

WATER SUPPLY FROM THE WEST GERMAN NAVIGATION CANALS

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ABSTRACT

In a highly industrialized and densely populated region navigation canals make possible the transport of bulk goods by ship and at the same time the supply of water for industrial use.

THE RUHR DISTRICT

The industrial agglomeration "Ruhrgebiet" in the territory of the state of North Rhine-Westphalia is bounded in the south mainly by the river Ruhr, and in the north by the Lippe River; the Emscher River is the central river flowing through this region. Situated for the most part north of the uplands, the Emscher and Lippe are typical rivers of flat country (Figure 1).

Until far into the 19th century it was a predominantly rural area. Based on local deposits of precious mineral coal, which is extracted by underground mines, iron and steel industries developed rapidly over a few decades and effected the settlement of some millions of people. Problems of water management arose essentially at the end of the 19th century; thereby the three rivers got the following tasks:

- Ruhr: drinking water supply,
- Lippe: industrial water supply,
- Emscher: waste water discharge.

In addition, during the 20th century chemical industries have been established and many power plants have been built to cover the considerably increased energy demand of industry and inhabitants.

The fringe areas are used intensively by agriculture.

THE NAVIGATION CANALS

To make low-cost transportation of bulk goods like coal, ore, steel, steel products and building materials possible, a system of navigation canals was built at the turn of the century (Figure 1). The Dortmund-Ems-Kanal (1898) connects the industrial region with the German North Sea coast, The Rhein-Herne-Kanal (1914) and the Wesel-Datteln-Kanal (1931) connect the area with the river Rhein, The Datteln-Hamm-Kanal (1914) also ties the eastern part of the Ruhr district to the system. The canals are mainly built for traffic by motor ship up to 1,350 t loading capacity; some parts are still being developed for this purpose.

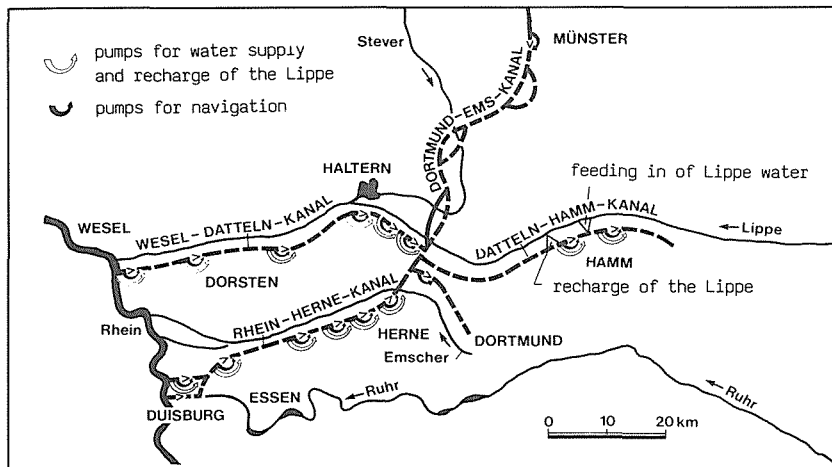


Figure 1. Rivers and navigation canals in the "Ruhrgebiet".

During construction of the canals to attract the settlement of factories which could use canal transport, such industrial firms soon got offers to use the canals not only as waterways but also for industrial water supply.

As waste water discharge into the canals is avoided as far as possible, the water quality is so good, that it is possible without special problems to use water indirectly also for drinking water supply; thus, for instance, in the region of Münster and in dry periods also near Haltern canal water is used for groundwater recharge.

The canals are forming double stairs from the Rhein to the upper reach of the Dortmund-Ems-Kanal between Datteln and Münster (Figure 2), into which on the same level the Datteln-Hamm-Kanal flows. It was planned that this canal should bring all the water needed by the system from the Lippe near Hamm in a free flow.

Because of the growing navigation activities soon the water from the Lippe was no longer sufficient (mean discharge in Hamm 29.3 m³/s). Besides, in dry periods so little water remained in the river downstream, that quantity strongly restricted its direct use for industrial water supply.

