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The Bigge Dam and Reservoir



Water for millions

More than 5 million people obtain their drinking water from the Ruhr River. The Ruhrverband provides the prerequisites for this permanent and ample supply.

Water quantity management

A system of large reservoirs balances the variation in the natural flow of the Ruhr. Floods are reduced, electrical energy is generated and the water supply is guaranteed even during dry periods.

Water pollution control

About 100 wastewater treatment plants in the Ruhr River Basin purify the wastewater from communities and industrial plants.

Water pollution control is the prerequisite for providing a supply of water for private households and for a variety of recreational activities in and along the Ruhr and its impounding lakes and reservoirs.



The Bigge Dam and Reservoir

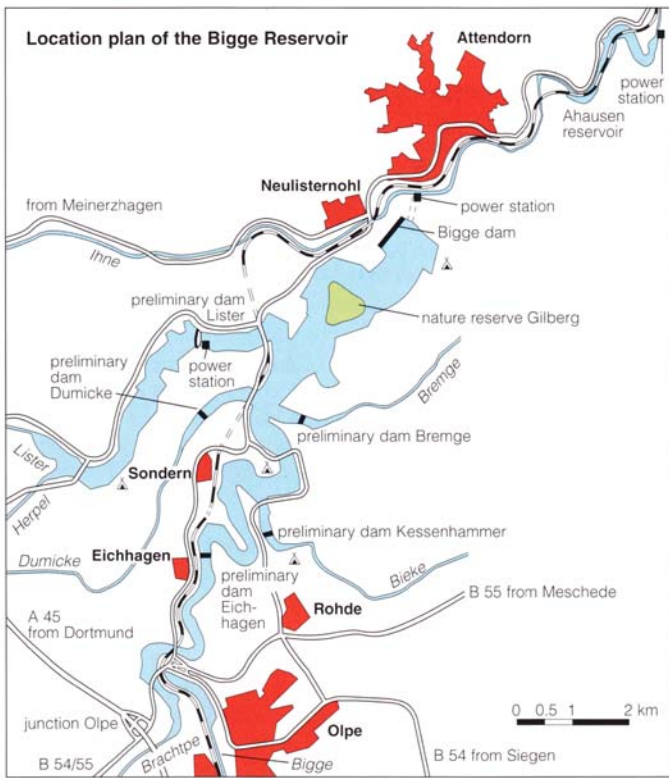
The water supply for the urban conglomeration of the Ruhr District is mainly provided by abstraction of water from the Ruhr River. Due to the natural flow regime of the river and losses of water resulting from water export to adjacent river basins, the demand can only be met continually by the operation of reservoirs on the tributaries of the Ruhr River. These reservoirs store the water during times of high river flow and discharge supplemental water during times of a low natural flow. Therefore the reservoirs provide flood protection and guarantee a minimum flow in the Ruhr River during drought periods.

The Ruhr Reservoirs Association (in German: Ruhrtalsperrenverein) was founded in 1899 as an organization of civil law and changed into a public corporation in 1913. This association built and operated a system of reservoirs in the catchment area of the Ruhr. In 1990, the Ruhr Reservoirs Association was united with the Ruhr River Association (in German: Ruhrverband), an organization responsible for water quality management. The new water association is called Ruhrverband and is responsible for both water quantity and water quality management. Besides that the Ruhr River Association facilitates various leisure activities at the Ruhr and the reservoirs.

Due to growing demand for drinking and industrial water even before World War II, the storage capacity established by the Ruhr Reservoirs Association soon became insufficient to guarantee an unrestricted water supply of this large urban industrial area. Following preliminary investigations, the planning for the Bigge reservoir began already in 1938. However, they had to be suspended because of World War II. Only the industrial boom and the population increase after the war prompted the Ruhr Reservoirs Association to resume its planning. In 1956 the state parliament of North-Rhine-Westphalia passed a specific law for the financing of this large project. This provided the prerequisites for the construction of the Bigge reservoir in the years between 1957 and 1965. The reservoir is situated between the cities of Attendorn and Olpe in the valley of the Bigge River. The Bigge River is a tributary of the Lenne River, which leads into the Ruhr River upstream from the Hengstey impounding. The Bigge reservoir's storage capacity of 150 million m³ increases the overall storage capacity of the system of reservoirs in the catchment area of the Ruhr River from 323 million m³ to 473 million m³.

