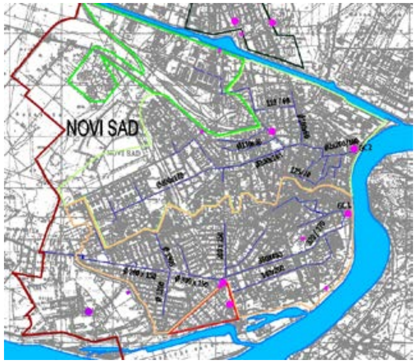

Redesign of the Existing Combined Sewer System (CSS) of Novi Sad

Matija Stipić
Rihard Šranc
VOJVODINAPROJEKT, Novi Sad, Serbia
matija@vojvodinaprojekt.rs; rihard@vojvodinaprojekt.rs

Dušan Prodanović
FACULTY OF CIVIL ENGINEERING, University of Belgrade, Serbia; eprodano@hikom.grf.bg.ac.rs

Radoica Stefanović
JKP "Vodovod i kanalizacija", Novi Sad, Serbia; radoica.stefanovic@vik.rs

Srđan Kolaković
FACULTY OF TECHNICAL SCIENCES, University of Novi Sad, Serbia; kolak@uns.ns.ac.rs

Content

- **Introduction – urban drainage systems in Serbia – city of Novi Sad: Combined sewer system**
- **Methodology and Design standards**
- **Sewer system in Novi Sad**
- **Precipitation data**
- **Simulation model – the existing combined system and the future combined system with overflow**
- **Storage tank with overflow**
- **Conclusions**

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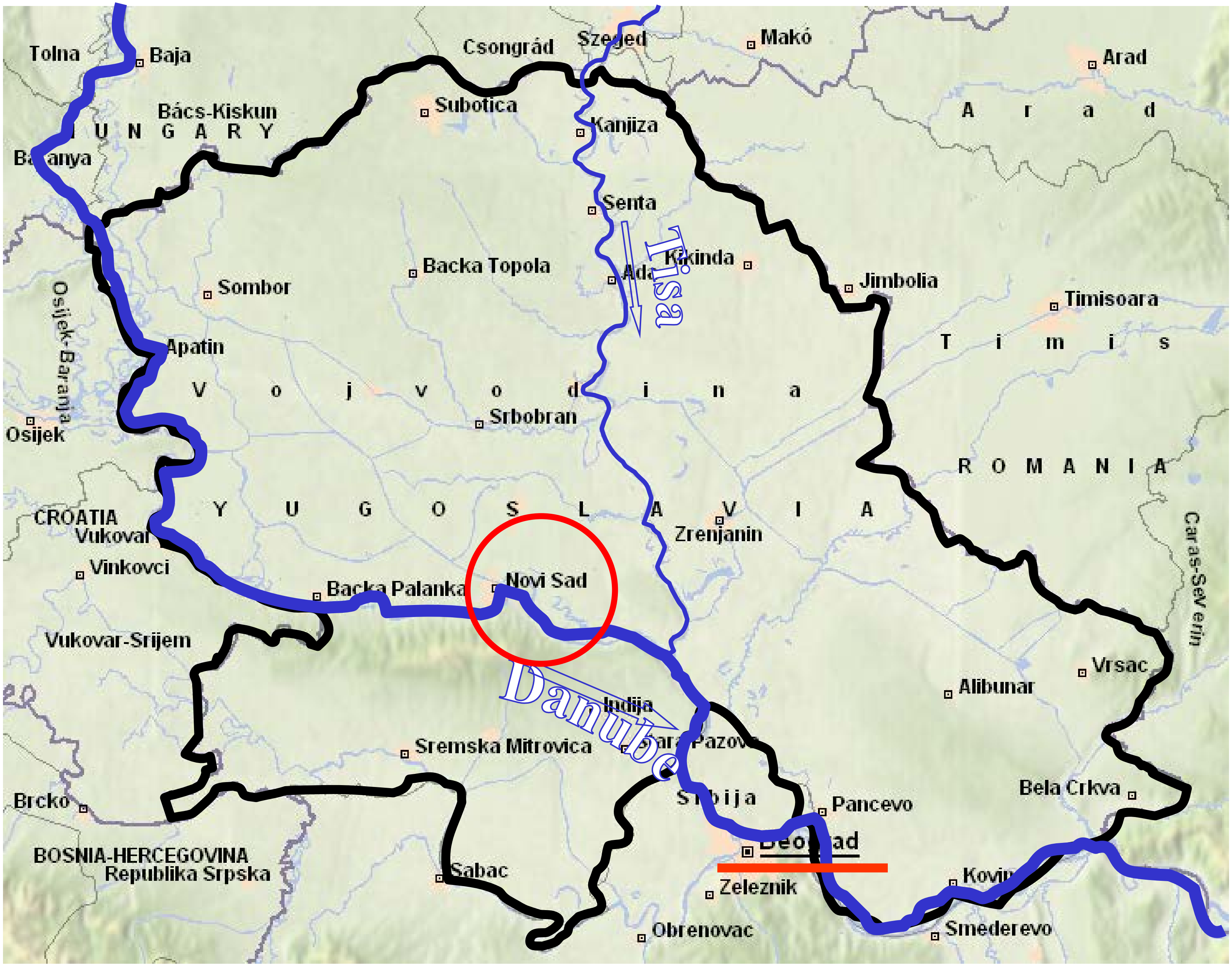
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Urban drainage systems in Serbia – city of Novi Sad: Combined sewer system

1950's – systematic developement of urban drainage systems in Serbia

Semi-separated systems
Combined drainage of wastewater and stormwater only in central areas in small towns

Wastewater and stormwater – immediate discharge with no preliminary treatment

Large cities: Belgrade, Novi Sad,…

Combined sewer systems are dimensioned with the overloading frequency of 1 in 1 year or 1 in 2 years

Rapid development, increased population and heavy rainfalls

SYSTEM OVERLOADING AND OVERFLOWING – TRAFFIC COLLAPSES AND SIGNIFICANT DAMAGES

The turning point of urban drainage in Serbia

How to combine the old system, urbanistic limitations and the requirement for increased reliability and reduced permanent environmental impact?

