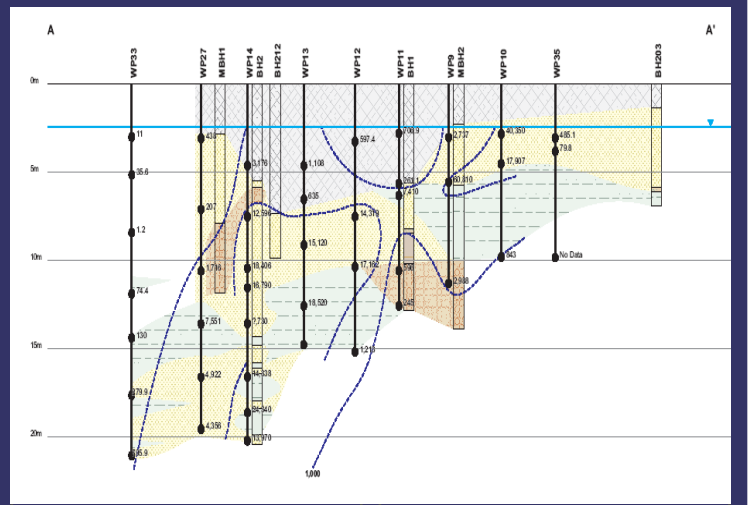
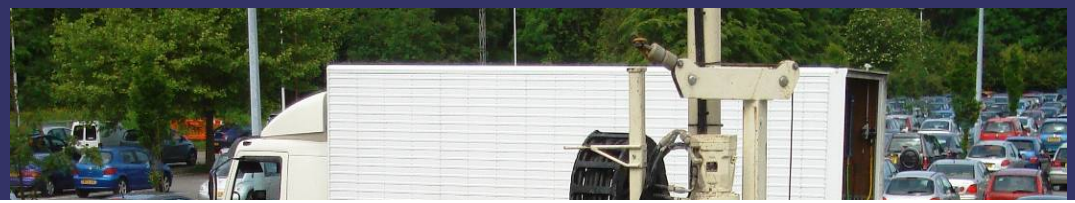
Case Study: Use of the Modified Waterloo Profiler™ (MWP) to provide high-resolution vertical and lateral delineation of groundwater impact from Volatile Organic Compounds (VOCs)



James Baldock, *Phil Crowcroft*
Amy Peacock, Andrew Sykes
Alan Thomas
Environmental Resources Management - ***22nd April 2009***

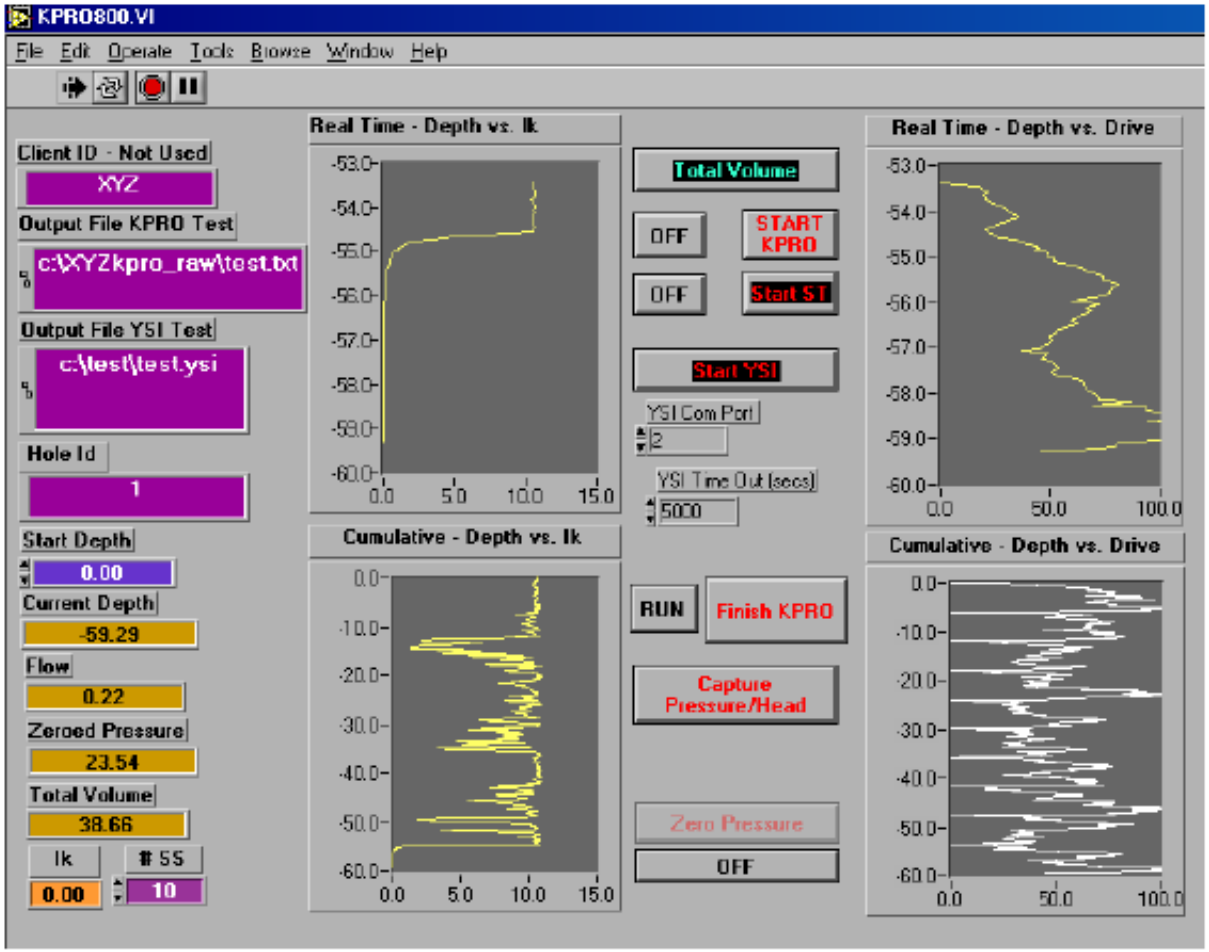
MWP™ Introduction



MWP™ Methodology

- **Clean water is injected during profiler advancement**
  - prevent clogging and quantify fluid pressure
- **Ratio of injection rate to injection pressure is defined as Index of hydraulic Conductivity (IK)**
  - continuous profile of relative hydraulic conductivity, directly visible in the field
  - minimal changes influence contaminant distribution
- **Flow reversal enables depth-discrete sampling**

MWP™
Logging Details



- Stratigraphy
- Hydraulic Head
- Index of Hydraulic Conductivity
- Sample Location Depth
- Drive Rate

