Water management Dömsöd

An orientating plan for managing the surface water system & improving the water quality

Laag Keppel – May, 2010

Principal	Student	University of Larenstein
Euroship Services	Jan willem Overmars	
Kees Cornelissen	Jan de Jagerlaan 2	Peter Groenhuijzen
Heerewaardensestraat 24	6998 AN Laag Keppel	Larensteinselaan 26a
6624 KK Heerewaarden	06-52285562	6882 CT Velp
0487-57 14 98		

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Summary

This water management plan describes a new surface water system for draining the Old Danube catchment area after the Old Danube got raised with one meter. Is also describes solutions for an improved water quality. See for locations the maps on page 9, 15, 19, 22.

Euroship Services has the objective to realize a marina in Dömsöd on the Old Danube. The Old Danube is a side branch of 6,5 km long of the RSD. The RSD, about 59 km long flowing from Budapest to the south, is a dammed side branch of the main Danube. Caused by this dam, the RSD rose with one meter. The Old Danube was closed off from the RSD to prevent a water level rise here. As a result, the Old Danube water level is one meter lower then the water level in the RSD. The lower surface water level is crucial for the Old Danube to drain a 50 km2 catchment area.

Surface water system
The Old Danube can be divided in a northern and a southern section. An irrigation canal divides the two sections and a siphon under this irrigation canal makes free flow between the two sections possible. The irrigation canal has the possibility to drain on the Old Danube. The southern section can be divided in three other sections: Section 1 is the most southern section and on the level of the RSD. Section 2 is, as the rest of the Old Danube, one meter lower. The only outlet of the Old Danube is in section 2 and is called the Tass canal. The Tass canal is discharging under free flow to the main Danube. In section 3 two pumps are located, discharging excess water out of the Old Danube when due to high water levels in the main Danube the discharge through the Tass canal is not possible. The Old Danube has two water inlets: at the northern point of the Old Danube, and between section 1 and section 2.
Two canals, I4 and I6 drain the northern drain area. A third canal (I5) drains the island Somlyósziget.

With open connections between the RSD and the Old Danube and a complete navigable Old Danube, the surface water level in the Old Danube rises with one meter. The draining function of the Old Danube must be adopted by a new surface water system. For this new surface water system, the following fundamental ideas are taken into account:

- Sufficient draining capacity
- Durable solutions
- Make use of the advantages the area offers
- Attractive for marina tourists

With this in mind, a new surface water system is designed. This new surface water system will have the draining function for the area. For this, the surface water system in the northern drain area is redesigned. The I4 and I6 canals are connected with a siphon on the Tókert canal. Also a retention reservoir before the siphon is realized to intercept a high peak discharge so the present capacity criterion of 3,5 m3/s can be lowered. The Tókert canal will be cleaned up and re-dimensioned, so it can drain the Tókert area and also discharge the water from the northern drain area. The Tókert canal will drain on the

900 meters long Bypass canal. The Bypass canal flows between the Old Danube and Dömsöd and discharges the water to the Tass canal. The Bypass canal will be designed as an attractive waterfront of Dömsöd by realizing a walking path over the quay and by preserving the weeping willows. The pumps are relocated to the new surface water system so when discharge through the Tass canal is not possible inundations are prevented by pumping the excess rain- and ground water on the Old Danube. Somlyósziget is drained by a pump situated at the outlet of the canal I5. This brings the advantage that Somlyósziget is dryer then in present situation, but the disadvantage is that the solution is not durable. The discharge point of sewage is readjusted to the raised surface water or is relocated and discharging on the Bypass canal, bringing the advantage that the Old Danube and marina do not get polluted by sewage water.
Excess rain water from the irrigation canal can discharge on the Tókert canal.

Water quality
The water quality in the Old Danube is visible in a bad condition. This is due to in arrear dredging, the lack of a refreshment flow, the shallow water, and the emissions discharged on it. The surface water quality can be improved by improving the quality of the run-off water and reducing the quantity of this run-off water discharging on the surface water. Dredging plans are made for the southern Old Danube. For nature reservation reasons the northern Old Danube will not be dredged. It is advised that for a navigable complete Old Danube also this section is dredged. When done with caution, a part of the old wood in the water can remain. Old wood is a place for microorganism. Microorganisms have an important role in filtering the water, improving the water quality and biodiversity.
A refreshment flow will improve the water quality significantly. For this, the Tass canal can attract extra flow into the Old Danube. The discharge of sewage water and run-off water (rainwater from roads and roofs) is separated in two different systems. The sewage system has at the main sewage pump one discharge point, that spills over in case of a breakdown of the main sewage pump. The run-off water is collected by a rainwater discharge (RWD) system. The RWD system consists of a few independently functioning RWD systems, each of them having its own discharge point. The Old Danube is the "drain put" for six of those discharge points, discharging the rainwater of 150.000 m2 paved area. In present situation five of the six RWD systems are silted up causing inundations. When renovated again, they will discharge pollution picked up from run-off water on the Old Danube. For cleaner run-off water and less inundations in town, a new RWD system is required. For this new RWD system the following fundamental ideas are taken into account:

- Sufficient capacity to reduce inundation of roads
- Not solving the problem by discharging the pollution downstream of Dömsöd
- Sufficient purification capacity
- Making use of what the existing RWD system offers
- Keep the RWD system simple and easy to maintain

With this in mind, a new RWD system is designed.
The rills catching the run-off water will be realized as an infiltration reservoir. Run-off water will be caught in here, infiltrate through an improved soil layer where pollution is absorbed before it reaches the groundwater.

If the purification capacity is insufficient due to to a low infiltrating capacity, storage settling tanks can be realized at the discharge points of each RWD system. A storage settling tank still has a cleaning effectivity of 40% and can clean the run-off water that does not infiltrate.

For a cleaner run-off water must also be looked for solutions to solve the pollution at the source, and to reduce the quantity of the run-off water so the capacity of the rills is used efficient. Measures can be found in making inhabitants and council aware of pollution on the roads, and reducing discharges and the risk on calamities. Roof water can be caught on the property of the house. It can infiltrate in the backyard of a house, if a backyard is available, or be caught in a reservoir and used for toilet flushing and watering the garden. This brings the advantage that less tap water is used.

A correct maintenance of the RWD system is crucial to keep the system functioning. A maintaining plan must be made when renewing the RWD system. The maintaining consist out of maintaining the lawn, remove cut grass, trash, leaves and mud, replace the top soil layer on time to prevent saturation, and re-adjusting the spillovers. The storage settling tank must be emptied periodical. Silt must be carried away under vision.

Conclusion water quality
Dredging the Old Danube, stimulating a refreshment flow, and catching and purifying the run-off water before it discharges on the surface water or seeps into the ground will make a big improvement on the surface water quality. The Old Danube will be a place to swim again, for locals and tourists.

Conclusion new water system
For the new surface water system there are no technical limitations. How ever before the Old Danube is raised with one meter the effects of the groundwater level rise must be investigated. High ground water levels can work out badly for the support on the marina of the locals. This is understandable, because no one wants inundated cellars or moist walls. Realizing the measures is an intense and expensive job and it is the question whether this weights out with an open connection for a marina.

Recommendations
If a sluice between the RSD and the Old Danube is realized, the surface water system can remain as it is. Also, the Old Danube will keep its own water level, independently of the fluctuating RSD water. The RSD water level is fluctuating when a flooding from the Danube is expected: the water level is then dropped by over a meter to create retention for the expected floodwater. With an open connection between the Old Danube and the RSD it is possible that the marina will hit dry bottom for a period of a few days, each time a flooding is expected. A sluice between the RSD and the Old Danube will give the Old Danube its own water level, independently of the fluctuating RSD water level. This is a simpler solution, leaving the existing surface water system in function, and saving enormous on the realizing costs of a new surface water system.
If chosen for an open connection anyway, further hydraulic calculations are required to determine the dimensions of each water surface subsystem.

H1 Introduction

1.1 Location

Dömsöd is a small town 45 km south of Budapest in Hungaria. It is situated along a side channel of the Danube, called the Ráckeve Soroksár Duna (RSD). The RSD starts in south-Budapest and ends 59 km south in the main Danube. At Dömsöd, the RSD has a side branch called the Old Danube. This side channel flows closest to town. The Old Danube is closed from the RSD and drains a catchment area of 50 square km. The catchment area is situated between the RSD and highway 51, from Ráckeve and Kiskunlacháza, till the southern point of Dömsöd. The town Dömsöd is situated on a low mount, overlooking the Danube Valley. See for an overview map 1, catchment area.