Redesign of the sewer system should provide unrestricted city developement including sustainable wastewater and stormwater management avoiding urban areas overloading and flooding as well as to protect the receiving water following the EU Directives.

Design standards

The national standard in Serbia (SRPS EN 752-4, 2007):

- basic principles – hydraulic calculation and environmental impact of the sewer systems functioning mainly as gravity systems
- design storm frequency (overflowing frequency – 1 in "n" year is recommended

Storage volumes and overflows:
- protect the receiving water
- protect the WWTP from large inflow

Design of overflows:
- overflows occures when the critical rainfall intensity is exceeded (10 L/s.ha – 30 L/s.ha for impervious areas)

or
- the criteria of diluting of 5 to 8 times of dry weather flow

Redesign of sewer system in Novi sad

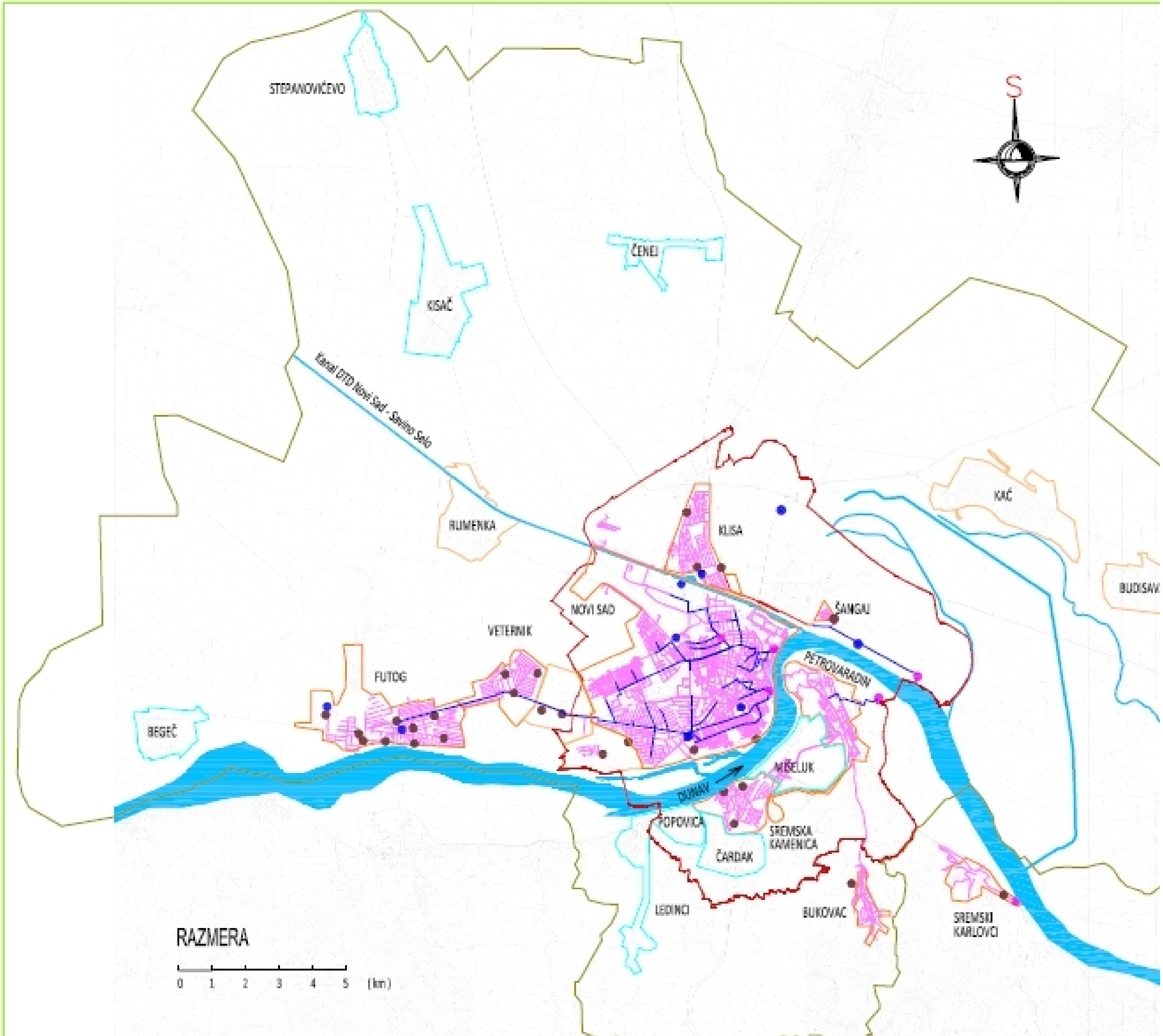
- relevant design storm frequency – overload of 1 in 3 years is used becouse of high population density and directions of city roads
- relevant design storm frequency of 1 in 5 years is applied for the city centre
- simulation flow models must be used to estimate matching with the limiting load values

Sewer system of Novi Sad

- Novi Sad is the second largest city in Serbia, the seat of administrative organs of the northern Serbian province of Vojvodina, and the administrative center of the South Bačka District.

- According to preliminary results of the latest census in Serbia conducted in October 2011, the urban area of Novi Sad has a population of 221,854, while its municipal area has a population of 335,701.