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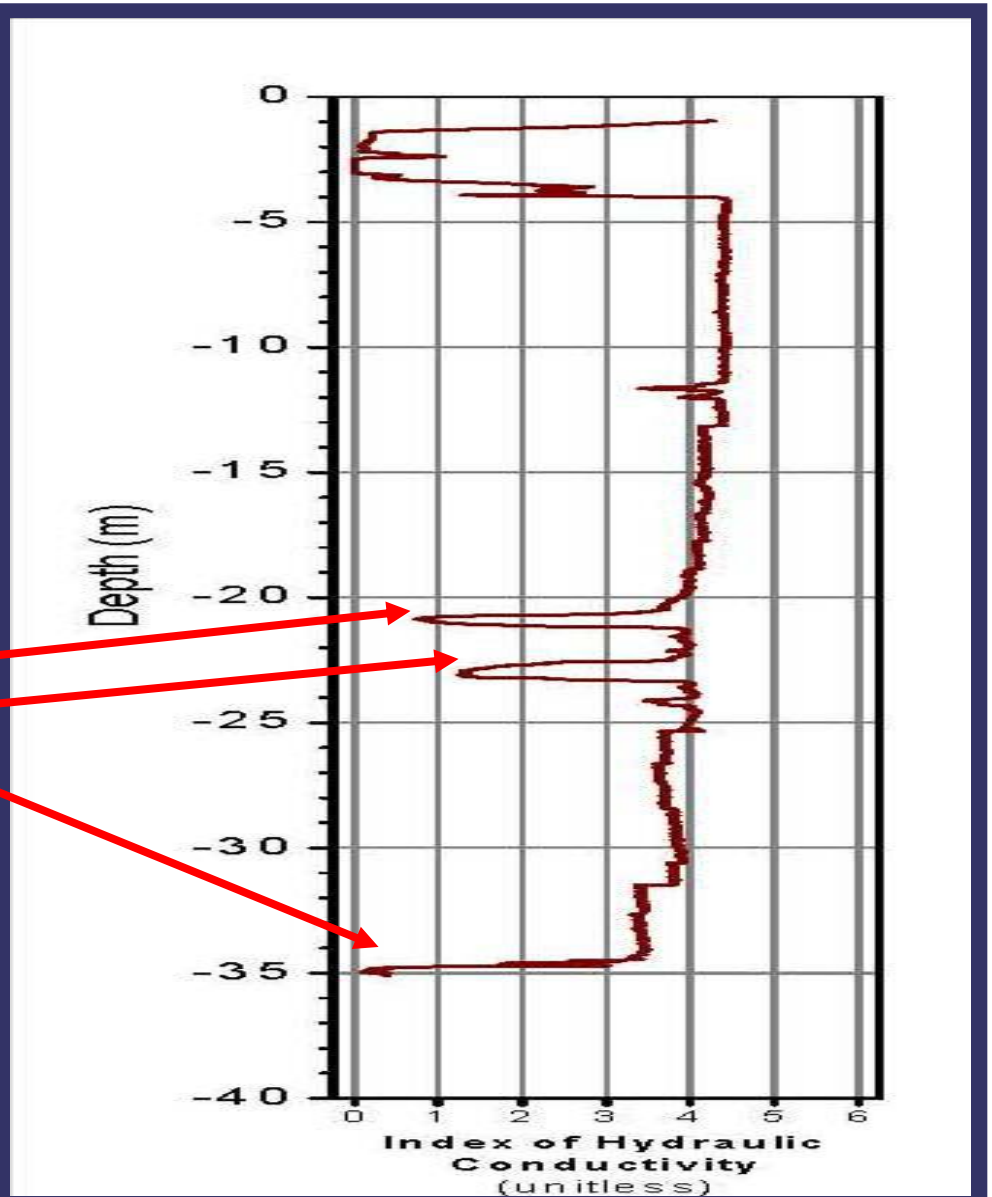
MWP™
Real Time Sampling

