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TECHNICAL, ECONOMIC AND ENVIRONMENTAL CONSIDERATIONS IN THE DEVELOPMENT OF THE WASTEWATER TREATMENT SYSTEM OF SOPRON

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Abstract

Developing the wastewater treatment system of Sopron is essential. What is the technically, economically and environmentally most efficient way. A new suggestion keeping the conservation of Lake Fertő in view is presented in this paper.

Keywords: Sopron, local authorities, wastewater.

1. Environmental Tasks of Local Authorities with Special Regard to Water Treatment

The environmental law accepted in 1995 ranks the creation of environmental programmes among the tasks of local authorities. Among others these programmes must include the settlement's tasks and regulations of communal wastewater treatment, collection, cleaning and drainage, as rainfall drainage, and drinking-water supply also.

2. Water Management of Sopron

About 55 000 live in the administrative area of Sopron, there were 20 515 flats in the total area of the city in 1995.

The construction of water pipes was finished by 1996 everywhere, so in Sopron's administrative area the water pipe supply is 100%.

About 60% of the annual consumption is used by the inhabitants, the rest is consumed by the industry, companies, institutions and other establishments.

3. Surface Waters of Sopron

Ikva, Rák, Rákos, Liget, Sós and Kecske creeks run through the area, the most important surface waters of Sopron's administrative area are Ikva creek, Rák, Liget, and Rákos creeks.

At some points of the municipal reach of Ikva creek rainfall and communal sewerage pipes are connected up, so the creek's water quality is hardly influenced by them. Ikva creek receives Sopron's wastewater treatment plant's (Győri road) handled wastewater outflow.

Rák creek has its source west of Brennbergbánya inside the boundaries. Runs across the city in a closed canal to flow into Ikva creek in the south-east of Sopron.

At some points of its municipal reach rainfall and communal sewerage pipes are connected up.

The most important surface water is Lake Fertő, as the heart of Fertő-Hanság National Park. Some smaller lakes belonging to the catchment area of Rákos creek and the Téglagyári lakes are less important.

4. Sewerage System

The wastewater sewerage system is almost totally built unlike the rainfall sewerage system. Diversion of the two sewerage systems is not finished yet, and due to the lack of rainfall sewerage the rainfall is connected up to the wastewater sewerage at many places.

Table 1. Length of different sewerage systems

Type of sewerage	Length [km]
Wastewater	147.200
Rainfall	69.500
United	7.900
Total	**224.600**

Wastewater sewerage is heavily loaded by additional water from different sources, such as rainfall load, infiltration and creek's water inflow.

Main receivers for Sopron's rainfall water are Ikva creek and Rák creek. Due to the geographical conditions there is not such a sewerage system as for the wastewater.

5. Wastewater Treatment Plants

Wastewater treatment plants working inside and around the city handle the wastewater of the city and conurbation. The settlements and plants form a system as

almost all the plants receive wastewater from other settlements and almost every settlement's wastewater or part of it is handled at a different plant. Due to this fact solving the problems of the wastewater treatment is only possible by thinking it over in a common and integrated system.

6. Municipal Wastewater Treatment Plant of Sopron (Győri Road)

With a nominal capacity of 15 000 m^3/d the plant is able to receive the average daily hydraulic load, while it cannot manage to handle the daily maximal hydraulic and the organic substance load. The mechanical step's organic substance-removal efficiency is 30–35%, the floating substance-removal efficiency is around 50–65%. The biological step cannot manage to reach the ordered performance.

7. Wastewater Treatment Plant of the Town of Balf

The wastewater treatment plant began working in 1988 with a capacity of 300 m^3 a day. The present wastewater treatment plant was built after completion of the wastewater sewerage system of Balf in 1998. The new BIOGEST type reactor has a hydraulic capacity of 700 m^3 a day using a single pool SBR (Sequencing Batch Reactor) technology equipped with a process-control computer.

8. Wastewater Treatment Plant of Sopronkőhida

The wastewater treatment plant is situated in the northern border of Sopronkőhida just connected to the built-up settlement area next to the Rákos creek.

