

LAKE NAARDEN CONSERVATION STRATEGY: SUPPLY WATER TREATED IN SPECIAL P-REMOVAL UNIT

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INTERNATIONAL WETLAND ON THE VERGE OF A DRY-UP

The oldest nature reserve in The Netherlands, Lake Naarden, has recently been acclaimed International Wetland according to the RAMSAR convention. This shallow freshwater lake, lying amidst the urbanized areas in the central part of the country, is famous for its unique flora and fauna, including colonies of cormorants and spoonbills.

During the past ten years, however, a continuing decrease in the summer water levels has been observed. Groundwater supply from the east is decreasing due to increased withdrawal and declining infiltration rates. Leakage towards the west is enhanced because of lower water levels maintained in the neighbouring polders (Figure 1).

As a consequence the peaty soils are subjected to oxidation, causing a release of nutrients which increase the eutrophication rate. This in its turn interferes with the ecological equilibria present, thus endangering the specific character of this area. In addition, due to the increasing inaccessibility of the area, difficulties arise with the execution of managerial measures and the traditional reed harvesting.

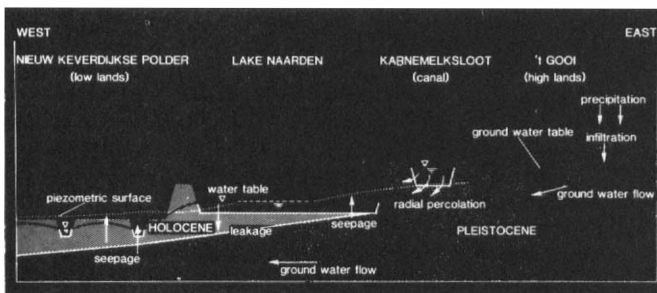


Fig. 1 Complex hydrological situation of Lake Naarden

STUDY ON EXTERNAL WATER SUPPLY

On behalf of the Society for the Promotion of Nature Reserves in the Netherlands, the proprietor of the lake, a feasibility study was carried out to develop and evaluate alternatives for additional water supply.

This study was conducted in close co-operation with the Ministry of Transport and Public Works, the Water Authority Amstel- en Gooiland, the Provincial Waterboard of North-Holland, the River Board Drecht en Vecht and the Society for the Promotion of Nature Reserves.

Considered as possible supply areas were (Figure 2):

- the IJmeer, the southern part of Lake IJssel (A)
- the Spiegelplas, a small, deep lake in the Spiegel- and Blijkpolder (B1, B2)
- the Horstermeerpolder, a seepage area of fresh and saline groundwater (C1, C2).

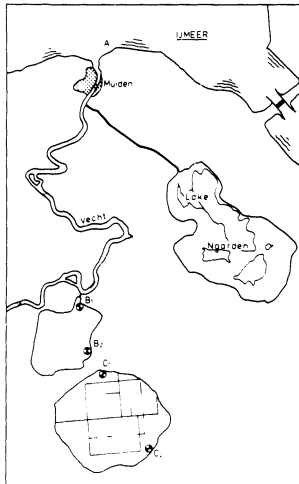


Fig. 2 Lake Naarden and possible supply areas

An interdisciplinary approach was pursued, involving (geo)hydrology, hydrobiology, ecology, civil engineering and treatment technology. In the following the main elements of the study are summarized.

Water quantity aspects:

- definition of minimum and maximum allowable water levels
- water balance studies
- estimation of supply water lost due to extra leakage
- consequences of different supply regimes (constant versus fluctuating flow rates)
- estimation of water quantity to be supplied
- mode of water transport (open canals versus pipelines)
- quantitative effects for the supply areas (present situation as well as future perspective)

Water quality aspects:

- definition of adequate supply water quality
- evaluation of existing water quality data for Lake Naarden and the supply areas
- field investigations of above mentioned areas, evaluating physico-chemical characteristics, presence of micropollutants and special hydrobiological aspects, such as biological water quality assessment and phytoplankton monitoring
- integration of water quality perspectives for the future
- evaluation whether supply water needs pretreatment
- consequences of the different modes of supply (number of inlets, flow variations in supply regime)

Aspects of engineering and technology

- design of the best routes for the individual pipelines or canals
- evaluation of consequences relating to existing regional and urban development plans
- evaluation of best applicable treatment methods
- preliminary design of the treatment system
- optimization of design with respect to simplicity and cost
- estimation of investments, working expenses, maintenance costs, etc.

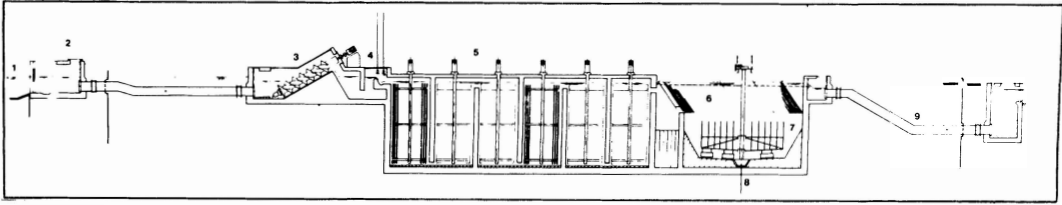


Fig. 3 Schematic overview of water treatment system for phosphate removal.

1. inlet	5. flocculation compartments
2. incidental chlorination in order to prevent growth of molluscs	6. lamella separators
3. archimedial pump	7. sludge thickener
4. dosage of FeCl_3 and sodium hydroxide	8. sludge transport to lagoons
	9. inlet of dephosphated water into Lake Naarden

TOWARDS A SOLUTION FOR THE WATER SHORTAGE

By means of selection matrices an overall evaluation of the various alternatives was carried out. This included criteria referring to:

- short term feasibility, legislative procedures
- minimum interference in the existing landscape features
- absence of possible conflicts with other interests

Finally it was unanimously concluded that the IJmeer offered the best perspective as supply area. Phosphate removal was considered essential to meet the water quality requirements.

For this purpose a compact, low cost treatment facility was designed for a continuous water flow of $14,000 \text{ m}^3$ per day during the spring and summer months. In this time of year IJmeer water enters the river Vecht through the Muider sluces after which it can be let into one of the canals leading to Lake Naarden. Here, at the inlet site, treatment takes place.

Phosphate removal is carried out by means of flocculation with FeCl_3 and the sludge is retained in a lamella-separator/sludge thickener combination (Figure 3). The sludge is further dried in sludge lagoons.

The exterior of the treatment plant is carefully designed to fit in well in the surrounding landscape. Low wooden buildings hide the subsurface treatment facilities from the eye (Figure 4).

Thus an unique wetland can be restored by means of special technological provisions. Technology put at the service of nature conservation.



Fig. 4 Skyline of northern part of Lake Naarden with treatment facilities (right)