

NANOFER 25S (9 months monitoring)

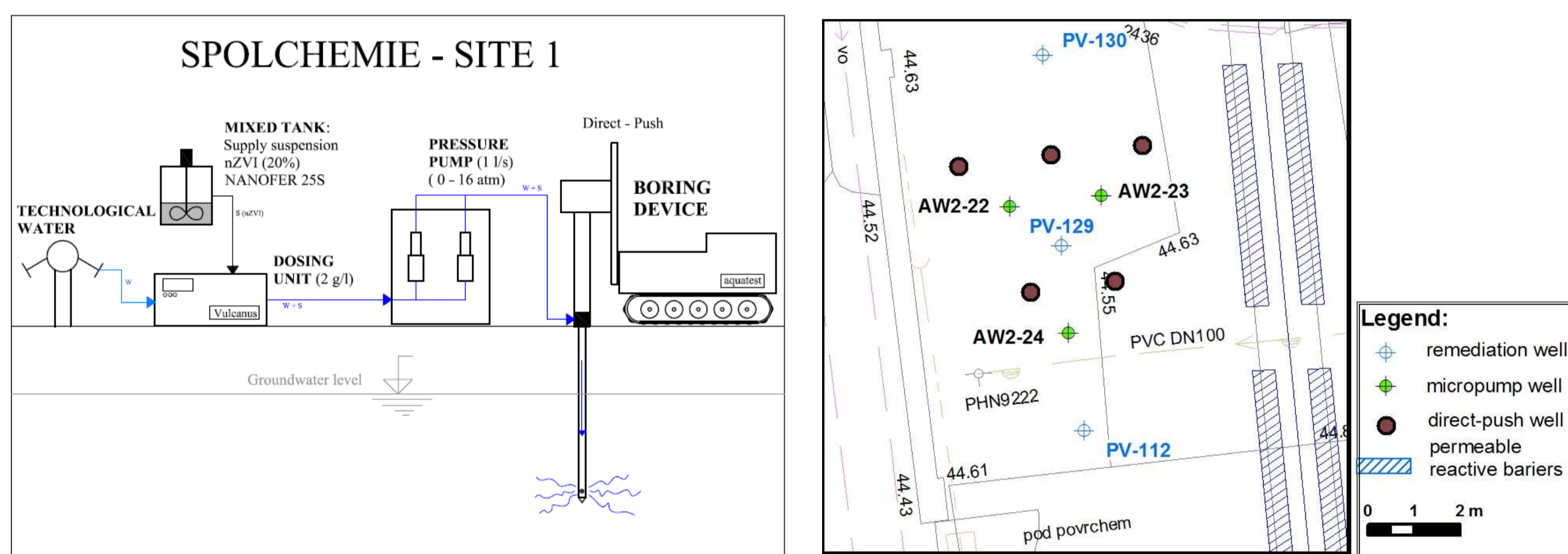
Introduction

– Application of **200 kg of NANOFER 25S** (axilate stabilization) took place in Spolchemie DNAPL NanoRem site, Czech republic. Site is situated in Ústí nad Labem, geologically in heterogeneous quaternary terrace of the river Bílina with hydraulic conductivity $K=1 \times 10^{-5}$ m/s.