Reservoirs for the storage of water for dry periods in the upper catchment area were not possible for geological reasons; so pumping plants were built at the navigation locks to satisfy the water need of the canals. Those plants can supply the water from the Lippe, from the Ruhr or directly from the Rhein.

In the beginning, the operation of the canals and industrial water supply from these canals were exclusively a matter of the canal administration. Following the foundation of the Federal Republic, with its federal structure, dual responsibility has developed: the ownership and the management of the canals as waterways lie with the Waterway and Navigation Administration of the Federation, while water management and thus also water supply are, in principle, a matter of the Federal states.

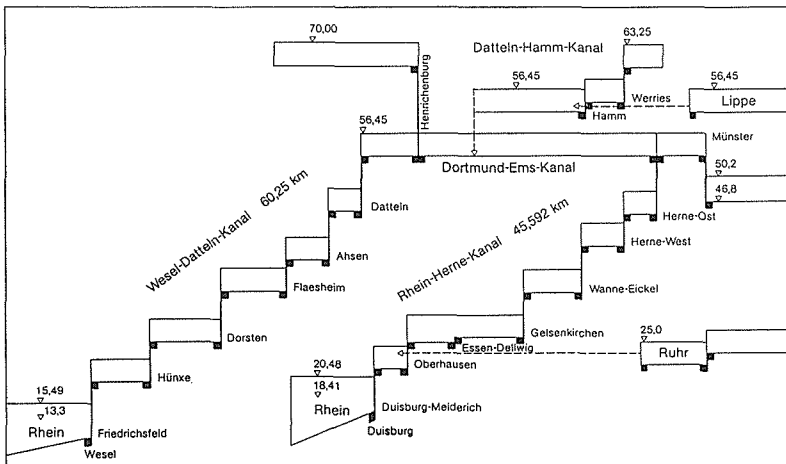


Figure 2. Schematic longitudinal section through the Western German canals.

According to an agreement of 1968 concluded between the two parties, the feeding of the canals and the water supply from these canals were put on a new basis; in consequence, the water quality of the Lippe could be clearly improved:

- When feeding the canals at least $10 \text{ m}^3/\text{s}$ must remain for the Lippe downstream.
- The Federal state shall reimburse to the Federation the higher energy costs incurred for the increased pumping operation necessary to satisfy the water demand of the navigation.
- The Federal state shall build new chains of pumping plants at the canals to guarantee industrial water supply and to recharge the Lippe in dry periods.

THE WATER RESOURCES ASSOCIATION FOR THE WESTERN GERMAN CANALS

As self-governing unions covering water supply & pollution control, water resources associations in North Rhine-Westphalia have for some decades proved very efficient in solving water resources problems.

So, in 1970, the State has founded the Association "Wasserverband Westdeutsche Kanäle" to safeguard the rights and obligations under the agreement of 1968. The essential tasks of this association are:

- financing of pumping water } for the industrial water
- managing of water } supply from the canals

Financing is ensured through contributions of the members of the association. The amount of the respective contribution is determined by the water demand of each member. It ranges from a few m³/d on individual days in especially dry years for irrigation of agricultural area, to up to 60,000 m³/d for the supply of a large power plant.

In addition to the above-mentioned contributions, fees are payable for the water actually used.

The respective situation of the intake at the canals is irrelevant for the amount of the contribution, that is, it is irrelevant whether a member is supplied via only one or several pumping plants.

All pumping plants were ready for operation in 1987 except three smaller stations where water is not yet actually needed. Planning and construction have been carried out by the existing and experienced Federal Waterway and Navigation Administration. In all a most economical and low-cost-management is possible for both partners. The Association for example works with part-time manpower, and includes no more than two full-time workers, but yet combines different competences. Moreover, it has been profitable that the Association's pumping plants and those planned by the Federation for navigation could be set up in common buildings. These are shown in Figure 1 by symbols.

The complete system, moreover is managed by the Federation from just one remote control plant in Datteln.

THE MANAGEMENT OF WATER

The system of the four canals is most complicated due to

- feeding from three rivers,
- impounded reaches of different lengths and lift heights,
- draw-offs and part returns of water, diverse in volume and distributed over places and times.

