

**PROJECT AMEDEUS**  
**“ACCELERATE MEMBRANE DEVELOPMENT**  
**FOR URBAN SEWAGE PURIFICATION”**

**WP9**

**DESIGN AND CONTROL OF DUAL MBR CONFIGURATIONS**  
**FOR PLANT REFURBISHMENT**

**D55**

**OVERVIEW OF TYPICAL WWTPS IN TARGETED**  
**COUNTRIES**



SIXTH FRAMEWORK PROGRAMME  
Priority 1.1.6.3  
“GLOBAL CHANGE AND ECOSYSTEMS”  
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**DESIGN AND CONTROL OF DUAL MBR CONFIGURATIONS FOR  
PLANT REFURBISHMENT**

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**OVERVIEW OF TYPICAL WWTPS IN TARGETED COUNTRIES**

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# 1 Executive summary

## Objectives and methodology

This Deliverable presents the Aquafin review work on the status of implementation and typical infrastructure of municipal wastewater treatment in Accession Countries and New Member States. The review work is in support of the examination of the plant upgrade potential with the Dual MBR concepts within the study region.

The review is based on a conventional literature survey. The Aquafin team collected data from regional databases, documents released by governmental bodies and other data from studies and projections.

## Anticipated relevance of the MBR technology

This review shows that primary consideration is to be given to the following areas:

1. Areas with severe water stress where wastewater treatment is not only envisaged for meeting environmental targets but it can also serve as an asset to increase the reliability of the water supply through appropriate reclamation and reuse of the wastewater treatment plant effluent (mainly: the Mediterranean coastal areas and islands - Cyprus, Malta, Croatia and part of Turkey, and the coastal areas on the Black sea).
2. Wealthier areas with specific geographical properties such as for instance ski resorts, where features such as the seasonal extremes in climate and population, the low footprint for plant upgrading, and the cost of the ground provide definite competitive advantages to plant upgrading scenarios based on MBR technology (mainly: Slovenia, but also some developing areas in Slovak republic, Macedonia, Bulgaria, ...).
3. Sensitive areas to eutrophication in highly urbanised environments (mainly: in the Danube, the Elbe and the Baltic region), and particularly those areas with legislation requirements about wastewater treatment exceeding those laid down in the EC Directives (e.g. the Baltic states and Cyprus). Because of the size of the investments that are needed - latest national estimates refer to 9,100 million euros - Poland is a decisive country for the examination of the plant upgrading potential in the region.

Within each of those areas, the plant upgrading potential is very diverse mainly because of the large differences existing from country to country especially regarding the level of wastewater treatment to approximate the *Acquis Communautaire*, and the timing of the investment cycles:

## The level of compliance to the Urban Waste Water Treatment Directive (UWWTD) is generally low

These low levels of compliance are mostly explained by lack of sewerage systems in small to medium size communities or lack of secondary and tertiary treatment at existing wastewater treatment plants (WWTPs) in larger communities. The connection rate to wastewater treatment in most of the study countries is hardly over 60%, the degree of biological treatment –either secondary or tertiary - is in most of the region less than 50% of the wastewater treated.

A substantial portion of wastewater is treated biologically only in the Czech Republic, Estonia, Hungary, and Latvia. In the rest of the countries most wastewater is either not treated, or mainly mechanically treated, with very low portions of secondary and tertiary treatment. Furthermore, the review reveals that the installed biological treatment is in most of the cases not capable of meeting the effluent requirements laid down in Annex 1 of the UWWTD, especially because of the fact that the study territories have prevalently been declared sensitive areas and the biological treatment is not equipped – or it is only partially equipped – to comply with nitrogen and phosphorus removal norms.

## Timing of the national investment programmes

Important national programs for expansion and construction/upgrade of the wastewater infrastructure are present in the whole study region. It is anticipated that the connection rate will increase in the next years, especially for towns of 2,000 - 50,000 PE. This will lead to the construction of new sewer networks with the associated WWTP, or the extension of existing sewerage networks. In this later case, if a WWTP is present, a capacity extension will be required. In addition, for most of existing WWTPs, a quality upgrade will be required (mainly: nutrients removal for sensitive area).

In some countries the national programmes are in an advanced status of implementation, and hence the plant upgrading potential is lower. For instance, while Malta shows today the lowest level of wastewater treatment in the region, it is the expected to be the first New Member State to meet the UWWTD requirements, already in 2007. Most of the countries within the study region will have to comply by 2015 (Romania being the last, by 2018), but differences there exist on the intermediate targets established for priority areas (mainly: wastewater treatment in sensitive areas and in larger agglomerations).

## A complete market overview will be developed in the next phase of the study

The examination of the plant upgrading potential must be tailored to local problems and needs and anchored to up-to-date information in order to be of any practical use. Therefore, the Aquafin team decided to dedicate the next phase of the research to:

- ◆ Updating the information on the status of implementation of the national programmes to meet the UWWTD requirements: with many plans being in a more or less advanced phase of implementation, data on connection rates and treatment levels are quickly getting outdated.
- ◆ Capturing latest evolutions in water resources management in the identified priority areas. Limited information was identified about the transposition of the Water Framework Directive (WFD) into national legislation and above all about the possible implications hereof for wastewater treatment. Experiences from Western European Countries show that the WFD might impact municipal wastewater treatment practices in many ways, including both in the provision of more advanced wastewater treatment and improved stormwater treatment practices (both in terms of quantities of water pumped up at the WWTP and on the level of treatment).
- ◆ Collecting data on the structure of the water sector, on the local water supply market structure, and on affordability and acceptance of the MBR technology for the identified priority areas.

With this in mind, Aquafin developed a self-compile questionnaire which is being sent to targeted institutions such as national governments, wastewater associations, water utilities, consultants and manufacturers to complement and validate the information gathered through the conventional literature survey. Moreover, Aquafin will carry out few site visits in certain identified priority areas.

## The evaluation will concentrate on three WWTP upgrading situations

As the review indicates that the dominant technology is activated sludge –either low or high loaded systems-, the analysis will focus on three alternative types of biological treatment, namely: conventional low loaded activated sludge systems **(A)** with or **(B)** without primary clarifier and **(C)** conventional high loaded activated sludge with primary clarifier.

The following three WWTP upgrading situations will be considered for each of the three schemes: **(1)** a WWTP biologically and hydraulically overloaded - the activated sludge system is either designed as a high loaded system (and does not meet the effluent standards on nutrient removal anyway), or low-loaded system (and does not meet the effluent standards on nutrient removal because of the overloading, i.e. the biology volume is not big enough). In addition, the size of secondary clarifiers is too small. **(2)** A WWTP only biologically overloaded: the activated sludge system is high loaded and does not meet the effluent standards on nutrient removal. **(3)** A WWTP only hydraulically overloaded: the secondary settlers are too small.

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## 2 Overview of municipal waste water treatment in the study region

The study region is characterised by large differences in the level of connections to municipal sewerage systems and to wastewater treatment plants. The most recent identifiable data on connection rates are illustrated in Figure 1.

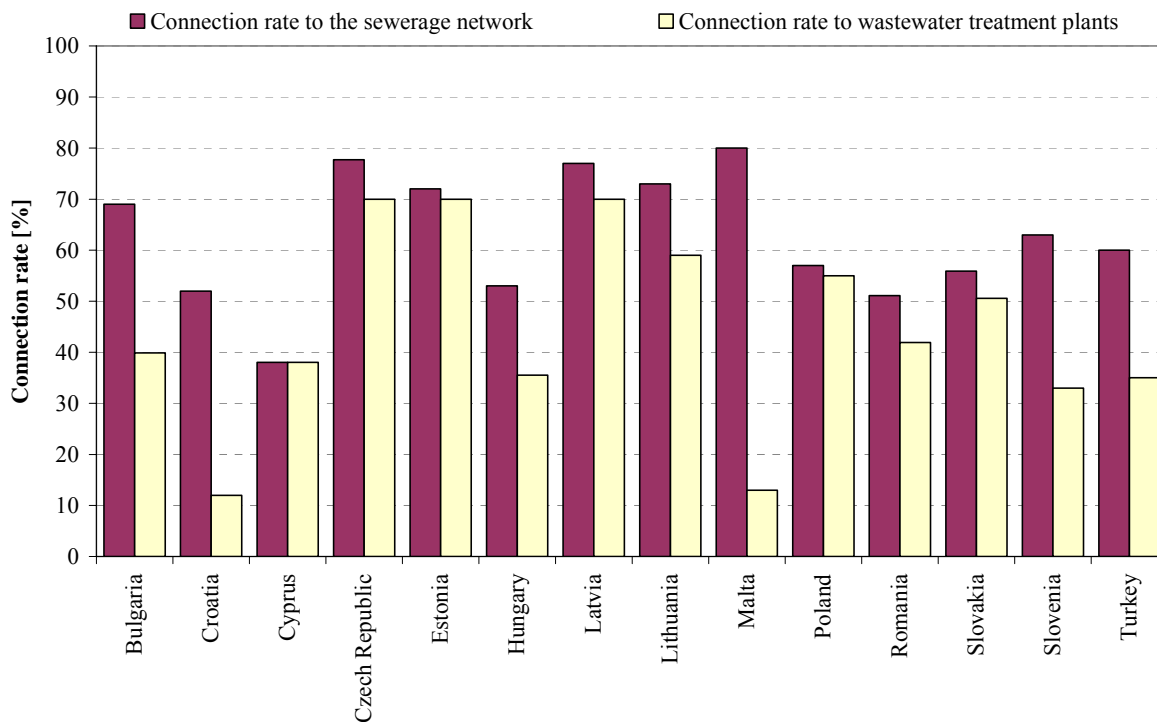


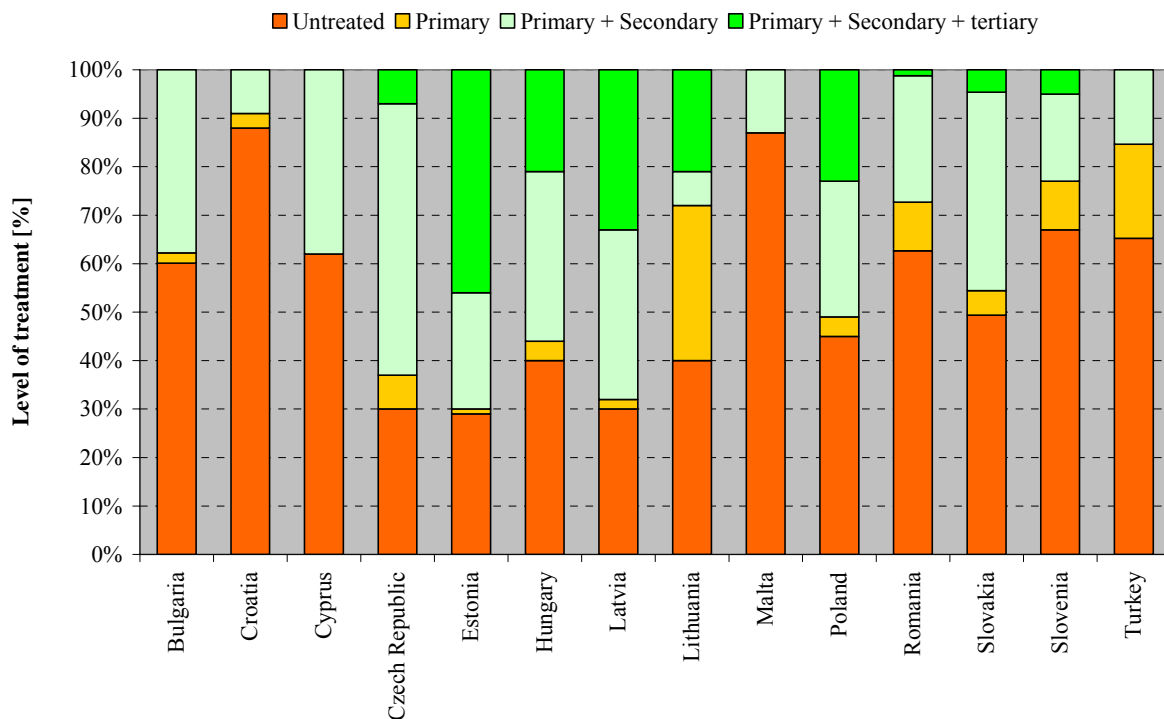
Figure 1. Connection rate to the sewerage network and to WWTPs in the study region

Figure 1 shows that most of the countries present a connection rate to municipal sewers in the range between 50% and 70%. Higher levels of connection are found in Malta, Czech Republic and the three Baltic States that were formerly taking part to the Soviet Union.

Moreover, within each country the level of connection shows large variations between urban and rural areas, with sewerage networks which are very common in urban areas, the connection rate decreasing with the size of the towns. In rural areas municipal sewerage networks are virtually absent. It is anticipated that the connection rate will increase in the next years (especially for towns of 2,000-50,000 p.e.): this will lead to the construction of new sewer schemes with the associated WWTP, or the extension of existing sewer schemes. In this later case, if a WWTP is existing, a capacity extension will be required.

### 2.1 Wastewater treatment plants

The level of wastewater treatment shows even more pronounced variations (Figure 2). In Figure 2, with **primary treatment** we mean the physico-chemical wastewater treatment step aiming at the reduction of oils, grease, fats, sand, grit, and coarse (settleable) solids. This step is done entirely with machinery, hence in some cases it will also be referred to as *mechanical treatment*. With **secondary treatment** we mean biological treatment, e.g. activated sludge or trickling filters; not including nutrient removal - nitrogen AND phosphorus -. With **tertiary treatment** we refer to forced nitrogen and phosphorus removal in activated sludge, unless specified otherwise in the text. Untreated wastewater is either not collected by the sewerage network or not brought to a WWTP.