- Targeted DNAPL sampling above low K horizon

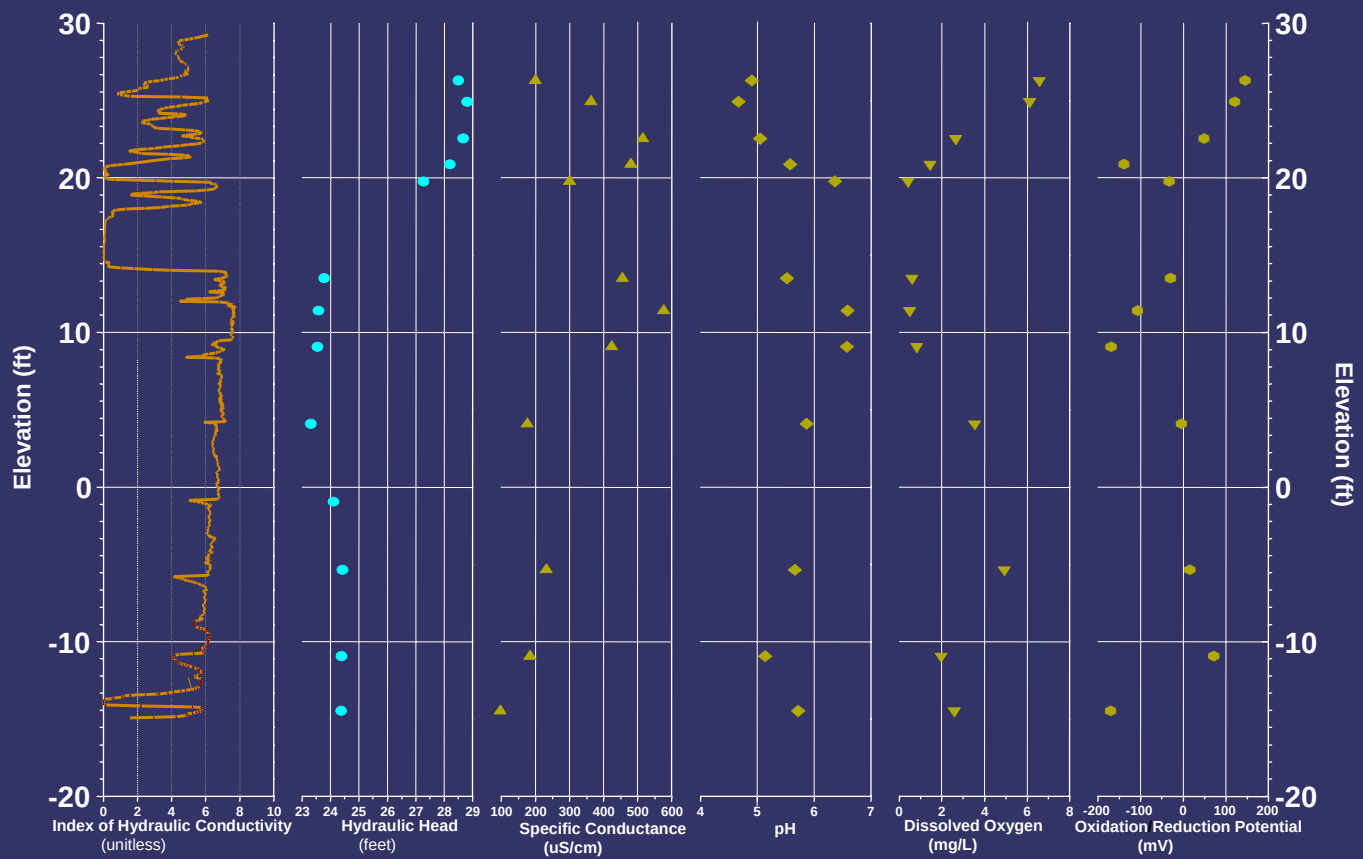


MWP™ Sampling Details

- Index of Hydraulic Conductivity (I_K)
- Hydraulic head
- Physical chemical data
  - Specific conductance
  - pH
  - Dissolved O2
  - Oxidation-reduction potential (ORP)
- Chemical concentration

MobiLab™
DEFENSIBLE REAL TIME ANALYTICS

MWP™ Output


Elevation (ft)
30
20
10
0
-10
-20
0 2 4 6 8 10
Index of Hydraulic Conductivity
(unitless)
23 24 25 26 27 28 29
Hydraulic Head
(feet)
