# Investigation of the urban groundwater – surface-water interface via bank-side extraction well field tests

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## Research concept and experimental design

### Hyporheic zone

- **Mixing** of the ground and river waters
- Natural attenuation possible ⇒ may mitigate the impact of urban groundwater contaminant plumes
- Ratio of vertical to horizontal head gradients may affect exchanges

### Objective

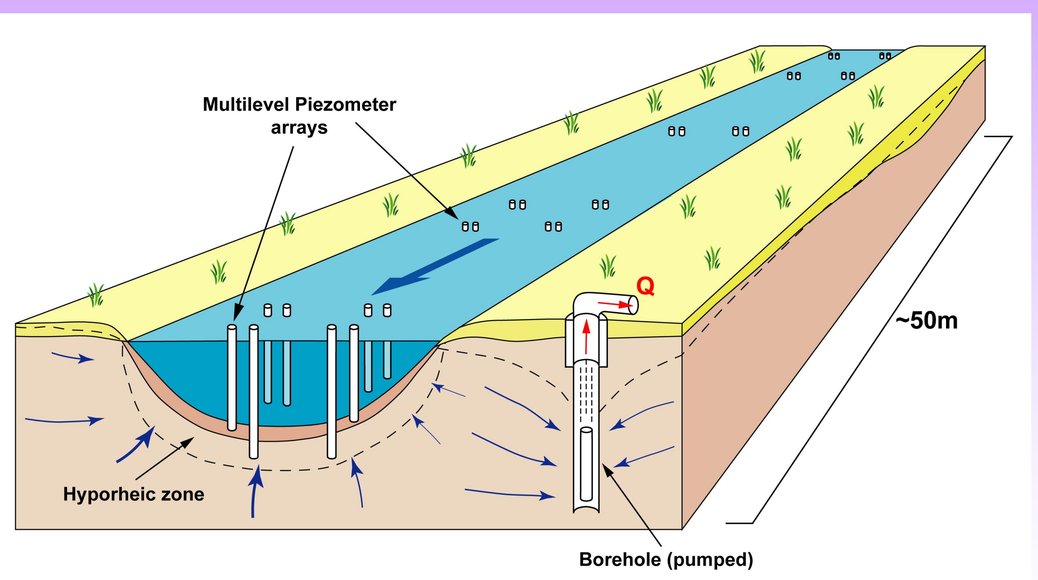
- Evaluate the **natural attenuation capacity** of the hyporheic zone under a **controlled flow regime**, given that the hydrodynamic conditions are assumed to influence those processes

### Method: field test approach

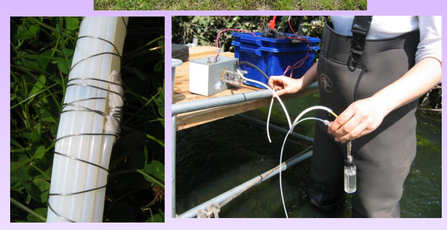
- Control the natural groundwater-surface water exchanges by **bank-side extraction well long-term field tests**
- Monitor the **transport of solutes/contaminants**
- Determine the **factors controlling the attenuation capacity of the hyporheic zone**

### Extraction tests

- 10 m wide and ~50 cm deep river, discharge of ~2 $m^3/s$
- Well 5 m adjacent to the river, 16 m deep
- Heads and quality monitoring in the riverbed
- Short-term tests to find optimal conditions for long-term tests




### Mini-drivepoint piezometers combined to multilevel samplers



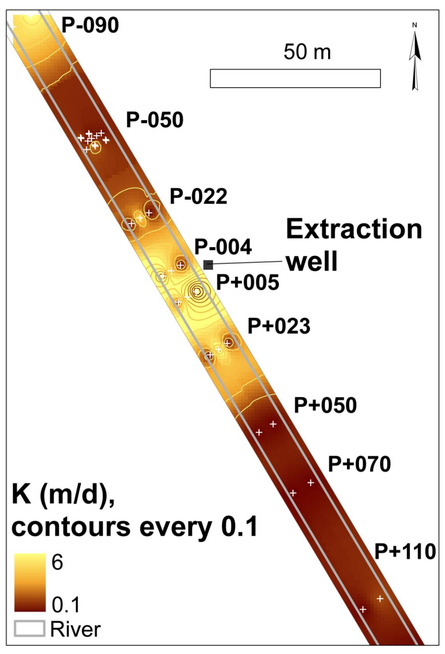
### Test site:

- Urbanised reach of the River Tame, Birmingham (UK)
- Alluvial-drift deposits overlying ~100m of Permo-Triassic sandstone

