WATER RESCUE

Water resources efficiency and conservative use in drinking water supply systems

WP	**3 Current Status Analysis and Assessment**
Deliverable *Tool*	**3.5.2 Water Audit report** *Joint Deliverable*
Sub-Deliverables integrated	**D.3.1.2, D.3.2.2, D.3.3.2, D.3.4.2, D.3.5.2, D.3.6.2**
Project Beneficiary No	**PB5**
Beneficiary Institution	**Municipality of Gotse Delchev**

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

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Chapter 1. Introduction: The WATER RESCUE project in brief

1.1 The Project in brief

WATER RESCUE project's concept is based on the common cross-border (CB) water management problems in the two international river basin districts (RBDs) shared between Greece & Bulgaria (Struma-Strymonas; Maritsa-Evros). The common CB problems include water resources quality & quantity being at risk due to natural and human activities and climate change conditions. The consequence is that water bodies fail to meet the good ecological status (GES) (recorded in the river basin management plans-RBMP). In particular, drinking water faces significant risks due to the deteriorated water resources quality while at the same time significant water volume is lost in the water distribution networks (WDNs). The project aims at the sustainable and efficient management of drinking water supply by increasing drinking water use efficiency in WDNs and improving water quality in the whole water supply cycle (from the source and back to the environment). Good Ecological Status can be achieved by improving water quality and reducing water abstraction and can be maintained by taking climate change adaptation measures. The project focuses in drinking water supply management suffering from high Non-Revenue Water (NRW) levels and deteriorated water quality jeopardizing the drinking water consumers' safety and health and their quality of life. Urban water volumes end up to the sewerage networks while wastewater treatment plants are a pressure to water resources quality. Surface water bodies are both used for drinking water abstraction and are the final recipient of treated effluents. Thus, their ecological status is affected by both water quantities abstracted and water quality in the whole water supply cycle (from the resource to the water supply and the wastewater treatment plant and back to the environment).

1.2 Theme of the Project

WATER RESCUE project is expected to achieve Non-Revenue Water/water losses reduction by upgrading and adapting already developed methodologies, technologies and tools including Water Balance assessment and Performance Indicators, hydraulic simulation models, decision support systems and GIS tools. Additionally, WATER RESCUE is expected to achieve water quality improvement across the entire water supply chain (from the water intake point and the raw water treatment plant, back to the environment after the waste water treatment plant) through constant monitoring of water quality parameters in real time, water quality simulation models (including water age) and automatic chlorination systems on line and in line. Climate change impacts will be assessed to finally propose and adopt measures for climate change adaptation. WATER RESCUE has a clear innovative character since the methodologies and tools are integrated and do not tackle individual problems. It is the first time that integrated methodologies will be adapted to include the entire drinking water supply cycle. These methodologies/tools will serve as Early - Warning Systems both for water quantity and quality. WATER RESCUE results will improve drinking water management. At the same time as drinking water is involved, the consumers' safety and health are safeguarded and their quality of life is improved. Non-Revenue Water reduction will increase water resources efficiency, since less water will be abstracted from surface and groundwater bodies and reduce energy consumption as water and energy are interconnected in water supply systems (water-energy nexus). Drinking water quality will be improved through real time monitoring of water quality parameters across the entire water supply chain, from the water intake points, to the water treatment plant and the water distribution network, back to the environment through the wastewater treatment plant. Thus, drinking water quality will be safeguarded from its source up to the consumer's tap. As wastewater effluents return to water resources, their quality monitoring prevents water resources degradation due to this pressure. Water and energy resources efficiency will be promoted and the ability of the cross-border area to adapt to climate change conditions will be improved as all possible natural and man-made pressures will be evaluated, including climate change conditions. Water saving will be accomplished through water losses reduction and increase of the environmental awareness of the public. The quality of life is expected to be upgraded with special emphasis to the protection of the natural environment. Joint policy recommendation guidelines and papers will be developed. Good governance, transparency and participation of all stakeholders in the design, implementation and monitoring of these policies is expected. Know-how and technology transfer will take place not only among the beneficiaries but also in the stakeholders' network that will be developed.

1.3 Project beneficiaries

Lead Beneficiary is the Municipal Water and Sewerage Company of Komotini (Greece); Beneficiary 2 is the Municipal Water and Sewerage Company of Thermi (Greece); Beneficiary 3 is the University of Thessaly-Special Account Funds for Research-Department of Civil Engineering (Greece); Beneficiary 4 is the Municipality of Kardzhali (Bulgaria); Beneficiary 5 is the Municipality of Gotse Delchev (Bulgaria); and Beneficiary 6 is the Municipal Water and Sewerage Company of Thermaikos (Greece).

1.4 The present deliverable

1.4.1 The subject of the present deliverable

The present deliverable refers to WP3.2., and specifically Water audit for each beneficiary utility (the whole utility or part of it - not only the pilot case). This deliverable includes parameters for the water networks such as: general data and characteristics for the water distribution network (population; area; km of pipes; SCADA; GIS; hydraulic simulation model; maintenance practices; etc.), parameters to estimate the water balance (SIV; consumption; seasonal fluctuations; etc.), parameters for specific indicators (PIs) regarding water efficiency (NRW by volume; real losses per km; ILI; ALI; etc.).

1.4.2 The approach applied developing the present deliverable

As the topics the WATER RESCUE project is dealing with, need precise knowledge of the way water supply and distribution systems operate, it was made clear, even during the kick-off meeting of the project, held in Komotini in January 2018 that WATER RESCUE beneficiaries, beyond their common agreement to work closely together, should be guided by the scientific beneficiary, University of Thessaly, to ensure the prompt delivery of what was expected by the WATER RESCUE project. Thus, the University of Thessaly, prepared the methodology and the questionnaires for this task. University of Thessaly supplied the software water audit tool WB/PI_CalcUTH (developed by the University of Thessaly) to all beneficiaries to use it for the estimation of the Water Balance and the Performance Indicators. Municipality of Gotse Delchev (PB5) as the WP Leader took over the responsibility to prepare the joint deliverable of Phase 3.2.

Regarding the implementation of Phase 3.2., the beneficiaries reported on the current situation of their Water Supply System(s) (WSS) regarding water use efficiency. University of Thessaly (PB3) provided a questionnaire consisting of the following chapters: (a) Introduction; (b) Network's current (operation, control and monitoring) status; (c) Water Balance assessment for the water distribution network; and (d) Performance Indicators. All beneficiaries provided their deliverables to the WP leader, who properly elaborated the data in order to prepare the joint deliverable. The WP leader prepared the respective deliverable D3.2.

Chapter 2. Water Audit– Results & Discussion

The analysis is based on two levels: National Level and Regional / Local level. As there are project beneficiaries who are National organizations (PB3), this beneficiary submitted the deliverable referring to the National level, focusing on the cross-border area. All other beneficiaries, who are water utilities, submitted their deliverable referring to regional / local level.

2.1. PB1 – Municipal Water Supply and Sewerage Company of Komotini, Greece

2.1.1. General description

WSS Komotini provides water supply and sewerage service to the municipality of Komotini. Total length of water supply network is 549 km composed of polyethylene and steel pipes. Water utility services 65,000 people and total area covered is 385.3 km^2. Two main water sources for the utility are – 10 underground wells combined in a common group and ground water source.

2.1.2. Network's current (operation, control and monitoring) status

Main challenges for WSS Komotini are high level of burst, hidden leakages and water losses they cause, illegal connections. Currently water utility doesn't have SCADA as well as any other type of monitoring system. It also doesn't have any DMA or pressure management program.

2.1.3. Water Balance assessment for the water distribution network

Municipal Water Supply and Sewerage Company of Komotini performs records for the two of the most important parameters part of the water balance – system input and billed water consumption. Despite the lack of information for the rest parameters based on its knowledge for the exploitation parameters Municipal Water Supply and Sewerage Company of Komotini has succeeded to prepare a water balance with all information required inside.

From the data presented following conclusions can be done:

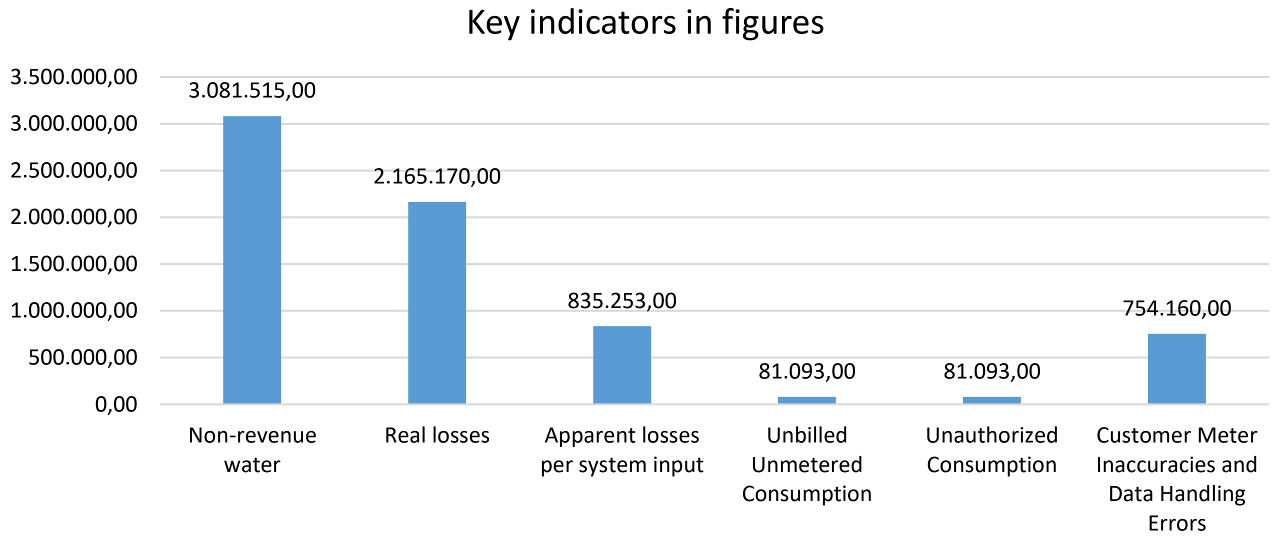
- The share of water losses from system input water is high – 37%. This is result from described by the PB exploitation condition of the pipe network.
- The share of revenue water from authorized consumption is high – 98.41%. This is extremely good result showing systematic approach to the billing process.
- Although apparent losses take high share from the water losses – 27.84% a detailed view of the data shows that 90.29% form those losses comes from customer meter inaccuracy and data handling errors which is a problem that can be solved relatively easy with an appropriate investment.
- At the same time losses that are difficult to fight – unauthorized consumption takes relatively small par from apparent losses – 9.71%. This is a good indication for the overall efforts of the DEYA of Komotini to meter and bill supplied water to its end consumers.
- Real challenge in front of DEYA Komotini is to manage with those 26.70% from system input volume which are reported as real losses

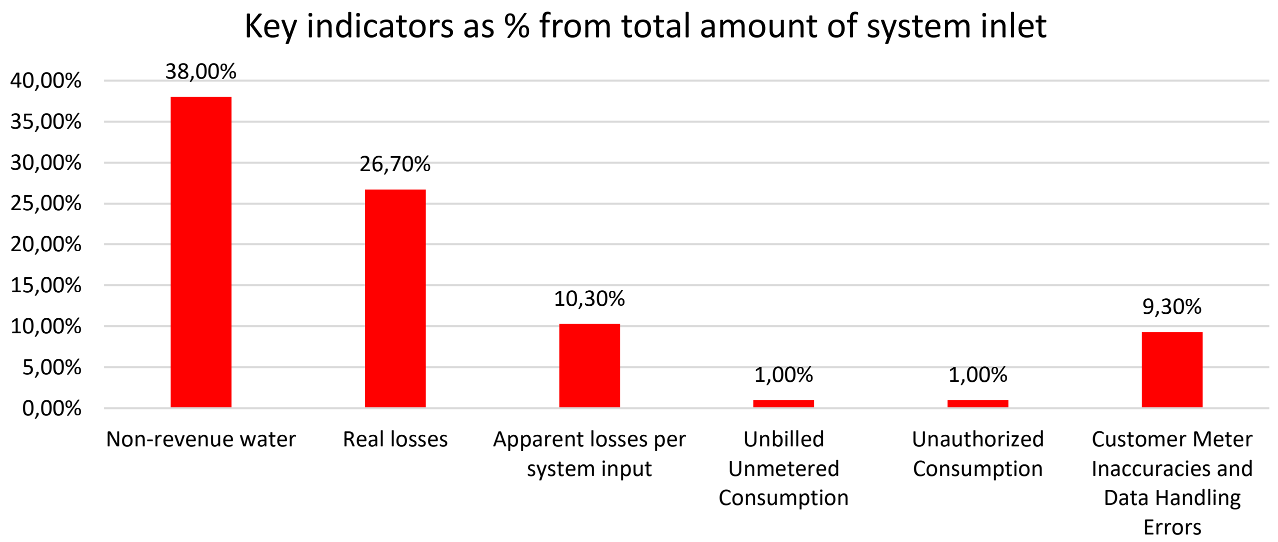
2.1.4. Performance Indicators

Values of all indicators calculated show high but not dramatically high level of water losses and non-revenue water.

- Inefficiency of use or water resources – 26.70%. Relatively high value is a result from old pipes which were described by PB. At the same time average pressure is reported as averagely 40 meters and no pressure regulation zones are available.
- Water losses per mains length – 14.97 m^3/km/year can be assessed as high based on DVGW W392

- Apparent losses per system input volume – 10.30% seems to be high but detailed view shows that 90.29% from those losses comes from customer meter inaccuracy and data handling errors. Usually this is a problem that can be handle easily with no such a big investment program and right technical strategy for selection of water meters. At the same time it should be taken into consideration that DEYA Komotini serves an extremely high number of water meters – 48,500 based on the total number of service connections 17,000 and population served 65,000.





2.1.5. Conclusions

One of the main problem of WSS Komotini is relatively high amount of real water losses. Based on the information presented main reasons for the high amount of real losses are old pipes, lack of district metering and pressure management areas and lack of monitoring system.

Another key challenge for the DEYA Komotini is the high number of water meters which it serves based on serves connection and population served. Due to this apparent losses in the part customer metering inaccuracies and data handling errors are high.

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2.2. PB2 – Municipal Water Supply and Sewerage Company of Thermi, Greece

2.2.1. General description

WSS Thermis provides water supply and sewerage service to the municipality of Thermi and following municipal districts – Thermi, Mikra, N. Redestos, Tagarades, N. Risio, Vasilika, Souroti, Agia Paraskevi, Agios Antonios, Lakkia, Peristera and Livadi. Total length of water supply network is 700 km composed of polyethylene and polyvinylchlorid pipes. Water utility services 53,070 people and total area covered is 1 559.34 km^2. Water is taken from three groups of underground wells one of the two biggest with water quality problems.

2.2.2. Network's current (operation, control and monitoring) status

Main challenges for WSS Thermis are high level of burst, hidden leakages and water losses they cause as well as pressure variation along the network. Currently water utility doesn't have SCADA as well as any other type of monitoring system. It also doesn't have any DMA or pressure management program.

WSS Thermis has scheduled to invest 17 million euro in water supply network extension, replacement of pipes, new wells, SCADA system and study for a master plan in order to solve most of the problems described above.

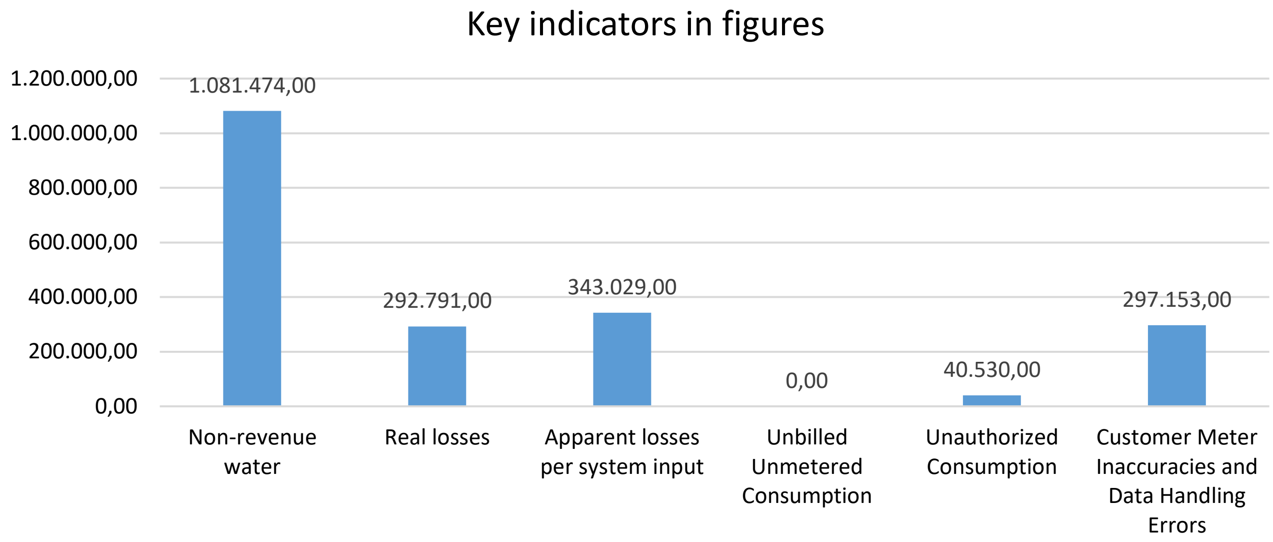
2.2.3. Water Balance assessment for the water distribution network

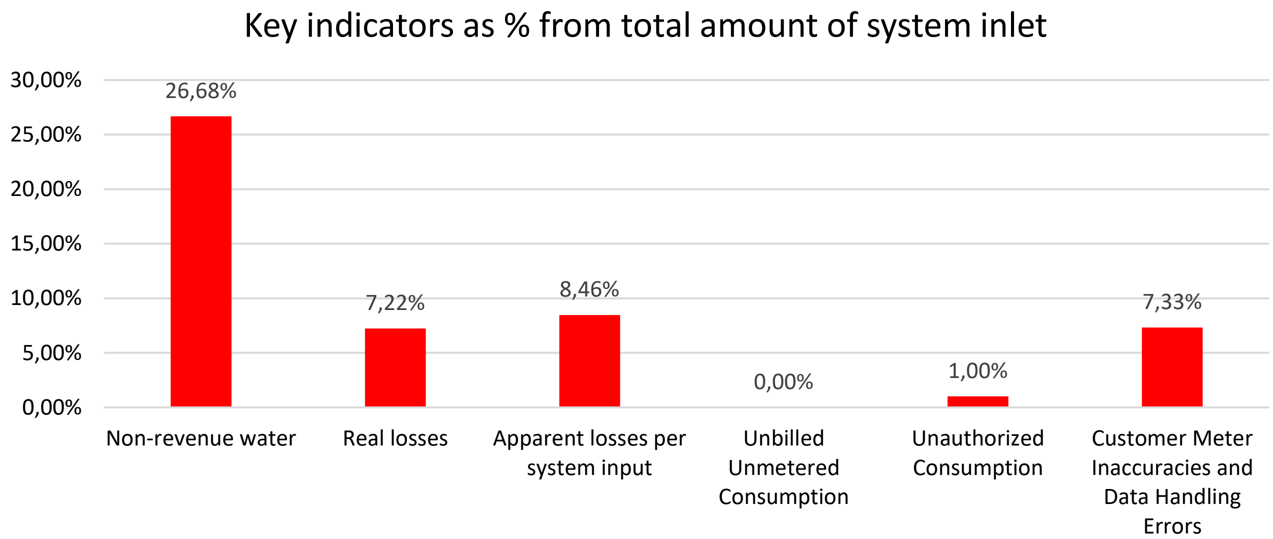
Municipal Water Supply and Sewerage Company of Thermi did some assumption in order to prepare water balance. Based on data provided and assumption done following results were achieved following conclusions can be done:

- The share of water losses from system input water is relatively low – 15.56%.
- The share of unbilled metered consumption from authorized consumption is relatively high – 13.18%.
- Apparent losses take huge share from the water losses – 53.56% a detailed view of the data shows that 87.70% form those losses comes from customer meter inaccuracy and data handling errors which is a problem that can be solved relatively easy with an appropriate investment.
- At the same time losses that are difficult to fight – unauthorized consumption takes 12% from apparent losses. This is relatively good indication for the overall efforts of the DEYA Thermis to meter and bill supplied water to its end consumers.
- Real challenge in front of DEYA Thermis is to manage with those high amount of unbilled metered consumption which takes 11.13% from total amount of system input volume

2.2.4. Performance Indicators

- Although concerns regarding the age of the pipes' inefficiency of use or water resources is really low 7.13%.
- Amount of real losses per mains length is also low – 2.47 m^3/km/year can be assessed as low based on DVGW W392
- Apparent losses per system input volume – 8.33% seems to be relatively high but detailed view shows that 87.70% from those losses comes from customer meter inaccuracy and data handling errors. Usually this is a problem that can be handle easily with no such a big investment program and right technical strategy for selection of water meters.