Efficiency of the plant has hardly reduced since the detachment of Sopronkőhida's communal wastewater due to the significant increase of industrial wastewater in percentage as the parameters of the wastewater – pH for example – have significantly varied with time.

Another problem is that the plant has a 500 m protective distance, but this is close to 0 m as it is situated in the built-up area.

We may say that this plant is not able to meet either the present requirements nor the growing future capacity and quality requirements. Furthermore there is no protective distance. So in its present form it is unable to work properly, may only keep the ultimate values after a very serious development.

9. Wastewater Treatment Plant of Fertőrákos

Fertőrákos does not belong to the administrative area of Sopron but the plant also receives wastewater from the administrative area of Sopron. The wastewater treat-

ment plant was built to receive and clean wastewater from the sports establishment of Fertő lake, Fertőrákos, Sopronkőhida, Tómalom and the connected areas.

The plant was built in 1994 with BIOGEST technology with a 2×400 m^3 hydraulic capacity. These two pools work again with SBR technology.

The plant cannot hold the required limits. Efficiency of the plant is poor due to the fact that the wastewater's concentration values kept in mind during the planning of the plant are much higher in reality. Most probably the plant was designed for a higher hydraulic and lower organic substance load.

To reduce the pollution of Lake Fertő cleaned wastewater is flowing into the Rákos creek and before reaching the lake it is led across a wetland functioning as a biological filtration field. This wetland consists of two pools. The smaller receives the water from the plant, so the larger does the creek's water.

10. Development of Wastewater Treatment Plants and System

Table 2. Main parameters of the observed plants

Plant	Origin of wastewater	Capacity [m^3/d]	Hydraulic load [m^3/d]	Receiver	Problems
Győri Road	Sopron Ágfalva Brennbergbánya Görbehalom Hermes	15 000	17 500	Ikva Creek	- OVERLOADED Hydraulic Organic substances Phosphorus Nitrogen Total floating substances
Balf	Balf (communal) Sanatorium	700	250–300	Inland waters canal Lake Fertő	- OVERLOADED Organic substances Phosphorus
S.kőhida	Prison Weaving mill	650	350–400	Rákos Creek Lake Fertő	- OVERLOADED Organic substances Phosphorus Nitrogen -PROTECTIVE DISTANCE
Fertőrákos	Fertőrákos Sopronkőhida (communal) Tómalom	800	App. 290	Rákos Creek Wetland Lake Fertő	- OVERLOADED Organic substances Phosphorus Nitrogen Hydraulic (future)

Development plans for the plant of Sopron are under construction right now. The goal is to reconstruct the biological cleaning technology for an average capacity

of 20 000 m^3 a day to ensure the quality of wastewater outflow by increasing the capacity of biological removal of organic substances, phosphorus and nitrogen.

There are two major plans for the reconstruction of the plants in Sopronkőhida and Fertőrákos.

The first one is about to rebuild the plant of Sopronkőhida into an industrial pre-cleaner and develop the plant of Fertőrákos so it would receive the communal wastewater of the settlement and the prison's and weaving mill's pre-cleaned wastewater.

According to the second – much more expensive – plan the present plant would be pulled down to give place to a new one. In this case keeping the 500 m protective distance is impossible.

Any of these plans would come true the impulses in wastewater of the weaving mill must be handled.

Although reconstruction of the plant of Balf was finished in 1998 – so its capacity was increased from 350 to 750 m^3 a day – we think it should be considered to develop this plant to enable it to replace both the plants of Sopronkőhida and Fertőrákos. At the same time it would be possible to divert the wastewater out of the catchment area of Lake Fertő keeping its protection in view.

Handling and deposition of originating wastewater sludge are essential in any case. Agricultural usage seems to be the most probable long term and economical solution.

11. Development of Wastewater Treatment Plants in Sopronkőhida and Fertőrákos

As presented, the plant of Sopronkõhida is unable to perform properly either at present or in the future so it is indispensable to consider and optimise the work of wastewater treatment plants and system.

Mestervonal LTD – with a seat of Sopron – conducted a research on this plant. In this report they also calculate the future load. They count with every possible area that might be connected to this system in the next 10–15 years.

