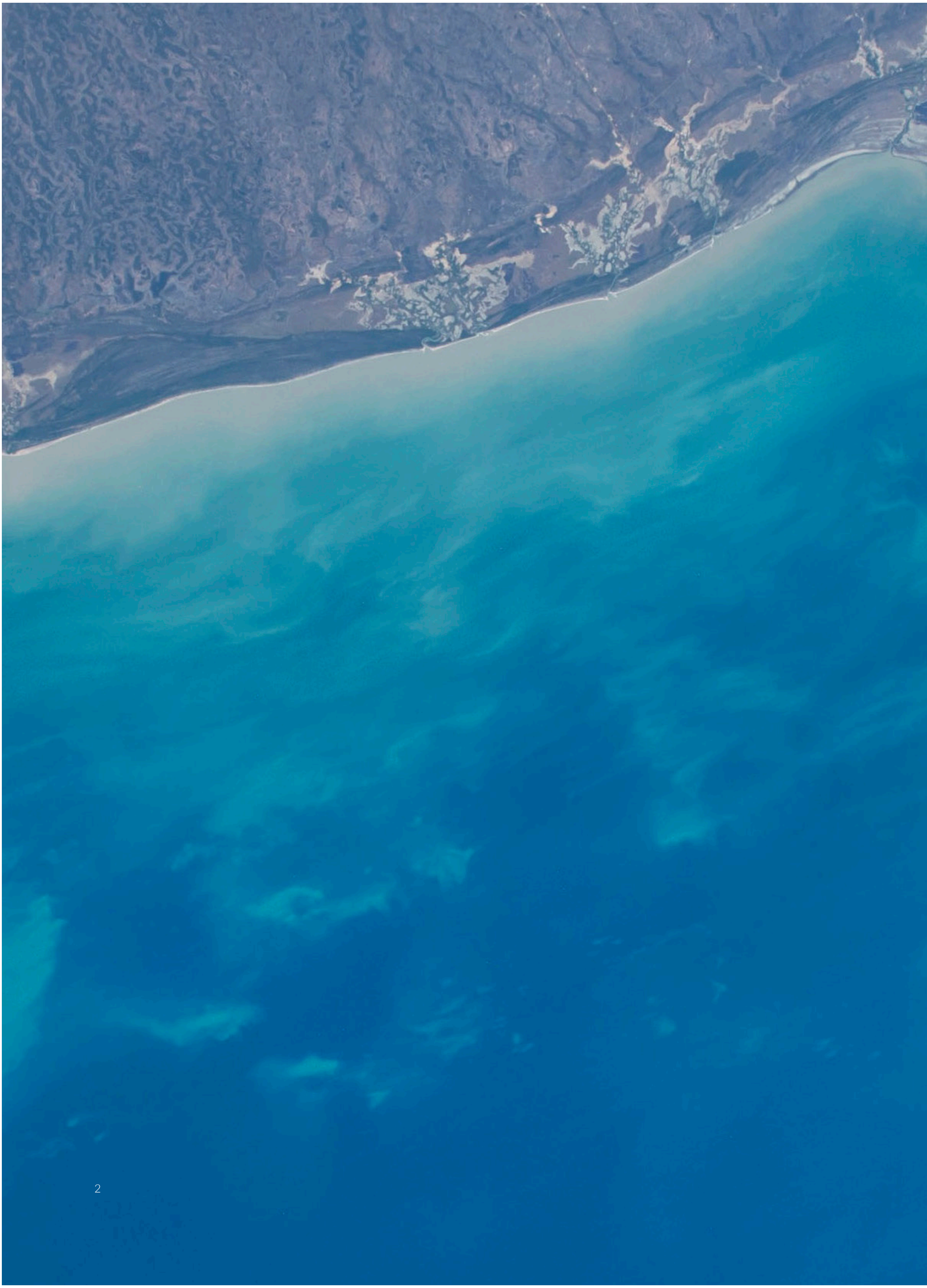
iFLUX

CONTAMINANT MIGRATION RISK

CASE STUDY:

Chemical Plant



Highlights

- CONTAMINANT MIGRATION REDUCTION
- FOCUS ON HIGH CONTAMINANT MASS FLUX
- LIMITED MITIGATION MEASURES, MAXIMUM RETURN

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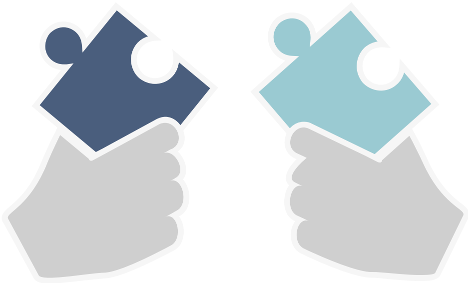
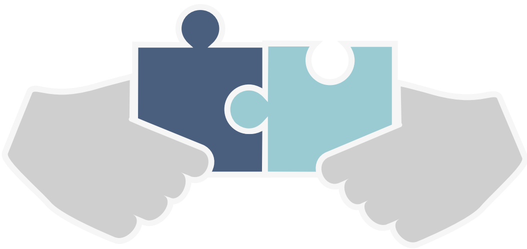
Situation

Soil & groundwater are heavily contaminated with mainly aromatic hydrocarbons at the site of this active chemical plant. Remediation is necessary to remove NAPLs and stop the off-site migration. The remediation is focussed on in-situ contaminant removal in the source areas. In the mean time active measures are required to stop further off-site migration of the contamination at the site boundary. The initial design was based on an hydraulic barrier at the site boundary in the soil layers representing the highest contaminant mass.

“ INSIGHT IN THE DISTRIBUTION PROFILES OF MASS FLUX IN SOURCE AND PLUME ZONES ALLOWS YOU TO FOCUS ON THE ZONES WITH THE HIGHEST IMPACT.”

Problem versus Solution

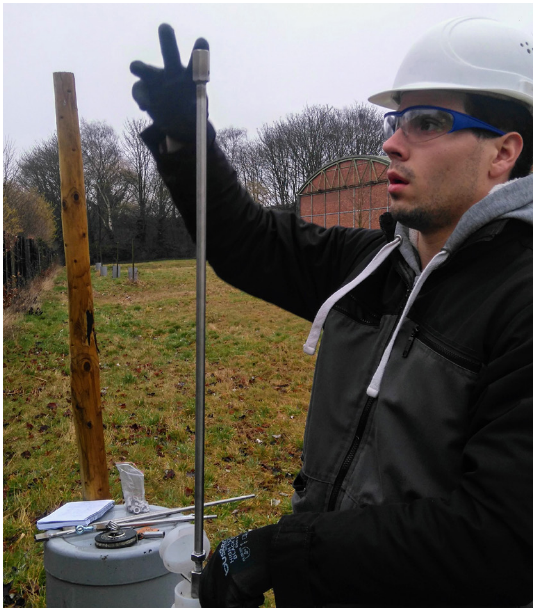




PROBLEM

How to assess and control the groundwater migration risk:

- → Preferential pathways?
- → Migrating contaminant mass?
- → Migration rate?
- → Optimized and limited mitigation possible?



SOLUTION

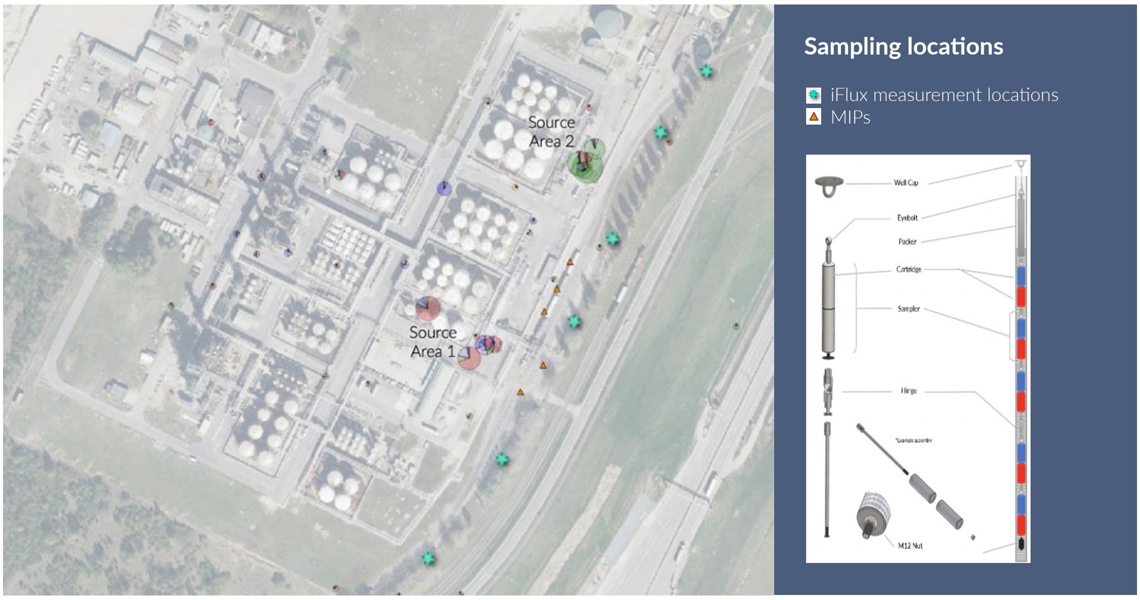
iFlux provides insight in a dynamic and complex process:

- → Preferential pathways related to heterogeneous soil permeability
- → Relevant mass present and migrating downgradient from the source area
- → Relatively fast migration and potential for later back-diffusion
- → Focused mitigation measures possible

(ex. hydraulic barrier or enhanced biodegradation in coarse sand layer in narrow zone, no measures needed on the total with or depth of the plume)

Sampling

The iFLUX sampling consisted of groundwater and contaminant flux measurements at different depths perpendicular to the groundwater flow at the downgradient site boundary. In total 9 sampling locations were selected. At each location 5 groundwater flux and 5 contaminant flux cartridges were installed at depths ranging from 3 to 14 m bgl. The contaminant flux cartridges were analysed for BTEX, MTBE and monochlorobenzene (MCB).



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:

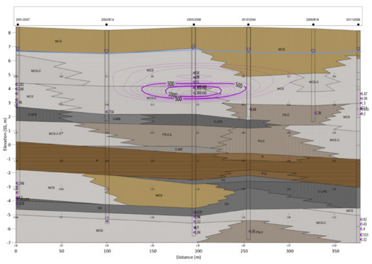
- → Installation of 5 iFlux samplers (5 X groundwater flux + VOC flux sampler) in 6 selected monitoring wells (screens at different depth intervals)
- → Measurement time: 4 weeks

Results

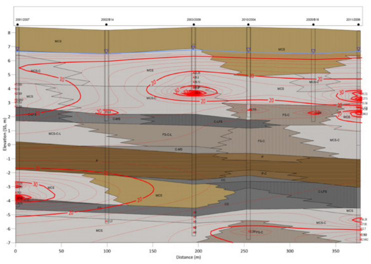
The flux results showed elevated contaminant fluxes in the high permeable, sandy layers. This was in contrast to the low permeable layers where the highest contaminant concentrations were measured. The results indicated a BTEX discharge of approx. 77 kg/year, an MTBE discharge of approx. 31 kg/year and a MCB discharge of approx. 14 kg/year. In total, a contaminant discharge of 340 g/day was estimated for off-site migration. The elevated contaminant flux in the high permeable layers is the main driver for the off-site migration. The elevated contaminant mass present in the low permeability layers may still be fed by the high flux and may in a later stage act as a secondary source (back-diffusion).

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)

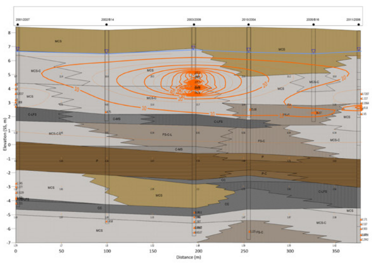
BTEX



MTBE



MCB



CONCLUSION 1:

Preferential pathways in the highly permeable layers.

CONCLUSION 2:

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

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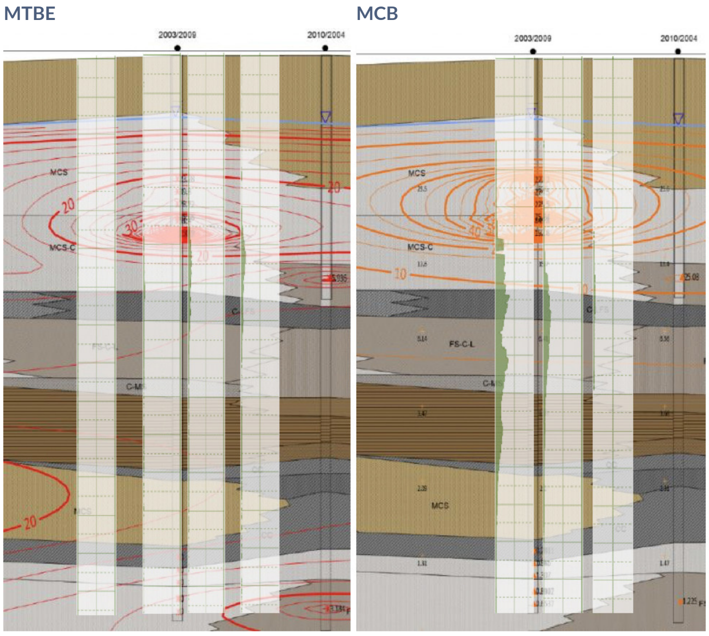
Results



CONCLUSION 3:

Large masses of contamination present in low permeable layers, potential sources for back-diffusion be identified. The soil matrix is relatively homogeneous. Water and contaminant flux are relatively constant.

