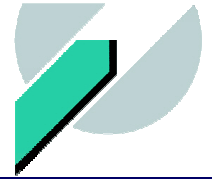


## PRB – International Development (U.S.)



- **General trend/attitude in the U.S.**  
**(what we feel *and* really see!):**

***Acting/testing re applying PRBs...***

*– especially in the field in a very early stage! –*

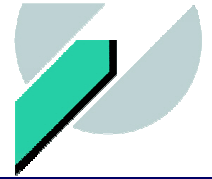
***...is better than waiting!***

(not everything must be scrutinized!)

**At least PRBs deploying ZVI for cVOCs represent an established remediation technique!**



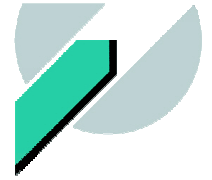
# Comparison



- Comparison Development German/U.S. PRB:
  - Germany: much more systems/sites (in percentage) where an extended control can be exerted
    - *this German attitude evokes (sometimes) a (little) smile among U.S. colleagues*
  - U.S.: confidence regarding the practicability and efficiency of the technology is very big
  - U.S.: no intense concern/care regarding emergency scenarios/decommissioning (maybe a mentality issue?!...)

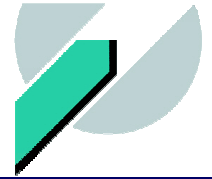


# Comparison



- U.S.: Different remediation targets in the U.S. at different sites; furthermore, differentiated regarding single pollutants
- Germany: 10  $\mu\text{g/L}$  cVOCs in total in general
- U.S.: cis-DCE target value often high (*70  $\mu\text{g/L}$* )
- U.S.: The focus is on the degradation of the main contaminant only, i.e., PCE or TCE, not the daughter products, AND **INSIDE** the wall only

# Comparison



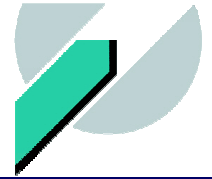
- If increased contaminant levels are measured downstream again, which can be validated at many sites, there seems to be no major concern about it („the plume has not entirely moved thru yet“)

(e.g., full scale ZVI PRB in Sunnyvale, CA, Intersil site, after more than eight years of operation)

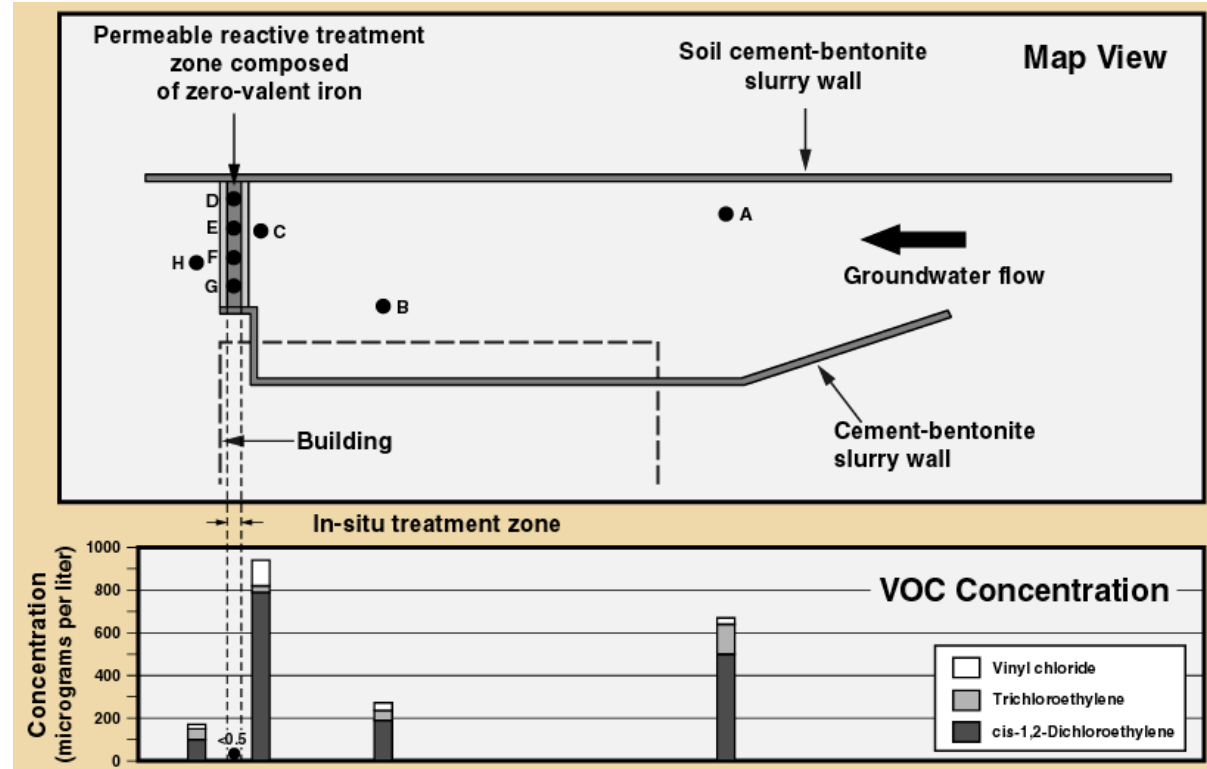
**In Germany, this is an important issue that ought to be solved/more clarified asap! Note that a German regulator can be put behind bars(!), because he may be held responsible for serious failures of a remediation measure!**



