Water Management to Protect Wetland to the North of the Rhenish Lignite District

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ABSTRACT

Opencast Lignite Mining requires topwall strata of seams to be fully depleted and footwall aquifers sufficiently depressurized. To prevent a spread of the cone of depression into protected wetlands some distance away, alternatives had been investigated such as closing water works, underground slurry wall barriers and recharge by infiltration.
As a result of these investigations, the infiltration method has been chosen and in a first phase during the next decade it will utilize as much as 55 x 10^6 m³/year. Using this approach, the survival of the wetlands is assured.

INTRODUCTION

Lignite Mining in the Rhenish Lignite District is a major factor in the energy supply of the Federal Republic of Germany. From at present four open cast mines of Rheinische Braunkohlenwerke AG (Rheinbraun) a total of up to 120 Mio t is excavated (3). Open cast technology requires all permeable topwall strata of the seams within the bounds of the mines to be fully depleted an the footwall strata sufficiently depressurized (1). The resulting cones of dewatering and depression have resulted in the past in local disturbances of public water supply. Rheinbraun has compensated water users by supplying substitute water.

By and large, no adverse impact to plant growth has been observed. The reason appears to be the existence of a loess topsoil having a high porosity which supplies the plants with water.

Only in relatively narrow stretches of land along natural streams and rivers, has phreatophytic vegetation suffered severely under the decline of the initially shallow water table. This process has been accompanied by a loss of habitat of endangered species of plant and wild life.

No further losses can be tolerated, so that it has become mandatory for Rheinbraun to protect by appropriate measures the remaining wetlands, principally located to the north of the mining area.

GROUNDWATER AND ECOLOGICAL CONDITIONS

The major hydraulic feature of this northern part of the mining area is a thick aquifer above the coal, consisting of Quaternary and Tertiary sands which are only locally separated by a confining or leaky clay bed. The footwall of the seams is formed by fine sands, forming a confined aquifer.

Figure 1 shows the principal systems of catchment streams: along the Erft River ground water flow directed towards the northeast, along the Niers River towards the north, and anlong the Schwalm River towards the northwest. The region is affected by public and industrial water works.

Groundwater withdrawal for the Garzweiler I Mine has resulted in a cone of depression whose present limit is shown in the figure. South of this limit, the flow of ground water is directed towards the mine, also shown. The total area directly affected by mine dewatering is identified by a dotted line.

The said wetland zones, mainly protected alder swamps but also bogs occur especially along the Schwalm (and Nette River) systems to the northwest of Garzweiler I Mine.