- It is located in the southern part of Pannonian Plain, on the border of the Bačka and Srem regions, on the banks of the Danube river and Danube-Tisa-Danube Canal, facing the northern slopes of Fruška Gora mountain.



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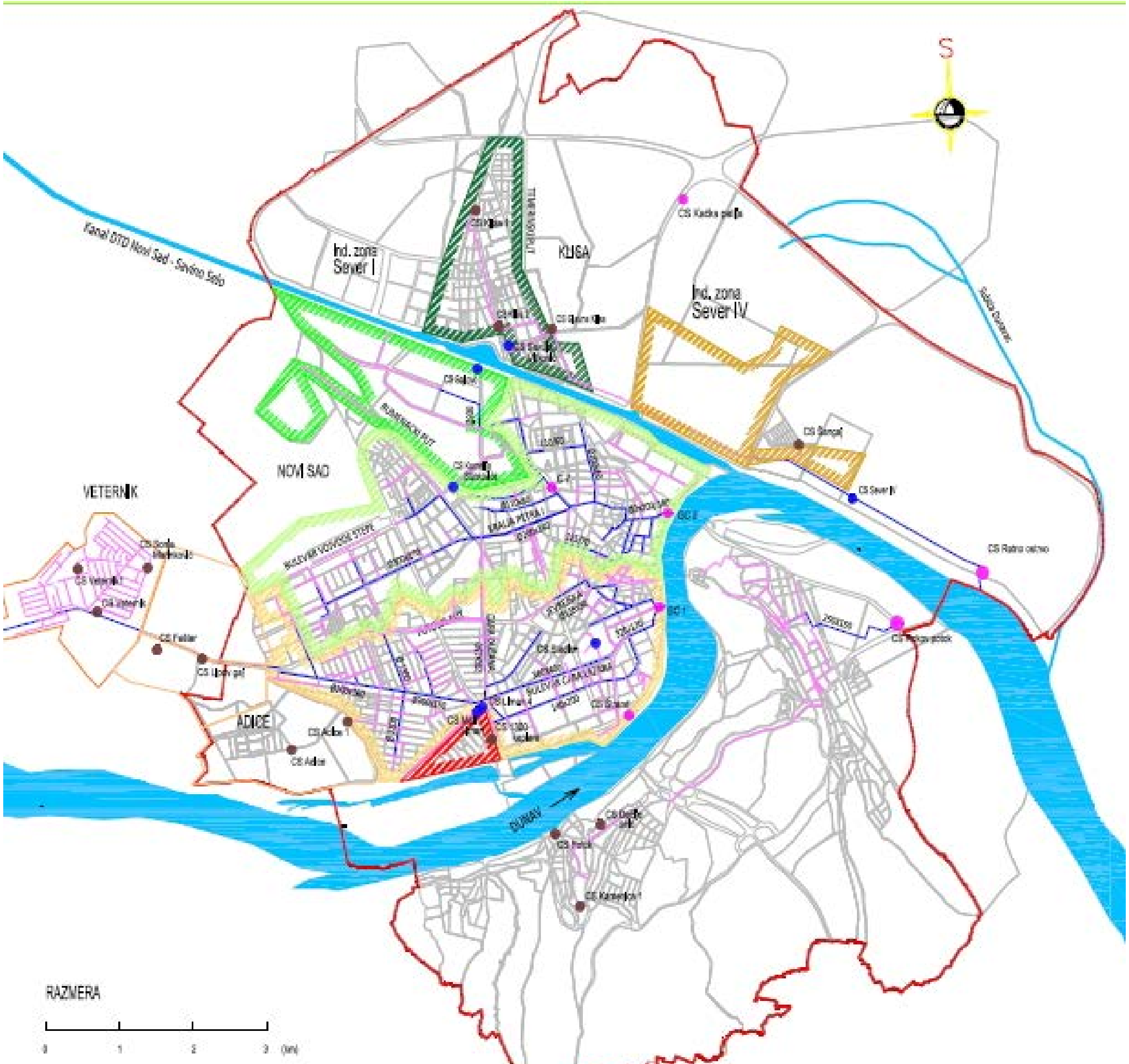
- The catchment area within the combined sewer system boundaries is 1960 ha – impervious areas: 36 %.
- Two subcatchment: southern – with pump station GC1; northern – with pump station GC2.
- Wastewater is discharged into the Danube with no preliminary treatment.
- Maximum capacity of the pump stations is 10.5 m^3/s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- The sewer system has connections from suburban areas with the total population of about 50.000
- Population growth and development and improper maintenance have caused the increase in the runoff from the catchment.
- The city area was flooded some ten times at many locations during the first decade of this century

Precipitation data

- Nearest state weather station – Rimski Šančevi – 8 km away from the catchment
- Network of modern rain gauges was installed in 2010 in the greather city area

