



Sector Review Paper on The Water Supply and Waste Water Sector

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WATER SECTOR IN SERBIA – REVIEW
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1 1 INTRODUCTION

In the preparation of proposals for municipal water supply and sanitation in the previous phase of the project, the MIASP regularly came across issues related to policies, laws, regulations and standards in this sector that were not clearly defined. For instance, such issues included policies and standards for the discharge of wastewater and design criteria for public water supply. This review paper on the water supply and sanitation sector will describe the main policies, laws, regulations and standards in this sector, and when appropriate recommendations will be developed for consideration by the relevant Serbian authorities and the EAR.

The review presents institutional aspects of the water sector in the Republic of Serbia, basic facts on the existing water and wastewater infrastructural systems, relevant local regulations and their relations with the applicable contemporary EU regulations and standards, annual investment in the water sector (water and wastewater), as well as some basic design criteria used for municipal water and wastewater systems.

2 Existing legal and regulatory framework regarding water supply and sanitation

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2.1.1 2.1 Overview of current legislation

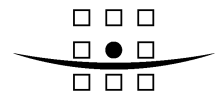
Current legislation is also in a phase of change, reflecting the transformation situation in the Republic of Serbia. Laws are amended and adapted on a regular basis. The following summary illustrates the status of these laws at the time this report was written. The following laws, ordinances, regulations and miscellaneous provisions are of importance with the planning, construction, and operation of water supply and sanitation utilities:

- Environmental Protection Law (OGRS No. 66/91, 83/92 and 53/93)
- Water Law (OGRS No. 46/91, 53/93, 67/93, 48/94 and 54/96)
- Law on Design and Construction (OGRS No. 47/2003)
- Law on Local Self-Government (OGRS No. 09/2002)
- Law on Municipal Operations (OGRS No. 16/97 and 42/98)
- Ordinance on the Adoption of the Republic of Serbia Water Resources Development Master Plan (SWRDMP) (OGRS No. 11/02)
- Ordinance on the Classification of Cross-Border and Coastal Water Bodies (OGRS No. 10/78)
- Ordinance on Water Body Classification (OGRS No. 5/68)
- Ordinance on the Categorisation of Water Bodies (OGRS No. 5/68)

2.1.1 Environmental Protection Law (OGRS No. 135/04)

This Serbian Law was adopted in December 2004. Its content was harmonized with the relevant EU legislation. It provides:

- Protection of soil, water, air, forest, biosphere and biodiversity, plants and animals
- Mandatory environmental monitoring: the programmes have to be adopted and performed every second year (including air monitoring).



- Responsibility of the Serbian Government to establish the criteria for environmental measurements and regular reporting of the results to the Serbian Parliament yearly.
- The important obligation of 1% taxes on all new investments in objects that could possibly be the sources of environmental pollution, and will be used for environmental protection and promotion.

2.1.2 Water Law (OGRS No. 46/91, 53/93, 67/93, 48/94 and 54/96)

The Water Law of the Republic of Serbia is the most important legal basis for the protection of water bodies, water use, and water management. It governs the conditions for design, construction, operation and financing of water management activities. The law applies to all surface water and groundwater, including drinking water and thermal/mineral waters (Art. 1). The Law on Water of the Republic of Serbia regulates the protection of waters, protection from the pestious effects of waters, utilisation of and management with the water as a wealth of general concern, conditions and ways of doing the water management and inspection over the implementation of regulations of this law. The regulations of this law addresses on all surface and ground waters, including drinking water, thermal and mineral waters, as well as the boundary and transboundary water courses, both those between the Republic of Serbia and Republic of Montenegro, and those between the Republic of Serbia and other countries in the vicinity, except it is not otherwise issued by other legal acts. The law regulates that waters can be used only in a way that does not threat their natural characteristics, does not endanger the life and health of people, does not peril the wild plant and animal species, natural wealth and immobile cultural wealth.

Every investor is required to observe and abide by water management requirements. It is even emphasised that wastewater is to be discharged upstream of one's own water supply sources (Art. 14). The obtaining of requirements is necessary for the construction, modification and enhancement of sewage disposal facilities (collection, channelling, treatment, and discharge of wastewater). This also goes for discharge into a sewerage system, but not for unpolluted rainwater and domestic household wastewater (Art. 15). The prerequisite for a water management permit (permit under the water law) is a "declaration of consent", which is granted by the public authority that sets the requirements, i.e.:

- The Ministry responsible for water management or
- The Municipality for small structures and properties

Declaration of consent from the Ministry of Health and the Ministry of Environment are also necessary for sewage disposal facilities. Construction of the facility must begin within two years after the receipt of the declaration of consent. The permit also confirms that water management requirements are complied with.

The funding of water-related activities is outlined in Paragraph IX of the Water Law. Fees are levied for:

- Water use
- Protection of water bodies
- Irrigation
- Pumping and drainage
- Material excavation from water bodies
- Use of water-related objects (navigation on water bodies, power supply, etc.)

2.1.3 Law on Design and Construction (OGRS No. 47/2003)

This law contains regulations on the design and construction activities. Specifically, it governs the phase of regional and city planning, as well as the implementation of civil works in terms of:

- Regional planning
- City development
- Brownfields
- Object-related design and execution of civil works
- Supporting documents of professional competence of responsible designers
- Chamber of Engineers
- Demolition and dismantling of structures
- Monitoring
- Sanctions

The regulations in paragraphs III, V and VI for city and object planning are of special importance for the design and construction of sewage disposal facilities. They cover the required documentation and permits, as well as the execution of construction. In paragraph III, the goals and contents for mapping documents are laid out, as well as the procedure of the design phase from the awarding up to the permit. It is of importance for sewage disposal facilities that, based on a general project and a preliminary planning, a regulation plan should be developed that specifies locations for detailed objects and routes for supply and discharge lines.

The contents of object-related design are covered in paragraph V (pre-feasibility and feasibility study, layout, construction permit, detailed designs, planning of the implementation phase, blueprints), as well as testing guidelines (authorisation process for the design phase, responsible planners, project revision, technical layout control and archiving of technical documentation). In the same paragraph, the process for the construction stage is outlined (preparatory work, announcement of construction commencement, responsibilities of the executing organisations, responsible construction supervisors, deviations from the design, technical certifications, rejections of the technical certifications, test run phase, operation permit, maintenance and upkeep).

2.1.4 Law on Local Self-Government (OGRS No. 09/2002)

With this law, the participation of citizens with the help of local representations in government is outlined, in terms of:

- the units of local self-government (establishment, territory, legal status, tasks)
- the direct participation of citizens in local self government
- local representation
- financing (taxes, dues, contributions)
- the relationship between the federal organs, territorial autonomy and local self government
- the co-operation and creation of communities between the units of local self government
- the symbols and names of places of local self-government units
- the legal means of protection of local self-government units

Municipalities decide upon their own development programs, urban development plans, budgets and organise community activities. They issue water management requirements, declarations of consent and permits for objects of local importance. The duty of wastewater disposal is not indicated in this law. This is covered in the Law on

Municipal Operations. The financing of wastewater treatment results partially from land use and building taxes. Furthermore, earmarked dues can be levied. The creation of wastewater associations would be possible from these dues.

2.1.5 Law on Municipal Operations (OGRS No. 16/97 and 42/98)

This law outlines the:

- Municipal operations of public interest
- Requirements for municipal operations
- Conditions and type of the execution of municipal operations
- Provision of funds for municipal operations
- Monitoring

This law assigns the duties and responsibilities of public interest to the municipality. This includes: water treatment and distribution which implies collection, processing, treatment and supply of drinking water and for other needs of the water supply network to the consumer's water gauge, treatment and evacuation of precipitation water which implies the collection and evacuation of waste, precipitation and surface water from public areas through a sewerage, drainage or in some other way, as well as their treatment and discharge from the network; production and supply of steam and hot water which implies the production, collection and supply of hot water and steam from a remote district unique source or individual sources for heating of apartment housing and apartments, business premises, hot water network, hot water network to the consumer's substation and measurement instrument.

The municipality fronts the funds for the construction and operation of sewage disposal facilities. The municipality puts a public utility company in charge of the operation of the facilities. The Public Utility Company sets the wastewater price, which is passed by the city or municipal council.

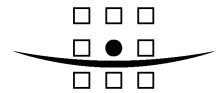
Participation interests up to 49 % in such public companies are possible. The company is entitled to participate with other companies in market competition.

2.1.6 The Law on assets owned by the Republic of Serbia («Official Gazette PC», No. 53/95, 3/96, 54/96, 32/97 and 44/99)

The assets acquired, namely acquired by public utility companies, are assets owned by the Republic. The state is the owner, and the public utility companies are users of these assets. Accordingly, there are respective powers, namely limitations in enjoyment of proprietary right, namely powers resulting from this right and forming this right (the proprietary right as *ius respondendi*). This Law stipulates that the acquisition and disposal of real estate used by the public utility company is decided on by the Government. The granting the use, namely lease, as well as mortgage on the real estate used by the public utility company, is decided by the authority defined by the municipality statute (assembly, namely council of municipality president) with the approval of the Republic Directorate for Assets of the Republic of Serbia.

2.2 The National Environment Action Plan and National Environment Strategy

The National Environment Action Plan (NEAP) for the next 5 years is in the final stage of preparation. Within this Plan, the Serbian Government will adopt action plans: for water protection, air and atmosphere protection, eco-system protection, chemical



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management, protection from ionizing and non-ionizing radiation, protection from hazards, protection from noise and vibration, sustainable energy management, information system development, scientific research development and education in two years, counting from the day the above mentioned Law enters into force.

3 3 EXISTING LEGAL AND REGULATORY FRAMEWORK REGARDING WATER SUPPLY AND SANITATION

Municipalities are responsible for provision, operation, maintenance, investment of water supply and sanitation services. Municipal water supply and wastewater systems are operated and maintained by local Public Utility Companies (PUC-s). PUC-s are basically state-owned companies, founded and managed by the Municipalities. The Public Utility Companies are responsible to the Municipalities for their performance. The Municipalities themselves operate under overall responsibility of the Ministry of Public Administration and Self-Government.

The Directorate for Water under the Ministry of Agriculture and Water Management has got overall responsibility for water management issues at the national level. The EAR particularly supports strengthening the capacity of the Directorate of Water to implement corresponding EU Framework Directive. The responsibility for environmental issues lies within the Directorate for Environmental Protection under the Ministry of Science and Environmental Protection. Several other Ministries are responsible for regulations and policy development in infrastructure, such as legal aspects of construction, environmental issues, quality standards and other.

3.1.1 3.1 Principle Stakeholders

The Ministry of Agriculture, Forestry and Water Management is responsible for the entire water sector in Serbia. The Directorate for Water is part of the Ministry, and has the following departments:

- Department for Analytical Studies and Administrative Tasks in Water Management
- Department for Water Supply and Protection
- Department for Water-Related Inspections

Disposal of industrial wastewater is a task of the Ministry of Agriculture and Water Management.

The Ministries of Health, Capital Investments, Energy and Mining, and Administration and Local Self-Government are also indirectly involved in water supply and treatment: The Directorate for Environmental Protection, within the new Ministry of Science and Environment Protection, is responsible for environmental protection in connection with water body and water management activities. The public companies JVP Srbijavode und Vode Vojvodine are also both responsible for various water supply concerns.

3.1.2 3.2 Organisation

The territorial organisation of Serbia is regulated by the Law of Territorial Organisation and Self-Government from July 1991. Municipalities, cities and settlements form the base of territorial organisation. Serbia, excluding Kosovo, is organised into 24 districts with a total of 147 municipalities, which are the smallest local self-government units.

The Ministry of Agriculture and Water Management is responsible for the Republic of Serbia Water Resources Development Master Plan and specifies water-related requirements. Within the ministry, the Directorate for Water is responsible for all water management related tasks.

The public water companies JVP Srbijavode and JVP Vode Vojvodine are responsible for the practical implementation of measures according to the Water Law. JVP Srbijavode was formed in 1997 through the fusion of three other public companies: „Dunav“, „Sava“ and „Morava“. This company, located in Belgrade and with its three water centers „Sava-Dunav“, „Morava“ und „Radonjic“, is active in the Republic of

Serbia, but not in the autonomous region of Vojvodina. JVP Vode Vojvodine administers these tasks in Vojvodina since 2002.

The tasks of JVP Srbijavode and JKP Vode Vojvodine are defined in the Water Law, and include the areas of water resources management, protection of water supplies and reserves, flood protection, and protection of water against pollution.

Sewage disposal is a municipal task. Units of self-government, cities and communities predicate public utility companies for water supply and sewerage, as well as for land development and construction. Water supply and sewerage companies are responsible for planning, construction and operation of sewage disposal facilities.

Other existing institutions have an important role in the area of environmental protection (Institute for Nature Conservation, Hydrometeorological Institute, Departments of Health, e.g. in Belgrade and Novi Sad). The Hydrometeorological Institute monitors and measures the amounts and quality of surface and groundwater.