The Lister reservoir, completed in 1912, became its preliminary reservoir, resulting in a joint storage capacity of 172 million m³ at this point.

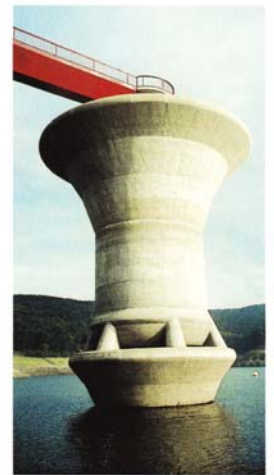
During times of a low natural flow the Bigge reservoir is able to contribute about 40% of the entire supplemental water to the Ruhr River system. Though this is its main task, another one is flood protection. During times of a high flood risk, i. e. from November 1st to February 1st, a flood control storage of 32 million m³ is available, which can be refilled from February 1st to May 1st. Thus, the flood peak below the dam is substantially attenuated.



The Bigge dam before impounding in 1965



Intake of the bottom outlet with emergency gate, trashrack and shut-off unit



Intake tower

The dam itself is located a few kilometres upstream from the city of Attendorn near "Gut Ewig" and impounds the valleys of the Ihne River and the Bigge River, which are separated from each other by a ridge. The dam body consists of rock-fill with a two-layer impervious blanket of asphaltic concrete. The two blanket faces are separated by a drainage layer consisting of bituminized coarse gravel. By asphaltic concrete layers the drainage layer is divided vertically into 10 m-segments, which are connected to the inspection gallery by drain pipes. By these means, any possible damage to the upper impervious layer can thus be easily noticed and located according to leakage water in the inspection gallery. The dam is strengthened by a crest protection of reinforced concrete and a bituminous transition zone in the core, designed to prevent erosion of the dam in case of leakage through the impervious blanket.

The sealing blanket is extended to below the deeper situated inspection gallery by a 50,000 m² cement grout curtain, which reaches a depth of 60 m. Additionally, drainage wells allow to control the impermeability of the established subsoil waterproofing.

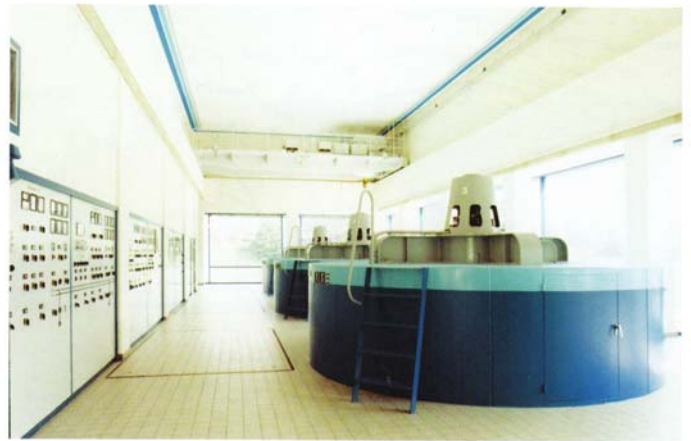
The discharge of water from the reservoir is only dictated by the requirements of water quantity management. Mostly the discharge passes through the power station, located about 600 m downstream of the dam. A bottom outlet and penstock tunnel traversing the Duennekenberg upstream from the dam leads to the power station. Before reaching it lines branch off to the two bottom outlets, which are equipped each with a Howell-Bunger valve serving for closure and regulation. The tunnel has a diameter of 4 m and a length of 437 m. Its maximum discharge amounts to 125 m³/s.

Parallel to the bottom outlet tunnel runs a spillway tunnel with a diameter of 4.8 m and a length of 505 m. The tunnel intake structure is a 50 m-high spillway tower, to which a cylinder valve was attached at a height of 33 m. This valve permits a faster drawdown of the water level in the reservoir. In order to prevent an uncontrolled water discharge from the reservoir in case of a malfunction of the cylinder valve, a second gate was installed within the first third of the horizontal tunnel. The tunnel leads into the stilling basin of the Bigge power station and the bottom outlets. It can discharge a maximum of 347 m³/s.