2.2.5. Conclusions

Based on the information presented about aged of the pipes, lack of DMA and PMA zoning and relatively high pressure around the network performance indicators of the water utility seems to be really good. Main problem that can be noted is high amount of unbilled metered consumption.

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2.3. PB3 – University of Thessaly – Special Account Funds for Research – Department of Civil Engineering, Greece

2.3.1. General description

University of Thessaly presented information about water utilities at national level. Water supply of Greece is provided by 127 water utilities all of them municipality owned. There are two multi-equity companies supplying Athens (EYDAP SA) and Thessaloniki (EYATH SA) with water.

The country shares three transnational water resources with Bulgaria (RBMP of Thrace, 2017; RBMP of Eastern Macedonia, 2017). These transnational water resources are: River Basin (RB) of Evros (Greece; Bulgaria; Turkey); RB of Nestos (Greece and Bulgaria); RB of Strimonas (Greece and Bulgaria).

Specifically, in the WD of Thrace, the River Basin (RB) of Evros has a total length is 528Km of which 310 Km belong to Bulgaria while 208 Km are the natural borders of Greece with Bulgaria and Turkey. The RB is shared among the three counties as follows: 35,085Km^2 (66.2%) belong to Bulgaria, 14,575Km^2 (27.5%) belong to Turkey and 3,340Km^2 (6.3%) belong to Greece (RBMP of Thrace, 2017). Water demand in all water districts per sector is given in Table below.

Water demand by sector (data gathered from the RBMPs, 2017)

Water District (WD)	WD name	Agriculture (hm^3)	Industry (hm^3)	Domestic (hm^3)	Livestock (hm^3)	Total (hm^3)
EL01	Western Peloponnese	171.1	18.8	27.5	1.5	218.9
EL02	Northern Peloponnese	406.5	8.6	61.8	3.3	480.2
EL03	Eastern Peloponnese	339.5	7.8	27.7	1.6	376.6
EL04	Western Sterea Ellada	493.0	2.0	39.0	8.0	542.0
EL05	Epirus	376.0	4.5	58.0	10.0	448.5
EL06	Attica	66.7	18.5	416.2	2.1	503.5
EL07	Eastern Sterea Ellada	839.6	29.1	76.1	10.5	955.3
EL08	Thessaly	1,305.5	9.0	94.0	13.0	1,421.5
EL09	Western Macedonia	636.0	68.5	166.3	8.2	879.0
EL10	Central Macedonia	953.1	40.4	177.9	7.3	1,178.7
EL11	Eastern Macedonia	772.0	4.1	58.9	2.5	837.5
EL12	Thrace	941.4	14.1	60.5	3.9	1,019.9
EL13	Crete	415.0	0.8	78.1	4.2	498.0
EL14	Aegean Islands	111.4	0.1	90.7	2.4	204.5
TOTAL		**7,826.8**	**226.2**	**1,432.7**	**78.5**	**9,564.1**

2.3.2. Network's current (operation, control and monitoring) status

In Greece there is not an official report on the current operational status of the water supply networks of water utilities. The Association of Municipal Enterprises for Water Supply and Sewerage (EDEYA) has presented a study performed in 67 out of all 127 municipal water utilities. It seems that only 9 of all water operators have hydraulic simulation model which is an important prerequisite for introduction of an effective water loss reduction program. In addition only 16 Operators have GIS which is another negative tendency and 41 of the water utilities have SCADA system.

In addition to that, Special Secretariat for Water (SSW) has established an internet database (http://wsm.ypeka.gr/login.html) where all water utilities have to report specific indicators (apart from cost and cost recovery indicators). Among these indicators are the following (included in the Joint Ministerial Decision 135275/2017):

- Water losses
- Average consumption m^3/water meter
- Density of sewerage network: connections per km
- Density of water supply network: water meters per km
- Percentage of consumers coverage from the sewerage network

2.3.3. Water Balance assessment for the water distribution network

There is no national benchmarking tool to compare behavior of water operators in different exploitation indicators. However, some data on the water demand per use are provided in Table above.

Taking into consideration the cross-border river basin between Greece and Bulgaria, the water abstractions per use is shown in Table below.

Water abstraction volumes per use and river basin (data taken from the RBMPs of Eastern Macedonia and Thrace)

River Basin	Total water abstracted (million m^3)	Irrigation (million m^3)	Drinking water supply (million m^3)	Industry (million m^3)	Livestock farming (million m^3)	Abstraction from surface water bodies (million m^3)
Strimonas	837.48	772.01	58.87	4.13	2.47	589.36
Nestos	268.07	259.16	7.85	0.14	0.93	121.76
Evros	315.47	290.95	21.86	1.01	1.65	184.8

One of the 15 groundwater systems in Strimonas river basin is assessed to be in bad quantitative status due to over exploitation (the system of Eleftheres – N. Peramos). The groundwater systems in the river basins of Nestos and Evros are assessed to be in good quantitative status.

2.3.4. Performance Indicators

Good practice introduced in Greece is that Special Secretariat for Water (SSW) has established a database where all water utilities have to report specific exploitation indicators – water loss, average consumption m3/water main, density of sewerage network: connection per km, density of water supply network: connection per km, percentage of consumers coverage from the sewerage network.

2.3.5. Conclusions

Greece made first step in improvement of efficiency of water utilities – establishment of database for important exploitation indicators. This give opportunity of Operators to compare each other.

Although that at national level more efforts should be invest in modern management approaches for water and sewerage networks. Lack of Hydraulic models and GIS limit opportunities of operational teams to provide more effective management of water supply and sewerage networks.

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2.4. PB4 – Municipality of Kardzhali, Bulgaria

2.4.1. General description

Water network of city of Kardzhali is operated by Reginal water supply company of Kardzhali. Population served in city of Kardzhali is 55,019 people with 19,854 service connections. Main water sources are river Borovitsa and river Perpereshka. Water supply of main cities in district – Kardzhali and Momchilgrad as well as some villages around is provided by dam Borovitsa. Most of the pipes are built in more than 35 years ago.

2.4.2. Network's current (operation, control and monitoring) status

Pressure in overall city of Kardzhali is controlled with PRV DN600 installed in a special service room just above the city. Pressure is controlled at two stages with day and night mode.

There is SCADA system build for monitoring of all key parameters including water consumption at main facilities – pumping stations, reservoirs, treatment plants. In addition city of Kardzhali is divided on DMAs.

There is no hydraulic model of the city.

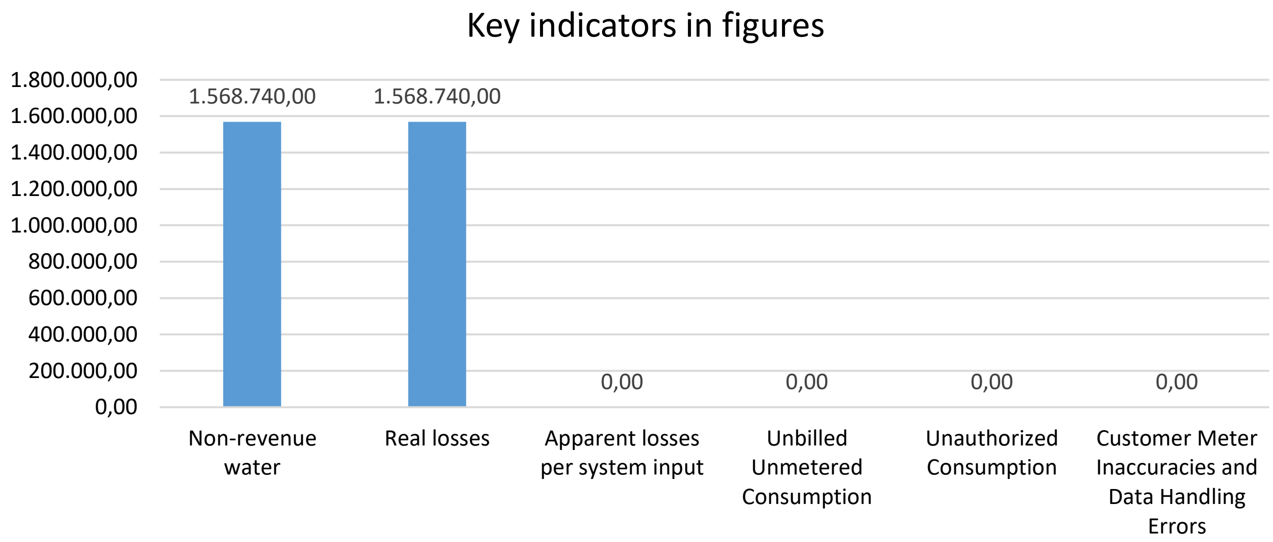
2.4.3. Water Balance assessment for the water distribution network

From data provided following trends can be seen:

- The share of water losses from system input water is relatively high – 33.51%.
- The share of billed consumption takes 100% from all authorized consumption
- Real losses are stated as 100% from water losses
- Real challenge in front of Regional water supply company of Kardzhali is how to manage with high level of real losses.

2.4.4. Performance Indicators

- Inefficiency of use or water resources – 33.51%. Relatively high value is a result from old pipes which were described by PB.
- Apparent losses per system input volume – 0.00% seems to be unrealistically low



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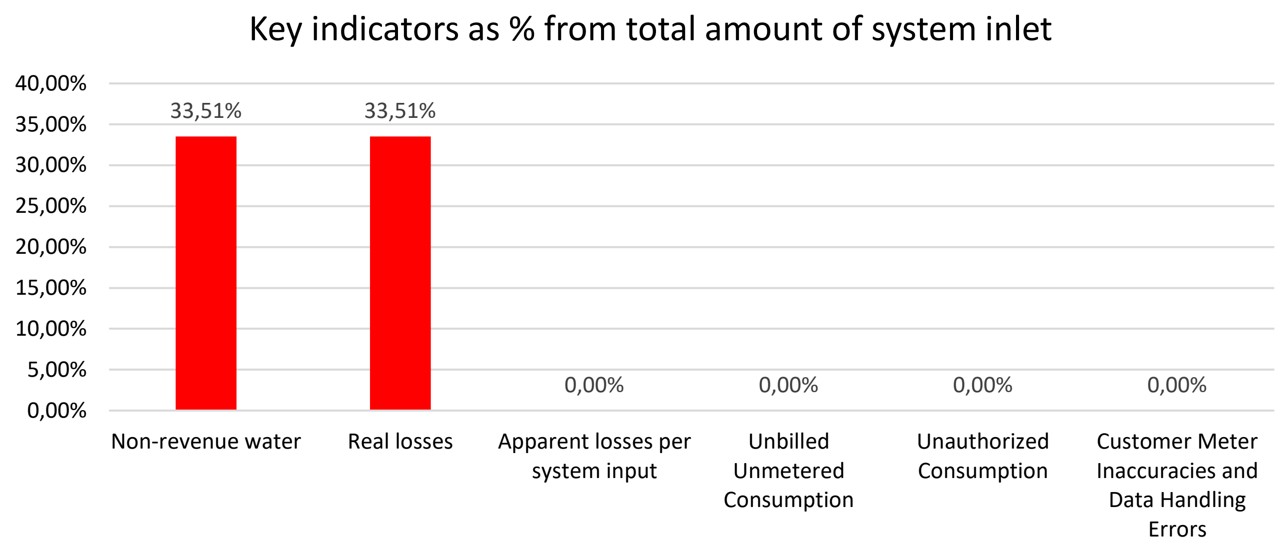

2.4.5. Conclusions

Values of some of the indicators raise some questions about quality of initial data used for preparation of water balance.

2.5. PB5 – Municipality of Gotse Delchev, Bulgaria

2.5.1. General description

Water supply of Gotse Delchev is provided by regional water supply company of Blagoevgrad. WSS Gotse Delchev comprises city of Gotse Delchev and Garmen. Capacity of water sources is enough to satisfy needs of the city. Quality of the water is guaranteed with potable water treatment plant. Biggest problem for the water network is high rate of water losses due to old steel pipes.

2.5.2. Network's current (operation, control and monitoring) status

Water supply network of Gotse Delchev is not divided in DMA zones, there is only one PMA. Hydraulic model is not available and there is SCADA system for monitoring and control of main facilities – pumping stations and reservoirs as well as local SCADA system for the treatment plant.

2.5.3. Water Balance assessment for the water distribution network

From water balance provided following trends can be seen

- The share of water losses from system input water is extremely high – 62.15%.
- The share of unbilled authorized consumption is 19.27% from total amount of authorized consumption which is too high value
- Good tendency is that apparent losses are just 2.79% from total amount of water losses.
- Real challenge in front of Regional water supply company of Blagoevgrad is how to manage with high level of real water losses which are 60,40% from system input.

2.5.4. Performance Indicators

- Inefficiency of water usage is extremely high – 60.42%. Relatively high value is a result from old pipes which were described by PB.
- Water losses per mains length – 86.75 m^3/km/year can be assessed as high based on DVGW W392
- Apparent losses per system input volume are very low just 1.74%.

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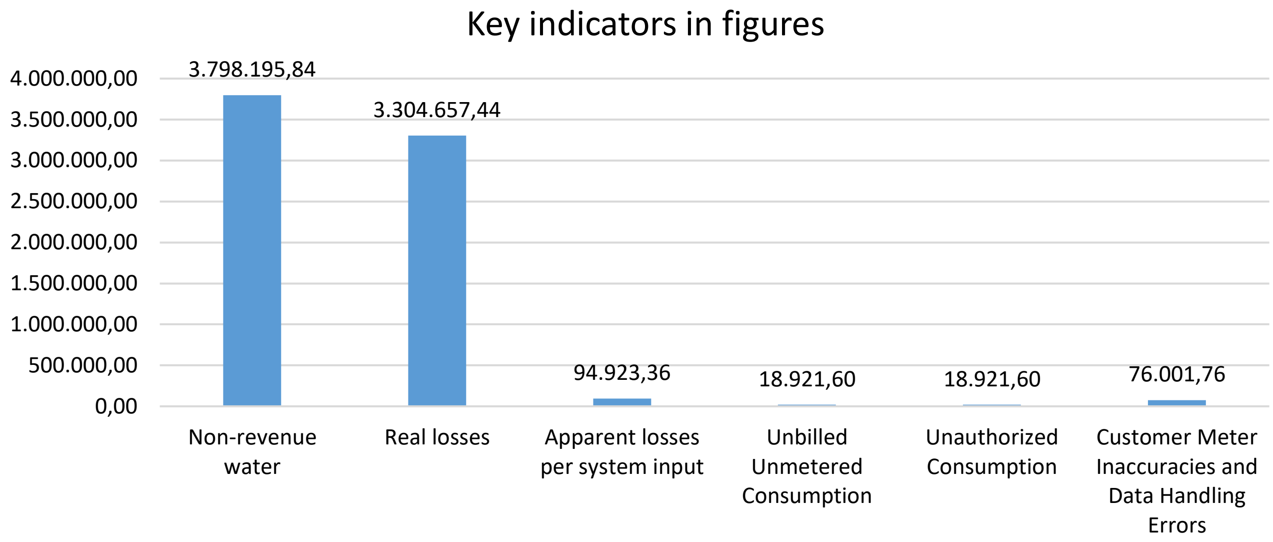

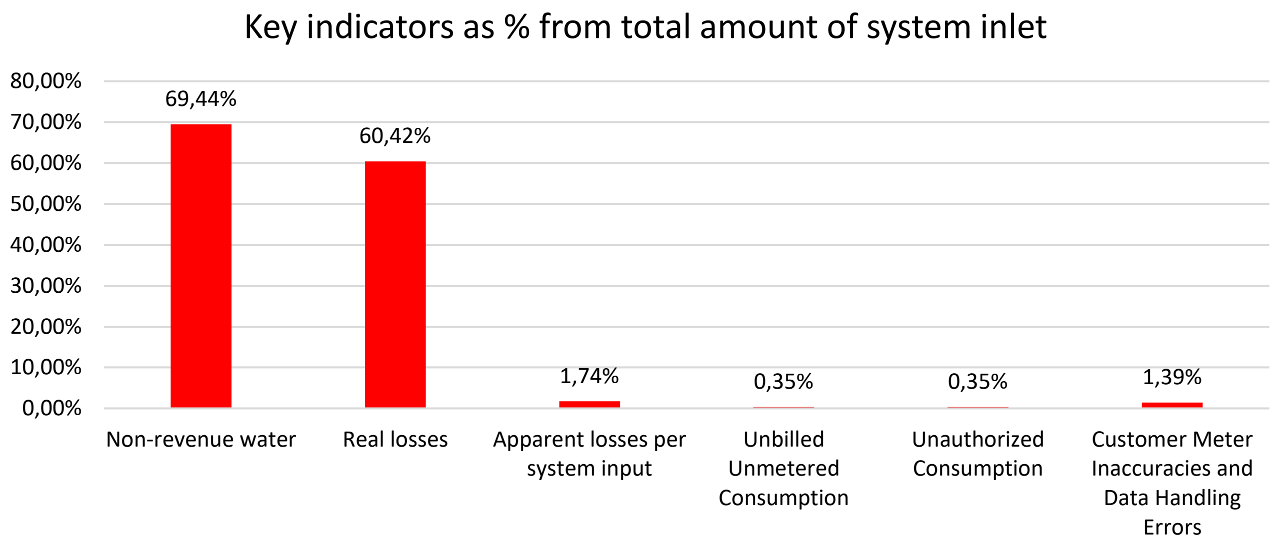

2.5.5. Conclusions

From data presented it can be seen a serious problem related with extremely high level of real losses of water. Urgent actions should be taken immediately for restriction of water losses at acceptable level.

2.6. PB6 – Municipal Water Supply and Sewerage Company of Thermaikos, Greece

2.6.1. General description

Municipal water supply and sewerage company of Thermaikos covers area of 135,50 km2 with mean altitude of 55 m. Total length of water supply network operated by the utility is 654 km with average pressure 3 bar. The pipes are composed of following materials:

- PVC – 33 years old
- Asbestos – > 55 years old

Total number of service connection served is 32,656.

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2.6.2. Network's current (operation, control and monitoring) status

Currently there is no pressure, DMA zones or hydraulic model established on the territory served by the water utility. In some of the areas Peraia, Neoi Epivatas and Agia Triada there is a central monitoring system for main reservoirs but the equipment doesn't work.