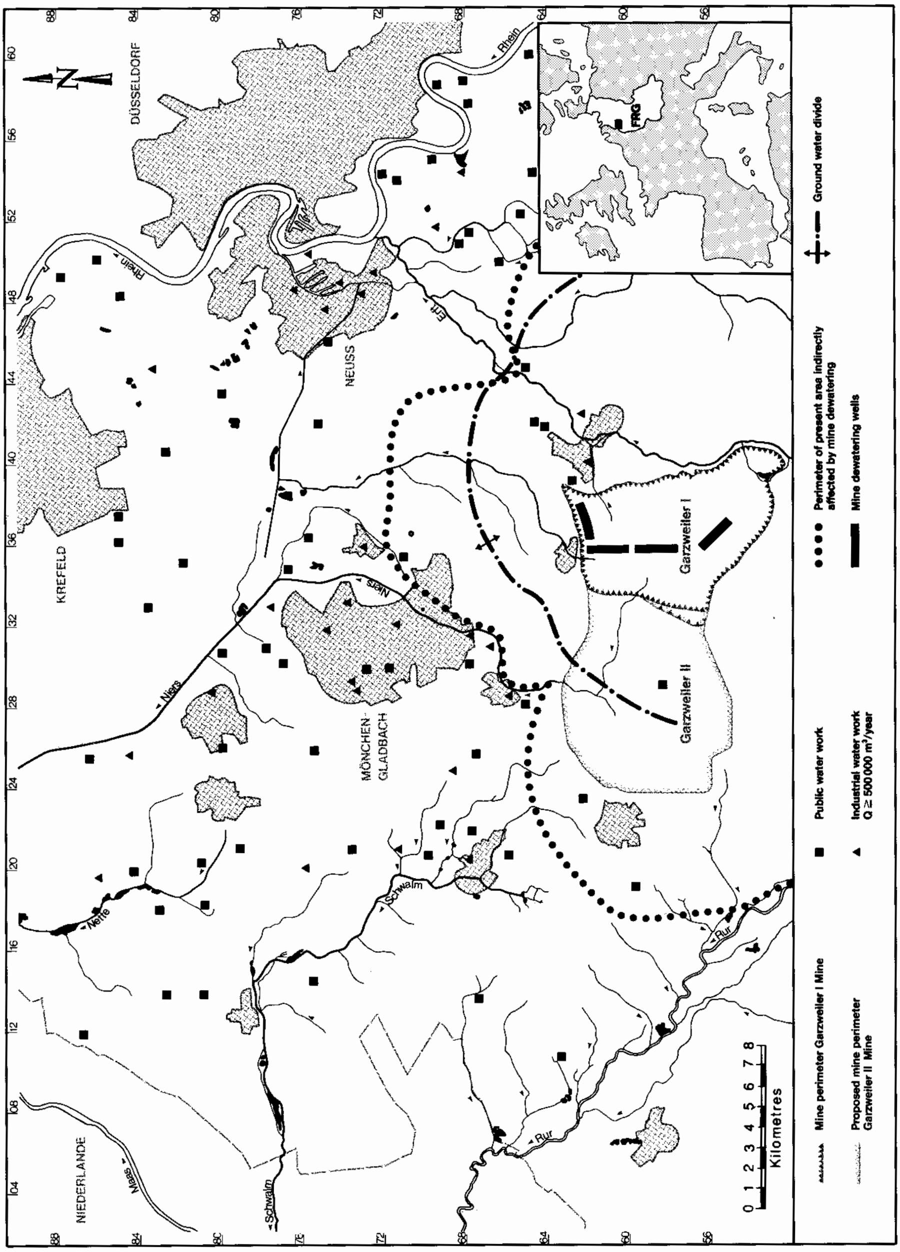


Fig. 1: Regional situation with ground water divide and area affected by mining

MINE DEWATERING MEASURES

Mine dewatering has been conducted by means of gravel packed wells which usually are sunk several years ahead of actual mining (fig. 2; (2)).

In 1986, there were 600 wells operating for Garzweiler I Mine alone which discharged 80 x10^6 m^3 to enable a lignite extraction of 30 Mio t. The average drawdown in the mining area amounted to 150 meters.

To determine the pumping rates required and assess the impact of dewatering, numerical ground water models have been applied. These models are especially adapted to the requirments of mine dewatering (6).

SOLUTIONS TO LIMIT ENVIRONMENTAL IMPACT OF DEWATERING

LIMITING THE GROWTH OF THE CONE OF DEPRESSION

To limit the growth of the cone of depression, i. e. to stop it effectively upstream of the protected wetlands, the following technical measures were thoroughly investigated:

1. Shutting off wells of water works near the perimeter of the cone of depression (dash-dotted line of figure 1)

2. Recharging the stressed aquifer(s) by allowing water to infiltrate close to the protected wetlands

3. Designing an underground slurry wall near the mine to act as barrier

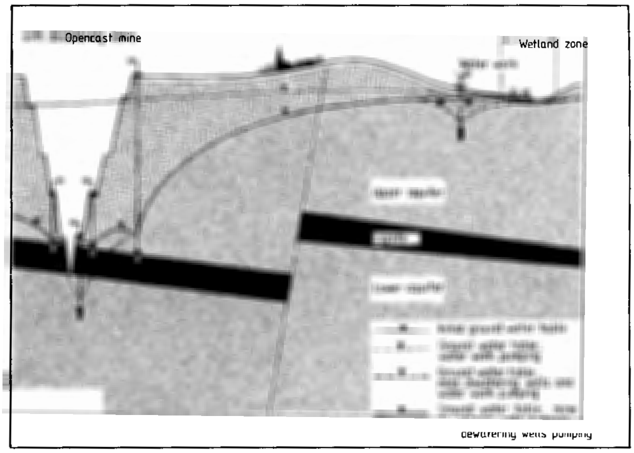
The following explanations are necessary:

case a): Public and industrial water works are often located in the valleys close to the rivers or their tributary streams, i. e. also close to the wetlands. Their cones of dewatering have already affected to some degree the water budgets of wetlands. If, by superposition of

