WELCOME: Integrated Management System for Antwerp Harbor and Polish landfill site

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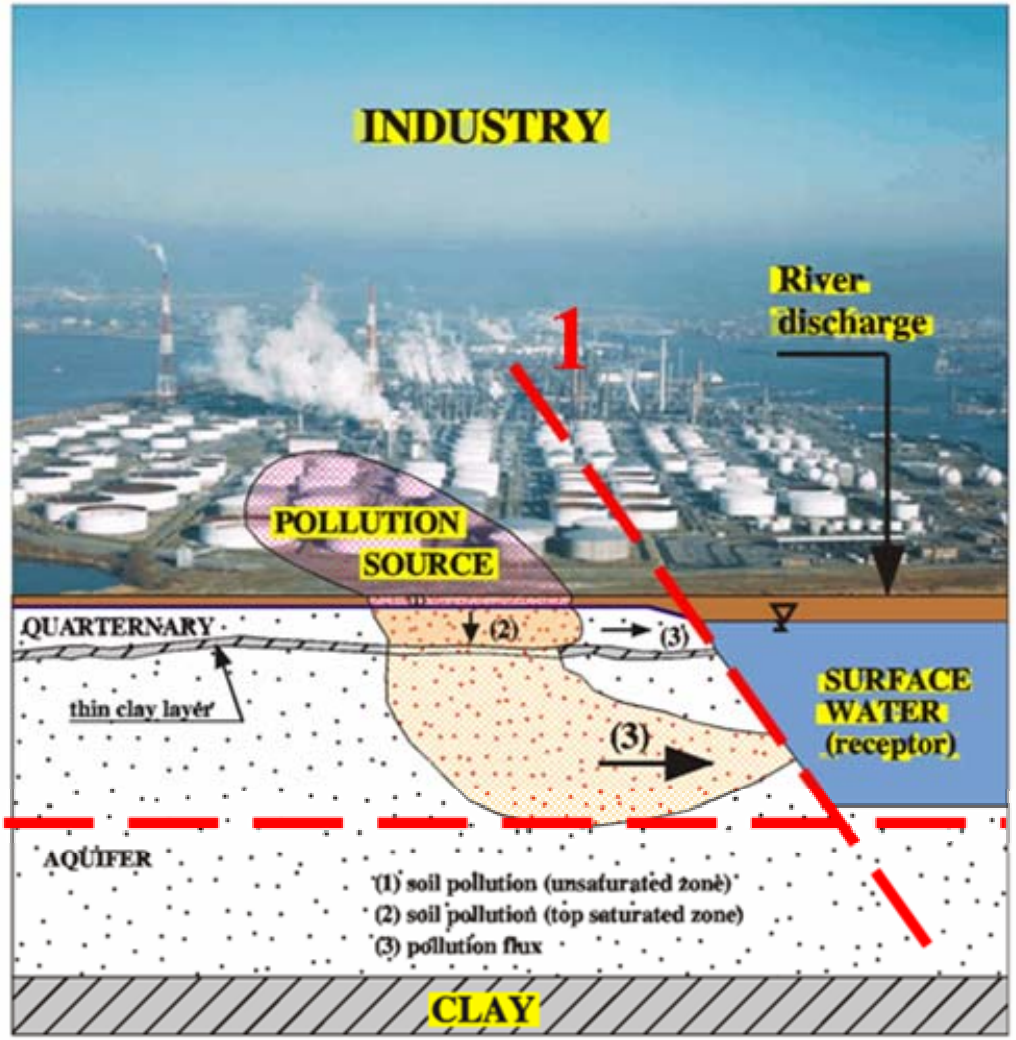
WELCOME: Integrated Management System for Antwerp Harbor and Polish landfill site

- IMS: reminder
- Antwerp Harbor Site
- Tarnowskie Gory Landfill Site
- Conclusions

IMS: Reminder

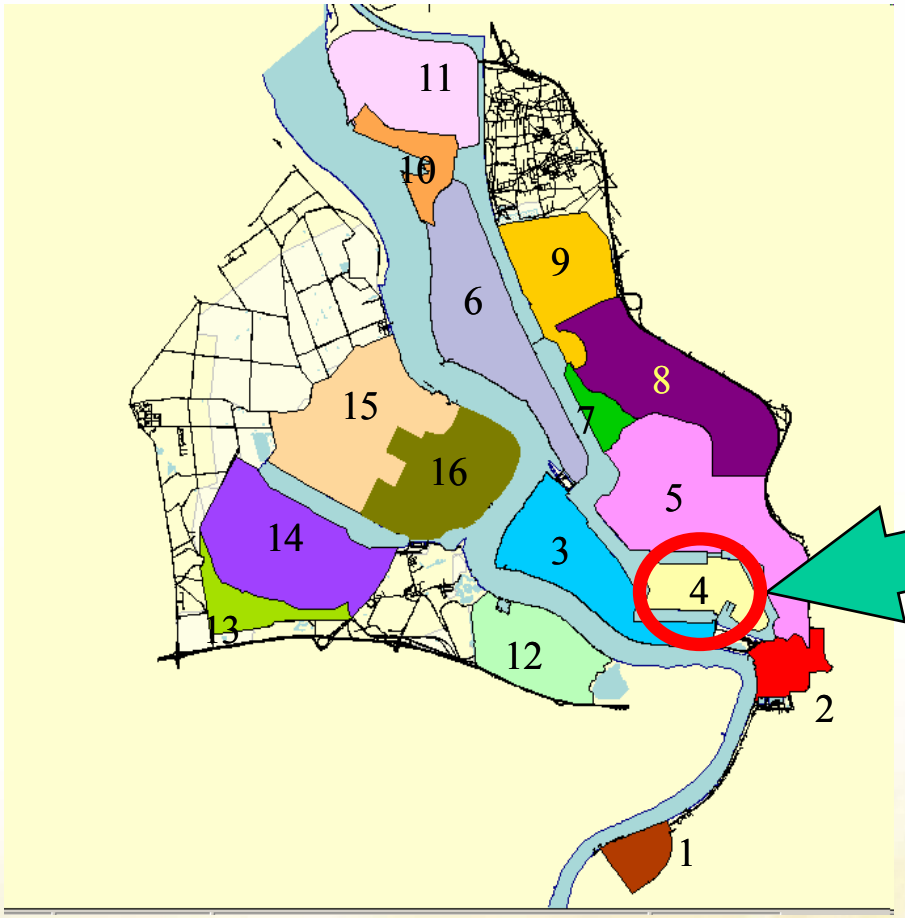
1. Megasite
    1. Definition of the site as a megasite
    2. Regulations and boundary conditions
    3. Definition of the organisatorial role and management of the megasite
2. Risks and risk reduction
    1. Megasite conceptual model
    2. Regional risk approach by clustering
    3. Risk reducing measures per risk cluster
3. Management scenarios or conceptual model
    1. Risk reduction scenarios at megasite scale
    2. Effects and uncertainties of the risk scenarios
    3. Cost effective calculation of the selected scenarios
    4. Priorities of the scenarios
4. Long term planning and management of a megasite
    1. Technical implementation and monitoring plan
    2. Long term audit of the IMS