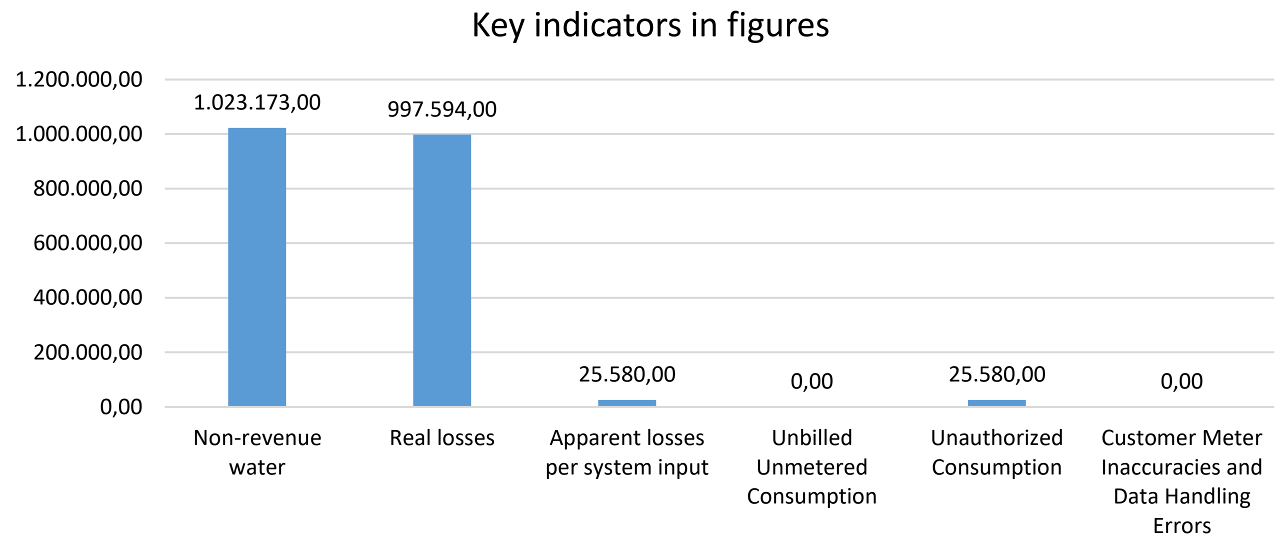
As it can be assumed main problems of the utility are related with frequent bursts due to the age of the pipes as well as availability and quality of the water due to intrusion of sea water in deep wells.

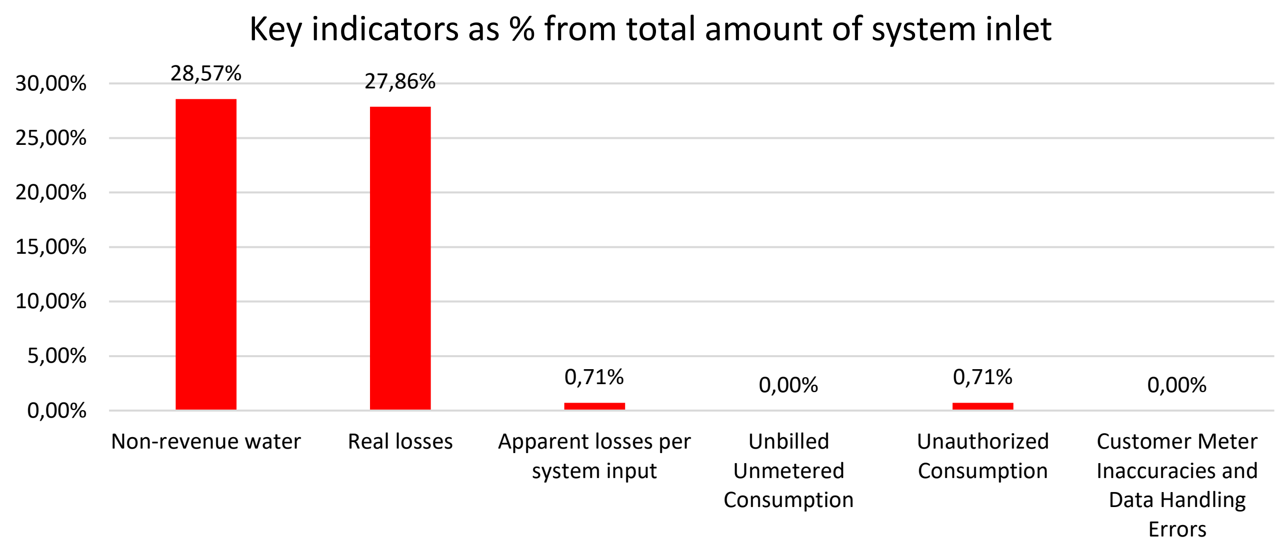
2.6.3. Water Balance assessment for the water distribution network

- The share of water losses from system input water is relatively high – 28.57%.
- The share of real losses from total amount of water losses is extremely high – 97.50%.
- Apparent losses take really small amount of water losses – 2.50%
- Real challenge in Municipal water supply and sewerage company of Thermaikos is to manage with high amount which real losses take from system water input – 27.86%

2.6.4. Performance Indicators

- Age of the pipes and lack of adequate monitoring and pressure management system reflect in high amount of real losses as percentage of system input – 27.86%
- Apparent losses per system input volume are really low – 0.71% which is extremely good result.





2.6.5. Conclusions

Main challenge in front of Municipal water supply and sewerage company of Thermaikos is how to reduce real losses. At the same time low level of apparent losses show that water utility works purposefully in this direction.

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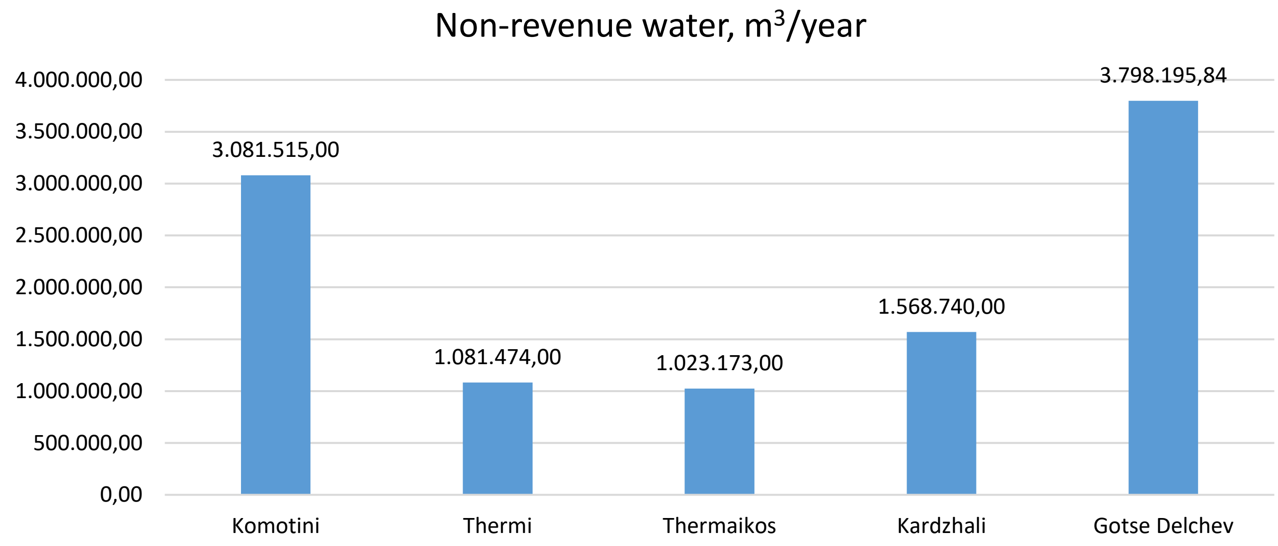
Chapter 3. Discussion & Conclusions

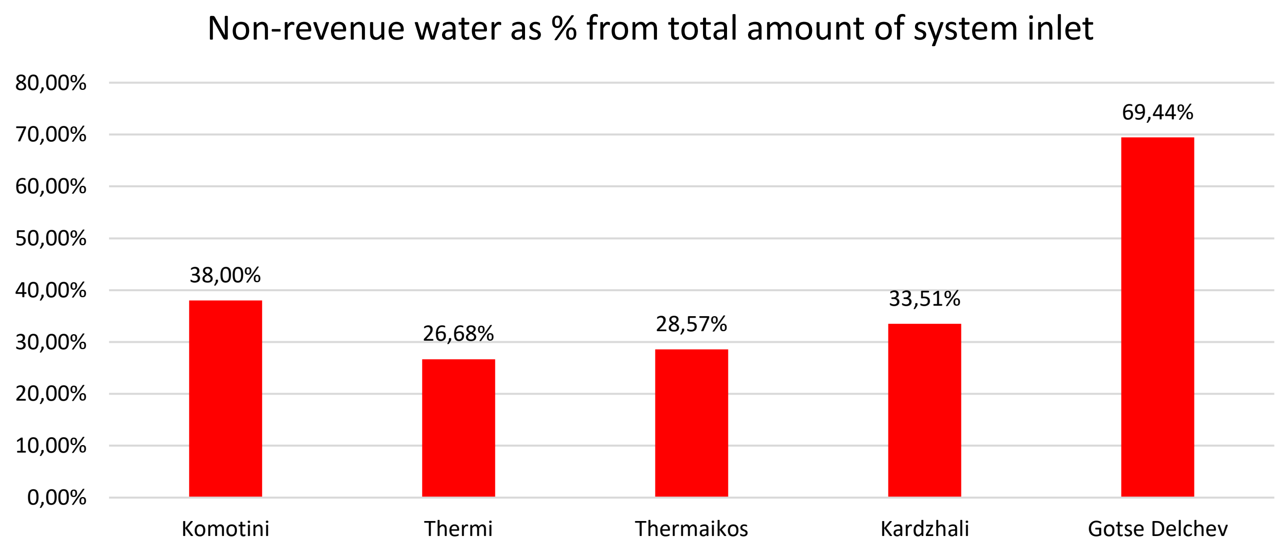
From the summary that has been made following common problems can be seen for all water networks:

- Lack of modern and well-developed monitoring systems;
- No strategy for zoning and pressure management;
- Age of the pipes;
- No strategy for development of hydraulic model.

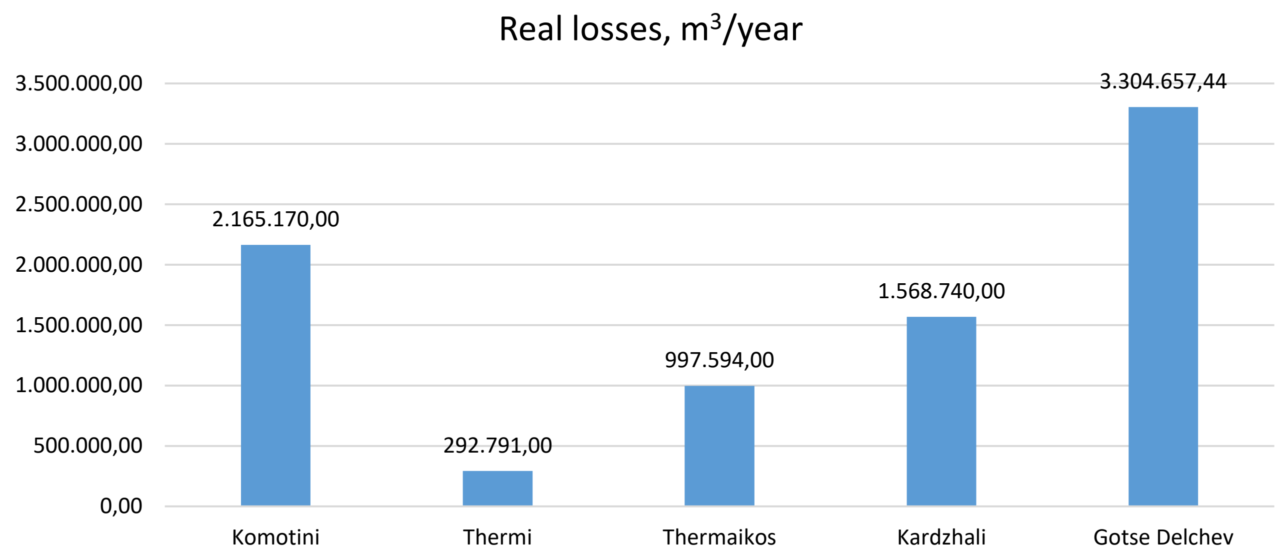
As a result, in some of the places water losses are extremely high and urgent measures must be taken before it is too late.

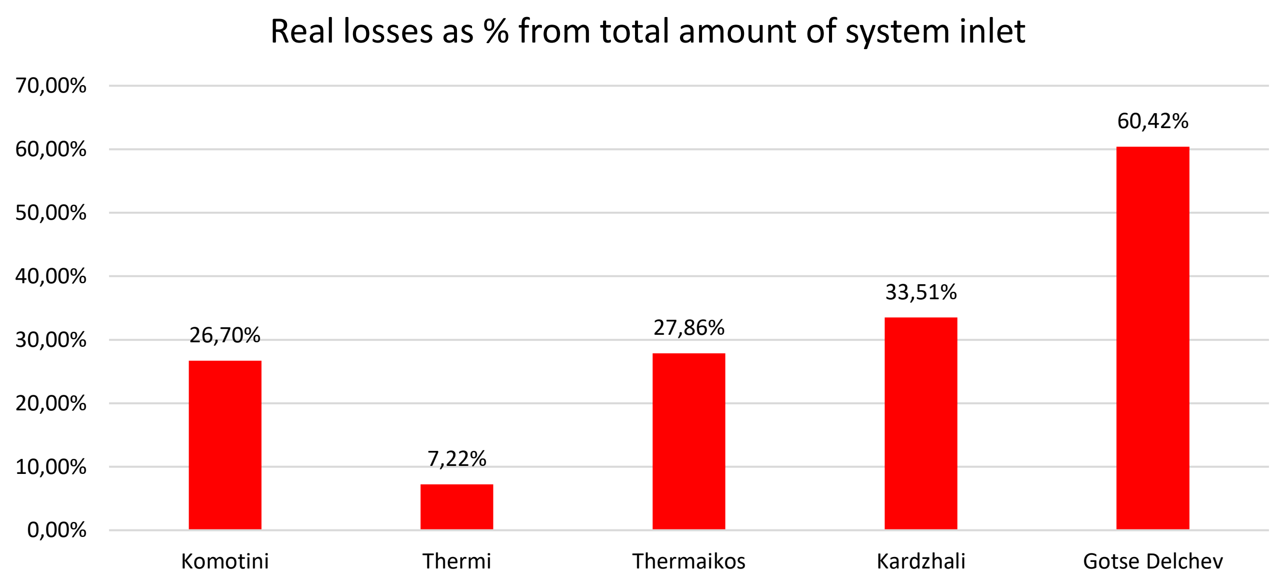
Based on data provided the team has tried to prepare key parameters comparison:



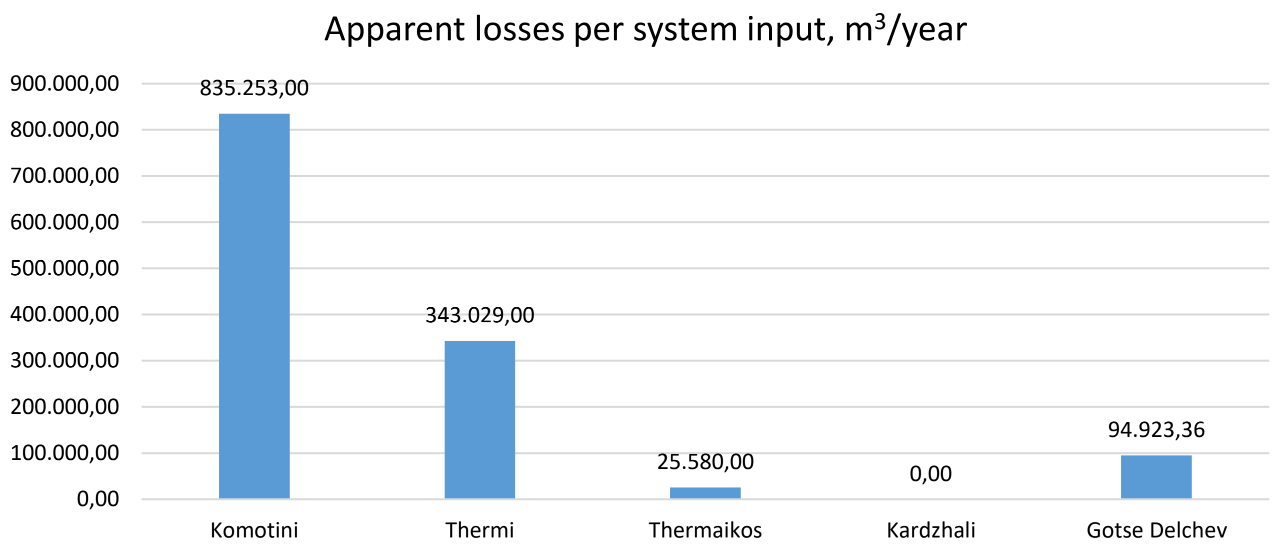


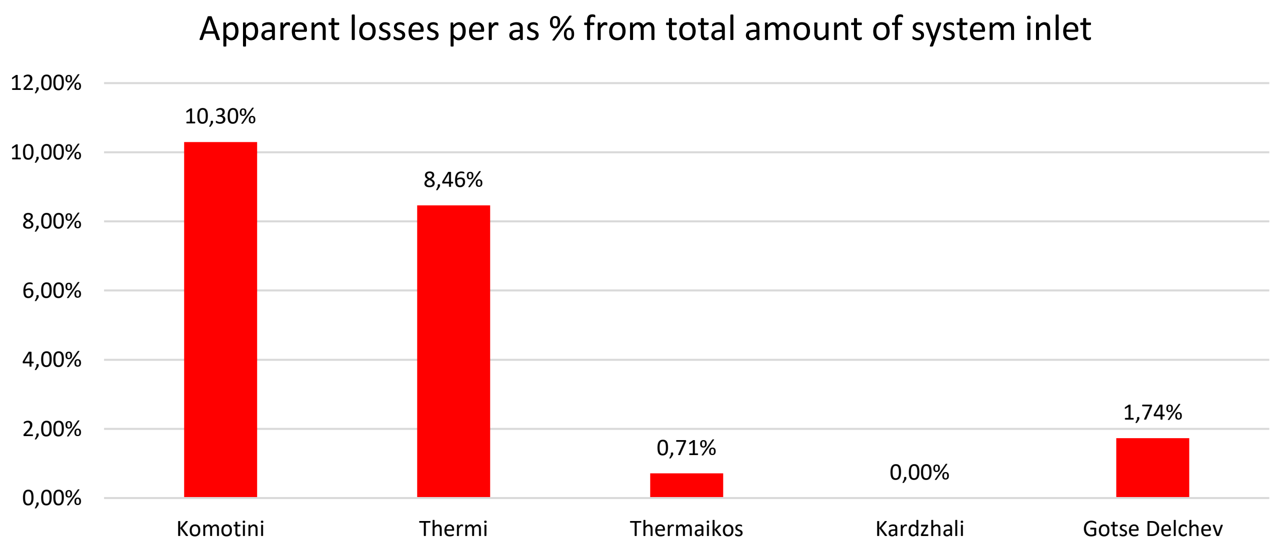
The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

