ENVIRONMENTAL ENGINEERING STUDY OF A MAIN CANAL REACH

By

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1. Introduction

Szentes is a small town of 33,400 inhabitants in the *Great Hungarian Plain*, sided by a main drainage canal 39.4 km long, named *Kurca*. An environmental engineering plan has been developed to provide for lasting healthy and pleasant conditions. Although the plan is focussed on Szentes, the entire run of the Kurca with riverside settlements Szegvár, Mindszent, and the catchment area, will be briefly dwelt upon.

2. Information on the town and its surroundings

In the Great Hungarian Plain the average annual precipitation amounts to 540 mm. The driest 12-month period during 150 years of observation exhibited 300 mm (Debrecen, 1862/1863), typical of a semi-arid climate.

On the other hand, wet periods have too much of precipitation. For instance, in the 1870s, some 12-month periods exhibited more than 1100 mm, resulting in damages because the greatest part of soils in the Great Hungarian Plain are very cohesive meadow clays of poor water holding capacity and of saline or alkali character. In wet years, important areas may be flooded (for instance, in 1940, 11 per cent of the country was flooded for a shorter or longer time).

Neither are temperature conditions favourable. Average minimum of the winter half-year being —7.8 °C, and average maximum of the summer half-year being +30.6 °C, a temperature fluctuation range of 38.4 °C is produced. Thus, according to the above data, natural features are rather adverse.

The population of Szentes is likely to grow from the actual 33,400 to 38,000 by the turn of the millennium. The town centre has an area of 72 hectares, divided by the canal Kurca into two parts of different reliefs. The right-bank family-house district is a flat area, about 83 m above sea level. The old district on the left bank is somewhat more elevated, at about 90 m.

Sewerage is non-existent in the right-bank district, and insignificant in the left-bank area requiring to be developed. The trickling filter-type sewage treatment plant has a daily capacity of 4000 cu · m. About thirty pollution sources discharging into the Kurca have been detected inside the town.

The attainment of a full water supply cannot be expected before the millennium (assumed as 300 lit/day per capita) whereas sewerage is likely to attain 35 per cent (150 to 350 litres per capita a day) to that time.

Storm sewerage has not been introduced so far, rainwater flows into the Kurca, washing away all the dirt from the streets.

There is a high groundwater table, especially in the left-bank area. Groundwater is filtrating into the Kurca, contrary to what is usual. Domestic cesspools emit much of the pollution.

3. Particulars of the Kurca canal

Kurca is a main drainage canal 39.4 km in length, constructed along a former natural channel, and divided by sluices into three "pools" such as:

1. *Zuhogó* pool
   average width 61 m
   water surface area 69 hectares
   storage capacity 1.0 million cu. m of water
   water level 79.53 m (max. 80.00 m).
2. *Talom* pool
   average width 60 m
   water surface area 69 hectares
   storage capacity 0.8 million cu. m
   water level 79.13 m (max. 80.00 m).
3. *Mindszent* pool
   average width 60 m
   water surface area 69 hectares
   storage capacity 0.8 million cu. m of water
   water level 79.13 m (max 80.00 m).

All the three pools have a sufficient water-carrying capacity.

Water in the pools is almost stagnant, a flow velocity develops only in rainy weather, with Kurca acting as a main drainage canal. The greatest part of the channel became eutrophized, especially Pool No. 2 near Szentes, with a thick deposit of putrid sludge.

The drainage area of 1140 sq. km of the Kurca canal accommodates several secondary drains totalling 705 km, conveying suspended matter and chemicals into the Kurca during wet periods, but running mostly almost dry.

About 30 per cent of the area are irrigated (actually from the Kurca but an independent main canal is planned).

Drainage and irrigation are insufficient for a continuous water exchange in the Kurca since — as stated — secondary canals run dry in dry months, and irrigation water is only conveyed on commission.

4. Main features of the plan

The environmental engineering plan is featured by:

4.1. An increase of sound water surfaces, making the Kurca a live water by healing actual eutrophization and by maintaining these conditions permanently.

4.2. More of green areas have to be established and maintained by increasing the number and area of urban parks, by afforesting both Kurca banks, and by integrating urban green areas and the afforested belt along the Kurca so that if desirous of recreation, people starting from urban green areas can follow the continuous green belt to arrive into the Kurca forest belts.

4.3 The Kurca water has to be efficiently protected from:

a) municipal sewage;
b) municipal solid wastes;
c) hazards of agricultural chemization: insecticides and fertilizers;
d) sewage from agricultural industries (e. g. animal husbandries);
e) suspended sediment of recharging water (to be supplied, however, continuously, to keep the Kurca water alive).

4.4 A center of water sports has to be established on the right bank of the Kurca (a training track for rowing, indoor and outdoor swimming pools, like the exemplary baths in *Gyula*, another small town in the Great Hungarian Plain).