3.1.3 3.3 Responsibilities

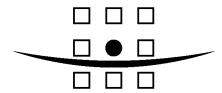
The Ministry of Agriculture, Forestry and Water Management is responsible for the Serbian water sector as a whole. The ministry is also responsible for issuing water management letters of agreement and declarations of consent. The Directorate for Water acts as the ministry's representative. The Ministry of Health and Ministry of Science and Environment Protection give their approval on planned projects. The Ministry of Capital Investments is responsible for planning and building permits and building inspections. Sewage disposal is the municipality's duty. Public utility companies JKP Waterworks and Sewerage acts as the representative of the municipality and is responsible for the compliance. In principle, these public utility companies are responsible for the construction and operation of sewage disposal facilities on behalf of the municipality. The provided services are different sometimes: this may be only water supply and sewage disposal, but can also involve other public service areas. Public companies or agencies for building land and development are sometimes responsible for municipal investments (e.g. Agency for Building Land and Development Belgrade). Local health authorities are responsible for the control of industries (indirect dischargers) and official supervision of watercourse quality.

3.1.4 3.4 Current systems for the collection of fees and charges levied to producers of wastewater

Common rates or fees will be charged for potable water and wastewater. In principle, the billing base is the water consumption, i.e. water and wastewater fees will be charged for households and industries corresponding to their consumed quantity of potable water.

Generally, the State is the owner of infrastructure objects, which are financed by the government budget. Fees will only cover operation and maintenance costs inclusive of staff costs. Public utility companies are responsible for the calculation of fees, which have to be approved by the Municipal Authority. Common rates or fees are charged for potable water and wastewater, whereas an internal clearing exists. The wastewater rate is not shown separately in the bill.

The water/wastewater rates are charged mostly together with other public service rates (e.g. in Belgrade by company INFOSTAN). In these cases, the bill shows the water consumption without any reference to the sewage disposal service. Installed



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watermeters are not calibrated regularly and not replaced as often as needed. Watermeters are often missing or are deliberately removed or destroyed. There is also a problem with illegal connections to the network. Due to these facts a large discrepancy exists between produced and billed water quantities. In view of these circumstances, the responsible public utility company cannot usually operate in a proper manner. Many consumers are notorious for paying their bills late. Only 40% - 80% of bills are paid.

4 Current status of water infrastructural systems

4.1 Public water supply systems

4.1.1 General

In accordance with the Water Act ⁽¹⁾, public water supply is defined as water supply of five or more households, that is more than 20 population, water supply of industrial premises, individuals who carry out food processing/production for further wholesale/retail, as well as potable water supply of public buildings (schools, municipal buildings, community centres, railway stations, etc.).

The population water supply, in general terms, encompasses potable water supply of households, industries that use high-quality water or are located within the urban agglomerations and of other users to whom potable water is regularly supplied, metered and invoiced (public buildings, schools, hospitals, banks, restaurants, etc.), as well as use of potable water for general public purposes, such as watering of public areas, public fountains, street washing, etc..

The most updated statistical data on the water supply sector in Serbia have been collected and presented by the Statistical Office of the Republic of Serbia, based on the Annual report on public water supply – form VOD-2V. Up to 2004 the aforesaid reports were collected once in three years, and since 2004 the reports have been collected and presented on annual basis.

Also, the data on the water supply sector in Serbia are presented and summarized in the ref. ⁽¹⁾. However, it must be noted that the data on the current status of the water supply sector in the Master Plan are referred to 1991.

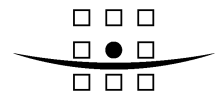
The information on major characteristics of the water supply sector in Serbia was also presented in the ref. ⁽³⁾.

Operationally, the sector can be characterized as having huge physical losses in the order of 50 % and more; no demand management; inadequate pricing policies; and fragmented institutional arrangements.

WATER RESOURCES

Serbia has access to sufficient volume of water, but it is heterogeneous in terms of space and time. It is estimated that only about 8% of all available surface water originates within the territory of Serbia. The remaining 92% are transit waters entering Serbia through the Danube, Sava, Tisa, Drina and other rivers, ref. ⁽⁴⁾.

Groundwater resources are of special significance for Serbia as they provide up to 90% of water supply for households and industry and about 70% of the drinking water. The existing groundwater resources in Serbia and Montenegro are 244 m³ per capita per year. Total abstraction is about 180 million m³ per year. The extraction of groundwater exceeds the natural capacity of replenishment in certain number of aquifers, leading to reduced level of groundwater. The problem of depletion of groundwater sources is especially marked in Vojvodina where many shallower aquifers were over-exploited and



now water is being extracted from deeper aquifers. It is estimated that about 57% of abstraction of water in Vojvodina comes from deeper sources. Aquifers in Vojvodina have a naturally increased level of arsenic.

The following information on the water resources in Serbia have been presented in the ref. ⁽⁵⁾.

Serbia has an annual water flow of about 1,500 m³ per capita, which classifies it among the water scarce areas of Europe. The mountainous area in the southwest, the east, and south of Serbia has greater water potential than the north and the centre. The rivers Danube, Sava, Drina and Morava form the main water resources in the country. As analysed in the Republic of Serbia Water Resources Development Master Plan, approximately 66 % of potable water comes from surface waters (including groundwater generated from surface waters, e.g. bank filtrate) and one third from groundwater. In Serbia, there are:

- 60 large reservoirs (about 20 of them larger than 10 million m³)
- 100 smaller reservoirs in the Danube River Basin
- The total retention volume of all reservoirs is about 6.5 billion m³
- 3,550 km of flood defence embankments

All rivers in Serbia belong to three sea basins: the Black Sea Basin, the Adriatic Basin, and the Aegean Basin. The major tributary to the left of the Danube is the Tisza River, flowing from Hungary. Its main tributaries are the Begej, the Tamis, the Karas and the Nera, all coming from Romania. The major tributary to the right of the Danube River is the Sava River, flowing from Croatia. Additional larger tributaries to the right of the Danube River are the Velika Morava and Timok Rivers. Sava River is the basic resource for water supply in Belgrade, either by direct use of surface water or exploitation of ground water springs. A net of melioration channels was built for the improvement of the water resources in Vojvodina.

Water flow is seasonally variable, leading to quantity problems throughout Serbia. Water shortages are particularly serious in southern Serbia. Water shortages required the construction of reservoirs as part of a regional water supply strategy.

Annual precipitation in Serbia varies from 550-650 mm in Vojvodina to 800-1200 mm in the mountainous regions. All the lower areas of Serbia, including the lower Drina basin, have a precipitation of less than 800 mm/year. Internally renewable water resources are limited since about 84 % of the available water resources originate outside Serbia.

WATER QUALITY

Quality of drinking water in Serbia is generally unsatisfactory. According to the findings of the Public Health Institute of the Republic of Serbia, 29% of samples from water supply systems did not satisfy physical, chemical or bacteriological standards in 2001. There are significant regional differences in the drinking water quality between Central Serbia and Vojvodina. The main problem in central Serbia is that more than 40% of samples were bacteriologically contaminated and did not satisfy quality criteria. In Vojvodina the primary problems with physical and chemical water quality parameters are turbidity, and the presence of iron, manganese, nitrates and arsenic. In general terms, only the city of Belgrade has adequate water quality, with more than 90% of samples satisfying standards. In many areas, the groundwater cannot be used for drinking purposes without prior treatment. This is especially the case in the Vojvodina Province, which has naturally elevated levels of arsenic and manganese.

The main problems/issues characterising potable water supply systems in Serbia, in accordance with the National Environmental Strategy, can be summarized as follows:

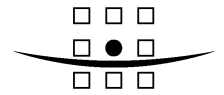
- Incompatibility of standards for drinking water and bathing water with EU directives;
- Overlapping competencies of the state institutions in the field of water management;
- Generally - low water tariffs not covering the costs incurred in water abstraction, treatment, transmission and distribution to consumers;
- Inadequate protection of water intakes and water reservoirs;
- Insufficient and inadequate treatment of water for drinking purposes;
- Poor condition of drinking water distribution network and other components, high rates of unaccounted for water;
- Very low level of monitoring of essential system parameters – water quality and hydraulic parameters;
- Uncontrolled use of fertilizers contributing to water sources pollution;
- Inefficient surface water monitoring network;
- Lack of effective groundwater monitoring network;
- Over-exploitation of groundwater resources;

WATER SUPPLY COVERAGE

Based on the information included in the 2004 Statistical yearbook of the Republic of Serbia, number of households being served by the public water supply system was 1.820.044 (5.460.132 inhabitants) out of 2.521.190 (7.563.570 inhabitants) households in Serbia and Vojvodina, meaning that **around 72% of the population is served by means of public water supply system.**

According to the survey included in the ref. ⁽⁵⁾, the following results were found (results from 109 out of 147 municipalities):

- Drinking water comes from groundwater, spring and surface water sources. About 59 % is from groundwater, 17 % from spring water and 24 % from surface water. In total, about 27 m³/s is extracted for public drinking water supply.
- The public water supply provides about 30 % of the capacity to industries according to the following table. The difference between produced and sold potable water results from losses (unaccounted water).



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Water supply in Serbia (ref. ⁽⁵⁾)

	Public water supply (m ³)		Own sources (m ³)
	Water production	Water consumption	Water production
Inhabitants	484.866.650	306.299.697	-
Industries/ Institutions	125.555.826	125.555.826	52.664.837
Total	610.422.476	431.855.523	52.664.837

- The average amount of water losses is about 30 % according to the survey. However, 28 % of the evaluated municipalities reported losses of more than 30 % up to 50 %. The share of the total losses in all municipalities is 42 % for those mentioned before. Only 11 % of the municipalities estimated less than 10 % of water losses. Most of the municipalities have water losses between 20 % and 30 %, which is 54 % of the total water losses in the survey, mostly affected by the City of Belgrade with water losses of 34 % of the total losses.
- About half of the population receives water from the three largest water supply systems (Belgrade, Novi Sad and Nis), with the remainder served by medium-sized public water supply systems. **About 76 % of the population has access to a public drinking water supply.**
- Water supply in big cities is well developed. More than 90 % of the population is connected to the public water supply system in 23 % of the investigated municipalities. 45 % of the total population of Serbia live in these settlements.
- The coverage index is below 50 % in 25 % of the municipalities with a total of 13 % of the Serbian population. This mostly includes municipalities with 5.000 – 50.000 inhabitants.

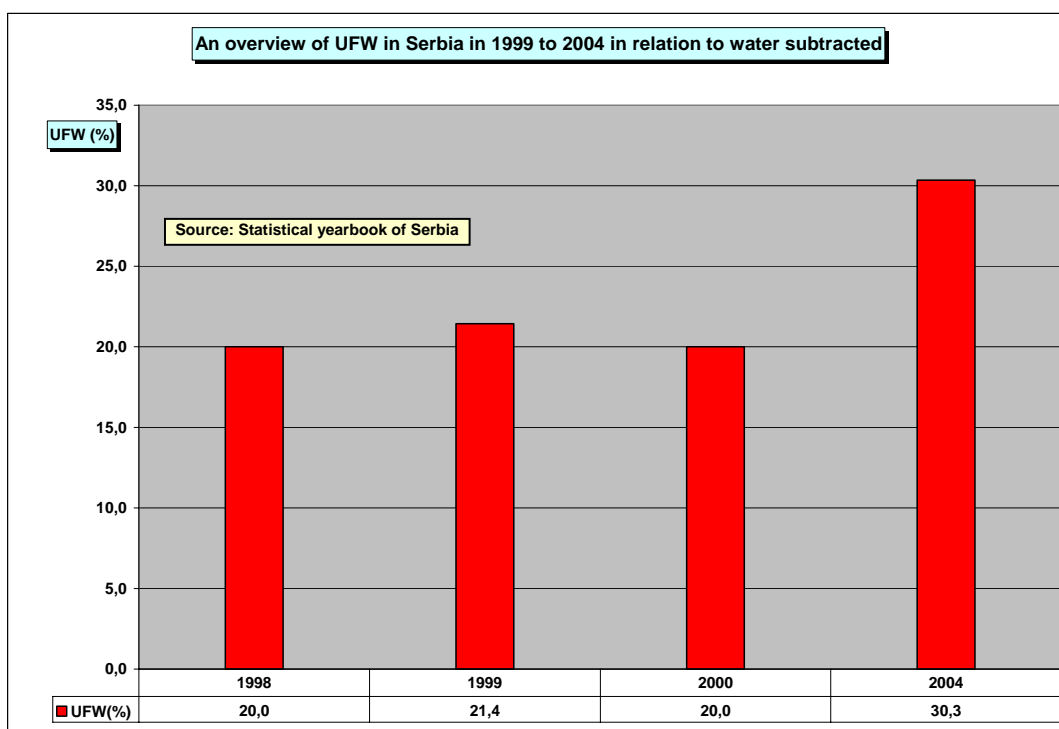
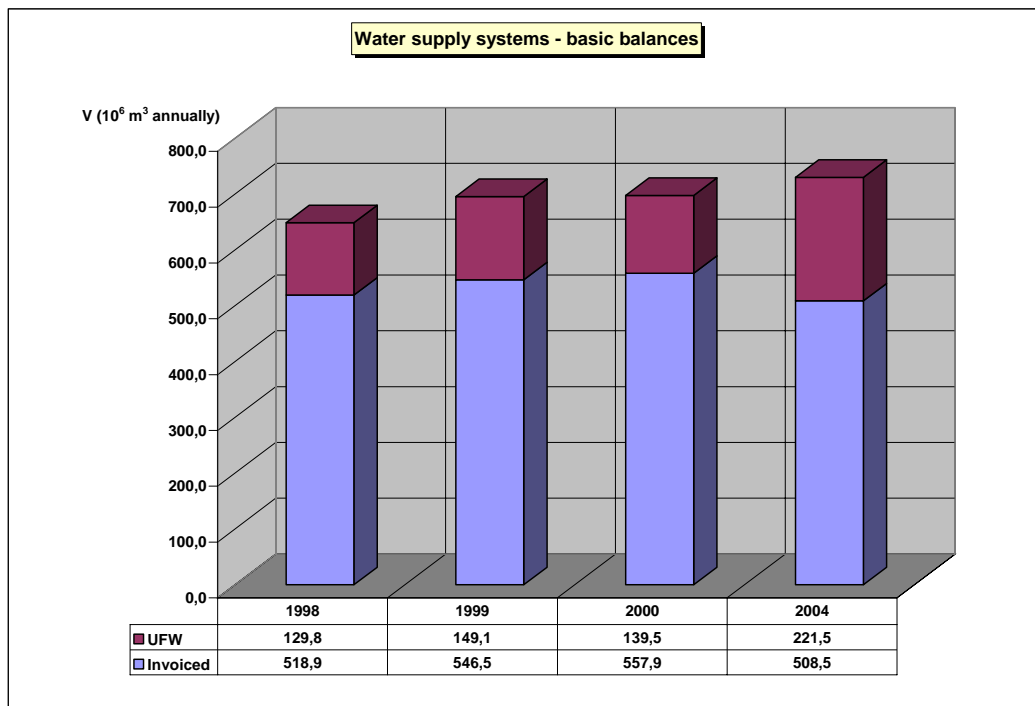
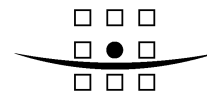
4.1.2 Basic water balances – an overview