Source-path-receptor model Antwerp harbour



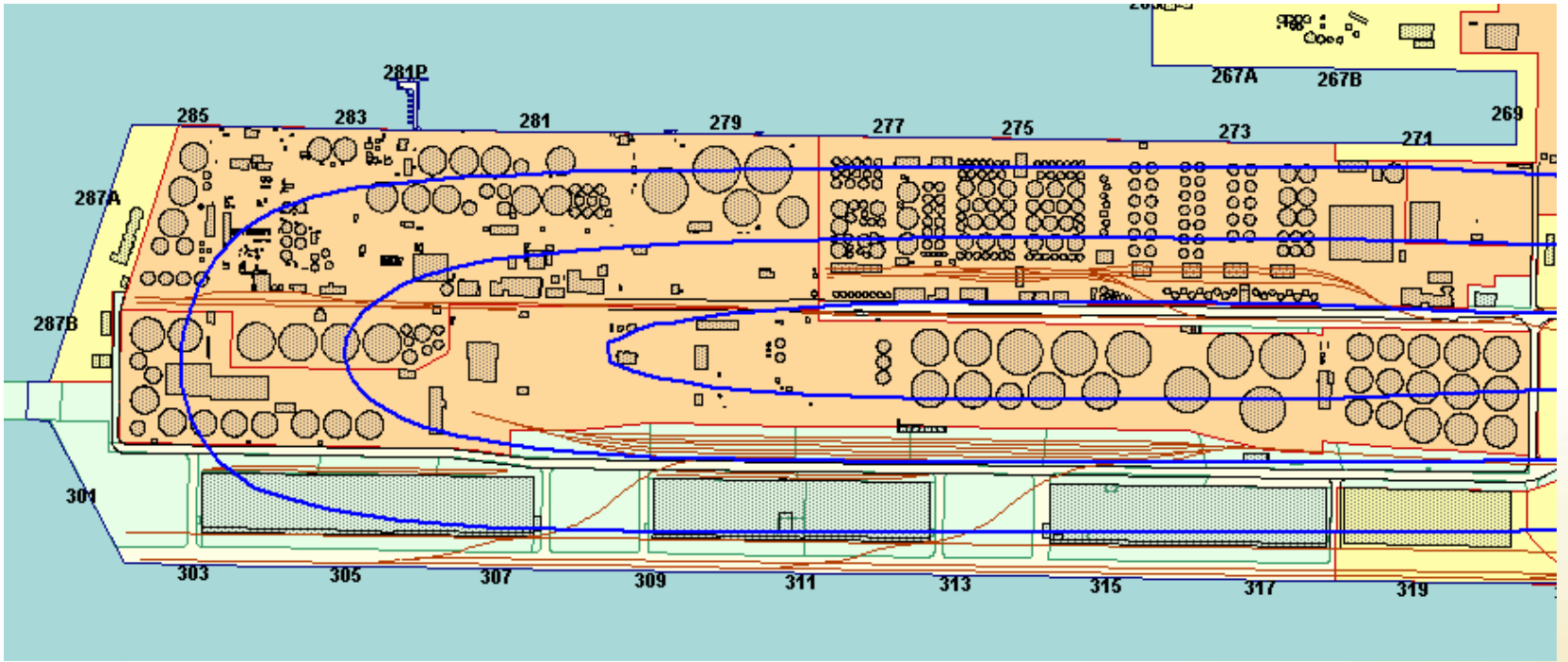
Planes of compliance

Selection of study area among 16 clusters



- Selection of example area for IMS application
- Clusters based on:
  - type of activity
  - availability of data
  - location of the area (docks)

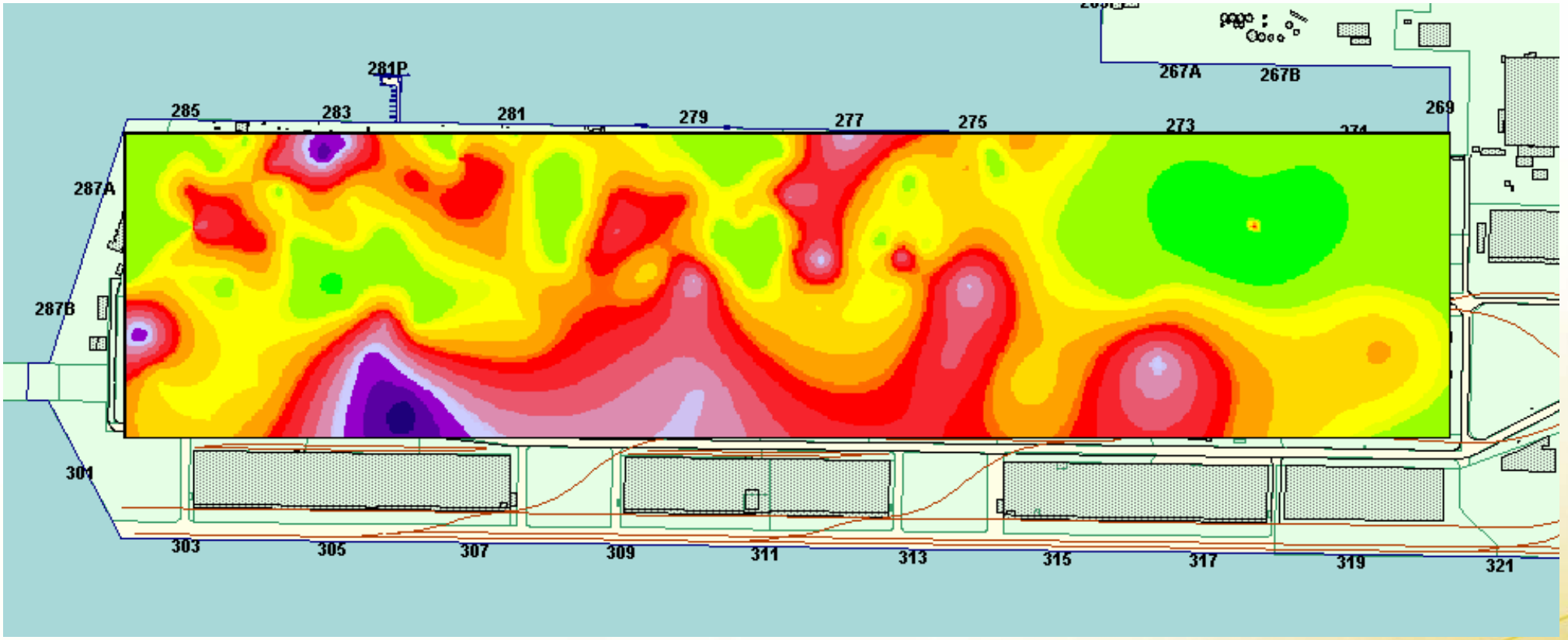
GIS data :Groundwater + type of investigation



groundwaterlevel

- preliminary investigation
- descriptive investigation
- no investigation carried out