Amount of wastewater to be treated in the area is very different during and off the main tourism season.

Values shown in this table include wastewater from the prison which is presently treated at the plant of Sopronkőhida. Diverting wastewater to Fertőrákos is only possible if the prison's wastewater outflow's quality is suitable to be conducted into a communal canal.

Thus, if it is impossible to pre-clean the industrial wastewater at the prison then it cannot be conducted to a communal canal to divert it to the plant of Fertőrákos; meaning the plant of Fertőrákos cannot be liquidated and it must be preserved as an industrial pre-cleaner at least.

If the plant of Sopronkőhida would keep on working then only the communal wastewater of Sopronkőhida would be handled there. Its calculated daily amount

Table 3. Calculated wastewater volume for Fertőrákos in 2005 and 2015 in case of liquidation of the wastewater treatment plant of Sopronkőhida

	2005 [m^3/d]		2015 [m^3/d]	
	July 1 – September 30.(1)	October 1 – June 30.(2)	July 1 – September 30.(1)	October 1 – June 30.(2)
Total	1 569	1 011	2 358	1 288

(1) During the main tourism season
(2) Off the tourism season

is about 81 m^3 a day for 2005 and 85 m^3 a day for 2015. It is important to repeat that the 500 m protective distance cannot be observed this way and it is forbidden to give building permission in this area.

Table 4. Calculated wastewater amount for Fertőrákos in 2005 and 2015 in case of conversation of the plant of Sopronkőhida as industrial pre-cleaner

	2005 [m^3/d]		2015 [m^3/d]	
	July 1 – September 30.(1)	October 1 – June 30.(2)	July 1 – September 30.(1)	October 1 – June 30.(2)
Total	1 119	571	1 753	787

(1) During the main tourism season
(2) Off the tourism season

12. Capacity of Sewerage System

If the Sopronkőhida-Fertőrákos wastewater line is built then it is a must to increase the capacity of pipelines and pumps between these settlements. We must keep in mind the values estimated in the previous calculations for the tourism season of 2015 as a maximum. We must compare the present and future capacity of works with this load.

12.1. Capacity of Gravitational Canal

All the three section's capacity exceeds the estimated maximum volume of

Table 5. Calculated maximum load and capacity of main pipeline

Sections	Maximum load [l/s]	Capacity [l/s]	Classification
1. section	28.1	40–65	Suitable
2. section	33.6	96	Suitable
3. section	36.1	56–69	Suitable

wastewater so suits for long term purposes. If the service area grows then reconstruction of the existing works should be considered.

12.2. Capacity of Pumps and Pressure Pipelines

We also have to compare the present capacity of the two pumps (of the same kind) working at Sopronkőhida and Fertőrákos with the load estimated for 2015 as a maximum.

Table 6. Calculated maximum load and capacity of pumps

Pumps	Maximum load [l/s]	Performance of pumps [l/s]	Classification
1. Sopronkőhida	22.6	14	NOT Suitable
2. Fertőrákos	46.8	18–24	NOT Suitable

12.3. Checking the Capacity of Wastewater Treatment Plant in Fertőrákos

Present capacity of the wastewater treatment plant of Fertőrákos is **800 m^3 a day**.

Table 7. Estimated load at Fertőrákos if the plant of Sopronkõhida prospers as an industrial pre-cleaner

	2005 [m^3/d]		2015 [m^3/d]	
	July 1 – September 30.(1)	October 1 – June 30.(2)	July 1 – September 30.(1)	October 1 – June 30.(2)
Load	1 119	571	1 753	787
Classification	NOT Suitable	Suitable	NOT Suitable	Suitable

(1) During the main tourism season
(2) Off the tourism season

Table 8. Estimated load at Fertőrákos if the plant of Sopronkőhida is liquidated

	2005 [m^3/d]		2015 [m^3/d]	
	July 1 – September 30.(1)	October 1 – June 30.(2)	July 1 – September 30.(1)	October 1 – June 30.(2)
Load	1 569	1 011	2 358	1 288
Classification	NOT Suitable	NOT Suitable	NOT Suitable	NOT Suitable

(1) During the main tourism season
(2) Off the tourism season

Thus after liquidating the plant of Sopronkőhida the plant of Fertőrákos would not be able to receive the amount of wastewater. If it works as an industrial precleaner then its estimated load for 2015 tourism season would exceed twice the capacity.