# Comparison



## Intersil, Sunnyvale, CA, 02/95

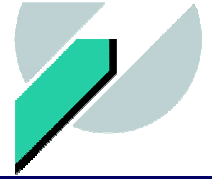


Scott D. Warner, Bettina L. Longino  
Geomatrix  
Oakland, California  
Lisa A. Hamilton  
DKTM  
King of Prussia, Pennsylvania



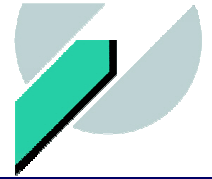


# Mainstream and Future Development



- PRBs with a specifically directed GW flow such as „*drain-and-gate*“, „*trench-and-gate*“ **look promising!**
  - *Because the hydrology is passively manipulated and controlled, therefore, regarding the flow towards the reactor, it is well understood in principle.*
- PRBs equipped with *reactors* which were inserted into *shafts* **look promising!**
  - *Because control/maintenance concerning the reactive material can be relatively readily exerted, if needed.*

# Mainstream and Future Development



- PRBs employing activated carbon (AC) **look promising!** *Because...*

*1. it is a well-established reactive (sorptive) material, deployed in a variety of other clean-up processes*

*2. it can be advantageously combined with other materials like ZVI in PRBs*

*3. it can treat a variety of different GW contaminants, even when encountered in complex mixtures and in difficult GW environments (high hardness, high sulfate etc), both successfully and economically*