In the Bigge power station, normally operated as a peak-load power station, three Francis turbines with a discharge of 12.5 m³/s each and a smaller Francis turbine with a discharge of 1.5 m³/s use the energy of impounded water. The net head is 53 m, the annual energy production amounts to some 22 million kWh. The minimum flow, set at 1 m³/s on the basis of ecological criteria, is discharged through the small turbine. Regular diurnal discharge of supplemental water into the downstream rivers is provided by the power station at the Ahausen impounding, situated some 7 kilometres downstream from the Bigge dam.

Between the valleys of the Ihne River and the Bigge River lies a ridge with the "Kraghammer Sattel", a steep anticline. The deepest point of this anticline is of a lower altitude than the maximum water level in the reservoir. The resulting gap is closed by a 216 m long cantilever retaining wall. Before the Bigge reservoir was built, a railway tunnel passed through this ridge. This tunnel was then converted into an outlet system, which can discharge up to 60 m³/s of reservoir water into the Ihne River. Above and below the tunnel two inspection galleries were excavated parallel to the ridge.

From there the deeply fissured rock was sealed with cement groutings. Preliminary dams were built in the gently diverging upper lateral valleys and in the Bigge valley near the city of Olpe. The assure a constant water level in these pre-reservoirs throughout the year. Thus, during variations in water level in the main basin, large areas subject to changes in humidity are avoided in the shallow intake areas of the reservoir. This also implies an improvement of living conditions for the aquatic flora and fauna, and better opportunities for human recreation. Apart from the Eichhagen pre-dam, there are smaller pre-dams in the valleys of the rivers Dumicke and Bremge and in the Bieke valley near Kessenhammer. All pre-dams were constructed as rockfill dams, but each was subjected to an individual sealing system in order to gain experience with several construction methods.



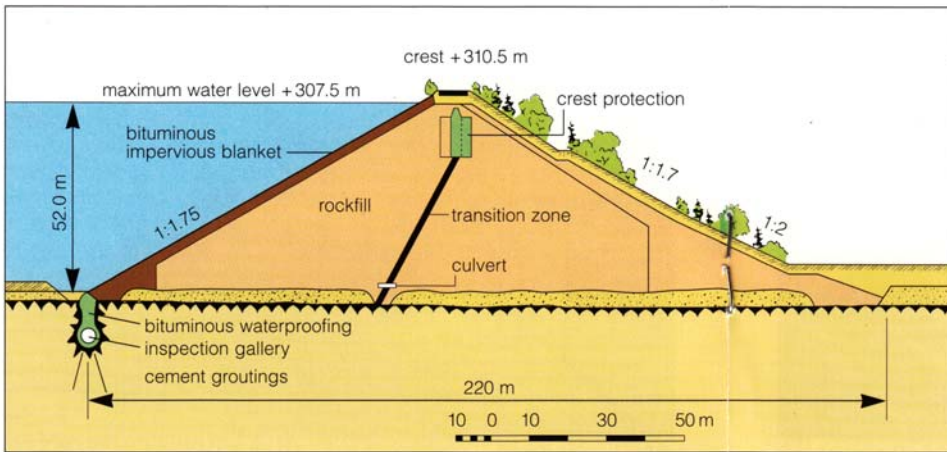
Generators at the Bigge hydropower station



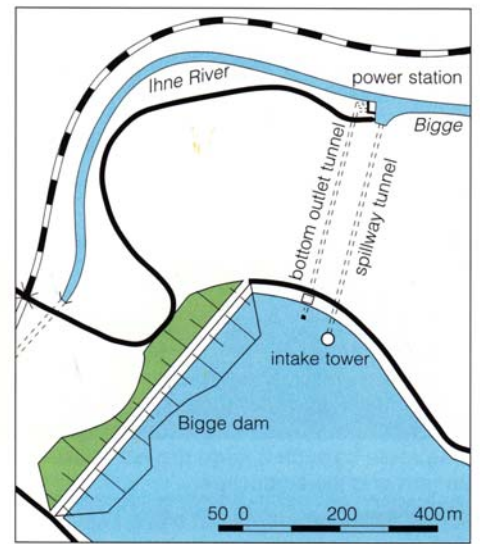
The anticline "Kraghammer Sattel"