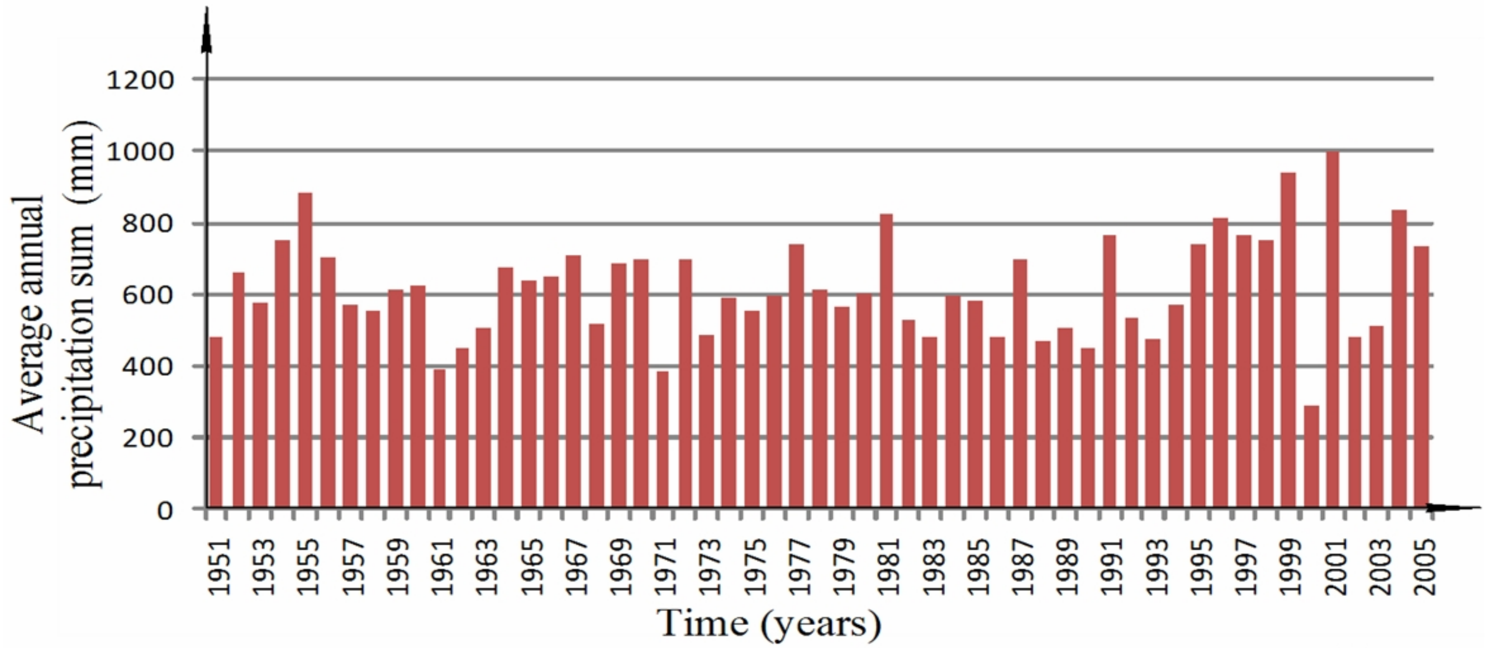


Figure 3. Annual precipitation time series at the weather station Rimski Šančevi, 1951-2005

- Statistical rainfall analysis with the intensity-duration-frequency graph is made for the given period of time based on the available data.