**Figure 2. Treatment levels of wastewater collected by wastewater networks in the study region**

Figure 2 shows that a substantial portion of wastewater is treated biologically only in the Czech Republic, Estonia, Hungary, and Latvia. Tertiary treatment is well established only in the Baltic States. It is standard practice to let the biological system –either secondary or tertiary– be preceded by primary clarifiers. In the rest of the study region, most wastewater is either not treated, or only mechanically treated, with a negligible portion of secondary and tertiary treatment.

Like for sewerage networks, a feature that is common to all countries is the lack of centralised and decentralised wastewater treatment infrastructure for small settlements and rural areas\*. In some rural areas households are equipped with septic tanks.

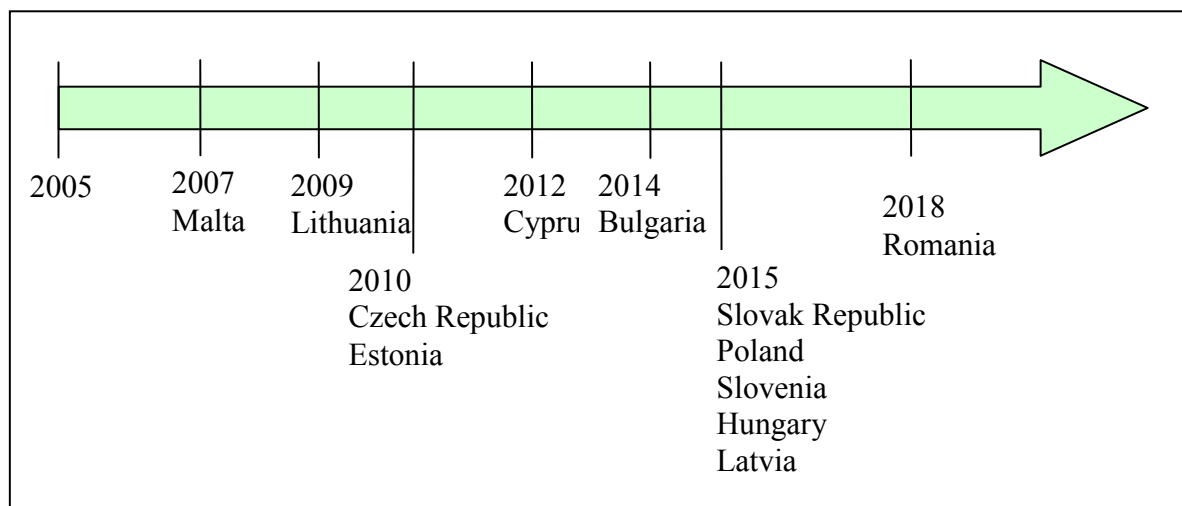
Statistical data on connection rates and treatment levels are however quickly getting outdated. Important national programs for expansion and construction/upgrade of the wastewater infrastructure are present in all the study countries. For instance, while today in Malta only 13% of the population is connected to a wastewater treatment plant, it is expected that by the end of 2007 100% of the wastewater collected in municipal sewers will receive treatment (compliant to the UWWTD).

These expansion programmes are in a different state of implementation. The state of implementation of the programmes is well correlated to the clause of transitional period granted by the EU to comply with the Urban Waste Water Treatment Directive, which reflects the status of wastewater infrastructure of a given country at the time of the negotiations to enter the European Union.

The transitional periods granted to comply with the UWWTD requirements are therefore showing marked variations too. Figure 3 shows that Malta is requested to comply already in 2007, the bulk of the countries in 2015 and Romania will be the last to comply, in 2018 (among those countries that already concluded the negotiation process to enter the European Union).

Moreover, the transition clause specifies intermediate targets to meet the UWWTD requirements, with wastewater treatment in sensitive areas and in larger agglomerations being given priority.

\* Small settlements refer to agglomerations with population equivalents between 2,000 and 10,000, while rural areas refers to settlements smaller than 2,000 PE, unless specified otherwise in the report



**Figure 3. Transition period granted to comply with the UWWTD in the study region**

Most territory in the study region has been declared sensitive area (SA) according to the criteria laid down in Annex II of the UWWTD, and as a consequence a great deal of agglomerations above 10,000 population equivalents will have to comply with additional effluent norms on nitrogen and phosphorus. Table 1 provides the reader with an overview of the extent of sensitive areas in each of the studied countries.

**Table 1. Sensitive areas in the study region**

Entire territory	Part of territory	None of the territory	Not designated yet
Czech Republic, Estonia, Latvia, Lithuania, Poland, Romania, Slovakia	Bulgaria, Cyprus, Hungary, Slovenia	Malta	Turkey, Croatia

Moreover, the transposition of the UWWTD into national regulations has in some cases introduced provisions which go beyond the requirements of the Directive. The analysis of the requirements contained in national regulations enables us to roughly classify groups of countries by the severity of existing legislation, taking the UWWTD as a reference (Table 2).

**Table 2. Severity of the wastewater treatment legislation in the study region**

Limit values identical to those of Annex 1 of the UWWTD	More stringent limit values	Additional water quality parameters	Not identified
Bulgaria, Croatia, Latvia, Romania	Cyprus, Czech Republic, Estonia, Slovakia	Czech Republic, Slovakia	Estonia, Hungary, Lithuania, Malta, Poland, Slovenia, Turkey

The review of relevant legislation reveals that limit values are identical to those specified in Annex 1 of the UWWTD in a majority of countries. In Czech Republic and Slovakia the 90-%ile limit values for BOD<sub>5</sub>, COD, SS, TN and TP are respectively 15 mg O<sub>2</sub>/L, 75 mg O<sub>2</sub>/L, 20/15 mg N/L and 3/1.5 mgP/L; moreover, their regulations introduce provision on NH<sub>4</sub>-N effluent limits. Estonian regulation requires to remove 90% of organic and phosphorous substances from wastewater.

## 2.2 Sewerage

The type of wastewater collection practice affects in many ways the examination of the plant upgrade potential with the Dual MBR concepts (e.g. WWTP dimensioning and operability, ...).

Within the study region the approach to wastewater collection practices shows marked variations. Most of the study countries have combined or partially combined sewerage networks. Only Cyprus is primarily installed with separate systems. Table 3 summarises basic identifiable information about the type of sewerage in each study country. In this report, combined systems refer to sewerage collecting sanitary (or foul) sewage and surface water (rainwater runoff), separate systems receive (in theory) only sanitary sewage and mixed systems are a combination of combined and separate sewers (e.g. the historical centre of the city served by combined sewers and the outskirts by separate systems).

**Table 3. Overview of the typical type of sewerage systems in the study countries**

Combined	Mixed	separate	Not identified
Bulgaria, Estonia, Hungary, Malta, Romania, Slovakia	Croatia, Czech Republic, Poland	Cyprus	Latvia, Lithuania, Slovenia, Turkey

## 2.3 Sludge handling and disposal

Another important aspect in support of examining the plant upgrade potential with the Dual MBR concepts is the review of the sludge management practices. Beside the fact that the sludge management aspect cannot be separated by wastewater treatment, it is also a major cost determinant in wastewater treatment, which influences in many ways the type of wastewater treatment to be installed in a given area.

Sludge management practices are very diverse, with at the extremes Bulgaria - where almost 100% of the sludge is landfill - and Slovakia – where over 80% of the sludge is reused on various applications, including agriculture. Within the region, the sludge management is in a transitional phase where more complex and diversified sludge handling techniques and disposal routes are undertaken.

The national regulations have been established on the basis of Directive 86/278/EEC on sewage sludge. However, the sludge management varies more markedly than wastewater treatment, as do their standards regulation and enforcement.

**Table 4. Severity of the sludge disposal regulation in the study region**

Comparable	More stringent	Not identified
Cyprus	Czech Republic, Estonia, Hungary, Latvia, Malta, Poland, Slovakia and Slovenia	Bulgaria, Croatia, Lithuania, Romania and Turkey

Table 4 shows that several countries have introduced provisions which go beyond the requirements of the sewage sludge Directive. Incineration or disposal to landfill of sludge is usually covered by general waste regulations on incineration or on landfill and not by specific provisions in national sludge regulations

Most of the study countries are in a transitional period regarding to the excess sludge handling and disposal practices. Dry beds are being abandoned in favour of more complex systems such as anaerobic stabilisation and mechanical dewatering.

Note that the perspective of the revision of Directive 86/278/EEC, which could lead to the implementation of more stringent limit values for heavy metals in sludge, could have an impact in most of the study countries, at least on the provisions to be set by national regulations (as in fact average heavy metals content in sludge is in most cases well below regulatory requirements).

### 3 Country profiles



#### 3.1 Bulgaria

Bulgaria has a population of 7.9 million inhabitants (2004) and is composed of 430 settlements with populations over 2,000 (Ministry of Environment and Water), 104 of which are larger than 10,000 population equivalents (CMRB, 1999). Around 70% of the population lives in urban areas.

##### 3.1.1 Status of implementation of wastewater collection and treatment

Basic statistics on the wastewater generated, collected and treated is reported in Table 5.

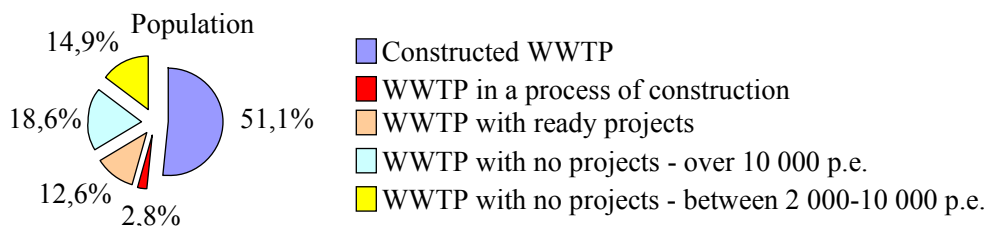
**Table 5. Wastewater load and degree of connection in Bulgaria in 2002 and 2003**

	2002	2003
wastewater discharged [1,000 m <sup>3</sup> /year]		878,555
wastewater discharged into the public sewerage [1,000 m <sup>3</sup> /year]	516,834	539,470
Part of population served by public sewerage [%]	68.4	69%
Part of population connected to a WWTP [%]	38.6	39.9

Source: National Statistical Institute of Bulgaria; Morris *et al.* (2004); Ministry of the Environment and Water (2003).

Within Bulgaria there is a wide variation in wastewater collection between urban and rural areas: while sewerage networks are very common in the former (degree of connections > 70%), it is virtually absent in the latter (degree of connections < 5%, with 98% of the villages that do not have sewerage systems). Moreover, sewerage networks are more common closer to the Black sea than in the rest of the Country.

Recent information on the percentage distribution of the population living in settlements with WWTP at different stage of their construction (in 2003) is presented in Figure 4.



**Figure 4. Distribution of the population living in settlements with WWTP at different stage of their construction in Bulgaria in 2003 (Ministry of the Environment and Water of Bulgaria, 2003)**

In 2003, 61 WWTPs were reported to be operational in Bulgaria (Ministry of the Environment and Water, 2003). Twenty-one WWTP were operating successfully and no expansion, reconstruction and modernization were projected. The remaining treatment plants (40) needed additional measures for expansion, reconstruction and modernization. According to the last census data, the constructed wastewater treatment plants served 40% of the population. Moreover, the Ministry let know that in 2003 the construction of urban wastewater treatment plant was started in an additional 12 settlements, with the population that will be served by the newly constructed treatment plants being a little above 2% of the entire country population.

After Morris *et al.* (2002), out of the 50 WWTPs operational in Bulgaria in 2002, 27 were located in agglomerations over 100,000 PE, 12 in agglomerations between 25,000 and 100,000 PE and 11 for agglomerations up to 25,000 PE. After the Sanitation Country Profile (2004), 13 cities were still without WWTP (but projects for their construction were underway), and some of the existing urban WWTP needed upgrading, reconstruction and modernisation.

Urban wastewater treatment plants are planned for 338 cities and towns with populations over 2,000 until 2015, 55 being larger than 10,000 PE (Ministry of Environment and Water, 2003).

After Phare (2002), sludge production and disposal quantities exhibit the following national values:

- ◆ Generation: 105,000 – 144,000 ton DS/y
- ◆ Disposal: 100,000 – 144,000 ton DS/y (680,000 – 890,000 m<sup>3</sup>/y)

The Ministry of the Environment and Water displayed quite different figures, namely, 52,259 ton DS in 2002, of which 27,459 are delivered to drying pits. The dewatered sludge is disposed directly on the regional landfills, which receive almost 100% of the generated sludge (in 2002 only 737 ton dry solids were reported to be used in agriculture).

### 3.1.2 Typical wastewater treatment systems

#### 3.1.2.1 Wastewater collection

The sewerage network is of a combined type. Many trunk sewers need major reconstruction (over 17% according to the Ministry of Environment and Water) and they are not in a condition to receive increased wastewater flow. The lack of compatibility between sewerage systems and existing wastewater treatment plants resulted in several operational and environmental problems, including discharge of wastewater in periods of drought into rivers by combined sewer overflows.

#### 3.1.2.2 Wastewater treatment

Statistical data about the level of wastewater treatment in 2002 and 2003 is summarised in Table 6.

**Table 6. Level of wastewater treatment in Bulgaria in the year 2002 and 2003**

Indicator	2002 <sup>†</sup>	2003
Untreated [% ww generated]	61.4	60.1
Primary treatment [% ww generated]	0.9	2.1
Secondary treatment [% ww generated]	37.7	37.8
Tertiary treatment [% ww generated]	0.0	0.0

Source: National Statistical Institute of Bulgaria.