These problems can be tackled either passively or actively.

5. Passive methods*

Passive methods are understood as keeping pollutants, essentially industrial sewage, away and to provide for the treatment of industrial sewage. In the specific case of Szentes, most sewage comes from the poultry processing industry with a daily water consumption of 100 to 150 cu. m, used at a rate of 20.7 to 24.8 cu. m per ton.

Sewage may result from animal droppings, meat processing, flushing, packaging.

Pollutants include: blood, fat, bowel content, horn and other wastes.

* After D. Dulovics, senior assistant

Water is the most polluted if used in processing fattened poultry.

Treatment has to begin with sewage passing a screen or a sieve. Feathers, pieces of bowel or other solids left in the sewage may clog the factory sewers. Thereafter, sewage from the poultry industry may be treated either in an anaerobic biological sewage treatment plant or in the municipal sewage plant.

Breweries require a great amount of water of drinking quality (6 to 9 litres per litre of beer). Breweries process daily 75 to 80 thousand cu. m of water, a quarter being new supply, and three quarters recirculated.

Brewery sewage results from various filtering and washing processes. Sewage contains many organic vegetable substances as well as N, P and K. Main pollutants are yeast and protein sediments in gauntry reservoirs, beer dreg and spilled-out beer.

Brewery sewage has to be handled along the following lines.*

From the aspect of water economy, the water consumption has to be reduced and the cooling water recirculated.

Hop leaves and marc have to be removed within the factory, as well as yeast and kieselguhr. After a pre-treatment in the factory, one of the following treatment processes may be selected:

a) discharging the sewage into the public sewer and thence to the central treatment plant where it can be treated without difficulty;

b) mechanical and subsequent aerobic biological treatment inside the brewery, completed by drained soil filtering or a low-rate stabilization pond;

c) mechanical and subsequent two-stage biological treatment inside the brewery, thereafter chemical conditioning;

d) sewage irrigation (provided agricultural exploitations utilize sewage for irrigation under contract) where sewage should be pre-treated in order to prevent acidification.

Choice of an adequate method has to be decided on the basis of careful preliminary biochemical tests and economical considerations.

Oil pollution has to be minimized and withhold in due time. Autobus terminals and garages have to be swabbed periodically and everywhere in the occurrence of oil spills, oil traps have to be installed.

Harms due to agricultural chemization should be prevented:

a) *in case of pesticides*, by a careful storage and economy in use, applying fine-spraying machines (the finer the spray, the greater the area protected by the same amount of substance). After being effective, insecticides should decompose to non-toxic compounds. Another means may be found in breeding plants resistant to pests, or in direct biological protection where pests are destroyed by their natural enemies;

b) *in case of fertilizers*, there is a choice between two ways: either these are mixed immediately with the soil, lest an unexpected rain washes

* After G. Réczei, E. Dobolyi and P. Farkas

them away into canals; or one should spread not more than one year's portion of fertilizer upon the soil in order to avoid losses, namely the soil must not store fertilizer for several years. Also, a preference should be given to fertilizers of low solubility in water.

A further possibility of protection is to discharge sewage plant effluents still containing some dilute agents promoting eutrophization into pool No. 3 downstream, rather than to No. 2 flanking the town.

This enhanced protection requires the extension of the actual sewage plant and to increase its efficiency by reconstruction.

Extension needs are estimated from 4000 to about 7000 cu. m/day capacity.

6. Active measures

These include water derivation from the Körös River. It contains suspended sediment, likely to be deposited in the Kurca, due to its low velocity, hence it should be settled first, maybe by means of a settling pond at the intake works (pumping plant). This is, however, insufficient to keep away suspended load arriving through drains in rainy weather. Thus, the pools No. 1 and 2 need periodical dredgings. Pool No. 1 acts as a primary sedimentation tank for water fed into pool No. 2 except for ordinary surface runoff.

Improvement of water quality is based upon water quality control according to closely interrelated biological characteristics of water quality such as:
halobity (entity of inorganic chemicals featuring the water),
trophicity (intensity of producing photoautotrophic organic matter),
saprobity (intensity of organic matter decomposition),
toxicity.

Means of controlling water pollution in watercourses and lakes:
a) Decontamination at the source of pollution;
b) sewage treatment;
c) water re-utilization in agriculture (e. g. irrigation, fish ponds);
d) purposeful dilution in the recipient itself, utilizing self-cleaning ability; and finally,
e) combination of the former measures.

Aeration of surface waters is of practical importance for water quality control. (Cascade aeration at dams, turbine aeration in other places, maybe introduction of rowing.)

Technologies have been developed to remove oil and other floating impurities. In minor watercourses, basic and acid waters can successfully be neutralized. Also decontamination and detergent removal are next to feasible.