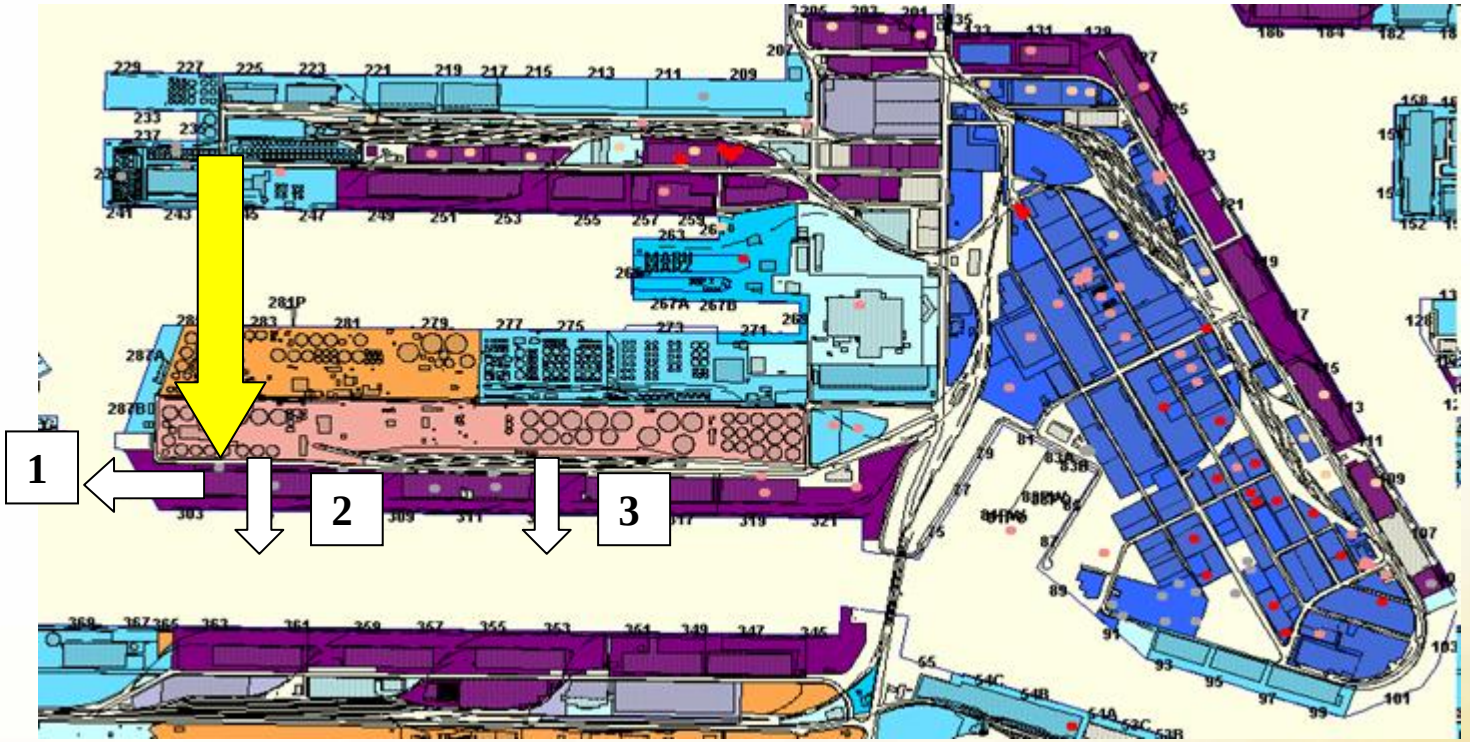
GIS interpretation of benzene in groundwater



- concentration lower than back ground level (BGL)
- concentration higher than BGL but lower than soil remediation criteria
- concentration higher than SRC
- concentration higher than 10 X SRC