The available statistical data on treatment levels are quickly getting outdated. According to the plan laid down into the National Program for Priority Construction of Urban Wastewater Treatment (CMRB, 1999) 36 out of 104 priority facilities are to be due by end 2007. Of these 36 priority projects, in the period 2000-2003 ISPA funds have been granted for the refurbishment of 2 WWTPs and the construction of 12 new ones. The newly-constructed WWTPs will provide a nominal capacity of approximately 1 million PE, with approximately 1/3 providing nutrient removal. The refurbishment works concerns a capacity of 179,500 PE, with approx. 1/7 including nutrient removal.

No comprehensive information was identified on the type of wastewater treatment technology that is installed at the WWTPs.

<sup>†</sup> Note that Morris *et al.* (2002) bring in quite different figures for 2002, namely: 13.5% of the wastewater treatment using primary treatment and 55.5% using secondary treatment.

From the limited available data, it seems that the typical refurbishment scenario is the expansion of the existing activated sludge system (extended aeration) and the adoption of simultaneous chemical phosphorus precipitation (McCann, 2004). Typical nominal biomass concentration for the design of these structures is 4 g MLSS /L. Moreover, it has been reported that around 65% of the dry matter is organic. The largest wastewater treatment plant in the Country, the Sofia WWTP (1,200,000 PE) is being expanded to a low loaded activated sludge system, with the primary clarification unit being kept in function (Amerlinck, 2004). Before renovation, the WWTP consisted of a conventional (high-loaded) activated sludge system, preceded by a physico-mechanical treatment (bar racks and screens) and primary clarifiers.

WWTP should be constructed and operated within the terms set in the National Good Practice on WWTP (governmental policy).

### 3.1.2.3 Sludge treatment and disposal

Prior to disposal, approximately 70 % of the sludge produced in Bulgaria is pre-treated by mechanical dewatering, the remainder being applied to drying beds. A distinction can be made based on the size of the wastewater treatment facility:

- ◆ WWTPs < 50,000PE: thickening, open unheated digestion/storage tanks and Imhoff tanks. All are equipped with drying beds.
- ◆ WWTPs > 50,000 PE: cold digestion plus mechanical dewatering by either vacuum filter or filter press is more commonly adopted, though most sites also have drying beds as a reserve option.

A draft National Plan for Management of UWWTP Sludge, being a part of the National Waste Management Program, has been released in 2003. The plan foresees that

- ◆ WWTP >10 000 PE should be provided with sludge facilities with equipment for mechanical dewatering (band filter presses). The dewatered sludge will be directly transported to the regional landfill;
- ◆ WWTP > 150,000 PE heated anaerobic digestion (35°C for minimum 15 days)
- ◆ WWTP > 500,000 PE fluidized-bed sludge incineration
- ◆ A central station for sludge treatment should be determined for each of the 28 districts. The central station may take liquid sludge transported from the smaller WWTP in the district;
- ◆ WWTP <10 000 PE may not be equipped with mechanical dewatering facility. The central station will treat the sludge and transport it to landfills;
- ◆ All the scenarios include the disposal of the treated sludge at landfills within the district. An average distance of 20 km from the WWTP, equipped with dewatering facilities, to the regional landfill is determined for each settlement.

### 3.1.3 Major drivers for WWTP refurbishment

The major driver for the construction and refurbishment of WWTPs is the transposition of the UWWTD into national law. In 2003, Bulgaria has designated the catchment areas discharging into the Danube River and the Black Sea as sensitive. Bulgaria has been granted a 9-year transitional period, with the transition clause differentiates between agglomerations larger than 10,000 PE (which will have to comply with the UWWTD already by 31 December 2010) and agglomerations with population equivalent between 2,000 and 10,000 (which will have to comply with the UWWTD by 31 December 2014).

The National Program for Priority Construction of Urban Wastewater Treatment over 10,000 population equivalents, identify 104 priority projects (CRMB, 1999), 81 new WWTPs and 23 WWTPs for reconstruction and modernization of operating ones.

A driver for the implementation of advanced treatment is the need for water reuse (Paskalev, 2001).

## 3.2 Croatia

Croatia has a population of 4,495,904 inhabitants (2005) and is composed of 1,268 settlements, of which 38 larger than 10,000 population equivalents, and 189 in the range between 2,000 and 10,000 population equivalents (Country report of Croatia, 2003).



### 3.2.1 Status of implementation of wastewater collection and treatment

Basic statistics on the wastewater generated, collected and treated is reported in Table 7.

**Table 7. Wastewater load and degree of connection in Croatia in 2003**

Indicators	2003
Percentage of generated wastewater connected to the public sewerage	52%
Percentage of generated wastewater connected to a WWTP	12%

Source: Country report of Croatia (2003)

Sewage systems are mostly constructed in bigger towns, where about 75 per cent of population is connected to the sewerage network. In smaller towns this relation is considerably worse and agglomerations with less than 2,000 inhabitants have a very low percentage of connection to the sewage system. In the majority of settlements with up to 10,000 population equivalents there is no sewage system constructed (Table 8).

**Table 8. Degree of sewage system construction in Croatia in 2003**

Settlements Size	Total no. of settlements	No. of settlements with sewage system			
		constructed	mostly constructed	partly constructed	no sewage system
< 2000	1,041	148	75	74	893
2,000 to 10,000	189	104	63	41	85
10,000 to 100,000	35	35	31	4	0
> 100,000	3	3	3	0	0
TOTAL	1,268	290	172	119	978

Source: Country report of Croatia (2003)

The Country Report (2003) inventoried 81 municipal wastewater treatment facilities (91 according to the Statistical office). The majority of plants are located within catchment areas of Primorje-Istria.

### 3.2.2 Typical wastewater treatment systems

#### 3.2.2.1 Wastewater collection

In 2004, 75% of the sewerage network was of combined type, the remaining 1,516 km being separate (Statistical office, 2004).

### 3.2.2.2 Wastewater treatment

Standards of wastewater treatment provision vary considerably between municipalities. Out of the 81 inventoried municipal wastewater treatment facilities, 22 had a pre-treatment, 26 had primary treatment and 34 secondary treatment wastewater treatment. Out of 12% of municipal wastewater volumes treated, 52% are treated in primary treatment (only mechanically). Only 37% of wastewater are secondary treated.

**Table 9. Level of wastewater treatment in Croatia in 2003 [1] and 2004 [2]**

Indicators	Total	Primary T	Sec.ary T	Tertiary T	Sources
Number of WWTPs	91 (81)	69 (48)	13 (34)	9 (0)	[2] ([1])
Percentage Wastewater treated	12%	6%	4%		[1]

Source: [1] Country report of Croatia (2003); [2] Statistical office (2004)

With the WWTP of Zagreb due to enter in operation by end 2006, the level of biological treatment will drastically increase (>20%). The plant will treat 1 million population equivalents at start-up, extendable to 1.5 million PE in the future (Reina, 2003)

### 3.2.2.3 Sludge treatment and disposal

No information is available about the sludge handling and disposal practices.

## 3.2.3 Major drivers for WWTP refurbishment

The major driver for the construction and refurbishment of wastewater treatment infrastructure is the transposition of the EU271/91/EC into national law.

With the annual tourist arrivals that are two times as high as the resident population - a total of 9,412,276 arrivals in 2004 – tourist areas and especially, the islands, are no doubt potential targets for MBR technology. Therefore, in the next phase Aquafin will seek detailed information on those areas and not only on the status of implementation of the UWWTD but also on other important variables such as the structure of the water sector including cost recovery practices, the local water supply market structure and the acceptance of the MBR technology.

### 3.3 Cyprus

Cyprus has a population of 780,133 inhabitants (July 2005), of which 66% living in urban areas (Zachariou Doudou, 2003).



#### 3.3.1 Status of implementation of wastewater collection and treatment

Basic statistics on the wastewater generated, collected and treated is reported in Table 10.

**Table 10. Wastewater load and degree of connection in Cyprus in 2003**

Indicators	2003
Percentage of population served by public sewerage	38%
Percentage of collected sewerage served by a WWTP	100%

Source: Zachariou Doudou (2003)

Also, Zachariou Doudou (2003) reports that the population not connected to a sewerage network is equipped with individual systems (septic tanks) enforced by Building and Street Regulation law, while hotel establishments in tourist areas are equipped with private treatment plants (300 in total)<sup>‡</sup>.

Recent information over the wastewater treatment infrastructure is reported in Table 11.

**Table 11. Municipal WWTPs and utilisation of treated wastewater in Cyprus**

City	Population (2002)	Capacity (m <sup>3</sup> /day)	Population Equivalent	Utilisation of treated wastewater
Nicosia				
Mia Milia	200,000	20,000	100,000	- Irrigation
Anthoupoli		800	4,000	*
Limassol	162,000	19,000	95,000	- Irrigation - Industry
Larnaka	72,000	4,200	21,000	- Farming - Industry
Pafos	47,500	5,500	27,500	- Ground water recharge
Paralimni	20,000	12,000	100,000	- Irrigation
Kiperounta	2,600	200	1,200	- Irrigation
<b>Total</b>	<b>504,100</b>	<b>61,700</b>	<b>348,700</b>	

Source: Theophilou (2004)

Table 11 indicates that the installed capacity can treated the wastewater of approximately 45 % of the population.

<sup>‡</sup> In 2004, the tourist arrivals totalled 2,349,000 people, i.e. a tourist arrivals over resident population ration of approximately 3

In 2003, the municipal WWTPs generated 2,860 ton DS of excess sludge. It was projected that, as a result of the implementation of the UWWTD, by end 2007 this amount would rise to 8,900 ton DS/year (Zachariou Doudou, 2003).

The regulation on sewage sludge encourages the reuse of sludge for agriculture. The heavy metals limits on sludge spreading in agriculture are equal to the upper limit values laid down in the European Directive 86/278/EEC, except for Chromium (500 mg/kg dry matter i.o. 1,000-1,750 mg/kg dry matter). Moreover, not all crops may accept sewage sludge.

Despite the relatively favourable legislation, the utilisation of sludge for agriculture is limited due to poor farmer acceptance of this practice (Zachariou Doudou, 2003). Utilisation of dewatered sludge as a fuel in cement factory or other power plants seemed, at the end of 2003, the most viable option. Use of sludge as a soil conditioner was also considered a potential option.

### **3.3.2 Typical wastewater treatment systems**

#### **3.3.2.1 Wastewater collection**

The sewerage system is of separate type (Eliades, personal communication). It is common practice to pump to the WWTP up to 1.5 max 2 times the average daily dry weather flow.

#### **3.3.2.2 Wastewater treatment**

All wastewater treatment plants are equipped with a biological step.

Typical wastewater treatment technology in the main towns is composed of secondary treatment (until now without nutrient removal) and a polishing step composed of filtration and disinfection, because of the stricter water quality standards, in term of BOD and SS, than those imposed by the UWWTD (cf. Section 3.3.3).

#### **3.3.2.3 Sludge treatment and disposal**

Sludge in urban wastewater treatment plants is subject to aerobic or anaerobic treatment and then dewatered.

The sludge generated in small treatment plants is transported to central treatment facilities, where it is stabilised and dewatered. Septic material is brought to a central treatment facility, where it is treated aerobically, stabilised and dewatered.

The regulation indicates the excess sludge may be spread on land only when subject to appropriate treatment, loading rates and heavy metals concentrations. The treatment methods which are foreseen in the code of good practice for sludge use in agriculture include: anaerobic, aerobic, thermal, storage in lagoons 2 years, stabilisation with lime, biological stabilisation, drying beds (storage for one year), and any other method after approval by the Authorities (Zachariou Doudou, 2003)

### **3.3.3 Major drivers for WWTP refurbishment**

One main driver for the construction and refurbishment of wastewater treatment infrastructure is the transposition of the UWWTD into national law:

- ◆ Part of the territory of Cyprus has been declared sensitive area regarding eutrophication. Some facilities need to be extended to include nutrient removal.
- ◆ Wastewater collection and treatment in rural areas is still limited

The harmonisation programme, to be completed by 2012, includes the 4 greater urban areas of Nicosia, Limassol, Larnaca and Paphos, the two tourist resorts of Agia Napa and Paralimni and 38

rural agglomerations with equivalent population of more than 2,000 (Department of Water Development of Cyprus).

A driver for advanced treatment is the need for strict water conservation and reuse practices, including water reclamation and reuse. Cyprus is subject to structural and temporal water supply shortages. Throughout the years the government took several water conservation measures, including turning to an increased use of reclaimed water (NTUA 2005). Water reclamation and reuse became regulated in 1997 and has been implemented—to a certain extent—in six schemes (cfr. Table 11).

The Cyprus legislation on water reuse requires:

- ◆ industrial uses: secondary treatment and disinfection
- ◆ irrigation: secondary effluent polishing (filtration) and disinfection

It is expected that with the implementation of the EU Water Framework Directive's full-cost-recovery principle a larger amount of reclaimed water will be reused, up to 100 percent of the reclaimed water—at least in dry years (cfr. Bixio *et al.*, in publication).

### 3.4 Czech Republic

Czech Republic has a population of 10.3 million inhabitants (2004), and is composed of 127 agglomerations larger than 10,000 population equivalents and 552 agglomerations between 2,000 and 10,000 population equivalents.



#### 3.4.1 Status of implementation of wastewater collection and treatment

Basic statistics on the wastewater generated, collected and treated is reported in Table 12.