Analysing *Fig. 1* we can see that several development ways theoretically correct and environmentally suitable can be found.

I. *Liquidation of the plant at Sopronkőhida*. Replacing it completely, the plant of Fertőrákos must be developed and enabled to receive the total future load. The necessary technological works include development of sewerage system, replacement of some existing pipelines and pumps, new pressure pipes. Decreasing impulses in the prison‘s industrial wastewater is essential.
II. *Converting it to industrial pre-cleaner*. It is sufficient to develop the plant of Fertőrákos for the total future load reduced by the industrial wastewater’s amount. The necessary technological works are the following: development of sewerage system, replacement of some existing pipelines and pumps, new pressure pipes. This is the most supported version.
III. *Building of a new plant in Sopronkőhida*. In this case developing the plant of Fertőràkos is still essential as its capacity is not sufficient. Thus this dual innovation is by far the most expensive solution, therefore it might be theoretically refused due to the lack of resources.

13. Diverting the Cleaned Wastewater out of the Catchment Area of Lake Fertő

Mestervonal LTD mentioned previously ran a research in 1995 examining the load of the catchment area of Lake Fertő.

According to the result of the research the cleaned wastewater with parameters below the ordered values would not endanger the water’s quality profile in terms of pH, salinity and organic substances in short term run. On the other hand, the lake would be endangered even in short term run due to the wastewater’s Phosphorus and Nitrogen content.