Source – path – receptor evaluation

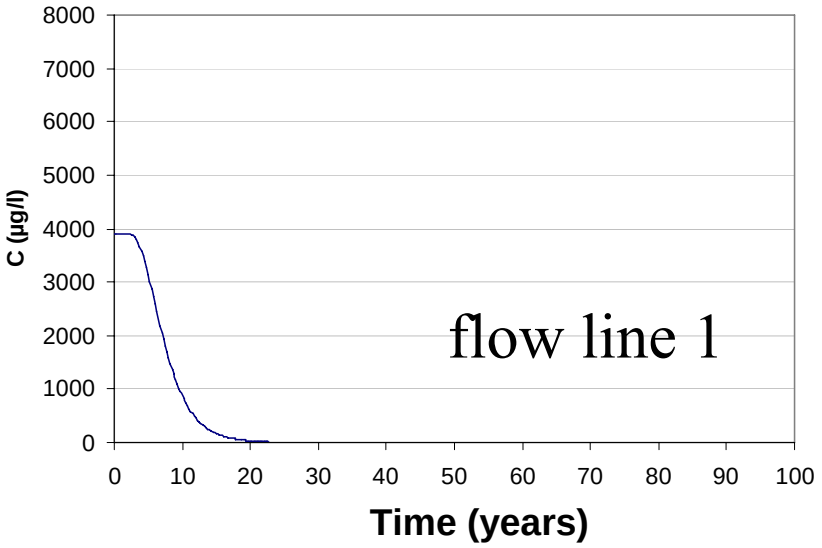
Example area

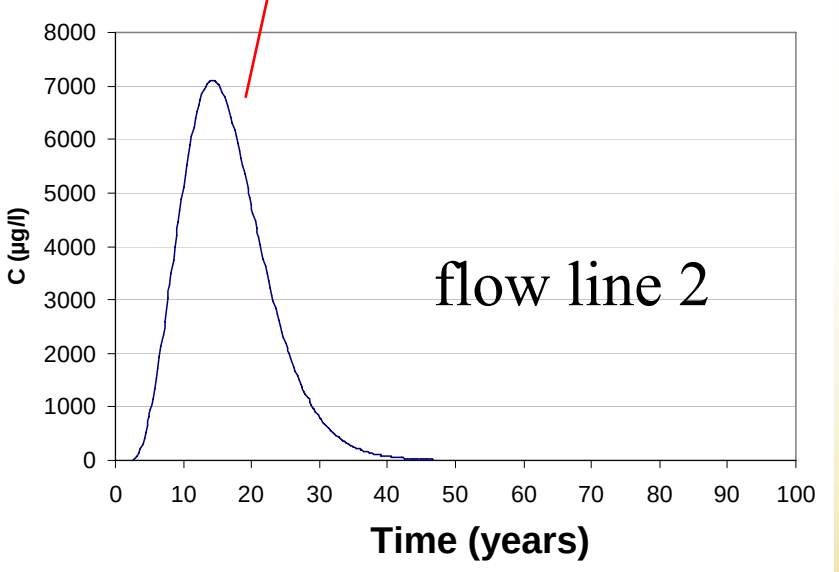


1, 2 + 3 : flow lines

Source – path – receptor evaluation: flux calculation

Σ peak flow to dock
= 60 g benzene /day





After dilution:
1.9 10^{-4} µg benzene/l surface water

Conclusions and Actions

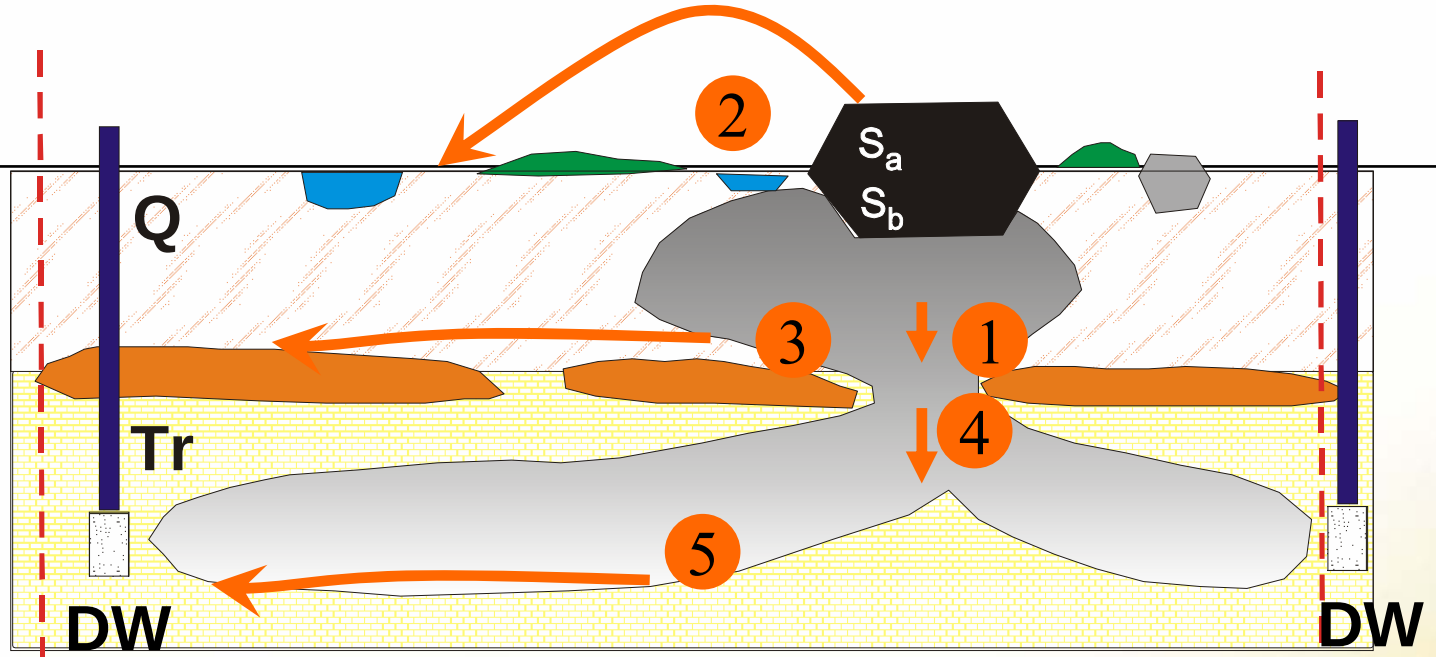
- IMS can be used on the harbor of Antwerp
- Integration of GIS data from Port of Antwerp and OVAM
- Management of pollution over time and prioritisation
- Document on the IMS for Antwerp, agreed by different stakeholders, to the ministry of Environment
- Discussions about implementation in legislation are planned
- In the mean time a second case ‘Kempen area’ heavy metal contaminated megasite (> 300 km²)

Tarnowskie Góry site

- Main pollutants: Cd, Zn, Cu, Ba, B, Sr, As: 100-250 000 ppb
  - → Diffuse pollution
    - * Soil: metal dust via the wind
    - * Surface water: groundwater + rain water infiltration
  - → Source pollution:
    - * From waste heaps and old landfills
    - * Into groundwater, Quaternary and Triassic aquifer

- Objectives of our study:
  1. General approach to manage the risks of heavy metals in contaminated areas
  2. Passive remediation measures: lab scale tests

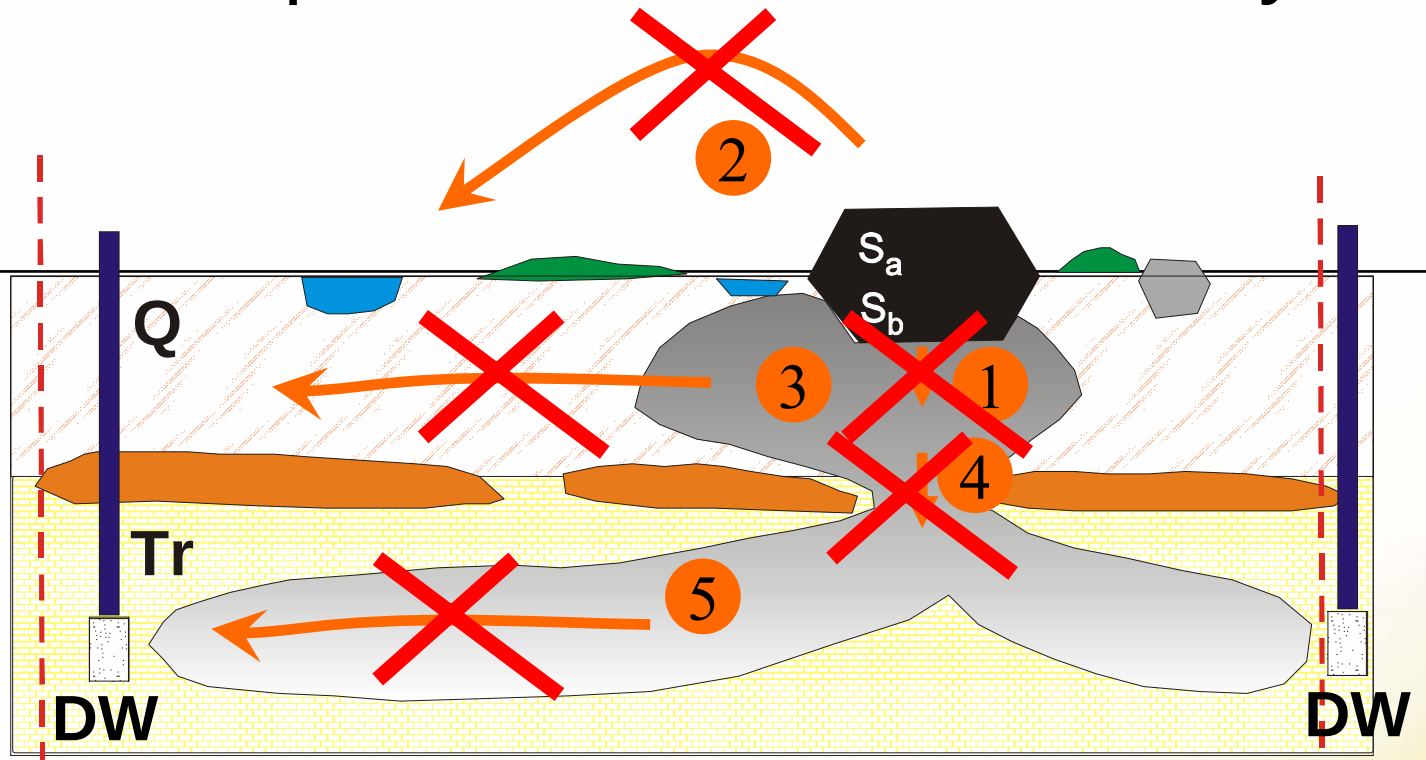
Conceptual Model for the Tarnowskie Góry Megasite (Poland)