Very expensive methods of computing would be necessary to calculate the movement of water in the canals in detail. In practice, this is not necessary because of the storage effect of the system for at least one day. If one looks to the system as one large water tank, it is possible to state the following (Figure 3).

Origin and use of the water are plotted here for a period of 12 years. Comparison of the percentage supplied by the three feeding rivers shows very large differences. The share of the Lippe, for example, fluctuates between 32% in 1976 and 89% in 1981 with a mean near 67%. The share of the Rhein has never exceeded 10% in the last 8 years; but in the dry year 1976 it climbed to 40%.

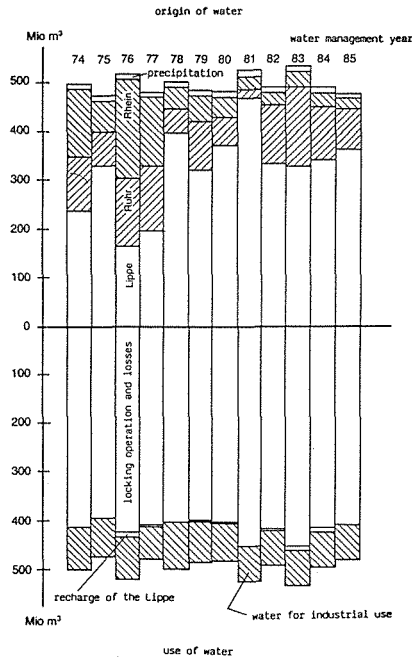


Figure 3. Origin and use of the canal water.

The major part of the water fed-in serves lock operations. Another important share is lost at the lock gates or by evaporation or seepage from the canals.

The share of water for industrial use lies near 15% of the water fed-in during the years covered by the investigations. The share of recharge of the Lippe is insignificant only in the light of annual volumes (in some years it can be dispensed with altogether) but its importance for the water quality of the Lippe is much higher than the percentage shows. Figure 4 shows for the water management year 1985 (November 1984 to October 1985) the volumes of inflowing and outflowing water for the whole system (dotted line).

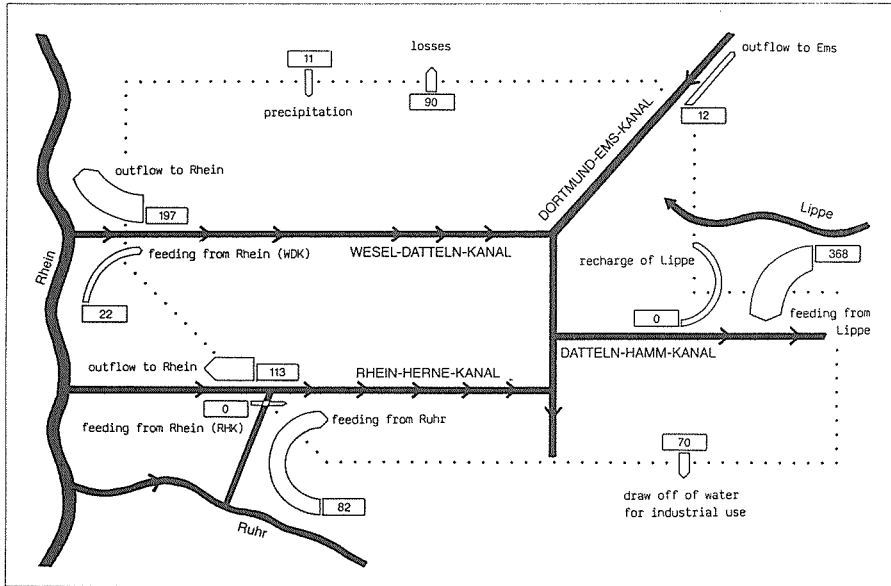


Figure 4. Origin and use of the canal water in the water management year 1985 (figures in 10^6 m^3).

The settlement of accounts for the volumes of industrial water withdrawn with the Waterway and Navigation Administration is made each month on the basis of a mixed price, which is formed by the costs of the transfer of Lippe water and the costs of the pumping of Ruhr or Rhein water. This is based on the daily notes of the members checked by random test by the association. The shares of the members are computed every year dependent on their notified water need and the real draw off of water. Accounts are usually paid by the members in monthly installments.