One of the prime data sources regarding basic water balances in the water supply systems in Serbia is the Statistical yearbook of Serbia published regularly by the Statistical Office of the Republic of Serbia.

Hereinafter are presented some basic water balances for the period 1998-2004 (water subtracted, invoiced, UFW) published in the Statistical yearbook of Serbia, and derived from the questionnaires regularly filled in by the local PUC-s in charge of municipal water supply systems.

Republic of Serbia - subtracted, invoiced water and UFW for water supply (10⁶ m³)

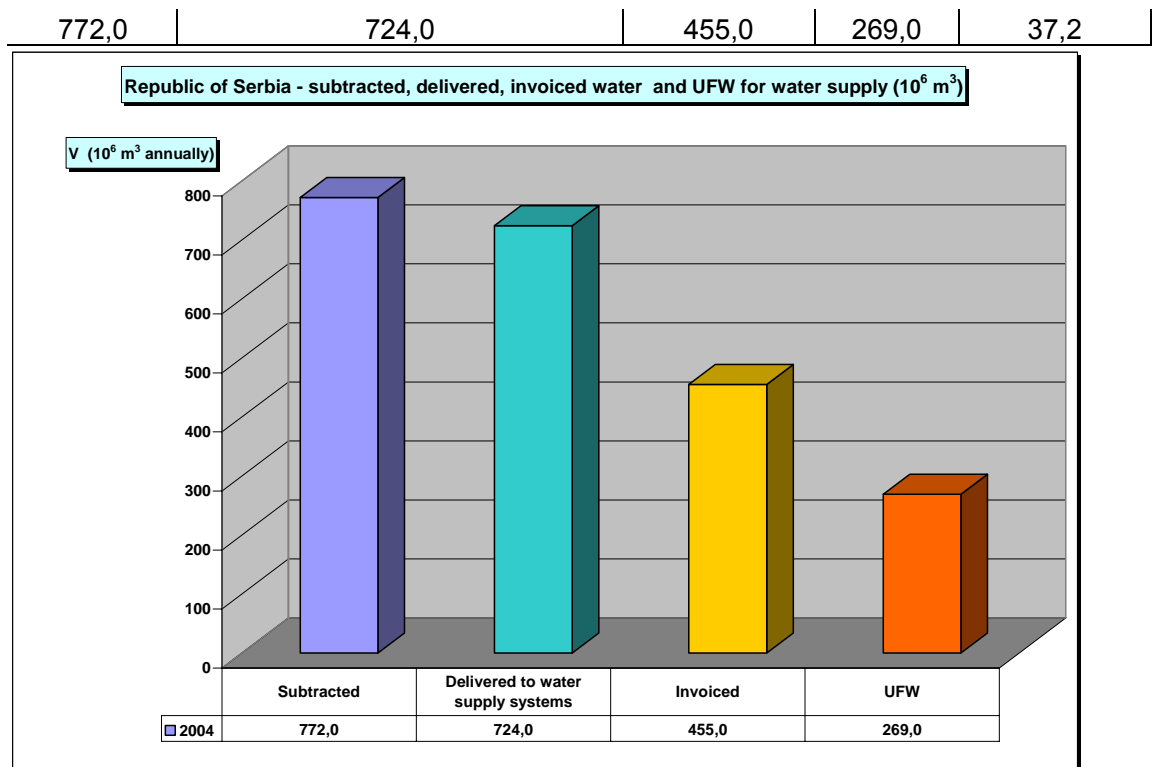
	Subtracted	Invoiced	UFW	UFW(%)
1998	648,7	518,9	129,8	20,0
1999	695,6	546,5	149,1	21,4
2000	697,4	557,9	139,5	20,0
2004	730,0	508,5	221,5	30,3
Average	692,9	533,0	160,0	23,1



Of particular relevance are data included in a recent comprehensive study, ref. (3). The aforesaid study on water losses was based on comprehensive questionnaires filled in by the PUC-s in 145 municipalities, with data being verified by the consultants.

Republic of Serbia - subtracted, delivered, invoiced water and UFW for water supply (10⁶ m³)

Subtracted	Delivered to water supply systems	Invoiced	UFW	UFW(%)
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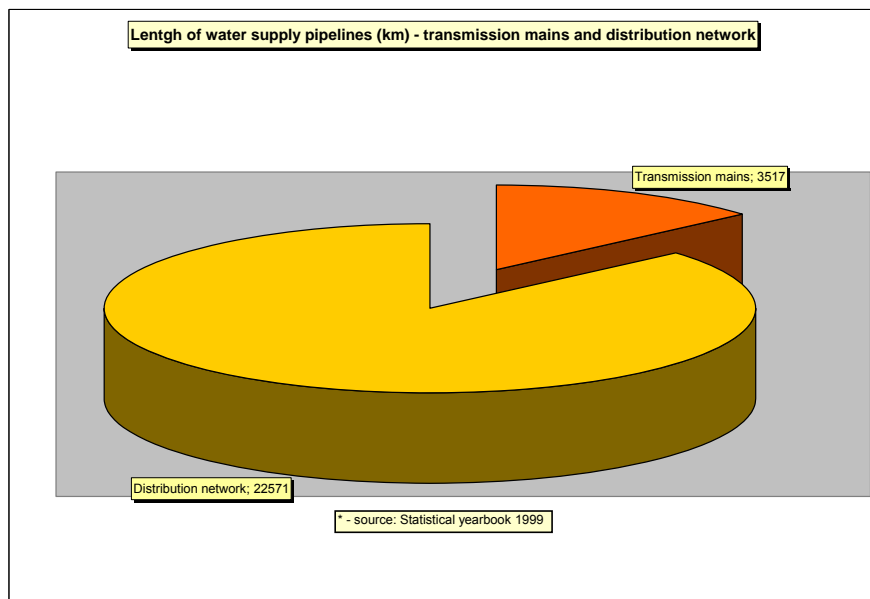
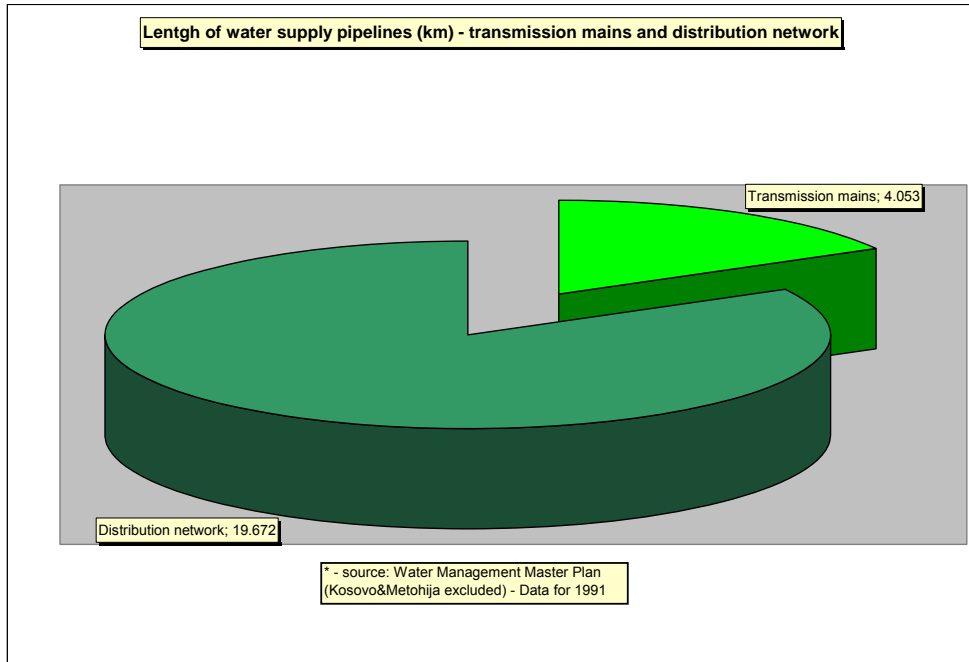


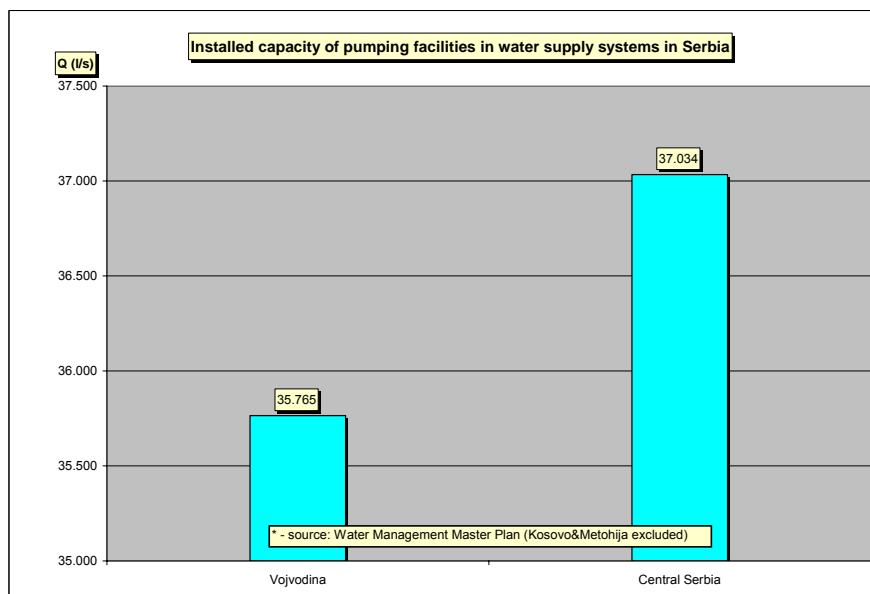
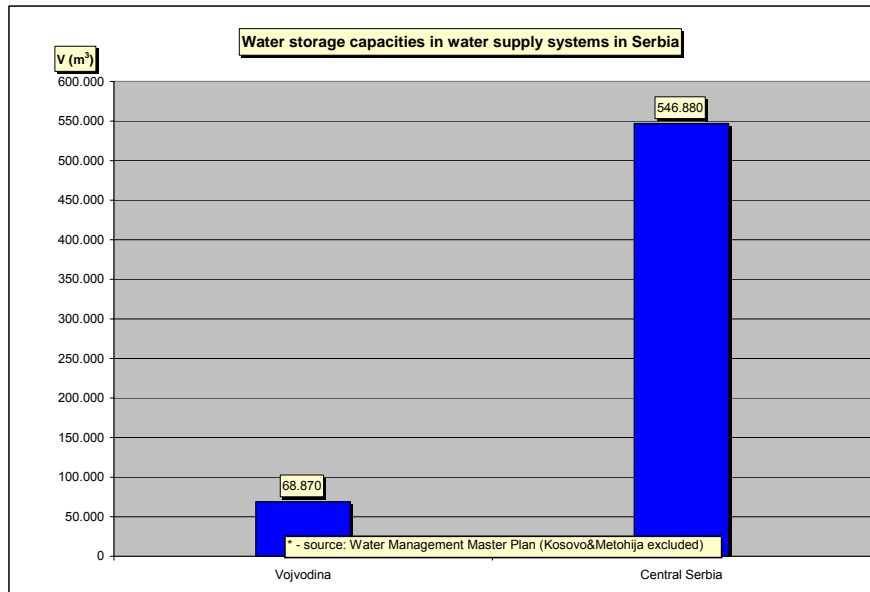
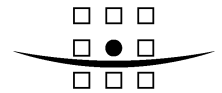
4.1.3 Status of system components and basic performance indicators – an overview

PHYSICAL COMPONENTS

This section represents a very basic overview of the major system physical components of the public water supply systems in Serbia.