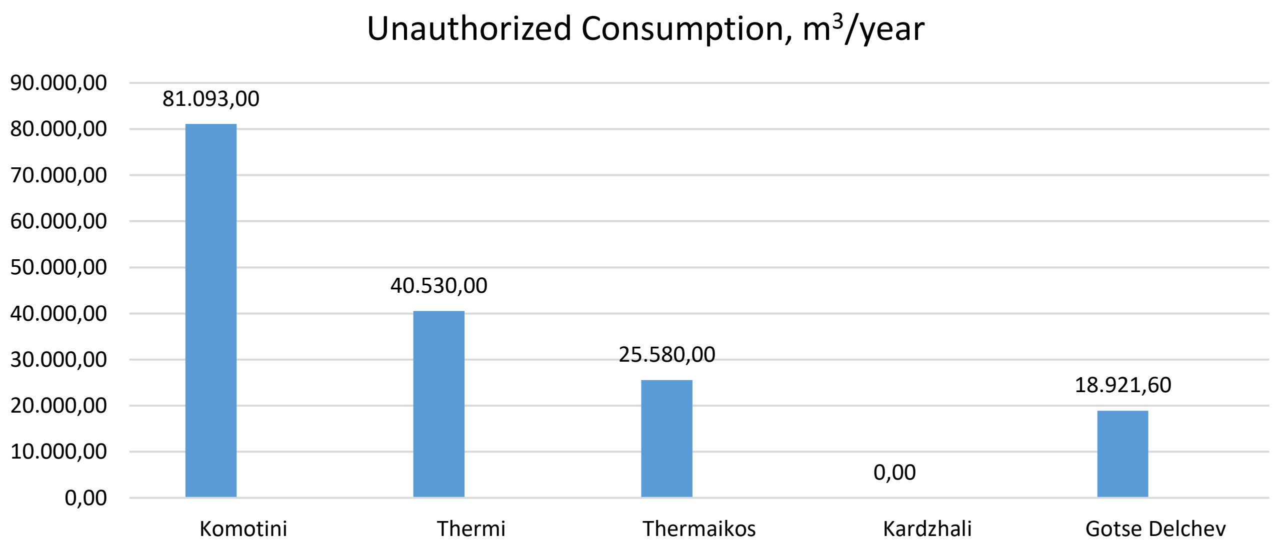




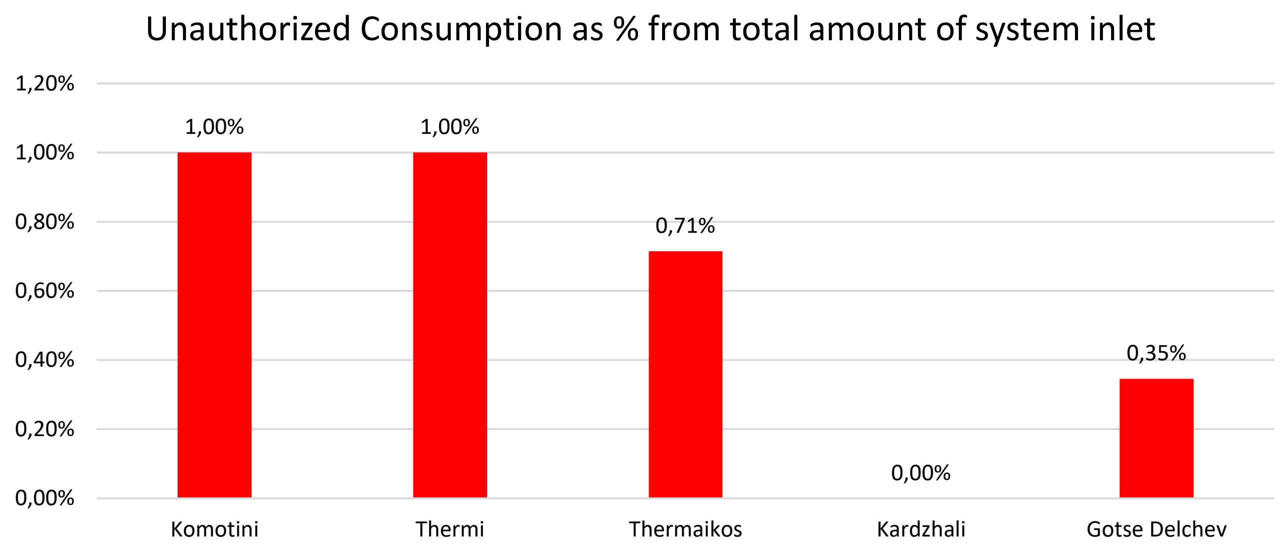
The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".







The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".



From data provided it can be seen that problem with real water losses is most serious in Gotse Delchev where percentage is highest. The other three PB – Komotini, Thermaikos and Kardzhali have similar results regarding real losses in range 26%-33% and with best indicator is Thermi with 7.22%.

What seems strange and raised some questions about quality of the data are apparent losses. It seems that all of the PBs did put much focus on providing reliable data for this indicators. Most of the gave values around 1% from system input and Kardzhali gave 0% which is practically impossible.

References

Appendix A: Beneficiaries' reports

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

WATER RESCUE

Water resources efficiency and conservative use in drinking water supply systems

WP	**3 Current Status Analysis and Assessment**
Deliverable *Tool*	**3.1.2 Water Audit report** *Questionnaire*
Project Beneficiary No	**LB/PB1**
Beneficiary Institution	**Municipal Water Supply and Sewerage Company of Komotini**

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

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Name of the organization/institution: Municipal Water Supply and Sewerage Company of Komotini
Beneficiary number: LB/PB1

1 Introduction

Municipal Water Supply and Sewerage company of Komotini (DEYAK) supplies with water the municipality of Komotini, located in the Water District of Thrace (EL12). The people supplied with water is 65,000. The area covered is 385.3 km^2 and the average altitude is 45m. The total pipes' length is 549 km consisting of pipes from PE (with diameters 90-450mm) and from steel (with diameters 600mm). The water pipes network is old enough. The average operating pressure is 4 atm and the total number of water meters is 48,500. The number of service connections is about 17,000. The billing period is 2 months for the city of Komotini and 4 months for the municipal districts. The river basin where water is taken from is the river basin of Komotini – Loutro Evrou stream (area 1,958.3Km^2). Water is taken from Vosvozis river (EL1209R0000010085N) and the groundwater system of Rodopi (EL1200120). All the information is given in Table 1.

Data (base year 2017)	
Total population served	65,000
Total area covered (km^2)	385.3
Total pipes' length (km)	549
Mean altitude (m)	45
Mean operating pressure (Atm)	4.0
Types of pipes (material, diameters)	PE (90-450mm) and steel (600mm)
No. of water meters	48,500
No. of service connections	17,000
Billing period	2 months for Komotini city; 4 months for municipal districts
River Basin where water is taken from	Komotini – Loutro Evrou stream

The water supply system consists from a group of 10 boreholes and the water supply from Simvola (surface water body) (Figure 1). 58.1% of the water abstracted comes from boreholes and 49.1% comes from Simvola.

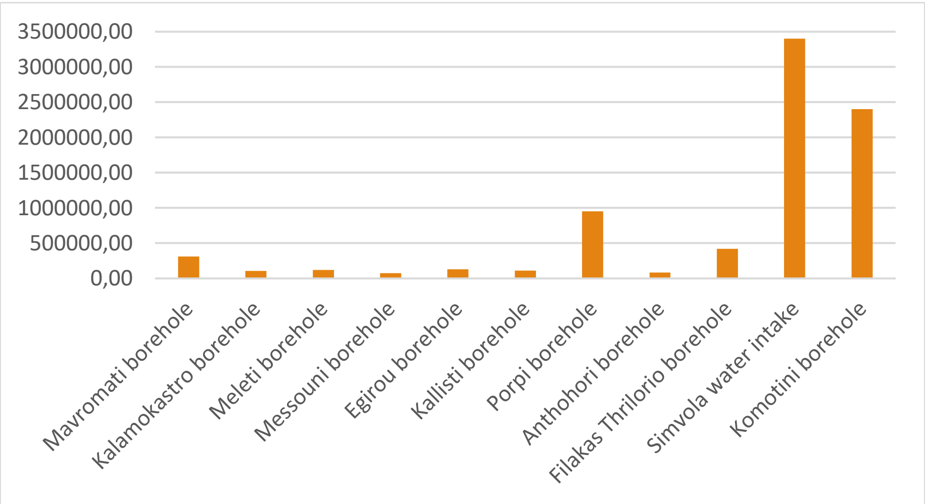

Figure 1. Water abstracted from boreholes and Simvola

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

Water Audit

2 Network's current (operation, control and monitoring) status

There are no pressure zones established and no DMAs formed in the water distribution network of Komotini. There is not a SCADA system in place and there is not a simulation model for the hydraulic simulation of the network. The technical department of DEYAK, through the maintenance department follows preventive maintenance regarding the network's failures.

The main problems the water network is facing are: (1) water pipes breaks; (2) invisible leaks; (3) high Non-Revenue Water levels; (4) illegal connections; (5) water balance problems. The main causes for these problems include the very old pipes in some parts of the city, the non-existence of SCADA system and zoning of the water distribution network. DEYAK trying to confront these problems is trying to get financing to replace the old parts of the distribution network in the city.

Water consumption has seasonal variations, showing higher values in the summer time.

3 Water Balance assessment for the water distribution network

In order to estimate the Water Balance, the following parameters are necessary:

- Water entering the network
- Water consumed (billed and unbilled)
- Unauthorized water consumption (theft and illegal connections)
- Water losses due to under-registration
- Real Water Losses due to leaks and breaks

<table>
<tr><td rowspan="7">System Input Volume
(A3)
8.109.250</td><td rowspan="4">Authorized Consumption
(A14=A10+A13)
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(A10=A8+A9)
5.027.735</td><td>Billed Metered Consumption
(A8)
5.027.735</td><td rowspan="2">Revenue Water
(A20=A8+A9)
5.027.735</td></tr>
<tr><td>Billed Unmetered Consumption
(A9)
0</td></tr>
<tr><td rowspan="2">Unbilled Authorized Consumption
(A13=A11+A12)
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(A11)
0</td><td rowspan="5">Non Revenue Water (NRW)
(A21=A3-A20)
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(A12)
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(A15=A3-A14)
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(A18=A16+A17)
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(A16)
81.093</td></tr>
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(A17)
754.160</td></tr>
<tr><td colspan="2">Real Losses
(A19=A15-A18)
2.165.170</td></tr>
</table>

Figure 2. The Water Balance for the whole water supply network of DEYA Komotinis for 2017

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

DEYA of Komotini holds records for water quantities entering the network (coming from boreholes and the water intake from Symvola) and billed water consumption. The following assumptions are made:

- Unauthorized consumption due to theft and illegal connections can be assumed as 1% of the water entering the network
- Meter under-registration can be assumed as 15% of the water metered
- Unbilled authorized consumption can be assumed as 1% of water entering the network.

Based on those data and assumptions, the Water Balance of the whole water utility of Komotini is given in Figure 2.

4 Performance Indicators

Based on the data provided above, the following Performance Indicators are estimated for the whole water supply network of Komotini.

Table 1. Performance Indicators for the water supply network of Komotini (2017)

Performance Indicators		**values**	**Units**
WR1	Inefficiency of use or water resources	26.7	%
Op24	Water losses per mains length	14.97	m^3/km/year
Op26	Apparent losses per system input volume	10.3	%
Op28	Real Losses per mains length	10,805.05	lt/km/day when system is pressurised
Fi46	Non-revenue water by volume	38.0	%

From Table 1, NRW is 38% of the System Input Volume (SIV), from which 10.3% is apparent losses. The remaining 27.7% is Real Losses. It is obvious that NRW levels are high for this network and this is mostly due to real losses.

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

WATER RESCUE

Water resources efficiency and conservative use in drinking water supply systems

WP	**3 Current Status Analysis and Assessment**
Deliverable *Tool*	**3.2.2 Water Audit report** *Questionnaire*
Project Beneficiary No	**PB2**
Beneficiary Institution	**Municipal Water Supply and Sewerage Company of Thermi**

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

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Name of the organization/institution: Municipal Water Supply and Sewerage Company of Thermi
Beneficiary number: PB2

1 Introduction

Municipal Water Supply and Sewerage Company of Thermi (DEYA Thermis) is the water utility supplying with water the area of Thermi including several municipal districts: Thermi, Mikra, N. Redestos, Tagarades, N. Risio, Vasilika, Souroti, Agia Paraskevi, Agios Antonios, Lakkia, Peristera and Livadi. The area covered by DEYA Thermis is 1559.34 Km^2. The area's altitude ranges from 0-200m. The water meters (active) are 25,786 supplying with water a population of 53,070 people (2011 census). The total pipes' length is about 700Km and the pipes are made of PE (60%) and PVC (40%). The pipes are installed since 1970 until now. The average operating pressure is about 5 atm.

DEYA Thermis is supplying the municipal district of Thermi with water from groundwater boreholes from three groundwater subsystems: down flow of Antemountas; Thermi – N. Risio; and Cholomontas – Oreokastro (Chalkidiki river basin). DEYA Thermis water abstraction is allocated in the groundwater systems as shown in Table 2. The major water volume (97.8%) comes from the subsystems of Anthemountas down flow and Thermi – N. Risio. The first subsystem is assessed in bad quantitative and chemical status, while the second is assessed in good quantitative and chemical status. Only 2.1% of water volume comes from the Cholomontas - Oreokastro subsystem which is found to be in good chemical and quantitative status.

Table 1. General data of the water supply network of DEYA Thermis (base year 2017)

General data	
Total population served	53,070
Total area covered (Km^2)	1,559.34
Total pipes' length (Km)	700
Mean altitude (m)	0-200
Mean operating pressure (atm)	5
Types of pipes (material, diameters, lengths)	PE (60%); PVC (40%)
Age of pipes (per material, diameter)	Since 1970
No. of water meters	25,786
Billing Period	Every 3 months
River Basin where water is taken from	Chalkidiki river basin

Table 2. Water availability, average annual abstraction and DEYA Thermis abstraction of three groundwater systems (source: RBMP, 2017)

Groundwater subsystem	Towns supplied with water	Water availability (10^6 m^3)	Average annual abstraction (10^6 m^3)	DEYA Thermis (m^3)	Chemical status	Quantitative status
Down flow of Anthemountas	Thermi, Mikra, N. Redestos, Tagarades, N. Risio, Vasilika, Souroti, Ag. Paraskevi	33.6	37.02	7,187,700	Bad	Bad
Thermi – N.	Thermi, Mikra, N.				Good	Good

Risio	Redestos, Ag. Antonios, Lakkia					
Cholomontas - Oreokastro	Peristera, Livadi	99	81.64	158,500	Good	Good

Water Audit

2 Network's current (operation, control and monitoring) status

There are no pressure zones established in the water supply network of DEYA Thermis. The water utility has not established DMAs in the network and there is no SCADA used. The utility does not use any hydraulic simulation model.

DEYA Thermis performs periodic inspections of the water supply system, checking the water tanks, the valves, the fire hydrants etc. Water tanks are cleaned every year. Proactive maintenance of the water supply networks is done by the department of water supply.

The water supply network faces problems regarding the aged pipelines which are not suitable in some cases and the network's failures (breaks, leaks etc.). The main causes are pressure variations within the network, the construction of the old water supply network without further studies, defective materials, failures due to third parties interventions, soil settling etc. The water utility replaces problematic parts of its network and expands the water supply network to other areas. DEYA controls and safeguards the water quality at the water supply positions and at the whole distribution network. The boreholes and the tanks are monitored through monitoring tools. DEYA Thermis has programmed several water works for the next periods. Such works include the water supply network extension, the replacement of water pipes, the drilling of new boreholes, the supply and installation of SCADA system, study of Masterplan and Water Safety Plan, etc. The total budget exceeds 17 million euros.

Water use in DEYA Thermis covers domestic, industrial, professional and agricultural water needs. Table 3 shows the number of water meters and water consumption by water use (base year 2015). The dominant water user is domestic use.

Table 3. Water meters and consumption by water use (2015)

Water use	No. of water meters	Water consumption (m^3)
Domestic	19,825	2,198,246
Industrial	130	25,182
Professional	4,850	686,433
Agricultural	350	28,000
TOTAL	**25,155**	**2,937,861**

3 Water Balance assessment for the water distribution network

Water Utility Level

The WB for the water supply system of DEYA Thermis has been estimated for 2016 and 2017. There are assumptions made for the estimation of some of the variables (Table 4).

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

Table 4. Assumptions regarding some variables for the estimation of the WB

Variable	Assumed value
Unauthorized consumption (theft and illegal connections)	1% of SIV (System Input Volume)
Meter and Metering errors	10% of Billed Metered Consumption
Billed Unmetered Consumption	0
Unbilled Unmetered Consumption	0

It is assumed that there is no unmetered consumption billed or unbilled. Unbilled metered consumption includes the water consumption from public buildings such as municipal buildings, schools, cemeteries, churches, parks, etc. which is metered since 2018. An assumption has been made for unbilled metered consumption based on the water volume metered for one 4-month period. Unauthorized consumption is assumed to be 1% of the System Input Volume. Meter and metering errors are assumed to be 10% of the billed metered consumption.

Based on the data available and the assumptions made, the WB for the water distribution network of DEYA Thermis is estimated for 2016 and 2017 (Figures 1 and 2).

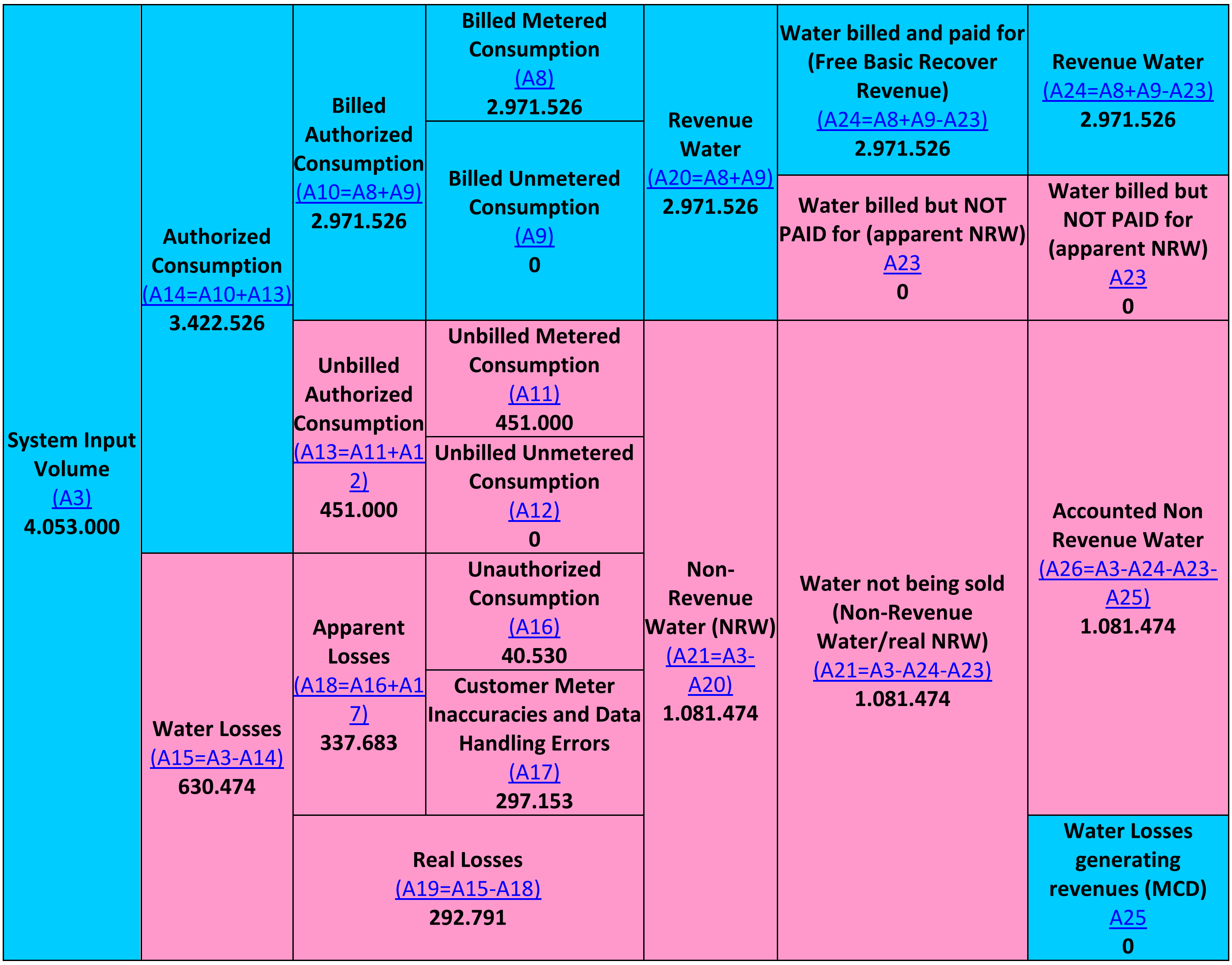

Figure 1. 2nd Modified WB for DEYA Thermis for 2016

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

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</tr>
<tr>
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A23
0</td>
<td>Water billed but NOT PAID for (apparent NRW)
A23
0</td>
</tr>
<tr>
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(A11)
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Figure 2. 2nd Modified WB for DEYA Thermis for 2017