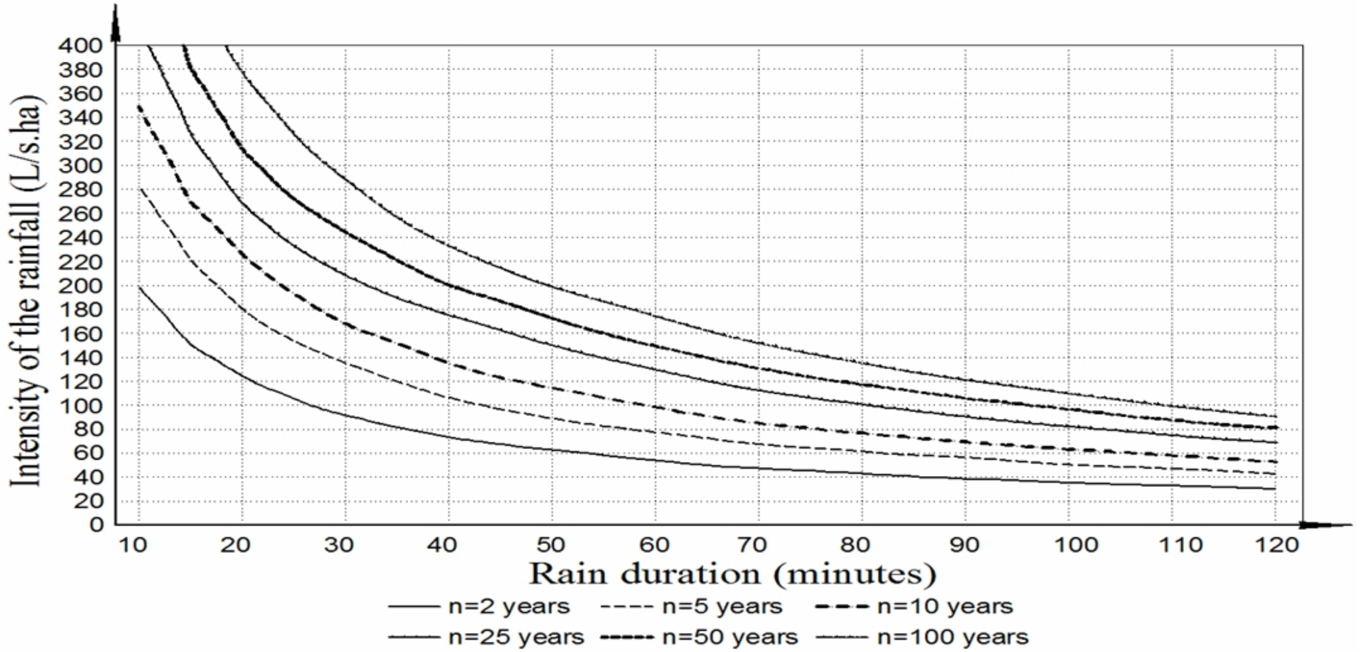
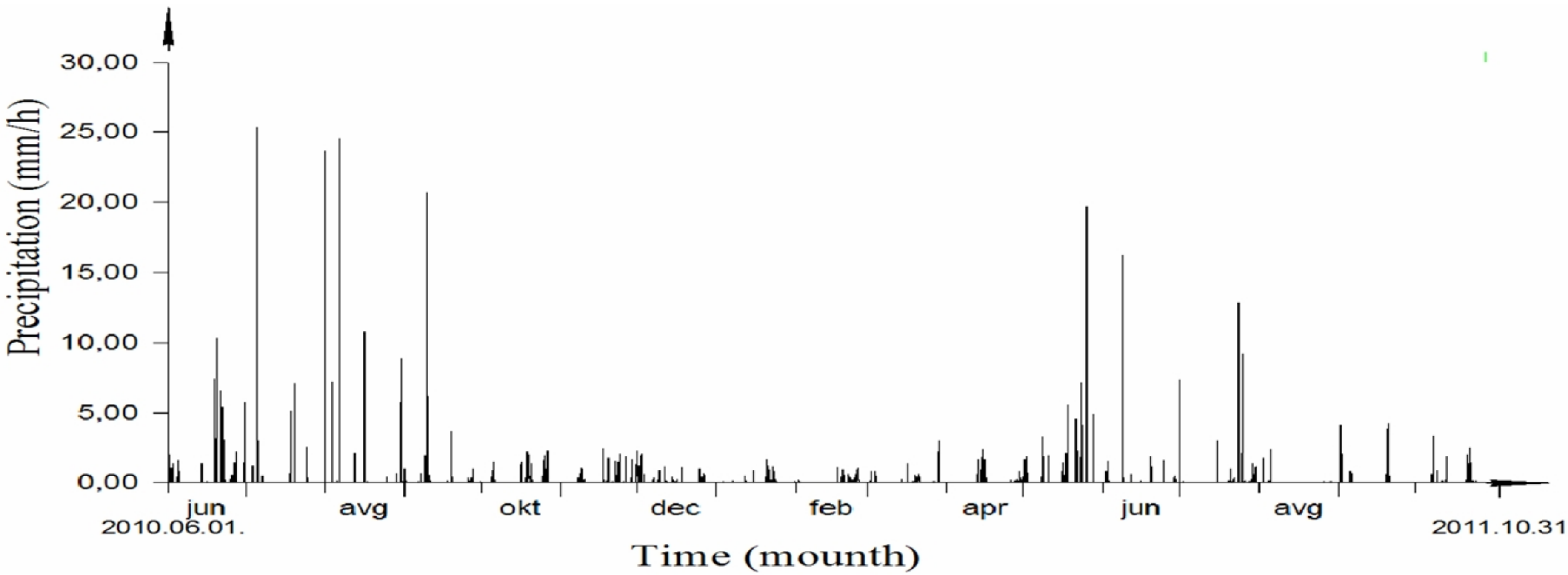
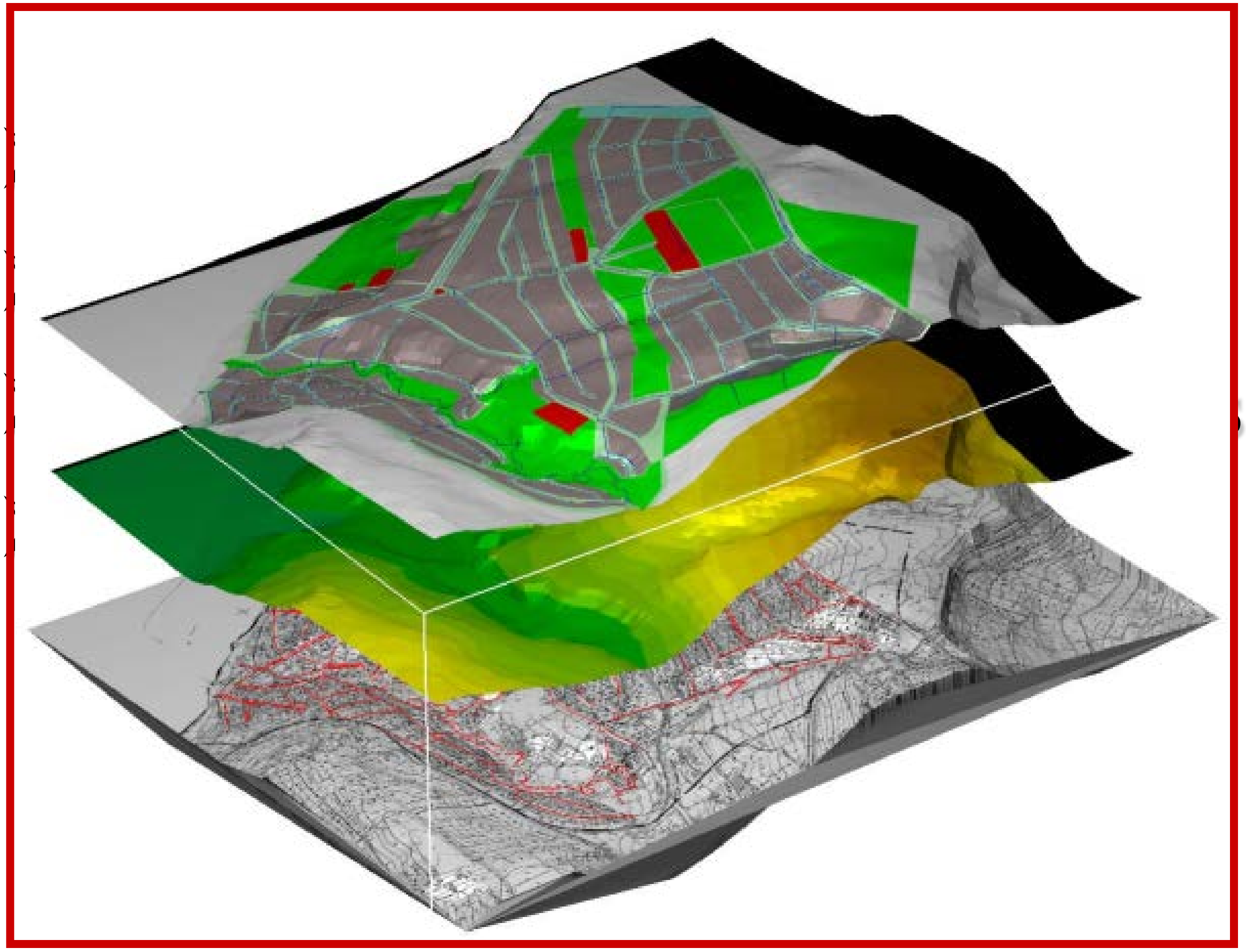