100 200 300 400 500 600
Specific Conductance
(uS/cm)
4 5 6 7
pH
0 2 4 6 8
Dissolved Oxygen
(mg/L)
-200 -100 0 100 200
Oxidation Reduction Potential
(mV)
Elevation (ft)

MWP™
Mobile On-site Laboratory

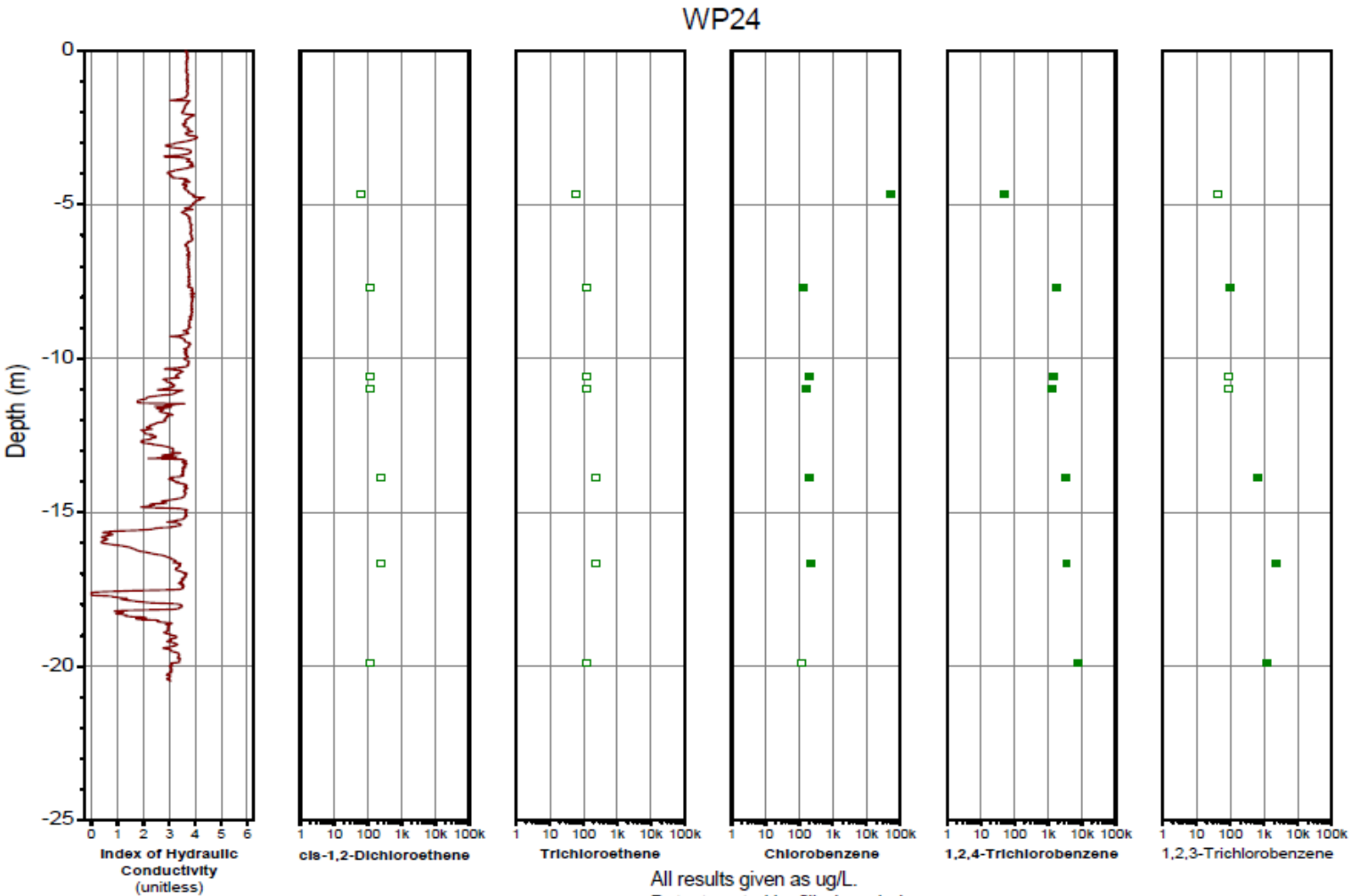
MobiLab™

DEFENSIBLE REAL TIME ANALYTICS

NELAP-Accredited Onsite Laboratories

Results arrive <2h after sampling

MWP™ Laboratory Results Output



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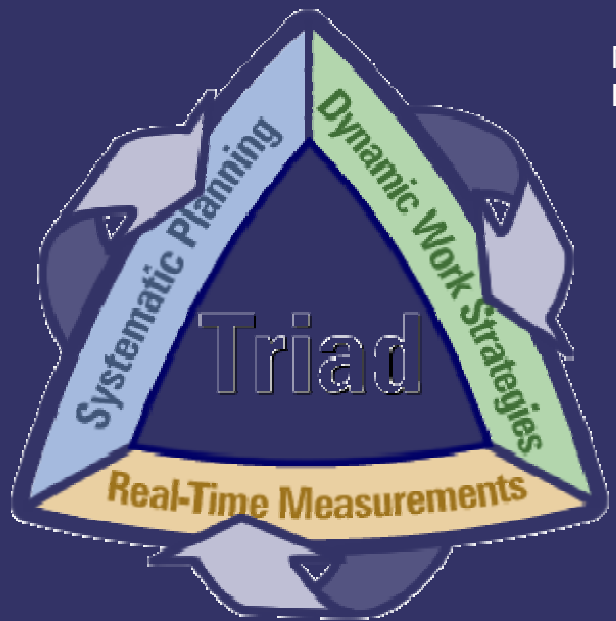
Triad Approach