The data presented are based on the information included in the following source documents: Statistical yearbook of Serbia, ref. 1 and ref.3.





PERFORMANCE INDICATORS & CONSUMPTION CHARACTERISTICS

Here is the overview of some of the major performance indicators for water supply systems in Serbia including:

- (1) Population coverage
- (2) Water losses
- (3) Unit consumption rates

(1) Population coverage

The information on the resident population served by the water undertaking in Serbia varies depending on the reference documentation used. Here is the summary of population coverage figures included in different references.

The following information presented in the ref. ⁽⁵⁾ are somewhat different from the data shown earlier, but is also included here in order to complement prospective on the current status of water supply in Serbia.

In general, the water supply and sanitation sector was well developed in former Yugoslavia, and even today, coverage in urban areas reflects this legacy. In 2000, 98 % of the country's population had access to safe drinking water using the commonly accepted definition of "access to improved water sources" as meaning sourced from a pipe, a public tap, borehole/tube well, protected well, protected spring or rainwater. In Serbia the coverage of drinking water supplies in homes or yards is 82 % with an urban/rural breakdown of 98 % and 63 %, respectively. Central Serbia has 71 % of rural settlements receiving piped water, versus 87 % in Vojvodina. Regional differences are significant and indicate that outside of the large cities, water supply coverage is low. /R-2/

- About 93 % of the population in the Belgrade area has water pipes in the house,
- This figure is only 77 % for the rest of central Serbia.

Percentage of the population with a water supply of various service levels in the ref. ⁽⁵⁾

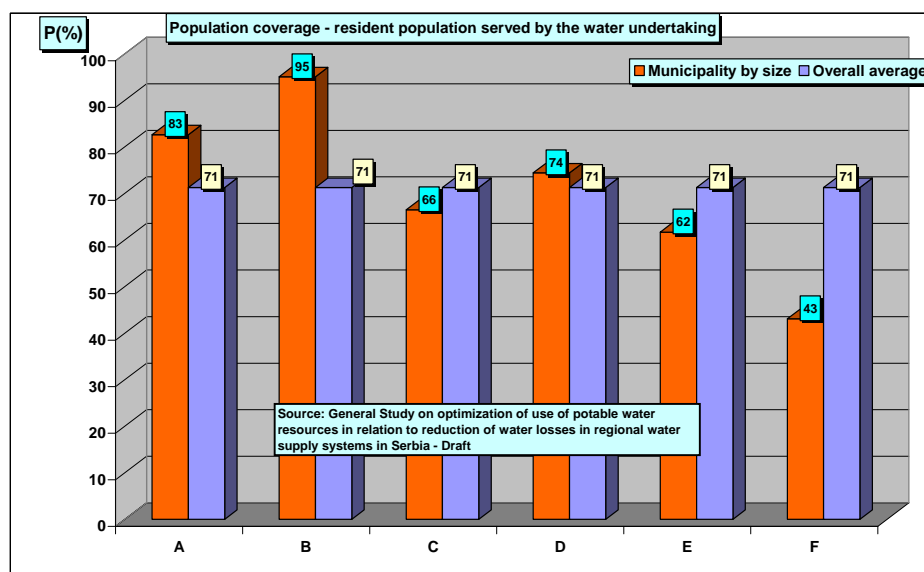
Territory	Pipes in the house	Pipes in garden or plot	Public tap	Tube well /borehole with pump	Protected dug-well	Unprotected dug-well
Serbia excl. Kosovo and Metohija	83.7	2.6	0.6	4.6	7.0	0.8
Central Serbia	81.3	2.6	0.6	4.4	9.6	1.0
Central Serbia excl. Belgrade	77.0	3.2	0.8	4.8	12.4	1.3
Belgrade	92.9	1.2	0.0	3.5	1.9	0.3
Vojvodina	90.4	2.5	0.7	5.2	0.1	0.0
Urban Areas	97.0	1.0	0.1	0.4	0.4	0.0
Rural Areas	68.0	4.8	1.3	9.1	14.1	1.6

These coverage figures are misleading in other regards as well. Households appear to have reported what they have, not what is properly functioning. Many of the piped water supply systems are operating poorly, if at all, particularly in rural areas.

The following table shows the percentages of resident population served by the water undertaking, based on different references:

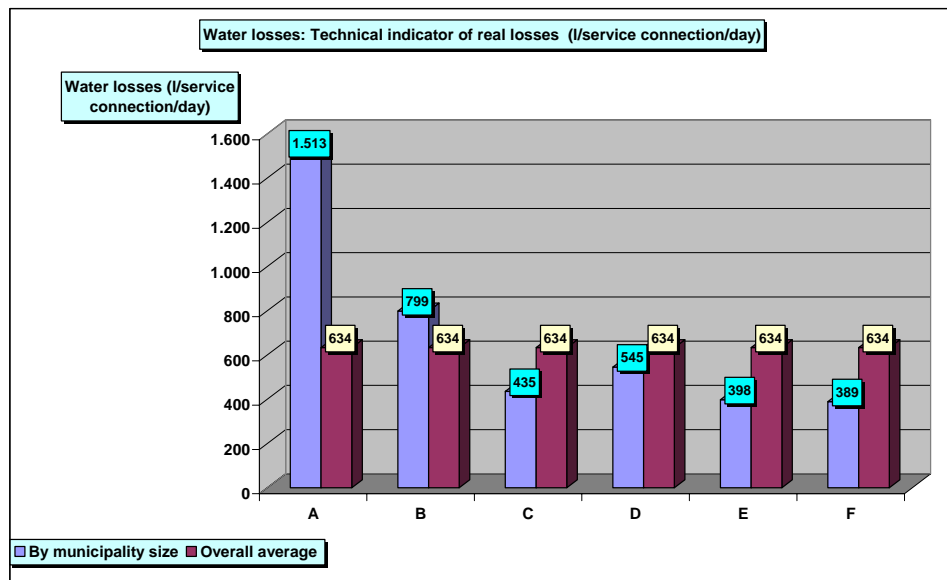
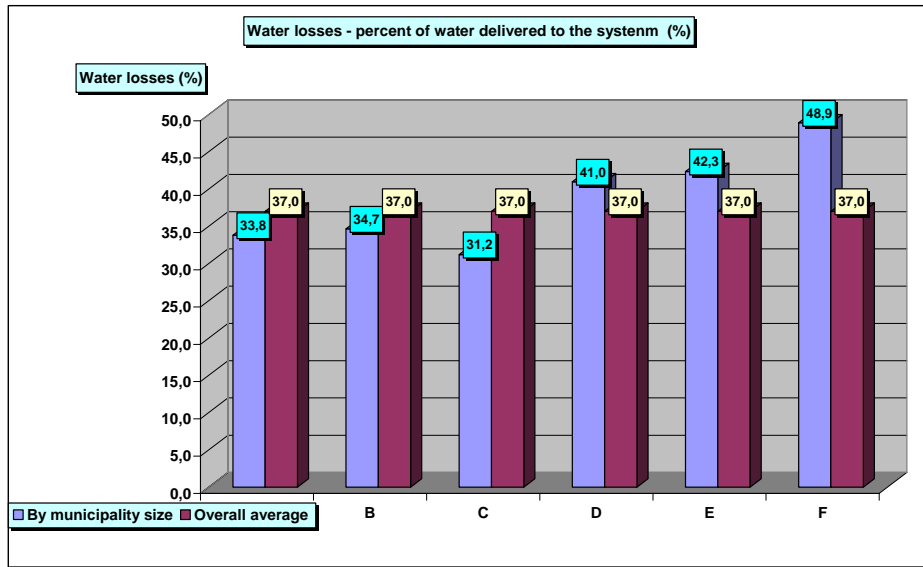
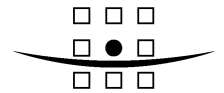
No	Population coverage (%)	Source documentation
1	72% (*)	Statistical Yearbook of Serbia 2004.
2	83,7%, 76 (*)	Global Serbia wastewater study
3	71% (*)	General Study on optimization of use of potable water resources in relation to reduction of water losses in regional water supply systems in Serbia – Draft
4	75%	Water Management Master Plan, 1991 data

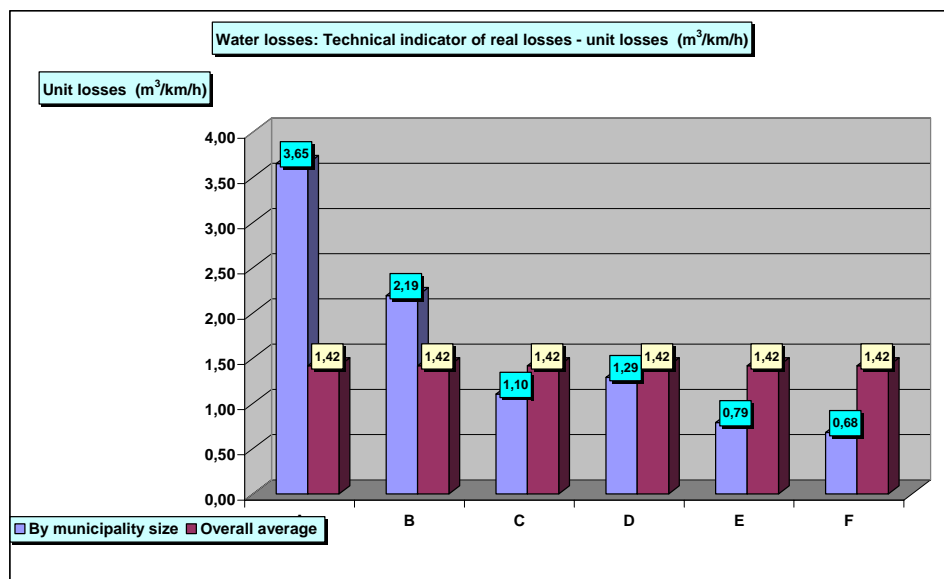
(*) – population coverage refers to percentage of resident population connected to public water supply systems



(2) Water losses

General balances related to water losses were presented earlier in the review. Here is also presented an overview of basic water losses performance indicators identified in the ref. (3).





(3) Unit consumption rates

No	Unit consumption rates (l/capita/day)	Source documentation
1	185	Statistical Yearbook of Serbia 2004 – resident population only
2	170	Global Serbia wastewater study – includes residential population and small enterprises
3	235	Ref. ⁽³⁾ - includes residential population, small enterprises and industrial consumption from public water supply systems

4.2 Wastewater collection, treatment and disposal

4.2.1 General

Current status of the wastewater collection, treatment and disposal in Serbia has been summarized and assessed in three important strategic documents; the Water Management Master Plan of the Republic of Serbia, the National Environmental Strategy of the Republic of Serbia and the Global Serbia Wastewater Study.

Water pollution and water quality problems

In accordance with the ref. ⁽⁴⁾, untreated industrial and municipal wastewater represents one of the key sources of water pollution in Serbia. Based on the 1998 data, about 55% of pollution load discharged to waters originated from the industrial sources, and 45% was municipal sewage (only 13% of municipal sewage is treated prior to discharge). The total BOD₅ load to recipient waters in 1998 was estimated at the level of 289.079 tonnes. The total nitrogen load in 1998 was 42,572 tonnes, and the total phosphorus load was 13.932 tonnes

Table 4.1. Discharges of wastewater in Serbia, 1998¹

Type of wastewater	Wastewater Discharge [000 m ³ /y]	BOD 5 [t/y]	Population equivalent [PE]	Total Nitrogen [t/y]	Total Phosphorus [t/y]
Municipal sewage	405,187	116,592	5,323,858	19,404	5,830
Industrial (BOD dominated)	386,916	159,007	7,263,792	6,454	1,972
Industrial (inorganically dominated)	436,432	13,409	612,285	16,714	6,130
TOTAL	1,228,535	289,079	13,199,935	42,572	13,932

Source: Federal Ministry for Development Science and Environment, 1998

Quality of waters in Serbia is generally low and it is further deteriorating. Examples of very clean water – so called Class I and I/II - are very rare, and are found only in mountainous regions, for example along the Djetinja, Rzav, Studenica, Moravica and Mlava rivers in Central Serbia. The most polluted rivers (with quality outside the classification system) include the Stari Begej, Lugomir, Crnica, Lukavic, and Veliki Lug. The water quality suffers especially from eutrophication caused by nutrients and organic pollutants (due to discharge of untreated sewage and agricultural run-off) and heavy metals. In large rivers (the Danube, Sava, Tisa and Morava) increased bacteriological pollution is found downstream large cities (Belgrade, Novi Sad).