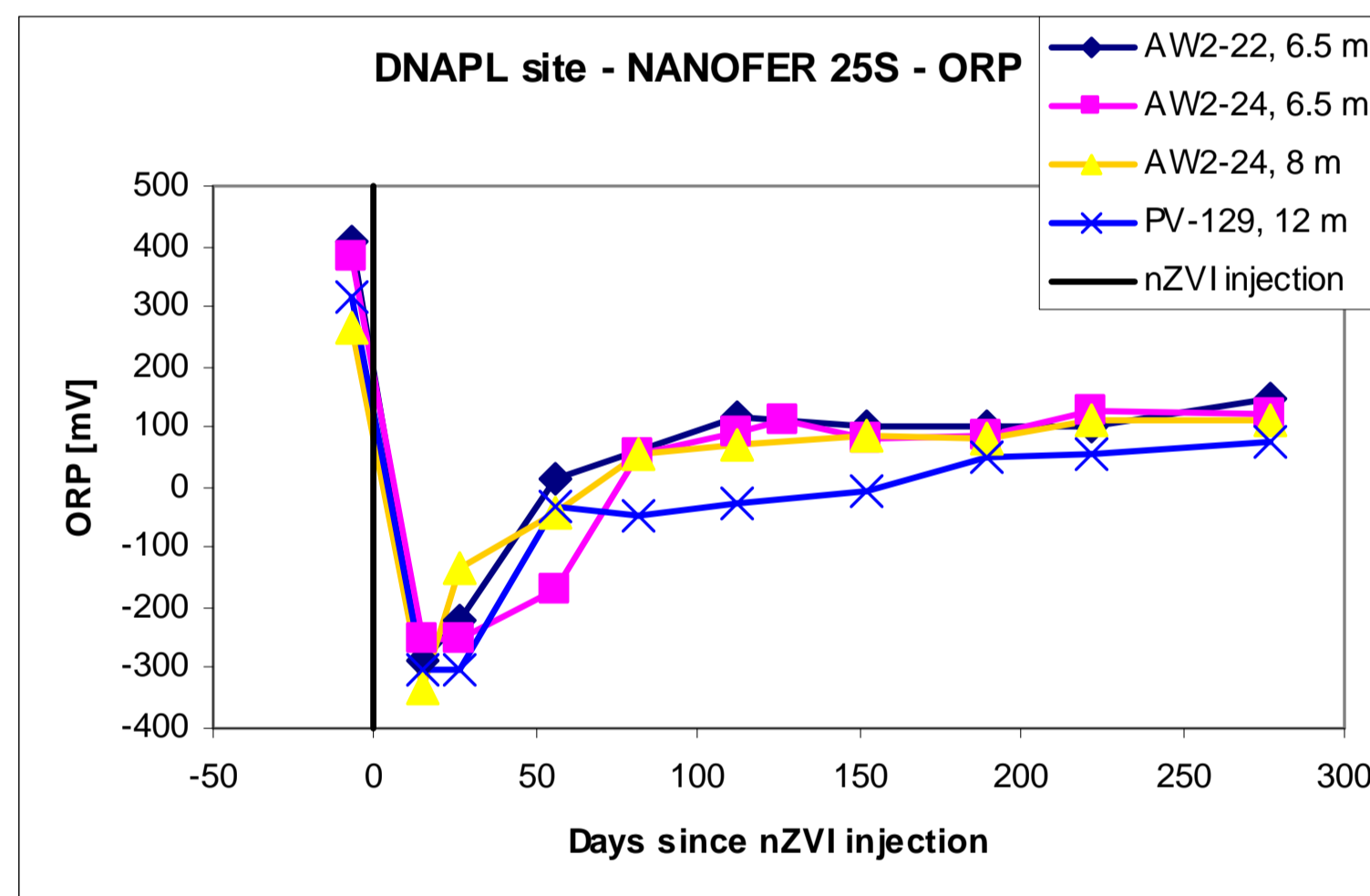
– Concentration of injected suspension was **2.2 g/l** (0.22 %), total injected volume was approximately **91 m³**. Continual **direct-push (DP)** application to 5 DP-probes (injection horizon 5 to 10.5 m bgl) took 190 hours.

– Monitoring system contains **3 remediation wells** (120 mm diameter) and **3 micropump wells** (each equipped in 5, 6.5, 8, 9.5 and 11 m bgl).

– Monitoring of groundwater (GW) includes GW measurement, physico-chemical parameters measurement and following laboratory analysis: Chlorinated solvents, metabolites of the their reduction and selected anorganic parameters.

