Innovative ISCO injection Technology

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Swedish Geotechnical Institute / Ejlskov

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SEVENTH FRAMEWORK PROGRAMME

www.UPSOIL.eu

Sustainable Soil Upgrading by Developing Cost- effective, Bio-geochemical Remediation Approaches

Objective

UPSOIL - WP 4:

“System Driven Injection”

↓

Objective:

“to take forward, test …….a new innovative design based on system driven injection….”

↓

Overall achievements:

Improved Cost-effectiveness' and sustainability

- When in-situ injection approach to remediate soil & GW is apllied.

How ?

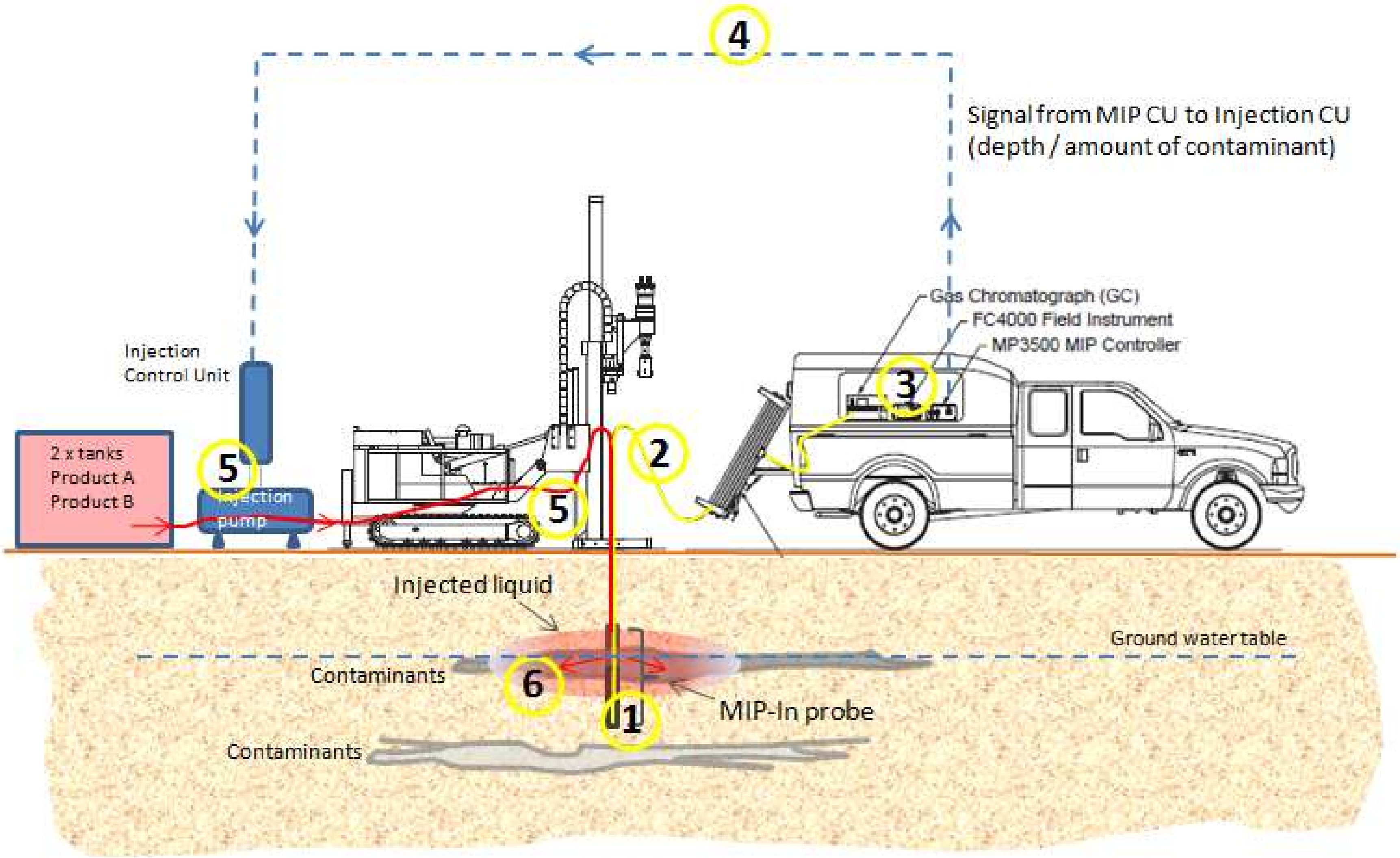
- Cost effective
  - Reduced consumption of product
  - Reduced project life span and time consumption
  - Minimize required mobilizations (injections)
  - Optimized effect of product injected
  - An operational and solid system
- Environmental sustainable
  - Minimized consumption of energy / product
  - Minimize risks of negative environmental impact
  - Minimize disturbance of uncontaminated soil/GW

- Targeted injection
  - Only where contamination
  - Injection vol. ⇔ contamination level
- Flexible system
  - Different products - "mixtures"
  - Flow rate / pressure
  - Concentration variability
- Real time data / logging (contamination / injection)
  - Decision making in the field
  - Documentation.