Fig. 2: Techincal Possibilities to Limit Environmental Impact of Mine Dewatering

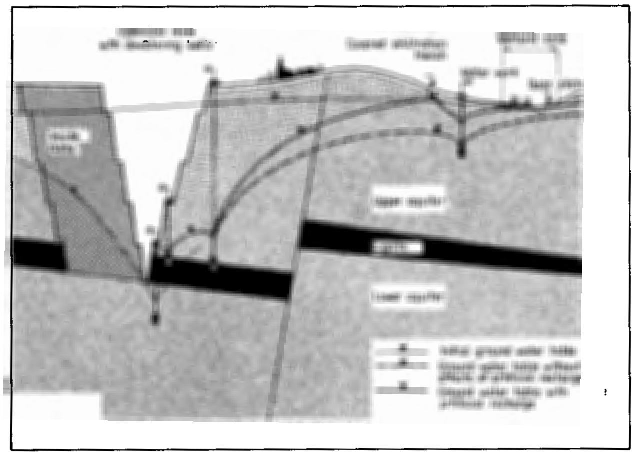
case a)

Shutting off wells



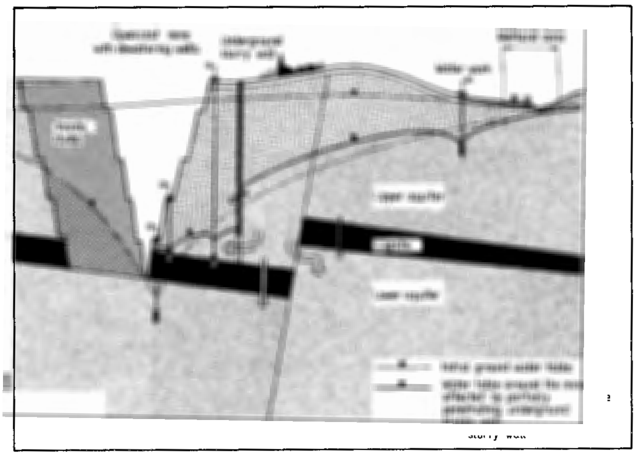
case b)

Infiltrating water



case c)

Designing an underground slurry wall



the cone of dewatering/depression from the mine, the shallow water table drops further, the wetland may completely dry up. If it were possible to shut off the wells of such a water works, the decline of the shallow water table would not be as notable and the wetland would be preserved (fig. 2, case a). Such hydrologic situations prevail along the perimeter of the cone of depression around the mine.

case b): There, were the mine-induced drawdown will amount to several meters, a shutting off of wells will be an insufficient cure. In such an area, recharging the stressed aquifer by allowing water to infiltrate is a suitable remedy. Where not only the mine-induced decline of the shallow water table is balanced by water infiltration, but also the discharge of the local water work, its then the water work's wells can continue to be utilized.

Today there are several methods known to infiltrate water into aquifers. The most suitable appear to be infiltration basins and infiltration trenches (4). Another possibility is the direct discharge of water via seasonally dry drains or irrigation pipes. Testing has been carried out for some time to gain operational experiences in operating such recharge facilities on a large scale.

case c): Detailed investigations were carried out, to evaluate the practicability, properties, and costs of underground slurry walls (5). The investigations concluded that such slurry walls are not suitable to check the adverse impacts of mine dewatering in the northern part of the Rhenish Lignite District. In the first instance, it is technically impossible nowadays to design them for depths of 200 meters and more. Secondly, even if such depths were technically possible, the heavy faulting would always allow water to bypass the barrier via the footwall aquifer (fig. 2, case c). It was therefore concluded that slurry walls are not the solution to the problem.

COMPENSATING THE AFFECT OF DECLINE WITHIN THE CONE

Everywhere, where the initally shallow water table has declined more than 5 meters, recharge by infiltration to raise it again is not economically feasible. Only locally, viz. where a wetland is underlain by a shallow impervious bed such as alluvial loam, can a perched water table be maintained in its initial position by infiltration.

In all other cases it must be accepted that the swamp or bog cannot be maintained. Careful management by ecologists can however gradually convert it to a protected area of different character.

WATER MANAGEMENT

To minimize the environmental impact due to dewatering the operating Garzweiler I Opencast Mine, the protective measures had been agreed upon as early as 1986 during negotiation between the government of the State of Northrhine-Westphalia and Rheinbraun. According to the agreement achieved, Rheinbraun will collect up to 55 x 10^6 m^3/year of water, de-ironize it in a central plant and pipe it to several discharge sites. 10 x 10^6 m^3/year of the above total will be directly discharged into receiving streams and seasonally dry ditches (fig. 3).

Following completion of the feasibility study, Rheinbraun now engaged in the detailed engineering, statutory processes, and land acquisition. The necessary facilites shall be erected during the years 1989 - 1991.