Figure 4. Duration dependent rainfall intensity (ITF curve – weather station Rimski Šančevi)

- Precipitation time series in the period of time 2010-2011 (GC2 location in Novi Sad)



Simulation model



Mathematical numerical hydraulic simulation model SIPSON used and implemented in the software 3DNet was developed at the Faculty of Civil Engineering in Belgrade

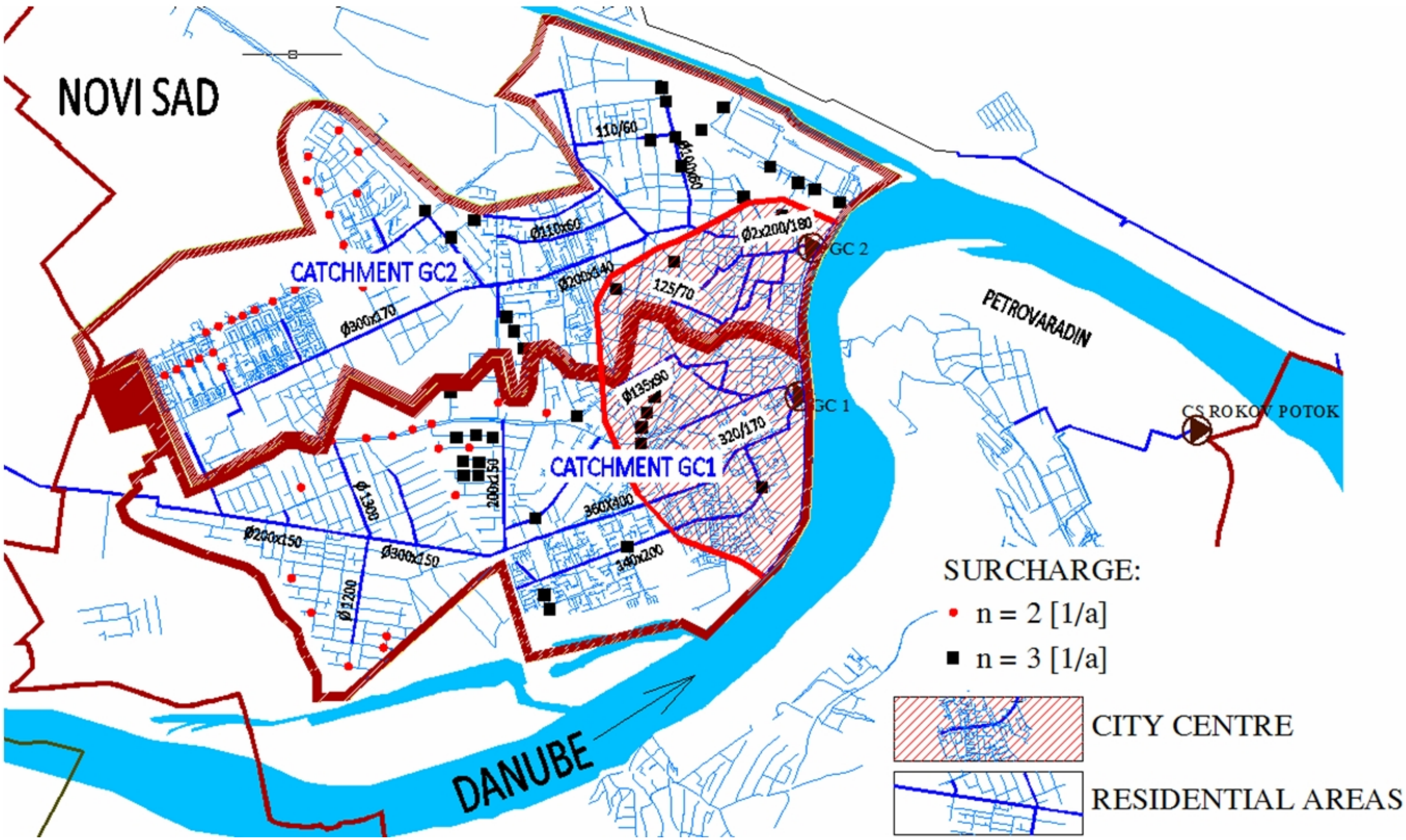
The model can calculate the runoff when the hydraulic capacity of the sewer system is exceeded, the flows in pipes is pressurized and the water overflows from the underground conduits on to the streets and roads

Tipical phases in application of 3DNet in the design process:

1. Creation of digital elevation model
2. Creation of sewer network
3. Creation of cover image
4. Automatic subcatchment delineation
5. Calculation of subcatchment charasteristics
6. Review of results

Hydrodynamic simulation – the existing combined system

• Hydrodynamic flow simulation is run for three different storms (with 2-, 3- and 5-year return periods) - system surcharge occurs in most of the residential area



The results obtained from the hydrodynamic modelling of the existing sewer system are compared with the history of flooding thus providing verification of the existing mathematical model.