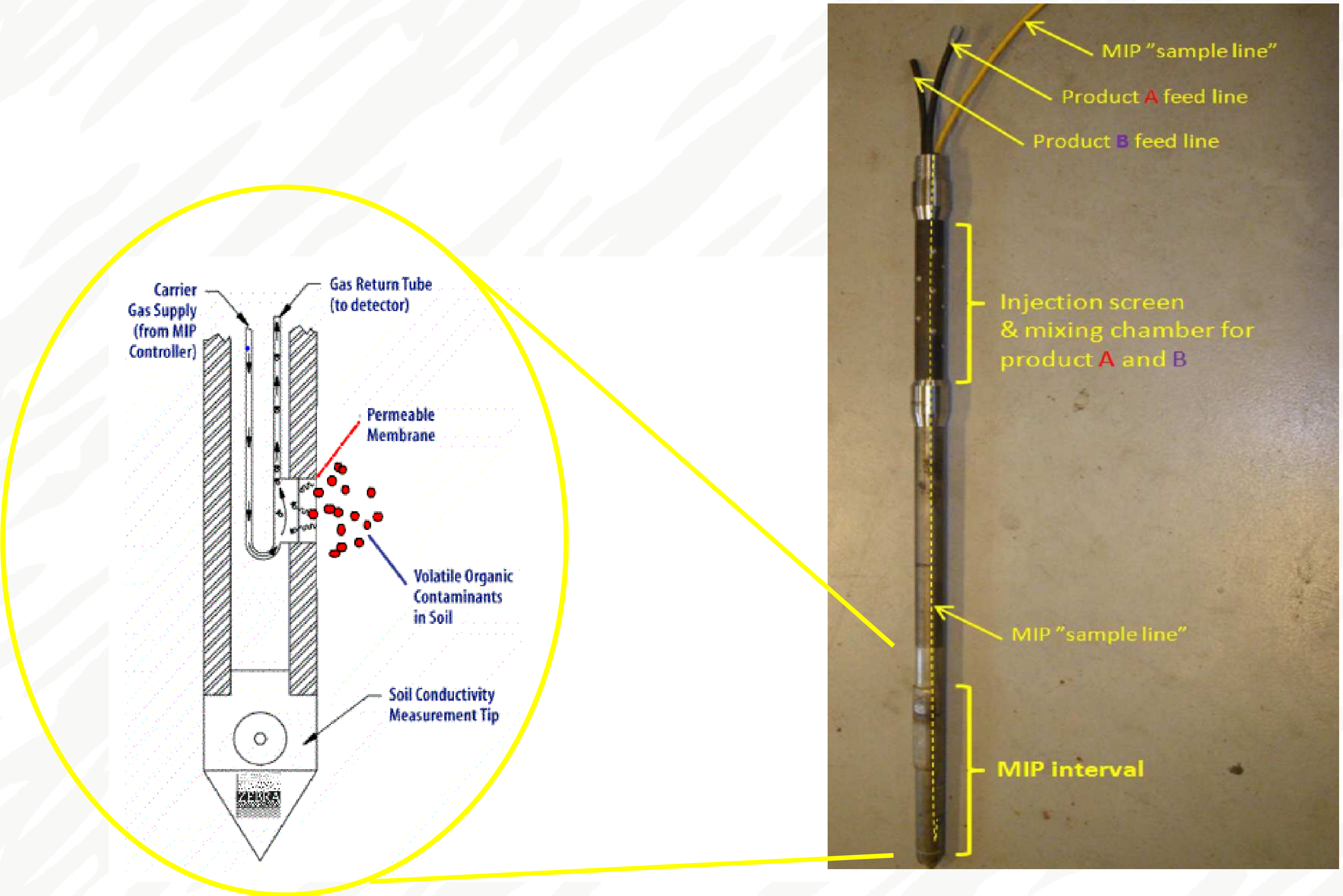
Traditionally two phases / operations

Data collection ➡ Lab./reports/design/meetings etc. ➡ **Injection**