Q – Quaternary aquifer
Tr – Triassic aquifer
DW – drinkwater well

Sa,b – source of contamination

Remediation options for Tarnowskie Góry Megasite



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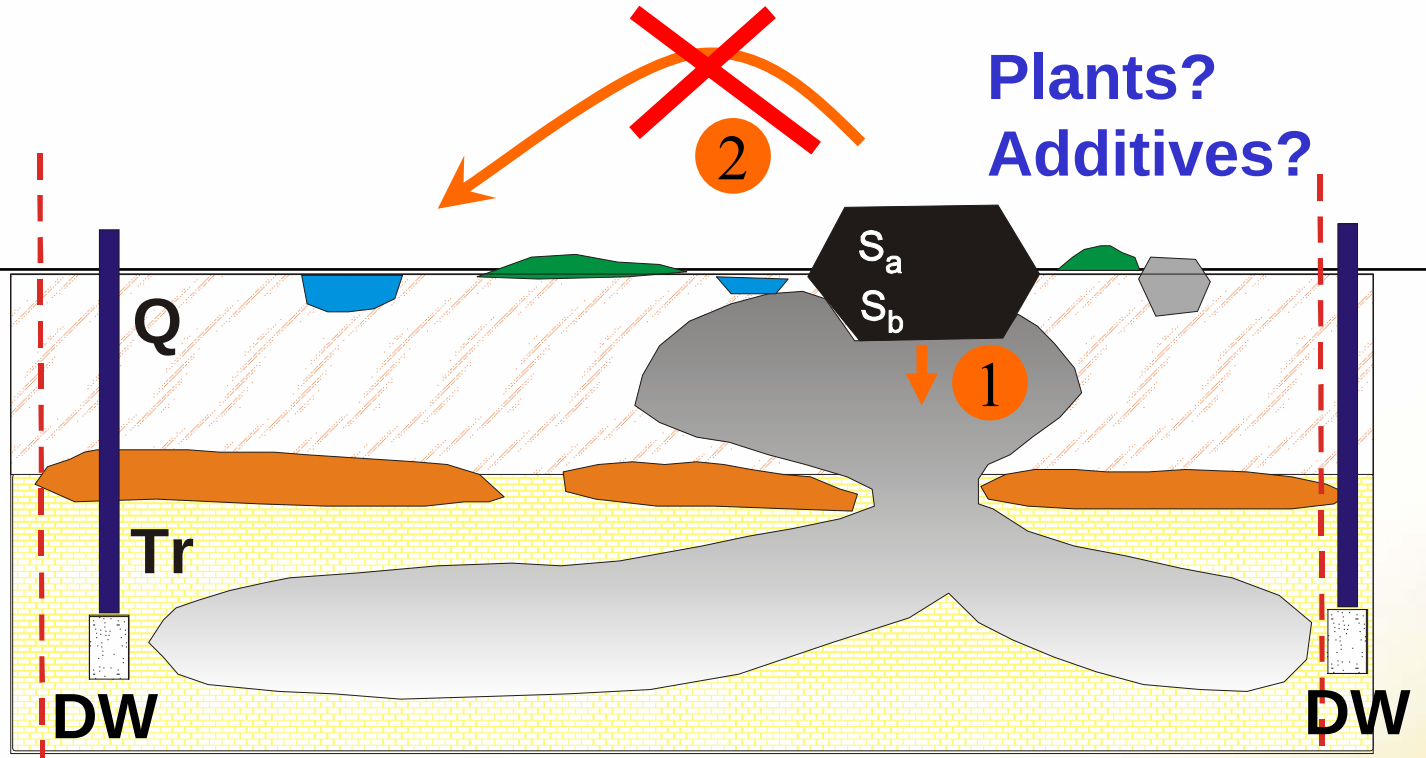
Remediation measures at the unsaturated zone



Q – Quaternary aquifer
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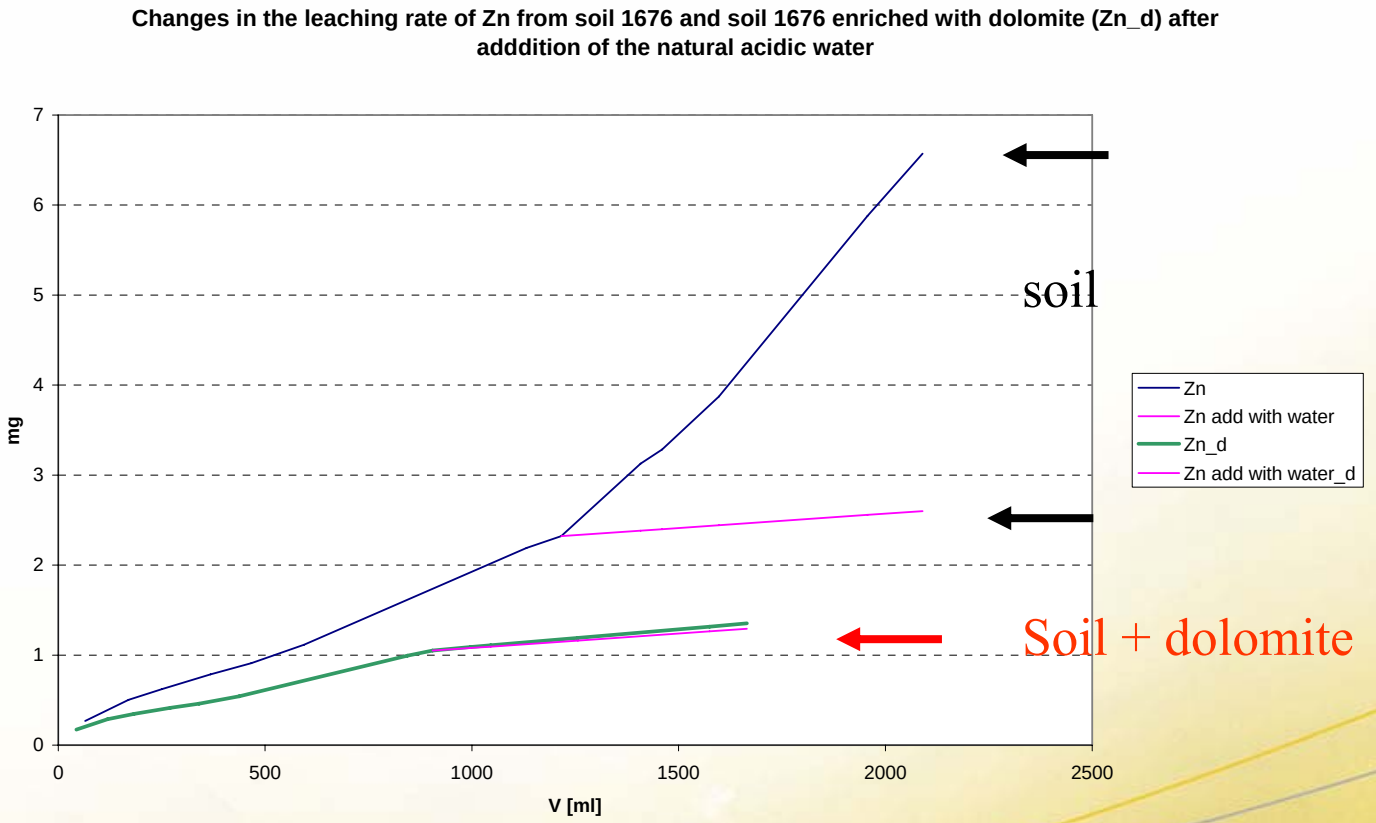
Remediation measures at the unsaturated zone