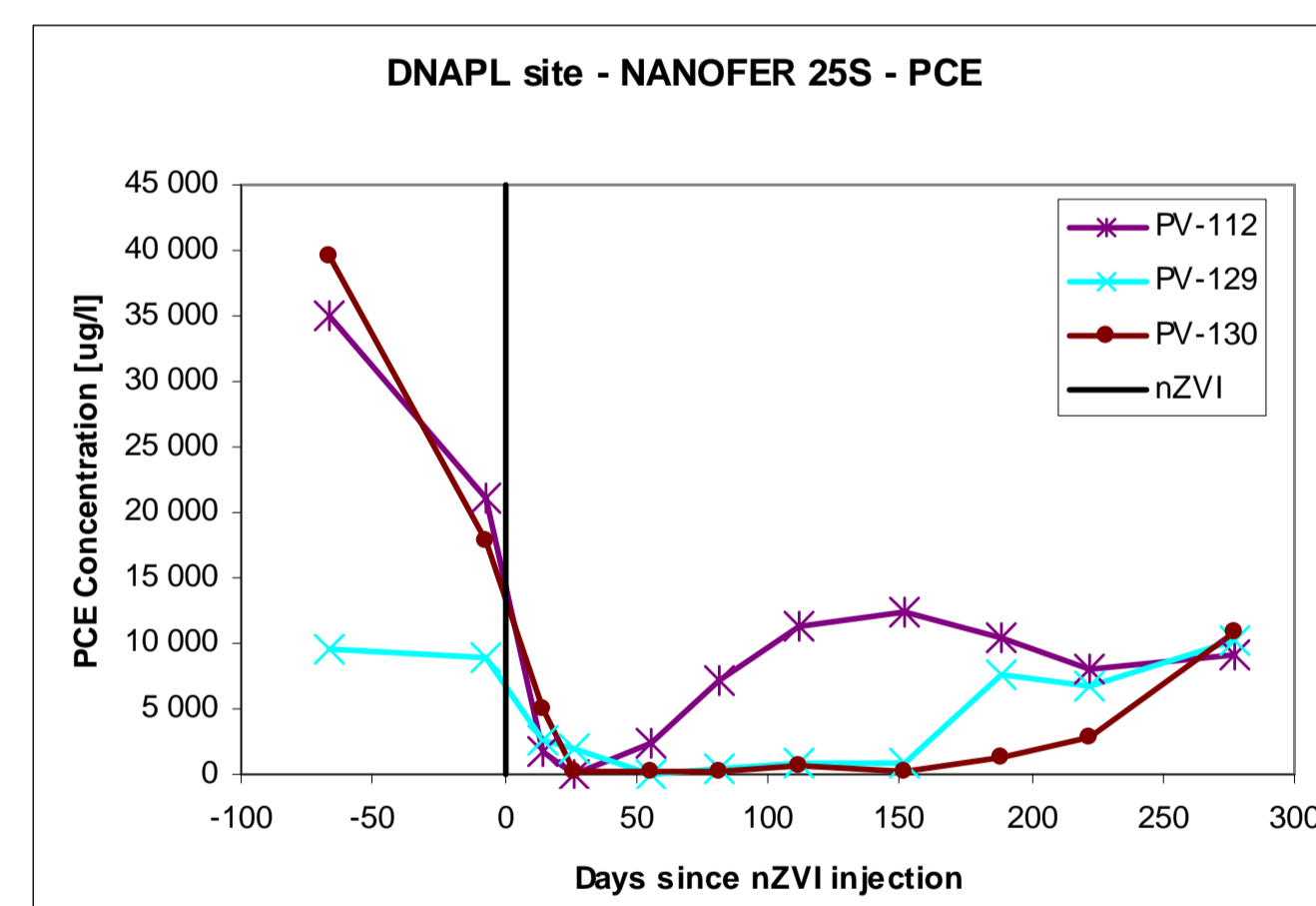


Results – nZVI injection

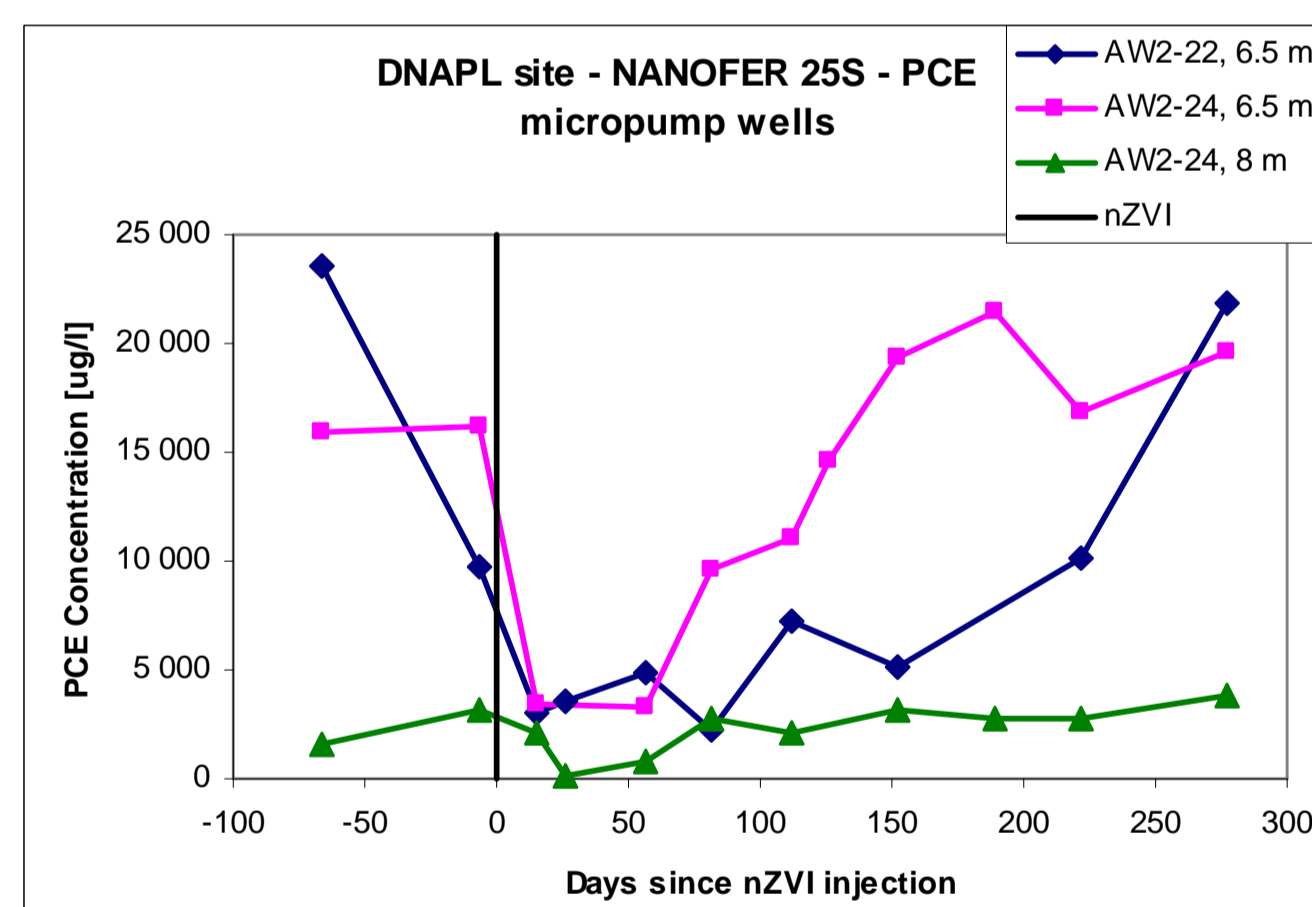


✓ short-term decrease of ORP per 700 mV (+400 → -300 mV)

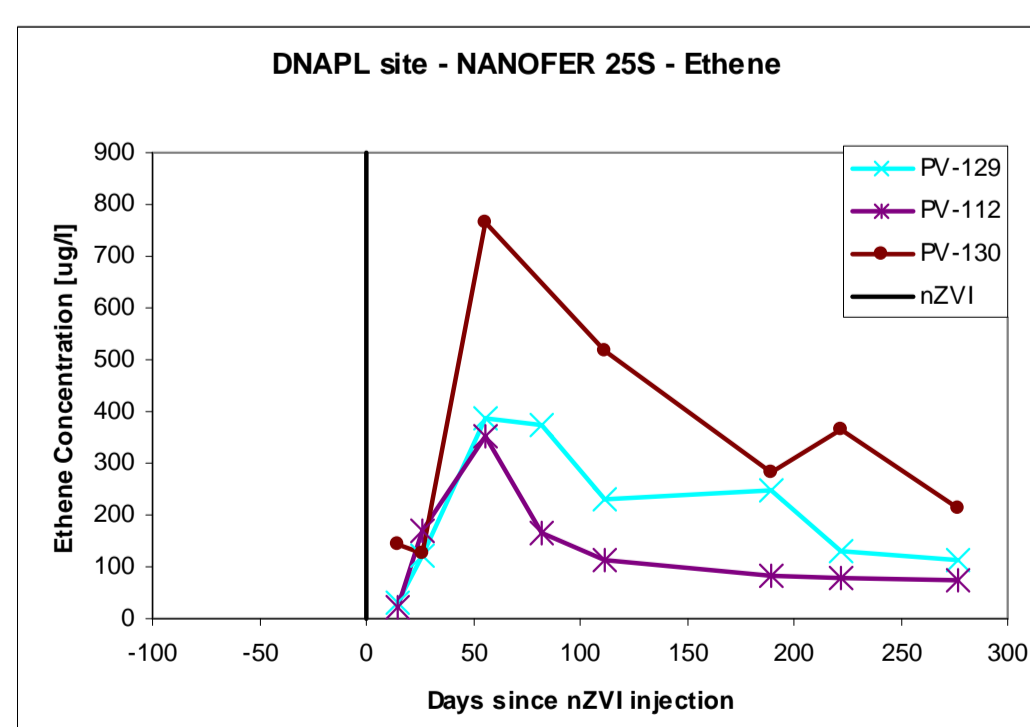
✓ long-term decrease after **277 days - 300 mV**



✓ short-term reduction 90 %
 ✓ long term-reduction after 222 days **25-85 %**
 ✓ Decrease of **PCE** lasted **277 days (9 months)**



✓ short-term reduction 60-80 %
 ✓ long term-reduction <10 %
 ✓ decrease of **PCE** lasted 100-150 days



✓ increase of ethene concentration in one order of magnitude
 ✓ proof of present CHC degradation