**Table 12. Wastewater load and degree of connection in Czech Republic in 2002**

Indicator	2002
Population connected to sewerage	7,928,450
Percentage of population connected to sewerage	77.7 %
Population connected to sewerage with WWTP	7,032,952
Percentage of population connected to WWTPs	70 %
Wastewaters discharged into public sewage systems [1,000 m <sup>3</sup> ]	558,111
Of which treated in wastewater treatment plants	94.5 %

Source: Czech Statistical Office (2003)

Wastewater collection is common in agglomerations above 5,000 PE and uncommon in smaller communities (Morris et al., 2004).

Statistics about the wastewater treatment infrastructure is reported in Table 13.

**Table 13. Number and size of WWTPs in Czech Republic in 2001**

Size	Number of WWTPs
> 100,000 PE	20
25,000 – 100,000 PE	100
< 25,000 PE	1 480
Total	1 600 <sup>§</sup>

Source: Morris and Kis (2004)

Statistics about sludge production and disposal is reported in Table 14.

**Table 14. Sludge production and disposal in Czech Republic**

Total [m <sup>3</sup> /y]	Dry matter [t/y]	Agricultural soil	Composted	Landfill
800,000	211,000	45%	26.3%	28.7%

Source: European Compost Network; Michanová et al. (2003)

The obligation requirements of the Directive 86/278/EC are fully covered (Michanová et al., 2003). The Decree of the ministry of the environment no. 382/2001 Coll. lays down more stringent limit values than the Directive's current requirements and include limits on arsenic (30 mg/kg DS), AOX (500 mg/kg DS) and PCBs (0.6 mg/kg DS).

The sludge disposal routes in the Czech Republic before and after transposition of the Council directive 86/278/EC are illustrated in Figure 5.

<sup>§</sup> After the website of the European Compost Network, the WWTPs amount to a total of 959, with a capacity of 1,370 million m<sup>3</sup> / yr.

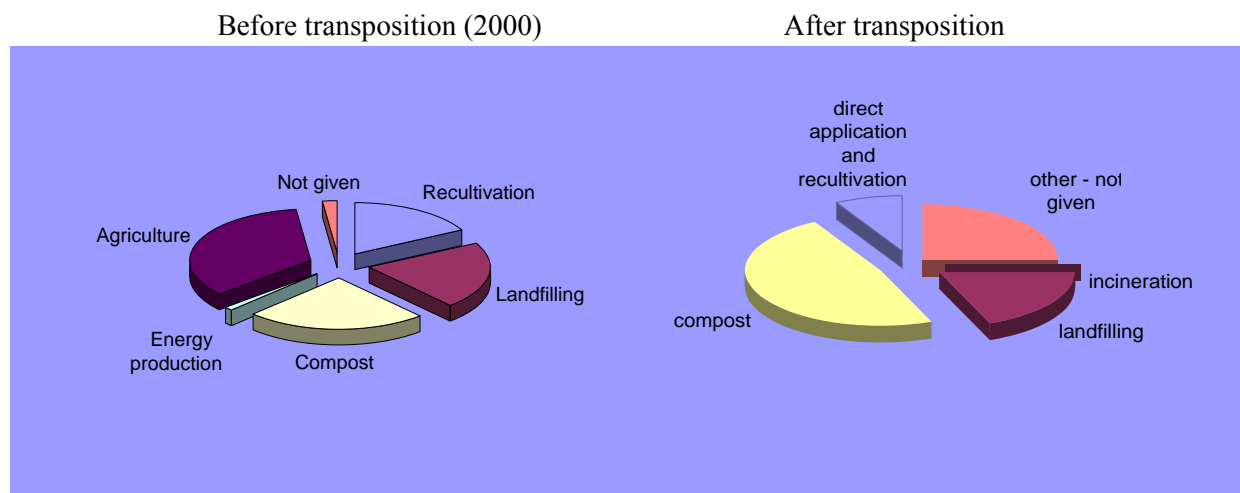


Figure 5. Sludge disposal routes in the Czech Republic before (left) and after (right) transposition of the Sludge Directive (Michanová *et al.*, 2003)

### 3.4.2 Typical wastewater treatment systems

#### 3.4.2.1 Wastewater collection

No comprehensive information is available on the type of sewerage collection network. Limited information reveals that most of the areas are served by combined systems.

#### 3.4.2.2 Wastewater treatment

In 2001, most of the collected sewerage received secondary treatment (Table 15).

Table 15. Degree of treatment of collected wastewater in WWTPs in Czech Republic in 2001

	Untreated	Primary treatment	Secondary treatment	Tertiary treatment
Collected sewage	20%	8-10%	60-70%	<10%

Source: Morris and Kis (2004)

Activated sludge systems including nutrient removal are becoming the standard technology in this region (cf. Section 3.4.3).

#### 3.4.2.3 Sludge treatment and disposal

No comprehensive information is available about the type of sludge treatment and disposal. The waste management plan for the period 2003-2012 encourages the energetic use of biogas from WWTP with corresponding production of sludge.

### 3.4.3 Major drivers for WWTP refurbishment

The major driver for the construction and refurbishment of wastewater treatment infrastructure is the transposition of the UWWTD into national law. Because of the extremely sensitive North Sea with regard to eutrophication (with the Elbe river as second major source of nitrogen and phosphorus), the Czech effluent standards should approach as closely as possible the requirements of the UWWTD for nutrient removal. Many secondary treatment facilities will have to be refurbished to include nutrient removal. The UWWTD requirements in agglomerations larger than 2,000 population equivalents shall not fully apply until 31 December 2010.

On top of that; few regions show signs of water stress and there can be policy drivers in the future to further improve the effluent quality, also in the option of industrial or agricultural water reuse (Jasanova *et al.*, 2005).

### 3.5 Estonia

Estonia has a population of 1,332,893 inhabitants (2005), and only 19 agglomerations larger than 10,000 population equivalents (EEA, 2005).



#### 3.5.1 Status of implementation of wastewater collection and treatment

Basic statistics on the wastewater generated, collected and treated is reported in Table 16.

**Table 16. Wastewater generated and connection rates to the sewerage and WWTP in Estonia in 2002 [1] and 2003 [2]**

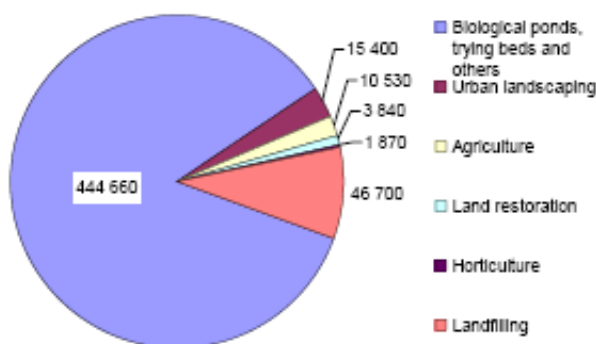
Wastewater discharged and sewerage connection degree	
Water released in water bodies [2]**	1,627,376 m <sup>3</sup> /yr
Wastewater collected in sewerage networks [2]	303,503 m <sup>3</sup> /yr
Percentage of population connected to sewerage [1]	72%
Percentage of pop connected to WWTP [1]	70%

Source: [1] Eurostat (2002); [2] Statistical Office of Estonia (2003)

According to the Ministry of Environment of Estonia, at the end of 2001 there were 856 WWTPs (!), of which 56 were working satisfactory. Major problematic areas are the rural areas where the wastewater treatment does not exist or has been phased out (EEA, 2005). EEA (2005) states that in the past the wastewater treatment plants at collective farms also received household wastewater, but the treatment units are no longer functioning now that the farms have been privatised.

Industrial and domestic wastewater is usually treated in a common wastewater treatment plant (Pachel, 2002).

Around 550,000 m<sup>3</sup> excess sludge may be produced per year, which contains approximately 24,000 ton dry solids. The share of sludge disposal routes in the year 2000 are shown in Figure 6.



**Figure 6. Sludge disposal routes in Estonia in 2000 (Raia and Sokk, 2003)**

In transposing the European Directive 86/278/EEC, the Estonian regulation laid down limit values for heavy metals in sludge that fall within the value requirements of the Directive. However there are permit conditions on sludge spreading activities that are more stringent than those laid down in the directive.

Acknowledged technological problems related to the implementation of the Estonian regulation on sludge disposal are (Raia and Sokk, 2003):

\*\* Water release includes also mining water (which also depends on precipitation) that only needs mechanical treatment, and 55% of water to be treated is industrial water in Kohla Jäive, and in every industrial site [2].

- ◆ Technology is out of date and facilities fallen into disrepair are expensive to operate
- ◆ The impact of forced chemical phosphorus on the sludge quantities (and properties)
- ◆ Marketing problems (sludge is rarely used in agriculture)
- ◆ Cost-price of composted sludge is high

### 3.5.2 Typical wastewater treatment systems

#### 3.5.2.1 Wastewater collection

The volume of wastewater may exceed water extraction because mixing conduit is common in towns where also precipitation water is collected. In addition, pipelines are often so fallen into disrepair that surface water flows in. Smaller water users who do not supply a separate report may be connected to public water supply facilities (Estonian Environment Information Centre, 2002).

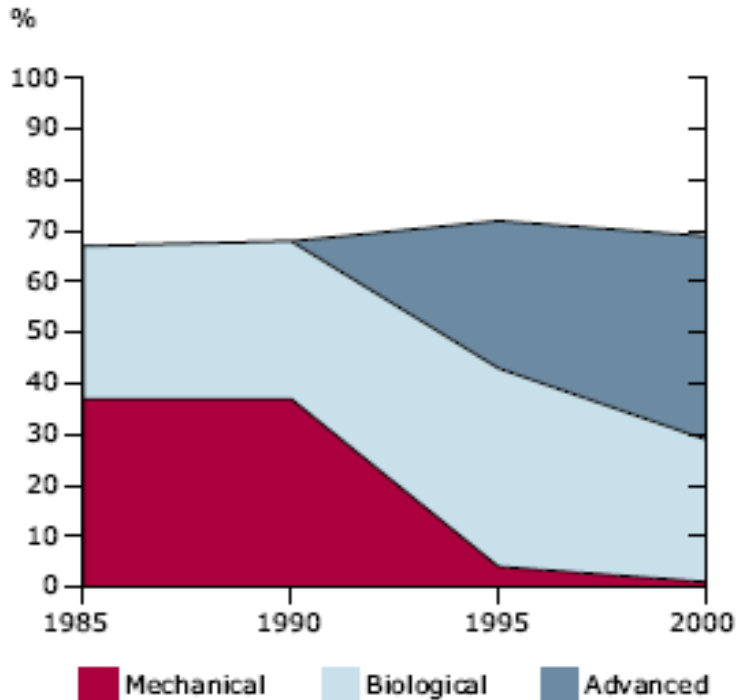
#### 3.5.2.2 Wastewater treatment

Statistical data about the level of WWTP treatment in the year 2002 is reported in Table 17.

**Table 17. Degree of WWTP treatment in the year 2002**

Degree of wastewater treatment	
Population connected to WWTP	70%
Primary Treatment	1%
Secondary Treatment	24%
Tertiary Treatment	46%

Source: Eurostat (2002)



source: EEA (2005)

**Figure 7. Share of population served with public wastewater treatment in Estonia in the period 1985-2000**

In Figure 7, advanced treatment entails essentially phosphorus removal.

### 3.5.2.3 Sludge treatment and disposal

There are no specific obligations on sludge treatment in the regulation. However, for green areas creation and recultivation it is allowed to use untreated sludge and mixture of sludge produced from untreated sludge from small treatment plants with the capacity of 2,000 PE in addition to treated sludge, mixture of sludge and sludge compost produced from treated sludge (EC, 2001).

Moreover, the sludge can be disposed on soil with pH between 5 and 6 only if it is stabilised with lime (sludge use to soil with pH < 5 is prohibited) and soil spreading of untreated sludge must be incorporate in 2 days (untreated sludge can be disposed of only in urban landscaping and cultivation).

The reported code of good practice of technological schemes applicable to the Estonian situation after transposition of the Directive 86/278/EC are summarised in Table 18.

**Table 18. Appropriate sludge treatment in Estonia (after Raia and Sokk, 2003)**

Plant Size	Thickening	Stabilisation	Dewatering	Composting
On-site and small	Sludge hauled to a bigger plant			Yes
Smaller small	Drying beds	-	-	Yes
Bigger small	Thickener	-	Yes	Yes
Medium	Thickening or aerobic stabilisation		Yes	Yes
Large	Thickener	Anaerobic	Yes	Yes

### 3.5.3 Major drivers for WWTP refurbishment

The main driver for WWTP refurbishment is the fulfilment of the European environmental *Acquis*, and in particular the requirement for nitrogen removal.

Regarding the transposition of the UWWTD into national law, Estonia declared the entire territory sensitive area for eutrophication. Estonia has obtained the following transitional periods for full compliance with the UWWTD:

- ◆ Agglomerations with a population equivalent of more than 10,000: 31 December 2009
- ◆ Agglomerations with a population equivalent of less than 10,000 : 31 December 2010

The priorities were further spelled out in the National Environmental Action Programme (NEAP), prepared for the pan-European collaboration process, which focussed on the control of point-source discharges from the major cities.

Note that as a result of the Estonian-Finnish agreement on water protection (Estonia was one of the signatory of the 1974 Helsinki Convention on Protection of the Baltic Sea), some water quality parameters are stricter than those laid down in the UWWTD (Pachel, 2002). In particular, Estonia maintains a bilateral treaty with Finland to remove 90% of organic and phosphorous substances from wastewater.