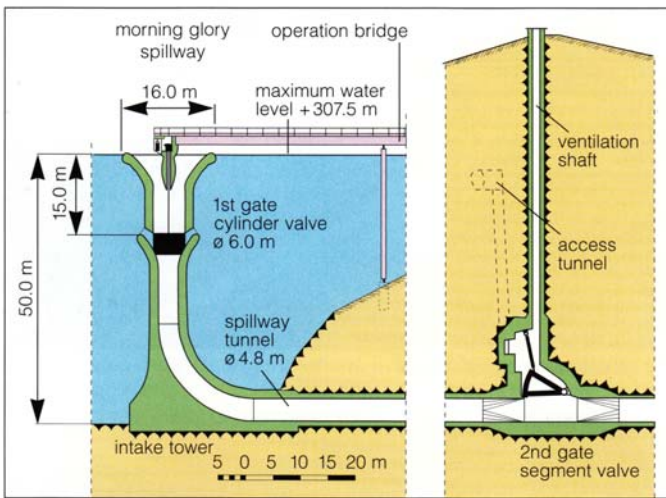
Preliminary dam Eichhagen



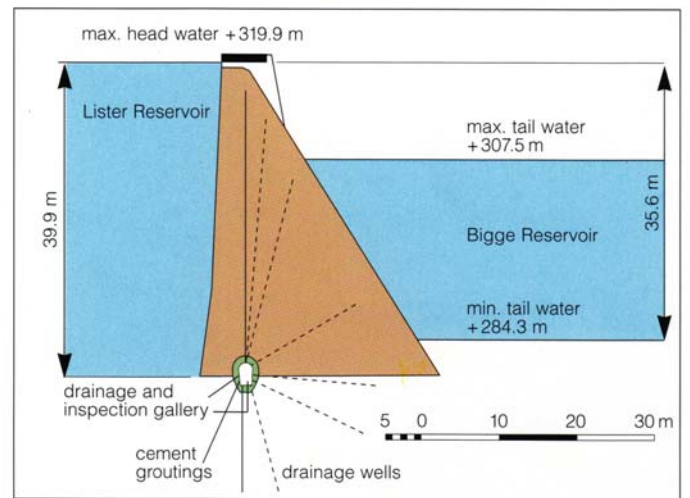
Cross section of the Bigge dam



Layout plan of the dam and the power station



Spillway with operation facilities



Cross section of the Lister dam

The Lister reservoir, which has been in operation since 1912, was integrated into the operational system of the Bigge reservoir. The Bigge dam floods the 40m-high masonry dam up to a height of two-thirds from the downstream. The difference in water level between the Lister reservoir and the Bigge reservoir is used for hydropower generation. The water works of the city of Olpe abstracts the largest part of its requirements from the Lister reservoir.

All damming structures of the reservoir are regularly controlled with regard to their imperviousness and movement. Conditions of water pressure in the subsoil are supervised and periodical test operations of all water discharge facilities control the functional safety.

Long before the beginning of the construction work the relevant administrations and institutions cooperated closely with the Ruhr Reservoirs Association concerning regional planning, especially the problems such a large project causes for the settlement pattern and the landscape.

About 2,500 people had to leave their homes because of the construction of the Bigge reservoir. Among those were also families who had already been forced to resettle because of the Lister reservoir some 50 years before. For most of the people new homes could be provided in the newly built villages of Neulisternohl, Sondern-Hanemicke and Eichhagen. Some, however, moved to the cities of Attendorn, Olpe or others outside the Bigge district. A large number of industrial enterprises were also obliged to give up their location.



Dam of the preliminary reservoir Lister



Due to specific planting the Bigge dam is adapted to the landscape



All structures are subject to regular monitoring



The new village Neulisternohl

Many traffic routes had to be relocated. Newly built were 4.4 km of federal highway, 14.8 km of state highway, 18.2 km of district and municipal roads and 31 km of service roads, amounting to a total of 68.4 km of major and minor roads the length of the realigned railway is 9.5 km, 2.3 of which pass through tunnels. Additionally, three halts and a station had to be constructed. The new traffic routes also required eight viaducts and twenty-four bridges. The first included two double-deck bridges, one running across the Dumicke valley, the other one across the Lister valley. The upper decks support the road, the lower ones the railway.