Conclusions

- nZVI activity lasted more than **277 days (ORP decrease)**
- Up to **85 % degradation of PCE** after **222 days (7 months)**
- Degradation of PCE confirmed by decrease of its concentration and increase of ethene concentration
- Micropump system is a very good technology for vertical stratification of contamination and other GW parameters in the aquifer

NANOFER STAR (11 months monitoring)

Introduction

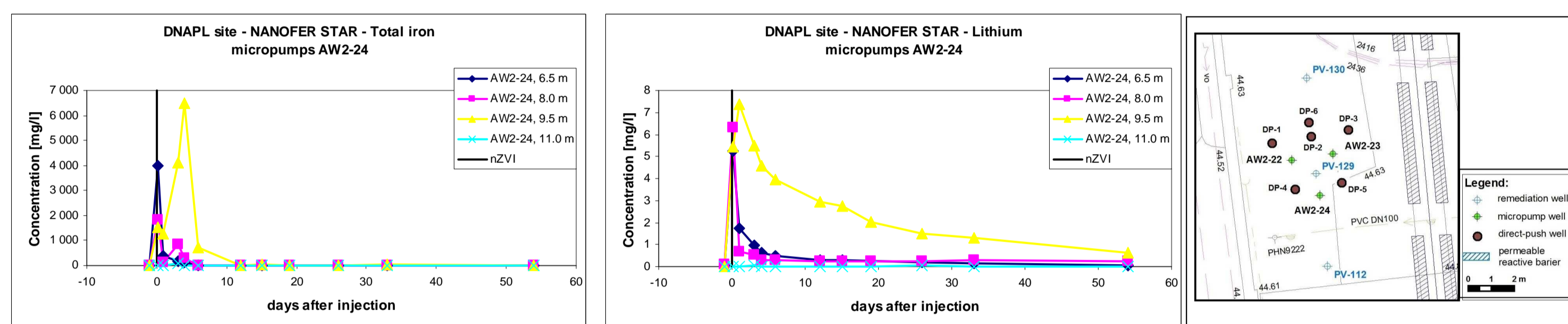
– Application of **300 kg of activated NANOFER STAR** (no surface modification) took place in Spolchemie DNAPL NanoRem site, Czech republic. Site is situated in Ústí nad Labem, geologically in heterogeneous quaternary terrace of the river Bílina with hydraulic conductivity $K=1 \times 10^{-5}$ m/s.

– Concentration of injected suspension was **5 g/l** (0.5 %), total injected volume was **60 m³**. **Direct-push (DP)** application to 6 DP-probes (injection horizon 6.5 to 10 m bgl) took 3.5 days. 1 kg of LiCl was injected as a tracer.

– Monitoring system contains **3 remediation wells** (120 mm diameter) and **3 micropump wells** (each equipped in 6.5, 8, 9.5 and 11 m bgl).