## 3.6 Hungary

Hungary has a population of 10,006,835 inhabitants (2005), of which 61% living in agglomerations larger than 2,000 population equivalents. It has been forecasted that in 2015 the Country will generate pollution for 14.18 million population equivalents (14.89 with the non-connected industries).



### 3.6.1 Status of implementation of wastewater collection and treatment

Basic statistics on the wastewater generated, collected and treated is reported in Table 19.

**Table 19. Degree of sewage system connection in Hungary at 1 January 2003**

Degree of sewage system connection	
Households connected to the sewage network in 2002	56%
Households connected to the sewerage network	5,780,997**
Homes connected to the sewage network in villages	37%
Homes connected to the sewage network in Budapest	90%
Population living in an area provided by public sewage system	62%
Level of treatment of the collected sewage	60.6% (67%**)

Sources: Ministry of Education of Hungary (2001); \* Ministry for Environment of Hungary (1999); \*\*Juhász (2006)

The untreated or poorly treated wastewater is mainly located in decentralised areas. Juhász (2006) points out that only 25 to 30 % of the 3.9 million living in small communities have an acceptable water and wastewater treatment system. Part of the 786 small villages will need appropriate decentralised wastewater treatment plant to be built (Juhász, 2006).

Basic statistics of wastewater treatment infrastructure is summarised in Table 20.

**Table 20. Number and size of WWTPs in Hungary in 2001**

Size	Number of WWTPs
> 50,000 PE	50
10,000 – 50,000 PE	400
2,000 – 10,000 PE	200
Total	650

Sources: Ministry of Education of Hungary (2001)

Because of the drastic decrease of the water consumption after the fall of the Soviet Union, the existing WWTPs are generally hydraulically underloaded. The pollutant removal remains however problematic (Juhász, 2006).

Today the renovated WWTPs are mostly hydraulically and biologically underloaded because they take into account the final capacity of the sewerage network, which are still to be connected (Juhász, 2006). The majority of real estates do not want to join the sewerage because the price of the service increased considerably; therefore it is quite typical that the sewerage and waste water treatment plants have large unused capacity (Ministry of Education of Hungary, 2001).

In Hungary one million tons of sewage sludge is handled at the purification plants creating 200 thousand tons of dry solids. By 2008 it has been projected that this amount will increase to 1.5 million tons (Biro *et al.*, 2003).

Main disposal routes for the waste sludge are the spreading in agriculture (43.5% DS) – with (29.1%) or without (14.4%) composting – and the landfilling (47.2%) (Juhász, 2006). Due to the transposition of the European landfill Directive of 1999, the landfill disposal route must be reduced

by 35% (Biro *et al.*, 2003). The trend is to substitute the landfill disposal with the incineration route, but for now this option is too expensive (Juhász, 2006).

The treatment and disposal of sludge has proven problematic in most purification plants to date, and the Government Decree No. 50/2001 has imposed even stricter rules on its placement into the environment, in particular with respect to sludge disinfection (placement into agricultural may only take place if the quantity of faecal coli and faecal streptococcus in ml must be reduced to an amount that is below 10 percent as compared to its original content).

### 3.6.2 Typical wastewater treatment systems

#### 3.6.2.1 Wastewater collection

No comprehensive information is available on the type of wastewater collection.

In the Sajo river basin, one can observe that the sewerage system is partially combined: sewerage built before 1980 are of combined type, while after the fall of the Berlin Wall it is common practice to build separate sewerage systems (McCullough *et al.*, 1993).

#### 3.6.2.2 Wastewater treatment

Basic statistics on the level of wastewater treatment is reported in Table 21.

**Table 21. Treatment of collected wastewater in Hungary in 2001**

Untreated	Primary treatment	Secondary treatment	Tertiary treatment
40%	4%	35%	21%

*Source:* Sanitation country profile-Hungary (2004)

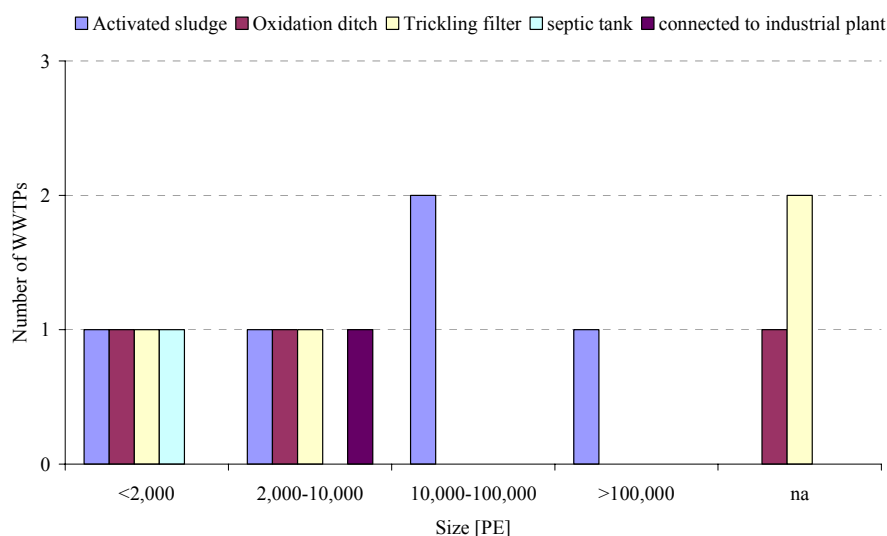
Juhász (2006) indicates that out of 555 WWTP's, having a nominal capacity of 2.19 million m<sup>3</sup>/d:

- ◆ 57% (1.24 million m<sup>3</sup>/d): biological treatment
- ◆ 26% (0.58 million m<sup>3</sup>/d): biological treatment with nutrient removal (i.e. tertiary treatment according to the notation of Table 21)
- ◆ 17% (0.37 million m<sup>3</sup>/d): mechanical treatment

More than 90 % of the Hungarian plants have activated sludge or (other) suspended growth systems (Ministry of Education of Hungary, 2001)

For facilities below 10,000 PE, the effluent results are seriously impaired in the winter season (during cold years) (Ministry for Environment of Hungary, 1999). This is especially true in the eastern part of the country, which has a continental climate.

The wastewater treatment infrastructure of the Sajo Hernad river basin should depict somehow the situation of wastewater treatment infrastructure before the WWTP refurbishment to approximate the Accession to the European Union. In the 1990s there were 15 WWTPs serving 290,000 PE (McCullough *et al.*, 1993). The type of wastewater treatment per size of WWTP is illustrated in Figure 8.



Source: McCullough *et al.* (1993)

**Figure 8. Wastewater treatment technology per WWTP size in the Sajó Hernád river catchment in 1993**

### 3.6.2.3 Sludge treatment and disposal

Mainly because of the strict regulation on sludge hygienisation, composting has been reported as a (proven) appropriate solution for Hungary, from the point of view of the quality and further applicability of the end-product as well as for technological and economical considerations (Aquamedia).

Regarding the sludge management practices before transposition of the European Directive 86/278/EC, McCullough *et al.* (1993) indicate that in 1993, in the Sajó Hernád catchment (14 facilities) heated digestion and dewatering were already common technologies for medium and large scale WWTPs.

### 3.6.3 Major drivers for WWTP refurbishment

The major driver for the construction and refurbishment of wastewater treatment infrastructure is the transposition of the UWWTD into national law. Part of the territory of Hungary has been declared sensitive area for eutrophication.

Hungary has been granted a 10-year transitional period. The transition clause differentiates between sensitive (>10,000 PE), normal (>15,000 PE) and the remaining normal areas (<15,000 PE). This shift the compliance deadline for the sensitive areas to 31/12/2008 and for the normal areas in agglomerations larger than 15,000 PE to 31 December 2010.

The Hungary's "National Wastewater Discharge Programme" pursues the aim of connecting and treating to biological level 87 percent of the population to the public sewer system by the year 2015 (Juhász, 2006), with the planned investment for wastewater treatment as reported in Table 22.

**Table 22. Estimation of the investment required to upgrade the wastewater treatment capacity in Hungary in the period between 2003 and 2015 (Juhász, 2006)**

Period	Developed capacity [10 <sup>6</sup> PE]	Cost for development of wastewater and sludge treatment [10 <sup>6</sup> EUR]
2003-2005	986	30
2006-2010	4,500	590
2011-2015	1,822	340
Total 2003-2015	7,308	960

### 3.7 Latvia

Latvia has a population of 2,290,237 inhabitants (2005), with around 70% of the population living in 72 settlements with a population equivalent larger than 2,000.



**Table 23. Distribution of agglomerations in Latvia after the Latvian water management plan**

Agglomeration Size	Number of towns	Total number of inhabitants
> 100,000 PE	3	~ 970 000
100,000 > PE > 10,000	18	~ 421 000
10,000 > PE > 2,000	51	~ 197 000

Source: Ministry of Environment (2000)

#### 3.7.1 Status of implementation of wastewater collection and treatment

Basic statistics on the wastewater generated, collected and treated is reported in Table 24.

**Table 24. Wastewater load and degree of connection to the sewerage network and WWTP in Latvia in 2003**

Indicator	2000
Wastewater collected in municipal sewerage systems, in million m <sup>3</sup> (1997) [1]	157.7
Percentage of population connected to the sewerage network [2]	77%
>20,000 PE [1]	76%
10,000 to 20,000 PE [1]	35%
5,000 to 10,000 PE [1]	38%
2,000 to 5,000 PE [1]	34%
Percentage of the collected sewage treated in WWTPs [1]	70% <sup>(††)</sup>

Source: [1] Ministry of Environment (2000); [2] Hansen (2003).

Approximately 95% of inhabitants in the mentioned towns larger than 2,000 PE will have to be connected to centralised wastewater collection.

In 2000, the greatest volume of waste water was discharged by Riga (135 million m<sup>3</sup>), Daugavpils (25 million m<sup>3</sup>) and Liepaja (19 million m<sup>3</sup>), where respectively 80%, 85% and 83% of the population is connected to the sewerage network.

The design capacity of WWTPs, in terms of BOD, in 2003 amounted to 157,000 Kg O<sub>2</sub>/d (Eurostat, 2003).

In 1991, completion of the first stage of a new biological wastewater treatment plant in Riga (70-80% of total needs), greatly contributed to the reduction of the municipal pollution load. Riga and

<sup>††</sup> 64% according to Hansen (2003)

Daugavpils contribute for about 70% of the organic pollutant load. Although Riga and Daugavpils have wastewater treatment plants (mechanical treatment only in Daugavpils), they are overloaded by the discharge of industrial wastewaters to the municipal systems, constituting 40-50% of the total amount of wastewater treated. This seems to be in fact one of the characteristic features of municipal sewage systems all over the former USSR Baltic states.

Industrial wastewater is discharged into the municipal sewage systems with little if any pre-treatment, creating severe difficulties, in particular interruption of the biological treatment processes. In other Latvian cities, wastewater treatment systems have been built mostly for the local industrial enterprises.

Generally, wastewater treatment facilities are inadequate due to longstanding maintenance neglect (cf. Table 28).

The sludge produced in 2003 amounted to 64,058 ton DS. The excess sludge disposal routes and their relative importance are shown in Table 25.

**Table 25. Sludge production and disposal in Latvia**

Reused on soil and agriculture	Reused in other ways	Landfills	Other means (except incineration*)
67%	9%	18%	6.3%

*Source:* Ministry of environment of Latvia; \*So far there is no sludge incineration plant in Latvia.

The limit values for heavy metals in sludge when sludge is to be used in agriculture are defined by the Regulation No. 316, and correspond to the lowest limits imposed by Directive 86/278/EEC. The limit values for heavy metals in soil vary depending on the types of soil are in most cases stricter than the limit values specified in Directive 86/278/EEC.

### 3.7.2 Typical wastewater treatment systems

#### 3.7.2.1 Wastewater collection

Historically, sewage was transported through combined sewerage networks. In recent years the tendency is to go for separate systems.

#### 3.7.2.2 Wastewater treatment

Within Latvia there is a wide variation in the type of treatment of wastewater (Table 26).

**Table 26. Degree of WWTP treatment in Latvia in 2003**

Indicator	2003
Population connected to WWTP	70%
Primary treatment	2%
Secondary treatment	35%
Tertiary treatment	33%

*Sources:* Eurostat (2003)

Of approximately 1,100 treatment plants (!), 159 provide mechanical treatment only and 805 secondary treatment (Ministry of Environment of Latvia, 2000).

Details of primary - mechanical and biological treatment plants characteristics are presented in Table 27 and Table 28, respectively. At the majority of wastewater treatment plants where there is secondary biological treatment the process is mainly based on activated sludge.

**Table 27. Statistics about primary - Mechanical Treatment only plants in Latvia (1996)**

Item		Result
Number of Plants		159
Number of Plants Serving:	<2,000 PE	128
	2,000 to 10,000 PE	7
	> 10,000 population	-
Number of hydraulically overloaded plants		16
Number of plants in poor condition		146
Treated effluent quality, BOD <sub>7</sub> mg/l	Typical (average of measured values):	154
	Maximum measured value:	441
	Minimum measured value:	3.2

Source: Ministry of the Environment (1996).

**Table 28. Statistics about secondary treatment infrastructure in Latvia (1996)**

Item		Results
Number of Plants		721
Number of Plants Serving	<2,000 PE	609
	2,000 to 10,000 PE	30
	10,000 to 15,000 PE	10
	> 15,000 PE	8
Number of Overloaded Plants		45
Number of Plants in Poor Condition		80
Treated Effluent Quality BOD <sub>7</sub> mg/l	Typical (average of measured values)	201
	Maximum measured value	570
	Minimum measured value	1.45
	Non-compliance with Latvian BOD <sub>7</sub> limit	268

Source: Ministry of the Environment (1996).