Control tends to become a regional, combined, comprehensive water management intervention — namely, complementing water by means of an adequate water take-off system permits to achieve the specified water quality.

A high water level is proficient for control: it counteracts hair-weed spreading, penetration of littoral plants in the water (density being more favourable in large water masses), algal growth, and reduces the occurrence of algal bloom.

The development of adequate longitudinal profiles and cross sections of the watercourse are important for making it a live water.

7. Development of the Kurca and its environment

7.1 Longitudinal profile of Kurca

Along the longitudinal section of the Szentes reach, the normal water level of 79.13 m has to be maintained (with a maximum of 79.26 m), with no substantial variations admitted. No long-time water level lowerings by more than 20 cm are tolerated. (Not even in winter is a water level below 78.90 m permitted.) A water level below 77.50 m would be injurious even for the settlement. This means of course that pool No. 2 practically cannot be used for storage, the permitted fluctuation of 35 cm is equivalent to a useful storage of about 100,000 cu. m.

Our detailed investigations also showed water level fluctuation to keep within a range of 35 cm even in wet seasons.

7.2 Development of the Kurca cross sections

Cross section follows the actual mean width of the Szentes reach of Kurca (pool No. 2). The 6400 m length of the narrowest section (at the municipal hospital) has been agreed upon to be built out with a uniform width, taken here as 50 m throughout and accepted for other reaches, too.

The inner 40 m width of the section has to be dredged to a depth of 2.20 m below the normal water level. Along both banks, the slope is suggested to obtain a berm 1 m below the water level, 2 m in width.

Minimum slope is 1 : 2, the maximum being limited by soil mechanic considerations.

Cross section design is governed by bio-engineering considerations, imposing themselves on the Szentes reach of the Kurca channel. The restitution and maintenance of a live-water character cannot dispense with positive self-cleaning due to living organisms, also with regard to general aspects of ecology. The depth of 2.20 m provides for the biological protection of the inner 40 m of water space (at a minimum depth of about 2.00 m for the lowest water level admissible).

*7.3 Bioengineering methods of bank design**

The above described development of the banks allows bioengineering measures to be applied. Further below details of the expected effects of bioengineering methods will be discussed as well as the conditions of their feasibility.

The live materials used in hydraulic engineering provide for the following effects:

a) a double stabilization of the bed is achieved both above and below the water, namely on and under the surface;

b) a wholesome tendency of soil formation;

c) shadow cast preventing water from warming up unduly;

d) development of sane aquatic ecosystems (e. g. improving thus fish breeding opportunities);

e) increasing dedusting and decontaminating effect due to gradual development of foliage and root system;

f) landscape aesthetics;

g) economical bank stabilization (permitting e. g. to be built up continuously).

However, labour-demanding and delicate bioengineering measures are, a great part of maintenance costs may be covered from incomes of a botanical garden and of the riverside sports establishments.

Bioengineering works have to be preceded by a careful survey and a correct specification of conditions including the following:

— engineering and ecological features of the area in question;
— the choice of a composite cross section (as described above);
— bank slopes and footings stabilized by some living matter, by plastic screens, by fascine work, horizontal layering, loads of local material filled into plastic tissue bags;
— a berm of variable width and height for water plants such as reed, bulrush, sweetsedge etc.;
— slopes coated by a variety of plants, implanted in different modes, combined with dead matter;
— bed depth minimum of 2.0 to 2.50 m, an efficient means of protection;
— efficient aeration;
— dredged sludge disposal.

* After F. Szarvas

Self-cleaning ability may be enhanced by water change, aeration, sludge removal. Water exchange is of a rather low rate; assuming a 2.6 cu. m/s capacity pumping plant at the Körös River, replacement of water in the upper part of pool No. 2 would last 9 days. If it proves insufficient in practice, the intake pumping station at the Körös River has to be enlarged.

Other problems in water quality improvement: the disposal of dry polluting substances, sludge compostation, and rehabilitation of damaged areas call for an organized regular collection, destruction or harmless disposal of garbage. Agricultural benefit from utilizing sewage sludge compost (digested and compacted) has to be pointed out.

Also green belts can be extended by

a) bioengineering development of the watercourse;

b) establishment of more parks in the downtown area;

c) a continuous forest belt along the Kurca, 10 to 30 m wide, beginning at the downtown pool, and later proceeding along the entire Kurca reach. This wood belt has to be designed by a botanist on the basis of indigenous phytocenosis in the Great Hungarian Plain.

8. Miscellaneous problems

a) The entire plan is doomed to failure lest the public mind is transformed so that every citizen feels to own, and insists on, environmental establishments rather than to soil and spoil vegetation and water. Such a transformation of the public mind is a social problem.