General comments on the status of municipal sewerage systems

In order to separate surface runoff originating from urbanized areas, the concept of so called separate sewerage system has been promoted. However, ever increasing pollution of urbanized areas led to unacceptably high pollutant concentration in rainwater runoff and consequent deterioration of receiving water body water quality. It is quite common that construction of sanitary sewerage precedes stormwater drainage system, resulting in significant portion of urban rainwater runoff being discharged into a sanitary sewerage system, increasing wastewater flows, potentially surcharging the system and creating additional sanitary and health hazards. These systems are grouped in a specific sub-class called mixed sewerage systems, which are neither separate, nor regularly designed and constructed combined systems.

The conditions for treated or untreated communal wastewater discharge are very heterogeneous throughout Serbia, influencing adopted concept of the wastewater collection, treatment and concept.

In general, purely sanitary sewerage systems are being extended and new service connection introduced at the highest rate compared to stormwater drainage and combined sewerage systems. There is a tendency of gradual abandoning the combined sewerage concept and also a lag in construction of new stormwater drainage systems.

Although the sanitary sewerage systems are being constructed at the highest rate compared to other sewerage/drainage systems, this progress still falls behind the construction and extension of potable water supply systems in Serbia.

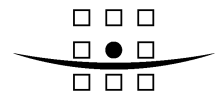
Extensive use of septic tanks, especially in Vojvodina and rural agglomerations not only contributes to increasing level of underground water table (shallow aquifer), but also significantly increases the risks of contamination of the basic aquifer and endangers public health.

The data on the percentage of population being connected to sanitary sewerage system were generated and assessed indirectly, because no explicit statistical data were available.

In accordance with the information presented in the ref. ⁽¹⁾, around 60% of the overall Serbian population was connected to public sanitary sewerage system (data refer to 1991).

However, the information presented in the ref. ⁽⁴⁾ is quite different; sanitary sewerage systems cover only about 33% of the country's population (45% in the urban areas of Vojvodina, 76% in cities of Central Serbia, and about 22% in the rural areas of Serbia; World Bank, 2003) which is far from being adequate environmental protection, and in particular of surface and underground water.

Of the total volume of municipal sewage, about 87% of all municipal sewage is discharge untreated. Much of the sewerage infrastructure has deteriorated over recent years due to lack of maintenance and upgrading (especially, sewage pumping stations are vulnerable to defects often resulting in nuisance and a public health hazard due to spilling of raw sewage). Rural areas mostly rely on inadequate septic tanks for sanitation.



Not all used drinking water is discharged as wastewater into the sewerage system. Potable water is often used in gardens or for agricultural purposes (e.g. watering of plants). In addition, there are losses in the distribution network. Evaporation losses often exist in industrial processes (e.g. in cooling systems), or potable water remains in products (e.g. chemical solutions, pastes etc.). Due to the low level of prices for drinking water in Serbia, the water consumption for these purposes is estimated relatively high.

Figures of the specific wastewater production in Serbian municipalities are not available because of missing measurements. It is expected that between 60 % and 70 % of the supplied drinking water is generated as wastewater. This percentage will rise to 80 %-95 % due to the expected thrifty water use in future. In addition, extraneous water reaches the sewer system caused by groundwater infiltration, faulty connections of surface water in separate sewer systems, connections to water bodies (such as brooks), etc. Reliable data on this are also not available. For further investments in the wastewater sector, it is very important to measure the wastewater quantities.

STATUS OF SEWER SYSTEMS AND TREATMENT OF WASTEWATER

The status of the sewage disposal is shown in the ref. ⁽⁵⁾. In accordance with the survey for the Study, the following results were found (results from 109 of 147 municipalities):

- Approx. 3.1 million (48 %) of the documented inhabitants are connected to a sewage system.
- Approx. 75 % of the total urban population is connected to a public sewage system, while this figure is only 9 % for the rural population.
- The total sewer connection rate is higher than 75 % in only three municipalities (Kragujevac, Novi Sad and Sremski Karlovci), whereas this rate is reported between 50 % and 75 % in 16 municipalities. 90 % of the urban population is connected to sewerage systems in the cities of Bor, Cacak, Kragujevac, Krusevac, Nis and Novi Sad. A total sewer connection rate between 50 % and 75 % for both urban and rural population is reported only for Belgrade and Novi Sad. In all the other municipalities a sewer connection rate of rural population lower than 50 % is found.
- Combined sewer systems are present in 37 % of the investigated municipalities, and 35 % have separated systems. In areas of separated systems, there are mostly sewage pipes. Separate sewerage systems for wastewater and surface water exist in 21 % of municipalities, whereas no responses on the drainage system were given for 7 %.
- Municipalities with less than 25,000 inhabitants are predominantly served by combined sewer systems, whereas separate sewer systems can be found mostly in municipalities with more than 25,000 up to 250,000 inhabitants. Novi Sad is almost exclusively served by combined sewer systems. In the capital Belgrade both sewer systems are in operation in about equal proportion. To date, approx. 7,227 km of sewers have been built. This gives a specific pipe length of about 2.3 m per connected inhabitant.

The highest share of the total sewer length by 40 % was evaluated in municipalities with both combined and separate sewer systems, whereas shares are found for separate systems by about 35 % and for combined systems by about 25 % of the total sewer length.

Information about the sewer conditions were not reported. Most of the sewers were built between years 1971 and 1990 (approx. 65 %). About 17 % of the total sewer length

were built before 1970 and after the year 1990, respectively. This shows that the sewer system in Serbia is relatively young. However, it is suspected that a lot of sewers need rehabilitation.

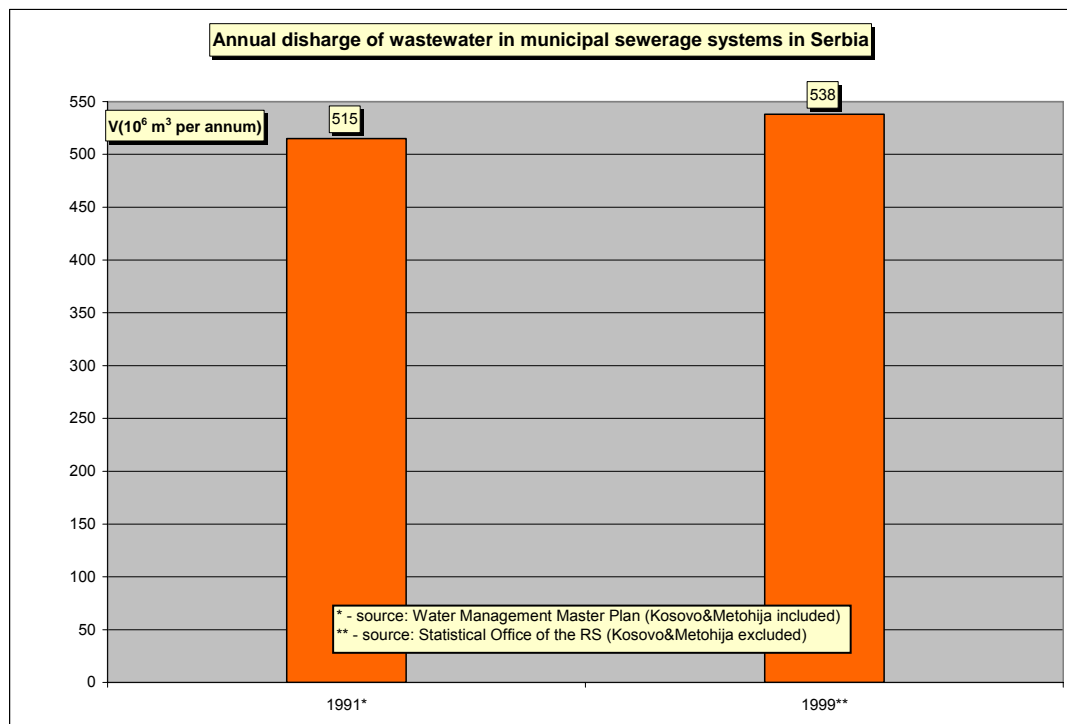
The material used most frequently for wastewater pipes:

- asbestos cement (about 35 %)
- PVC-plastic (about 25 %)
- vitrified clay (about 20 %)
- concrete (about 20 %)

Wastewater treatment plants (WWTPs) exist in 20 of the surveyed municipalities (15 with biological treatment and 5 with mechanical treatment only). In additional 7 municipalities started the construction of WWTPs, thereof 6 plants with a biological process step. 11 municipalities reported the planning of 9 mechanical and 2 biological treatment facilities. Approximately one third of the investigated municipalities have a WWTP or plan the construction. 4 municipalities reported about WWTP construction activities without details. 57 municipalities are discussing the construction of new WWTPs. A biological wastewater treatment plant exists in the municipality of Negotin, which is not in operation since 1990. Approximately 16 % of the population are connected to a WWTP, thereof about 80% to a biological treatment (about 13% of the total population).

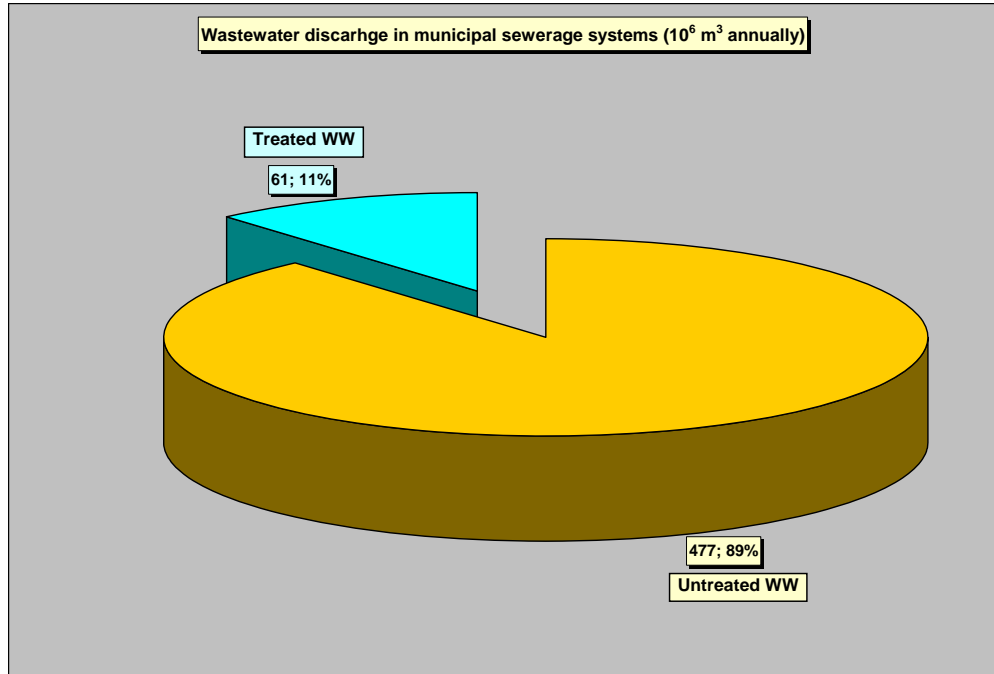
4.2.2 Basic wastewater balances – an overview

Basic wastewater balances shown hereinafter include some historical data (Water Management Master Plan) referring to 1991 and more recent data (1999-2204) published by the Statistical Office of the Republic of Serbia.



