

Collection of depth-discrete groundwater samples using a new multilevel device

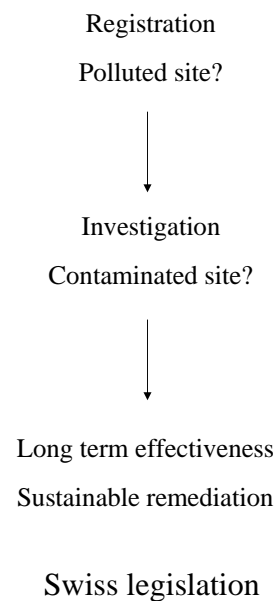
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Introduction - 1

- The problem
 - Since 1920, chlorinated solvent have been used in variable and large amount in Switzerland
- Risk assessment
 - Hazard for human health and the environment, natural resources
 - Need of monitoring or remediation
 - Objectives and urgency of remediation
- Remediation project
 - Decontamination
 - Securing measures
 - Restricted soil utilisation



Introduction - 2

- Groundwater
 - The main affected natural resource
- Chlorinated solvents
 - PCE and TCE are the second and third most often detected organic groundwater contaminants
- DNAPLS
 - Complex migration and contaminant distribution
- Geology
 - Heterogeneities
- Hydrogeology
 - Hydraulic conductivity

Goal of the project

—————> **Development and application of a multilevel device**

- Requirements
 - Adapted for typical swiss geological context
 - Cost efficient
 - Compatible with common drilling methods
- Existing multilevel device
 - Expensive
 - Not adapted to coarse aquifer
 - Depth limited
 - Number of sampling points limited
 - Diameter limited

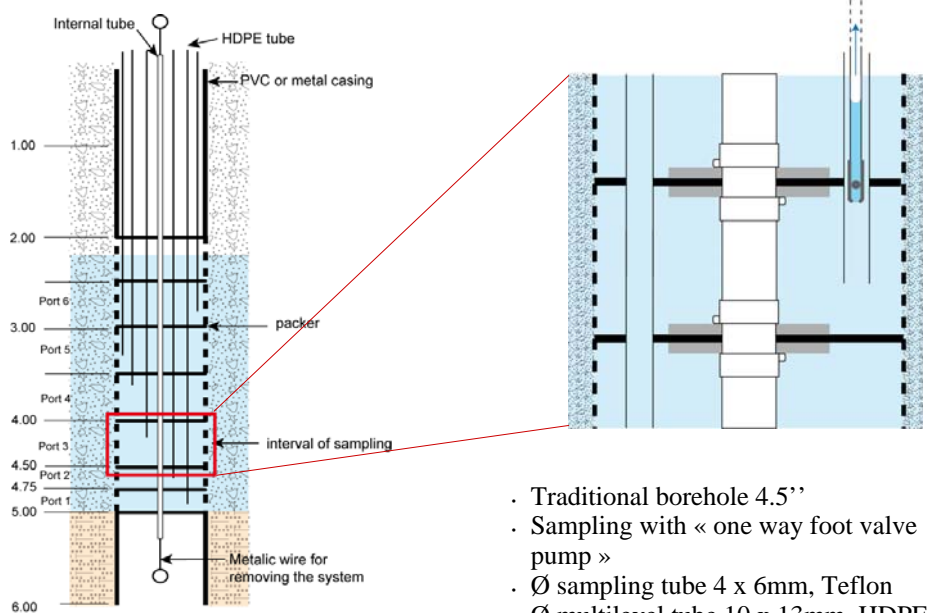


Development of a new multilevel device

System 1

- Characteristics
 - 6 to 8 depth-discrete sampling points
 - System removable and flexible
 - Cost efficient
- Installation
 - Traditional drilling borehole
 - Direct-push piezometer (DPT)
- Sampling
 - Peristaltic pump
 - Inertial pump « one way foot valve »

System 1 - borehole



- Traditional borehole 4.5''
- Sampling with « one way foot valve pump »
- Ø sampling tube 4 x 6mm, Teflon
- Ø multilevel tube 10 x 13mm, HDPE