Number of Data Points

High

Low

Cost Per Data Point

Low

High

Phreatic Zone

MIP

Waterloo Profiler

Monitoring Wells

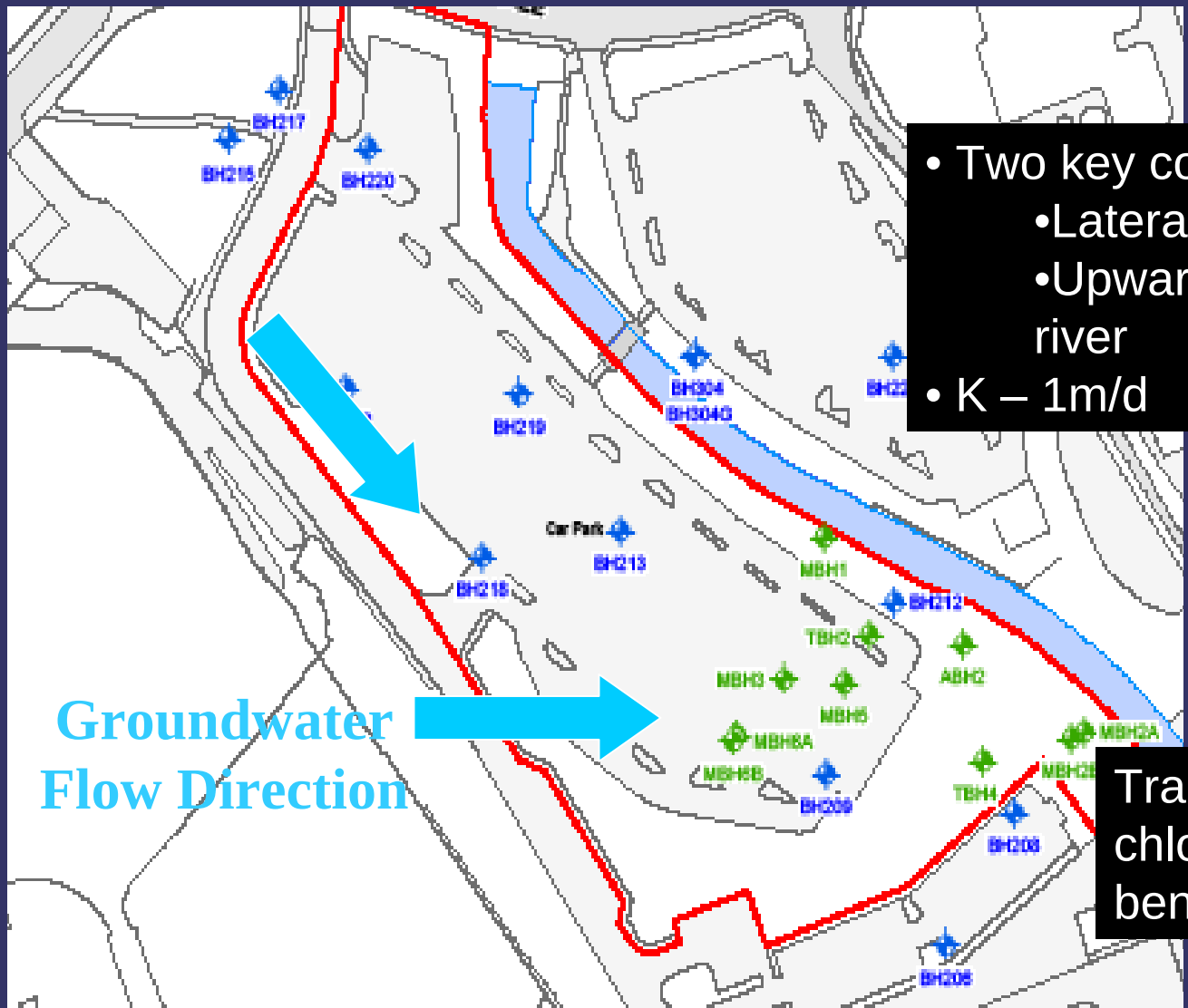
Risk Characterization / Remediation

Typical Regulatory Requirement

Case Study

Site Overview

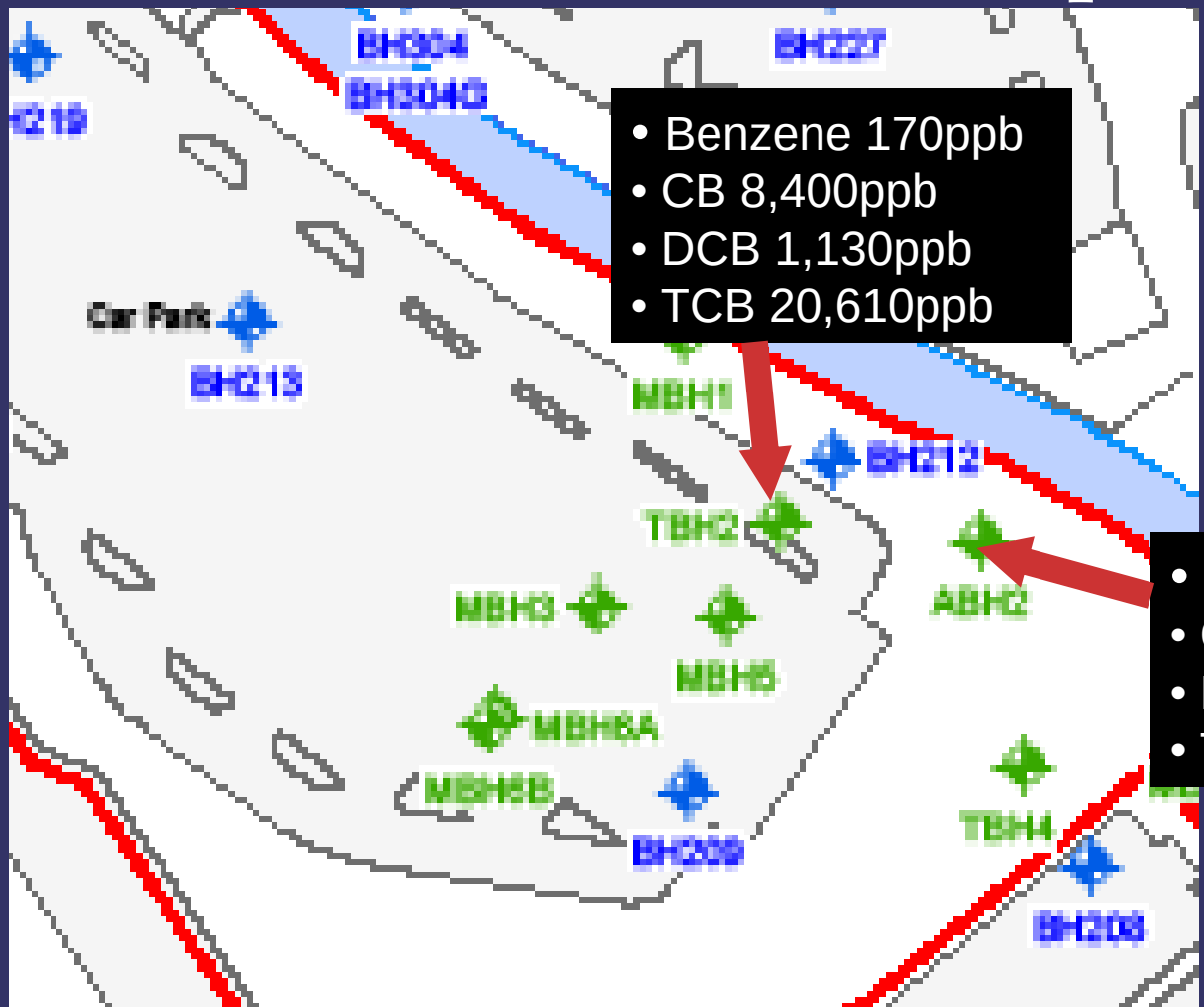
- Former industrial site in northern England
- Historic use of chlorinated benzenes (TCB, DCB, CB)
- DNAPL presence suspected
- Previous investigation and remediation undertaken by others using traditional techniques (soil borings, well installation, soil excavation)
- Geology: Made Ground underlain by sands/gravels/ clays. Sandstone bedrock at depth (circa 15-20m bgl)



- Two key components:
  - Lateral flow to river
  - Upward Gradient near river
- K – 1m/d