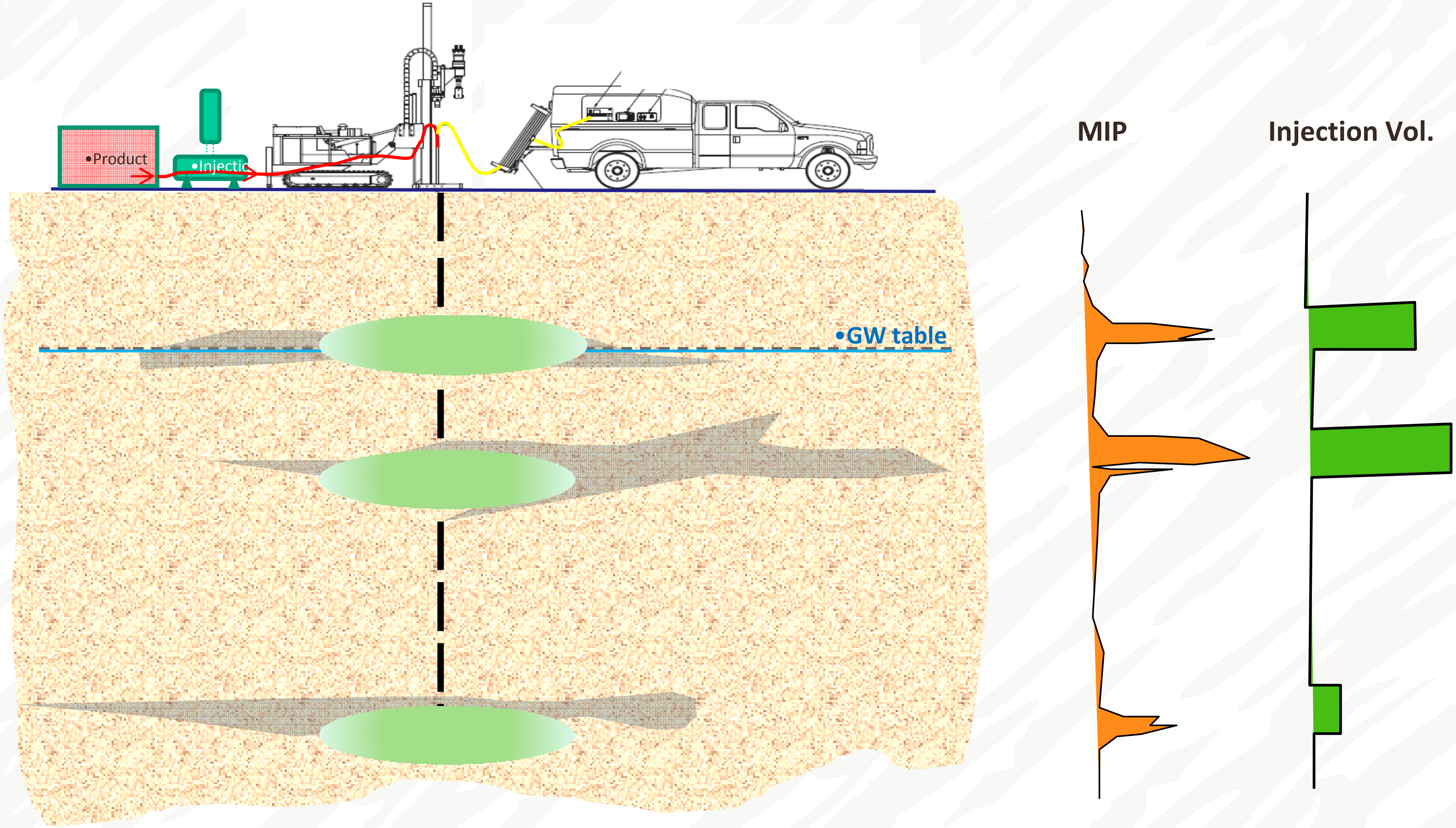
Principle of the new MIP-IN system
(merging detection and injection)