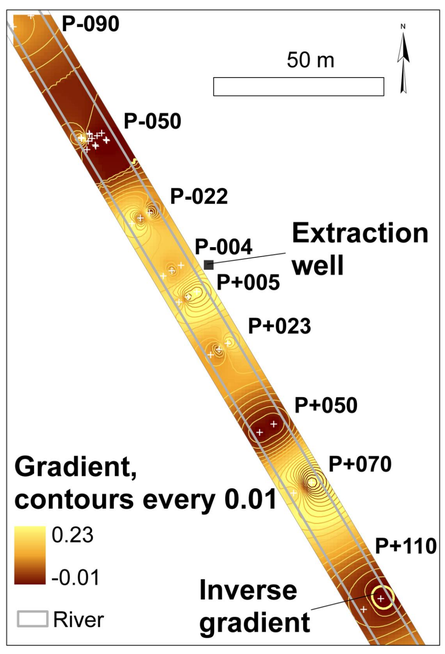
## Pre-extraction test baseline monitoring

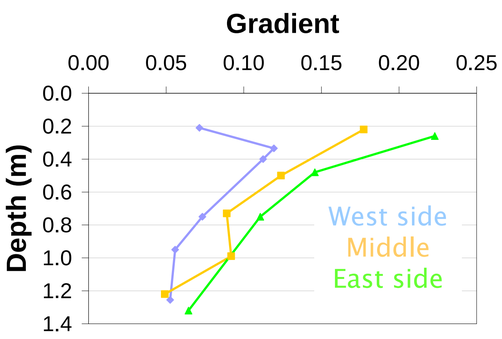
### Hydraulic data

Hydraulic conductivity



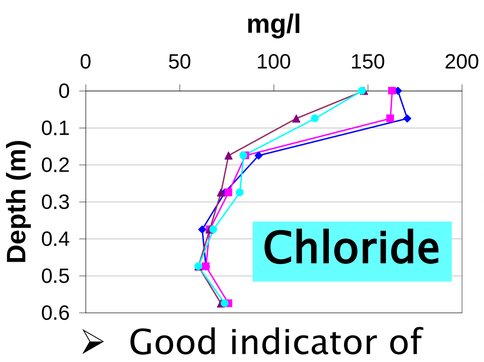

Gradient



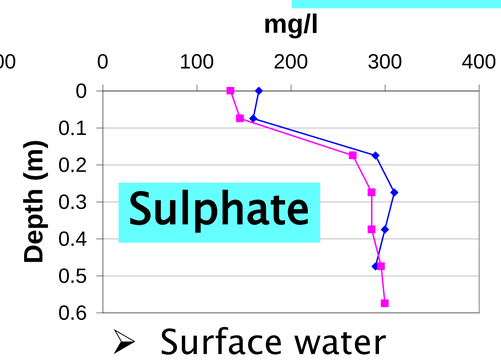




- Positive gradients → vertical flows towards the river
- Spatial heterogeneity in hydraulic data

### Chemical profiles

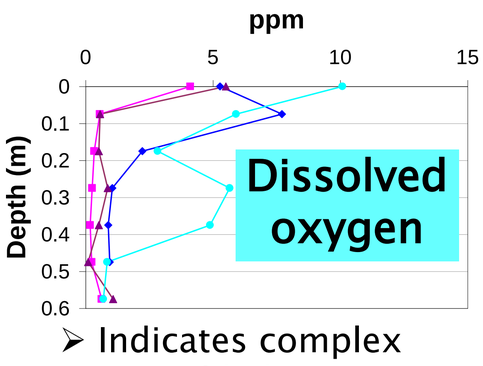



- Good indicator of groundwater-surface water mixing to 15-20cm below the riverbed