Trace levels of chlorinated benzenes in river

Previous Groundwater Sampling Results



- Benzene 170ppb
- CB 8,400ppb
- DCB 1,130ppb
- TCB 20,610ppb

variable screen placement in wells

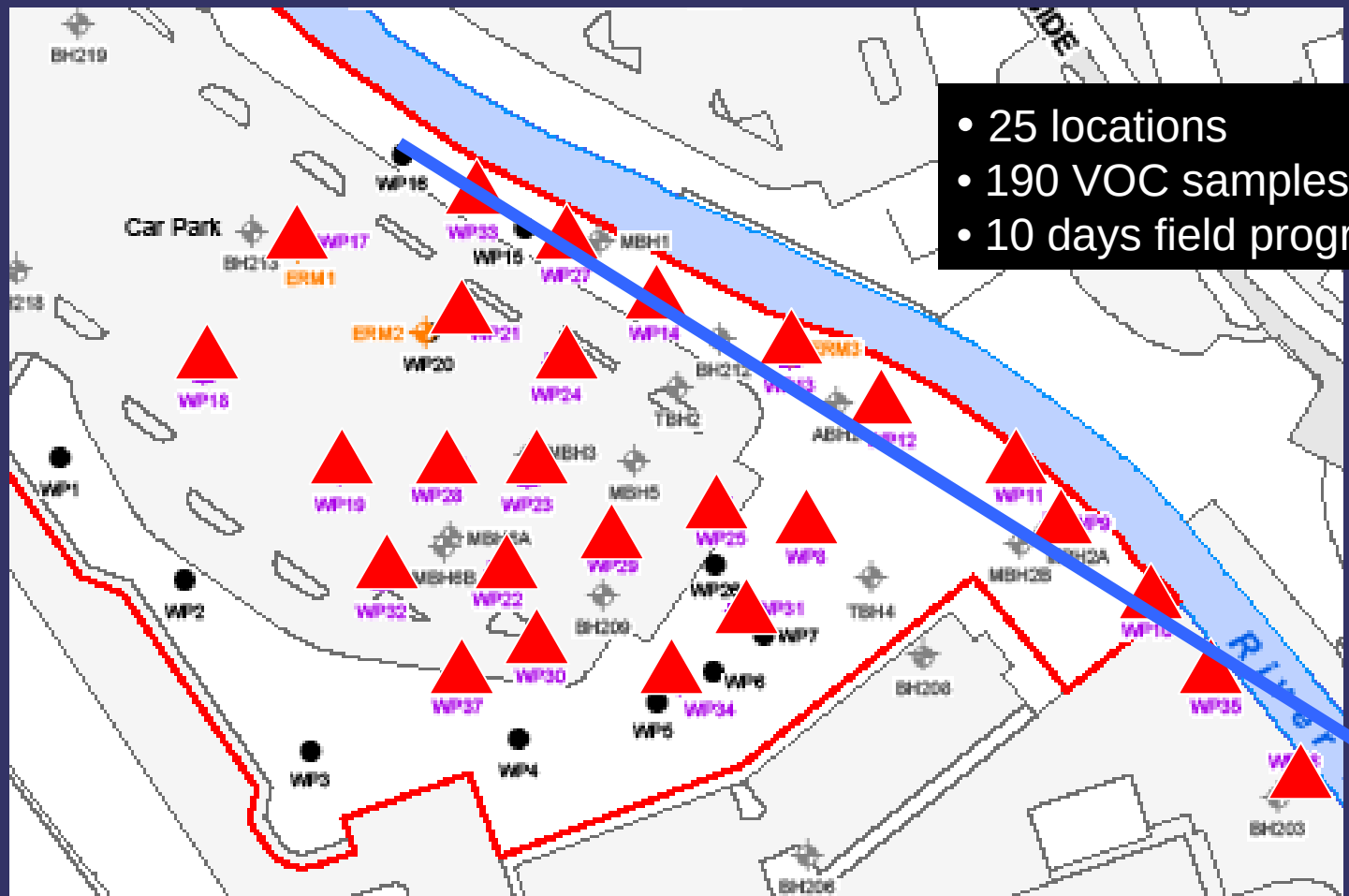
DNAPL suspected but not identified

- Benzene <10ppb
- CB 94ppb
- DCB 77ppb
- TCB 40ppb

Groundwater Investigation Objectives

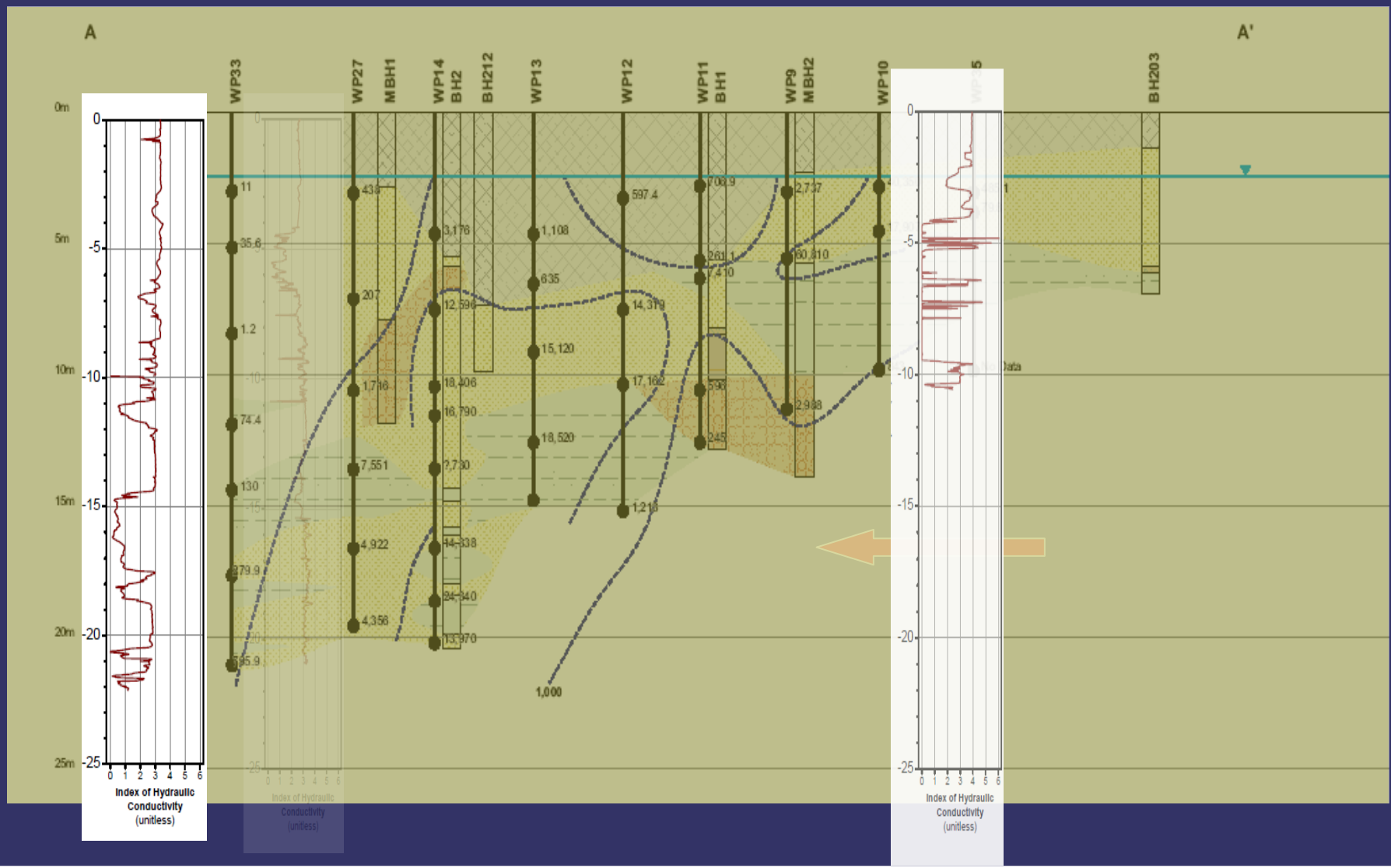
- **MWP™ investigation undertaken to refine incomplete Conceptual Site Model, specifically:**
  - Evaluate linkages between shallow groundwater and river
  - Define lateral and vertical extent and magnitude of groundwater treatment zones required for subsequent remediation works