The MIP-IN probe



Principle of operation



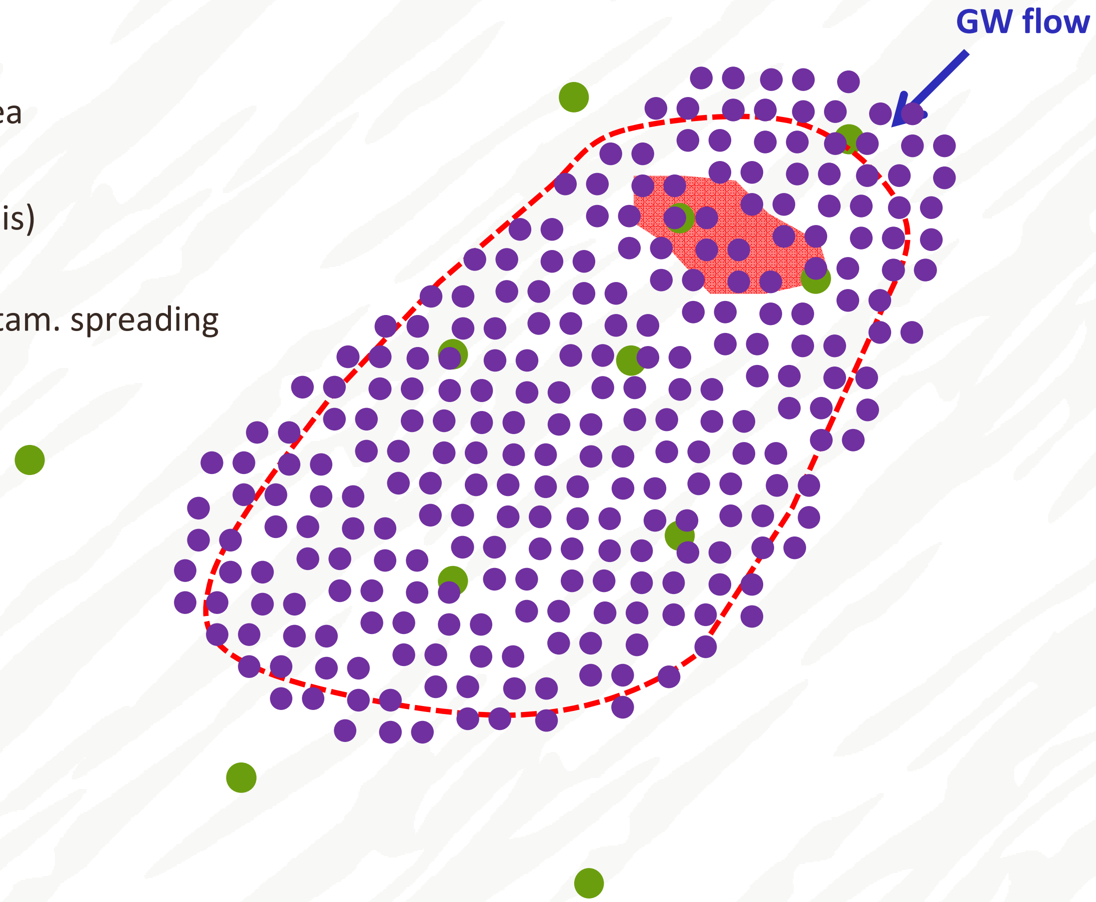
Traditional Approach

Actual contamination source area

Investigation well (soil / GW analysis)