1.2 A short background of the project

1.2.1 The Old Danube and the RSD

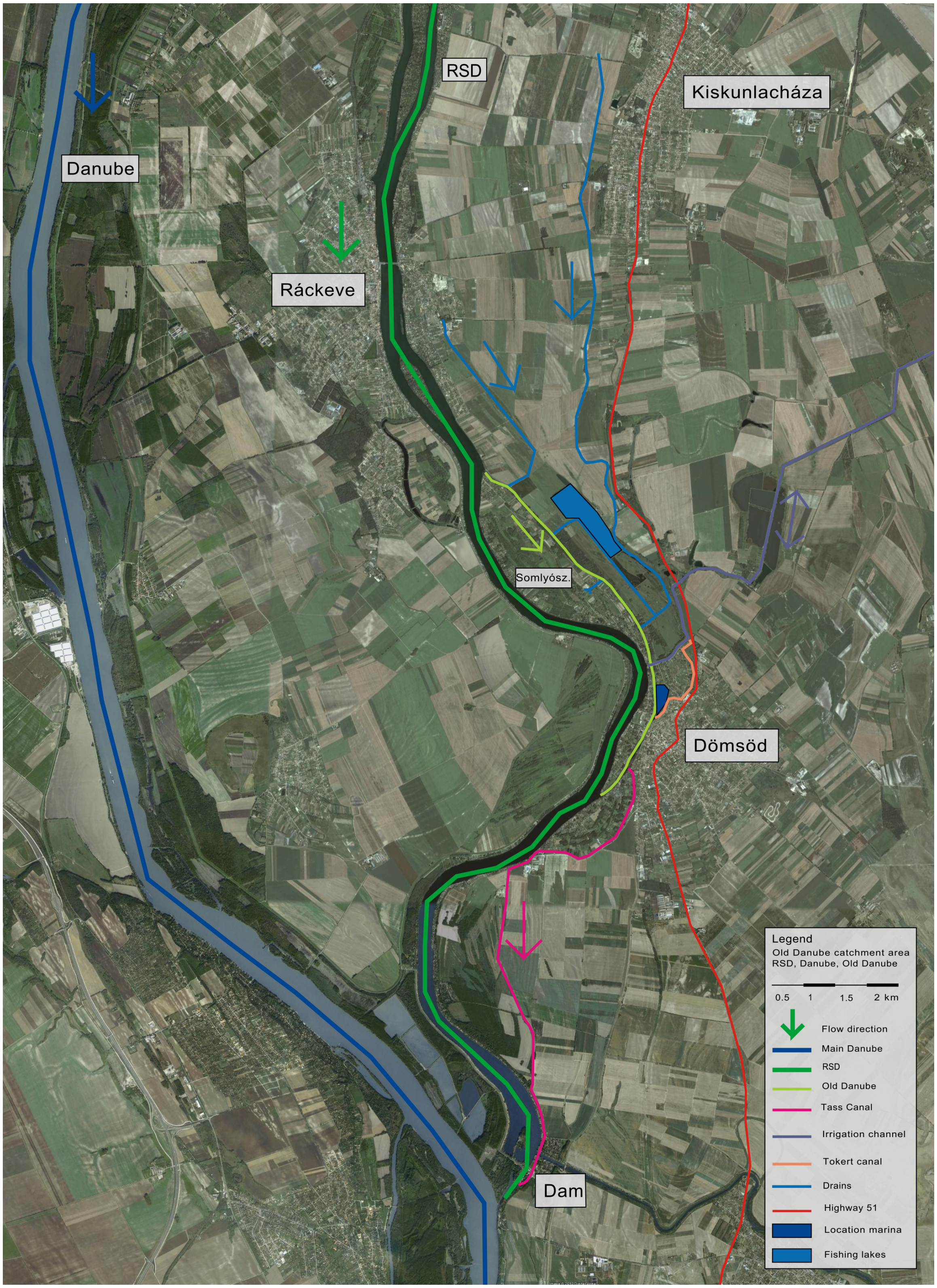
In 1926 the RSD was dammed on both ends. Caused by this damming, the water level in the RSD at Dömsöd rose about 1 meter. The Old Danube was closed-off from the RSD at that time, and was kept on the original water level of the RSD. This way the draining function of the Old Danube catchment area is maintained by the Old Danube, and also seepage water out of the higher leveled RSD is partly caught by the Old Danube. This prevents groundwater level rises and wet conditions in the lower parts of Dömsöd town. The Old Danube drains on a little canal, called the Tass canal. The Tass canal discharges in the main Danube, just south of the southern dam of the RSD.
This surface water system is well designed, but in a state of neglect.

1.2.2 Water quality

The Old Danube has a water quality problem. Especially in summer the water quality is bad. This is, among other causes, partly caused by the lack of flow in the Old Danube, and partly caused by the emissions of waste draining on the old Danube.

1.2.3 Euroship Services

Principal for this study Euroship Services, a company who designs and manufactures yachts in the Netherlands, has the objective to build a Water Tourism Center (marina) in Hungaria and bought for this purpose land in Dömsöd (see picture 1). This land is situated on the banks of the Old Danube. Euroship Services wishes an open connection (no sluices) between the Old Danube and the RSD.



Map 1: map of the catchment area.

1.2.4 Previous studies

Previous studies about the marina project are:

- Conception plan of water Tourism Centre (Vidra, 2007).
  In this plan the surface water system as it is now is described, and alternatives for creating a passageway between the RSD and the Old Danube are mentioned.
- Dömsöd water tourism centre, feasibility study (HKV, 2009).
  This study written by HKV investigates three alternatives for the marina on technical, ecological, economical and financial prospect for the marina in Dömsöd.

Picture 1: location marina of Euroship Services with on the left the Old Danube

1.3 Objectives

For an open connection between the Old Danube and the RSD, the surface water level of the Old Danube needs to be leveled with the RSD. This means a one meter surface water rise of the Old Danube. With a higher surface water level, the Old Danube will not be capable to drain the catchment area. To keep the surface water system functioning and to keep the Old Danube catchment area dry, this study investigates the present surface water system, and works out an alternative surface water system for draining the Dömsöd catchment area.

This study also investigates the need and the chances to improve the water quality of the Old Danube.

The main question in this study is:
When the surface water level in the Old Danube is raised, how can negative effects caused by a higher surface water level be prevented and what measures can be taken to get cleaner surface water?

1.4 Approach

In the Vidra conception plan and the HKV feasibility study (see 1.2.4) not all questions are answered. This study will focus on the unanswered questions in relation to water quality and the surface water system.
The study includes a visit to Dömsöd. Euroship Services offers the Hungarian expertise of Gabor Kelemen translator and communicator in Dömsöd.
The study is using references of gathered information. Some of this information is translated from Hungarian to English.
After analyzing the gathered information and the situation on location, conclusions and solutions for the surface water system and the surface water quality are made.
The expertise and wishes of Euroship Services, Middle Danube Valley Water Management, Municipality of Dömsöd, Duna-Ipoly National Park, Fishing association Dömsöd, and other stakeholders living in Dömsöd and hinterland will be taken into account.
The study is reported in this report and will be presented at the University of Larenstein.
The activities, method of study and results are listed in the progressive scheme, found in the appendix.

1.5 Project organization

This study is accomplished by Jan Willem Overmars, part time student on the University of Larenstein. It is his final report for his graduating.

Principal for this study is Euroship Services. The contact person (also owner of the company) is Kees Cornelissen. For Euroship Services the marina needs to be a financial success. This study will bring him a step closer to this goal.

The guide from Larenstein is Peter Groenhuijzen, teacher in urban water management.

During this study Peter Groenhuijzen guided the proceedings and answered questions about urban water if he could. Kees Cornelissen was kept posted by the proceedings and results and could interfere if he wishes.

1.6 Reading guide

In chapter two the present situation is described.
This chapter is especially for those who are new on the marina project. The description of the water surface system is essential to understand the project. New is the analysis of discharge points of rainwater and sewage water. In previous reports this has not been investigated. Knowledge about the discharge points, which are big source of pollution for the Old Danube, is required for improving the water quality.

In chapter three the desired situation is described.
This chapter describes the ideal situation. It describes the Old Danube with the raised surface water level of 1 meter, and what is required to keep the Old Danube catchment area dry. It also describes the desired improvement of the water quality, and how this will benefit the tourists and locals.

In chapter four, the consequences of a raised surface water level on the Old Danube are described.
In this chapter it is made clear, what the consequences of a raised surface water level in the Old Danube are. Also the consequences of a not improved water quality are described.

In chapter five, a new surface water system is designed.
This chapter describes a new design of the surface water system on functional prospect and defines measures that have to be taken for the new water management system for the catchment area of the Old Danube.

In chapter six, is described how to improve the water quality.
This chapter describes the measures that can be taken to improve the surface water quality and how to reduce diffuse pollution downstream of Dömsöd.

In chapter 7, recommendations on the marina project in Dömsöd are given.

H2 Present situation

2.1 Introduction

In this chapter the present situation is described. The present situation of the surface water system is described in paragraph 2.2, and the present situation of the water quality is described in paragraph 2.3. The locations mentioned are plotted on map 2, map of the present surface water system.

2.2 The surface water system of the Old Danube

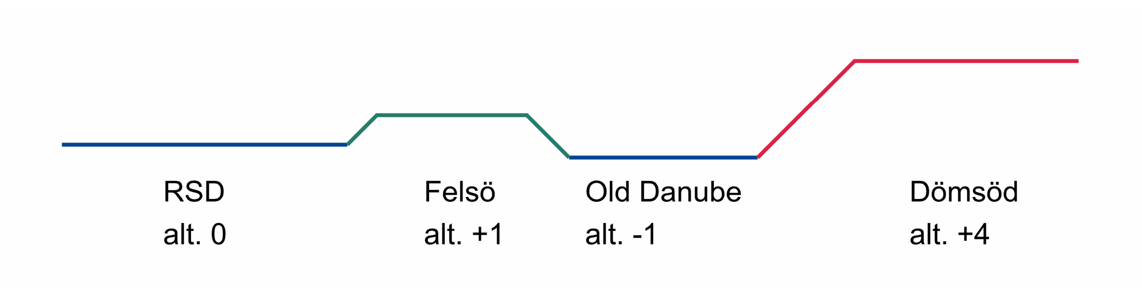
The Old Danube is a side branch of the RSD. The length is 6,5 kilometer, it has an average water width of 28 meter and a average depth of 1-1.5 meter. It can be divided in a northern (picture 3) and a southern section (picture 4). The irrigation canal, which supplies the need for water in the hinterlands, is the border between these sections. The irrigation canal has a higher surface water level then the Old Danube (but lower then the RSD) and has the possibility to drain on the Old Danube. This is necessary for the discharge of the irrigation canal is case of heavy rain.
The north- and southern section of the Old Danube are connected through a siphon underneath the irrigation canal, this means free flow between the sections.
The Old Danube drains a catchment area of 50 square km (source: HKV, 2009). The larger part of this area is between Dömsöd and the northern towns Ráckeve and Kiskunlacháza (see map 1, page 9) and is called in this study as the “northern drain area”. Two canals (called I4 and I6) are draining this northern drain area. A third irrigation canal (I5) drains the smaller Island of Somlyó (Somlyósziget). A fourth canal (called Tókert canal, 4) is draining the Tókert area, a low lying residential area of Dömsöd.

The southern section can be divided in three other sections, each of them fenced by a dam with culverts. The most southern section, called section 1 (s1) is on the same water level as the RSD. From here water flows through a culvert (2) in the one meter lower middle section 2 (s2). The most northern section of the southern Old Danube is called section 3 (s3). This classification of sections has been used in previous reports and will be retained in this study.

The fishing lakes located 1 km west of Somlyósziget get their water supply out of the Old Danube (picture 5). A pump (5) tides over the height difference of 1 to 2 meters. The lakes have hereby the higher surface water level. The ditch (6) around the lake discharges the water out of the lakes on canal I4 and on the Old Danube.