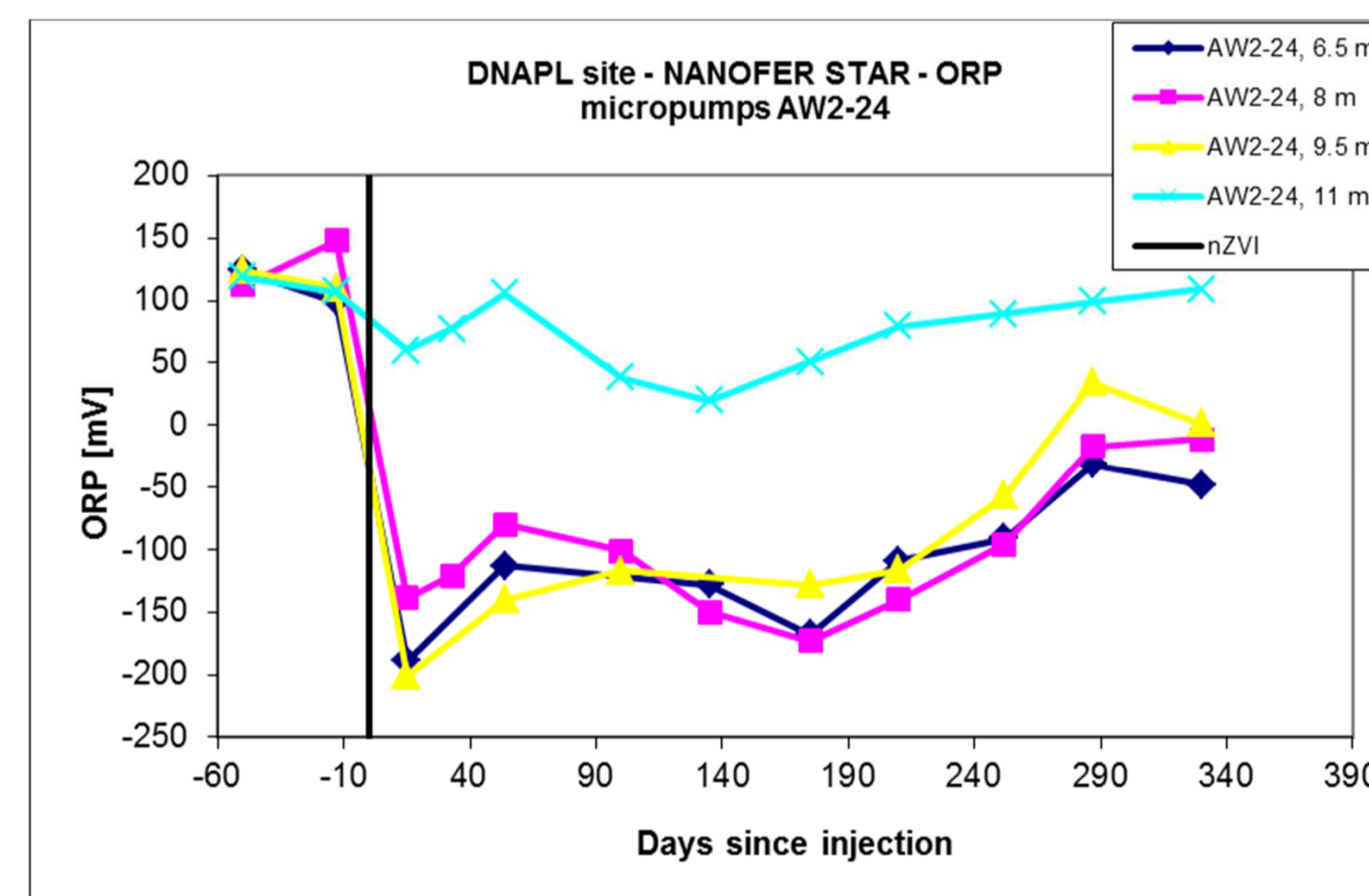
– Monitoring of groundwater (GW) includes GW measurement, physico-chemical parameters measurement and following laboratory analysis: Chlorinated solvents, metabolites of the their reduction and selected anorganic parameters.