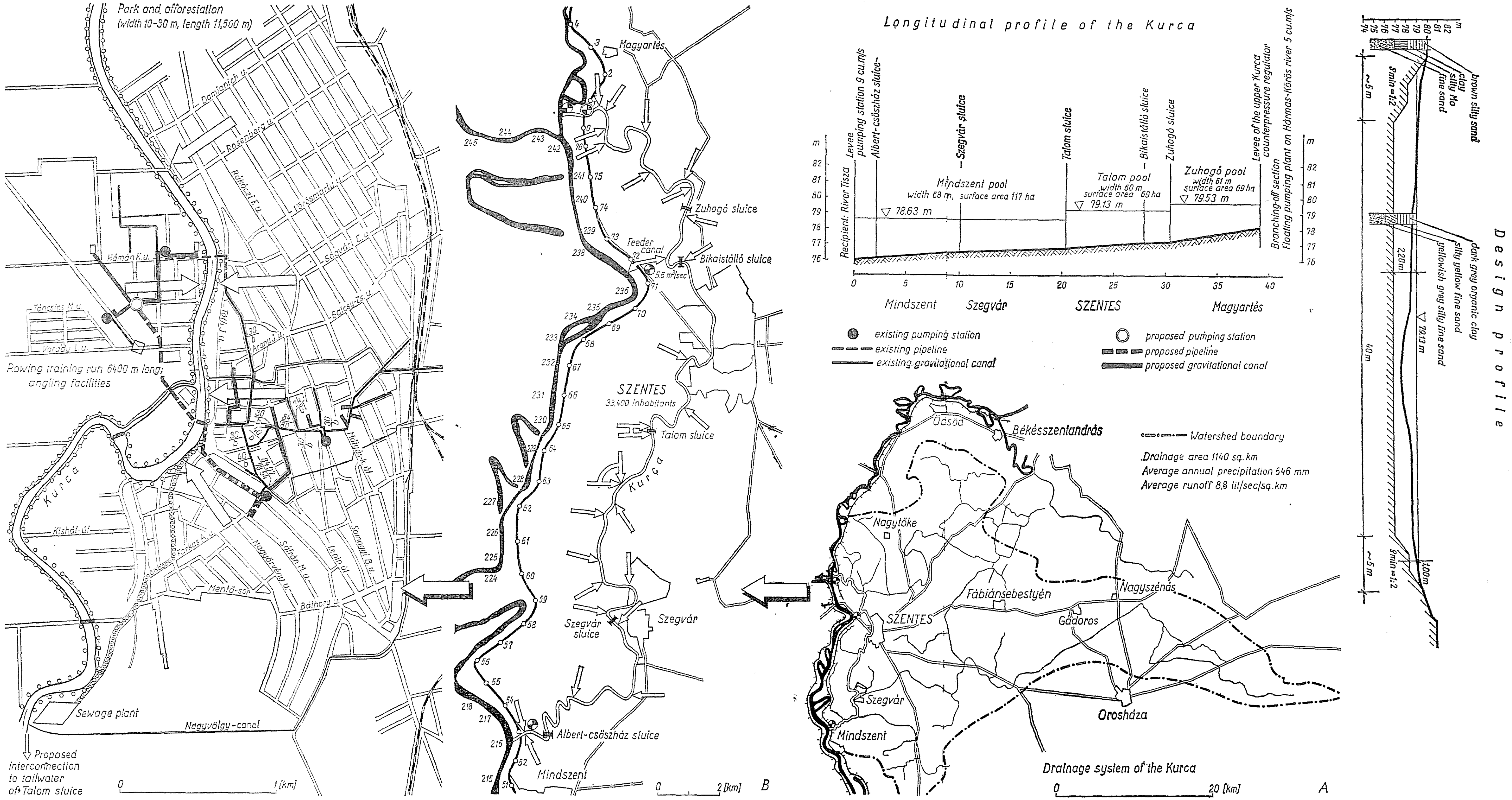
b) Green belt and water surfaces have to be shielded against noise, air pollution and pollution through oil. Therefore motor cars have to be excluded from the green belt, and so are motor boats from the Kurca (except those of the rescue service).

c) Five obsolete bridges on the Szentes reach of the Kurca have to be replaced by r. c. bridges. The existing (foot and road) bridges are too narrow, made of obsolete materials (timber and brick constructions) of low load capacity, have an insufficient clearance to let pass watercraft beneath. The new reinforced concrete bridges should be adequate in width, in load-bearing capacity, and of a clearance permitting boats to pass.