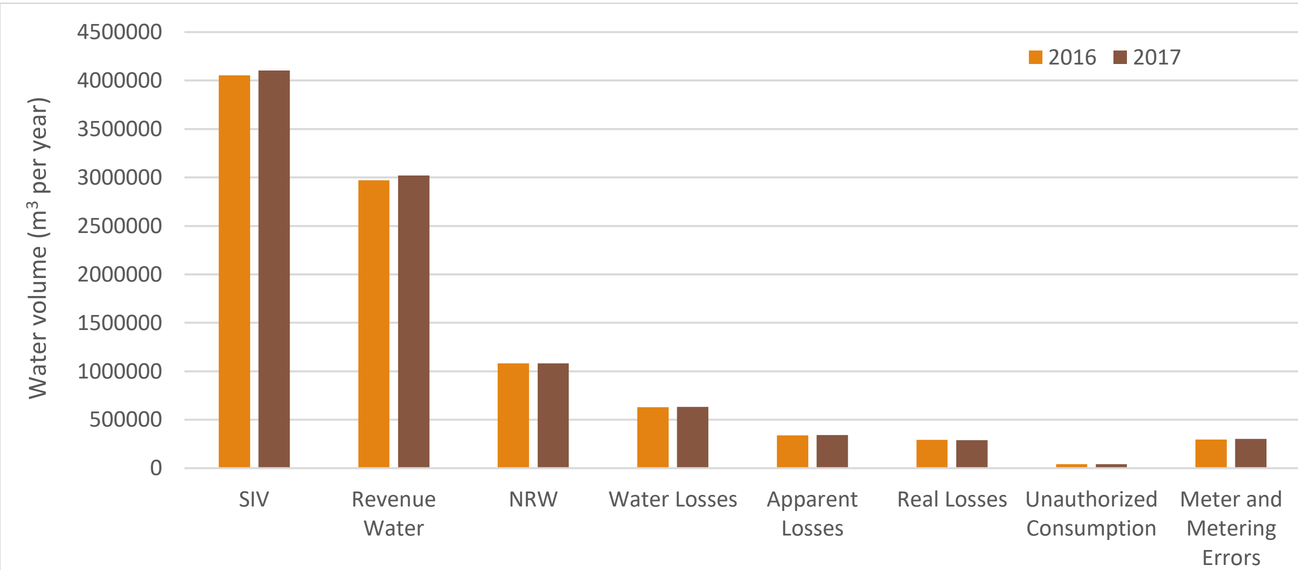

Figure 3. WB components for DEYA Thermis for 2016 and 2017

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

The 2nd modified WB has been estimated for both years. Although DEYA Thermis applies a fixed charge in its water bills, there are no data to estimate the Minimum Charge Difference component.

Figure 3 presents the WB components for 2016 and 2017. Revenue Water is the largest value of SIV while apparent and real losses are almost equal parts of NRW.

4 Performance Indicators

Based on the WB variables and the values of some other variables such as no of water meters, mean operating pressure, etc. some Performance Indicators (PIs) have been estimated. These include NRW by volume (Fi46), inefficiency use of water resources (WR1), apparent losses (Op25) and apparent losses per SIV (Op26), unmetered water (Op39), water losses per mains length (Op24) and real losses per mains length (Op28). Figures 4 and 5 show the values of the calculated PIs.

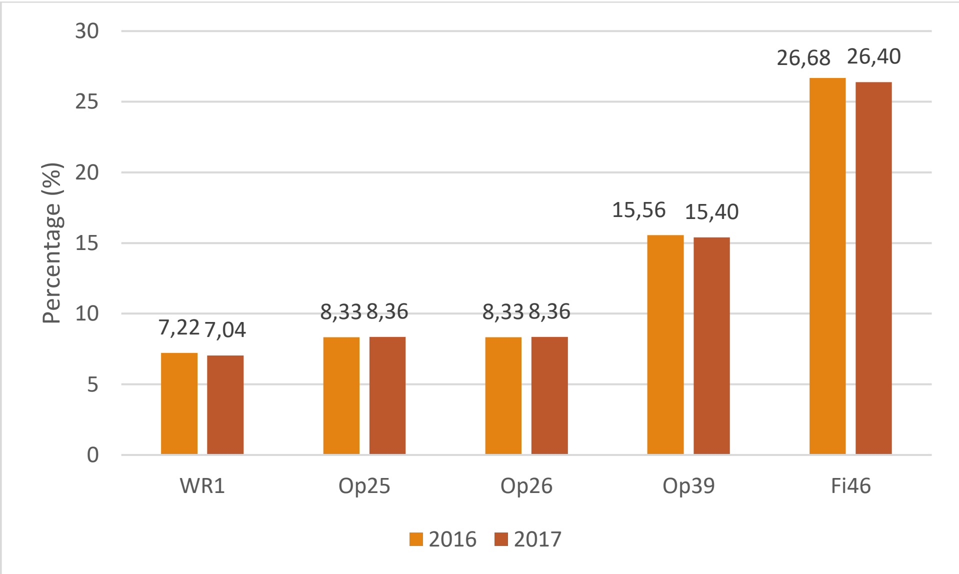

Figure 4. WR1, Op25, Op26, Op39 and Fi46 values for 2016 and 2017

The PIs values show that NRW is about 26% of SIV for both years. Apparent losses count for about 8% of SIV. Real losses per mains length values reduce slightly in 2017 compared to the 2016 values, while water losses per mains length increase slightly for 2017 compared to 2016 values.

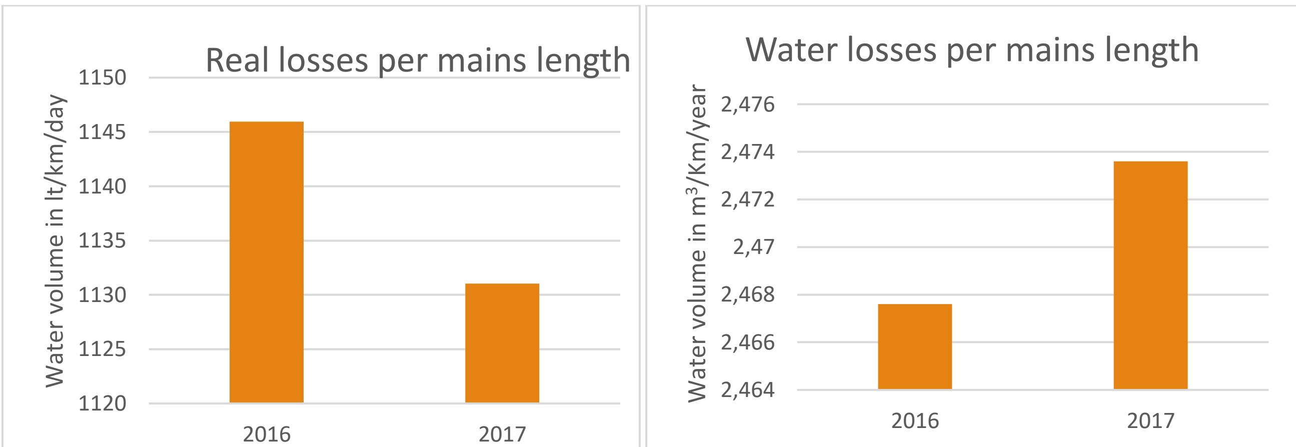

Figure 5. (a) Real losses per mains length values and (b) Water losses per mains length values (2016 and 2017)

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

WATER RESCUE

Water resources efficiency and conservative use in drinking water supply systems

WP	**3 Current Status Analysis and Assessment**
Deliverable *Tool*	**3.3.2 Water Audit report** *Questionnaire*
Project Beneficiary No	**PB3**
Beneficiary Institution	**University of Thessaly-Special Account Funds for Research-Department of Civil Engineering**

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

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The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

Name of the organization/institution: University of Thessaly-Special Account Funds for Research-Department of Civil Engineering
Beneficiary number: PB3

1 Introduction

The University of Thessaly reports the current status analysis regarding water use efficiency at national level. Greece consists of 14 Water Districts (WDs) (Figure 1).

Figure 1. Water Districts in Greece (source RBMPs)

The country shares three transnational water resources with Bulgaria (RBMP of Thrace, 2017; RBMP of Eastern Macedonia, 2017). These transnational water resources are: River Basin (RB) of Evros (Greece; Bulgaria; Turkey); RB of Nestos (Greece and Bulgaria); RB of Strimonas (Greece and Bulgaria).

Specifically, in the WD of Thrace, the River Basin (RB) of Evros has a total length is 528Km of which 310 Km belong to Bulgaria while 208 Km are the natural borders of Greece with Bulgaria and Turkey. The RB is shared among the three counties as follows: 35,085Km^2 (66.2%) belong to Bulgaria, 14,575Km^2 (27.5%) belong to Turkey and 3,340Km^2 (6.3%) belong to Greece (RBMP of Thrace, 2017). Water demand in all water districts per sector is given in Table 1.

Table 1. Water demand by sector (data gathered from the RBMPs, 2017)

Water District (WD)	WD name	Agriculture (hm^3)	Industry (hm^3)	Domestic (hm^3)	Livestock (hm^3)	Total (hm^3)
EL01	Western Peloponnese	171.1	18.8	27.5	1.5	218.9
EL02	Northern Peloponnese	406.5	8.6	61.8	3.3	480.2
EL03	Eastern Peloponnese	339.5	7.8	27.7	1.6	376.6
EL04	Western Sterea Ellada	493.0	2.0	39.0	8.0	542.0
EL05	Epirus	376.0	4.5	58.0	10.0	448.5
EL06	Attica	66.7	18.5	416.2	2.1	503.5
EL07	Eastern Sterea Ellada	839.6	29.1	76.1	10.5	955.3
EL08	Thessaly	1,305.5	9.0	94.0	13.0	1,421.5
EL09	Western Macedonia	636.0	68.5	166.3	8.2	879.0
EL10	Central Macedonia	953.1	40.4	177.9	7.3	1,178.7
EL11	Eastern Macedonia	772.0	4.1	58.9	2.5	837.5
EL12	Thrace	941.4	14.1	60.5	3.9	1,019.9
EL13	Crete	415.0	0.8	78.1	4.2	498.0
EL14	Aegean Islands	111.4	0.1	90.7	2.4	204.5
TOTAL		**7,826.8**	**226.2**	**1,432.7**	**78.5**	**9,564.1**

Water Audit

2 Network's current (operation, control and monitoring) status

In Greece there is not an official report on the current operational status of the water supply networks of water utilities. The Association of Municipal Enterprises for Water Supply and Sewerage (EDEYA) has presented a study performed in 67 water utilities in Greece regarding the existence of SCADA systems, GIS and hydraulic simulation models. According to this study implemented in 2016, sixty-seven (67) out of the total 127 municipal water utilities in Greece replied to a questionnaire. The study showed that 41 of the water utilities have SCADA system, 16 of them have GIS system and only 16 of them have a hydraulic simulation model (Table 2).

Table 2. Number and percentage of water utilities with tools for control and monitoring of their water distribution networks (data taken from EDEYA)

	SCADA system	GIS	Hydraulic simulation model
Number of Water Utilities	41 (out of 67)	16 (out of 67)	9 (out of 67)
Percentage of water utilities	61.2%	23.9%	13.4%

In addition to that, Special Secretariat for Water (SSW) has established an internet database (http://wsm.ypeka.gr/login.html) where all water utilities have to report specific indicators (apart from cost and cost recovery indicators). Among these indicators are the following (included in the Joint Ministerial Decision 135275/2017):

- Water losses
- Average consumption m^3/water meter
- Density of sewerage network: connections per km
- Density of water supply network: water meters per km
- Percentage of consumers coverage from the sewerage network

3 Water Balance assessment for the water distribution network

As mentioned above, there is not a national benchmarking tool so far. However, some data on the water demand per use are provided in Table 1.

Taking into consideration the cross-border river basin between Greece and Bulgaria, the water abstractions per use is shown in Table 3.

Table 3. Water abstraction volumes per use and river basin (data taken from the RBMPs of Eastern Macedonia and Thrace)

River Basin	Total water abstracted (million m^3)	Irrigation (million m^3)	Drinking water supply (million m^3)	Industry (million m^3)	Livestock farming (million m^3)	Abstraction from surface water bodies (million m^3)
Strimonas	837.48	772.01	58.87	4.13	2.47	589.36
Nestos	268.07	259.16	7.85	0.14	0.93	121.76
Evros	315.47	290.95	21.86	1.01	1.65	184.8

One of the 15 groundwater systems in Strimonas river basin is assessed to be in bad quantitative status due to over exploitation (the system of Eleftheres – N. Peramos). The groundwater systems in the river basins of Nestos and Evros are assessed to be in good quantitative status.

4 Performance Indicators

There is not a benchmarking tool so far, at national level.

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

Literature

River Basin Management Plans (updated) for all WDs, available at: http://wfdver.ypeka.gr/el/management-plans-gr/1revision-approved-management-plans-gr/

River Basin Management Plan (RBMP) of Eastern Macedonia 1st Revision, 2007. Available at: http://wfdver.ypeka.gr/wp-content/uploads/2017/12/EL11_SDLAP_APPROVED.pdf (in Greek)

River Basin Management Plan (RBMP) of Thrace 1st Revision, 2007. Available at: http://wfdver.ypeka.gr/wp-content/uploads/2017/12/EL12_SDLAP_APPROVED.pdf (in Greek)

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WATER RESCUE

Water resources efficiency and conservative use in drinking water supply systems

WP	**3 Current Status Analysis and Assessment**
Deliverable *Tool*	**3.4.2 Water Audit report** *Questionnaire*
Project Beneficiary No	**PB4**
Beneficiary Institution	**Municipality of Kardzhali**

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

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The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

Name of the organization/institution: Municipality of Kardzhali
Beneficiary number: PB4

1 Introduction

Please describe your water distribution network.

Water Utility Level (2017 base year)

- Total population served = 55019
- Total area covered (Km^2) =
- Total pipes' length (Km) =
- Mean altitude (m) =
- Mean operating pressure (atm) = 4-5 atm.
- Types of pipes (material, diameters, lengths) =
- Age of pipes (per material, diameter) = average age 35 years
- No. of service connections = 19854
- Billing Period = monthly
- River Basin where water is taken from = Borovitsa River / dam. Borovitsa / Perpereshka River

- Types of pipes (material, diameters, lengths)

MUNICIPALITY	length of the water supply network			
	in the settlements		out of populated areas	
	Ф ≤300 мм	Ф > 300 мм	Ф ≤ 300 мм	с Ф > 300 мм
	км	км	км	км
MUNICIPALITY KARDZHALI	171171	7608	143539	33380
Incl.				
ethericity	97668	7608	122202	33380
steel	11975		12811	
PEPP and PVC	61528		8526	

-

Water Audit

2 Network's current (operation, control and monitoring) status

Water Utility Level

- Are there any pressure zones established? If yes, do provide further details.

e.g. how many are they?; which is the mean altitude level difference?; how much part (% of total pipes' length; % of total population served) of the network do they cover (mean value and total value)?; etc. (wherever available, please do provide proofs e.g. sketches, diagrams, designs, photos) - NO

- Are there any DMAs established? If yes, do provide further details

e.g. how many are they?; which is the mean zone altitude level difference?; how much part (% of total pipes' length; % of total population served) of the network do they cover?; how much is their average size; how much population do they serve as a mean value?; etc. (wherever available, please do provide proofs e.g. sketches, diagrams, designs, photos)

- Is there a SCADA system in place? If yes do provide further details.

e.g. type, number and mean density of data collection stations; number and mean density of telecontrol stations etc. (wherever available, please do provide proofs e.g. sketches, diagrams, designs, photos)

- Yes

SKADA systems - current state, systems implementation

On the territory of the company there are three dispatching systems equipped with a program for control of pumping stations and reservoirs (SKADA) - Kardzhali, Krumovgrad and Kirkovo. 12 PCs located in areas where there is no radio signal coverage are not covered. The plan of the Company is a phased inclusion of these vehicles.

In newly constructed WWTP Kardzhali and Momchilgrad there is a three-stage "SKADA" system, which provides fully automated management, including and remote.

At the Pazardzhik town of Kardzhali was put into operation in 1990. there is a partially built automation. The PIP currently under development envisages a major repairs to the WWTP, including the construction of a three-tier "SCADA" system.

At the entrances of Kardzhali and Momchilgrad, as well as large water mains are installed induction flow meters, which signal constantly in the dispatch stations. The program of the company envisages additionally mounted on such flowmeters in separate zones as well as at the entrances of the larger settlements. They are designed to be mounted on pressure sensors with remote reading.

In order to locate accidents on the main water supply from Borovitsa dam to the town of Kardzhali with a length of 25 km. another 4pcs are provided. pressure sensors with remote reading from dispatcher point. One sensor is currently installed.