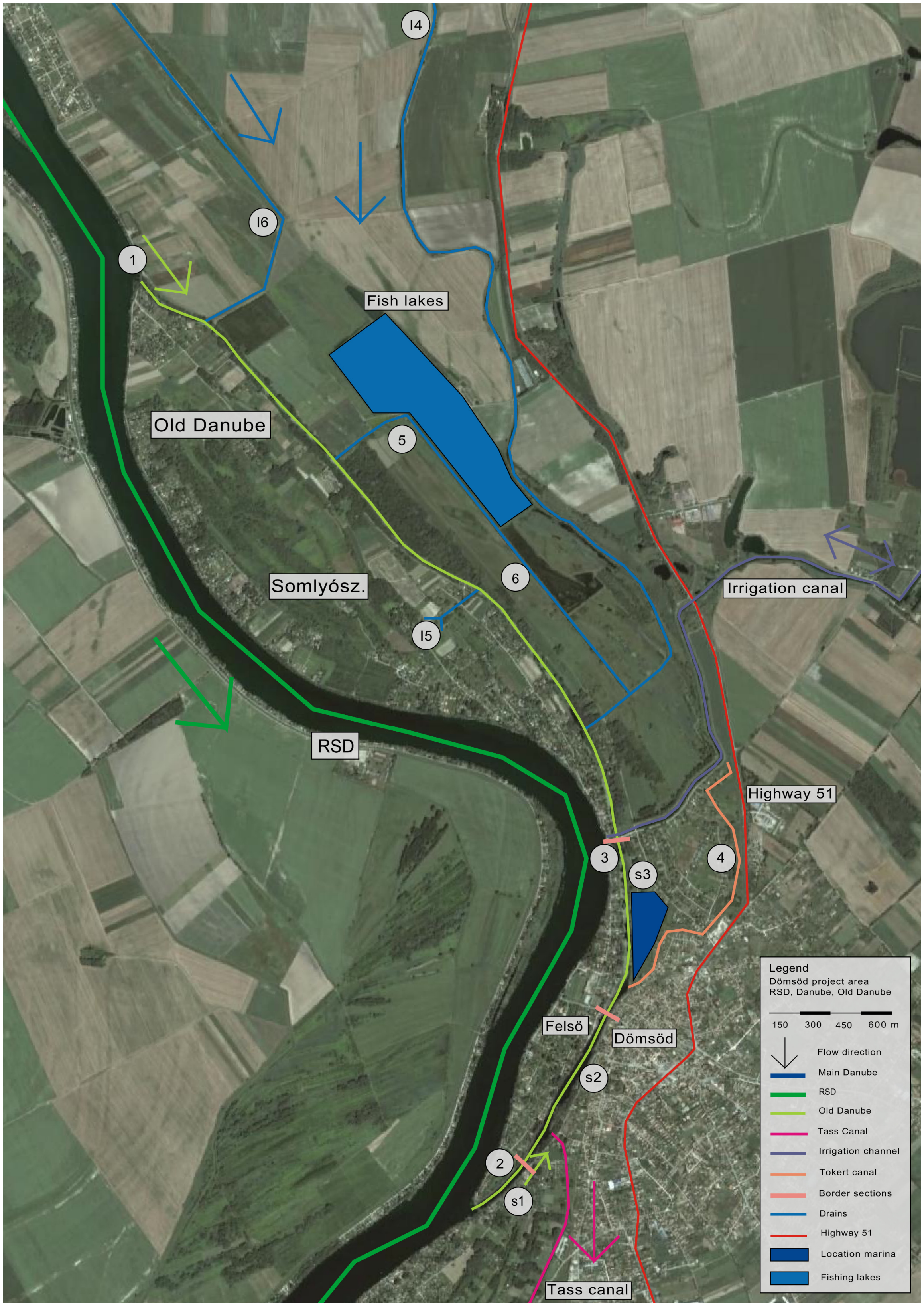
The Old Danube also catches the run-off rainwater of the west part of Dömsöd and in fewer proportions of the less intense populated island Felsö (Felsösziget). The run-off rainwater brings pollution from roads and roofs on the Old Danube.

The Old Danube (the northern section and the southern section s2 and s3) is under normal circumstances one meter lower then the RSD water surface level (see picture 2, cross section). The water level in the Old Danube is the natural water level of the RSD of before it was dammed. The RSD rose one meter caused by the dam at the southern point of the RSD (read more about this in 1.2.1 the Old Danube and the RSD). South of the dam is the main Danube. The main Danube has its natural fluctuating water level.
The Old Danube has two water inlets from the RSD, at the northern (1) and southern point (2) of the Old Danube, and one outlet in section two (Tass Canal). The Tass canal discharges all excess rain- and ground water from the Old Danube into the main Danube, 7 km south of Dömsöd. The Tass Canal is discharging under free flow on the Main Danube.



Picture 2: cross section with relatively altitudes of land or water surface, in Dömsöd, east-west direction

If the main Danube has a high water level, discharge through the Tass canal is not possible. Therefore two pumps in section three are located. The pumps (3) have a capacity of 3,5 m3/s and pump the excess rain- and ground water out of the Old Danube on the RSD. With this capacity and the total water surface of the Old Danube of 6500 meter * 28 meters = 1.820.000 m2 the pumps can let the surface water drop by 0,07 meter per hour, if no inflow is present.
The actual amount of rain- and drain water draining on the Old Danube is difficult to estimate. Making a water balance on this is a complicated job because of the unknown factors. What amount of water runs off the surface into the Old Danube, how long does it take? How much groundwater seeps in the Old Danube? Known is that the pumps are rarely used, but if used, the full capacity is turned on, and the surface water level of the Old Danube does not rise (e-mail notification of Gábor Kelemen, 19th of May 2010).
With this in mind it can be concluded that the pump capacity of 3,5 m3/s is sufficient. Also HKV mentions that in extreme conditions the discharge out of the catchment area of the Old Danube can be 3,5 m3/s. In this study the 3,5 m3/s is also the criterion and is used for the new water management system.



Map 2: map of the present surface water system

Picture 3: southern section of the Old Danube (seen from the irrigation canal)


Picture 4: northern section of the Old Danube (seen from the irrigation canal)


Picture 5: filling the fishing lakes with water from the Old Danube

2.3 Water quality

Although parameters of the water quality of the Old Danube are unknown, the water quality of the Old Danube is at this moment visible in a bad condition. Flow is minimal and in the (almost) standing water pollution and nutrients remain. Especially in summer algae are growing on the nutrients effecting a low oxygen level. The water surface becomes dirty and is smelly.

In this study the water quality is determined by the management (maintenance of the surface water, refreshment flow) and features of the surface water (depth of the surface water), and the emissions discharged on it.

The surface water management is not sufficient for a good water quality. The refreshment flow in minimal and the last time the Old Danube has been dredged was before 1940. As concluded by HKV (2009) the water in the RSD is of good quality. Also the university of Budapest (Ecology of the RSD – a review, 2007) confirms that the southern part of the RSD (this includes Dömsöd) is suitable for bathing for most time of the year. RSD water can be used for refreshment of the Old Danube. Hereby a residence time of two weeks is recommended by HKV as sufficient, although shorter time offers advantages (less midges, even more improved water quality and refreshment flow). Refreshment is especially important for the Old Danube because of the shallow water depth of 1-1.5 meters. Water is by the sun easily warmed up in summer, increasing the growth of algae's. The best refreshment flow will be created if the northern and southern arm will be opened and have an open connection with the RSD on both ends. The discharge into the Tass canal can attract extra flow into the Old Danube, as flow through the RSD will naturally take its shortest route through inside bend of the RSD. The Old Danube should not have an open connection at the irrigation canal. This way also the northern part of the Old Danube will have advantage of the attracted flow into the Tass Canal.

With a change in the management and features of the surface water by dredging the Old Danube and increasing the refreshment flow the water quality will improve, but it will not solve the emissions flowing into the Old Danube. In this study the following emissions points have been investigated:

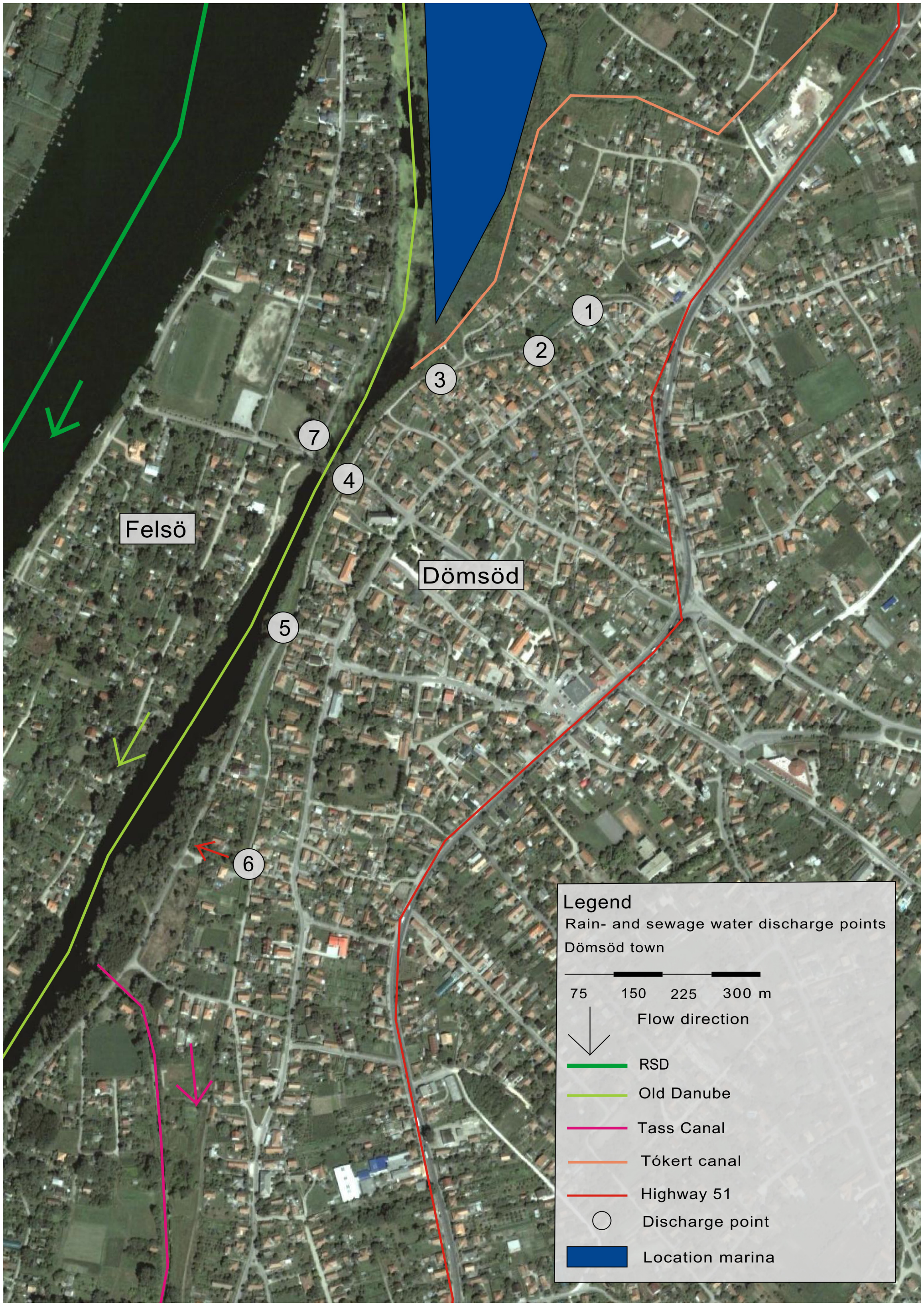
- Discharge points of rainwater from roads and roofs
- Discharge points of sewage spillovers
- Discharge points of other waste points