Adapted from IMW, Germany

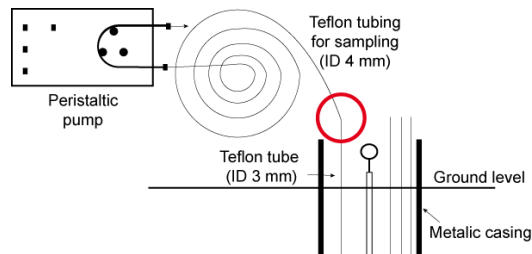
System 1 - piezometer



Installation
→
Direct push machine



- DPT piezometer 1.25''
- Sampling with peristaltic pump
- Low flow sampling < 200 ml/min
- Ø multilevel tube 4 x 3mm, Teflon



Field test and applications

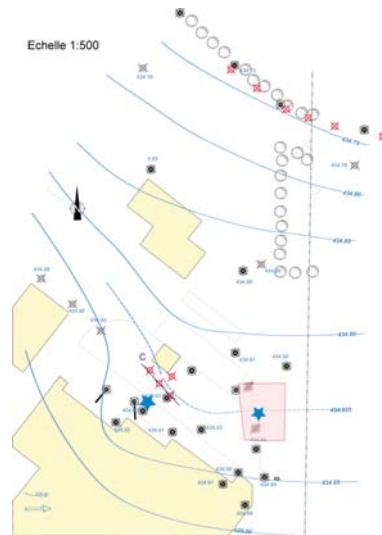
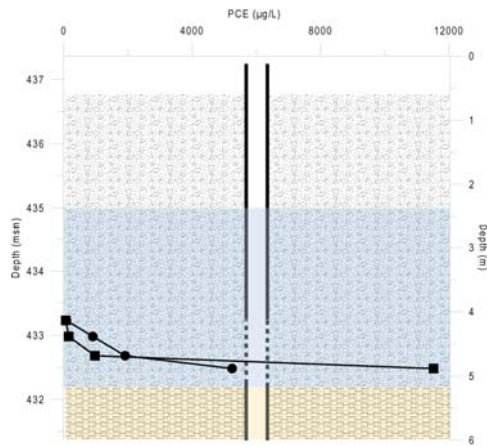
2 contaminated sites in Lyss, canton of Bern, Switzerland

- **Site 1**
 - PCE groundwater contamination
 - Pools of DNAPLS in phase on impermeable basement
 - Pilot scale remediation plan by In-Situ Chemical Oxidation « ISCO » with Permanganat
 - Summer 2007
 - Groundwater monitoring during remediation
- **Site 2**
 - PCE and Freon 113 contamination
 - Evaluation of contamination: source and plume
 - Field tests



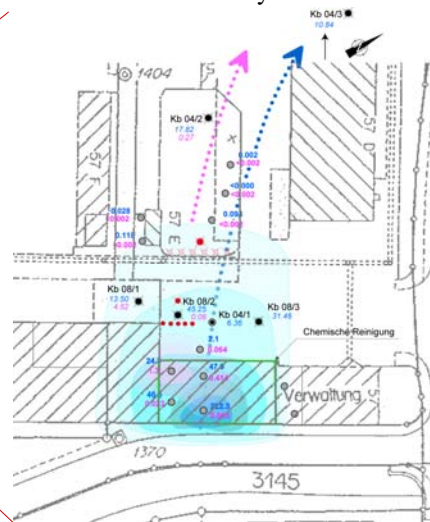
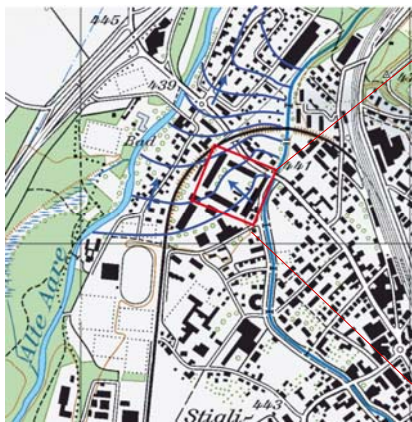
Field test 1 - Results

- PCE concentrations profiles
 - Increasing PCE concentrations with depth
 - Decreasing PCE concentrations