Interpretation of horizontal contam. spreading

Injection well configuration



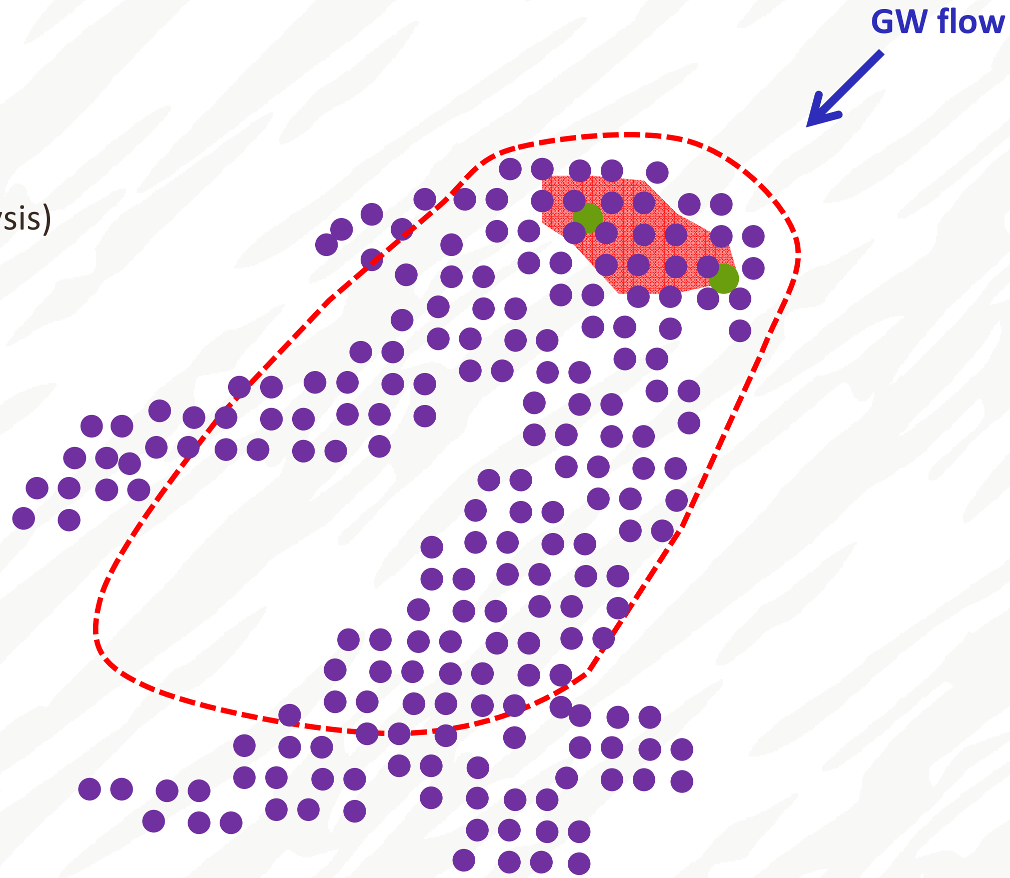
New Approach

Actual contamination source area

Initial Investigation well (soil / GW analysis)

MIP-IN well configuration

Interpreted spreading
(Traditional approach)

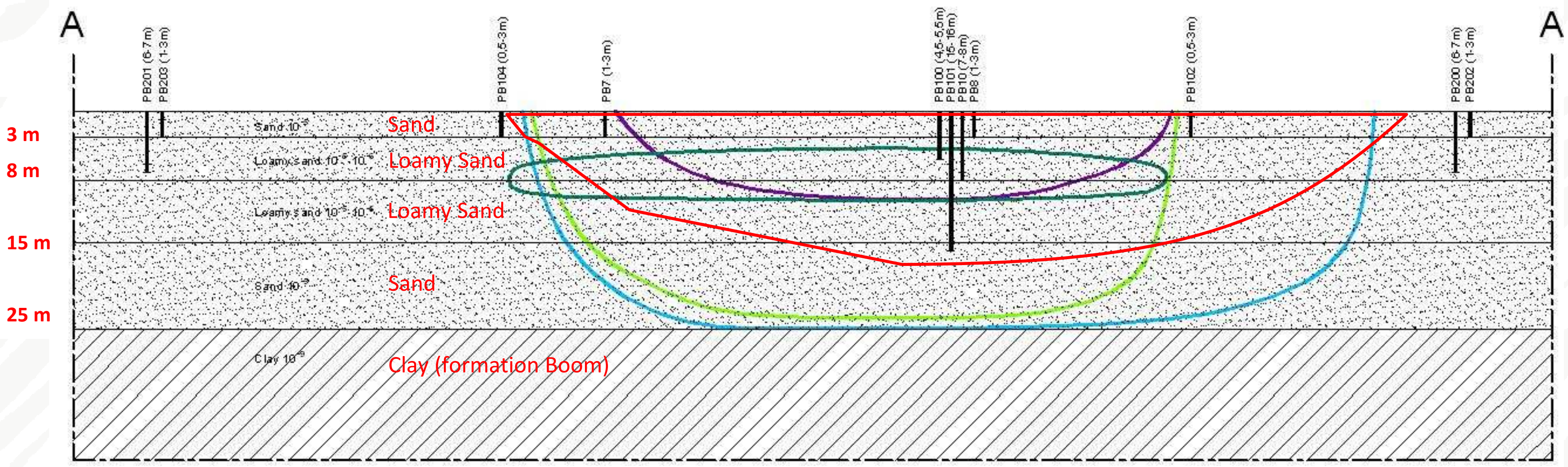


Site contaminants:

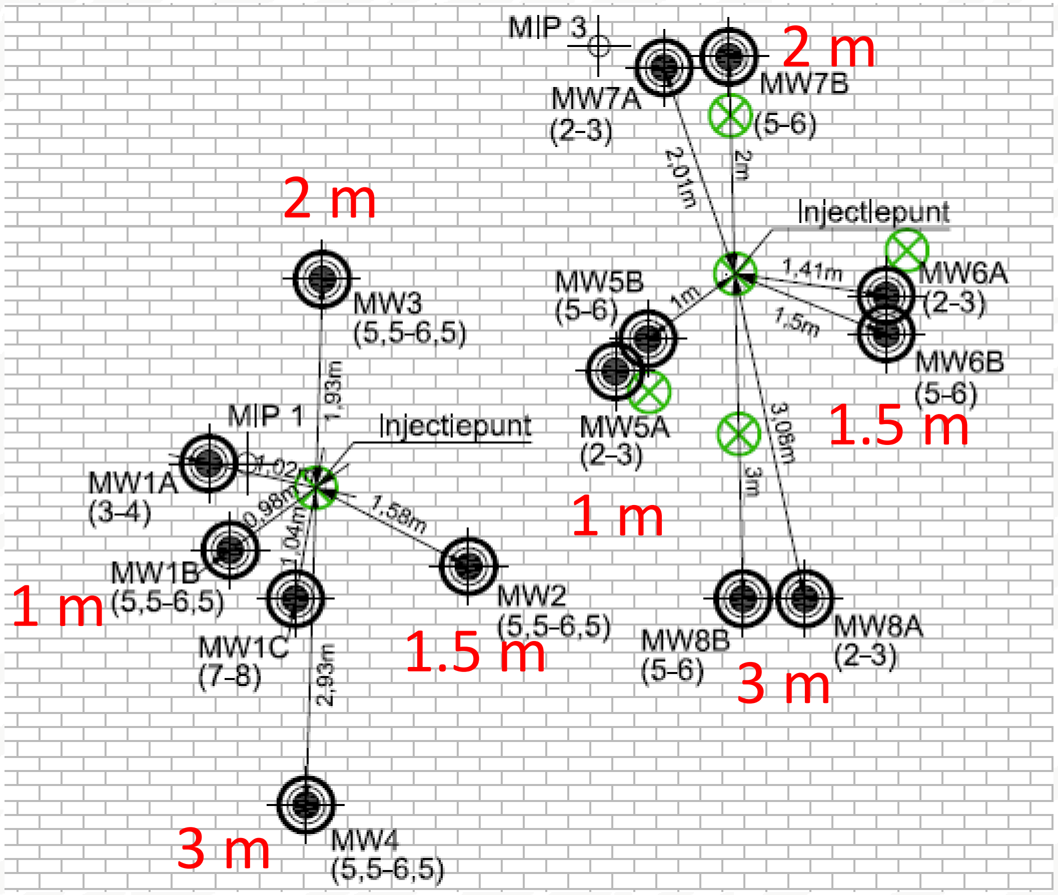
Chlorinated hydrocarbons

(DCM, DCA, 1,2-DCE, VC)

BTEX's :



Field test: set-up



Injection point -> MW 1 – 3 m

MW filters (1 m) in the depth interval 2 – 8 m b.g.l.

Monitoring equipment:

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Matrix & Degradation demand: tests

		Concentration (µg/L)				
		DCM	cis-DCE	PCE	Toluene	Ethylben.
Sterile control		120474	2113	149	1404	13543
Oxidant	Activation	Degradation (%)				
$KMnO_4$	-	0	100	100	100	100
$Na_2S_2O_8$	-	14	78	36	81	59
$Na_2S_2O_8$	Fe(II)citrate	21	68	43	83	60
$Na_2S_2O_8$	NaOH	66	51	0	80	41
$Na_2S_2O_8$	heat (50 °C)	67	100	100	100	100

Conclusion:

Permanganate is the best oxidant – except DCM

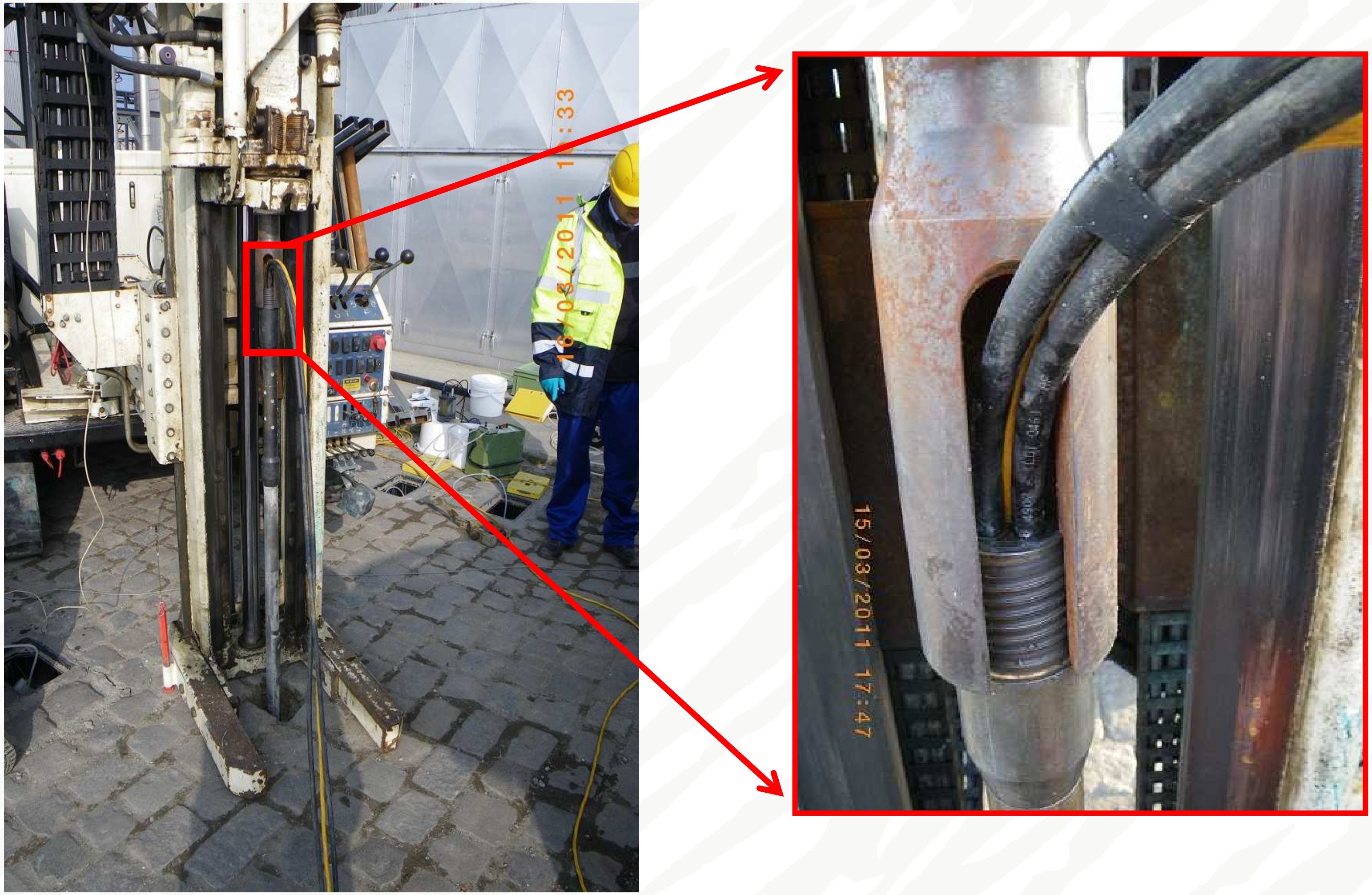
NB ! Degradation test is important to choose the best oxidant and properly determination of oxidation demand.

Field test: injection

- MIP-IN at 3 points between 2 to 7 m bgl
- Injection of 332 kg $NaMnO_4$ in app. 4 m^3 injection solution
- Arrival of oxidant in closest wells:
  - purple colour
  - redoxpotential ↑↑
  - electrical conductivity ↑
- Immediate injection radius of influence: 1 to 2.2 m
- Heterogeneous geology → heterogeneous distribution of oxidant

upsoil

Test of the system



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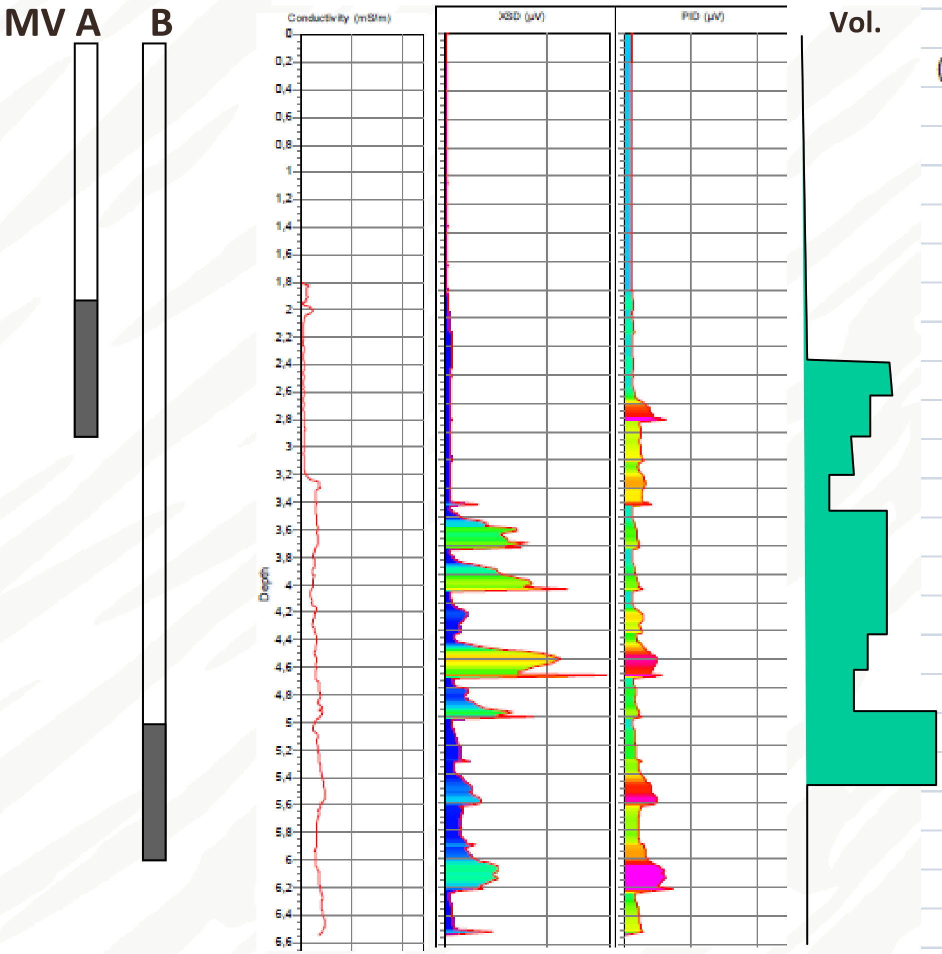
Test of the system