Other possible sources of emission, like the fishing lakes discharging on the Old Danube and agriculture land, have not been investigated in this study.

2.4 Discharge points

The sewage system has one discharge point. This discharge point is located at the main sewage pump (see map 3, location 7). The main sewage pump pumps the sewage water to the sewage treatment plant, about 8 km north in the town Ráckeve. In Dömsöd the rainwater is not collected by the sewage system. This brings the advantage that the sewage system will not exceeds its limit due to a large peak discharge of rainwater and will not spillover on the surface water. Only in case of a breakdown of the main sewage pump the sewage water will after the reservoir got filled up discharge on the Old Danube. (source: verbal notification February 2010, municipality Dömsöd Mr. László Varga).
In what frequency and in what quantity this happens is unknown.

Dömsöd has a separated system for the discharge of rainwater. This rainwater discharge systems consists of a few free-standing open systems, each of them discharging the rainwater of a part of Dömsöd to a different outlet where the rainwater flows on the surface water. Seven free-standing rainwater systems discharge on the Old Danube (see map 3, locations of the discharge points)
In Dömsöd town the area west of highway 51 is draining on the Old Danube or Tass canal. The rainwater of the area east of highway 51 discharges on reed beds east of town. Significant for the water quality for the Old Danube are the discharge points of rainwater discharging on the Old Danube. Only these discharge points are included in this study. However, the advice given on rainwater discharge system can be taken into account for the rainwater system in Dömsöd.
Rainwater run-off gets polluted by the waste present on roads and roofs. This is also the case in Dömsöd.



Map 3: locations of the discharge points

The rainwater discharge (RWD) systems have not been maintained and are in a state of neglect (pictures 6, 7, 8). It is silted up with sand. In some cases the last stretch of the RWD system works partly. The last years hindrance caused by inundation of the roads by intense rain has been increased (source: verbal notification February 2010, municipality Dömsöd Mr. László Varga). The council of Dömsöd desires to renovate the existing rainwater discharge system; however due to shortage of financial support only one part of the rainwater discharge system has been renovated recently (discharge point 1, map 3)

The advantage of the bad state of the RWD system is that polluted rainwater does not flow on the Old Danube. Because the system in silted-up, rainwater is preserved on the spot where it evaporates and infiltrates into the ground. Waste does not flow on the Old Danube. Good for the water quality of the Old Danube, but not a solution for the future. To reduce inundations the RWD system will be renovated in future, although when this will happen and how this will be financed is unclear.

Picture 6: filled up RWD system almost causing inundation of the roads, Dömsöd

Picture 7: RWD system in state of neglect

Picture 8: outlet 5 (see map 3) RWD system, silted up with sand and trash

H3 Definition of the desired situation

3.1 Introduction

Euroship Services requires changes in the surface water system for an open connection between the RSD and the Old Danube to benefit the marina on the Old Danube. In this chapter the desired new water surface system is described in paragraph 3.2. Also the desired improvement in the water quality is described in paragraph 3.3

Map 4: map of the marina Dömsöd, source: Euroship flyer, concept

3.2 New surface water system

Euroship service plans to develop a marina in Dömsöd on the banks of the Old Danube. Therefore Euroship service wants an open connection with the RSD and the Old Danube for marina boats navigable.

The Old Danube has an important drainage function in the present water surface system, as written in 2.2 the surface water system of the Old Danube.
However, by raising the water level of the Old Danube, the Old Danube will lose this drainage function. In the desired situation of Euroship Service the Old Danube has open connections with the RSD. This means that the Old Danube will be raised with one meter. The drainage function of the Old Danube must be adopted by a new surface water system that will keep the area dry.
Here fore, a new surface water system must be made, so the draining the catchment area of the Old Danube is guaranteed. If this new surface water system is well designed and correct functioning, the Old Danube can have an open connection with the RSD.

3.3 Improved water quality

Euroship service requires a good water quality of the Old Danube for attractive water recreation. Good water quality for attractive recreation is a water surface that has sufficient water quality for swimming in summer. This means that the surface water must have a good biological balance; no fast growing algae's in summer that withdraw the oxygen and can even make the water toxic. It also means that the surface water must have a good chemical status to insure the health of people living around it; people who are swimming in the Old Danube, or eating the fish out of the Old Danube. Good water quality in the Old Danube with enough refresh flow and fewer chemicals discharged on it is also the goal for the European Water Frame Work guidelines, in which all surface waters must declare a good chemical and biological status.

H4 Analyzing the consequences

4.1 Introduction

The present water system is clever designed (see 1.2.1, the Old Danube and the RSD). Changing the system must be well considered. In paragraph 4.2 the consequences that will appear when the Old Danube is raised with one meter are described.
The water quality is in a bad state. The consequences if not taken care of the water quality are described in paragraph 4.3.

4.2 Surface water system

When the Old Danube water level is raised with one meter it will not be able to discharge the rain- and ground water out of the area. This will have the following consequences on the surface water system:

- The northern drain area
  The canals I6 and I 4 drain the northern drain area and discharge under free flow on the Old Danube. If the Old Danube water level is higher, the water level in the canals will rise as well, causing wetter conditions in the hinterlands.
- Somlyósziget
  Somlyósziget is already struggling with a high surface water level. The canal I5 drains under free flow rainwater from Somlyósziget on the Old Danube. In the present situation the level of the Old Danube is too high to drain the lowest areas of Somlyósziget. Also the siphon under the irrigation canal gets jammed easily (picture 9); causing a higher surface water level in the Northern old Danube until the siphon is cleaned. The lowest areas inundate regularly (picture 10). A raised water level of the Old Danube will cause more local permanently inundations on Somlyósziget.
- The pumps
  The pumps located in section three of the Old Danube discharge the rain- and ground water out of the Old Danube in case discharge through the Tass canal is not possible. The Old Danube will lose its draining function so the pumps in section three will be useless. The new surface water system will need pumps to discharge excess rain- and ground water out of the new surface water system.
- The sewage spillover
  The spillover of the sewage system will not work properly after the Old Danube is raised with one meter.

Picture 9: cleaning the jammed siphon under the irrigation canal, March 2010


Picture 10: inundations on Somlyósziget, March 2010

4.3 The surface water quality of the Old Danube

The surface water quality of the Old Danube is in a bad state. The EU gives regulations on surface water quality. In these regulations is written that all surface waters within the EU have to achieve a "good ecological status" (Source: Water Frame Work: Note 7) and a "good chemical status" (source: Water Frame Work: note 8) by 2015.

An open connection with the RSD and a discharge into the Tass canal will improve the fresh flow (see 2.3 water quality). This will improve the ecological quality significantly. However, it will not be enough to achieve good quality swimming water and a good chemical status. If not taken care of, the consequences will be:

- The Old Danube is filled with mud.
  Not dredged, the Old Danube will be to shallow for marina boats, and the mud will decrease the water quality.
- Run-off rainwater from roads and roofs is polluted by road waste and zinc.
  The rainwater discharge system is designed to flow directly and as quick as possible on the Old Danube. The amount of run-off rainwater on the surface water will increase when rainwater discharge systems get renovated, effecting a decrease in the water quality, harming nature and people living around it.
- The spillover of sewage is located on the Old Danube.
  The spillover of sewage brings pollution occasionally. If not relocated, the sewage water on the Old Danube will keep decreasing the water quality.

4.3.1 Dredging the Old Danube

The last time the Old Danube has been dredged was before the Second World War, around 1939. The Hungarians dredged half of the Old Danube (half of the width over the full length of the Old Danube). The other half of the width had been planned but because of the Second World War end the unstable times after this it was never accomplished.
In 2007 the preparation of the plan for *improvement of water management and water quality of the RSD* started. The plan, written by Öko Zrt, is subsidized by the EU. In this plan the whole RSD and some of the side branches (including the Old Danube) will be dredged. However, the Duna-Ipoly National Park service decided for nature preservation reasons not to dredge the northern section of the Old Danube. The dredging of the southern section of the Old Danube will be done in future.
A riverbed clean of mud will improve the water quality significantly. For a navigable northern Old Danube also this section needs to be dredged (picture 11). The dredging of the Old Danube must be done with caution. Some of the fallen trees and branches must remain, as long the marina boats can navigate over or around them. Old wood in the Old Danube is a place for microorganism. Microorganisms have an important role in filtering the water, improving the water quality and biodiversity. (source: Wildernis Consultancy, 2009)


Picture 11: the northern part of the Old Danube needs dredging

4.3.2 Run-off water

Rainwater that falls on the roads and roofs takes up local pollution. This rainwater, called run-off water, discharges in Dömsöd through open ditches and pipes on the surface water. Dömsöd has a hydraulic well designed rainwater discharge (RWD) system. This RWD system separates the rainwater from the sewage water. Due to lack of maintaining the system got silted-up causing local inundation in case of rain (read more about this in paragraph 2.4 discharge points). The RWD system consists out of more local smaller, independently functioning, RWD systems. The RWD systems might become renovated in future, when financial support is available. So far one local RWD system (map 3 on page 19, location 1) is renovated with EU subsidy (source: verbal notification February 2010, municipality Dömsöd Mr. László Varga).