SCADA on-board report for control and management of feed water from the HP and HP

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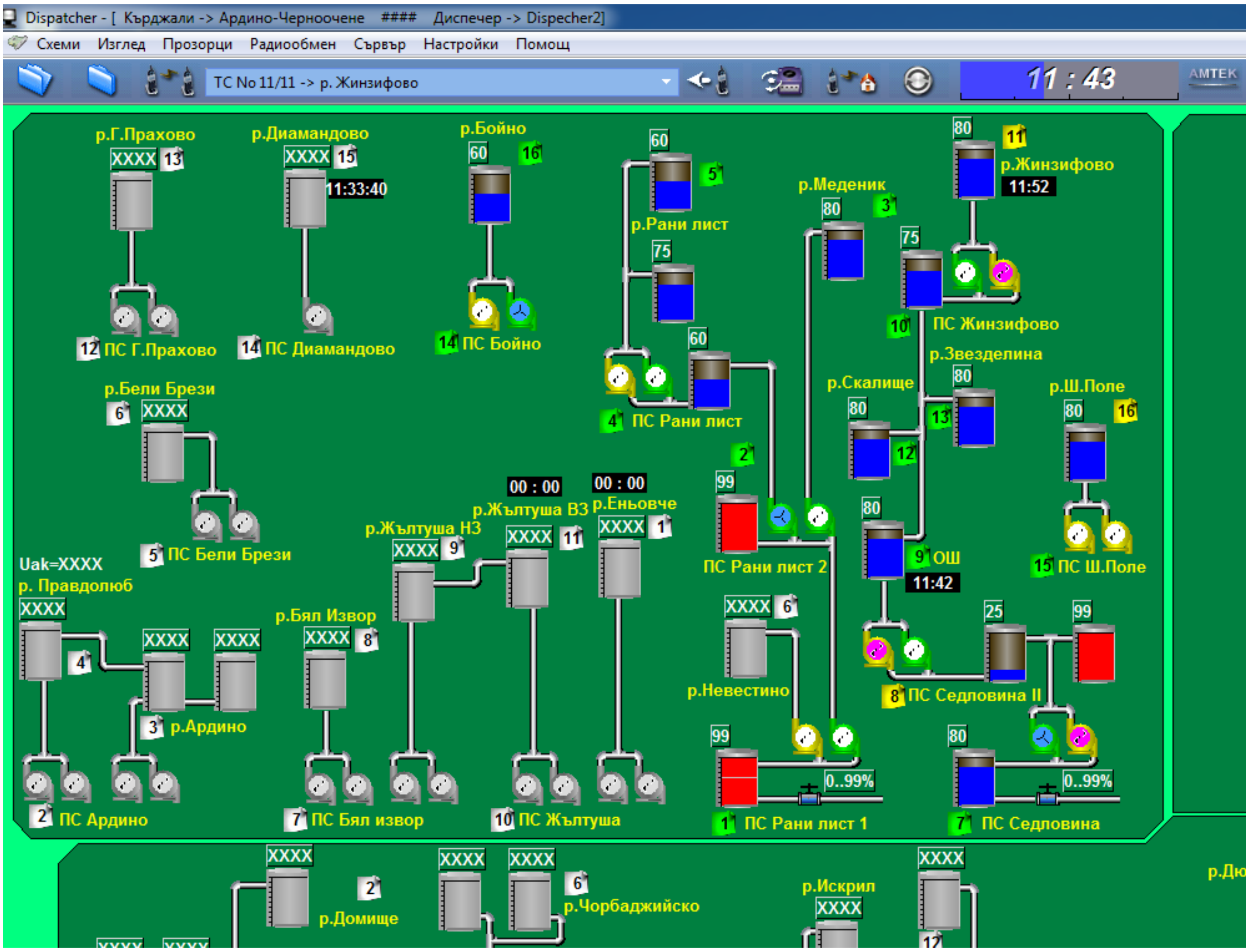
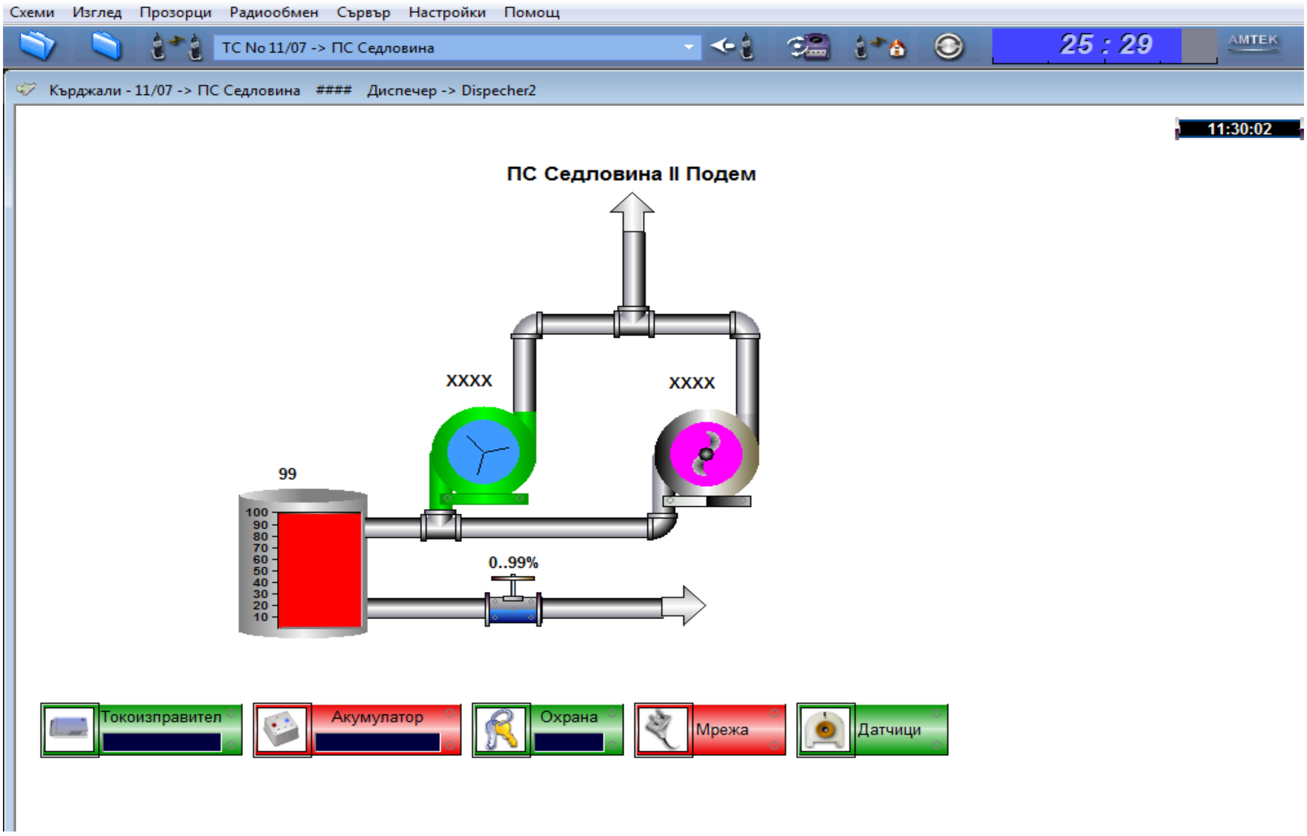
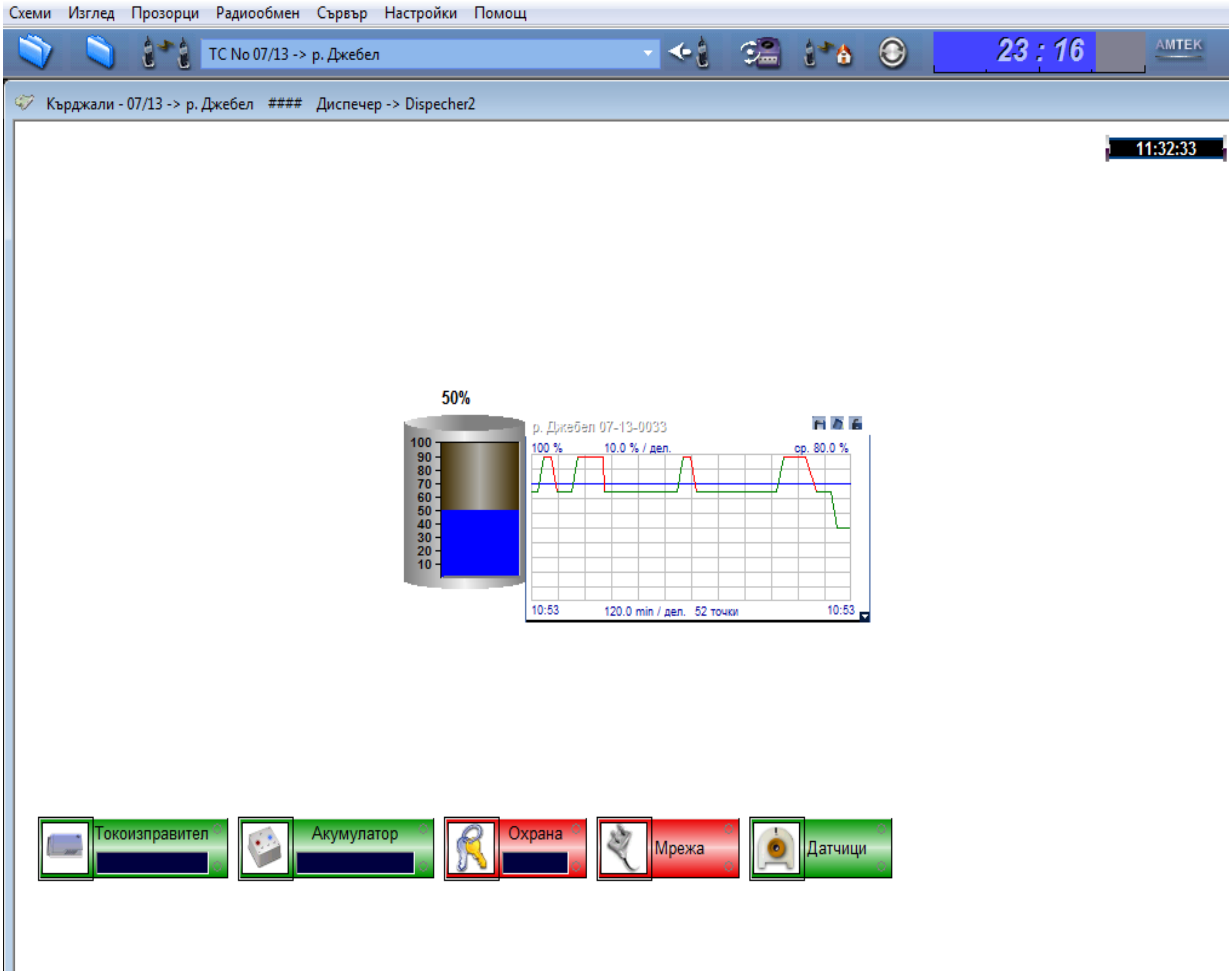

Dispatcher - [Кърджали -> Ардино-Черноочене #### Диспечер -> Dispecher2]
Схеми Изглед Прозорци Радиообмен Сървър Настройки Помощ
TC No 11/11 -> р. Жинзифово
11 : 43
AMTEK
р.Г.Прахово
ПС Г.Прахово
р.Диамандово
11:33:40
ПС Диамандово
р.Бойно
ПС Бойно
р.Рани лист
ПС Рани лист
р.Меденик
р.Жинзифово
11:52
ПС Жинзифово
р.Звезделина
р.Скалище
р.Ш.Поле
ПС Ш.Поле
р.Бели Брези
ПС Бели Брези
Uak=XXXX
р. Правдолюб
р.Ардино
ПС Ардино
р.Бял Извор
ПС Бял извор
р.Жълтуша НЗ
р.Жълтуша ВЗ
р.Еньовче
00 : 00
ПС Жълтуша
ПС Рани лист 2
ОШ
11:42
р.Невестино
ПС Седловина II
ПС Рани лист 1
ПС Седловина
0..99%
р.Домище
р.Чорбаджийско
р.Искрил
р.Дю



The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".



SCADA for HP control and management

Flow meters for monitoring incoming water in Kardjali from the Encez PWN and zone water meters.

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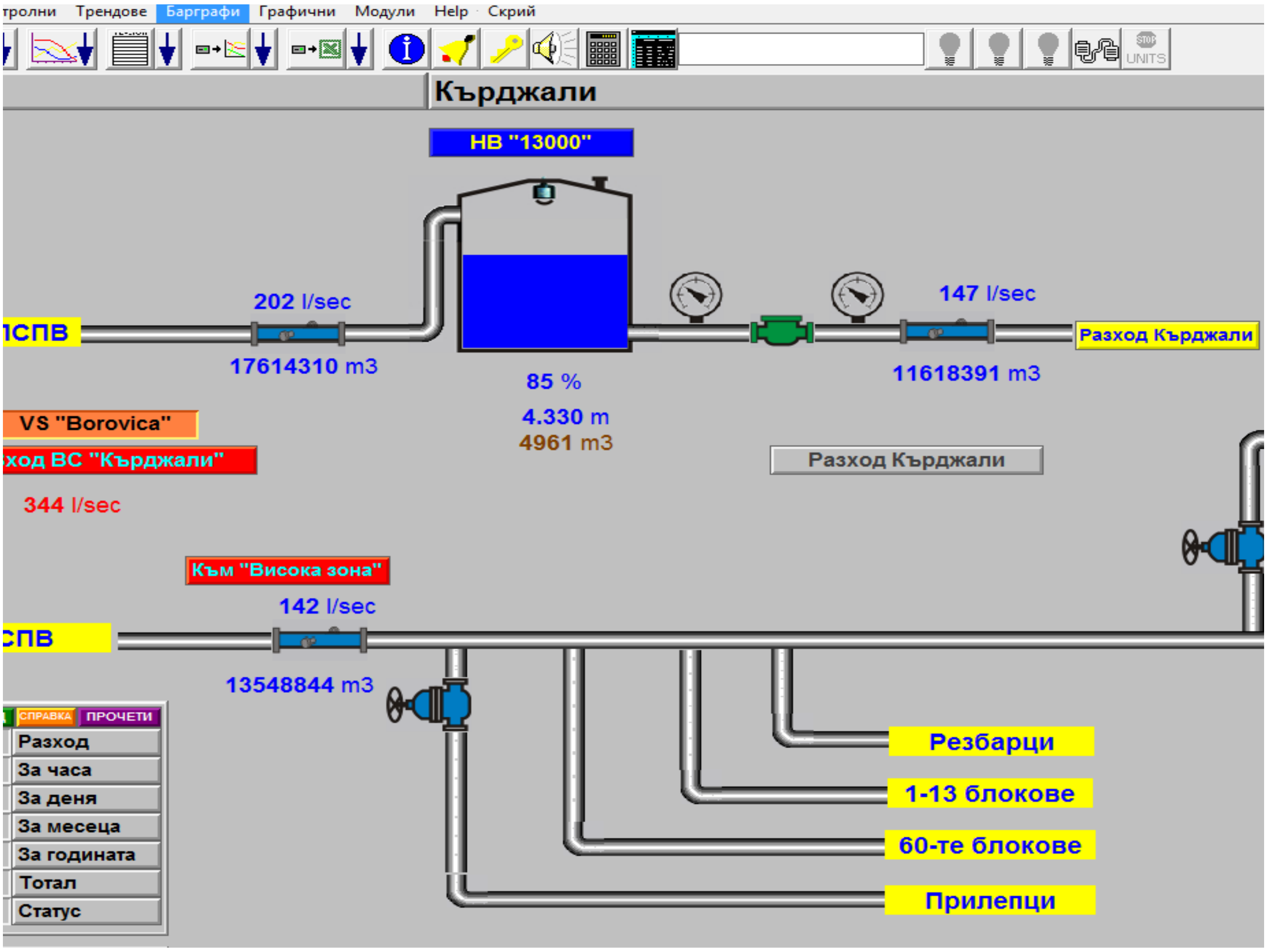
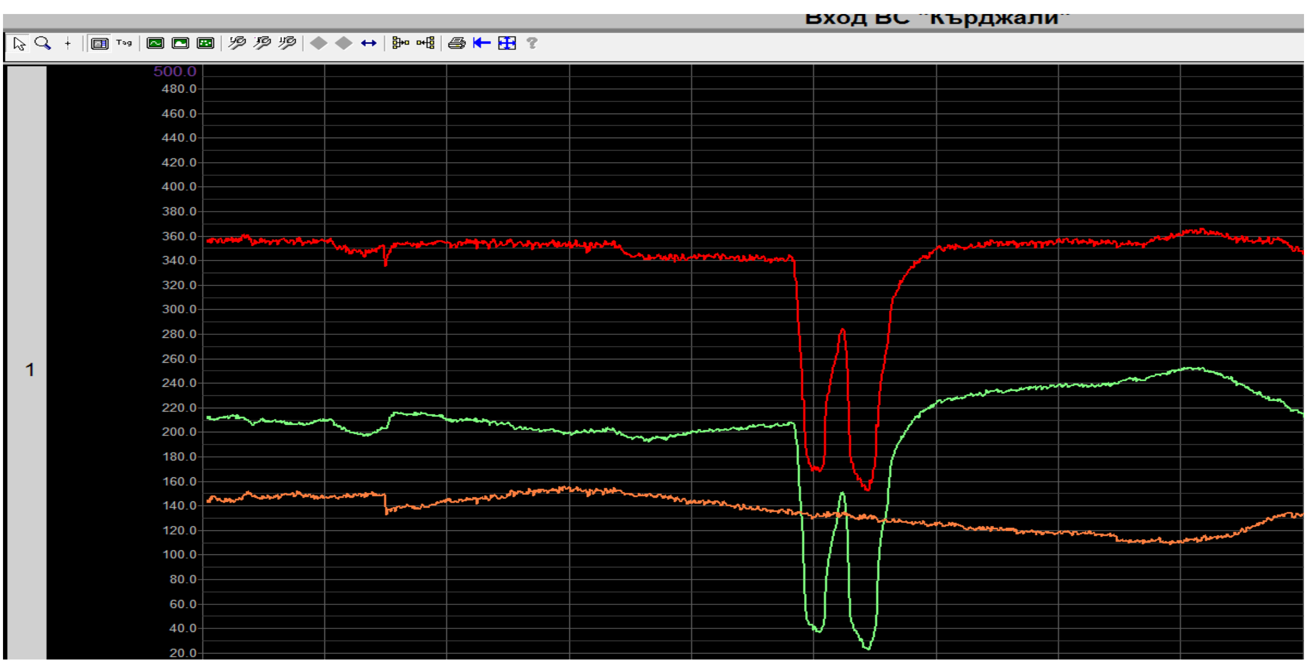
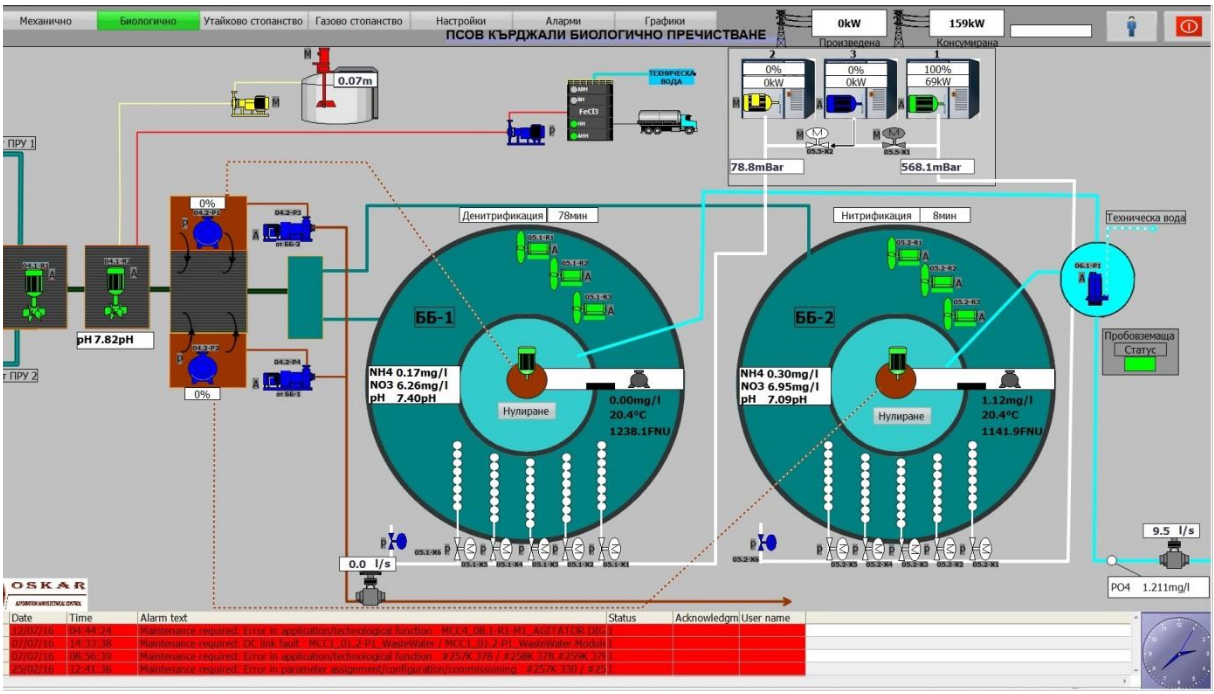
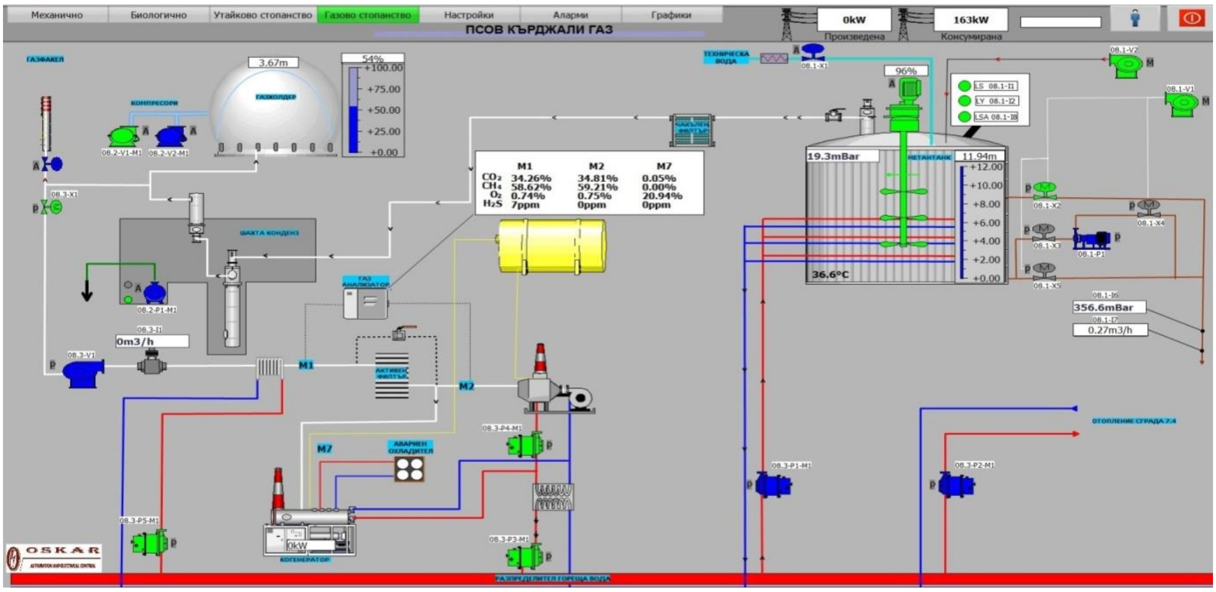