The simulation results show that the existing CSS is not capable of receiving and draining storms larger than 2-year storms.

Hydrodynamic simulation – future combined system with overflow

• The future sewer system in Novi Sad should provide the relevant design overloading frequency of 1 in 3 years and 1 in 5 years for the city residential and greater areas.

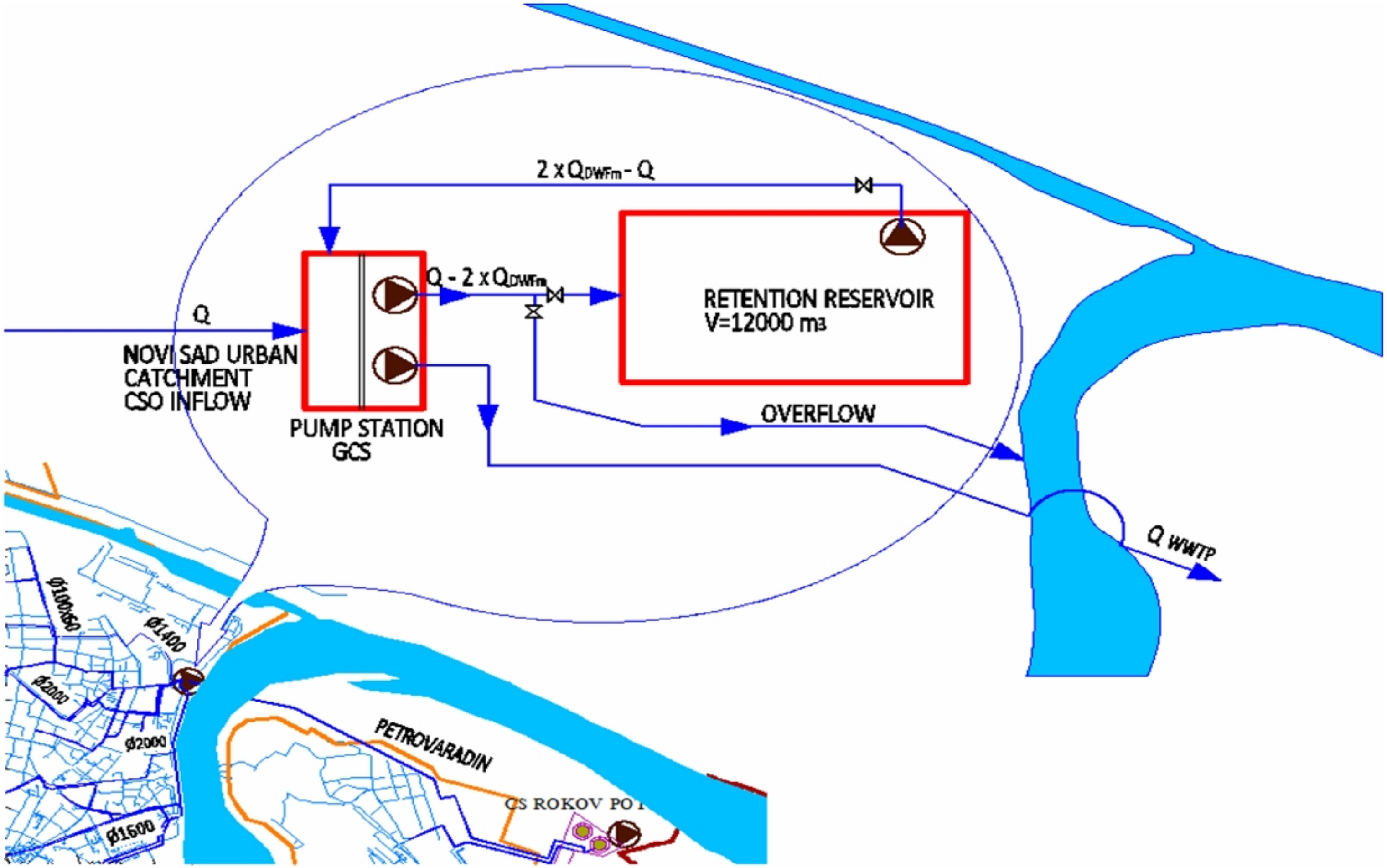
• In addition, it is necessary to consider structures that control the allowable discharge into the receiving water that is, the protection of the receiving water with no system surcharge and diminishing effects of the treatment at the WWTP – **STORAGE TANK**