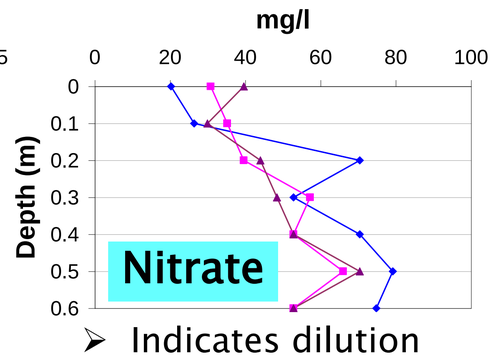



- Surface water dilution just below the riverbed

20/07/06
02/08/06
08/08/06
14/08/06

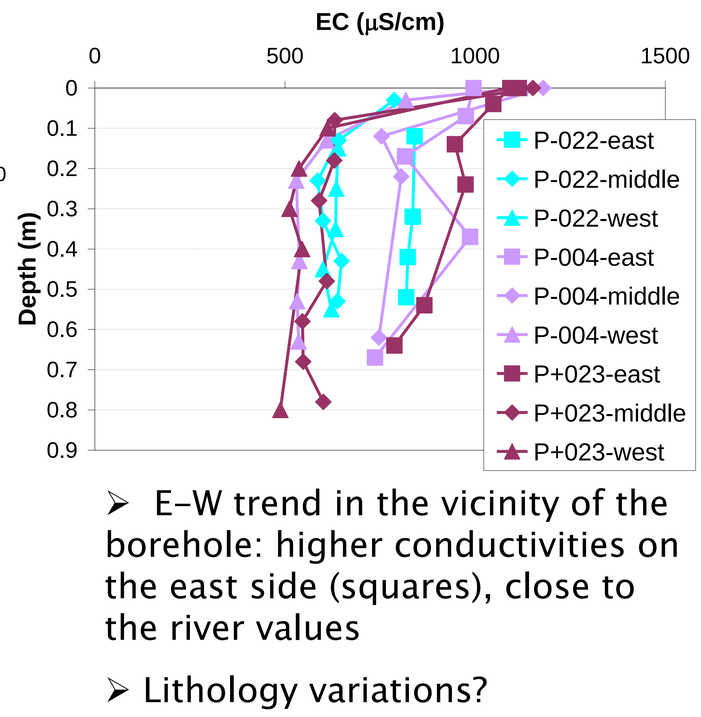



- Indicates complex temporal behaviour of this reactive solute




- Indicates dilution of groundwater nitrate and/or reaction

### Conductivity



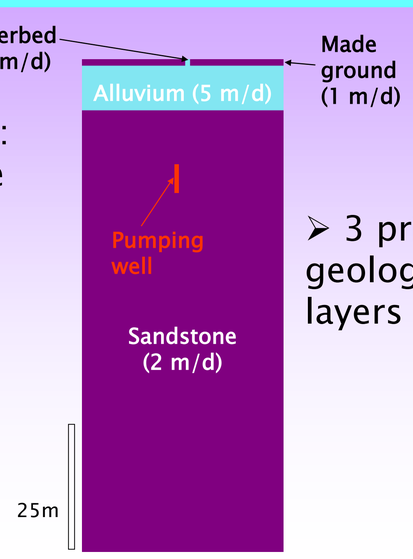

- E-W trend in the vicinity of the borehole: higher conductivities on the east side (squares), close to the river values
- Lithology variations?

## Flow simulations

### Hydraulic conductivities

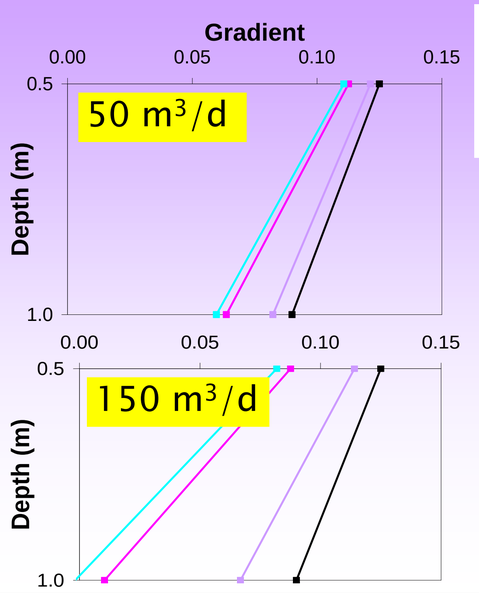
#### Aims

- First simple model: helps to calibrate the **aquifer properties** based on head monitoring
- Find an optimal extraction rate for long-term test with reduced riverbed hydraulic gradients




- 3 principal geological layers

### Sensitivity tests




Reference hypothesis
Test 1: base case properties
Test 2: Kriverbed =20m/d
Test 3: Ksandstone = 1m/d

- Sensitivity to K heterogeneity
- Riverbed hydraulic gradient decreased by pumping
- At 150$m^3/d$, vertical exchanges might be inversed: negative gradient in test 3

## Future work

- Short-term extraction tests (a few days) to determine the hydraulic conductivities and optimal pumping rates
- Long-term extraction test (a few months) to determine the hydraulic factors that control the attenuation in the hyporheic zone

Groundwater Quality in Urban and Industrial Environments, GQ 2007, Fremantle, 2-7th December 2007.