An overview on waste water treatment options for small and medium size settlements tailored to Latvian conditions has been reported by Juris Laicans (2003) and Wach (2003). The WWTP options focused on biological treatment systems with activated sludge and on more extensive systems such as wetlands and infiltration fields. Based on the experiences from the project in Tīnūži, Wach (2003) concluded that constructed wetlands technology has a large potential, if the plants are designed according to Latvia's local conditions, and that constructed wetlands treatment plant is suitable up to 1,000 PE. He concludes that the large area required for these plants is not a real obstacle in Latvia, but that isolation must be ensured in order to keep the necessary temperature range during winter.

In contrast to such decentralised systems, Krukļitis (2003) illustrated a project about a single waste water management system serving four municipalities (Lielplatone, Vilce, Sesava and Eleja). This project can be seen as showcase on how to implement centralised solutions for waste water treatment in small villages in Latvia. Here a combined pressure-pipe system ensures the connection of small communities to a larger treatment plant where more advanced treatment is applied. The project started from the need for reconstruction of the existing waste water treatment plant. As the existing plant was built too large for a single settlement, it was possible to increase the waste water load by connecting few more settlements in a joint treatment system (transport+treatment cost ~0.8 LVL/m<sup>3</sup>).

### 3.7.2.3 Sludge treatment and disposal

No information is available on the existing infrastructure. There are also no specific obligations in the legislation on this issue.

In the National waste management action plan for the period 2004-2008 one reads that by 2008 the “*equipment for acceptance, treatment and processing of waste to be annihilated biologically, including dehydrated sewerage sludge will have to be installed in areas of municipal and household landfills*”. Note that Latvia experiences serious problems with waste disposal. Among others: large number of landfills are not complying with environmental protection requirements, there is the lack of a municipal solid waste inventory, and that systems for the management of hazardous waste, and for the recycling of packaging have not yet been established.

### 3.7.3 Major drivers for WWTP refurbishment with MBR technology

The major driver is the transposition of the UWWTD into national law. Latvia has declared whole of its territory sensitive area for eutrophication and the eutrophication of the water courses is a recognised problem.

The deadlines for meeting the requirements of the Directive 91/271/EEC shall not fully apply until December 2015 in accordance with the following intermediate targets:

- ◆ Agglomerations with a population equivalent larger than 100,000: 31/12/2008
- ◆ Agglomerations with a population equivalent between 10,000 and 100,000: 31/12/2011

In order to ensure the implementation of wastewater treatment measures, the Ministry of Environmental Protection and Regional Development established the 800+ Program for water management. The Programme sets down the same maximum permissible pollutant concentrations than the UWWTD. The programme states that in settlements smaller than 2,000 PE, if sewage is discharged into a river with high self-purifying capacity, mechanical purification could be sufficient.

The NATIONAL ENVIRONMENTAL POLICY PLAN 2004 – 2008 of the Republic of Latvia mentions that in the year 2004 an agenda should have been set for reduction of pollution in priority fish and bathing waters, and increase the reliability of the systems. It will be useful in the next reporting period to solicit the Ministry of the Environment on the progresses on such a plan. In seeking for compliance with the hygienic requirements set by the new Bathing Water Directive, municipalities might seek to implement disinfection at wastewater treatment plants, hence the competitive advantage offered by MBR technology in comparison to conventional secondary and tertiary wastewater treatment technology. Hansen (2003) argues that in order to comply with the bathing water requirements, substantial financial resources are needed in Latvia.

Another issue that should be investigated further in the context of the plant upgrade potential study is the reportedly low quality of drinking water. Pending issues such as poor condition of the drinking water distribution network, in certain areas low connection rate of population to centralized water supply and imperfections in water accountability (cf. Mičulis, 2003) might be factors encouraging the use of alternative water sources including e.g. the high-quality MBR effluent.

In evaluating the plant upgrading potential of MBR technology in achieving the water quality and water efficiency objectives laid down in the Water Framework Directive, the next phase of the project will also solicit information from the National Authorities on the steps and measures of the integrated water management system based on the river catchment basin approach implemented on the Daugava River Basin Project.

## 3.8 Lithuania

Lithuania has a population of 3,596,617 inhabitants (2005), of which 58% living in 39 towns and municipalities larger than 10,000 inhabitants ([www.citypopulation.de](http://www.citypopulation.de)).



### 3.8.1 Status of implementation of wastewater collection and treatment

Basic statistics on the wastewater generated, collected and treated is reported in Table 29.

**Table 29. Wastewater load and degree of connection to the sewerage network and WWTP in Latvia in 2003**

Indicators	2003
Percentage of population served by public sewerage	73%
Percentage of population connected to a WWTP	59%

Source: Eurostat (2003)

According to Eurostat, the design capacity of WWTPs in BOD load in 2003 was 397,000 kgO<sub>2</sub>/day.

### 3.8.2 Typical wastewater treatment systems

#### 3.8.2.1 Wastewater collection

No information is available on the type of wastewater collection systems.

#### 3.8.2.2 Wastewater treatment

The degree of treatment of the Latvian WWTPs in 2003 is set out in Table 30.

**Table 30. Degree of sewage treatment of WWTP in Lithuania in 2003**

Level of treatment	2003
Untreated	41%
Primary treatment	32%
Secondary treatment	7%
Tertiary treatment	21%

Source: Eurostat (2003)

#### 3.8.2.3 Sludge treatment and disposal

No information is available on the type of sludge treatment facilities.

### 3.8.3 Major drivers for WWTP refurbishment

Lithuania has been granted a 4-year transitional period to comply with the UWWTD. Lithuania has designated the whole of its territory as a sensitive area and therefore all wastewater treatment infrastructure larger than 10,000 PE is to be upgraded to nutrient removal standards. The transition clause differentiates between agglomerations requiring nutrient removal (> 10,000 PE) and those not requiring nutrient removal (<10,000 PE). The compliance deadline for the former is 31 December 2007 and for the latter 31 December 2009.

The Water Economy Management Strategy, which was adopted in 2005, aims at

- ◆ ensuring compliance with centralized water supply and wastewater treatment services with the requirements for health and nature protection, and to maintain sustained functioning of centralized water supply and wastewater treatment systems;
- ◆ to reduce discrepancies in the price of centralized water supply and wastewater treatment services, and in the state of water supply and wastewater treatment between cities and villages, and throughout the whole territory of the country;
- ◆ to increase accessibility of centralized drinking water supply and wastewater treatment services, and
- ◆ to ensure effective use of centralized water supply and wastewater treatment infrastructure.

The Law on the Evaluation of the Impact of Planned Economic Activity on the Environment was amended in 2005. The procedure for public information and participation in the preparation of plans and programmes intended for protection of ambient air and water was approved by the Minister of Environment by Order No. D1-381 of 26 July 2005. National Environmental Monitoring Programme for 2005-2010 was approved by Resolution No. 130 of 7 February 2005. The aim of the programme is to halt the biodiversity decline by 2010.

### 3.9 Malta

Malta has a population of 398,534 inhabitants (2005), of which 78% living in 43 towns and municipalities larger than 5,000 inhabitants, 12 of which larger than 10,000 ([www.citypopulation.de](http://www.citypopulation.de)). Tourist arrivals are about three times the number of the residential population.



#### 3.9.1 Status of implementation of wastewater collection and treatment

Basic statistics on the wastewater generated, collected and treated is reported in Table 31.

**Table 31. Waste water loads in Malta in 2003**

	2001	2003	2007*
Water Consumption [million m <sup>3</sup> /year]	31.2	-	
Wastewater in sewerage systems	24.96	-	
Percentage connected to the sewerage systems	80%		
Treated wastewater [million m <sup>3</sup> /year]	3.28	2.5	
Percentage of collected sewage treated in a WWTP	13.1%		100%
Treatment plant capacity [million m <sup>3</sup> /year]		6.2	

*Source:* University of Malta; \*projection by Vassallo (2003)

Despite the fact that 80% of the population is connected to the sewerage system, in 2003 only a marginal part of it was treated at a wastewater treatment plant. Most of the wastewater was discharged untreated into the sea through 3 main submarine outfalls.

At present there is only one WWTP at Sant Antnin, in the Southern part of Malta, treating only 13.1% of the collected sewerage. It is expected however that by 2007, with the completion of three other WWTPs, 100% of the collected sewage will receive treatment (Vassallo, 2003).

In 2003, the Sant Antnin WWTP produced 1,760 ton sewage sludge, and the sludge was disposed of into the marine environment through the submarine outfalls. With the completion of the remaining three WWTPs, it has been projected the waste sludge production will rise to 9,330 ton per year (Vassallo, 2003).

#### 3.9.2 Wastewater treatment infrastructure

##### 3.9.2.1 Wastewater collection

From the limited available information, one can deduce that the sewerage network is of combined type.

##### 3.9.2.2 Wastewater treatment

The WWTP is conventional activated sludge system. A certain percentage of the Sant Antnin WWTP effluent is polished through a coagulation-flocculation and filtration unit and disinfected before reuse for irrigation purpose.

##### 3.9.2.3 Sludge treatment and disposal

The sludge resulting from the Sant Antnin WWTP is currently being discharged at one of the sea outfalls.

The possibility of applying treatment sludges as fertilisers and soil improver is no longer considered as acceptable (Vassallo, 2003). Co-digestion seems the most likely plan. In this option, stabilised biowaste from the organic fraction of the mixed municipal waste is combined with the dewatered sewage sludge and used as landfill cover.

### **3.9.3 Major drivers for WWTP refurbishment**

The requirements for treatment of urban waste water shall not fully apply in Malta until 31 March 2007 in accordance with the following intermediate targets:

- ◆ Marsa Land (representing 19% of the total biodegradable load): by accession
- ◆ Gozo-Main (representing 5% of the total biodegradable load): 31 December 2004
- ◆ Gharb in Gozo and Nadur in Gozo (representing 1% of the total biodegradable load): 31 December 2005
- ◆ Malta North (representing a further 8% of the total biodegradable load). 31 October 2006

Malta has not been designated as a sensitive area in regards to urban wastewater treatment and therefore nutrient removal is not required.

A second driver is the structural and temporal water resources shortages, with a high potential for water reclamation reuse (Hochstraat *et al.*, 2004). Water reclamation and reuse is not regulated yet.

### 3.10 Poland

Poland has a population of 38,635,144 habitants (2005), with almost 100 agglomerations larger than 100,000 population equivalents.



#### 3.10.1 Status of implementation of wastewater collection and treatment

Basic statistics on the wastewater generated, collected and treated is reported in Table 32.

**Table 32. Degree of connection in Poland in 2002 and 2003**

Indicator	2002	2003
Wastewater discharged in million m <sup>3</sup> [1]		73,840
Households connected to sewerage system [2]	57%	n.a.
Households connected to a WWTP [3]	55%	

Source: [1] Ministry of Environment of Poland (2003b); [2] IWA (2005); [3] EEA (2005)

In 2001, approximately 80% of the population was connected to a sewerage system in urban areas (Twardowska, 2003). In rural areas the connection rate is much lower (approximately 15% in 2001).

The status of implementation of sewerage collection and treatment in the year 2000 is set out in Table 33.

**Table 33. Wastewater collection and treatment infrastructure in Poland per size of agglomerations (2000)**

Agglomeration size (PE)	Agglomeration with sewerage network	Agglomeration with WWTPs (at least biological type)	Agglomeration with WWTPs with "biogenic" <sup>**</sup> removal
2,000 – 10,000	507	321	
10,000- 15,000	100	64	
15,000- 100,000	329	97	97
> 100,000	80	21	21
TOTAL	1,016	503	118

Source: Ministry of environment of Poland

The number of wastewater treatment plant per size of agglomeration is set out in Table 34.

**Table 34. Number of WWTPs in Poland in 2003**

Size of agglomeration (PE)	Number of WWTPs
≥ 100,000	97
15,000 - 100,000	294
2,000 – 15,000	762
TOTAL	1,153

Source: Ministry of Environment of Poland (2003b)

Due to shortage of funds, upgrade of old wastewater treatment plants was often given a higher priority than the provision of new infrastructure (EEA, 2005).

In 2001, 44,322 ton dry solids of sludge were produced nationally (Twardowska, 2003). After Twardowska (2003), these amounts will more than double by 2015. The types of sewage sludge disposal routes and their relative importance in 2001 is set out in Table 35. Note that in 2001 only a marginal fraction was incinerated.

<sup>\*\*</sup> It is not clear what the term "biogenic" mean; our interpretation is that these are nutrient removal plants

**Table 35. Status of sewage sludge disposal routes in Poland in 2001**

Landfilled	Agriculture	Composted	Reused in industry	Other
42%	14%	7%	20.6%	16.4%

Source: European Compost Network; Twardowska (2003)

Sewage sludge use in agriculture as a source of nutrients and valuable organic matter appears to be the most attractive and cost-effective, but at the same time also the most controversial disposal outlet due to particularly high concentration of heavy metals, metalloids and hazardous organic pollutants (Twardowska, 2003).