Run-off water from roads brings pollution of traffic (picture 12). Sources of pollution are fuel combustion, wear of vehicles, wear of the asphalt road surface, and chemicals. Run-off water from roofs can bring zinc parts from gutters and high levels of nitrate and nitrogen caused by the dung of birds living on the roofs in town. All rainwater from the roofs is discharged directly on the road.

Picture 12: pollution of traffic comes with the run-off water in the RWD systems

Only a small part (about 10-20%) of all the pollution on the roads comes in the run-off water. The bigger part (about 80-90%) is taken away by drift (by the wind) (source: afstromend wegwater, CIW, 2002). By controlling the run-off water only a relatively small amount of the traffic pollution can be caught. Still this will be an improvement for the water quality of the Old Danube. The Old Danube as it is now has a function of a "sink" for the run-off water. With other words, all pollution transported by run-off water of the western part of Dömsöd is concentrated on the Old Danube. Because of the relatively small size of the water body of the Old Danube, the slow water flow, the relatively larger urban area connected to the RWD system, and the habits of some people in Dömsöd (using old cars, throwing waste on the road), the amount of pollution brought by run-off on the Old Danube can be estimated as high. The pollution consists of heavy metals, polycyclic aromatic hydrocarbons (PAHs), mineral oil, chemicals, and zinc caused by corrosion of highway furniture and gutters on the roofs, and phosphate and nitrate of the roofs. The pollution can be a hazard for people who eat the fish out of the Old Danube, and for recreationist. It also harms the ecological system of the Old Danube, and is causing algae flowering. When the RWD systems are renovated, run-off water will again flow on the surface water. The pollution brought with this run-off water must be reduced.

4.3.3 Discharge point of sewage

The discharge point of sewage is located on the Old Danube (on map 3, page 19 no. 7, & picture 13). It is situated next to the main sewage pump and brings sometimes heavy pollution on the Old Danube, harming the water quality of the Old Danube (read more about this in paragraph 2.4 discharge points).

Another consequent of a raised surface water level in that the discharge point of sewage will not function properly. No exact data of the height of the sewage discharge point is available for this study, but it can be concluded that this height is designed for the water level of the Old Danube in present situation. Also with the Old Danube water level is raised with one meter, the spillover must keep functioning properly.

Picture 13: main sewage pump along the Old Danube

H5 A new surface water system

5.1 Introduction

In this chapter is the new surface water system described. In paragraph 5.2 fundamental ideas for the new surface water system are first explained. In paragraph 5.3 solutions on the consequences, as written in 4.2 surface water system, are described.

5.2 Fundamental ideas for the new surface water system

When the Old Danube is raised with one meter, the drain function of the Old Danube must remain working so excess rain- and drain water can discharge into the Tass canal. For this drain function a new water management system must be designed and realized. The following fundamental ideas are for the design of the new surface water system taken into account:

- Draining capacity of the new surface water system
  The capacity of the new surface system is sufficient to keep the Old Danube catchment area dry.
- Durable solutions for the new surface water system
  Solutions are with the minimal use of hydraulic instruments (i.e. pumps) and the maximal use of the present natural slope. A durable surface water system is easier to maintain and lower in realizing- and running costs.
- Make use of the advantages the area offers
  Solutions for the new surface water system are suitable for the area. Using the advantages of the area, as the natural slope and the re-use of existing water ditches, the realizing costs will be lower. Also the new surface water system will be more durable, as with the use of advantages the landscape offers less hydraulic instruments will be necessary.
- Make the new water system attractive for marina tourists
  With the new water system, the waterfront of Dömsöd will be improved to be more attractive and joyful for tourists and locals. An attractive waterfront will attract more tourist, what improves the economical situation of Dömsöd.

5.3 Measures for the new surface water system

With the following measures the new surface water can have the drain function of the Old Danube. Taken into account is also the beauty of Dömsöd waterfront, an attractive place for tourists:

- Redesigning the water surface system of the northern drain area and connect it on the Tókert canal
- Design a retention reservoir to intercept a high peak discharge.
- Dimension the Tókert canal on a capacity of 3.5 m3 or lower.

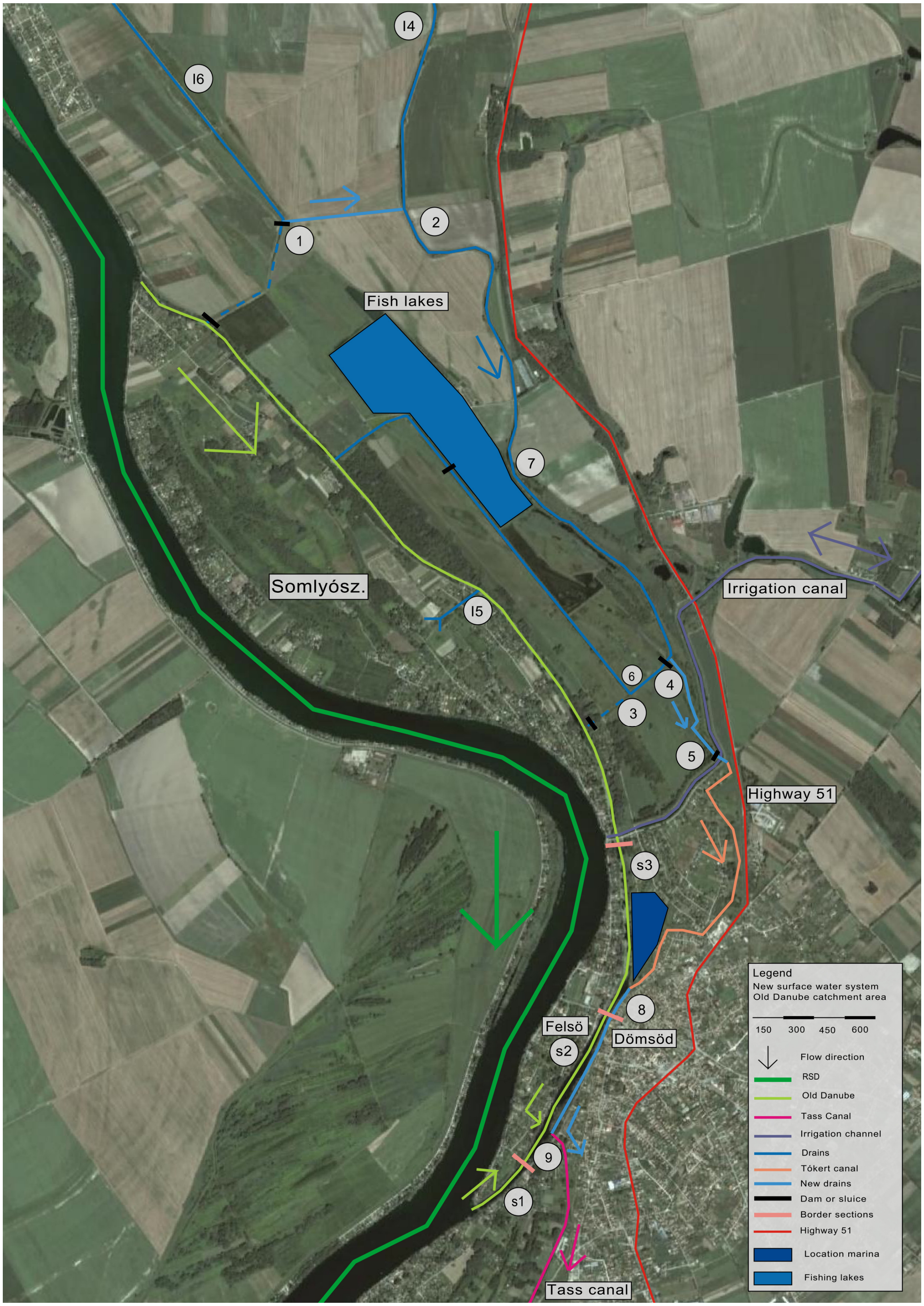
- A new bypass-canal between the Tókert canal and the Tass canal.
- Creating an attractive waterfront
- Relocation of pump one and two
- A pumping station on Somlyósziget (canal I5) to drain excess rain- and drain water out of Somlyósziget and to discharge it on the Old Danube.
- Redesign discharge point sewage water

5.3.1 Redesign water surface system of the northern drain area

The existing drain canals (I4 and I6, see map 2, page 15) are in present situation discharging on the Old Danube. Read more about this in paragraph 2.2, the surface water system of the Old Danube.

In the HKV study (2009) the Tókert canal is introduced as a groundwater canal. In the HKV study it is mentioned that the northern drain area must be connected on the Tókert canal. The functions of the Tókert canal will then be:
-Collect seepage water from Tókert area
-Discharge the excess rain- and drain water from the northern drain area.

Picture 14: the I6 canal (Ráckeve canal) at point 1



Map 5: map of the new surface watersystem

This study also recommends using of the Tókert canal to discharge excess rain- and drain water. The Tókert canal is already present. It is an advantage the area offers, keeping the realizing costs lower, and the system durable.
The study of HKV does not react to the design of the northern drain area. The canals I4 and I6 have to be connected on the Tókert canal and for this the northern drain area needs to be redesigned.
With the following measures the I4 and I6 canal can be, with the fundamental ideas taken into account as described in 5.2 (durable, making use of the advantages the area offers, and sufficient capacity), connected on the Tókert canal; (see for locations mentioned map 5 new surface water system)

- Connecting the I6 canal on the I4 canal

The I6 canal needs to be dammed at point 1 (picture 14). From here the canal will take a new route to the I4 canal. For this, a new ditch must be made between point 1 on the I6 canal, and point 2 (picture 15) on the I4 canal. The route of this ditch leads over a mount difference of circa 1,5 meter but this is not considered to be a problem. The length of the new ditch will be 650 meters and is the shortest length between canal I4 and I6.