It is of particular importance that only 28 municipalities in Serbia have some sort of municipal and industrial wastewater treatment plants (WWTP). The largest municipalities/cities in the country, including Belgrade, Novi Sad and Niš discharge

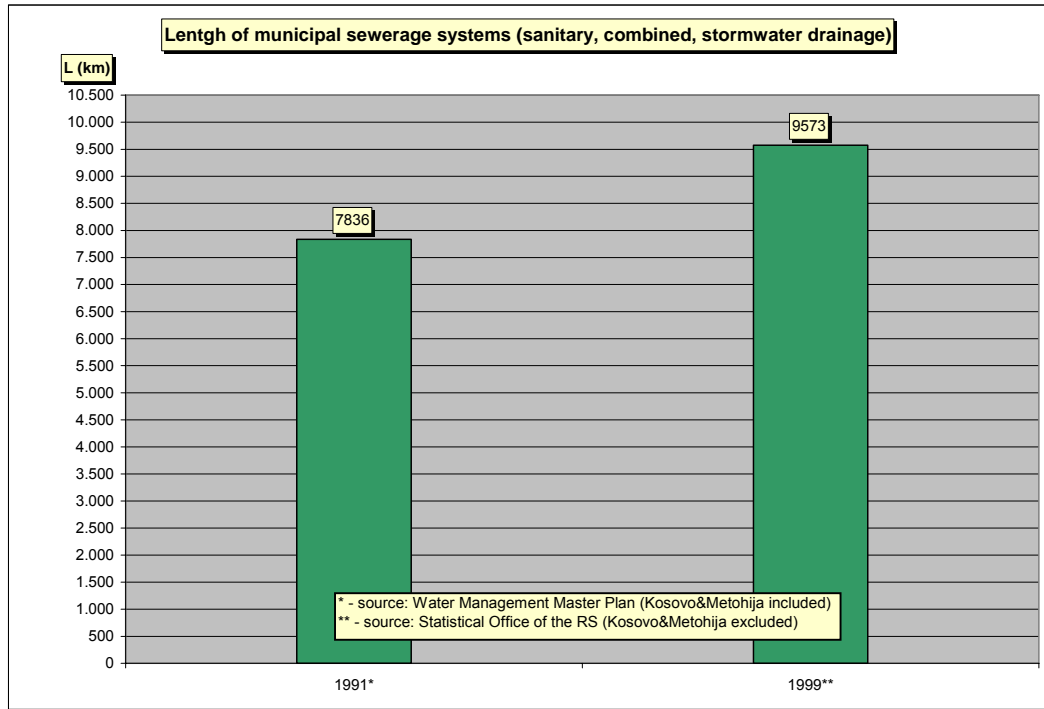
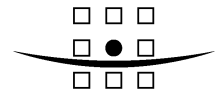
untreated sewage into recipients. Some of the existing WWTP-s are either out of service, or provide primary (mechanical) treatment only and most are not continually operated, due to poor maintenance and lack of financial resources. The result is poor utilization even of the existing facilities. The following graph shows the volumes and corresponding percentages of treated and untreated wastewater that is discharged in the municipal sewerage systems in Serbia.



Wastewater that is being subjected to some sort of treatment (mechanical, chemical, biological and combined) is further classified depending on the treatment applied.

4.2.3 Status of system components – an overview

This section shows a very basic overview of characteristics of municipal sewerage systems in Serbia including collection network and main gravity sewers (sanitary sewerage, stormwater drainage, combined systems).



5 Overview of investments in water supply systems and wastewater collection, treatment and disposal

5.1 Republic of Serbia Funds

In the 2006 Budget Law of the Republic of Serbia (Official Gazette RS, No 106/05) total resources for water management activities are planned to the amount of CSD3.900.000.000 or € 44.5 million: CSD 1.300.000.000 from the Budget and CSD2.600.000.000 from the revenues of the water management: fee for using water, fee for protection of water and fees for concessions from material taken from the river beds.

5.2 International Projects

5.2.1 EBRD Investments in Water Supply Systems and Wastewater collection, treatment and disposal

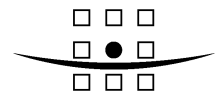
During previous five years the EBRD had several investments in water supply systems and wastewater collection, treatment and disposal.

Type of investment	Project name	Sub project	Description	Sector	Portfolio class	Year of signing	Project value (€000)	Loan (€000)	Equity (€000)	Guarantee (€000)	Total EBRD finance (€000)
Direct investment	Belgrade municipal infrastructure reconstruction programme	-	Improvement of urban transport, water supply, waste-water treatment and district heating services.	Infrastructure	State	2001	78,671	40,000	0	0	40,000
Direct investment	City of Kragujevac municipal infrastructure reconstruction programme	-	Supply and installation of consumer meters, improvements to water supply distribution system and waste-water collection network.	Infrastructure	State	2002	6,743	3,963	0	0	3,963
Direct investment	City of Nis municipal infrastructure reconstruction programme	-	Purchase of sewer cleaning equipment and completion of city water main ring.	Infrastructure	State	2002	12,190	6,000	0	0	6,000
Direct investment	City of Novi Sad municipal infrastructure reconstruction programme	-	Improvement to waste-water collection and treatment.	Infrastructure	State	2002	5,818	1,938	0	0	1,938
Direct investment	City of Subotica municipal infrastructure reconstruction programme	-	Modernisation of waste-water treatment plant.	Infrastructure	State	2004	14,000	9,000	0	0	9,000

5.2.2 The World Bank

The Government of the Republic of Serbia together with the World Bank is preparing three initiatives within the water sector of Serbia.

- The Serbia Danube River Enterprise Pollution Reduction Project (which would comprise a US\$ 6 million Global Environment Fund [GEF] Grant) is intended to increase prevalence of environmentally friendly practices among eligible enterprises and thereby reduce nutrient pollution of the Danube River. The project is also intended to support implementation of the guiding principles of the EC Water framework Directive in Serbia.
- The Water Resource Management Project (which would comprise a US\$30 million International Development Association [IDA] loan and a US\$5 million borrower contribution) is intended to (a) to reduce the risk of damage to land, crops, property and infrastructure from flooding; (b) to increase agricultural productivity through support to high priority rehabilitation of drainage and irrigation infrastructure; and (c) to improve water resources management and strengthen the associated water resource management institutions and policies.



- The Municipal Water and Sanitation Project (which would comprise a US\$20 Million International Development Association [IDA] loan, a US\$20 Million International Bank for Reconstruction and Development [IBRD] loan and a borrower contribution) is intended to improve safety and reliability of the water supply and sanitation services in selected towns and rural areas.

5.2.3 EU funded Project: Capacity Building in the Water Sector - €9.2 million

The specific objectives of the project are:

- Implementation of the guiding principles of the Water Framework Directive throughout Serbia.
- Increased availability of reliable water quality monitoring results.
- Provision of conditions for increased investment in wastewater treatment and sewerage, and protection of watercourses.

Budget by project components:

- Capacity building for the Directorate of Waters - € 2.2 million
- Development of a Water Resource Information Management System for the Water Directorate as well as preparation of a Wastewater and Sewerage 'Master plan' and an action plan for the remediation of 'hotspots' - € 5.7 million
- Supply of equipment for water monitoring/ testing - € 1.6 million

5.2.4 Other donors' contribution

After a four-year environmental campaign in Serbia, the United Nations Environment Programme (UNEP) has cleaned up two post conflict hot spots (Kragujevac and Novi Sad) and significantly reduced concerns about two others (Pancevo and Bor). "As a result fresh drinking water has been secured for tens of thousands people, hundreds of tons of hazardous waste has been taken away for treatment and environmental management capacities strengthened", UNEP stated. The US\$ 12.5 million (EUR 10.4 million) UNEP programme was created in the aftermath of the Kosovo war as the first UN-led clean-up of conflict-induced, environmentally hazardous areas, focusing especially on depleted uranium. The programme is officially being transferred to the Serbian government.

A number of bilateral donors are providing specific assistance to the upgrading of the water sector in Serbia: Greece is supporting the strengthening of a dam; Germany is supporting the rehabilitation of water supplies and wastewater treatment; the Czech Republic is supporting technical assistance for the improvement of water resources in Valjevo and a risk assessment of the danger of oil intrusion to the River Ibar; Norway is supporting the protection of water quality in the Grand Canal at Vrbas.

6 Design criteria

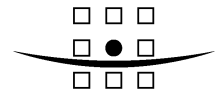
This section presents key water quality and other design criteria incorporated in corresponding laws and regulations currently being in force in the Republic of Serbia.

6.1 Water quality criteria

6.1.1 Potable water

Water quality parameters, monitoring, analysis, disinfection and other related aspects for high quality water intended for potable water supply has been governed by the following laws, regulations and standards, and also dealt with in the corresponding strategic documents on the national level.

- (1) Draft National Environmental Strategy of the Republic of Serbia, Directorate for Environmental Protection, Ministry of Science and Environment, EAR, 2005
- (2) Water Act with Supplements and Amendments, Official Gazette of the Republic of Serbia, 46/91, 53/93, 48/94, 54/96 – Regulating water protection, water use and management, protection from detrimental effects of water, implementation, organization and financing of water management, and control of Water Act practical implementation. - Annex
- (3) Water Management Master Plan of the Republic of Serbia 2021, Ministry of Agriculture and Water Management, 2001
- (4) Rulebook on disinfection and inspection of potable water, Official Gazette of the Republic of Serbia, 60/81 – Prescribes the procedures of systematic disinfection of water intended for potable water supply, scope, types and methods of inspection of water, structures and facilities used for potable water supply.
- (5) Rulebook on dangerous substances in water, Official Gazette of the Republic of Serbia, 31/82 – Defines dangerous substances that must not be found in water.
- (6) Rulebook on prerequisites for companies carrying out water analysis (surface, underground waters, wastewater), Official Gazette of the Republic of Serbia, 41/94 – Prescribes conditions to be fulfilled by the companies carrying out examination of water (surface, underground, wastewater) in terms of human resources, equipment, premises and other.
- (7) Provision on zones of sanitary protection for potable water sources in the area of the City of Belgrade, Official Gazette of the City of Belgrade, 8/86 – Defines the boundaries of the Belgrade potable water sources sanitary protection zones.
- (8) Provision on companies that fulfil prerequisites and conditions for carrying out water quality examinations (surface, underground, wastewater), Official Gazette of the Republic of Serbia, 16/91 – Lists companies that were assessed as fulfilling all prerequisites and conditions for performing examination of surface, underground and wastewater.
- (9) Law on fluoridation of water for potable purposes, Official Gazette of the Republic of Serbia, 38/94 and 25/96
- (10) Rulebook on water quality criteria for potable water, Official Gazette of the FRY, 42/98 – Prescribes water quality criteria for potable water. – Annex



ROYAL HASKONING

- (11) Guideline on sampling and laboratory methods for potable water analysis,
Official Gazette of the SFRY, 33/87

6.1.2 Wastewater collection, treatment and disposal

This section presents the laws, regulations, standards and strategic documents in the area of communal wastewater collection, treatment and disposal in the Republic of Serbia.

- (1) Draft National Environmental Strategy of the Republic of Serbia, Directorate for Environmental Protection, Ministry of Science and Environment, EAR, 2005
- (2) Water Act with Supplements and Amendments, Official Gazette of the Republic of Serbia, 46/91, 53/93, 48/94, 54/96
- (3) Water Management Master Plan of the Republic of Serbia 2021, Ministry of Agriculture and Water Management, 2001
- (4) Ordinance on categorisation of water courses, Official Gazette of the Republic of Serbia 5/68 – Ranks water courses and lakes into classes and subclasses in accordance with the Ordinance of categorisation of waters.
- (5) Ordinance on categorisation of waters, Official Gazette of the Republic of Serbia 5/68 – Defines, in accordance with pollution level and recommended/intended usage four basic classes of water.
- (6) Guidelines generated and introduced by the local municipal or city authorities defining maximum permissible concentrations for different wastewater constituents/pollutants in communal and industrial wastewater to be discharged into a municipal sanitary sewerage system.

Hereinafter are presented the extracts and articles from the abovementioned and other relevant laws, regulations, guidelines and standards that are of particular relevance to the area of communal wastewater collection, treatment and disposal.

Water Act – Article 59

POC-s, other companies and legal entities discharging wastewater into recipients or public sewerage system are obliged to install a wastewater discharge measuring device, to measure and keep records on wastewater discharges, and all corresponding records submit to a State Water Management Company. Companies and other legal entities that possess wastewater treatment facilities and measuring devices are obliged to keep them in good working order, provide their regular operation and keep records on operation of wastewater treatment facilities. The abovementioned companies and legal entities are also obliged to provide analysis of wastewater being discharged, and of their influence on a recipient.

Ordinance on categorisation of waters - Article 4

Categorization of waters into classes and sub-classes is carried out based on water quality parameters and their maximum allowable concentrations, as shown in the following table.

Categorization of waters

	Parameter	Class I	Class II	Sub-class IIa	Sub-class IIb	Class III	Class IV
1	Suspended matter, dry-weather flow (mg/l)	10	30	30	40	80	-

2	Total dry residual during dry weather (mg/l)						
	-surface waters and natural lakes	350	1000	1000	1000	1500	-
	-underground water	800	1000	1000	1000	1500	-
3	pH	6,8-8,5	6,8-8,5	6,8-8,5	6,5-8,5	6-9	
4	Dissolved oxygen (mg/l) – not applicable to underground water and natural lakes	8	6	6	5	4	0,5
5	BOD ₅ (mg/l)	2	4	4	6	7	-
6	Stepen saprobnosti after Libman – not applicable to underground water and natural lakes	?	?	?	?	?	-
7	Rate of biological productivity – applicable to lakes only	?	?	?	-	-	-
8	Most probable number of coliforms	200	6000	6000	10000	-	-
9	Visible waste matter	without	without	without	without	without	without
10	Colour	without	without	without	without	-	-
11	Odour	without	without	without	without	-	-

Underground waters not being specifically categorized in the Ordinance on categorisation of water courses ⁽³⁾ shall be classified in accordance with the parameters and their limit values shown in the previous table.