1. Soil + dolomite:
- Reduced leaching Zn
- No reduced leaching Sr and Ba

2. Soil + diatomeaus earth:
- Release metals

3. Soil + zeolites, Metasorb:
- Reduced leaching of Zn
- Limited leaching of Sr and Ba



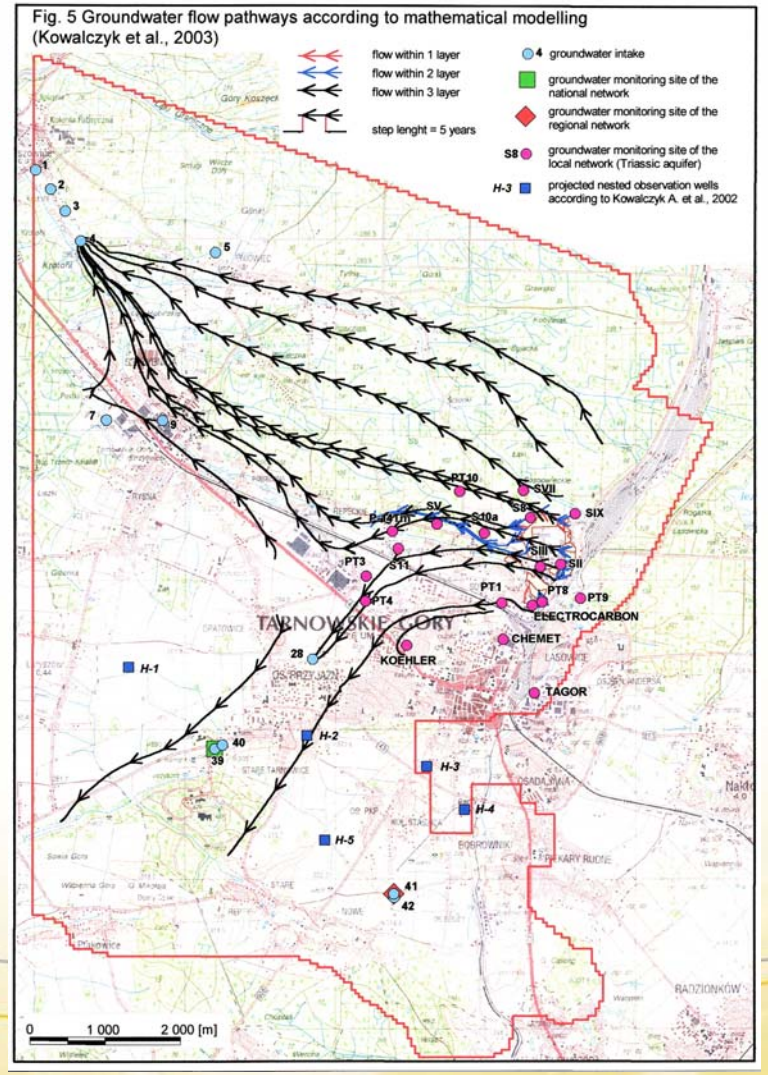
Remediation measures at the unsaturated zone Measured with BIOMET®-sensor

Soil + waste products:

- Dolomites
- Diatomeaous earth
- Zeolites

Soil	% bioavailable Zn
Diatomeaous earth	~ 100
Dolomite	~ 90
Zeolites	**~ 67**

Evaluation of *In situ* treatment options for the Tarnowskie Gory megasite



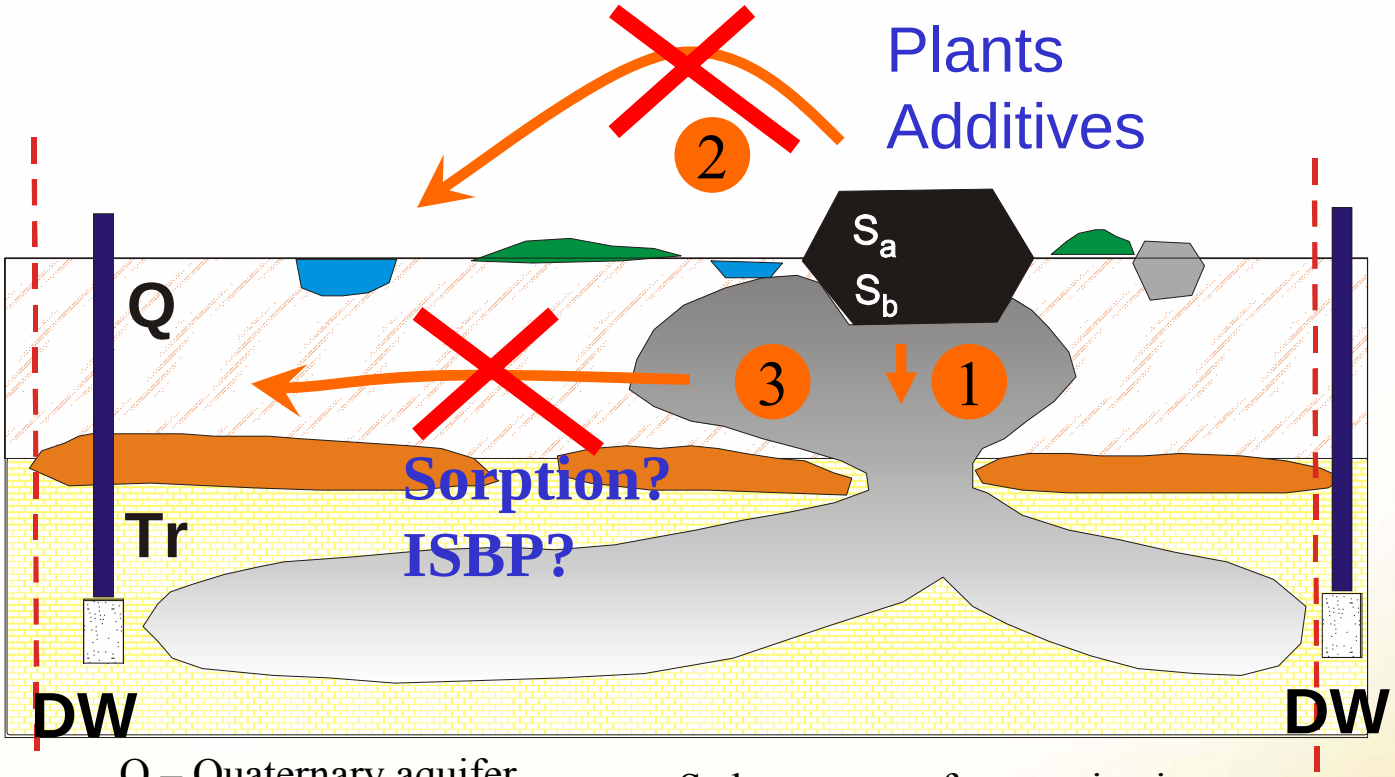
Installation of Reactive zones or

Permeable Reactive Barriers based on:

- Adsorption

- *In situ* bioprecipitation process

Remediation measures at the saturated zone



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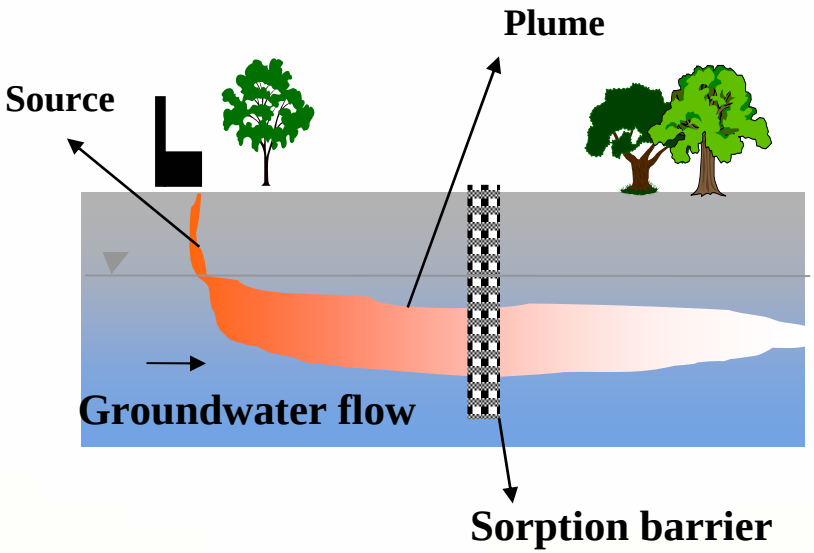
Remediation measures at the saturated zone Quaternary aquifer