- Discharge of the I4 and I6 canal to the siphon

The I4 canal needs to be dammed at point 4. An existing ditch can be cleaned and dimensioned between point 4 and point 5. The discharge of both I4 and I6 will drain through here.

- Inflow Tókert canal

A new siphon will be placed under the irrigation canal at point 5 (picture 16). On the other side of the canal, the water can flow in the Tókert canal. Also the irrigation canal requires on the south side the possibility to discharge on the Tókert canal.

- Water inlets

The old water outlets of I6 and I4 can be used as water inlets. For the I6 canal, a sluice is required at the old water outlet at the Old Danube and in the damming at point 1. The sluices will regulate the amount of water flowing in the northern drain area. For the I4 canal also a sluice needs to be realized at the old water outlet, and at point 3 to let the water into the I6 canal, plus a sluice at point 4 to regulate the amount of water flowing into the new ditch and the Tókert canal. The water flowing into the Tókert canal can be used to refresh the Tókert and Bypass canal during dry periods. The water flowing into the I4 and I6 canal can be used for watering the agricultural land.

- Fishing lakes

The fishing lakes have their water supply out of the Old Danube. The existing ditch on the south side of the fishing lakes can be split up: the northern part of the ditch will be on the level of the Old Danube for water inlet, and the southern part will be on the level of the new surface water system for water outlet of the fishing lake.
An outlet of the fishing lakes can be placed at point 6. At this location the fishing lake can discharge under free flow on the I4 canal and flow through the sluice at point 4 to the siphon. A second outlet, if considered necessary, can be build at point 7.

Picture 15: the I4 canal at point 2

Picture 16: location of the new siphon to connect the northern drain area with the Tókert canal

5.3.2 Retention reservoir

To intercept a high peak discharge a retention reservoir can be realized. By realizing a retention reservoir in the northern drain area, the Tókert and Bypass canal will be reduced by a high peak discharge and the design criterion of 3,5 m3/s (read more about this in 2.2 the surface water system of the Old Danube) can be lowered.
The northern drain area covers a large part of the Old Danube catchment area. Intercepting a peak discharge there has a good effect for getting a lower peak discharge downstream. In dry times the retention reservoir, working as a sponge, is maintaining a flow in the Tókert- and Bypass canal.
The retention reservoir can be realized as a nature area. Reed beds growing in the retention reservoir will filter the rainwater (make the water nutrient low); what improves the water quality in the Old Danube.
A suitable location for the retention reservoir is between the fishing lakes and the irrigation canal. This is before the siphon and the Tókert canal. Here a peak discharge from the northern drain area is fully caught.

With the following measures are required for a retention reservoir:

- The land for the retention reservoir must be purchased
- The land must be surrounded by a little dike, preventing that water kept in the retention reservoir flows to surrounding land, owned by other parties.
- A sluice at the new siphon (location 5) is required to regulate the amount of water flowing into the Tókert canal.

A hydraulic design is required. Determined must be the necessary capacity of the retention reservoir.

5.3.3 The Tókert canal

The Tókert canal (picture 17) discharges excess drain water from the northern drain area and requires, without a retention reservoir, a dimension of 3,5 m3/sec (read more about this in 2.2 the surface water system of the Old Danube). With a retention reservoir (see 5.3.2 retention reservoir) the peak discharge will be lower and so the design criterion of the Tókert canal can be lower. Both ways, the Tókert canal is in a state of neglect and measures are required for draining the Tókert area on the Tókert canal and discharge the drain water of the northern drain area through the Tókert canal;

- The Tókert canal needs to be cleaned from plants and waste
- The Tókert canal needs to be widened and deepened.
- The capacity of the bridges and culverts must be checked and if necessary re-dimensioned (picture 18).

A hydraulic design is required. Determined must be, with the retention reservoir into account, the necessary capacity of the Tókert canal. Based on this, the dimensions of the Tókert canal can be determined.

Picture 17: the Tókert canal

Picture 18: bridge over the Tókert canal what might need re-dimensioning.

5.3.4 The bypass canal

A bypass-canal of 900 meters long is needed to discharge the water from the Tókert canal into the Tass canal. The bypass-canal is situated from point 8, at the end of the Tókert canal, till point 9, the start of the Tass canal. Through the Tass canal the water will flow into the main Danube (read more about this in paragraph 2.2 the surface water system of the Old Danube).

There is little place for the bypass canal because of the steep slope on the left side, and the Old Danube on the right side of it. At the last stretch of the Bypass canal is more place. Here the Bypass canal can flow between the road and the market (picture 21). To discharge the water, the bypass canal will have a lower water level (the water level of the Old Danube of present situation) then the raised water level of the Old Danube. As HKV (2009) concluded, seepage water from the Old Danube must be prevented to infiltrate into the bypass canal. A sheet pile (see picture 19) must prevent this infiltration. Added by this study is that seepage water in small amounts will not wash away a quay. Seepage water in controlled small amounts will refresh the surface water in the bypass canal and attract flow out of the RSD into the Old Danube.

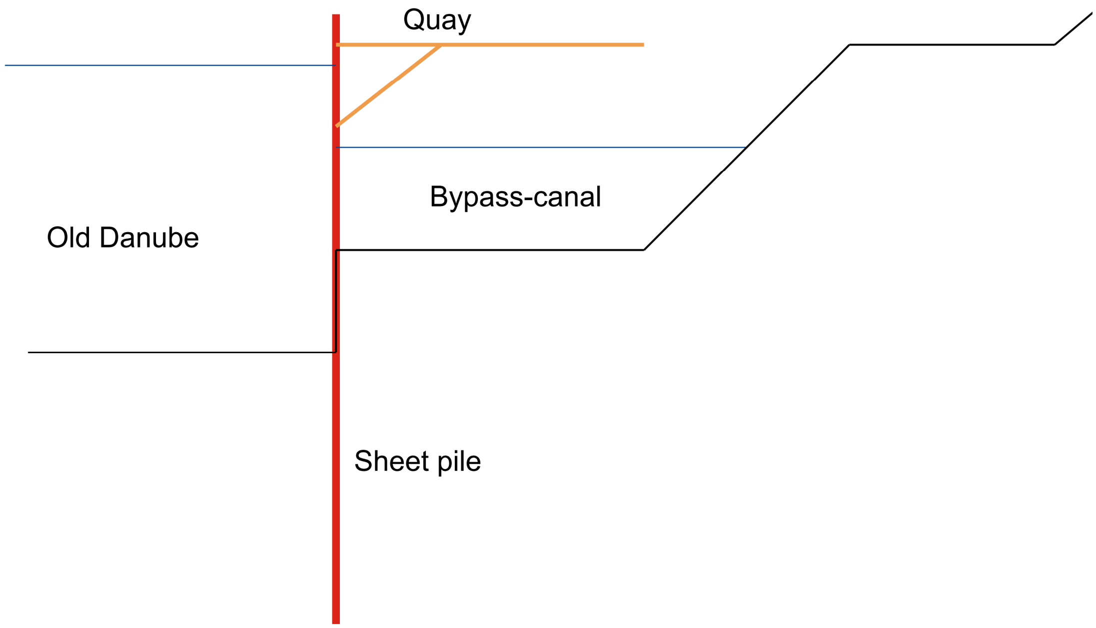
For the bypass canal the following measures are required:

- The bypass canal needs to be dimensioned at a capacity of 3,5 m3/s. This can be lower if a retention reservoir is realized (see 5.3.2 retention reservoir).
- The Old Danube need to be narrowed by 5 meters to make place for the bypass canal. Except for the last stretch, where the Bypass canal can flow further from the Old Danube, between the road and the market.
- The bypass canal needs a sheet pile to prevent large amounts of seepage water from the Old Danube coming in the bypass-canal.
- The conductivity of the soil must be known, and the needed depth of a sheet pile must be determined.

Also for the bypass canal is a hydraulic design required. Determined must be, with the retention reservoir into account, the necessary capacity of the bypass canal. Based on this, the dimensions of the bypass canal can be determined.

5.3.5 Attractive waterfront Dömsöd

The steep slope between town and the Old Danube eroded at the time the Old Danube was still flowing (before the damming in 1926). It is a geological location in town with weeping willows along the side. The beauty of the place must be preserved. The bypass-canal can be situated in the Old Danube, under the crown of the trees. On the Old Danube side of the bypass-canal a sheet pile must be constructed to prevent large amount of seepage water. As HKV (2009) already recommended, can on top of this sheet pile a quay be constructed. Fishermen can enjoy fishing at this place, and people can walk over it between the marina and town (section three). It will be the presentation of the town to visiting guests. See for a cross section view picture 19, and for a location view picture 20 & 21.



Picture 19: cross section of the bypass canal

Picture 20: the steep slope between Dömsöd and the Old Danube

Picture 21: here the bypass canal can flow between the market (the stone tables between the trees) and the road

5.3.6 Relocation of pump one and two

To maintain the function of pump one and two (discharging excess rain- and drain water out of the area when discharge through the Tass canal is not possible, read more about this in 2.2 the surface water system of the Old Danube), the pumps need to be replaced to the Tókert canal. With the raised Old Danube, the Tókert canal will have the draining function of the area. The pumps can discharge excess rain- and drain water out of the Tókert canal on the Old Danube. A hydraulic plan must be worked out. Attention must be given to the reduced size of the water body. In the present surface water system, the Old Danube has the function of a retention reservoir for the discharge of rain- and ground water. In the new situation the Tókert and Bypass canal will have this function, although the retention is smaller. A smaller retention leads to a more rapid surface water level rise in case of rain or melting snow, and especially in the low Tókert area this can lead to inundation if the capacity of the new pumps is not sufficient.

5.3.7 Draining Somlyósziget

To drain Somlyósziget on the Old Danube with a raised surface water level, a pumping station at the outlet of the I5 canal must be realized. This will be the only possibility to keep Somlyósziget dry. The advantage of this solution is that a pumping station can make Somlyósziget dryer then present situation (read more about this in 4.2 surface water system). The disadvantage is that the solution is not durable, and the local authorities may be against it because of the higher costs of running a pumping station. A hydraulic plan, in which the capacity of the pump will be determined, must be worked out.