тролни Трендове Барграфи Графични Модули Help Скрий
Кърджали
НВ "13000"
202 l/sec
17614310 m3
85 %
4.330 m
4961 m3
147 l/sec
11618391 m3
Разход Кърджали
Разход Кърджали
VS "Borovica"
ход ВС "Кърджали"
344 l/sec
Към "Висока зона"
142 l/sec
13548844 m3
Резбарци
1-13 блокове
60-те блокове
Прилепци
СПРАВКА ПРОЧЕТИ
Разход
За часа
За деня
За месеца
За годината
Тотал
Статус


Вход ВС "Кърджали"
500.0
480.0
460.0
440.0
420.0
400.0
380.0
360.0
340.0
320.0
300.0
280.0
260.0
240.0
220.0
200.0
180.0
160.0
140.0
120.0
100.0
80.0
60.0
40.0
20.0

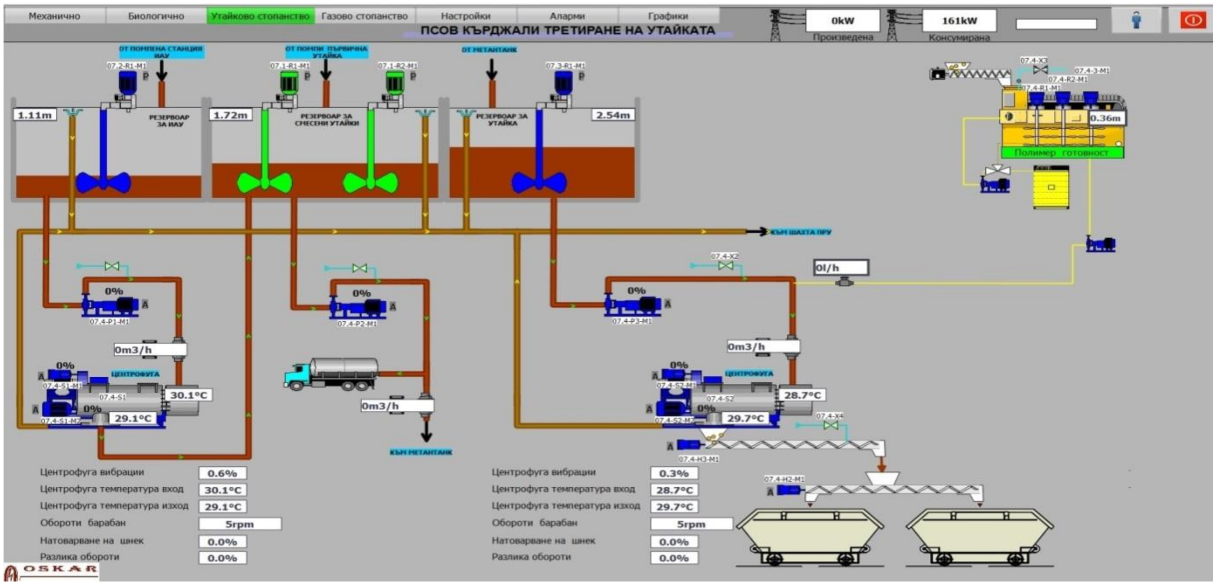
At the inlet and outlet of the WWTP there are installed automatic sampling systems and flowmeters for recording the input and output water. All water and sludge purification processes are automated and controlled by a SCADA (Data Dispatch Control and Data Collection System). The WWTP is capable of being controlled by the PLCs of the programmable logic controllers or manually controlled on each section to ensure continuous operation in case of a SCADA system failure or any device.



SCADA for Biological Steps



SCADA Gas Holding



SCADA Sludge Holding

• Is there a simulation model available for the network? If yes, give more details. No

such as whether it is market software or own model? what is his degree of reliability? whether it is regularly calibrated and validated? Used for decision-making and / or planning? etc. (if any, please provide evidence, such as sketches, diagrams, designs, pictures)

• Is there a policy for support? If yes, give more details. Yes. Monitoring and networking with specialized equipment.

how does maintenance work? Is there a separate support department? etc.

• Identify the main problem (s) facing the water network. - Common accidents

• Identify the root causes of these problems - Pipe and fitting wear

• Actions to improve existing network operation (what, how, how) Replacement of the depreciated water network

• Are there seasonal fluctuations in water consumption? Please provide data

Consumption of water by months in 2017

January February March April May June July August September October November December

191996 205375 204161 207366 220022 222179 256392 265212 273326 249817 211004 187214

• The water balance assessment period used for water

for example per year / semester / four months / three months / two months / month / another (give sufficient reasons for your choice, such as the billing period, availability of data) Quarterly

3 Assessment of the Water Balance for the Water Supply Network

Water level

Please provide the water balance of the water distribution network (you can use the xls file named "WB-PI_Calc-UTH_version 2.2_EN")

4 Performance indicators

Water level

Please rate the following performance metrics (at least). You can use the xls file named "WB-PI_Calc-UTH_version 2.2_EN"

- NRW by volume (Fi46) (%) =

- NRW per cost (Fi47) (%) =

loss of connection water (Op23) (m3 / link / year) =

Water losses over network length (Op24) (m3 / Km / year) =

Significant losses (Op25) (%) =

- Significant losses for SIV (Op26) (%) =

actual loss of connection (Op27) (lt / connection / day when the system is under pressure) =

- actual network length losses (Op28) (l / km / day when the system is under pressure)

- UARL =

- ILI =

- ALI =

- Others

Appendix A:

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

WATER RESCUE

Water resources efficiency and conservative use in drinking water supply systems

WP	**3 Current Status Analysis and Assessment**
Deliverable *Tool*	**3.5.2 Water Audit report** *Questionnaire*
Project Beneficiary No	**PB5**
Beneficiary Institution	**Municipality of Gotse Delchev**

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

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The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

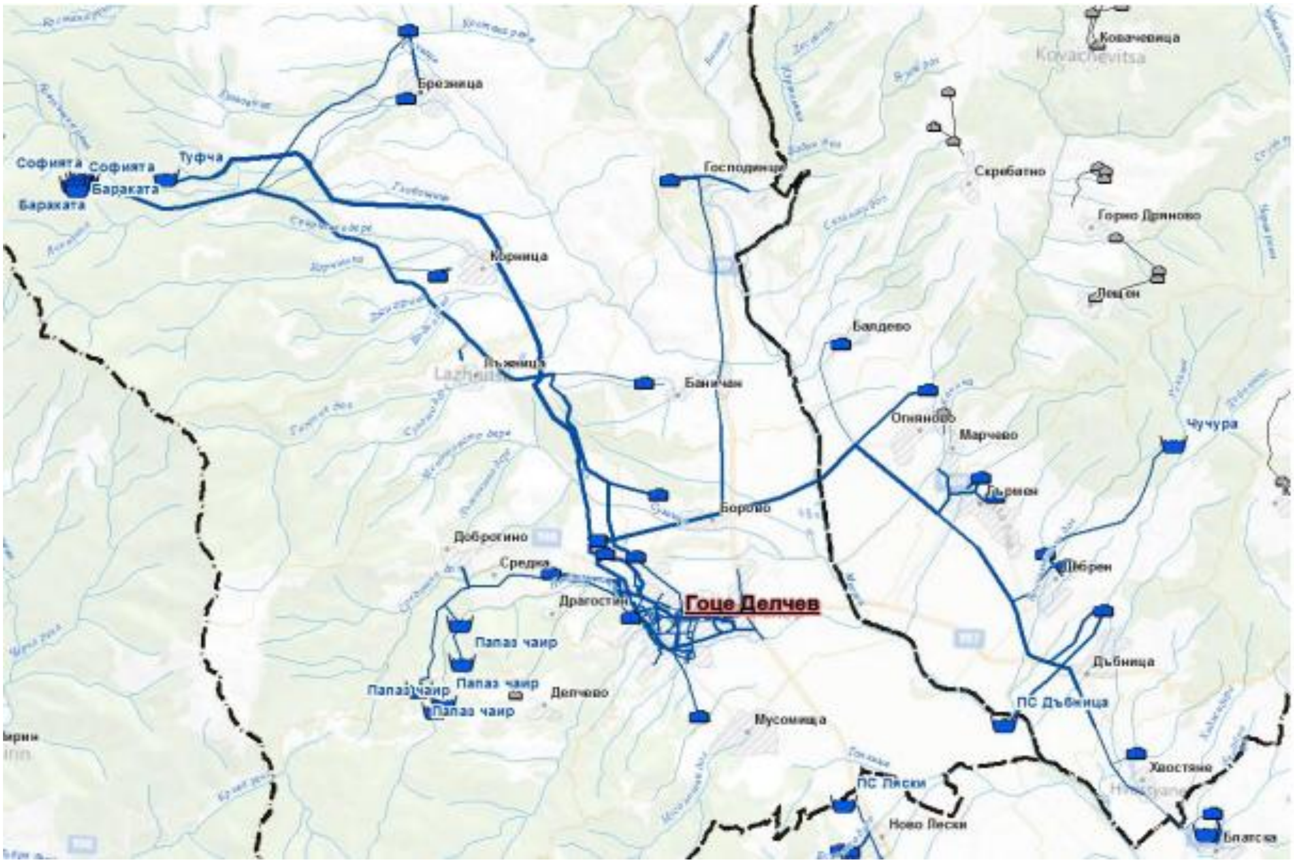
Name of the organization/institution: Municipality of Gotse Delchev
Beneficiary number: PB5

1 Introduction

Water supply system of Gotse Delchev supply settlements from two municipalities – Gotse Delchev and Garmen. Water supply for the system is provided by following water sources located on the territory of Gotse Delchev municipality:

- Spring Barakata – spring is located 15 km away from Gotse Delchev at altitude 1 555 m. It consist of three springs, collector and a chamber. Water is supplied to a reservoir V=1250 m3 with DN250 mm asbestos cement pipe installed in mid-sixties. Capacity of the spring is 91 l/s.
- Spring Sofiata – spring is located 16 km away from Gotse Delchev at altitude 1 430 m. It consist of three springs, collecting pipe and a chamber. Water is supplied to a reservoir V=1250 m3 with DN250 mm asbestos cement pipe installed in mid-sixties. Capacity of the spring is 16 l/s.
- Spring Papaz Chair– spring is located 16 km away from Gotse Delchev at altitude 1 382 m. Water is supplied to a reservoir V=700 m3 with DN150 mm steel pipe. Capacity of the spring is 11 l/s.
- Ground water source Tufcha – Ground water source is located 15 km away at altitude 1 110 m. It consist of a chamber with overflow, screen and a sedimentation chamber. Water is supplied to a Potable Water Treatment Plant (PWTP). After water is treated, main quantity is supplied to water supply network of Gotse Delchev and rest is provided for Gospodinovci and Garmen. Capacity of the water source is 420 l/s.

In addition to those main water source on the territory of water supply system some local wells are used as water sources.



Scheme 1 – water source on the territory of WSS Gotse Delchev

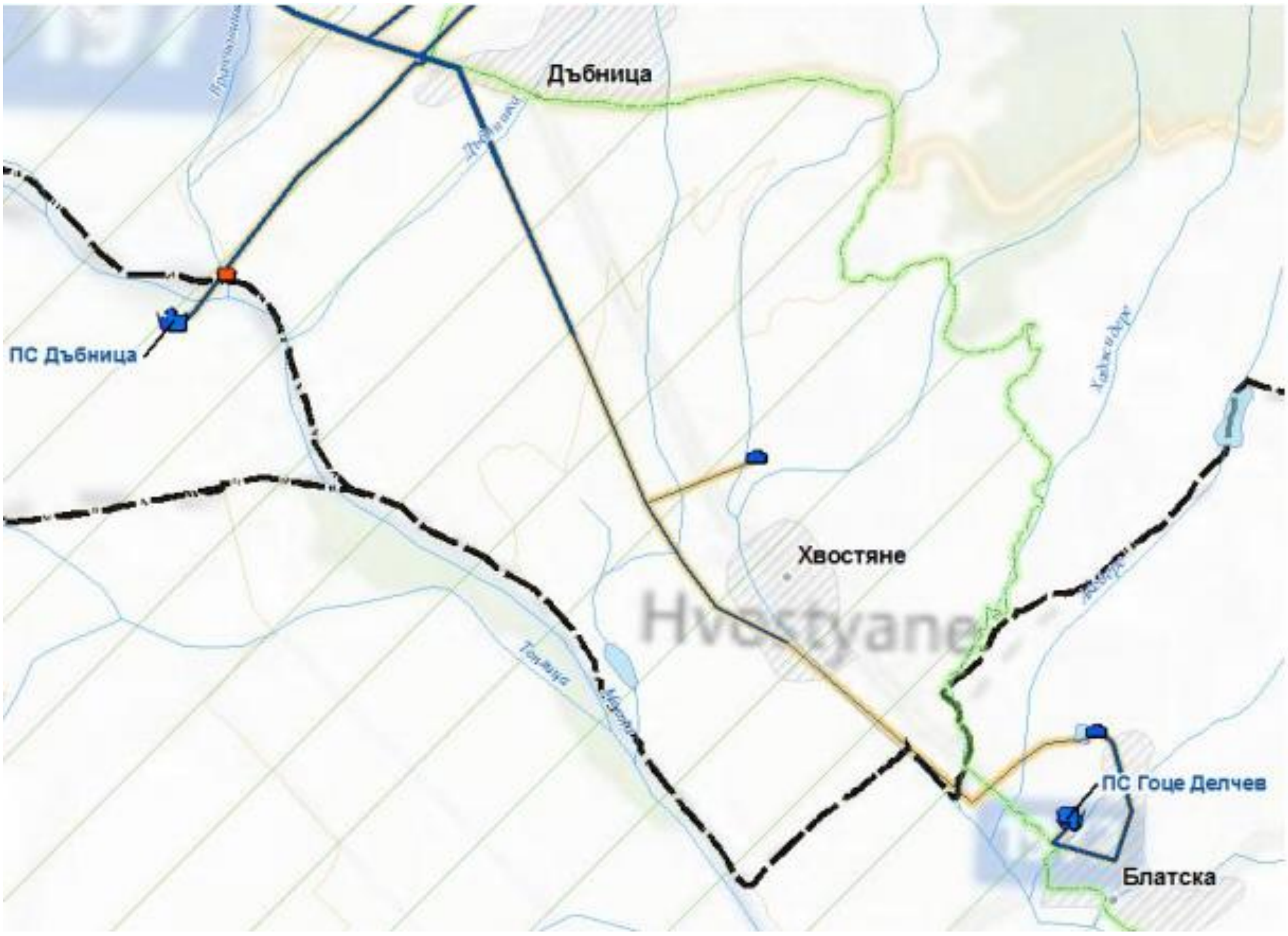
The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

Main facility for the water supply system is potable water treatment plant Gotse Delchev. It is a two stage treatment plant which is put into operation in 2006. Plant is located just above main reservoir of Gotse Delchev with capacity V=7000 m3. Production capacity of the plant is 36 250 m3/day.

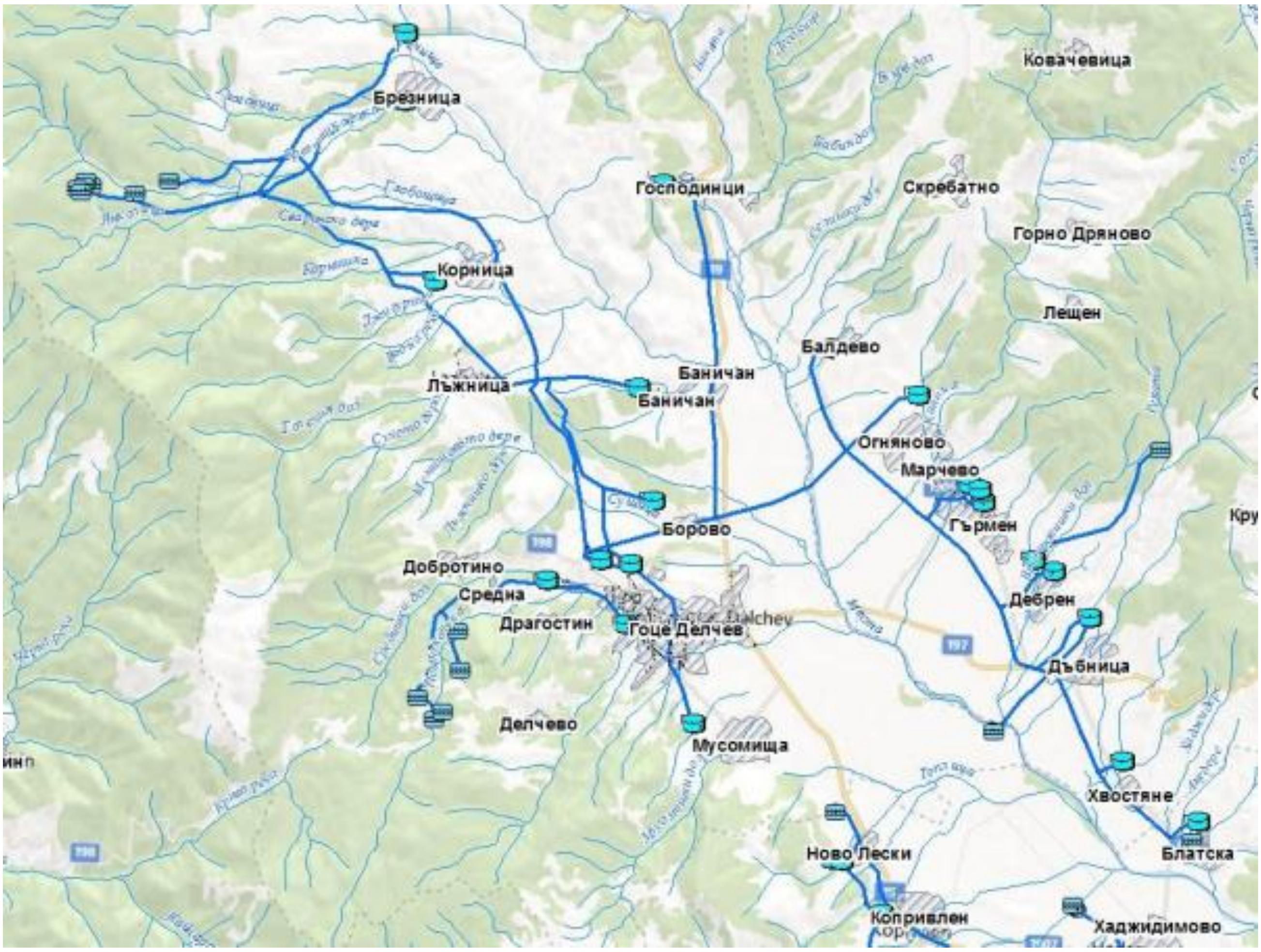
On the territory of water supply system of Gotse Delchev 20 reservoirs are used to store water needed for efficient water supply. Three of the reservoirs are used for the water supply of Gotse Delchev – V=7000 m3; V=1250 m3; V=750 m3. Rest reservoirs are used for following settlements – Musomishte V=300 m3; Borovo V=80 m3; Banichan V=120 m3; Kornica V=120 m3; Breznica V=800 m3 and V=80 m3; Gospodinci V=50 m3; Badlevo V=300 m3; Ognyanovo V=800 m3; Garmen V=300 m3 and V=150 m3; Debren V=450 m3 and V=300 m3; Dabnica V=300 m3; Hvostyane V=300 m3; Blatska V=300 m3.