Results – tracer test



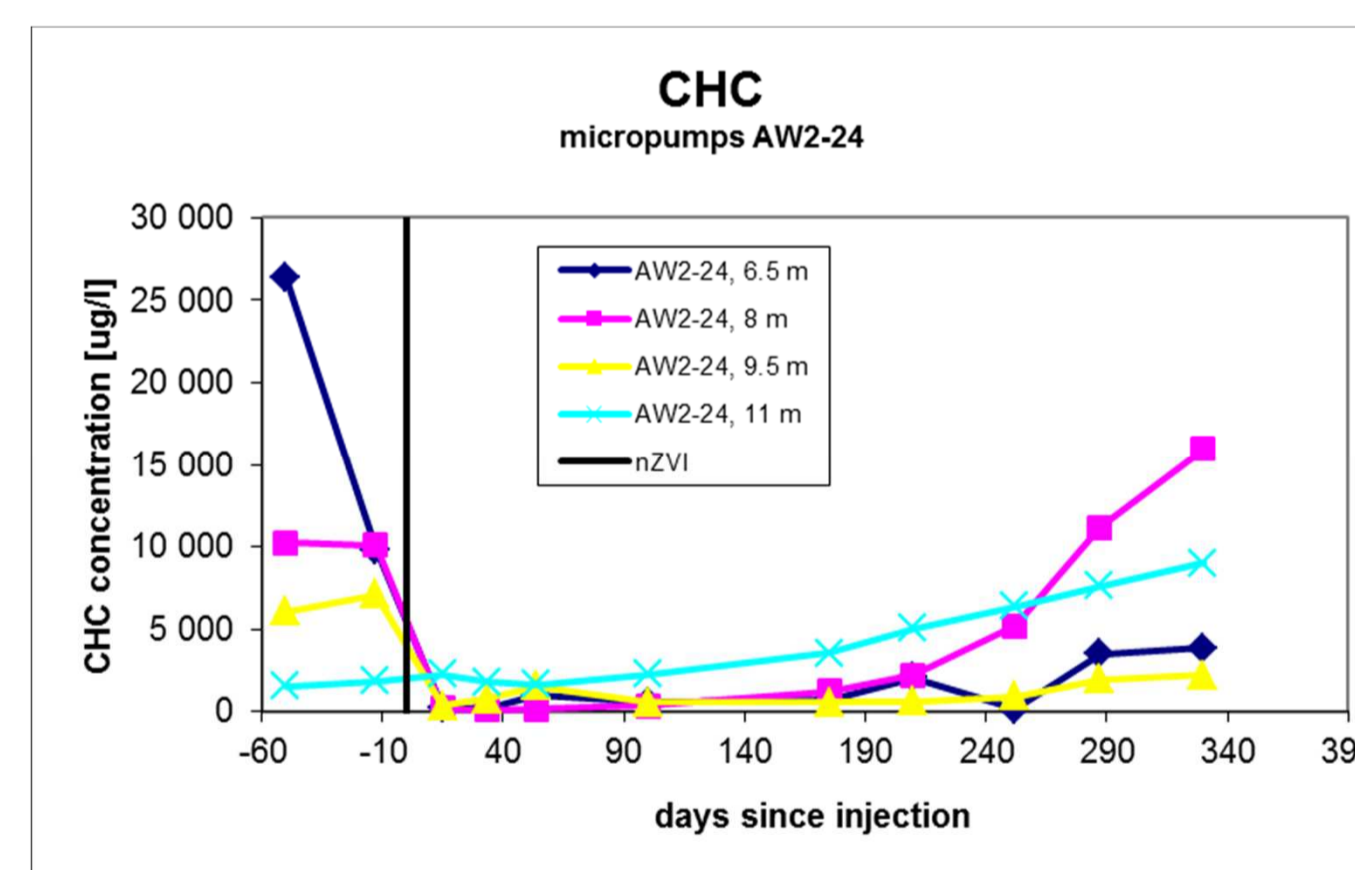
✓ horizon 6.5 to 10 m bgl was fully saturated by NPs (total iron up to **4 g/l**)
 ✓ injected liquid was fully replaced by groundwater 15-33 days after injection (lithium concentrations were back at the background level)