5.3.8 Discharge point sewage

The raised surface water level of the Old Danube will hinder the spillover of the sewage. The spillover can be redesigned and be adjusted to the raised surface water level, or be relocated and discharge in case of a breakdown (read more about this in 2.4 discharge points) on the bypass canal. For this, a siphon must be realized under the Old Danube and quay. Through this pipe the sewage water can discharge on the bypass canal. This brings the advantage that the Old Danube with marina does not get polluted in case of a break down of the main sewage pump.

5.4 Conclusion

With a raised Old Danube the discharge system of rain- and groundwater of the area draining on the Old Danube and Tass canal must be redesigned. Measures are required to let the new water management system function correctly. The plan for those measures as above written is plain and clear and has no technical limitations. The measures need to be hydraulically calculated and dimensioned. Realizing the new water surface system is possibly, but it will be an expensive and intense job, but necessary to keep the Old Danube catchment area dry after the open connection between the marina and the RSD is realized. How ever before the Old Danube is raised with one meter the effects of the groundwater level rise must be investigated. High ground water levels can work out badly for the support on the marina of the locals. This is understandable, because no one wants inundated cellars or moist walls.

H6 Improving the water quality

6.1 Introduction

The surface water quality of the Old Danube can be improved by reducing emissions. As written in 2.3 water quality, not all emissions sources are described in this study. Large emissions from the discharge of polluted run-off water (see 2.4 discharge points) are investigated in this study and solutions to reduce the quantity and increase the quality of the run-off water in Dömsöd town are described in this chapter.

As written in 4.3.1 dredging the Old Danube, will a dredged Old Danube improve the water quality. Because plans for dredging the southern Old Danube are already made (improvement of water management and water quality of the RSD, 2008), there are no further recommendations on this subject in this report, except that is it recommended to dredge also the northern Old Danube.

Improving the water quality by attracting a refreshment flow, as HKV (2009) recommends, is described in 2.3 water quality.

Improving the water quality by relocating the discharge point of sewage is described in 5.9 discharge point sewage.

In this chapter a new RWD system for cleaner run-off water is described.

6.2 Fundamental ideas for a new rainwater discharge system

The fundamental ideas taken into account for the design of the rain water discharge (RWD) system are partly similar with the ideas for the surface water system (5.2, fundamental ideas for the new surface system).

- Sufficient capacity to reduce inundations in town
  The capacity of the rills is sufficient to catch he run-off water, so water standing on roads in Dömsöd town is prevented.
- Not replacing the pollution problem downstream
  Discharging without purifying polluted run-off water on the Tókert, Bypass or Tass canal is not considered as an option.
- Sufficient purification capacity
  The purification capacity of the RWD system is sufficient to have a best quality of run-off water seeping to the groundwater or discharging on the surface water.
- Make use of what the old RWD system offers
  Keep realizing costs low by using the advantages of the designed existing RWD system.

- Keep the RWD system simple and easy to maintain
  A simple RWD system which is easy to maintain has the better chance on keeping functioning correctly.

6.3 Measures for a new rainwater discharge system

With the Tókert- and bypass canal fulfilling the drain function of the area, the run-off water from west Dömsöd can discharge on here. This is easy to be done. All rainwater discharge points are situated on the Tókert- and bypass canal side, so the rainwater can discharge on these canals.
The run-off water is polluted (see paragraph 2.4 discharge points). Direct discharging on the Tókert- and bypass canal will bring diffuse pollution downstream in the Tass canal and main Danube and is not considered as an option. It is important to remove the pollution out of run-off water as much as possible. With extra measures taken when renovating the old rainwater discharge system the quality of run-off water discharging on the Tókert- and bypass canal will improve, and the quantity will be reduced.

The following measures must be taken for cleaner run-off water:

- Solving the pollution problem at the source
- Reducing the amount of run-off water
- The overground rills catching the water must be cleaned up, re-profiled, re-dimensioned, and made erosion-proof.
- The soil of the bed and sides of rills must be replaced by a soil with high infiltration and purification capacity.
- A storage settling tank can be realized at every rainwater discharge point.

It must be taken in mind that some of the roads in Dömsöd are unpaved (like on picture 22). Rills along unpaved roads will silt up easily, costing more maintenance. It is advised that these rills are renovated and connected on the RWD system when paving the road. If no rills are present, an on-surface situated drain can be realized, discharging on the rills. Also here it is advised that if the road is unpaved, to not realize such a drain before the road is paved.

6.3.1 Solving the pollution problem at the source

The most efficient way of getting the run-off water cleaner is tackling it at the source. Sources of pollution can be:

- Leaching of the road surface
- Polluting activities
- Calamities
- (Il)legal discharges

(source: leidraad riolering B2200)

Measures can be found in

- Making the inhabitants and the council aware of pollution on roads and roofs (gutters) so they can decrease their habits that pollute Dömsöd.
- Controlling illegal discharges, reducing legal discharges
- Reducing the risk on calamities

6.3.2 Reducing the quantity of run-off water

With a lower quantity of run-off water the filter capacity of the rills and storage settling tank are better used. The quantity of run-off water can be lowered by:

- A council regulation that all houses with property have to catch the roof-water on there own land. This way the roof water will not be discharged on the roads directly (picture 22) and it reduces the peak discharge during rain. An infiltration location must be realized by the inhabitants them selves. If the infiltration location is full it can spillover on the rills.

- Roof-water can also be kept in a reservoir and used for toilet flushing and watering the garden. This has also the advantage that less tap water is used.

Picture 22: rainwater from roofs in present situation; discharging on the road

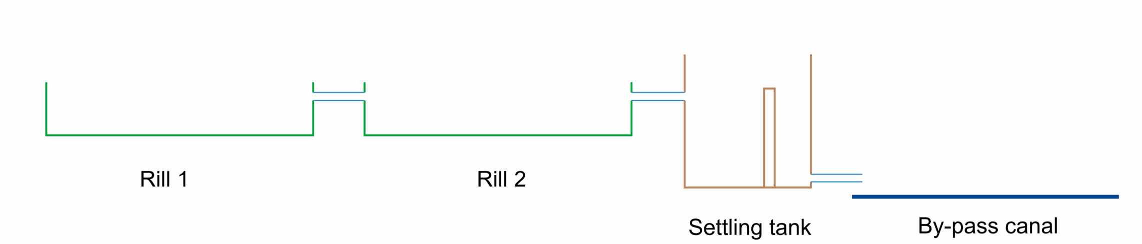
6.3.3 Dimensioning the rills

The RWD systems in Dömsöd are in a state of neglect (page 20 picture 6, 7, 8, and picture 26 on page 46) . They need to be cleaned up, re-profiled and re-dimensioned. When dimensioning the rills, the following matters should be taken in account;

- All rills need a spillover to prevent inundations. The spillover discharges the water on the next rill, on the storage settling tank (see 5.2.5 storage settling tank), or on the surface water.
- The rills require a green cover to prevent erosion. Lawn grass suits best for this (see picture 24).
- The sides of the rills require a balanced slope. A slope of 1/3 is easy for maintaining but due to lack of space and the required retention a steeper slope is needed (1/1 or 1/2).
- The rough-and-ready rule for the maximum length of rills discharging run-off water to the discharge point is 150 meters (leidraad riolering B2200). However, in Dömsöd the length of the rill does exceed the 150 meters in some cases. Longer rills have to discharge a larger amount of run-off water and need more retention capacity.

Smaller roads without space for rills can discharge on a drain above the surface. This drain discharges the run-off water in the rills.

See for a functional RWD design picture 23.



Picture 23: functional design RWD system

Picture 24: a with grass covered rill in the neighbor town Ráckeve

Picture 25: a street in Dömsöd with on both side rills


Picture 26: sand flows in the RWD systems

6.3.4 Improve infiltration and purification capacity

When infiltrating polluted run-off water through the soil, pollution is absorbed in the soil. Run-off water will infiltrate cleaner to the deeper groundwater. If the infiltration capacity of the soil under the rill is inefficient a drain pipe, situated under the improved top layer in the rill, can catch the infiltrated rainwater and discharge it on the surface water. This system demands a higher quality of maintaining and is therefore not recommended. According to Laszló Gáspár, who made several wells in Dömsöd, the soil in Dömsöd consists out of the following layers:

1. Agricultural soil 0- 30cm
2. Clay 20-30cm
3. Sand 30-50cm
4. Sand and gravel 50 cm-10meter

Based on the soil information of Laszló Gáspár, concluded can be that the layer of clay varying between 0 and 10 meters thick in Hungaria, (source: wildernis consultancy, 2009), is thin and shallow in Dömsöd town. If this is the case everywhere in Dömsöd needs further investigation.

Because west-Dömsöd is, except for the Tókert area, situated on a higher mount, and because the Old Danube drains the groundwater, the groundwater level is deep enough and will not hinder the infiltration.

The loess (clay) layer has a low infiltration capacity and can not be used as an infiltration reservoir. Where the loess layer is thin it can be digged off until the layer of sand under it is found. A layer of sand has a sufficient infiltration capacity (source: wadi, aanbevelingen voor ontwerp, aaleg, en beheer, Rioned 2006). On top of this sand layer a new top soil can be placed. The top layer, about 30 cm thick, will be the bed of the rills. To stimulate purification, and infiltration, and to have a bigger retention of the run-off water, the new top layer must consist of sand, including a humus element of 3% to 5% and a silt element of 1% (source: Leidraad riolering B2200, Rioned 2008). The sand will stimulate the infiltration, and enlarge the retention. The humus and silt element will absorb pollution and clean the run-off water before it infiltrates to the groundwater.

To know if complete infiltrating of all run-off water is possible in Dömsöd, the profile and the conductivity of the soil must be determined. With a good infiltration (about 0,5 m/day), the surface needed for the infiltration is about 5 to 10% of the paved urban area. (source: wadi, aanbevelingen voor ontwerp, aaleg, en beheer, Rioned 2006).

The rills situated along the sides of most roads in Dömsöd can be designed as an infiltration area. Run-off water can be kept in the rills where it can infiltrate (partly) in de ground. If a rill is full with run-off water, it must be prevented that inundations on the road occur. For this, a spillover must be situated so run-off water can discharge on the next rill, the storage settling tank (see 6.3.5 storage settling tank) or on the surface water.