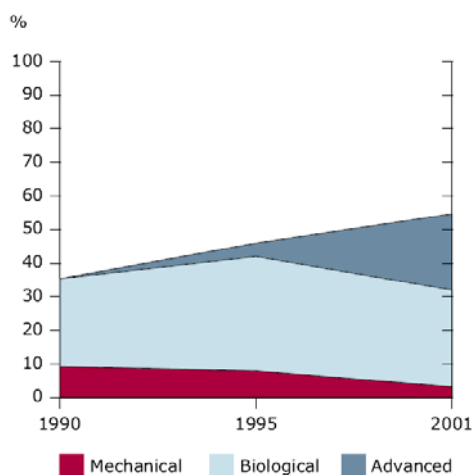
### 3.10.2 Typical wastewater treatment systems

#### 3.10.2.1 Wastewater collection

Most of sewers are of combined type (Twardowska, 2003).

#### 3.10.2.2 Wastewater treatment

Figure 9 shows that of the 55% of households connected to the sewerage treatment plant by the year 2000 23% of the wastewater received advanced (tertiary) treatment.



source: EEA (2005)

**Figure 9. Share of population served with public wastewater treatment in Poland in the period 1985-2000**

Of the 509 cities which are required to comply with the UWWTD in 2005, the most recent available data indicate that 182 have so far been equipped with at least secondary treatment (EEA, 2005).

**Table 36. Agglomerations with the existing WWTPs that complied with the UWWTD in 2002**

Size of agglomeration (PE)	Number of agglom.	PE Mill	Number of agglomerations in which WWTPs comply with the requirements of the directive in 2002			
			WWTPs in compliance		WWTPs that require expansion	
			number	PE(mill)	number	PE (mill)
≥ 100,000	76	21.645	12	3.052	0	0
15,000 - 100,000	366	13.653	93	3.587	22	0.553
2,000 – 15,000	936	5.718	229	1.609	261	1.573
TOTAL	1,378	41.016	334	8.250	283	2.126

Source: Ministry of Environment of Poland (2003b)

### 3.10.2.3 Sludge treatment and disposal

No information is available concerning excess sludge treatment practices.

Obligations for sludge treatment are specified in the Decree of 11 August 1999, where the use of sludge is authorised if sludge is stabilised after chemical treatment, heat treatment or other treatments in order to minimise health risks. The limit values for heavy metals and microbial pathogens (salmonella and parasite eggs) in sludge for application in agriculture and soil are tougher than those laid down into the European Directive 86/278/EEC.

### 3.10.3 Main drivers for WWTP refurbishment

In the transposition of the UWWTD, Poland has designated the whole of its territory as a sensitive area, to which additional nutrient removal requirements apply.

Poland has been granted a 10-year transitional period. The transition clause differentiates between industry and various urban areas (European Environmental Bureau, 2003):

- ◆ 674 agglomerations, representing 69% of the total biodegradable load: 31 December 2005
- ◆ 1,069 agglomerations, representing 86% of the total biodegradable load: 31 December 2010
- ◆ 1,165 agglomerations, representing 91% of the total biodegradable load: 31 December 2013
- ◆ Full compliance: 31 December 2015

Effectively this means that 361 projects for WWTP construction or refurbishment must be completed by 31 December 2010 (medium and large WWTPs) and 707 projects by 31 December 2015 (small scale WWTPs) (Table 37).

**Table 37. WWTPs needing modernisation and expansion and construction of new plants for compliance with the UWWTD**

Size of agglomeration (PE)	Agglomerations which need modernisation, expansion, or construction WWTPs				Number of WWTPs that need action
	before 31.12.2010		before 31.12.2015		
	number	PE	number	PE	
≥ 100,000	64	18,592,171	0	0	69
15,000 - 100,000	273	10,065,690	0	0	294
2,000 – 15,000	0	0	707	4,108,698	762
TOTAL	361	28,657,861	707	4,108,698	1,125

Source: Ministry of Environment of Poland (2003b)

Estimates of the capital requirement of the approximation plan are reported in Table 38.

**Table 38. Capital work for equipping agglomerations WWTPs during the period 2003-2015**

Size of agglomeration (PE)	Number of WWTPs	WWTP with the following actions planned:					PE
		M	IM	R	RM	BN	
≥ 100,000	97	69	-	-	21	7	19 237 021
15,000 - 100,000	294	182	13	22	55	22	9 807 786
2,000 – 15,000	762	77	28	261	176	220	3 721 752
TOTAL	1153	328	41	283	252	249	32 766 559

Source: Ministry of Environment of Poland (2003b)

Legend: *M* – wastewater treatment plants to be modernised, *IM* – modernisation of sewage sludge process, *R* – wastewater treatment plants to be extended, *RM* – wastewater treatment plants to be extended and modernised, *BN* – construction of new wastewater treatment plants.

### 3.11 Romania

Romania has a population of 22,455,500 inhabitants and is composed of 263 towns and municipalities (agglomerations over 10,000 PE) and 15,779 villages and communes (agglomerations smaller than 10,000 PE), 2,346 larger than 2,000 PE. The number and size of the agglomerations larger than 2,000 PE are reported in Table 39.



**Table 39. Number and size of agglomerations larger than 2,000 PE in Romania**

Size	Number of agglomerations	Total population equivalent
2,000-10,000 PE	2,346	10,192,131
10,000- 150,000 PE	241	7,012,655
> 150,000 PE	22	9,562,512
Total	2,609	26,767,398

Source: Government of Romania (2004)

#### 3.11.1 Status of wastewater collection and treatment

The connection rates to the sewerage network and to the WWTPs in Romania are set out in Table 40.

**Table 40. Degree of connection to the sewerage network and to the WWTPs in Romania**

Indicator	All country	Urban	Rural
% of dwellings with sewage network	51.1	85.6	12.9
Number of agglomerations with sewerage networks	636	262	374
Number of WWTPs	340 [1]	216 [2]	53 [2]
Capacity of the WWTPs [2]	5,098,300 m <sup>3</sup> /d*	98.72 %	1.28%

Sources: [1] Government of Romania (2004); [2] Chiru (2004). \*At the end of the year 1999

Table 40 shows that the sewerage system infrastructure is concentrated in urban areas and it is virtually absent in rural districts. Out of the 2,609 agglomerations larger than 2,000 PE, 636 have a sewerage system and 340 are equipped with a wastewater treatment plant.

The general level of wastewater treatment is low with only 77% of the flow to the public sewerage being treated, and only 18% treated to EU standards (Chiru, 2004). Moreover, more than 67% of urban WWTPs are over 15-year old (Romanian national Water Management, 2004) and the wastewater treatment efficiency is reported to be negatively influenced by the equipment inefficiency (Ministry of environment of Romania). In 47 municipalities, the waste water is even discharged without treatment.

Currently, the sludge from wastewater treatment plant is land filled in urban waste landfills.

**Table 41. Quantity of sludge discharged by the WWTP in Romania in 2001**

Indicators	Primary	Secondary	Total
Disposed sludge [ton DS/yr]	67,910.5	103,640.1	171,550.6

Source: Government of Romania (2004)

### 3.11.2 Typical wastewater treatment infrastructure

#### 3.11.2.1 Wastewater collection

According to the Government of Romania, in 2004 there were 211 separated sewers, 11 unitary sewers, 88 mixed and 10 combined (Government of Romania, 2004).

#### 3.11.2.2 Wastewater treatment

The number and type of wastewater treatment is summarised in Table 42.

**Table 42. Number and types of WWTP in Romania**

Total WWTPs	Mechanical	Mechanical-chemical	Mechanical-biological	Mechanical-biol-chemical
340	112	6	212	10
	33%	1.8%	62.3%	2.9%

*Source:* Government of Romania (2004)

Chiru (2004) asserted that the wastewater treatment plants are typically composed of bar racks and screens, sand-traps and skimming tanks, primary settlers, aeration basins and secondary clarifiers.

Chiru mentions that the existing waste water treatment plant efficiency is lower than the considered designed parameters, mainly because of the poor condition of the infrastructure, the changes in the wastewater characteristics and the alteration of the permitted effluent limits.

Many existing WWTPs in urban areas have been recently renovated or are planned to be renovated in the coming years. EU ISPA grants in the period 2000-2003 included 18 WWTP refurbishments, including the WWTPs of all the major cities (Romania is the second beneficiary of ISPA grants after Poland). These projects are intended to bring about compliance with the UWWTD effluent norms to over 6,000,000 PE. These plants are planned to be operational in the period between 2005 and 2008.

Looking at the description of the existing wastewater treatment infrastructure available from the ISPA projects, it emerges that lagoons are also common technologies (in the ISPA applications are reconverted to activated sludge systems).

#### 3.11.2.3 Sludge treatment

No comprehensive information was found on the sludge treatment practices.

Reina (2004) indicates that at Timisoara WWTP (440,000 PE), the only sludge treatment was composed of open sludge drying beds. In the refurbishment of the facility, the existing sludge treatment is being substituted with mechanical dewatering equipment.

### 3.11.3 Main drivers for WWTP refurbishment

The need to comply with the EU's environmental *acquis* is the main factor which helps to promote the control of point-source discharges such as WWTPs. In the transposition of the UWWTD, Romania has designated the whole of its territory as a sensitive area, to which additional nutrient removal requirements apply for agglomerations larger than 10,000 PE.

Romania has been granted a 13-year transitional period. The transition clause differentiates between sensitive (>10,000 PE) and non-sensitive areas (<10,000 PE). This shifts the compliance deadline for the 263 urban areas (representing 61.9% of the total biodegradable load) to 31/12/2015 and for the 2,346 rural areas (representing 38.1% of the total biodegradable load) to 31/12/2018 (Government of Romania, 2004).

## 3.12 Slovak Republic

Slovakia has a population of 5,431,363 inhabitants (2005).

### 3.12.1 Status of implementation of wastewater collection and treatment

The degree of connection to the sewerage network and to WWTP and related wastewater quantities in Slovakia in 2003 and 2005 are reported in Table 43.



**Table 43. Degree of connection to the sewerage network and to WWTP and related wastewater quantities in Slovakia in 2003 and 2005**

Indicator	Unit	2003	Estimate 2004	Estimate 2005
Number of inhabitants connected to public sewerage network	1,000	3,005	3,020	3,040
% of population connected to sewerage	%	55.9	-	--
Of which: connected to public WWTPs	1,000	2,716	2,718	2,720
% of population connected to WWTPs	%	50.6	-	-
Discharged wastewater [1]	Mill m <sup>3</sup>	443.7	420	410
Discharged wastewater [2]	Mill m <sup>3</sup>	950.7	-	-
Of which/ treated [1]	Mill m <sup>3</sup>	424.4	400	390
Of which/ treated [2]	Mill m <sup>3</sup>	653.6	-	-
Of which/ untreated [1]	Mill m <sup>3</sup>	227.2	225	220.2
Of which/ untreated [2]	Mill m <sup>3</sup>	297.1	-	-
(Untreated) Of which: sewage waters [1]	Mill m <sup>3</sup>	131.2	127.7	124.8
(Untrea.) Of which: Industrial and others ww [1]	Mill m <sup>3</sup>	96	97.3	95.4

Sources: [1] Report on Water Management in the Slovak Republic in 2003 (2004); [2] State of environment report- Slovakia (2003)

The highest rate of the settlements with the public sewerage system was situated in the Bratislava (41.7 %), Žilinska (27.6 %) and Banskobystrica regions (22.5 %).

The National Environmental Action Plan II, issued in 2000, listed around 140 projects under the heading 'reduction in the amount of pollutants in discharged wastewater'.

The overview of sludge generated by the municipal wastewater treatment plants administered by Water and Sewerage Company and the practically realised method of its treatment in the years 1998-2002 is provided in the table below. The leading concept of the treatment of sludge generated by municipal wastewater treatment plants is the controlled application of sludge into soil.

**Table 44. Treatment and disposal of sludge in Slovakia in 2001 and 2002**

Year	Sludge generation ton DS/y	Application into soil		Temporarily stored		Disposed at landfill	
		ton DS/y	%	ton DS/y	%	ton DS/y	%
2001	53,350	37,855	71	8,493	15.9	7,002	13.1
2002	51,270	41,960	81.8	4,870	9.5	4,440	8.7

Source: Report on Water Management in the Slovak Republic in 2003 (2004)

The sludge application to soil was carried out without any regulation (Gergelova, 2003). The European Directive 86/278/EC on sewage Sludge was transposed into national legislation by the Act No 188/2003, which entered into force on 1<sup>st</sup> January 2004. The limit values for heavy metals are

equal to the minimum values of the Directive's current requirements and even more stringent for Cadmium (10 mg/kg DS) and Mercury (10 mg/kg DS). Pathogenic indicators of microbiological contamination for sewage sludge are thermo-tolerant coli and cesspit streptococci. Among the several restrictions for sludge use into soil, one can notice the 18%-dry matter threshold and that the total volume of nitrogen must not exceed 75% of the batch necessary to fertilise the grown agricultural crops.

### **3.12.2 Typical wastewater treatment systems**

#### **3.12.2.1 Wastewater collection**

Combined sewer systems prevail (Sztruhár *et al.*, 2002).

#### **3.12.2.2 Wastewater treatment**

The number of WWTP in 2003 reached 384. The highest rate was represented by the mechanical and biological WWTPs. According to Morris and Kis (2004), 95% of the wastewater collected to the sewerage was treated with primary treatment (10%) and secondary treatment (90%), nutrient removal being limited to only 1-2%.

Many WWTPs in urban areas have been recently renovated or are planned to be renovated in the near future. In the period 2000-2003 EU ISPA funds were granted to 12 WWTP refurbishments projects, for a treatment capacity that approximate 1,000,000 PE (most of these project will be completed by end 2008). The existing secondary treatment infrastructure seemed to be composed, typically, of conventional (high-loaded) activated sludge systems, preceded by a physico-mechanical treatment (bar racks and screens) and primary clarifiers.