Scheme 2 – water reservoirs on the territory of WSS Gotse Delchev

Only two pumping stations are used in water supply system Gotse Delchev – PS Dabnica and PS Gotse Delchev both of them use water from local underground water sources. PS Gotse Delchev is used to provide water from local water source to water supply network of village Blatska.



Scheme 3 – pumping stations on the territory of WSS Gotse Delchev



Scheme 4 – external pipelines on the territory of WSS Gotse Delchev

Water Utility Level (2017 base year)

- Total population served = 46 416 people

Population	Number
Gotse Delchev municipality	32 169
Garmen municipality	14 247
Total population served in WSS Gotse Delchev	**46 416**

- Total area covered (Km^2) = 718,69

Area	Number
Gotse Delchev municipality	330,21
Garmen municipality	388,48
Total area covered (km2)	**718,69**

- Total pipes' length (Km) =
  - Total length of main pipelines in WSS Gotse Delchev is 107,36 km.
  - Water distribution network of Gotse Delchev city is about 53 km. Main pipelines which brings water to the water supply network of the city consist of following pipelines: 15 km. DN250-DN300 asbestos-cement and 14 km 430-500 mm steel.

- Water is supplied to the water distribution network of Garmen through 426 mm steel pipeline with total lenght 6,04 km.
- For the rest of the settlements there is no reliable data for the exact length of the pipelines.

- Mean altitude (m) =
  - Gotse Delchev municipality is located in a hollow with average altitude of 530 m.
  - Average altitude of Garmen municipality is 1000 m;
- Mean operating pressure (atm) = pressure in water distribution network of Gotse Delchev city varies between 3 bars and 6 bars
- Types of pipes (material, diameters, lengths) =
  - Main external pipelines

Size	Steel	Asbestos cement	Other	Total Length
0-100	3,92	8,40	0,37	12,69
101-150	22,92	7,91		30,83
151-200	10,69	0,60	10,79	22,08
201-300	6,16	17,23		23,39
301-500	6,20			6,20
501-600	12,18			12,18
Total length of water distribution network				**107,37**

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

- Main distribution pipelines

Size	Polyethylene	Steel	PVC	Other	Asbestos cement	Total Length
0-100	1,14	2,45	0,32		0,82	4,73
101-150	2,94	9,72			1,59	14,25
151-200	2,4	2,21		2,9	0,1	7,61
201-300	0,8	6,17			2,52	9,49
301-500					1,56	1,56
Total length of main water distribution network						**36,08**

- Age of pipes (per material, diameter) =
  - Main distribution pipelines – most of the main pipelines are installed from 30-50 years ago
  - Distribution networks – most of the pipelines are installed in more than 50 years ago.
- No. of service connections =
- Billing Period =
- River Basin where water is taken from =

Water Audit

2 Network's current (operation, control and monitoring) status

Water Utility Level

- Are there any pressure zones established? If yes, do provide further details.

e.g. how many are they?; which is the mean altitude level difference?; how much part (% of total pipes' length; % of total population served) of the network do they cover (mean value and total value)?; etc. (wherever available, please do provide proofs e.g. sketches, diagrams, designs, photos)

For the overall WSS Gotse Delchev only one pressure zone is established. It is located in water distribution network of Gotse Delchev city where pressure in the lower part of the city is reduced with pressure reducing valves on the main pipeline DN300 for the zone.

- Are there any DMAs established? If yes, do provide further details

e.g. how many are they?; which is the mean zone altitude level difference?; how much part (% of total pipes' length; % of total population served) of the network do they cover?; how much is their average size; how much population do they serve as a mean value?; etc. (wherever available, please do provide proofs e.g. sketches, diagrams, designs, photos)

There is no DMA zones established on the territory served from WSS Gotse Delchev. First DMA Dunav was established as a part of the current project.

- Is there a SCADA system in place? If yes do provide further details.

e.g. type, number and mean density of data collection stations; number and mean density of telecontrol stations etc. (wherever available, please do provide proofs e.g. sketches, diagrams, designs, photos)

WSS Gotse Delchev is a part of central SCADA system of WSSC Blagoevgrad. On the territory of WSS Gotse Delchev a limited SCADA system is integrated only for the facilities which are used for the water supply of Gotse Delchev city. The only available information is for water level in reservoirs and position of few isolating valves equipped with electric actuators.

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

- Is there a simulation model available for the network? If yes, do provide further details.

e.g. is it a market software or an own-built model?; what is its reliability level?; is it being regularly calibrated and validated?; Is it used for decision making and/or planning?; etc. (wherever available, please do provide proofs e.g. sketches, diagrams, designs, photos)

There is no simulation model available for the territory served from WSS Gotse Delchev

- Is there a maintenance policy followed? If yes, do provide further details.

e.g. how is maintenance done? Is there a specific department for maintenance? etc.

Maintenance of water network of WSS Gotse Delchev is provided by a service teams responsible for the whole territory. For each municipality there is a separate field team and even small settlements have one person to take care for the normal operation of the network supported by municipality field teams.

- Define the main problem(s) the water network is facing

Main problem of the water network for the overall territory served from WSS Gotse Delchev is related with the age and condition of pipelines. Main pipelines are build more than 30-50 years ago. Due to their age and not so good maintenance steel pipes are corroded and gaskets between asbestos cement pipes are worn.

Conditions of distribution network is even worse with most of the network built in more than 50 years ago. Except corroded steel pipes more than 36% of the pipelines are built with asbestos cement pipes with compromised gaskets on the connections.

As a consequence of bad condition of main and distribution pipelines physical water losses on the territory served from WSS Gotse Delchev are above 60%.

Other problem is the lack of a reliable monitoring system at key points for the water supply. Due to this service teams are limited in active leakage control and network management actions and they act more as emergency teams taking care for daily problems.

- Define the main causes of these problem(s)

Main reason for the problems is the lack of an adequate investment program for rehabilitation and upgrade of water network and main facilities in WSS Gotse Delchev. In last 30 years WSSC Blagoevgrad didn't follow golden rule for rehabilitation of at least 2% of the network each year. Due to this currently most of water supply network of WSS Gotde Delchev is extremely amortized and big investments are needed.

- Actions regarding the upgrading of the network's operation already scheduled (what; when; how)

WSSC Blagoevgrad operates in accordance with 5 years business plan approved by Water Regulator. An investment program in different directions, including pipelines rehabilitation is provided inside. However due to the limited money for investment less than 1% from the water supply network operated from WSSC Blagoevgrad is rehabilitated every year. In fact money for investment plan are enough just for rehabilitation of most urgent sections of the pipeline.

- Are there seasonal variations in water consumption? Please provide data

There is no touristic cities on the territory covered from WSS Gotse Delchev and water consumption is generated mainly from population and industry. Except seasonal variation in water consumption there is no other fluctuations.

- Water Balance assessment period used for the water utility

e.g. per year / semester / four months / three months / two months / month / other (do provide adequate reasoning for your choice e.g. billing period; availability of data)

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

Due to the lack of enough measuring equipment preparation of water balance is not an easy task. Usually Operator prepares water balance for water systems exploited for their annual reports for the Water Regulator.

3 Water Balance assessment for the water distribution network

Water Utility Level

<table>
<tr><td rowspan="4">System Input Volume
173,45 l/s
100%</td><td rowspan="4">Authorized Consumption
65,65 l/s
37,90%</td><td rowspan="2">Billed Authorized Consumption
53,01 l/s
30,60%</td><td>Billed Metered Consumption
53,01 l/s 30,60%</td><td rowspan="2">Revenue Water
53 l/s
30,60%</td></tr>
<tr><td>Billed Unmetered Consumption
0 l/s 0%</td></tr>
<tr><td rowspan="2">Unbilled Authorized Consumption
12,65 l/s
7,30%</td><td>Unbilled Metered Consumption
12,05 l/s 7,00%</td><td rowspan="5">Non Revenue Water (NRW)
120,44 l/s
69,40%</td></tr>
<tr><td>Unbilled Unmetered Consumption
0,60 l/s 0,30%</td></tr>
<tr><td rowspan="3"></td><td rowspan="3">Water Losses
107,8
62,10%</td><td rowspan="2">Apparent Losses
3,01 l/s
1,70%</td><td>Unauthorized Consumption
0,60 l/s 0,30%</td></tr>
<tr><td>Customer Meter Inaccuracies and Data Handling Errors
2,41 l/s 1,40%</td></tr>
<tr><td colspan="2">Real Losses
104,79
60,40%</td></tr>
</table>

Table 1 – Water balance of WSS Gotse Delchev

4 Performance Indicators

Water Utility Level

Please estimate the following performance indicators (at least). You can use the xls file named "WB-PI_Calc-UTH_version 2.2_EN"

- NRW by volume (Fi46) (%) = 69,40%;
- NRW by cost (Fi47) (%) = 1,05%
- Water Losses per connection (Op23) (m3/connection/year) = 306
- Water Losses per mains length (Op24) (m3/Km/year) = 86,75
- Apparent Losses (Op25) (%) = 1,74%
- Apparent Losses per SIV (Op26) (%) = 1,74%
- Real Losses per connection (Op27) (lt/connection/day when system is pressurized) = 816
- Real Losses per mains length (Op28) (lt/km/day when system is pressurized) = 84 324

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- UARL = 2,01 for Gotse Delchev city
- ILI = 16,88 for Gotse Delchev city
- ALI = 0,003 (for the overall WSS Gotse Delchev)
- Other

5 Comments

Values of some of the indicators don’t follow logical trend due to following reasons:

- Apparent losses – data which are used are official data from Regional Master Plan of WSSC Blagoevgrad where apparent losses (Unauthorized Consumption + Customer Meter Inaccuracies and Data Handling Errors) are reported as low as 1,7% from total amount of input water for the system. Obviously that value is too low and actual value based on the average for Bulgaria should be 15-20%. However the team which is responsible for providing the data preferred to work with values from official documents and we did all calculations with 1,7%
- NRW by cost – due to the low percentage of apparent losses accepted and relatively low cost of potable water that coefficient is really low. If we take a reasonable value for the apparent losses (average for the country is around 15%) the coefficient would be two times higher.
- Depends on data available, some of the information is provided for the overall WSS Gotse Delchev and rest for the Gotse Delchev city.

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Appendix A:

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WATER RESCUE

Water resources efficiency and conservative use in drinking water supply systems

WP	**3 Current Status Analysis and Assessment**
Deliverable *Tool*	**3.6.2 Water Audit report** *Questionnaire*
Project Beneficiary No	**PB6**
Beneficiary Institution	**Municipal Water Supply and Sewerage Company of Thermaikos**

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Table of Contents

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

Name of the organization/institution: MUNICIPAL WATER SUPPLY AND SEWERAGE COMPANY OF THERMAIKOS
Beneficiary number: PB6

1 Introduction

Please describe your water distribution network.

Water Utility Level (2017 base year)

- Total population served =
- Total area covered (Km^2) = 135.5
- Total pipes' length (Km) = 654
- Mean altitude (m) = 55
- Mean operating pressure (atm) = 3
- Types of pipes (material, diameters, lengths) =
- Age of pipes (per material, diameter) = PVC – 33 years old, Asbestos - >55 years old
- No. of service connections = 32,656
- Billing Period =
- River Basin where water is taken from = River Basin of Halkidiki

Water Audit

2 Network's current (operation, control and monitoring) status

Water Utility Level

- Are there any pressure zones established? If yes, do provide further details.

NO

- Are there any DMAs established? If yes, do provide further details

NO

- Is there a SCADA system in place? If yes do provide further details.

There is a SCADA in the municipal districts of Peraia, Neoi Epivates and Agia Triada which measures the water level I water tanks, but it is not working

- Is there a simulation model available for the network? If yes, do provide further details.

NO

- Is there a maintenance policy followed? If yes, do provide further details.

e.g. how is maintenance done? Is there a specific department for maintenance? etc.

- Define the main problem(s) the water network is facing
    - Breakdowns in daily basis
    - Water availability
    - Water quality
- Define the main causes of these problem(s)
    - The age of the network
    - Seawater intrusion, due to the proximity of many wells to the sea
- Actions regarding the upgrading of the network's operation already scheduled (what; when; how)

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  - The DEYA is working to unite the networks of municipal districts in order to increase the quantity and quality of water as well as to provide an alternative in case of damage to more than one wells in a municipal community.
  - The upcoming scheduled works are:
    - The building of a new water tank in the area of Radar
    - The modernization of the water supply network for addressing the Epanomi water scarcity problem

- Are there seasonal variations in water consumption? Please provide data
  There is an increase of water demand in the summer
- Water Balance assessment period used for the water utility
  Yearly

3 Water Balance assessment for the water distribution network

Water Utility Level

Please provide the Water Balance of the water distribution network (you can use the xls file named "WB-PI_Calc-UTH_version 2.2_EN")

See the attached excel file ''WB-PI_Calc-UTH_version 2.2_EN''

4 Performance Indicators

Water Utility Level

Please estimate the following performance indicators (at least). You can use the xls file named "WB-PI_Calc-UTH_version 2.2_EN"

- NRW by volume (Fi46) (%) = 28.5
- NRW by cost (Fi47) (%) =
- Water Losses per connection (Op23) (m3/connection/year) =
- Water Losses per mains length (Op24) (m3/Km/year) =
- Apparent Losses (Op25) (%) = 0.71
- Apparent Losses per SIV (Op26) (%) = 0.71
- Real Losses per connection (Op27) (lt/connection/day when system is pressurized) =
- Real Losses per mains length (Op28) (lt/km/day when system is pressurized)
- UARL =
- ILI =
- ALI =
- Other

5 Comments

Please provide any comments.

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Appendix A:

IWA standard WB

<table>
<tr>
<td rowspan="7">System Input Volume
(A3)
3,581,107</td>
<td rowspan="4">Authorized Consumption
(A14=A10+A13)
2,557,934</td>
<td rowspan="2">Billed Authorized Consumption
(A10=A8+A9)
2,557,934</td>
<td>Billed Metered Consumption
(A8)
2,557,934</td>
<td rowspan="2">Revenue Water
(A20=A8+A9)
2,557,934</td>
</tr>
<tr>
<td>Billed Unmetered Consumption
(A9)
0</td>
</tr>
<tr>
<td rowspan="2">Unbilled Authorized Consumption
(A13=A11+A12)
0</td>
<td>Unbilled Metered Consumption
(A11)
0</td>
<td rowspan="5">Non Revenue Water (NRW)
(A21=A3-A20)
1,023,173</td>
</tr>
<tr>
<td>Unbilled Unmetered Consumption
(A12)
0</td>
</tr>
<tr>
<td rowspan="3">Water Losses
(A15=A3-A14)
1,023,173</td>
<td rowspan="2">Apparent Losses
(A18=A16+A17)
25,580</td>
<td>Unauthorized Consumption
(A16)
25,580</td>
</tr>
<tr>
<td>Customer Meter Inaccuracies and Data Handling Errors
(A17)
0</td>
</tr>
<tr>
<td colspan="2">Real Losses
(A19=A15-A18)
997,594</td>
</tr>
</table>

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WB-1stMOD(McKenzie,2007)

<table>
<tr><td rowspan="7">System Input Volume
(A3)
3,581,107</td><td rowspan="4">Authorized Consumption
(A14=A10+A13)
2,557,934</td><td rowspan="2">Billed Authorized Consumption
(A10=A8+A9)
2,557,934</td><td>Billed Metered Consumption
(A8)
2,557,934</td><td>Water billed and paid for (Free Basic Recover Revenue)
(A24=A8+A9-A23)
2,557,934</td><td>Water which is sold and generates
(A24=A8+A9-A23)
2,557,934</td></tr>
<tr><td>Billed Unmetered Consumption
(A9)
0</td><td>Water billed but NOT PAID for (apparent NRW)
A23
0</td><td rowspan="6">Water which does not generate revenues (TOTAL Non-Revenue Water)
(A23+A21)
1,023,173</td></tr>
<tr><td rowspan="2">Unbilled Authorized Consumption
(A13=A11+A12)
0</td><td>Unbilled Metered Consumption
(A11)
0</td><td rowspan="5">Water not being sold (Non-Revenue Water/real NRW)
(A21=A3-A24-A23)
1,023,173</td></tr>
<tr><td>Unbilled Unmetered Consumption
(A12)
0</td></tr>
<tr><td rowspan="3">Water Losses
(A15=A3-A14)
1,023,173</td><td rowspan="2">Apparent Losses
(A18=A16+A17)
25,580</td><td>Unauthorized Consumption
(A16)
25,580</td></tr>
<tr><td>Customer Meter Inaccuracies and Data Handling Errors
(A17)
0</td></tr>
<tr><td colspan="2">Real Losses
(A19=A15-A18)
997,594</td></tr>
</table>

WB-2ndMOD(Kanakoudis+Tsitsifli)

<table>
<tr><td rowspan="7">System Input Volume
(A3)
3,581,107</td><td rowspan="4">Authorized Consumption
(A14=A10+A13)
2,557,934</td><td rowspan="2">Billed Authorized Consumption
(A10=A8+A9)
2,557,934</td><td>Billed Metered Consumption
(A8)
2,557,934</td><td rowspan="2">Revenue Water
(A20=A8+A9)
2,557,934</td><td>Water billed and paid for (Free Basic Recover Revenue)
(A24=A8+A9-A23)
2,557,934</td><td>Revenue Water
(A24=A8+A9-A23)
2,557,934</td></tr>
<tr><td>Billed Unmetered Consumption
(A9)
0</td><td>Water billed but NOT PAID for (apparent NRW)
A23
0</td><td>Water billed but NOT PAID for (apparent NRW)
A23
0</td></tr>
<tr><td rowspan="2">Unbilled Authorized Consumption
(A13=A11+A12)
0</td><td>Unbilled Metered Consumption
(A11)
0</td><td rowspan="5">Non Revenue Water (NRW)
(A21=A3-A20)
1,023,173</td><td rowspan="5">Water not being sold (Non-Revenue Water/real NRW)
(A21=A3-A24-A23)
1,023,173</td><td rowspan="4">Accounted Non Revenue Water
(A26=A3-A24-A23-A25)
1,023,173</td></tr>
<tr><td>Unbilled Unmetered Consumption
(A12)
0</td></tr>
<tr><td rowspan="3">Water Losses
(A15=A3-A14)
1,023,173</td><td rowspan="2">Apparent Losses
(A18=A16+A17)
25,580</td><td>Unauthorized Consumption
(A16)
25,580</td></tr>
<tr><td>Customer Meter Inaccuracies and Data Handling Errors
(A17)
0</td></tr>
<tr><td colspan="2">Real Losses
(A19=A15-A18)
997,594</td><td>Water Losses generating revenues (Minimum Charge Difference)
A25
0</td></tr>
</table>

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