

Verification of Groundwater Flow Conditions at the Boundary of a Groundwater Protection Zone

Project background

As part of the re-designation of a groundwater protection zone, in-situ flow measurements were conducted to determine groundwater flow direction and velocity in the peripheral areas of the existing protection zone. The results were intended to provide supporting evidence and supplementary data for the re-designation of the protection zone.

Hydrogeological Setting

Porous aquifer (gravel-sand)

Purpose of Investigation

- Detailed investigation to support the re-designation of the groundwater protection zone
- Verification of the capture areas of the abstraction wells
- Contribution to drinking water protection

Investigation Results

The measurements were conducted while the groundwater abstraction wells were in operation. In all monitoring wells investigated, groundwater flow throughout the entire aquifer profile was directed towards the respective abstraction wells. Locally, exceptionally high flow velocities exceeding 1 cm/s were observed, together with partially turbulent flow conditions.

Client Benefits

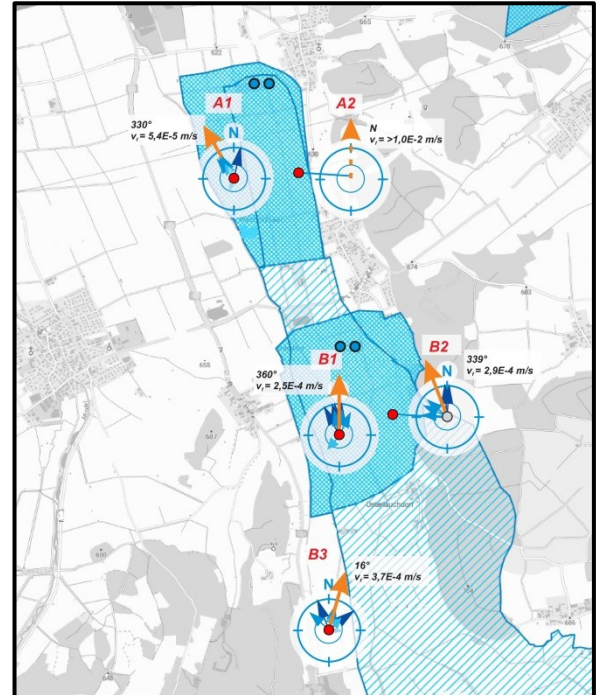
- Supporting evidence for the designation of the groundwater protection zone
- Provision of data for groundwater flow modelling
- Information for characterizing hydraulic conditions throughout the aquifer profile
- Documentation of monitoring well construction and condition for subsequent investigations

Client

Engineering consultancy on behalf of a water authority

Hydrogeological Challenge

The locally very high flow velocities and partially turbulent flow conditions (well A 2) exceeded the upper measurement range of the system in some measurement intervals. Under these conditions, flow direction could be determined from the live measurement images, while flow velocity could only be estimated by visual assessment of the observed particle movement.



Services

- Monitoring well camera inspections
- Horizontal in-situ groundwater flow measurements
- Data analysis and project documentation

Scope of Field Work

5 monitoring wells / 6" diameter
Measurement depths: 5–15 m

Location

Bavaria, Germany

Duration of Field Work

5 days

131P154

Assessment of Shallow Groundwater Inflow to the Production Horizon of Drinking Water Wells

Project Background

The production horizon of a reserve drinking water supply system is located at a depth of approximately 40 m within a heterogeneous sequence of unconsolidated sediments. It was unclear to what extent the deeper production horizon is hydraulically connected to the shallow aquifer and what proportion of shallow groundwater contributes to the deeper production horizon at different pumping rates. As this hydraulic connection could not be reliably determined from groundwater flow models based on groundwater level measurements, horizontal in-situ flow measurements were conducted within the shallow monitoring well network. The objective was to characterize groundwater flow conditions both under natural, non-pumping conditions and at different pumping rates. A river located west of the site drains towards the northeast and has a major influence on the natural groundwater gradient and flow direction within the investigation area.

Hydrogeological Setting

Porous aquifer (fine sand-gravel)

Purpose of Investigation

Detailed investigation to verify hydraulic inflow from the shallow aquifer into the deeper production horizon and to provide a reliable data basis for adjusting pumping rates and safeguarding drinking water production.

Investigation Results

The results demonstrated that both low and high pumping rates at the production wells had a distinct influence on groundwater flow within the shallow aquifer, as observed, for example, at monitoring well P1. This response provides evidence of a hydraulic connection between the shallow aquifer and the deeper production horizon.

At monitoring well P4, by contrast, groundwater flow remained directed towards the receiving river. Although pumping resulted in a noticeable reduction in flow velocity, no reversal of groundwater flow towards the production wells was observed. Shallow groundwater flow in this area was therefore only slightly influenced by pumping. (Arrow lengths in the figure are proportional to the respective mean flow velocities.)