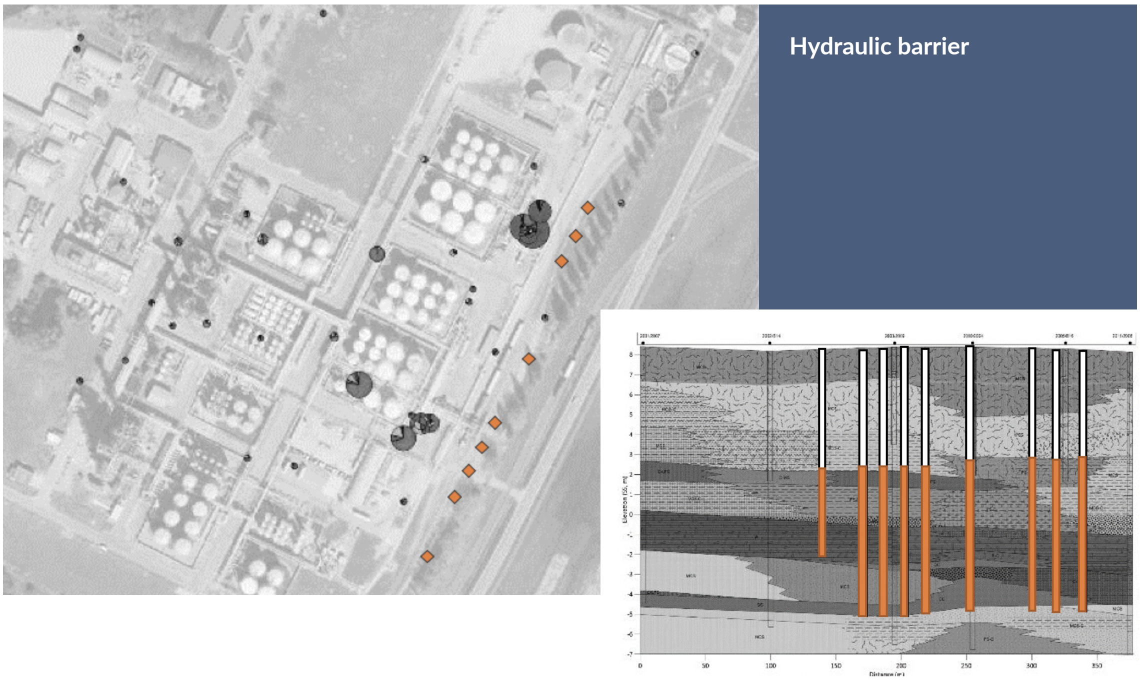
CONCLUSION 4:

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, strong sorbent soil: contaminant mass in high permeability, weak sorbent: MTBE <<<< Benzene, Toluene < (MCB) < Xylene, Ethylbenzene

Added Value iFLUX

The iFLUX measurements identified the main driver for the migration risk. This information allowed for a more focussed mitigation measure, namely extraction at well-defined locations to stop the elevated contaminant flux, by means of limited pumping to reduce dilution effects. This resulted in a focussed high-yield low-effort approach, versus a more traditional hydraulic barrier over the full length of the site boundary. The focussed approach is expected to decrease the duration from 5 to 4 years and cost by 40%.



Without flux information:

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

Numbers:

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

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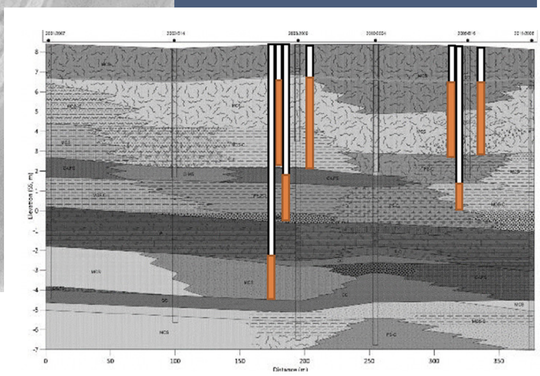
Added Value iFLUX

Hydraulic barrier



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

Numbers:

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

> “ GAIN: FINISHED ONE YEAR EARLIER, 40% LESS EXPENSIVE

Theoretical case study based on measurements
and interpretations from flux projects.

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