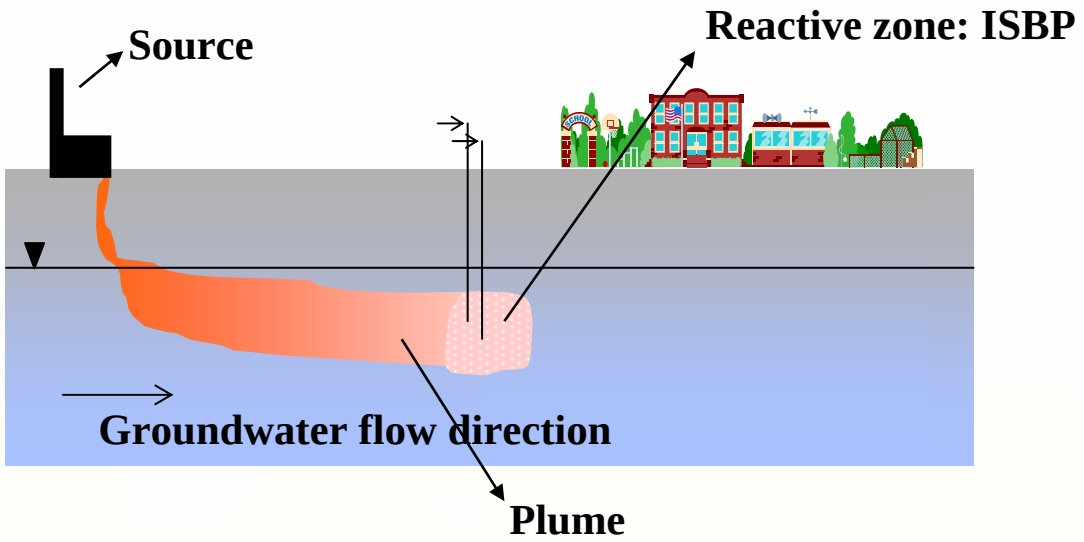
Element /Metal	ZVI	Compost	Zeolite	Metasorb
Sr	-	-	+	+
B	-	-	-	+(1)
Ba	-	+	+	+
Zn	+	ND	+	+
Cd	+	+	+	+
Cu	+	+	+	+

+: good removal; -: no removal

(1): special anionic Metasorb

ZVI: Zero Valent Iron

Remediation measures at the saturated zone



$C_3H_6O_3 + SO_4^{2-} \leftrightarrow$ CH3COO- + S^{2-}

$S^{2-} + Me^{2+} \leftrightarrow$ MeS (immobilisation)

(1) Using different aquifer types:
- sand (Pr6 and Pr4)
- clay (Pr2 and Pr5)

(2) Using different C-sources:
- molasses
- HRC® (Regenesis)
- MRC® (Regenesis)
- acetate

Remediation measures at the saturated zone Quaternary aquifer

Metal	Sand NA	Clay NA	Formal-dehyde	Sand + HRC®, acetate	Clay + HRC®, acetate	Sand + molasses	Clay + molasses
SO_4	±	±	-	+++	++	+++	++
Sr	-	-	-	-	-	Release	-
B	-	-	-	-	-	Release	-
Ba	-	-	-	-	-	release	-
Zn	±	±	-	+++	++	++	++
Cu	±	±	-	+++	++	++	++

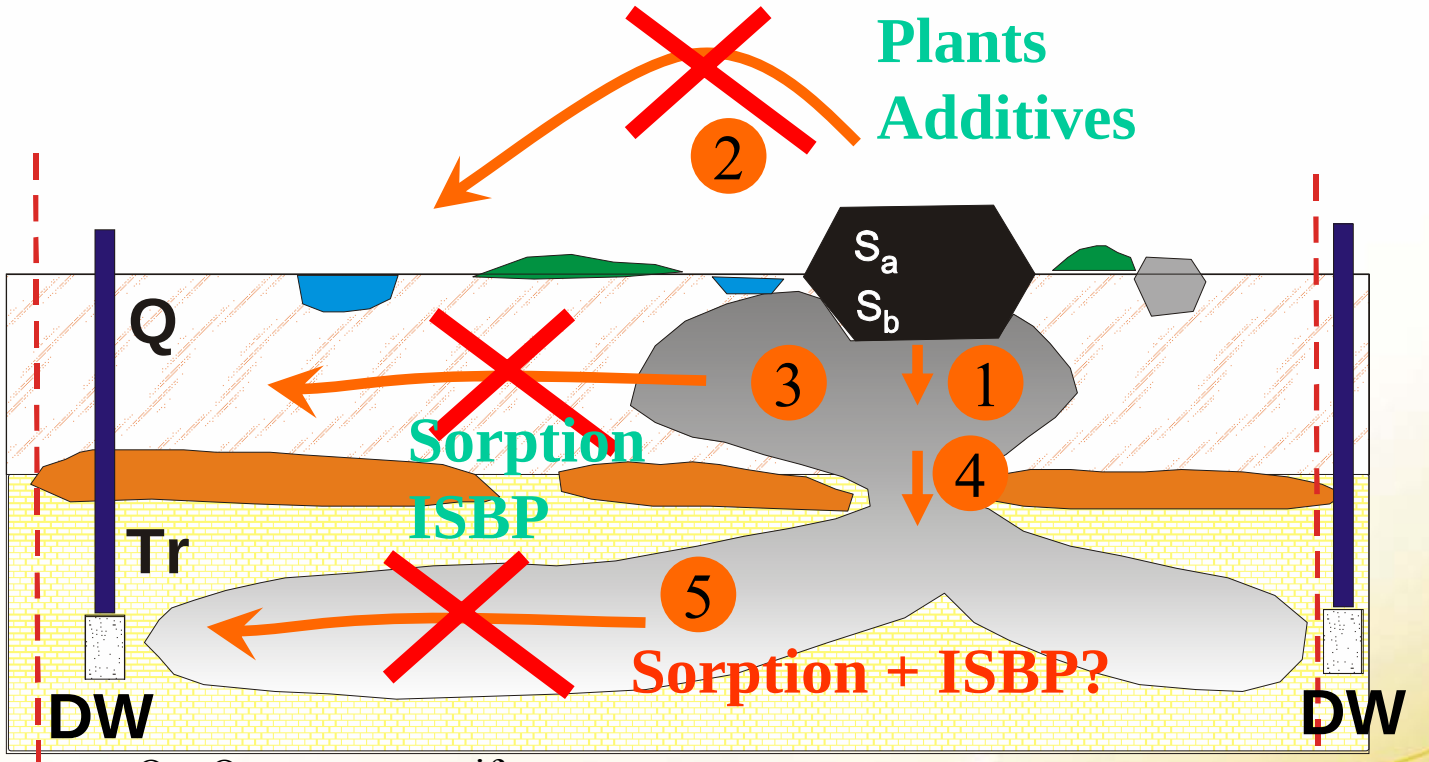
+++: very fast; ++: fast; ± removal; - no removal; S: sand; C: clay