Client Benefits

- Data basis for optimizing pumping rates
- Information on the response time of the aquifer system to changes in groundwater abstraction
- Assessment of the spatial extent of hydraulic influence at different pumping rates
- Provision of data for groundwater flow modelling

Client

Municipal utility / water supplier

Services

- Monitoring well camera inspections
- Horizontal in-situ flow measurements
- Project documentation

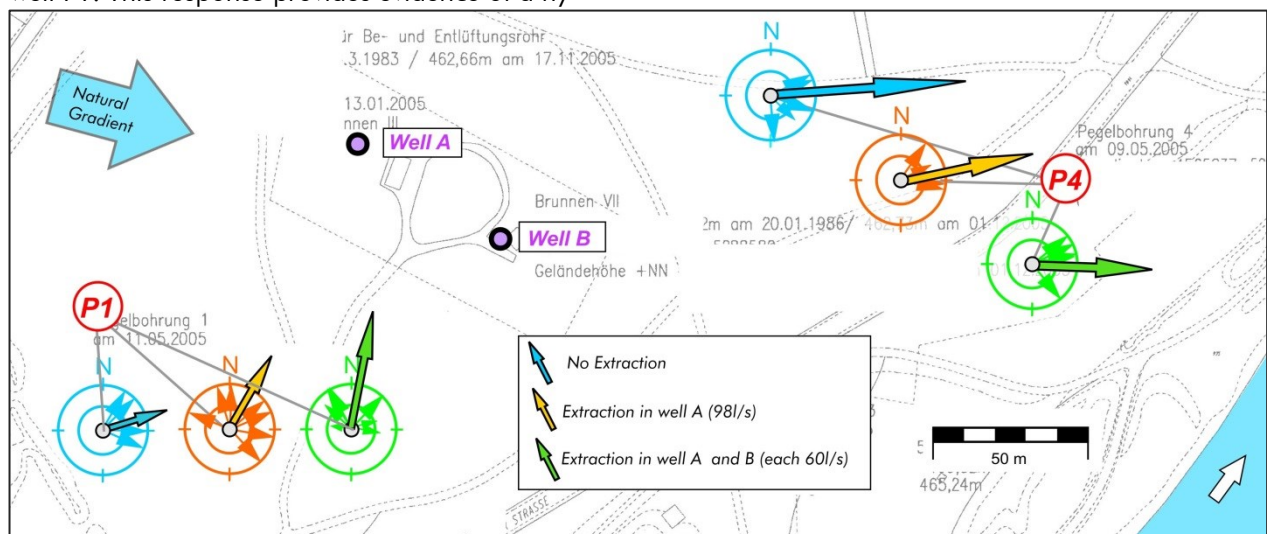
Scope of Field Work

4 monitoring wells / 2" diameter
Measurement depths: 10 m

Location

Bavaria, Germany

061P078



Detailed Investigation of Groundwater Inflow to a Well Gallery

Project Background

A groundwater contamination site is located within the upgradient area of a drinking water production facility. To assess whether further migration of the contamination could be prevented or limited by adjusting pumping rates, additional information on groundwater flow dynamics within the pumping-influenced shallow aquifer was required to refine the existing groundwater flow model. The production facility abstracts approximately 25,000 m³/day from a depth of about 60 m below ground level. The contamination site is located approximately 300 m away upgradient of the well gallery.

Hydrogeological Setting

Porous aquifer (fine to coarse sand)

Purpose of Investigation

Detailed investigation of groundwater flow dynamics within the shallow aquifer section upgradient of the well gallery. Gaining data to refine the groundwater flow model and assess whether further contaminant migration could be limited by adjusting pumping rates.

Investigation Results

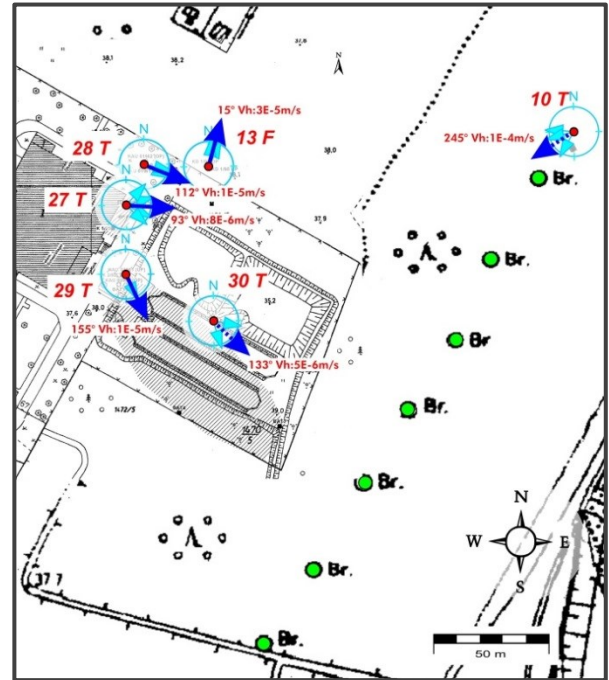
Horizontal in-situ groundwater flow measurements were conducted in seven monitoring wells at shallow aquifer depths while the production wells were in operation. With one exception, the measured groundwater flow directions were consistent with both the natural groundwater gradient towards the southeast and the general flow towards the well gallery. However, predominantly low flow velocities indicated that groundwater from the shallow part of the aquifer contributed only to a limited extent to the inflow towards the well gallery.

At monitoring well 10T, located in the immediate vicinity of the well gallery, significantly higher groundwater flow velocities towards the production wells were observed. The results provided additional data for further groundwater flow modelling and optimization of the pumping regime.

Well camera inspections revealed discrepancies in the documented construction details of several monitoring wells, allowing the corresponding well records to be corrected.

Client Benefits

- Supplementary data on groundwater flow dynamics upgradient of the well gallery
- Additional data for groundwater flow modelling and optimization of the pumping regime



- Additional data for assessing contaminant migration towards the drinking water production facility
- Verification and correction of monitoring well construction data, assessment of well condition

Client

Drinking water supplier

Services

- Monitoring well camera inspections
- Horizontal in-situ groundwater flow measurements
- Project documentation

Scope of Field Work

7 monitoring wells / 5" diameter
Measurement depths: 5–20 m

Location

Brandenburg, Germany

Duration of Field Work

6 days

031P045