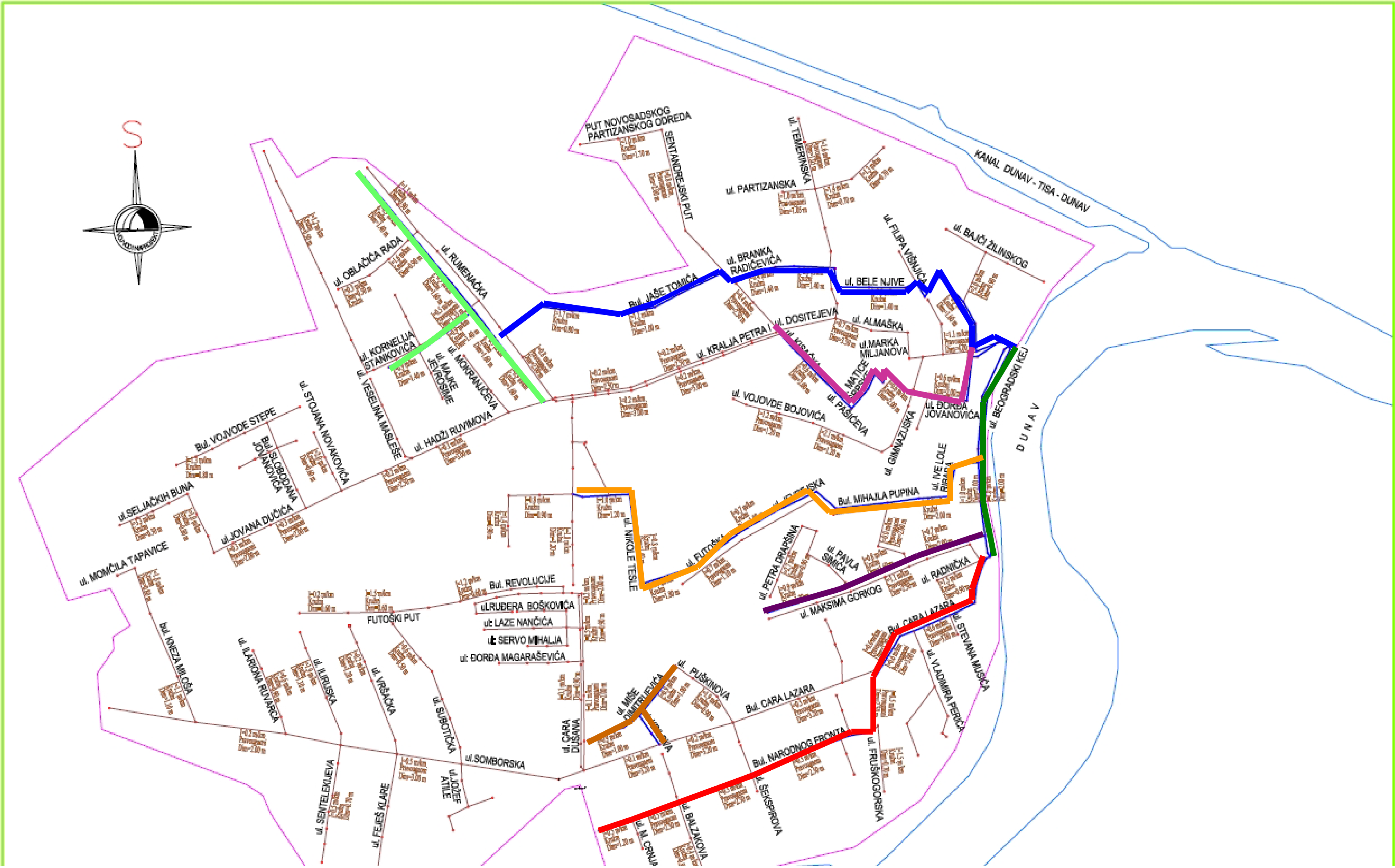
↓

1. Connection of two existing outfalls at the location of GC2 pumping station

2. Foreseen the central pumping station (GCS), settling storagetank and overflow

• The connection of the outfalls into a joint one with GCS and storage tank provides the conditions for the analysis of the new required conduit sections in the sewer system.

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ul. BRANKA RADIČEVIĆA
ul. BELE NJIVE
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ul. OBLAČIĆA RADA
ul. KORNELIJA STANKOVIĆA
ul. MAJKE JEVROSIME
ul. MOKRANJČEVA
ul. VESELINA MASLEŠE
ul. KRALJA PETRA I
ul. DOSITEJEVA
ul. ALMAŠKA
ul. MARKA MILJANOVA
ul. MATICE SRPSKE
ul. PAŠIĆEVA
ul. ĐORĐA JOVANOVIĆA
ul. BEOGRADSKI KEJ
DUNAV
ul. VOJVODE BOJOVIĆA
ul. GIMNAZIJSKA
ul. STOJANA NOVAKOVIĆA
Bul. VOJVODE STEPE
Bul. SLOBODANA JOVANOVIĆA
ul. HADŽI RUVIMOVA
ul. SELJAČKIH BUNA
ul. JOVANA DUČIĆA
ul. MOMČILA TAPAVICE
ul. NIKOLE TESLE
ul. FUTOŠKA
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Bul. NARODNOG FRONTA
ul. FRUŠKOGORSKA
ul. ŠEKSPIROVA
ul. BALZAKOVA
ul. M. CRNJA
ul. SOMBORSKA
ul. JOŽEF ATILE
ul. FEJEŠ KLARE
ul. SENTELEKIJEVA

Storage tank with overflow

- The national standard (SRPS EN 752-4, 2007) does not specify the required capacity of storage tanks – settling tanks but it provides framework for the dimensioning of the overflow
- Austrian guidelines OEWAV Regelbat 19 specifies the storage tank volume of 15-25 m^3/ha (for impervious areas)
- German ATV 128 (ATV A 128, 1992) guidelines - required storage tank capacity is specified within the range of 10-40 m^3 / ha (for Impervious areas)

As the total catchment area is 1960 ha, with impervious area of about 36%, the storage tank capacity of 15 m^3/ha was adopted and give the total storage tank capacity of 12.000 m^3 for the entire catchment

Conclusion

• The paper presents the combined sewer system (CSS) of the city of Novi Sad as being currently overloaded.

• The system is transformed, redesigned into the combined sewer system with storage volume and overflow (CSO) according to the national standard (SRPS EN 752-4, 2007)

• The sewer system, CSO, is dimensioned and redesigned with the design surcharge frequency of 1 in 5 and 1 in 3 years for the city central and residental area respectively

• The software package 3DNet used provided the verification of a large number of different discharge scenarios in the system.

- The results produced by the developed methodology indicate that the old existing CSSs can be successfully redesigned into modern CSOs, which is the first instance of the kind in Serbia.

- CSO system including the adopted storage tank capacity can significantly reduce the pollution of the receiving water and provide its protection.

- In addition, hydraulic flow conditions in the conduits are improved and the pressurized flow time and overflowing are significantly reduced.

Thank you