Field test 2

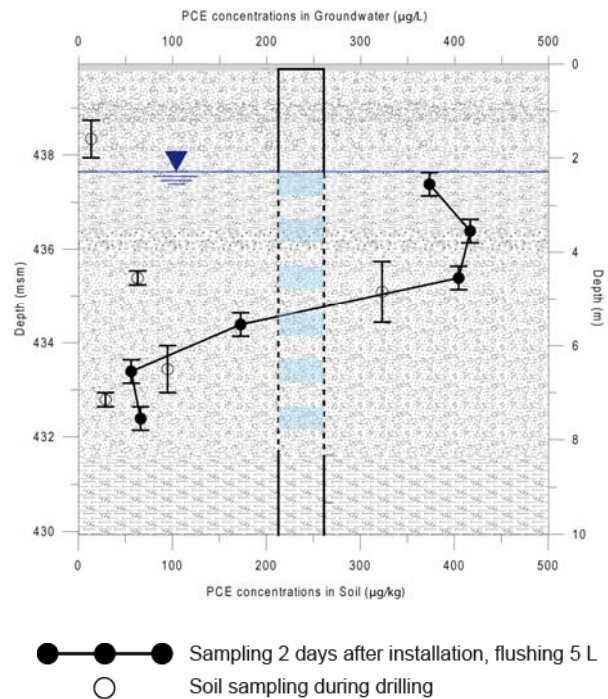
- Situation
 - 3 boreholes 4.5'' in 2004 along the PLUME
 - 3 new boreholes 4.5'' in 2008 in the SOURCE with soils analysis



Field test 2

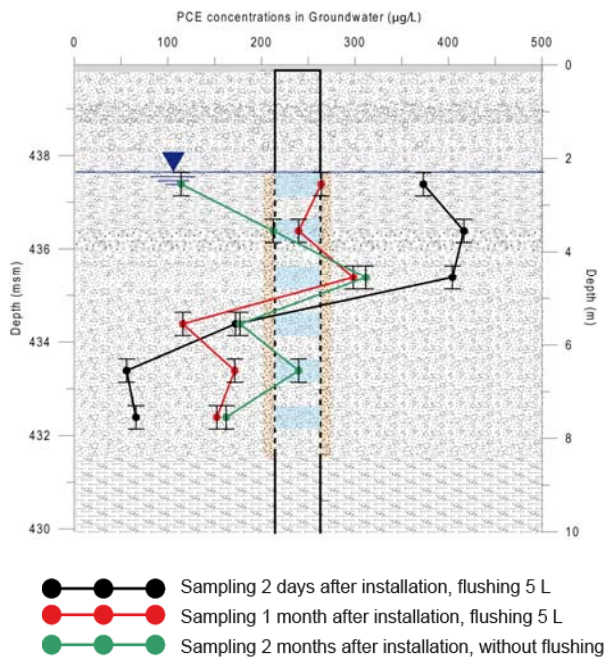
- Measurements
 - soils sampling during drilling
 - groundwater sampling 2 days after installation of the multilevel device

- Results
 - no correlation between soil and groundwater analysis
 - PCE concentrations profile in groundwater
 - high PCE concentrations correlated with less permeable lithologies



Field test 2

- Measurements
 - sampling at different dates
 - sampling with different protocols
- Results
 - no correlation between the different sampling dates
- Conclusions
 - vertical flow within the gravel pack perturbate the concentration profiles



Conclusions - Perspectives

- Biases in obtaining depth-specific representative groundwater samples
 - *sampling device*
 - *sampling protocol*
 - *sampling materials*
 - *hydrogeological context*
- Development of a new device System
 - *installation by DPT and casing removed*
 - *packer: bentonite mud injection*
 - *grouting*
 - *non-corrosive materials*
- Comparison with dedicated reference systems
 - *cluster systems, prepacked screen*
- Field and laboratory tests
 - *establishing protocol of construction, handling and application*

References

- Bundesamt für Umwelt, W.u.L.B.f.W.u.G.H., 2004. NAQUA - Grundwasserqualität in der Schweiz 2002/2003, Bern, 204 pp.
- Einarson, Multilevel Ground-Water Monitoring, in *Handbook of Environmental Site Characterization and Ground-Water Monitoring*, (2nd Ed.), David M. Nielsen, 2005, Taylor and Francis, Eds, pp. 807-848.
- Office fédéral de l'environnement, 2001. Sites contaminés: recenser, évaluer, assainir. Bern, 40 pp.
- Pankow, A. and Cherry, J.A., 1996. *Dense Chlorinated Solvents and other DNAPLs in Groundwater*. Waterloo Press, Waterloo, Canada, 522 pp.

Thank you for your attention