MWP™ Location Plan



- 25 locations
- 190 VOC samples
- 10 days field programme

Cross Section North to South



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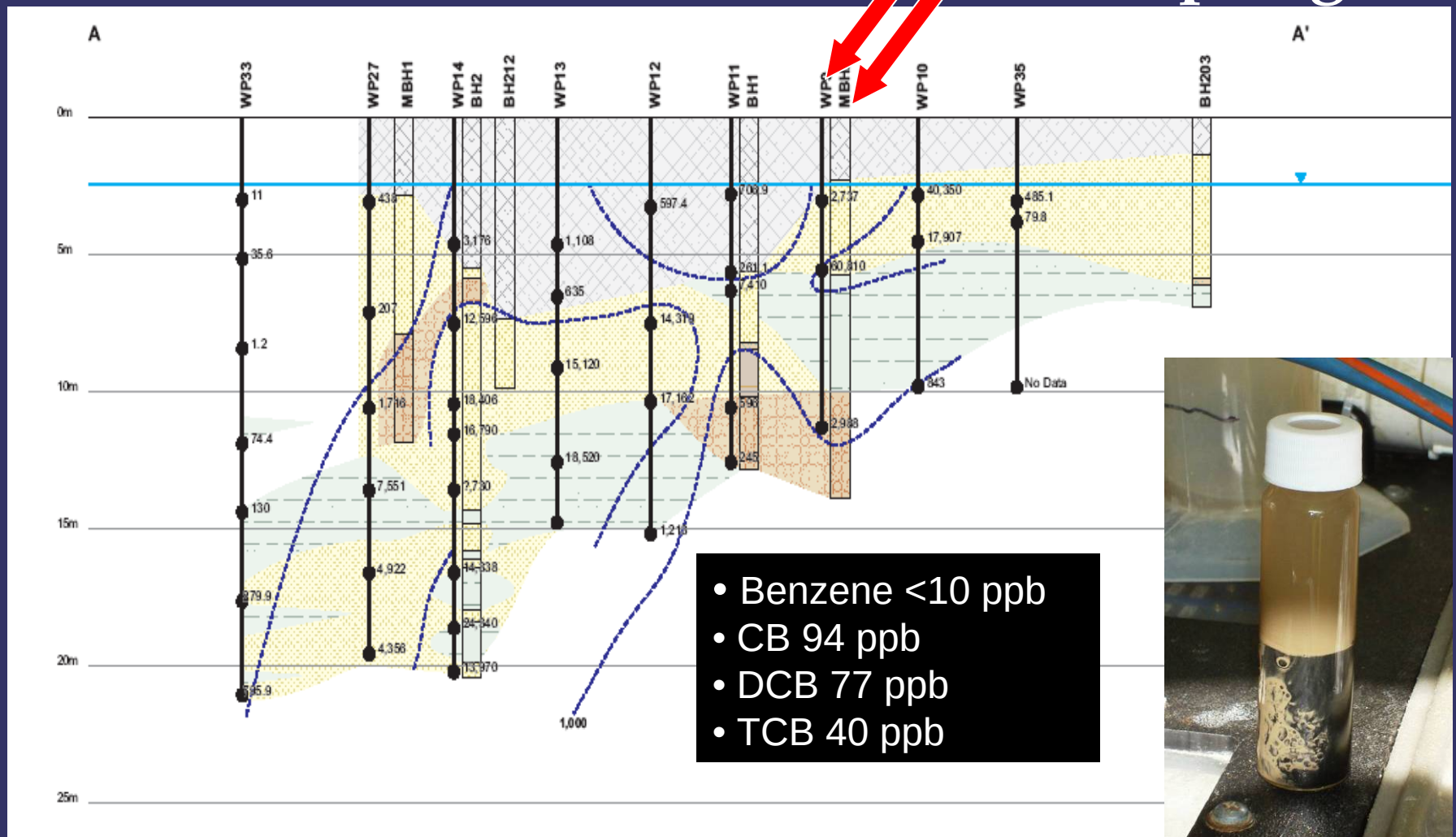
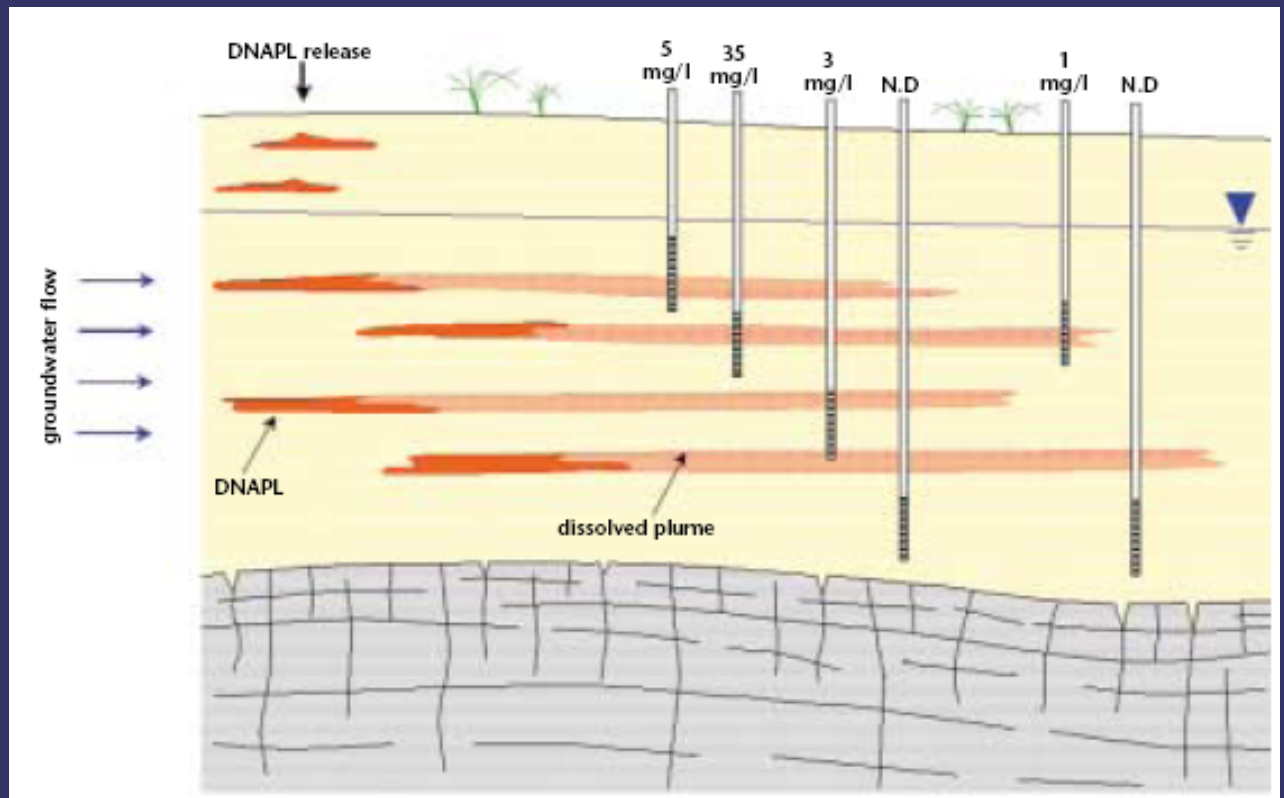
Traditional Well Versus MWP™ Sampling