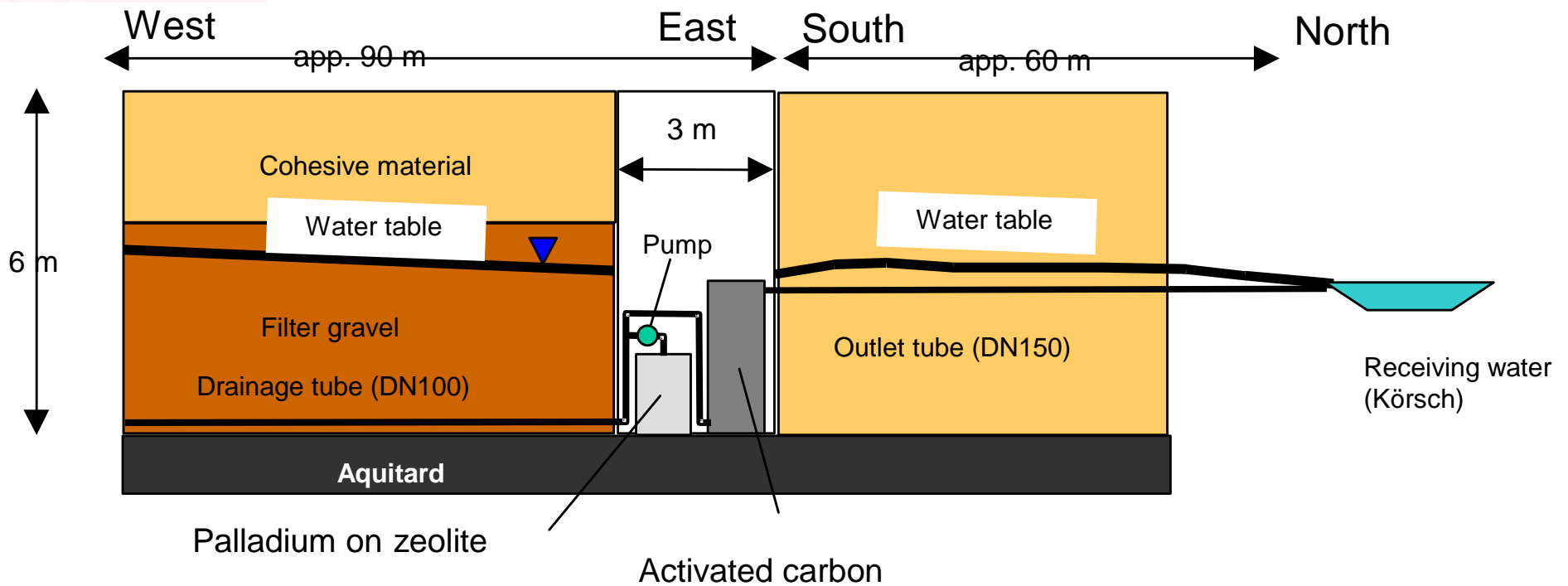
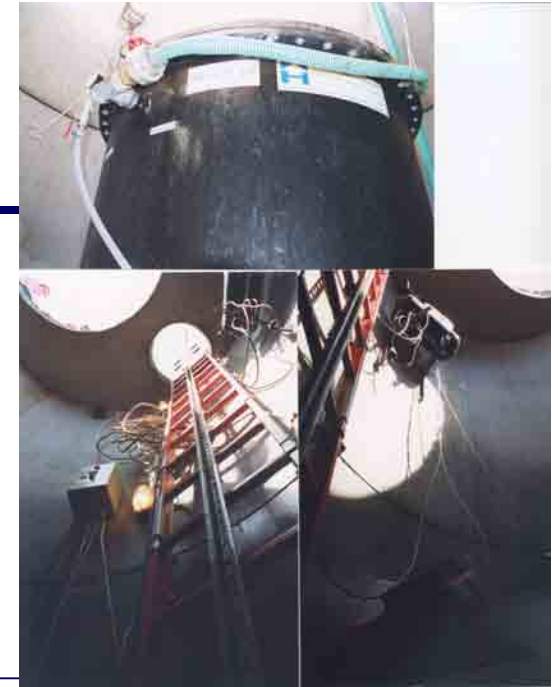


# Some PRB Success Stories



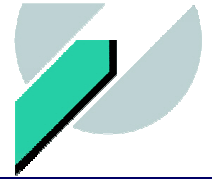
**Shaft Reactor  
plus AC plus Drainage:**