Test of the system

Verified immediate ROI was 1 – 2,25 m

MIP-In # 1

Project: Upsoil WP4	Date: 2011-03-16	Operator: SNA
Location: Flanders	Project Id: 08078	QC: OPS
Client: EU	MIP Id: Upsoil-1	



Vol (Lires)	Flow (L/min)	P (Bar)
0	-	-
0	-	-
0	-	-
0	-	-
0	-	-
0	-	-
0	-	-
200	12	10
150	12	11
96	12	11
50	12	12
200	18	11
200	18	10
200	18	10
150	18	11
100	18	10
300	18	12
300	18	12
-	-	-
-	-	-
-	-	-
-	-	-

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Estimated Potential Savings

New approach	Traditional approach	Est. Potential Savings
Initial investigation	Initial investigation	0%
Supl. inv.+tests	Detailed.inv + test	40%
Injection no.1	Injection no.1	30%
Monitoring	Monitoring	10%
Injection no. 2	Injection no. 2	30-50%

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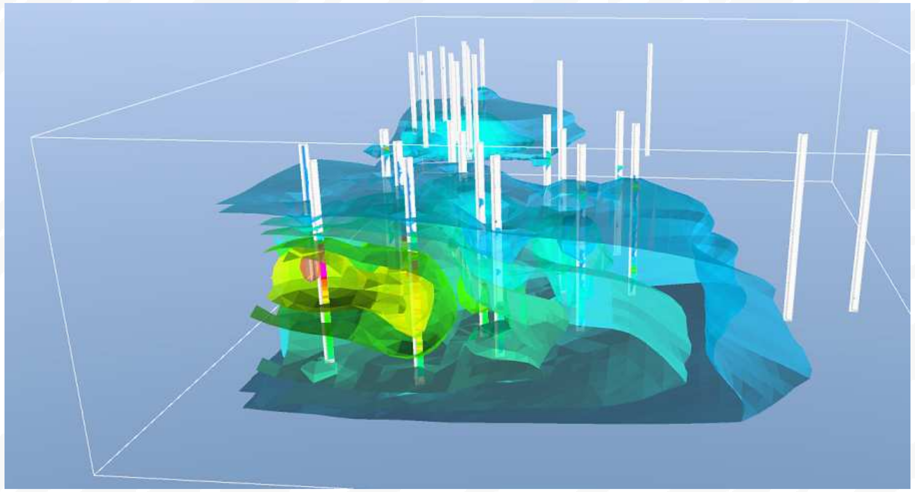
Achievements

- Cost effective ☺
  - Reduced consumption of products; equipment; “time”
  - Optimized effect of product injected - targeted and balanced injection
  - Increased probability for full “remediation coverage” - large quantities of MIP data
- Environmental sustainable ☺
  - Minimize risks of negative environmental impact
  - Minimize disturbance of uncontaminated soil/GW
  - Minimized consumption of energy / product.

Achievements

- Flexible system ☺
  - Different products - "mixtures"
  - Flow rate / pressure
  - Concentration variability



Interpretation of MIP data

- Real time data / logging ☺
  - Decision making in the field (Triad Approach)
  - Documentation
  - Large data amount – quality / decision making.

Future applications & Challenges

- Applicable also for more viscose remediation products like: EHC, Newman Zone, EZVI, BOS100/200, -
  - Injection depth challenges when increasing radius of rods

- Also high flow / pressure applications (fracturing)

- Full scale project experiences required => limitations / challenges etc.

- Optimize operation and improve solidity of the system .

MIP-IN is the outcome of an interesting collaboration between researchers, authorities, SME's and contractors !

Further development and divulgation of the system could result in significant environmental and social impact – and exports ?!

Thank you –