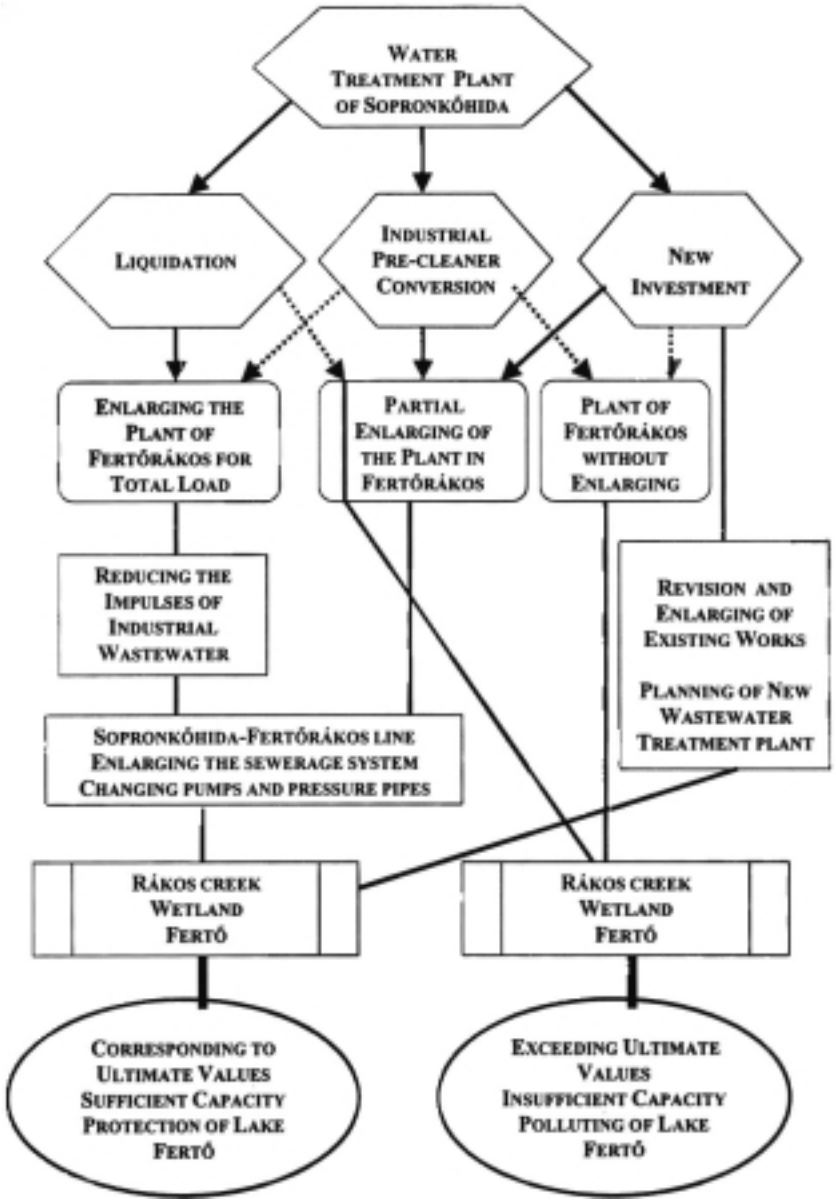

Fig. 1. Possible ways of development and their preconditions

Therefore keeping in view the lake's water quality the researchers found it reasonable to divert the cleaned wastewater from the catchment area of Lake Ferő.

14. Collecting Wastewater from Sopronkőhida and Fertőrákos for Treatment in Balf

For the previous reasons we find the most efficient, most reliable and most environment-friendly the following innovation. Where the costs would be approximately the same as for the solutions presented before, however it would solve the problem of Lake Fertő's catchment area protection.

Pulling down the treatment plant at Sopronkőhida – solving the problem of 500 m protective distance – all the communal wastewater of the settlement, the prison's and the weaving mill's wastewater could be taken to Fertőrákos. After converting this into a pre-cleaner it could handle the problem of industrial wastewater. Collecting the wastewater from the settlement (meaning Fertőrákos) and Tómalom recreation area as the communal wastewater of Sopronkőhida – the present load – also the total (partly pre-cleaned) volume should be transported to Balf.

Thus a new plant in Balf sized for the total load would clean all the collected wastewater. From here the cleaned wastewater outflow would be connected up to Ikva Creek avoiding the pollution of Lake Fertő's catchment area.

Capacity of present plant of Fertőrákos exceeds the capacity of the plant in Balf but none of them is able to keep ordered ultimate values, so this solution means that a single innovation would be enough to develop the wastewater cleaning system most efficiently. Thus the plant of Fertőrákos should be converted to an industrial pre-cleaner and the plant in Balf should be developed for the total estimated amount.

Estimating the total future load at Balf we got the shown in *Table 9* values.

Table 9. Estimated total load at Balf

Area	2015 [m^3/d]	
	July 1 – September 30.(1)	October 1 –June 30.(2)
Total (as above)	**2 358**	**1 288**
Balf	**700**	**500**
Total	**3 058**	**1 788**

(1) During the main tourism season
(2) Off the tourism season

Thus a wastewater treatment plant with a capacity sized for about this estimated 3 000–3 500 m^3 a day load could solve the neighbouring settlement's wastewater treating problems. When planning and selecting the technology, the average concentrations of the collected wastewater should also be taken into account.

15. Reconstruction and Development of Wastewater Sewerage

The following changes of the system are required by choosing the previous suggestion:

- Pulling down of the plant in Sopronkőhida
- Building up the Sopronkőhida-Fertőrákos wastewater line including the capacity of the pipelines, pumps and pressure pipes between the two settlements. Therefore this coincides with the existing plans so far.
- Conversion of the plant of Fertőrákos into an industrial pre-cleaning making it possible to handle the critical parameters of the industrial wastewater.
- Building up the Fertőrákos-Balf wastewater line sized for the maximum capacity of 2 358 m^3 a day as estimated for tourism season. The settlements are almost at the same elevations (116 m and 119 m) so one pressure pump with sufficient capacity could solve the transport.
- Developing the plant of Balf to a capacity of 3 000–3 500 m^3 a day.
- Diverting the cleaned wastewater to Ikva Creek through the village of Kópháza. One suitable pump and pipeline would do the task.

These explained changes would cost approximately the same as the plans created already, but on the other hand the development of a single plant would be necessary. Theoretically after a proper work it could yield the best technical and environmental performance as the protection of Lake Fertő – the heart of the National Park – conserving its water quality and reducing its pollution load.