For the proposed Garzweiler II Mine, which is scheduled to operate between the years 2005 and 2045, planning is still in the prefeasibility phase. Planning includes a gradual extension of the infiltration facilites to the northwest and an increase of the infiltration rates up to 90 x 10^6 m^3/year. Following the end of operations in this mine, the remnant hole shall be filled with water from the Rhine River. Water from the emerging lake will also recharge the depleted aquifers. Direct infiltration can thus gradually be reduced. A new equilibrium between ground and surface water flow will be achieved around the year 2085 (6).

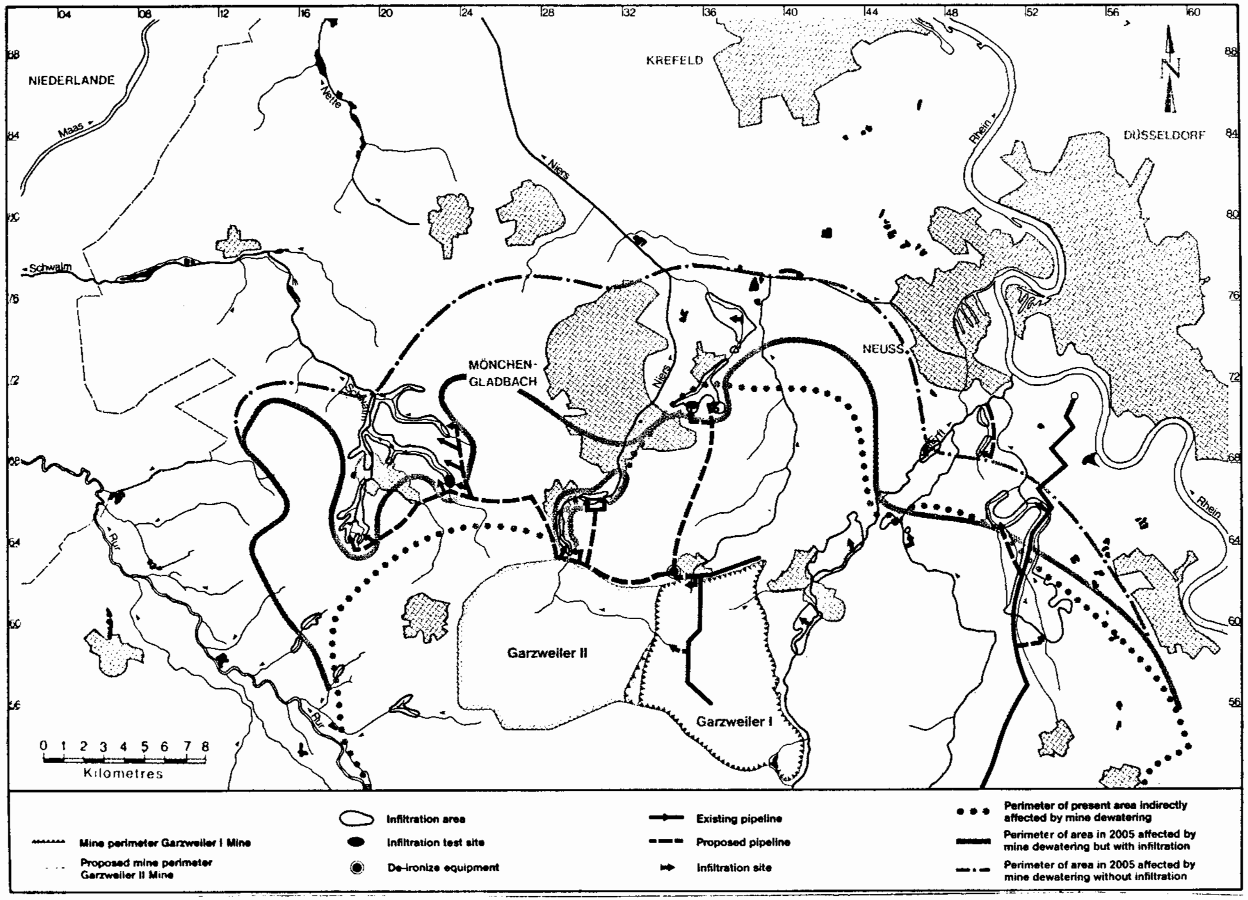


Fig. 3: Water management schemes in the northern part of the Rhenish Lignite Destrict

OUTLOOK

Numerical simulation and field tests have shown that recharge to the stressed aquifer will be an effective means to protect ecologically valuable wetland from drying up. Swamps and bogs will thus survive open pit mining. Such a technique will not remain confined to Garzweiler I and II Opencast Mines District but will certainly also apply to other mines elsewhere. It has been proven that Mining and the Environment can be reconciled.

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