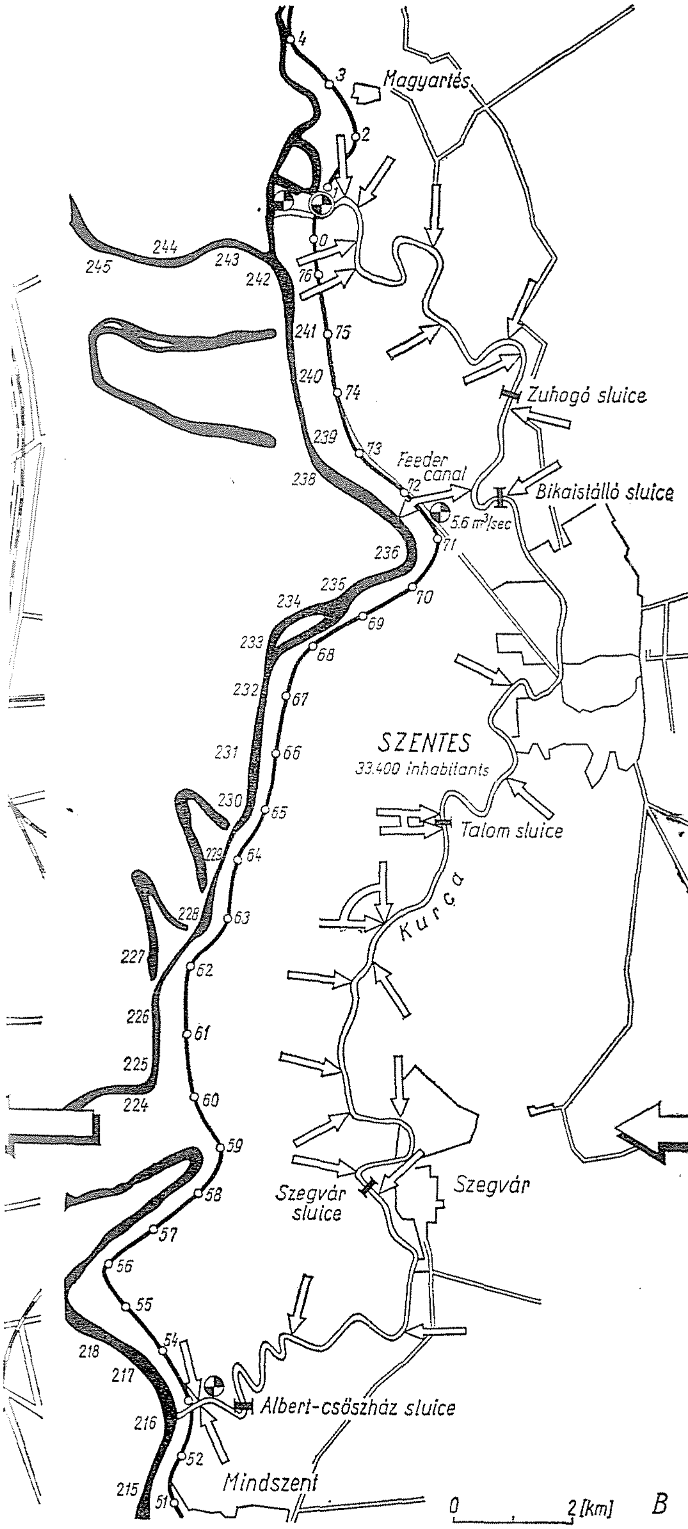
d) The high left bank of the downtown reach of Kurca lends itself for a modern housing estate, with dwellings facing the green belt and the revived Kurca, of a pleasant overall townscape effect.

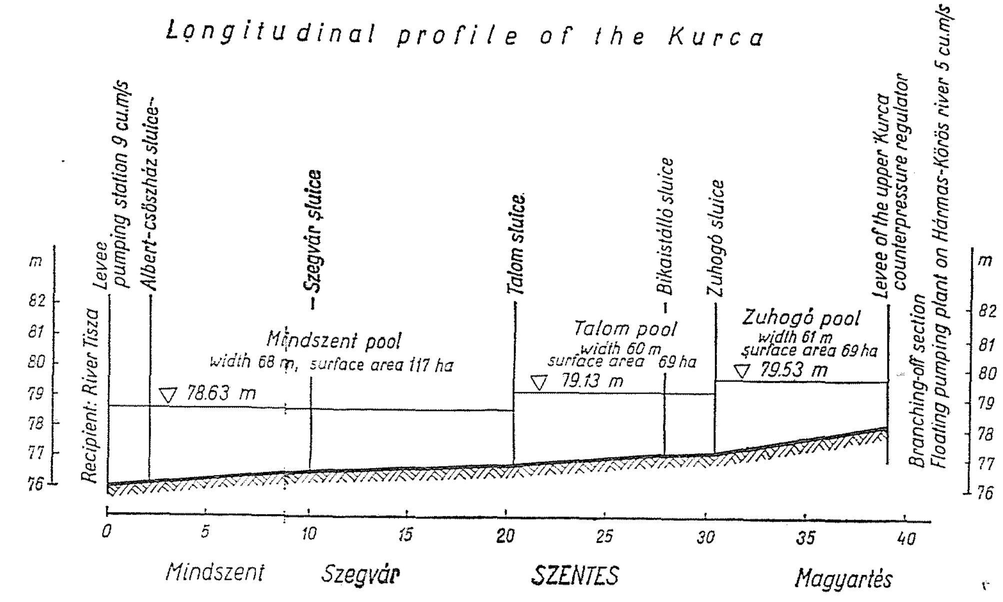
e) Sluices between pools have to be supplied with means of boat locking, especially for boats of a heavier type such as keelboats and fishing boats.