Simultaneously with the construction of the reservoir a land redistribution programme was carried out in order to reallocate the property in the area affected by the construction. Thus, a system of farm tracks was created as well, thereby effectively accessing up the area according to the new situation.

The Ruhr Reservoirs Association lay particular emphasis on the effort to fit this large project as well as possible into nature. It was necessary to design a viable landscape and to create pleasing natural surrounding. Famous landscape architects helped with this project. In cooperation with them also the vegetation of the affected area was planned and performed. The island of Gilberg, situated in the reservoir, was – together with the surrounding water areas and the banks opposite – classified as a nature reserve. Today it harbours an important bird sanctuary.

All the reservoirs are surrounded by forests which protect the stored water. These forests are being ecologically cultivated by the Ruhr River Association. In shore protection and other construction activities also ecologically sound methods are applied.

The Bigge reservoir – as are the other reservoirs in the area of the Sauerland – is an important centre of recreation because of its charming location in a hilly region, its short distance from the conurbations on the rivers Rhine and Ruhr and its easy access. This is consistent with the 3rd State Development Plan – advocating conservation by protection of the natural environment in terms of freedom, nature, forests, water and recreational values – and in the local development plans, which were derived from it. In order to be able to offer recreation facilities, the community of Olpe, the landscape association of Westphalia-Lippe and the Ruhr River Association jointly founded the Biggensee Ltd., which operates camping and bathing sites. The development of these facilities was completed in 1986 with the construction of a large recreation centre on the peninsula north-east of the village of Sondern.



Double-deck bridge in the Lister valley



The reservoirs are surrounded by forests which protect the stored water and are being ecologically cultivated



Recreation centre Biggensee-Sondern owned by the Biggensee Ltd.

Technical Data

Water management

overall storage capacity	171.7 million m ³
thereof preliminary reservoirs	
Lister	21.6 million m ³
Eichhagen	5.3 million m ³
Dumicke	0.2 million m ³
Kessenhammer	0.3 million m ³
Bremge	0.3 million m ³
maximum water level	
Bigge reservoir	307.5 m above sea level
Lister reservoir	319.45 m above sea level
catchment area (including the Lister reservoir)	287 km ²
average annual inflow	225 million m ³
storage ratio (storage capacity/annual inflow)	0.72
surface area at maximum storage (including the Lister reservoir)	8.76 km ²

Damming structure (rockfill dam)

height of crest	310.5 m above mean sea level
maximum height above ground level	52 m
length of crest	640 m
width of crest	10 m
base width	220 m
volume of dam	1.9 million m ³
expanse of the impervious blanket	46,000 m ²
expanse of the subsoil waterproofing	50,000 m ²

Bottom outlet and penstock tunnel

diametre	4.0 m
length	437.0 m
outlet elements: 2 Howell-Bunger valves, diametre respectively the power station	1.5 m
maximum discharge	125 m ³ /s

Spillway intake tower

height above ground level	50 m
diametre	4.8 m
spillway tunnel diametre	4.8 m
length	505 m
maximum discharge	347 m ³ /s

Bigge power station

penstock bottom outlet and penstock tunnel diametre	4.0 m
diametre of the manifold	2.0 m
3 Francis-turbines with a vertical shaft and a synchronous AC-generator per unit:	
maximum head	53 m
discharge	12.5 m ³ /s
capacity	5,000 kW
1 Francis turbine with a horizontal shaft and a synchronous AC-generator	
maximum head	53 m
discharge	1.5 m ³ /s
capacity	600 kW
average annual power generation	22 million kWh

Lister power station

penstock: diametre	2.0 m
1 Kaplan-turbine with a vertical and a synchronous AC-generator	
maximum head	27 m
discharge	9 m ³ /s
capacity	2,200 kW
average annual power generation of the Lister power station	2 million kWh

The power stations are operated by the Lister- und Lennekraftwerke Ltd. in Olpe, a 100 % subsidiary of the Ruhr River Association.