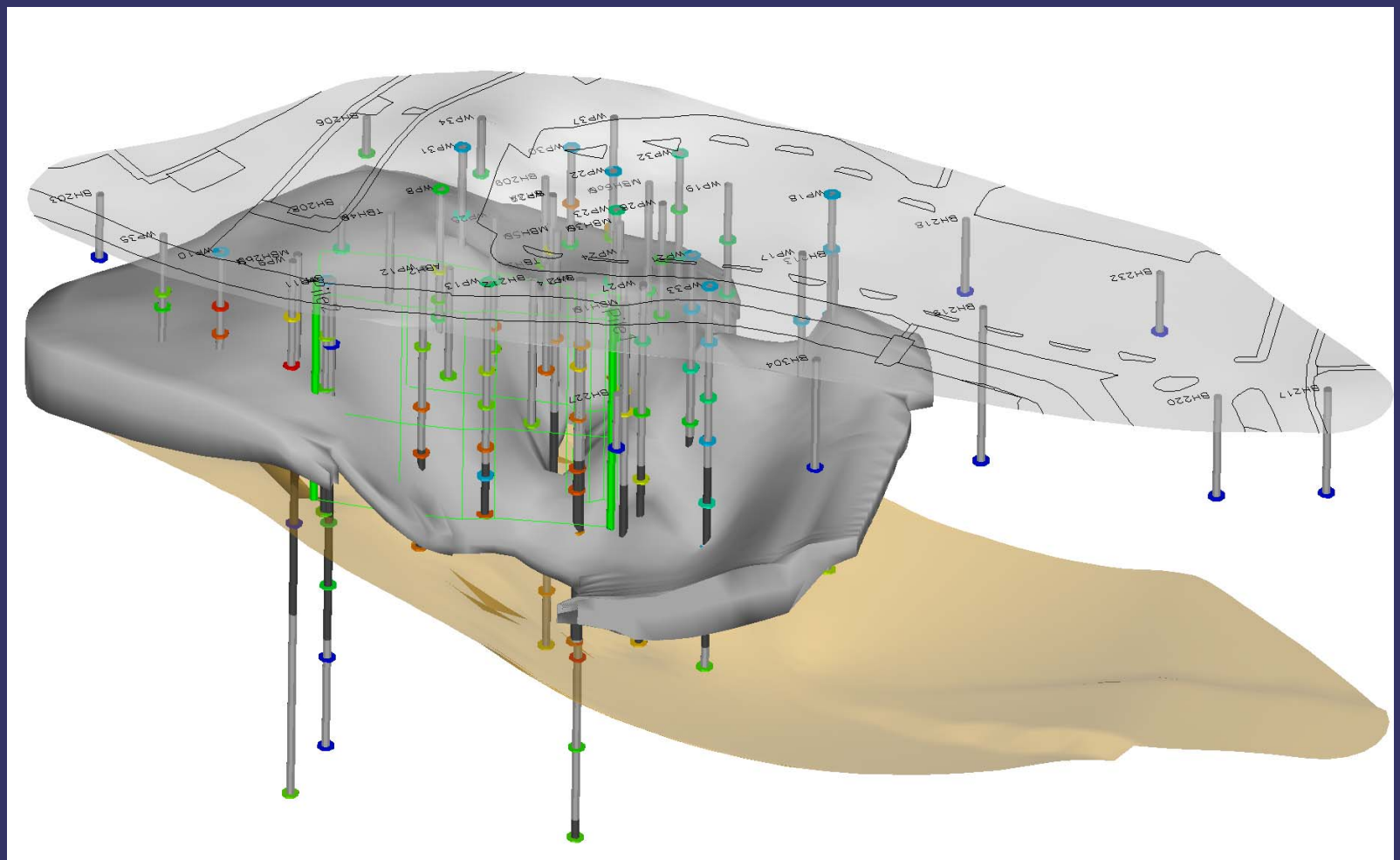
- Benzene <10 ppb
- CB 94 ppb
- DCB 77 ppb
- TCB 40 ppb

Traditional Well Versus MWP™ Sampling



Environment Agency, 2003

EVS Output



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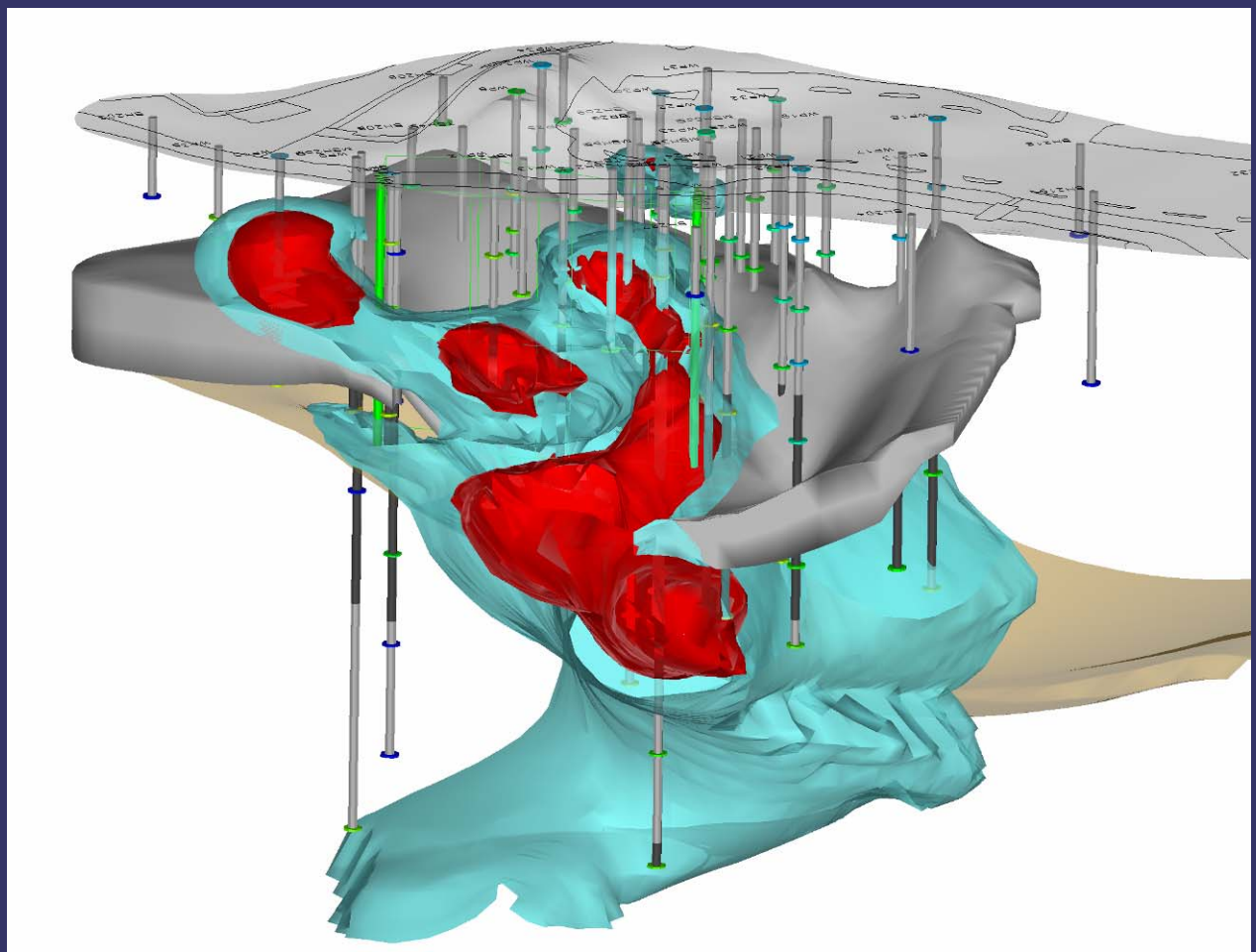
EVS Output



Heterogeneity rules (even in “homogenous” geology)

Source area contaminant mass above low K zones

Plumes migrate in high K zones

MWP™ Benefits

- Improve delineation and hence confidence
- Equivalent costs using traditional methods would have been greater
- Data quality more robust (smaller sampling interval showed higher and more representative concentrations)
- Cost savings on remediation by being able to focus effort on the areas that really need it

Conclusions

- Use of Modified Waterloo Profiler for 10 days = 190 VOC samples
- Significant advance of Conceptual Site Model
- Robustness of CSM led to greater regulatory confidence with respect to validation scheme for subsequently completed remediation
- Only the second time MWP equipment used in the UK – likely future increase in use

Questions??