Remediation measures at the saturated zone Quaternary aquifer

1. Molecular technique:
   Detection SRB by PCR *dsrB* gene

2. Sequential extraction:
   - Immobilisation Zn and Cu
   - Not for Ba, B, and Sr

Remediation measures at the saturated zone
Triassic aquifer



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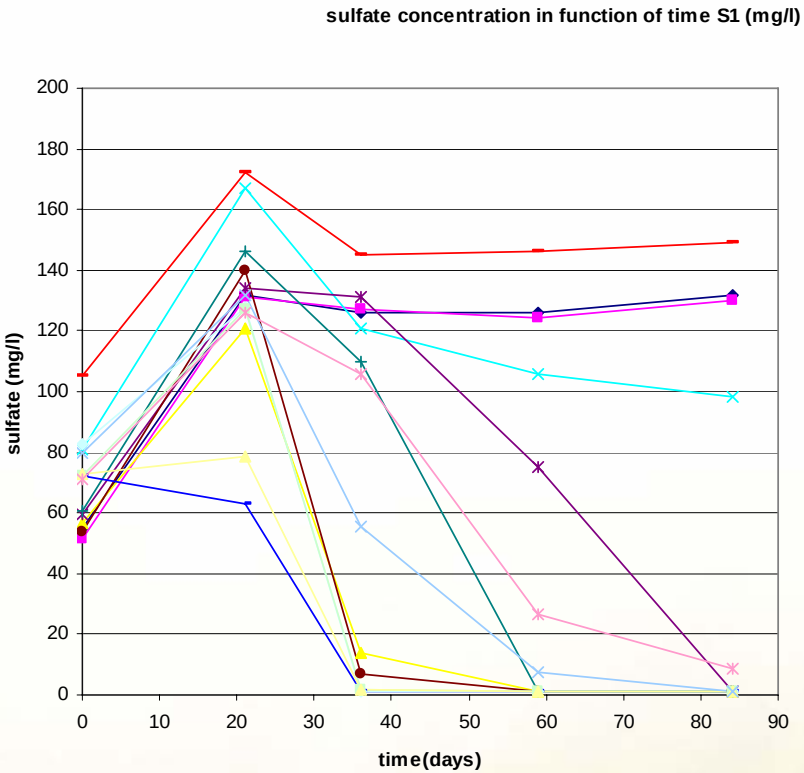
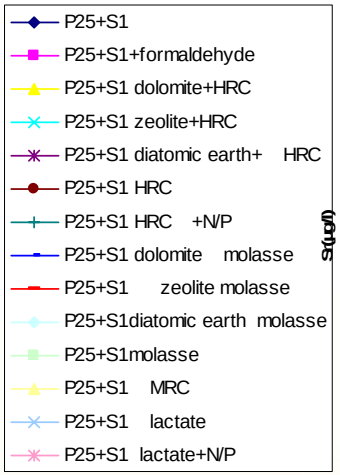
Remediation measures at the saturated zone Triassic aquifer

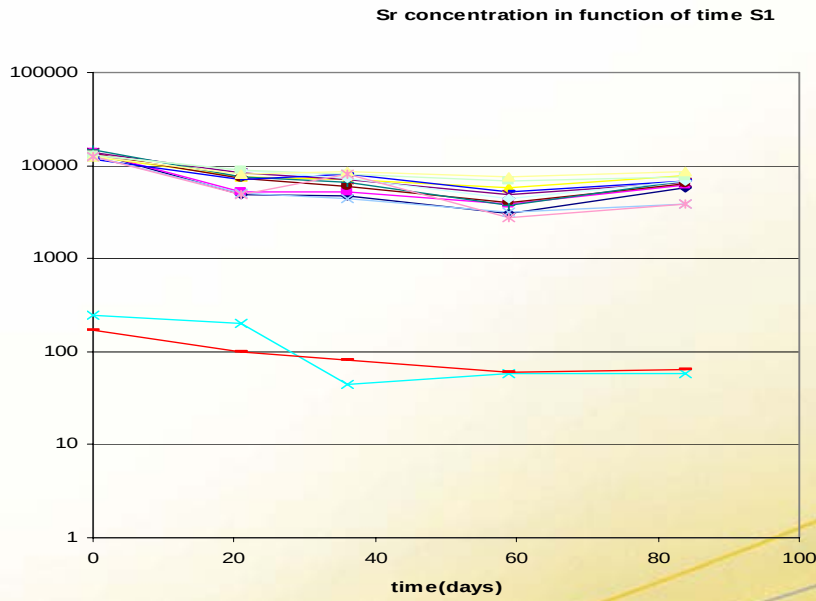
Immobilisation metals by:

1. Stimulation ISBP by different C-sources:
   - Molasses
   - HRC® (Regenesis)
   - MRC® (Regenesis)
   - Lactate
2. Precipitation metals by different adsorbents:
   - Zeolite
   - Dolomite
   - Diatomeaous earth

Remediation measures at the saturated zone Triassic aquifer







Zeolite + molasses

Zeolite + HRC®

Remediation measures at the saturated zone Triassic aquifer

Metal				
	No addition	HRC®, MRC®, lactate, molasse	C-source + dolomite, diat. earth	C-source + zeolite
SO_4	-	+	+	(+)
Zn	-	+	+	(+)
Sr	-	-	-	+
B	-	-	-	+ (>35 %)
Ba	-	-	-	+

+ removal; - no removal C-source: molasse or HRC®

Conclusions on remediation measures at the Tarnowskie Góry Megasite

Unsaturated zone

- Evaluation of plants
  - → Toxicity towards plants
  - → Selection of low-uptake plants to prevent spreading heavy metals: grass
- Immobilization with additives
  - → Control by
    - BIOMET® -test
    - Plant uptake tests
    - Leaching tests
  - → Zn immobilisation by dolomite and zeolite; release by diatomeaus earth
  - → Sr and Ba immobilisation by zeolites and Metasorb
  - → B immobilisation by combination of ApX-As and Metasorb-anionic)

Conclusions on remediation measures at the Tarnowskie Góry Megasite

(II) Saturated zone

- Quaternary aquifer
  - * Adsorption on adsorbents in a Permeable Reactive Barrier
    - All metals removed by zeolite except B
    - B removal ↔ Metasorb (arsenate) + Apeyron adsorbent
  - * *In situ* bioprecipitation
    - Difficult for B, Sr and Ba
    - More mobile metals as Zn and Cu very well removed but stimulation by C-sources (NOT molasse!) necessary
    - Molecular technique: unravelling microbial populations
- Triassic zone
  - * *In situ* bioprecipitation in combination with additives
    - ISBP for Zn but C-sources needed
    - Zeolite + HRC® or molasse for B, Ba and Sr but some inhibition ISBP!
    - Confirmation necessary of adsorbents + C-sources

Integrated Management System: applicable on

- Harbor sites
- Large industrial sites
- Metallurgical sites
- Mining areas
- Surface treatment
- …

Possibilities for passive treatment systems

➔ ISBP: www.vito.be

➔ IMS: www.euwelcome.nl