A danger is that the improved top layer soil gets saturated with pollution. When soil is saturated with (one type of) pollution, it will not absorb (one type of) that pollution. A monitoring plan must be set up to notice saturation on time. If saturation is the case, the top layer soil must be renewed to prevent leaking of pollution to the groundwater.

6.3.5 Storage settling tank

The space at the discharge points of the rainwater discharge is insufficient for large infiltration locations. Also, the high groundwater level directly along the Old Danube will hinder infiltration (see picture 27). Therefore, a storage settling tank is the solution for these locations. In a storage settling tank the run-off water will become still. Pollution on silt will sink to the bottom. Dissolved pollution will not sink in a storage settling tank. A storage settling tank has a cleaning effectivity of 40 % (source: afstromend wegwater, CIW, 2002).

In order to know if the storage settling tank will be necessary, the infiltration capacity and purification capacity of the rills (see 6.3.4, improve infiltration and purification capacity) must be determined. If the infiltration and purification capacity are sufficient, extra storage settling tanks on top of the infiltration system will not be necessary. If the infiltration and purification capacity of the rills is not sufficient, and run-off water spills over directly on the surface water, a storage settling tank can reduce the pollution of the spilling over run-off water still by a 40%.

In this case, a storage settling tank requires a storage for 2 mm (source: leidraad afstromend wegwater, CIW, 2002) . This 2 mm is during rain the first flush run-off water arriving at the storage settling tank and is bringing most pollution.
The total paved discharge area of Dömsöd draining on the Old Danube is about 150.000 m2. The run-off water from this paved discharge water is divided over six discharge points. All discharge points have a more or less equal connected size of paved discharge area. This means that on a rainwater discharge point 25.000 m2 paved area is connected. The storage settling tank will need a size of 25.000m2 paved area*0.002 m first flush = 50 m3 to accommodate the first 2 mm arriving at the storage settling tank. This 50 m3 size fits on the discharge point locations. It can even be over dimensioned for a better cleaning effectivity.
If in extreme situations a storage settling tank is full and more run-off water is discharging, the storage settling tank will spillover on the Tókert- or bypass canal.

Picture 27: small space at the outlets of the RWD system along the old Danube. Here: outlet nr 4 (map 3 on page 19)

6.4 Maintaining the RWD system

The rills and storage settling tank require periodical checks and maintaining. A maintaining plan is required before the RWD system is renovated. If chosen for the infiltration and settling system to prevent diffuse pollution downstream of the bypass-canal, it must be clear what this maintaining contains in order to keep a new system properly functioning.
The information in this paragraph is based on the Dutch report C3200 beheer infiltratiezoorzieningen, Rioned 2006. This report gives guidelines how to maintain RWD systems.

6.4.1 Maintaining activities infiltration rill

The maintaining activities for the infiltration rills are

- Maintaining lawn
  A vital lawn is important for a strong surface where people can walk over without damaging the rill bed. Maintaining the lawn means mowing it every week during summer, lime it every autumn to increase the pH level (a higher pH level stimulates the grass growth), and aerate it to make to lawn loose. A compacted lawn does not grow well.
- Remove cut grass
  To keep the rill bed nutrient low, it is important to remove all cut grass. A rill bed low on nutrients will absorb more pollution.
- Remove trash, leaves, and mud
  To prevent the rill from blocking up, trash, leaves and mud must be removed.
- Replace rill bed (top soil)
  If the run-off water is polluted, the topsoil can get saturated. If this is the case, the pollution is not absorbed. Pollution will reach groundwater. Saturated top soil must be replaced on time. A monitoring plan to notice saturation must be planned.
- Adjusting spillovers
  Spillovers can tumble. Every now and then they need to be checked and if necessary adjusted.

6.4.2 Maintaining storage settling tank

Silt will pile up in the storage settling tank, decreasing the retention and cleaning capacity. Periodical the silt must be removed from the storage settling tank and carried away under vision.

6.4.3 Signals for decreased functioning infiltration rill

Signals for decreased functioning of the infiltration rill are if the water stays too long in the rills. Longer then 48 houres is considered to be too long.

Reasons for decreased functioning can be:

- Decrease infiltration capacity
  Possiby reasons: aggradation, piled up street dirt or leaves.
- Decrease retention capacity
  Possibly reasons: sagging of rill bed or spillover, silted up rill bed
- Decrease discharge capacity
  Possibly reasons: RWD system jammed
- Polluted groundwater
  Possibly reasons: saturated rill bed (not replaced on time), chemicals or de-icing salt influencing the absorb capacity of the rill bed.

6.5 Conclusion

By using the rills as an infiltration location, run-off water can infiltrate on many locations in the west part of Dömsöd to the groundwater. Questions are if the infiltration capacity of the natural soil is sufficient to infiltrate all run-off water during a standard rain shower. A standard rain shower is a rain shower with an amount of rain in millimeter, falling during a period, happening once every few years. For Dömsöd must be chosen for what standard rain shower the rills will be dimensioned.
If the infiltration capacity is sufficient, the existing RWD system can have a spillover discharging directly on the Tókert and Bypass canal. This spillover will only be used in extreme situations. If the infiltration capacity is insufficient, the spillover will discharge polluted run-off water on the surface water, also during a standard shower. To prevent this, a storage settling tank can be used, still having a purification effectivity of 40%.
The controlled infiltration system in the rills and, if necessary, the storage settling tank at the discharge points for removal of polluted silk will, if well maintained, be the best achievable option with a minimum of maintaining for a cleaner surface water in Dömsöd and downstream of it. With the spillovers in the rills inundations of roads are prevented.
A detailed technical design is required. In this design a standard rain shower will be chosen, will the rills be checked hydraulically, and will the capacity of the infiltration and retention be determined.

H7 Recommendations

The RSD water level is fluctuating when a flood from the Danube is expected: the water level is then dropped by over a meter to create retention for the expected floodwater. With an open connection between the Old Danube and the RSD it is possible that the marina will hit dry bottom for a period of a few days, each time a flooding is expected. A sluice between the RSD and the Old Danube will solve this problem.

If a sluice between the RSD and the Old Danube is realized, and some catching up of behindhand maintenance (dredging, cleaning and re-profiling) is done, the present surface water system can function well. Also, the Old Danube will keep its own water level, independently of the fluctuating RSD water. This is a simpler solution, leaving the existing surface water system in function, and saving enormous on the realizing costs of a new surface water system.

The new rain water discharge system can in this situation function as described. The discharge out of the storage settling tanks or discharge points of the rills can drain on the Old Danube. This is not harming the water quality, as most of the polluted run-off water infiltrates through the rills to the groundwater, or is purified in the storage settling tank. Only in extreme situations it can occur that the rills and if present the storage settling tank exceed their limit and spillover on the surface water, but pollution is then less concentrated. How often this happens depends on the chosen capacity were the RWD system will be dimensioned on.

If chosen for an open connection between the Old Danube and the RSD as described in this study, a sluice must be realized anyhow to keep the Old Danube’s water level on a for the marina boats high enough water level when the RSD water level is dropping. Further hydraulic calculations must be done to determine the required capacity of each surface water subsystem. Also effects on the groundwater level must me precisely determined. If the effects of the groundwater rise are big, and solving the effects takes too much effort in proportion of the value of the marina, it is again recommended to keep the Old Danube surface water level the same and to install a sluice as an entrance of the marina.

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Appendix - progressive scheme

	Activity	Method of study	Results
1	**Data collection**	Desk study	Gathered and organized data
1.1	Maps of Dömsöd area		Knowledge of Dömsöd surface water system
1.2	Find guidelines and/or laws on water quality and waste water discharge points applying on the Old Danube		List of EU/Hungarian guidelines applying on the Old Danube
1.3	Maps and report of the sewage system		Knowledge of Dömsöd sewage system
2	**Site visit of Dömsöd**	Field study	Getting a good overview and pictures of the project location
2.1	Site visit of Northern Drain area		
2.2	Site visit of Dömsöd and other surroundings		
3	**Determination of present situation**	Field study	
3.1	Determination of surface water system Dömsöd		Description of the functioning of he surface water system
3.2	Determination of sewage system		Description of functioning of the sewage system and flow-off rainwater from roads,
3.3	Determination of other waste water discharge points		Description of possibly other (illegal) waste water discharge points.
4	**Definition of desired situation**	Field / Desk study	
4.1	Describing desired functioning of the surface water system Dömsöd		Description of the desired functioning of the surface water system of Dömsöd
4.2	Describing desired water quality		Description desired water quality

4	**Analysis of the problems**	Field / Desk study	
4.1	Describing change in surface water system when the Old Danubes water level has raised with one meter		Description of changes of the surface water level system after the Old Danube has raised with one meter
4.2	Analyze the quantity of sewage water that (also because of flowing-in rain water) spills over on the surface water		Worked-out analyze describing the amount of sewage water spilling over on the surface water
4.3	Estimate the amount of dirt flowing out of waste water discharge points		An estimated amount of dirt flowing out of the waste discharge points, specified by its type of dirt.
4.4	Estimate the water quality of the Old Danube		An estimated surface water quality of the Old Danube
4.5	Check the estimated water quality with the applying guidelines and/or laws		Worked-out check describing if the water quality meets the applying guidelines and/or laws.
4.6	Consider if present water quality has to or can improve		Worked-out consideration describing the necessity of an improving water quality.
5	**Develop alternatives**	Desk study	
5.1	Develop an alternative surface water system to discharge the northern drain area		A worked out alternative surface water system to discharge the northern drain area in the situation of the Old Danube with a raised water level of 1 meter.
5.2	Develop an alternative for the waste discharge points.		Worked-out alternatives for waste discharge points
5.3	Develop an alternative for the rainwater flowing in the sewage system to reduce the discharge in the sewage system		Worked out alternative were rainwater is not flowing in the sewage system
6	**Defining measures of alternatives**	Desk study	
6.1	Defining measures for alternative surface water system		Description of measures per alternative
6.2	Defining measures for improving water quality		Description of measures per alternative
7	**Reporting**	Desk study	Final report publishing findings
8	**Presentation**		Final presentation showing findings