The aforesaid parameters and their limit values are applied to the following waters/discharges:

- For non-regulated water courses; for average monthly low discharge of 95% reoccurrence;
- For regulated water courses; for guaranteed low discharge;
- For underground water; for all flows;
- For lakes; for unfavourable regimes of mixing of waters (surface formation of ice, in critical summer months);

In line with the Ordinance on categorisation of water courses the essential requirement is that any discharge of treated/untreated wastewater must be carried out in a way not to imperil specified category of the corresponding recipient.

6.2 Relations to relevant EU regulations

6.2.1 Potable water criteria

Required quality of water used for public water supply or for processing/production of foods intended for sale to the public is regulated by the Rulebook on water quality criteria for potable water, Official Gazette of the FRY, 42/98 – Annex 1.

It could be generally conclude that the Serbian standards regarding quality of water intended for human consumption is comparable to the corresponding EU regulations (Council Directive 98/83/EC concerning quality of water for human consumption – Annex 2).

The reference (1) includes a comparative overview of key water quality parameters in Serbian and EU regulations regarding quality of water for human consumption.

Parameter	Units	Serbian standards	EU standards
Colour	mg/l Pt/Co	10,0	20,0
KMnO ₄	mg/l	8,0	5,0
Nitrites	NO ₃ mg/l	45,0	50,0
Ammonia	NH ₄ , mg/l	0,10	0,50 (N)
Iron	Fe, mg/l	0,30	0,20
Manganese	Mn, mg/l	0,05	0,05
Zink	Zn, mg/l	5,0	
Arsenic	Ar, mg/l	0,05	0,05
Cadmium	Cd, mg/l	0,005	0,005
Cyanides	Cn, mg/l	0,050	0,050
Chrome	Cr, mg/l	0,050	0,050
Mercury	Hg, mg/l	0,001	0,001
Lead	Pb, mg/l	0,005	0,005
Total coliforms	n / 100 ml	0,000	0,000

6.2.2 Wastewater discharge criteria

The Council Directive 91/271/EEC concerning urban wastewater treatment and its annexes concerns collection, treatment and discharge of urban wastewater and the treatment and discharge of wastewater from certain industrial sectors in the EU.

3.1.5

3.1.6 So far no equivalent national standard/regulation has been adopted in Serbia, with essential guidelines regarding wastewater discharge still relying on the articles of the Ordinance on the categorization of waters (OGRS 5/68).

3.1.7

3.1.8 However, the attempt was made to harmonize the Serbian regulations regarding wastewater collection, treatment and discharge with the abovementioned EU Directive. As a result the draft Guidelines on conditions for discharge of wastewater to surface waters were prepared for the Ministry of Agriculture and Water Management in 2003. It was recommended that these Guidelines were respected until the corresponding national guideline is established. The aforesaid guidelines comply with the aforesaid 91/271/EEC directive (Annex 3).

3.1.9 6.2.3 Adaptive development towards EU regulations and laws

Basically, it is intended that Serbian laws be adapted towards EU guidelines. The Serbian Government stressed that their primary duty and responsibility is not only to stop the collapse of institutions that have existed for several decades, but also to create an institutional and constitutional framework that will eventually secure stable progress for Serbia. The government will introduce a common system of environmental and natural resources protection and take urgent legal measures to bring it up to European Union standards.

On 23 October 2000, the "Directive 2000/60/EC of the European Parliament and of the Council establishing a framework for the Community action in the field of water policy" or short the EU Water Framework Directive (WFD) was finally adopted. The key aims are:

- expanding the scope of water protection to all waters, surface waters and groundwater,
- achieving "good status" for all waters by a set deadline,
- water management based on river basins,
- "combined approach" of emission limit values and quality standards,
- getting the prices right,
- getting the citizen involved more closely,
- streamlining legislation.

The current Law on Water of the Republic of Serbia regulates the protection of waters, protection from the detrimental effects of waters, utilisation of and management with the water as a wealth of general concern, conditions and ways of doing the water management and inspection over the implementation of regulations of this law. The regulations of this law addresses on all surface and ground waters, including drinking

water, thermal and mineral waters, as well as the boundary and trans-boundary water courses, both those between the Republic of Serbia and Republic of Montenegro, and those between the Republic of Serbia and other countries in the vicinity, except it is not otherwise issued by other legal acts.

The law regulates that waters can be used only in a way that does not threaten their natural characteristics, does not endanger the life and health of people, does not threaten the wild plant and animal species, natural wealth and immobile cultural wealth.

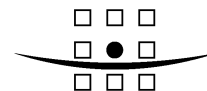
According to The Law on Water of the Republic of Serbia, three water regions have been established: the river Danube water region, the river Sava water region and the river Morava water region. Basic activities of the State Water Management Companies JVP Srbijavode and JVP Vode Vojvodine are water management, water conservation and protection from waters in their areas of responsibility. This refers to both, surface and ground waters, including potable, thermal and mineral water, too.

The water management in Serbia, since 1992, has been under the exclusive control of the central authorities of Serbia, without the influence on its operations of the districts, municipalities or water users. This shows also the centralised responsibility of JVP Srbijavode and JVP Vode Vojvodine.

According to the EU Water Framework Directive, the best model for a single system of water management is management by river basin - the natural geographical and hydrological unit - instead of according to administrative or political boundaries. For each river basin district - some of which will traverse national frontiers - a "river basin management plan" will need to be established and updated.

Further to this Directive, "Public Participation" is a key element in integrated water management. There are two main reasons for an extension of public participation. The first is that the decisions on the most appropriate measures to achieve the objectives in the river basin management plan will involve balancing the interests of various groups. The economic analysis requirement is intended to provide a rational basis for this, but it is essential that the process is open to the scrutiny of those who will be affected. The second reason concerns enforceability. The greater the transparency in the establishment of objectives, the imposition of measures, and the reporting of standards, the greater the care states will take to implement the legislation in good faith, and the greater the power of the citizens to influence the direction of environmental protection, whether through consultation or, if disagreement persists, through the complaints procedures and the courts.

According to the current Water Law, the protection of waters from the pollution is conducted by bans, limitations and preventions from introducing of the pestious and dangerous materials, by regulating and undertaking other measures for the preservation and improvement of the water quality. Measures for the water protection are carried out in order to enable the non-harmful and undisturbed utilisation of waters, human health protection, protection of the wild flora and fauna and environment protection. The financial means for the water management affairs are provided from the fees for melioration, irrigation, water usage, water protection, for the sand and gravel taken out from the water courses, and for the utilisation of water management facilities. The Ministry of Agriculture, Forestry and Water Management is due to carry out the inspection over the implementation of this law's regulations by water management inspectors.



Owing to the common interests for clean water it is necessary to organise the water management with additional decentralised structures on district and municipal level. However, the trans-boundary aspect of river basin management required also regulations for close co-operation and certain centralised responsibilities.

It is necessary to establish intensive co-operation with international organisations dealing with water management issues, as well as the intensive co-operation with the neighbouring countries sharing the same water resources.

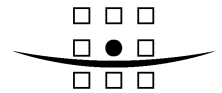
The principles of environmental financing in Serbia were laid out by Law on Environmental Protection. The law advocates the “polluter pays” principle. Industries or individuals that are the source of air, soil, and water pollution, or cause damage to natural resources, are under obligation to adjust their activities by adopting appropriate technology or by taking remediation measures so that their environmental impact is limited to permissible levels set forth by regulations. All these activities are to be financed from the enterprises’ own resources. The law also defines in broad terms the types of activities that may be funded using public resources.

However, the law stipulates public funding of activities that are not in line with the “polluter pays” principle. In particular, “creating co-financing of investments capable of substantially reducing environmental pollution” should be mentioned. Rather, what is needed also for wastewater is an effective wastewater management system in which polluting industries are induced to take remediation and mitigation measures. In reality, in Serbia the “polluter pays” principle is rarely implemented.

In 2000, Serbia had the complete disharmony with the EU laws and an uncontrolled usage of natural resources. Since then, the Serbian Government has made strenuous efforts to change the situation. The National Waste management Strategy has been adopted, as one of the first strategies, which has the programme of accession to the EU.

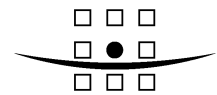
The new Draft Law on System of Environmental Protection in Serbia has been prepared with support of the international community by the former Ministry for Protection of Natural Resources and Environment in May 2002. The protection of human’s and citizen’s rights on the healthy environment, conservation of nature and its resources, as well as the wealth that are of general concern, and the further development of the community by utilisation of resources in the way that provides their preservation are the principles the Draft Law lies on. It would bring Serbia closer to the EU standards, in a manner which is adjusted to the needs of Serbian citizens, and would bring new investments into the country.

In connection with the new creation of the government in spring 2004, the tasks of the Ministry for Protection of Natural Resources and Environment were transferred to the newly established Ministry of Science and Environment Protection, specifically to the Directorate for Environmental Protection. Unfortunately, the parliamentary ratification procedure for the new Draft Serbian Law on the System of Environmental Protection that was being prepared by the Ministry for Protection of Natural Resources and Environment was discontinued. To sum up, we can say that current state is characterised by laws governing this field that are mostly obsolete and not efficient. Furthermore, the enforcement of present legislation is rather weak. The “polluter pay” principle is not enforced. Local legislation is not harmonised with relevant EU legislation (e.g. Water Framework Directive). Serbia is continuing to integrate environmental



concerns into other policies Changes toward EU harmonisation and decentralisation are ongoing.

- The Water Law will be adapted to the EU Water Framework Directive. This new law will be prepared in order to introduce the requirements of the Water Framework Directive into its national legislation.
- The new Law on Local Self-Government was adopted in early 2002.



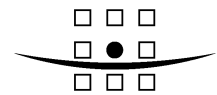
6.3 Other design criteria

This is an overview of some of the basic design criteria in the water and wastewater sector in Serbia defined in relevant regulations and guidelines, or as commonly applied, recommended, engineering practices.

WATER DEMAND PROJECTIONS			
Component	Design Criteria		
Population and Growth projections	Population		
	Based on the recorded demographic trends, the National Urban Master Plan and municipal Urban Master Plans, where availabl.		
Average unit consumption rates [Q _{av}]	Average water demand (based on production/consumption records and corresponding recommendations)		
	Reference, description	Unit consumption rates [Q]	
	WMMP–(resident population demand, institutional demand, industry, losses)–urban population	Q= 600 l/capita/day	
	WMMP–(resident population demand, cattle, losses)–rural population	Q= 400 l/capita/day	
	Positive EU engineering practices – resident population only	Q= 150 l/capita/day	
Maximum daily demand [Q _{maxd} =k _{maxd} *Q _{av}]	Maximum daily demand Factor – depends on the size of urban agglomeration		
Peak hour demand [Q _{hmax} =k _{hmax} * Q _{av}]	Maximum hour demand Factor – depends on size and characteristics of urban agglomeration and consumer type		
Fire fighting demand Q _{ff} [l/s]	Depends on the size of urban agglomeration		
	Population	No of concurrent fires	Q (l/s) per fire
	Up to 5.000	1	10
	5.000 – 10.000	1	15
	10,000 – 25,000	2	20
	25.000 – 50.000	2	25
	50.000 – 100.000	2	35

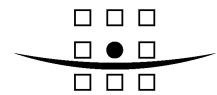
	1.000.000 – 2.000.000	4	90

WATER TRANSPORT AND DISTRIBUTION SYSTEM	
Component	Design Criteria
RESERVOIRS	
Ground water tanks (GWT)	Volume should be sufficient to balance, on a daily basis, water inflow (from water source, treatment plant) and further transfer – to transmission mains, distribution, plus fire-fighting volume.
Elevated water tanks (EWT)	Volume to balance demand fluctuations in the network plus fire-fighting volume – generally 30-40% of the maximum day demand.



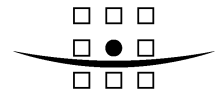
	TRANSPORT
Suction pipes	Diameter sizing according to the pump NPSH. Net positive suction head. Recommended $V \leq 1.0$ m/s
Pumps	Capacity (Q, H) Q=required water demand $H = h_{st} + H_f + (3 - 5m)$. Variable running speed module for distribution without EWT One stand by pump 25% to 100% not less than 1.
Utilities (fittings) downstream the pump	Minimum selection as following: Gate valve Non-return valve Flow meter Pressure gage Sampling tap Air valve
Roughness coefficient	According to the pipe specification and formula
Transport line	Max velocity (v_{max}) of water $v_{max} < 2.5$ m/s, $V_{min} \geq 0.6$ m/s. Materials: DI or plastics. Consideration must be taken for aggressive soil and economic comparison. Double air ventilation valves (DAV) to the peak points and/or according to the water hammer study. Single Air ventilation valves located on the rising distance of 500 – 1000 m if there are no DAV. Wash-outs (WO) at the low points. Gate valves (isolation valves) distance shall be less than 5.0 km. Minimum pressure 5 meters above the peak point. Parallel lines if the future need is more than the existing can carry on. Pipeline corridor must be wide enough for the future construction. Construction of two lines can be divided to two stages.