Typical refurbishment work is to expand the activated sludge system to make it low-loaded and the adoption of simultaneous chemical phosphorus precipitation (McCann, 2004; Haloun, 2005). Typical nominal biomass concentration is 4 g MLSS /L. In the refurbishment, primary clarifiers are retained in the treatment train or even newly constructed.

The case study of the Orava region<sup>§§</sup> described by Haloun (2005) provides an example of wastewater treatment infrastructure in small and medium scale catchments. The Orava region is composed of 4 towns and 59 villages -for a population totalling 121,000, and by now it is served by 3 WWTPs. The WWTP Námestovo (phase 1: 15,000 PE; phase 2: 42,000 PE): it is being renovated towards nutrient removal. The biological system will be composed of an activated sludge unit with simultaneous nitrification/denitrification and chemical precipitation. The design mixed liquor suspended solids concentration is 4 g MLSS/L. The biological system will be preceded by a newly-built primary clarifier and part of the storm flow be diverted to a storm water tank. The sludge line is composed of a sludge thickening unit followed by an anaerobic sludge digester which is operated at mesophilic conditions. The stabilised sludge is dewatered in centrifuges, hygienised by lime and may be used for composting. The plans also foresee the construction of a new small scale WWTP at Zázrivá (3,400 PE).

Note that despite the combined sewers, wastewater treatment facilities are usually designed to handle only dry weather flows, but not storm water runoff. The primary settling tanks are designed to treat two times the daily maximum dry weather flow (Sztruhár *et al.*, 2002). Storm water flow is generally treated to storm retention tanks having a retention time of approximately 35 minutes or bypassed.

#### **3.12.2.3 Sludge treatment and disposal**

We did not find comprehensive information about the sludge treatment practice. For the few case studies for which we could find information, the sludge was originally stored in sludge drying beds. Recent practices are also to stabilise the sludge, aerobically or anaerobically (at mesophilic

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<sup>§§</sup> In the Orava region are located 4 towns and 59 villages -for a population totalling 121,000- and 3 WWTPs

conditions, after thickening), and dewatering it by e.g. centrifugation (e.g. McCann, 2004; Haloun, 2005). The dewatered sludge may be used for composting (after hygienisation, e.g. by lime dosage).

### 3.12.3 Major drivers for WWTP refurbishment

The need to comply with the EU's environmental *acquis* is the main factor which helps to promote the control of point-source discharges such as WWTPs. In the transposition of the UWWTD, Slovakia has designated the whole of its territory as a sensitive area (Act No. 184/2002) and therefore all wastewater treatment infrastructure larger than 10,000 PE is to be upgraded to nutrient removal standards. Slovakia has been granted a 10-year transitional period. The transition clause differentiates between sensitive (>10,000 PE) and non-sensitive areas (<10,000 PE). This shifts the compliance deadline for the agglomerations larger than 10,000 PE to 31/10/2010 and for the agglomerations between, 2,000 PE and 10,000 PE to 31/12/2015 (Fresh Water Country Profile- Slovakia, 2004).

Moreover, all lowland areas and alluvial plains of larger rivers are designated as vulnerable areas for groundwater pollution by nitrate under the Water Act (Jozef and Martin, 2005).

Finally, approximately 14% (17.5%) of the entire Slovak territory is designated as protected water management (water supply resources) area \*\*\* (Jozef and Martin, 2005). These and other areas might soon be included into the new integrated European system of protected areas Natura 2000.

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\*\*\* The two zones are sometimes overlapping and therefore the total is less than the sum of the two.

### 3.13 Slovenia

Slovenia has a population of 2,011,270 inhabitants (2005).



#### 3.13.1 Status of implementation of wastewater collection and treatment

The degree of connection to the sewerage network and to WWTP in 2002 are reported in Table 45.

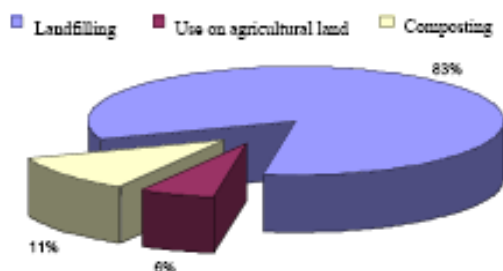
**Table 45. Degree of connection to the sewerage network and to WWTP and related wastewater quantities in Slovakia in 2002**

Indicator	2002
Percentage of population connected to sewerage	63%
Percentage of population connected to WWTPs	33%

Source: Eurostat (2003)

According to Eurostat, the design capacity of urban WWTPs in 2003 in BOD was 65,000 kg O<sub>2</sub>/d.

Approximately 10,000 ton of sewage sludge was produced in Slovenia in 2002 and in 2015 this will amount to ca. 25,000 (Turk, 2003). The types of sludge disposal routes in Slovenia and their importance in 2002 are set out in Figure 10.



Source: Turk (2003)

**Figure 10. Sludge disposal routes in Slovenia in 2002**

A number of severe restrictions limits the use of sewage in agriculture and safeguards the environment and quality of the derived food.

#### 3.13.2 Typical wastewater treatment systems

##### 3.13.2.1 Wastewater collection

No information is available on the wastewater collection system.

##### 3.13.2.2 Wastewater treatment

The degree of WWTP treatment in 2002 is reported in Table 46.

**Table 46. Degree of WWTP treatment in Slovenia in 2002**

Untreated	Primary T	Secondary T	Tertiary T
63%	10%	18%	5%

Source: Eurostat

##### 3.13.2.3 Sludge treatment and disposal

No information is available on sludge handling systems.

In transposing the Directive 86/278/EEC into national legislation, Slovenia laid down more stringent limit values for heavy metals in sludge as well as for maximum annual load than the Directive's requirements. In addition, Slovenian legislation prohibits the sludge spreading on agriculture if it contains pathogens (Salmonella and Shigella bacteria).

After (Mihelič, 2003), realistic scenarios for the future situation will be

- ◆ Incineration of majority of sewage sludge;
- ◆ Recycling:
  - Agriculture – up to 40% of sludge (through composting and/or pelletising);
  - Land reclamation, landfill and road bank
  - Vegetative cover (large niche for the next decade).

### **3.13.3 Transposition of the EU271/91/EC into national law**

The need to comply with the EU's environmental *acquis* is the main factor which helps to promote the control of point-source discharges such as WWTPs.

In the transposition of the UWWTD, Slovenia has designated part of its territory as a sensitive area (Act No. 184/2002), to which additional nutrient removal requirements apply for agglomerations larger than 10,000 PE.

Slovenia has been granted a 10-year transitional period. The transition clause differentiates between sensitive (>10,000 PE) and non-sensitive areas larger than 15,000 PE. Effectively this shifts the compliance deadline for the former areas to 31/12/2008 and for the latter to 31/12/2015.

### 3.14 Turkey

Turkey has a population of 70.7 million inhabitants (2005), with about 75% of the population living in the 3,227 municipalities.



#### 3.14.1 Status of implementation of wastewater collection and treatment

The degree of connection to the sewerage network and to WWTP and related wastewater quantities in Turkey in 2003 are reported in Table 47.

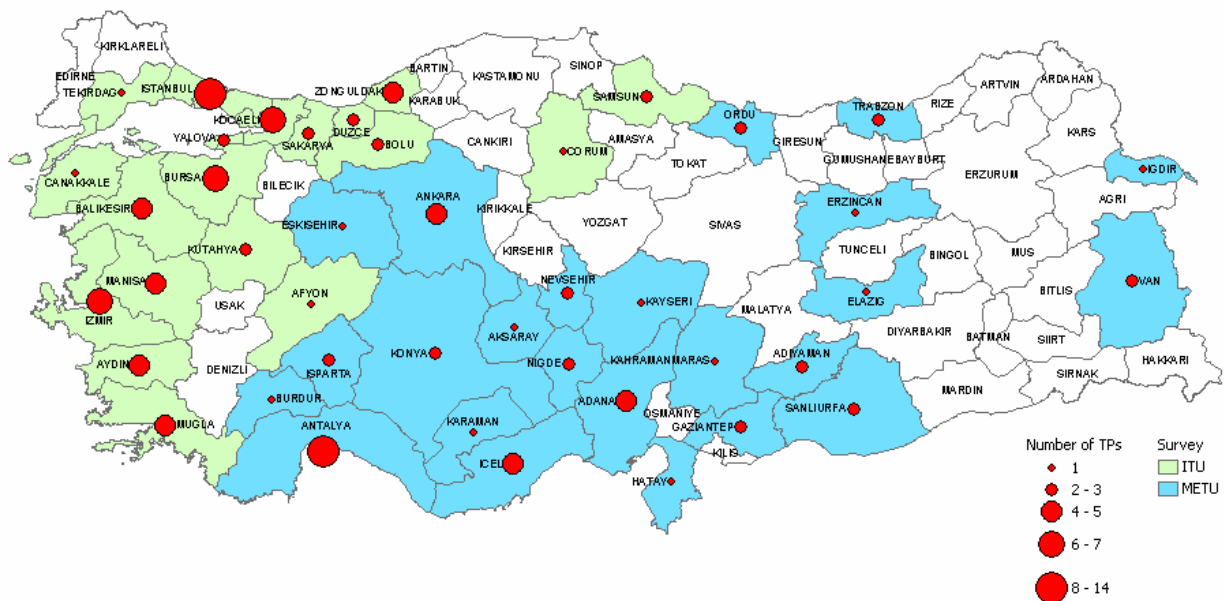
**Table 47. Degree of connection to the sewage network and to a WWTP in Turkey in 2003**

	Number of municipalities	Municipal population	Number of WWTPs	Number of municipalities served	Rate of population served
Sewerage system	3,227	53,430,733	158	2 164	60%
WWTP				239	35%

Source: Turkish Institute of Statistics (2003); Gokcay (2003)

According to the Turkish State Institute of Statistics, the wastewater discharged into network systems in 2003 was 3.2 billions m<sup>3</sup>, and the wastewater treated was 1.64 billion m<sup>3</sup>.

The distribution of the WWTPs is illustrated in Figure 11.



Source: Gokcay (2004)

**Figure 11. Distribution of WWTPs in Turkey**

### 3.14.2 Typical wastewater treatment systems

#### 3.14.2.1 Wastewater collection

No information is available on the type of wastewater collection systems.

#### 3.14.2.2 Wastewater treatment

Number of WWTPs and amount of wastewater treated in 2003 is reported in Table 48.

**Table 48. Number of WWTPs and amount of wastewater treated in Turkey in 2003**

	Number of plants	Capacity (m <sup>3</sup> )	Treated amount (m <sup>3</sup> )	% of wastewater treated
Primary treatment	36	1,059,322	478,574,000	29.3
Secondary treatment	118	1,523,325	906,658,000	55.4
Tertiary treatment	4	294,896	250,155,000	15.3

Source: National Programme for the Adoption of the Acquis (2003); Turkish Institute of Statistics (2003)<sup>†††</sup>

#### 3.14.2.3 Sludge treatment and disposal

No information is available on the sludge handling practice.

The range of treatment plant technologies used at large wastewater treatment plants is described in Ozsoy *et al.* (2006). These include a sludge thickening step, followed either by anaerobic digestion and dewatering (in a belt filter press) or directly by the dewatering step (belt filter press) and lime stabilisation. Ozsoy *et al.* (2006) concludes that the sludge may be used for agricultural purposes in accordance with the limits set out by the EU Directive

### 3.14.3 Main drivers for WWTP refurbishment

Turkish legal arrangements on urban wastewaters are in approximation with the UWWTD, however there is not any clear obligation for the municipalities having a population of more than 2,000 to collect their wastewaters. Moreover, the highest permissible BOD concentration is two times higher in the Turkish legislation than in the UWWTD, and there is no limit value for the total nitrogen and phosphorous concentrations in the discharge of urban wastewaters.

The soil pollution control regulation (2001) set the limits for sludge spreading on land equal to those laid down into the European Directive 86/278/EEC.

<sup>†††</sup> Capacities of wastewater treatment plants which are not operated are also included

## 4 Conclusions and next steps

The review shows that:

- ◆ The connection rates to the sewerage network and, especially, the level of wastewater treatment is very diverse within the study region.
- ◆ The data on treatment levels and use of technology are quickly getting outdated
- ◆ The gathered information on wastewater treatment practices is not entirely coherent, with databases that are sometimes in (apparent) contradiction to each other.

Consequently, a Microsoft Excel self-compile questionnaire has been developed and is being sent to targeted institutions such as National governments, wastewater associations, water utilities, consultants and manufacturers to complement and validate the information gathered through the conventional literature survey and provide the most up-to-date background information upon which to base the examination of the plant upgrade potential offered by Dual MBR concepts. A copy of the questionnaire form is annexed to this report.

As the review indicates that the dominant technology is activated sludge –either low or high loaded systems-, the analysis will focus on three alternative types of biological treatment, namely:

- ◆ Conventional low loaded activated sludge systems with primary clarifier
- ◆ Conventional low loaded activated sludge systems without primary clarifier
- ◆ Conventional high loaded activated sludge with primary clarifier

The following three WWTP upgrading situations will be considered for each of the three schemes:

(1) a WWTP biologically and hydraulically overloaded - the activated sludge system is either designed as a high loaded system (and does not meet the effluent standards on nutrient removal anyway), or low-loaded system (and does not meet the effluent standards on nutrient removal because of the overloading, i.e. the biology volume is not big enough). In addition, the size of secondary clarifiers is too small.

(2) A WWTP only biologically overloaded: the activated sludge system is high loaded and does not meet the effluent standards on nutrient removal.

(3) A WWTP only hydraulically overloaded: the secondary settlers are too small.

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