

## Sustainable water supply in Denmark: Protection zones and land management to restore contaminated groundwater on the island of Tunø

*For the first time in Danish water supply history, it has been possible to use protection zones to restore groundwater from the effects of agricultural production. Here permanent grass reduced nitrate leaching rapidly and effectively. After just one year, the nitrate concentration in the new groundwater formed under the grassland remained at around 1 mg/l.*

As experience with groundwater protection zones was very limited ten years ago, the project involved extensive water quality monitoring in order to determine the effects of the protection zones. The project was centred around Tunø Waterworks on the island of Tunø in Aarhus Bay. The waterworks abstracts water from the only water resource of significance on the island. Water consumption is 11,000 m<sup>3</sup> per year. The level of net precipitation on Tunø is low, ranging between 100-150 mm per year. Tunø has a permanent population of approximately 90 persons. In addition, there is a considerable flux of tourists

to the summer cottages and in particular to the marina during the summer months.

During the course of the 1980s, the nitrate content of the drinking water increased so much that action was needed to ensure compliance with the EU contamination standards for groundwater.

In 1988 a working group was established whose task was to draw up a strategy for safeguarding the drinking water supply on Tunø.

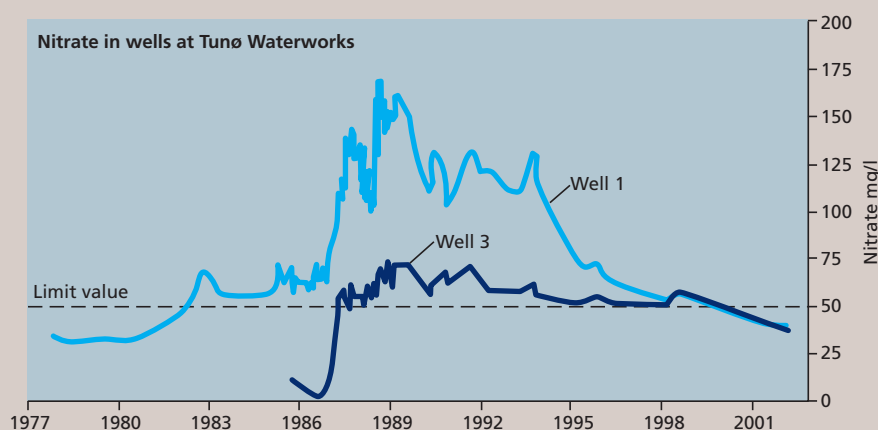
### Economic preconditions for choice of solution

Before deciding to establish the protection zones around Tunø Waterworks, the working group examined a number of different solutions.

Three main solutions were proposed:

1. Establishing protection zones involving regulation of land use and associated monitoring aiming to restore good groundwater quality.
2. Establishing advanced water treatment systems, such as reverse osmosis or denitrification.
3. Importing pure drinking water, either via a pipeline from the mainland or using road tankers.

In 1987, the working group concluded that from both technical and economic viewpoints, groundwater protection was the most appropriate solution. The only other economically viable solution was to import water in road tankers, but this would demand installation of domestic water tanks and create a considerable daily practical nuisance for the consumers.





Solution (1986 prices)	Establishment	Annual running costs
Protection zones	EUR 27,000	EUR 300
Monitoring	EUR 53,000	EUR 11,000
Water treatment	EUR 27,000	EUR 27,000
Import of water in tankers	EUR 9,000	EUR 35,000
Import of water by pipeline	EUR 480,000	EUR 53,000

In the spring of 1989, two protection zones were established: an inner protection zone with permanent grass immediately surrounding the abstraction wells in which the application of nitrogen fertilizer was prohibited; and an outer protection zone extending to a radius of 300 metres in which the nitrogen fertilizer was strictly regulated at low levels.

Protection zones can restore contaminated groundwater and ensure pure groundwater. Permanent grass reduces nitrate leaching rapidly and effectively. After just one year, nitrate concentration in new groundwater formed under the grassland remains at around 1 mg/l.

Monitoring is necessary in order to rapidly focus efforts so as to ensure the necessary improvement in water quality. It took five years for the pure groundwater to reach the water table. After ten years, the upper metres of the groundwater underneath the inner protection zone are now completely pure.

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