f) It would be beneficiary for the urban development of Szentes to establish a watersports center based on the Kurca, herself unsuitable to swim-



Park and afforestation
(width 10-30 m, length 11,500 m)
Damjanich u.
Rosenberg u.
Rákóczi F. u.
Vörösmarty u.
Szegvári F. u.
Táncsics M. u.
Hámán K. u.
Bajcsy-Zs. u.
Arany J. u.
Várady L. u.
Rowing training run 6400 m long;
angling facilities
Mátyás kir. út
Kurca
Kisházi út
Farkas A. u.
Nagyörvény u.
Sáfrán M. u.
Lenin út
Somogyi B. u.
Mentő-sor
Báthory u.
Sewage plant
Nagyvölgy-canal
Proposed interconnection to tailwater of Talom sluice
0
1 [km]
Magyartés
Zuhogó sluice
Feeder canal
5.6 m³/sec
Bikaistálló sluice
SZENTES
33,400 inhabitants
Talom sluice
Kurca
Szegvár sluice
Szegvár
Albert-csószház sluice
Mindszent
0
2 [km]
B
Longitudinal profile of the Kurca
Recipient: River Tisza
Levee
pumping station 9 cu.m/s
Albert-csószház sluice
Szegvár sluice
Talom sluice
Bikaistálló sluice
Zuhogó sluice
Levee of the upper Kurca
counterpressure regulator
Branching-off section
Floating pumping plant on Hármas-Körös river 5 cu.m/s
Mindszent pool
width 68 m, surface area 117 ha
78.63 m
Talom pool
width 60 m
surface area 69 ha
79.13 m
Zuhogó pool
width 61 m
surface area 69 ha
79.53 m
Mindszent
Szegvár
SZENTES
Magyartés
existing pumping station
existing pipeline
existing gravitational canal
proposed pumping station
proposed pipeline
proposed gravitational canal
Öcsöd
Békésszentandrás
Watershed boundary
Drainage area 1140 sq.km
Average annual precipitation 546 mm
Average runoff 8,8 lit/sec/sq.km
Nagytőke
Fábiánsebestyén
Nagyszénás
SZENTES
Gádoros
Szegvár
Mindszent
Orosháza
Drainage system of the Kurca
0
20 [km]
A
Design profile
brown silty sand
clay
silty Mo
fine sand
dark grey organic clay
silty yellow fine sand
yellowish grey silty fine sand
79.13 m


Magyartés
Zuhogó sluice
Feeder canal
Bikaistálló sluice
5.6 m³/sec
SZENTES
33.400 inhabitants
Talom sluice
Kurca
Szegvár sluice
Szegvár
Albert-csöszház sluice
Mindszent
0 2 [km]
B