Results – nZVI injection

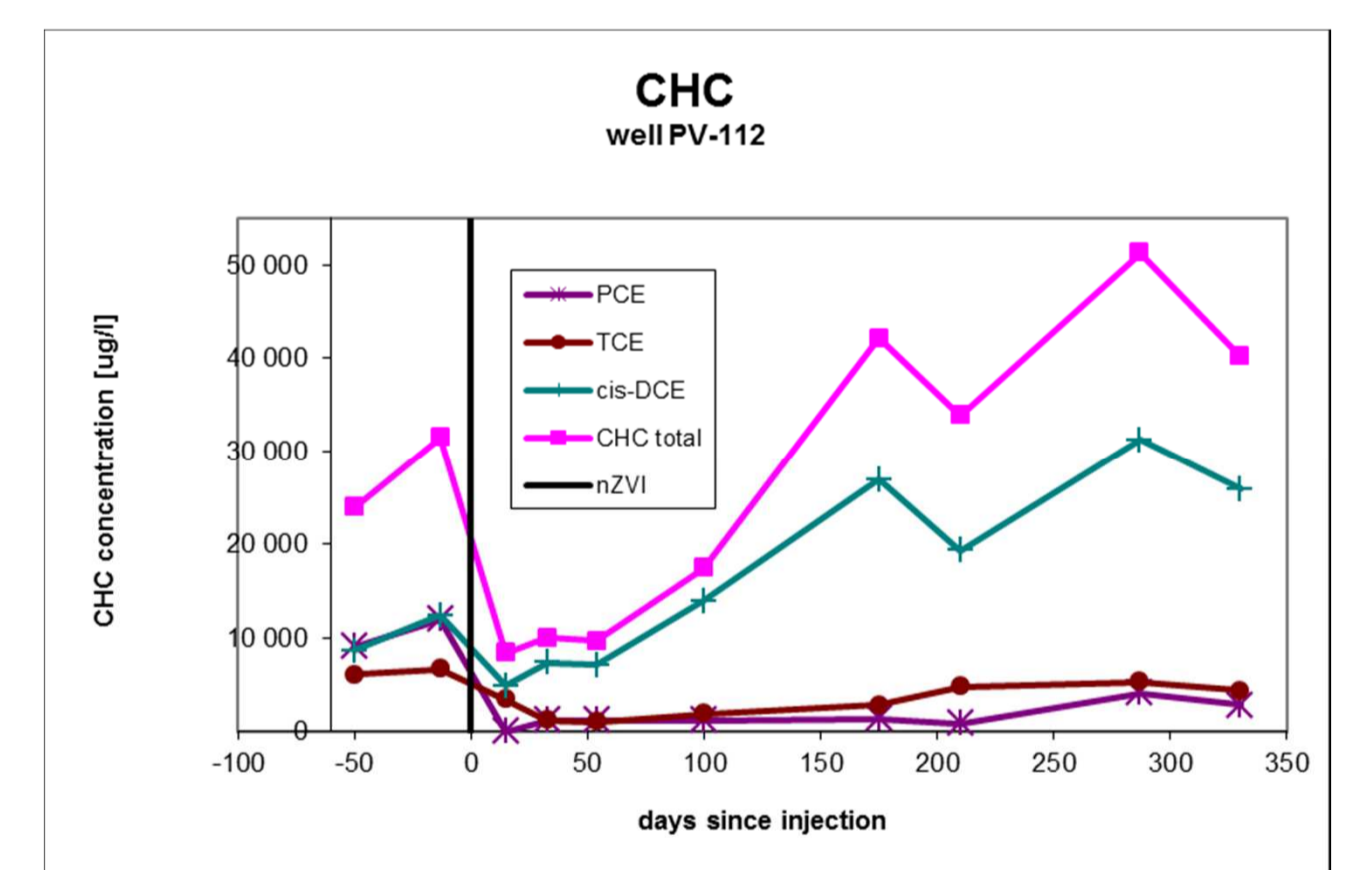


✓ immediate decrease of ORP per 350 mV (**+130 → -220 mV**) in the injection horizon

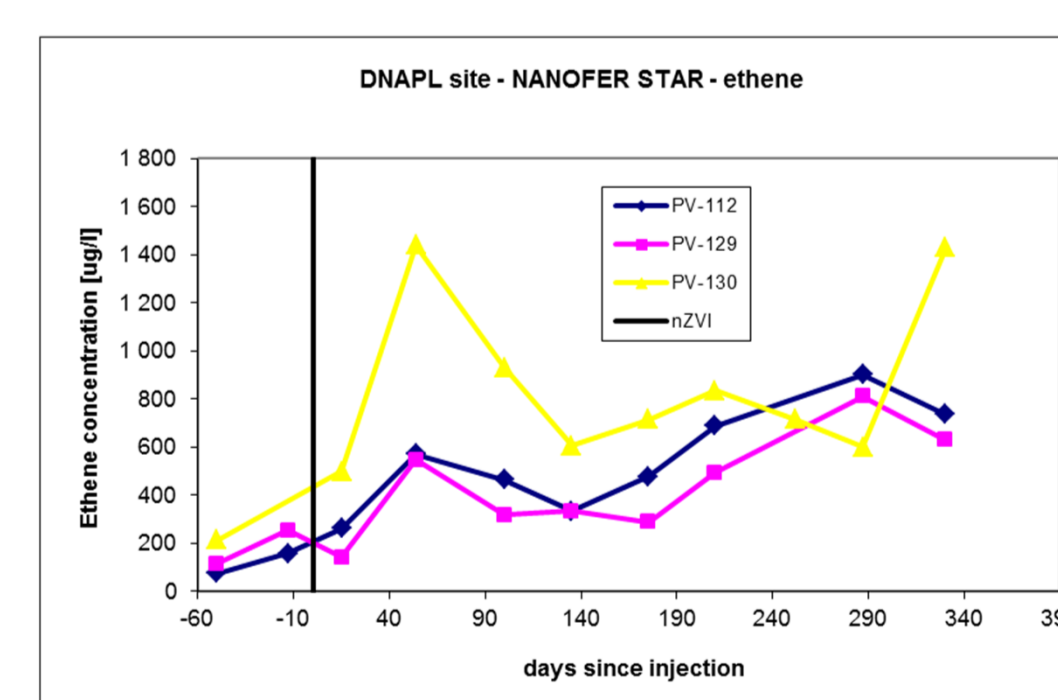
✓ decrease of ORP in two most contaminated horizons lasted **252 days**



✓ dilution effect first 15-33 days only, no rebounding effect
 ✓ **CHC reduction 90 %**
 ✓ reduction lasted 252 days and partially continues until now



✓ dilution+reduction first 54 days
 ✓ **50 % reduction of PCE and TCE** 330 days after the injection
 ✓ increase of degradation products as 1,2-cis-DCE



✓ significant increase of ethene concentration (7 times higher than before injection)
 ✓ proof of present CHC degradation to non-toxic products

Conclusions

- **Importance of tracer test** – soil was well saturated by NANOFER STAR, information how fast is the injected liquid replaced by contaminated groundwater
- Up to **90 % degradation of CHC** after **330 days** (11 months, micropumps)
- 50 % degradation of PCE and TCE and increase of 1,2-cis-DCE as a degradation product (wells PV-XXX, 330 days after injection)
- Increase of ethene concentration proves full degradation of CHC to final product

