HYDROGEOLOGICAL AND ENVIRONMENTAL ANALYSIS OF THE RELATIONSHIP BETWEEN SURFACE MINING AND RIVERINE WATER WELLS

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SUMMARY

An experimental area of 3 km x 6 km was selected near the waterworks of Szentendre located at the Danube bank in order to analyse the relationship among water wells, surface gravel mining and groundwater pollution caused by agricultural activity and urbanization more than one-year observation period was used for determining the underground flow pattern, aquifer parameters and water residence time. A finite-difference model was applied to investigate various hydrological conditions. Calculation was compared with measurement data.

Based on the results:
- expansion boundaries of gravel mining were delimited,
- methods were recommended for water pollution control,
- hydrogeological protection area of the waterworks was determined,
- suggestions were given on the reclamation of abandoned mining pits and ponds,
- emergency measures were recommended for water pollution events.

The investigation showed that the interaction between mining and water-supply might be even advantageous.

INTRODUCTION

From the total Danube length of 419 km in Hungary some 380 km have gravel bed of various width. As a result, both gravel mining and water supply from this aquifer have been common near larger settlements. In recent years some catastrophic pollution events have occurred at such waterworks. Now, environmental impact assessment is necessary before gravel mining can be started. Such an analysis is described in this study.

PROBLEM DEFINITION

An experimental area of 6 km x 3 km was selected near Szentendre to analyse the interaction between surface mining and water-supply /Fig. 1/. Two rows of wells /22 wells/, a mining pit pond system of 1 km^2, agricultural activity and three villages characterize the experimental area.

Thickness of the gravel layer is 10-14 m and it is covered by a 1 m top layer. Average groundwater level is 4-5 m beneath soil surface.

The waterworks can be found in a distance of some 100 m from the mine. This latter can be expanded only in the direction of the waterworks, however the waterworks would be also developed.

The mining pond and the well system modify natural seepage conditions. Direct surface pollution can reach pond surface and in this way, groundwater. The task is to determine the minimum distance between mining and waterworks which does not lead pollution in the water-supply, and to recommend measures for a proper water quality.

Regular measurements were taken in 25 observation wells throughout a year in order to form a correct hydrogeological model. Specific objectives of the observations were to determine:

- the effect of Danube flow on groundwater level,
- the seepage flow from the landside, originating from infiltration,
- boundary conditions for the finite-difference model.

Groundwater level measurements show that
- groundwater flows toward the Danube with an average slope corresponding to the Danube water level of 50% duration,
- there is a strong correlation between groundwater level over a 1000-1200 m wide area, the mining region along the Danube, and river water level,
- there is seepage flow from the mining ponds toward the waterworks if river water level is relatively low and vica versa.

Simultaneously with groundwater level observation, water quality sampling was also effected /total hardness, sulphate ion, nitrit and nitrate ions/ in the ponds, the background, the Danube and the waterworks. The same regression relationship holds within 10-15% tolerance between water levels in the background and Danube, and supplied water quality. Thus, water quality changes can be inferred from water level changes.

The sampling of ponds shows that if surface pollution into the ponds are eliminated, mining does not pollute groundwater. On the contrary, pond water quality is better than background groundwater quality, as result of aerobe biological processes.

However, the possible surface pollution of the ponds requires a safety filtration buffer zone between the waterworks and the mine. The sizes of this zone is determined from the necessary water residence time difference between that for the river and the waterworks and that for the waterworks and the mine. This difference should correspond to the better water quality in the ponds.

A finite-difference model was used for calculating hydraulics influencing the residence times.

The following control measures are recommended to protect pond water quality:

- diverting polluted surface run off from the ponds,
- restricted use of agricultural chemicals,
- observation pond to check the quality of groundwater recharge into mining ponds.

There is a possibility of indicating pollution events in the observation pond by fishes such as trout /Solmo iridens/ and carp /Cyprinus carpio/.

In case of an excessive pollution it is possible to form a drawdown in the observation pond by pumping in order to prevent seepage into the mining pond and the waterworks.

Results of this study make possible to mine some 1 800 000 m^3 of gravel. Thus, both mining and water-supply can be continued in a safe environment.

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LIST OF FIGURE

II. **Mine pond**

Protection pond

Mine enlargement

Water-works area

Water-works well

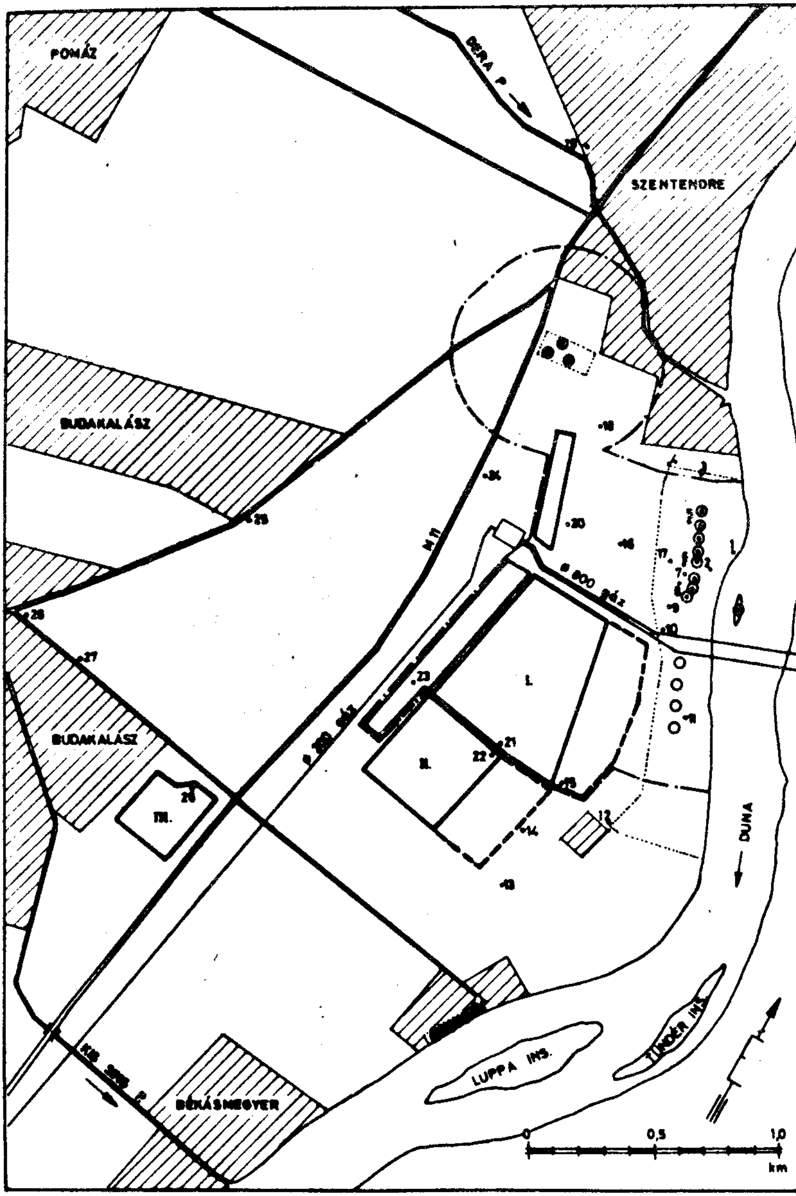
Water-works enlargement

.2 **Water level observation point**

Village

M1 **Highway**

Hydrogeological protection area boundary



1. ábra Figur 1.