Longitudinal profile of the Kurca
Recipient: River Tisza
Levee
pumping station 9 cu.m/s
Albert-csöszház sluice
Szegvár sluice
Talom sluice
Bikaistálló sluice
Zuhogó sluice
Levee of the upper Kurca
counterpressure regulator
Branching-off section
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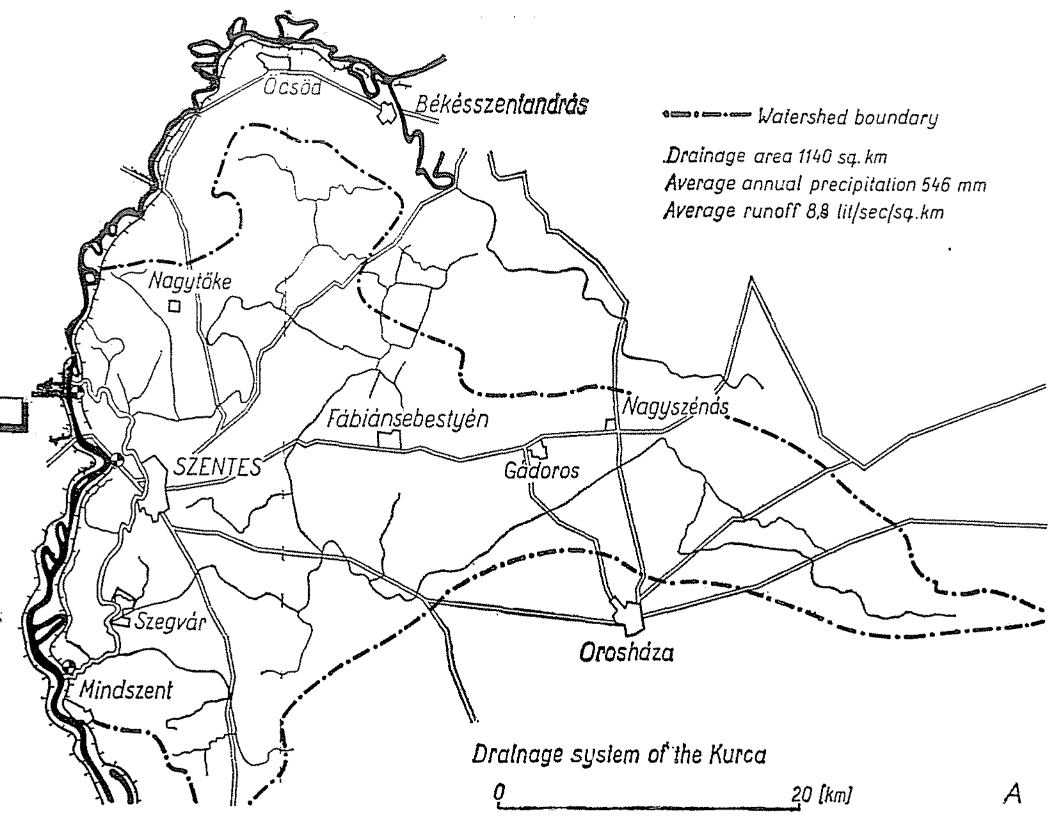
surface area 69 ha
79.53 m
Mindszent
Szegvár
SZENTES
Magyartés
existing pumping station
existing pipeline
existing gravitational canal
proposed pumping station
proposed pipeline
proposed gravitational canal


Öcsöd
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Watershed boundary
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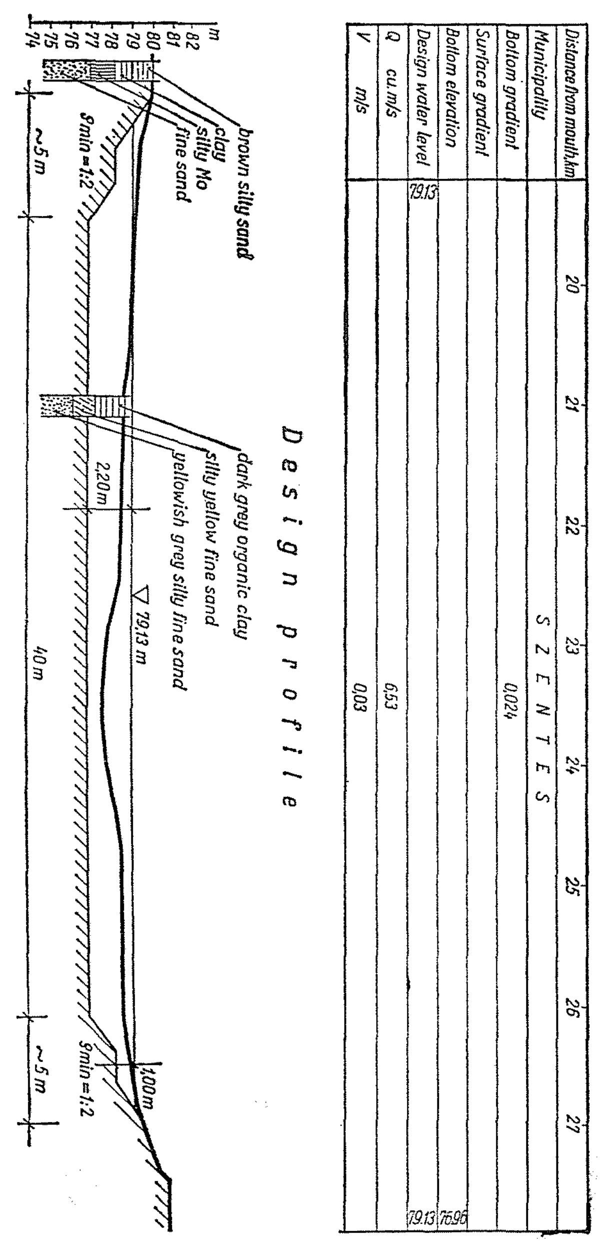
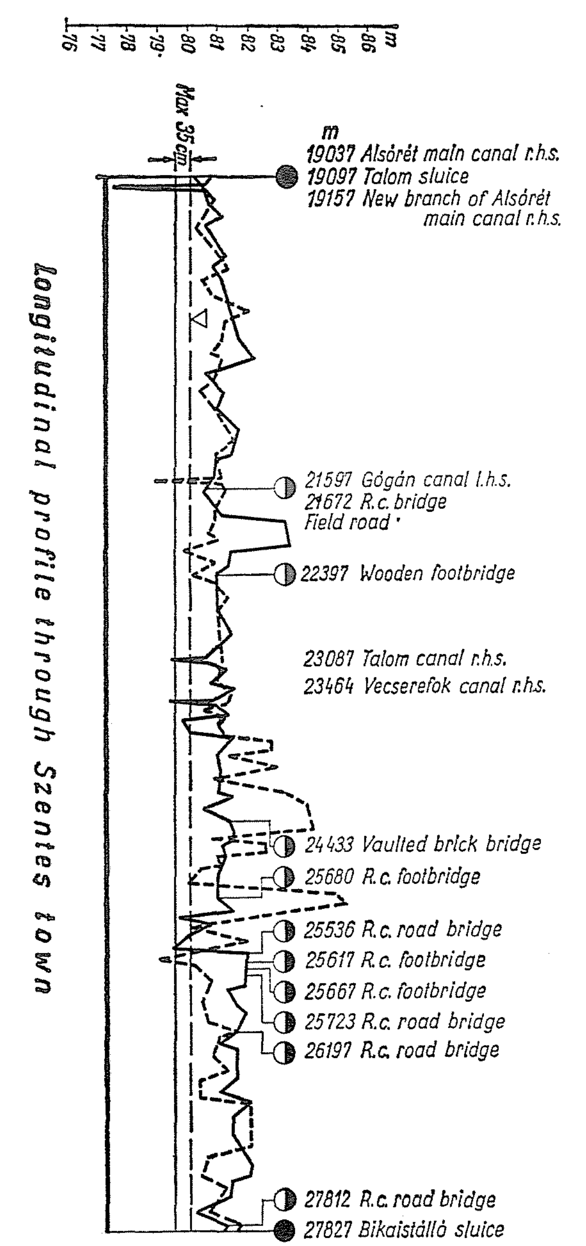
Average runoff 8,8 lit/sec/sq.km
Nagytőke
Fábiánsebestyén
Nagyszénás
SZENTES
Gádoros
Szegvár
Orosháza
Mindszent
Drainage system of the Kurca
0 20 [km]
A