✓ Denkendorf  
= working well

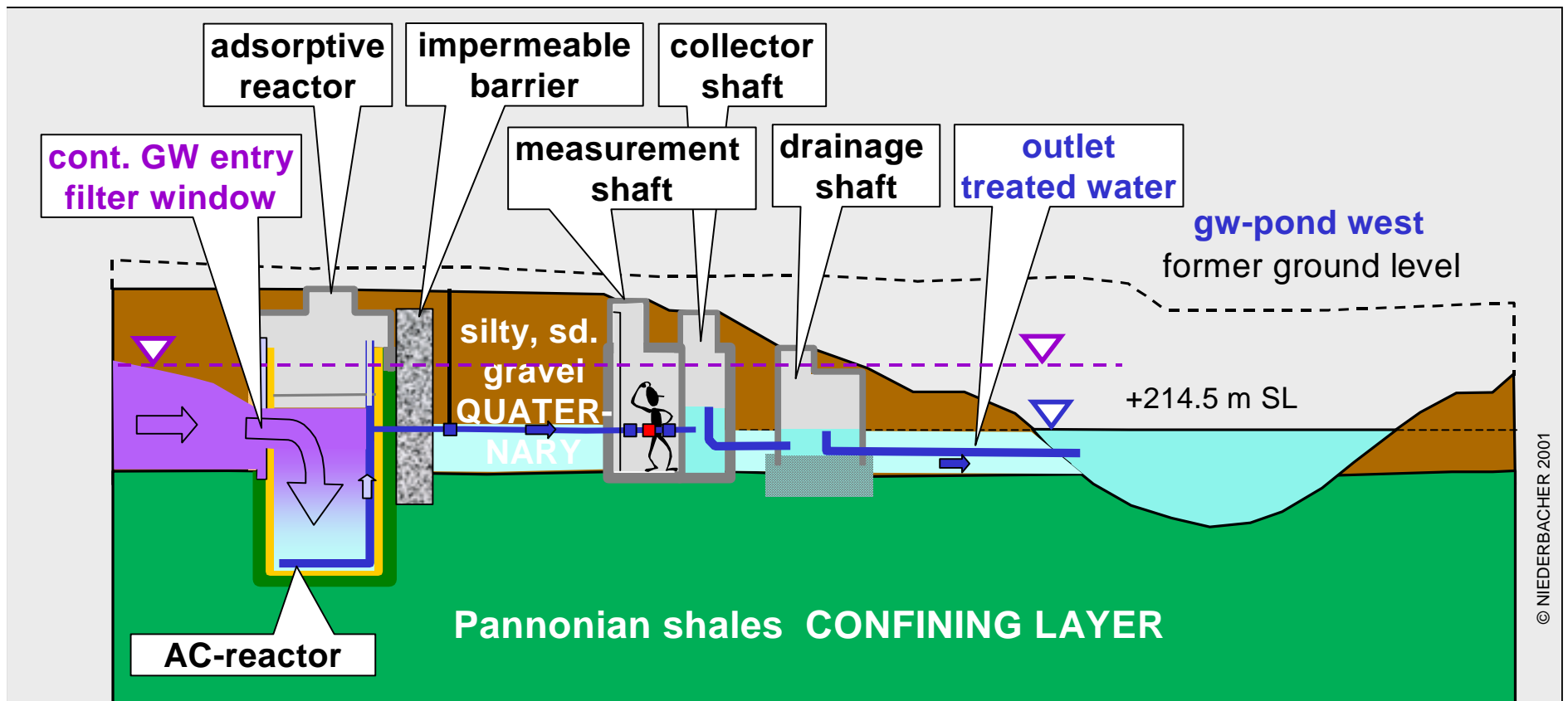




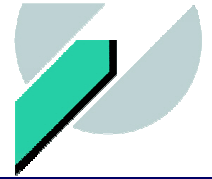
# Shaft Reactor plus AC plus Drainage



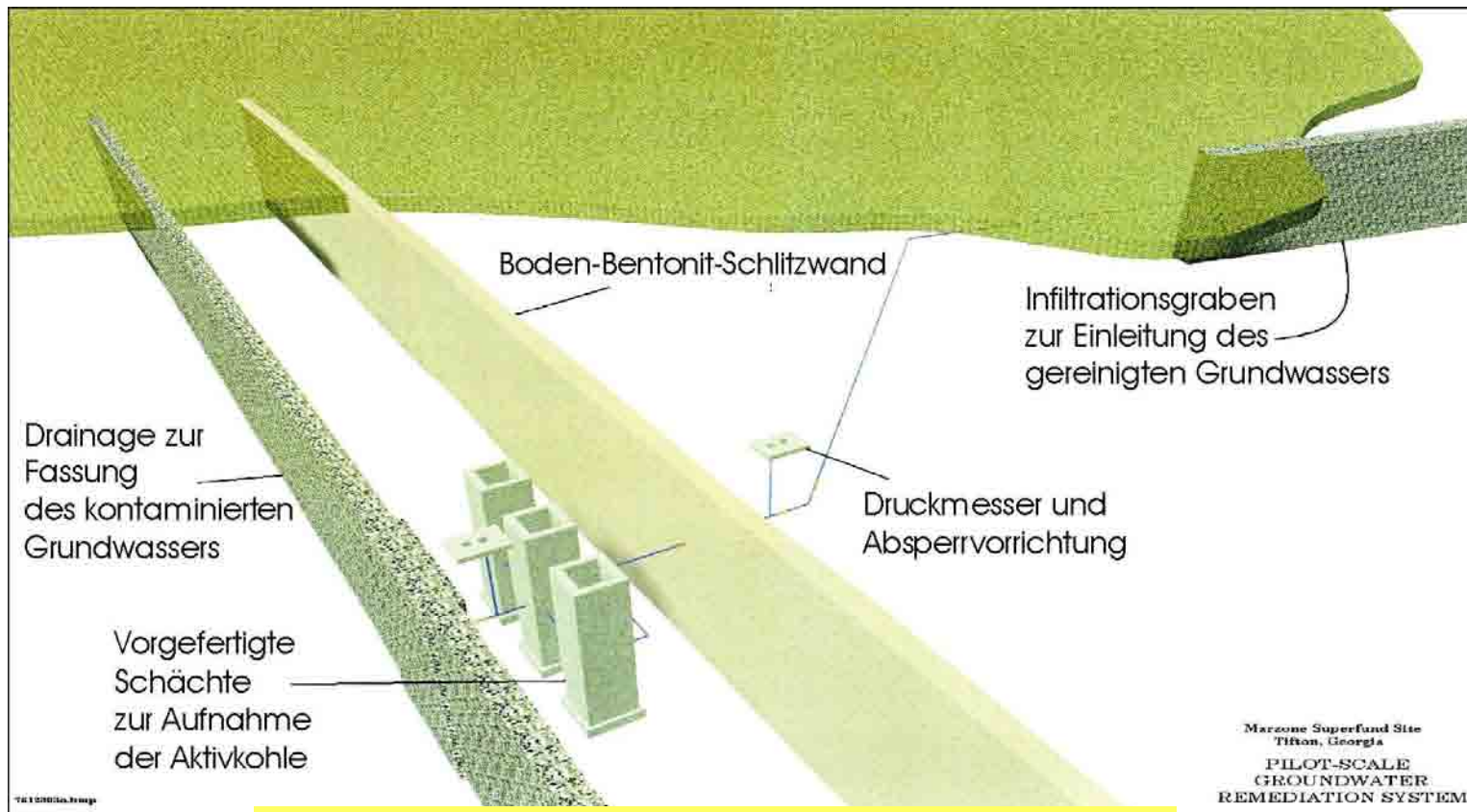
✓ Brunn am Gebirge, Austria,  
= working perfectly



# Shaft Reactor plus AC plus Drainage



✓ Tifton, Marzone Site, U.S.A.,  
= performing well



**Karl Hoenke**  
**Chevron Environmental Management Co.**  
**San Ramon, CA**



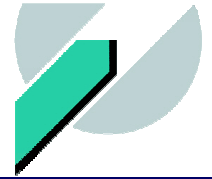


**Hence:  
Shaft Reactor  
plus AC plus Drainage –  
seems to have  
a bright future!**

**However, ...**

**... what is the fate  
of the „classical“  
F&G?**

# German PRB Guidance

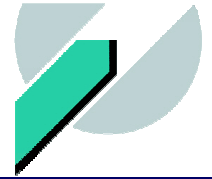


- Chapter 1: Introduction, „PRBs require a special, enhanced interdisciplinary knowledge“
- Chapter 2: Planning, Design, Implementation, Operation, Decommissioning, Regulations (flow charts etc) regarding practical site remediation
- Chapter 3: Basic information
- Chapter 4: Lessons Learned
- Appendix 1: Reports of RUBIN projects
- Appendix 2: References
- Appendix 3: Database

Preliminary version: end of 2003.

Projected publication: 2005





University of Applied Sciences-  
NE Lower Saxony, Suderburg  
Department of Civil Engineering  
Water and Environmental Management  
Office Hanover

Prof. Harald Burmeier Dr. Volker Birke

Co-ordination Group of RUBIN  
Steinweg 4, D-30989 Gehrden  
voice +49 5108-9217-30

burmeier@fhnon.de birke@fhnon.de

[www.rubin-online.de](http://www.rubin-online.de)