	DISTRIBUTION
	Pressure head
Minimum head	15 mwc, 1,5 bar for defined duration during the day (0,5 h)
Maximum head	50 mwc, 5,0 bar
Minimum head – fire-fighting requirement for both internal and external hydrants	25 mwc, 2,5 bar (external network, or internal on the top floor)
	Network pipelines and utilities
Distribution lines DN > 100mm	Max velocity (V_{max}) of flow <2.5 m/s (recommended) Min velocity (V_{min}) of flow >0.6 m/s (recommended) Pipe materials DN150–400mm – plastics (recommended) Pipe materials DN>400mm – DI, ST (recommended) Consideration must be taken for aggressive soil and underground water,



	economic comparison. No house connections on lines DN≥300mm (recommended) Trust blocks according to the design pressure and soil characteristics.
Secondary distribution lines DN <100mm	Max velocity (V_{max}) of flow <1.5 m/s. Min velocity (V_{min}) of flow >0.1 m/s. Pipe materials – plastics (recommended) Trust blocks according to the design pressure and soil characteristics.
Fire-fighting requirements	DN to satisfy pressure and flow requirements, but for external hydrant network not less than 100mm.
Water meters	Must be installed on all service connections
Cover depth	Under traffic area ≥ 1.0 m Outside traffic area ≥ 0.8 m The cover depth must follow the manufactures recommendations and protection requirements (external forces, frost protection).
Gradient	Not less than 0.1 %

SEWAGE COLLECTION SYSTEM	
Component	Design Criteria
Average sewage flow [$Q_{av\ sew}$]	Based on the Average water demand as follows: $Q_{av\ sew} = (0,75-0,90) * Q_d$
Peak sewage flow [$Q_{max\ sew}$]	Based on the Peak hour water demand or applicable formulae (Harman, Fedorov, Babbitt, ...) $Q_{max\ sew} = (0,75-0,90) * Q_{hmax}$
Self cleaning criterion	Self cleaning velocity ≥0,75-0.80 m/s for pipe flowing full DN<500mm, $Q_{max}/Q_f = 80\%$ $d/D = 0.5$ DN≥500mm, $Q_{max}/Q_f = 90\%$ $d/D = 0.58$
Roughness coefficient	According to the pipe specification and formula (Manning, ...).
House connections	Min. size Ø 150 mm, material is plastic, min slope within a range of 1 – 2 %. If the connection distance is more than 50 m, the pipe size shall be Ø 200 mm
Laterals	Size Ø 200 ... 300 mm, material is plastic, min slope according to the self cleaning criterion.
Sewer sub-mains	Size Ø 300 ... 400 mm, material is plastic, min slope according to the self cleaning criterion.
Sewer mains	Size Ø 400 ... 2000 mm, material is plastic or GRP for the aggressive soil conditions, min slope according to the self cleaning criterion.
Cover depth	According to the pipe material and manufacturers recommendation. Bedding and embedding shall be done of sand or fine gravel, in compacted layers. Sewers must be installed below the water supply pipes, or in accordance with protection requirements.
Manholes	For house connections Ø 800 mm, opening 600x600 mm for the system manhole diameter 1200 mm, opening Ø 600 mm. Materials: concrete or for the aggressive soil conditions plastic or GRP. Manhole cover in accordance with the road category: cast iron or DI, heavy duty or for light traffic.



	<p>Inspection manholes will be located at:</p> <ul style="list-style-type: none"> • change of direction • change of slope • change of pipe diameter • change of material • beginning of each line • at points of branches <p>Manholes distance: 40–60m, DN≤400mm, 60-120m DN>400mm.</p>
Pumping Stations	<p>Located to the lower points of the network, but away from public and flood-prone areas. Overflow is not allowed.</p>
Pressure sewers	<p>Max velocity (V_{max}) of flow <2.0 m/s.</p> <p>Air ventilation valves (AV) to the peak points and/or according to the water hammer study.</p> <p>Sewer from the discharge manhole shall be dimensioned according to the flow from the pumping station.</p> <p>Wash-outs (WO) should be avoided.</p>

7 National policies and strategies

This chapter presents basic national policies and strategies in the area of water supply and sanitation incorporated in the corresponding national strategic documents.

7.1 Water supply

The National Environmental Strategy formulates the priority environmental policy objectives related to water quality, water resources, and hence to drinking water supply:

(1) Short-term policy objectives 2005-2009

- (a) To harmonise the national water management legislation with the EU Water Framework Directive 2000/60/EC;
- (b) To establish protection zones for all current and planned water supply sources;
- (c) To harmonise national institutional competences for integrated water management
- (d) To adjust the drinking water standards to requirements of the Drinking Water Directive 98/83/EC by 2007 To ensure sustainable use of groundwater aquifers;
- (e) To improve standards and efficiency of laboratories for water quality monitoring;

(2) On-going policy objectives 2005-2014

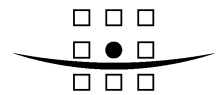
- (a) To ensure that drinking water in urban areas meet quality standards of the Drinking Water Directive 98/83/EC, and to extend the centralised water supply to selected rural areas with the most unsatisfactory water quality;

(3) Medium-term policy objectives 2010-2014

- (a) To achieve rational water consumption by individual users

In accordance with the Water Management Master Plan of the Republic of Serbia general status of the water supply in Serbia can be summarized as follows:

- (1) In terms of available water resources for drinking purposes (quantities) current status is unfavourable with no sufficient resources available. With regard to water quality of the resources, current situation is assessed as even more unfavourable.
- (2) Water supply shortages and supply cuts are regularly recorded in municipalities throughout Serbia, in particular during summer months which coincide with peak demand and minimum available capacities of springs and other sources.
- (3) It was observed that in many cases population uses water which is in terms of water quality (physical and chemical parameters) does not satisfy potable water standards in continuity. Micro-biological non-compliance of water used for drinking purposes was frequently observed, as well.



- (4) Widespread misuse and irrational use of available drinking water resources (watering of gardens, agricultural use, unnecessary industrial use of potable water.
- (5) Very high rates of unaccounted water (so called technical and administrative water losses)

Further to the abovementioned problems in water supply, it was recommended to proceed with and intensify revitalization and extension of the existing water supply schemes primarily to improve water quality parameters in the water supply systems and bring them into accordance with relevant local and European regulations and standards.

Water supply objectives in accordance with the Water Management Master Plan of the Republic of Serbia by 2021:

- (1) To provide water supply from public water supply systems for 90% of the population;
- (2) To provide specified unit consumption rates – for urban population 600 l/capita/day (including population itself, industries, institutional and public demand, losses) and for rural population 400 l/capita/day (population, cattle, public, losses);
- (3) Based on the abovementioned unit rates and demographic trends the total water demand was calculated for municipalities throughout Serbia;
- (4) Water sources – pollution prevention and protection, rehabilitation required, regional approach recommended;
- (5) Water treatment facilities – construction, rehabilitation and upgrade necessary wherever water does not meet standards – compliance with local and European standards compulsory;
- (6) Water distribution – rehabilitation and development, measurement, monitoring and control to be introduced;
- (7) Water resources allocation plan outlined – balances and spatial distribution;

7.2 Wastewater collection, treatment and disposal

In accordance with the National Environmental Strategy the priority environmental policy objectives related to water quality, water resources from the prospective of wastewater collection, treatment, disposal and reuse are defined as follows:

(1) Short-term policy objectives 2005-2009

- (a) To harmonise the national water management legislation with the EU Water Framework Directive 2000/60/EC, and introduce emission limit values for effluent discharges according to the Urban Wastewater Treatment Directive 91/271/EEC;
- (b) To establish protection zones for all current and planned water supply sources
- (c) To harmonise national institutional competences for integrated water management
- (d) To improve standards and efficiency of laboratories for water quality monitoring

(2) On-going policy objectives 2005-2014

- (a) To improve water quality in water courses by reducing discharges of untreated industrial and municipal wastewater
- (b) To provide primary and secondary wastewater treatment in agglomerations above 100,000 population equivalent (Excluding agglomerations discharging directly to large water bodies (Danube, Sava), where wastewater treatment plants will be completed after 2014);
- (c) To extend sewerage system in agglomerations above 100,000 population equivalent to cover 90% of their population by 2014

(3) Medium-term policy objectives 2010-2014

- a. To adjust the bathing water quality standards to the Bathing Water Directive 76/160/EEC by 2012
- b. To ensure environmentally and technically sound reuse or disposal of sewage sludge from WWTP-s
- c. To achieve rational water consumption by individual users

The Water Management Master Plan of the Republic of Serbia specifies the basic for action plan and measures in the area of wastewater collection, treatment, disposal and reuse:

- Development of wastewater systems must be carried concurrently with extension of water supply systems;
- The deadline must be introduced for construction of municipal wastewater treatment facilities for urban agglomerations of certain size;
- In general, an integral approach is recommend in planning municipal and industrial wastewater treatment facilities;
- The limit size of the settlement for the first stage protection measures should be defined;
- Minimum urban wastewater effluent standards should be defined for non-sensitive and sensitive areas;
- Toxic industrial wastewater must be treated prior to discharging into a sanitary sewerage systems and effluent quality must be in accordance with set standards;
- Rehabilitation of industrial wastewater treatment facilities should reduce effluent quantities, introduce reuse of treated wastewater and improve effluent quality;

- Adequate landfills for safe disposal of sludge originating from wastewater treatment plants;
- Potable water sources protection by introduction of sanitary sewerage network and appurtenant elements in urban agglomeration

A special set of measures is prescribed in order to improve monitoring, control and performance of wastewater treatment facilities:

- Control of WWTP-s performance, operation and maintenance in relation to the original design criteria, discharge permits and instruction manuals;
- Improvement of plant management and maintenance, remedying observed deficiencies;
- Rehabilitation and extension;
- Reduction of hydraulic and pollutant loading;

Priorities and instructions for construction of wastewater treatment facilities are formulated as follows:

- Location of sources of pollution in relation to sensitive areas (for such areas so called tertiary treatment is compulsory);
- Location in a catchment area;
- Toxicity of influent;
- Effects of pollution source on overall catchment/water course pollution;
- Feasibility of treatment of municipal and industrial wastewater on common facilities;
- Coverage of urban areas by sanitary sewerage system;
- Coverage of industries by industrial wastewater treatment;

The priority measures are ranked as follows:

Phase I

- Rehabilitation of the existing wastewater treatment facilities;
- Erection of treatment plants for toxic industrial wastewater;
- Construction of wastewater treatment plants for large pollution sources affecting sensitive areas
- Erection of wastewater treatment plants for large and medium pollution sources (>15.000PE) with significant effect on catchment water quality

Phase II

- Construction of WWTP-s for pollutants significantly affecting the recipient water quality

Phase III

- Construction of WWTP-s for all settlements with population over 5.000 PE, and other settlements with public water supply and sanitary sewerage systems;

Basic effluent standards incorporated in the Water Management Master Plan include:

- For point organic pollutants sources (settlements and bio-degradable industrial wastewater) secondary biological treatment is prescribed with effluent BPK_5 of up to $20 \text{ g O}_2/\text{m}^3$. Only in specific circumstances tertiary treatment with nitrification and denitrification is required. Effluent BPK_5 for WWTP-s for inorganic wastewater should be up to $10 \text{ g O}_2/\text{m}^3$.

8 References

8.1 General references

- (1) Water Management Master Plan of the Republic of Serbia 2021, Ministry of Agriculture and Water Management, 2001
- (2) Statistical yearbook of the Republic of Serbia, 1999-2004, Statistical Office of the Republic of Serbia
- (3) General Study on optimization of use of potable water resources in relation to reduction of water losses in regional water supply systems in Serbia – Draft, Ministry of Agriculture and Water Management – Directorate for Water, 2006
- (4) National Environmental Strategy of the Republic of Serbia – Draft, Directorate for Environmental Protection Ministry for Science and Environment, 2005
- (5) Global Serbia Wastewater Study, EAR, 2005

8.2 Legislation

- (6) Environmental Protection Law (OGRS No. 66/91, 83/92 and 53/93)
- (7) Water Law (OGRS No. 46/91, 53/93, 67/93, 48/94 and 54/96)
- (8) Law on Design and Construction (OGRS No. 47/2003)
- (9) Law on Local Self-Government (OGRS No. 09/2002)
- (10) Law on Municipal Operations (OGRS No. 16/97 and 42/98)
- (11) Ordinance on the Adoption of the Republic of Serbia Water Resources Development Master Plan (SWRDMP) (OGRS No. 11/02)
- (12) Ordinance on the Classification of Cross-Border and Coastal Water Bodies (OGRS No. 10/78)
- (13) Ordinance on Water Body Classification (OGRS No. 5/68)
- (14) Ordinance on the Categorisation of Water Bodies (OGRS No. 5/68)