Design profile
brown silty sand
clay
silty No
fine sand
dark grey organic clay
silty yellow fine sand
yellowish grey silty fine sand
79.13 m
2.20 m
40 m
~5 m
~5 m
1.00 m
Distance from mouth km
Municipality
Bottom gradient
Surface gradient
Bottom elevation
Design water level
Q cu.m/s
V m/s
SZENTES
0.024
6.53
0.03
79.13
76.96


Longitudinal profile through Szentes town
Max 35 cm
19037 Alsórét main canal r.h.s.
19097 Talom sluice
19157 New branch of Alsórét main canal r.h.s.
21597 Gógán canal l.h.s.
21672 R.c. bridge
Field road
22397 Wooden footbridge
23087 Talom canal r.h.s.
23464 Vecserefok canal r.h.s.
24433 Vaulted brick bridge
25680 R.c. footbridge
25536 R.c. road bridge
25617 R.c. footbridge
25667 R.c. footbridge
25723 R.c. road bridge
26197 R.c. road bridge
27812 R.c. road bridge
27827 Bikaistálló sluice

ming and bathing because of both its bed material and slope. But a watersports center could be established on the right bank where there is room for it. It could be combined with a training track for rowing, about 6.5 km in length, 40 m of bed width and 2 m deep. Rowing would forward O_2 absorption by the Kurca water. Also angling might become possible upon naturalizing fish in the revived water.

Even other sports could find here an accommodation with clubhouses, sports grounds or indoor halls.

9. Conclusions

This study has been abridged from a plan developed by a team under the active guidance of Prof. P. Salamin in 1975 and submitted for discussion to the Szeged Group of the Hungarian Hydrological Society. The plan is now under realization preceded by tests on bioengineering revetments directed by Mr. *Mihály Ötvös*.

The study plan aiming at the environmental development and protection of an average Central-European town in the plain has as fundamental aspects:

— ecological and economical equilibrium between natural and social forces and factors;

— hydrological approach to any problem, process and intervention.

Acknowledgements

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Summary

An environmental engineering plan has been developed for a drainage main canal built in a former natural channel. The main canal has been perfectly eutrophized and needs reviving. The plan is of importance for the development of Szentes, a town suffering from climatic and water management difficulties.

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