2011

Energy Audit of Water and Wastewater Utilities in 6 towns of Moldova

Final Report

FLORESTI

Tehno Consulting & Design

December 2011

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ABBREVIATIONS

Selected Definitions:	**Abbreviation / Synonym Definition**
A.S.L.	Above Sea Level
BPS	Booster Pumping Station
WB	World Bank
IDA	International Development Association
Client	Water Supply and Sanitation Projects Implementation Unit
Auditor/Consultant	Tehno Consulting & Design
EE	Energy Efficiency
ECM	Energy Conservation Measures
EEP	Energy Efficiency Program
EMP	Energy Management Program
PS	Pumping Station
SPS	Sewage Pumping Station
MSPS	Main Sewerage Pumping Station
NWSSP	National Water Supply and Sanitation Project
RWTP	Raw Water Treatment Plant
WWTP	Waste Water Treatment Plant
O&M	Operation and Maintenance
BoQ	Bill of Quantities
VSD	Variable Speed Drive
HVAC	Heating, Ventilation, and Air Conditioning
WSS	Water Supply and Sanitation

EXECUTIVE SUMMARY

Present Energy Audit reportsummarizes SA “Servicii Comunale Floresti” facilities description, historical data, Auditors findings, site measurements data, analyses and ECM proposals.

Our energy audit team visited Floresti and collected historical water and energy usage data, as well as the existing equipment operating data. As a result of the site measurements we identified several ECM, which in our opinion will provide feasible opportunities for significant energy savings.

The feasibility of each proposed ECM was estimated through a payback analysis. The simple payback period was determined after establishing Engineer’s estimation of capital investments, O&M equipment costs,projected annual energy savings estimates, and the potential value of energy tariff.

Recommended ECMs

The following table presents the ranking of recommended ECMs identified for SA “Servicii Comunale Floresti”. The ECMs are ranked on a simple payback period basis.

ECM description	Annual energy savings, kWh	Annual energy savings, MDL	Capital investment cost, MDL	Simple payback period, years	Ranking
Replacement of submersible pump in the wells nos. 5,7,10,12	212,145	381,861	674,190	1.8	**1**
Replacement of pumps at PS 2	56,093	100,968	816,585	8.1	**7**
Replacement of pump at PS 3	48,253	86,855	421,575	4.9	**3**
Replacement of damaged disk aerators at WWTP	27,000	48,600	320,000	6.6	**4**
Installation of sludge pumps in secondary clarifiers	7,200	17,960	200,000	15.4	**8**
Speed control for air blower at WWTP	18,000	32,400	140,000	4.3	**2**
Sewage pump for SPS Main	38,850	69,930	509,850	7.3	**5**
Sewage pump for SPS 1	10,877	19,579	193,875	9.9	**6**

Recommended ECMs to be included in the EMP

In order to prioritize investments from different Project towns, the indicator for relative energy saving as % of total energy consumption of each separate water utility was used as the most fair and important indicator. Thereby, the investments bringing the highest relative reduction in energy consumption in the respective towns were prioritized. This selection criterion was applied as primary one, while the secondary criterion of simple payback period was applied after preliminary sorting.

Five ECMs have been shortlisted for EMP investment package:

ECM description	Annual energy savings, kWh	Annual energy savings, MDL	Savings in % compared to total power consumption	Capital investment cost, MDL	Ranking
Replacement of submersible pump in the wells nos. 5,7,10,12	212,145	381,861	17.1%	674,190	1
Replacement of pumps at PS 2	56,093	100,968	4.5%	816,585	2
Replacement of pump at PS 3	48,253	86,855	3.9%	421,575	3
Sewage pump for SPS Main	38,850	69,930	3.1%	509,850	4
Replacement of damaged disk aerators at WWTP	27,000	48,600	2.2%	320,000	5

Total investment amount for selected Floresti ECMs is **230,243 USD.**

1. INTRODUCTION

The IDA provided financing in the amount of 0.9 mln USD which will be used for investments to raise energy efficiency in 6 (six) water and wastewater utilities of Moldova. The EEP is expected to demonstrate and disseminate through energy audits and following investments the potential for increasing energy efficiency in municipal water and wastewater operations.

The program finances energy audits, hydraulic regime optimizations, and the selective rehabilitation of electromechanical equipment (equipment replacement) which are expected to increase energy efficiency in municipal water and wastewater operations in the cities Balti, Cahul, Orhei, Ungheni, Causeni and Floresti.

This Final Audit Report summarizes findings, proposals, planned activities, schedule for completion of audit components, staffing and submission deadlines of audit reports and other deliverables for Energy Audit of Water and Wastewater Utilities in 6 towns of Moldova.

The contract has been let for open international tendering for consultancy services. The contract was awarded to Tehno Consulting & Design and became effective on 20th June 2011. The duration of the services is expected to be 6 months.

1.1 Draft Audit Report

In this Draft Audit Report the Consultant has introduced his assessment of energy conservation measures and investment needs in the city of Floresti. The Report includes conditional and operational analysis of existing water and wastewater facilities and energy conservation measures, as well as a financial assessment of the proposed investments.

The report also includes the Consultants proposal ofECM measures for the future EMP investments.

Furthermore, this Report includes the output from the Baseline Studies as presented in the Consultants Inception Report.

After delivery of the Draft Audit Report the Consultant will organize a meeting with all stakeholders to present the proposed investments. Preliminarily the meeting will be held within 2 weeks from the delivery of the Report.

There is one separate report for each of the six cities covered by the project.

1.2 Final Audit Report

Present Final Audit Report includes comments and suggestions to the Draft Report from the World Bank experts, WSSPIU and SA "Servicii Comunale Floresti".

The meeting with stakeholders was held on December 07, 2011. The agreed shortlist of EMP investments for Floresti contains the following:

Table 1-1 *Agreed EMP investments for Floresti*

Ranking	The proposed ECM description	Annual energy savings, kWh	Annual energy Consumption of Water Utility, kWh	Savings in %, as compared to total consumption	Capital investment cost, MDL	Simple payback period, years
1	**Replacement of submersible pump in the wells nos. 5,7,10,12**	212 145	1 242 453	17.1%	674 190	1.8
2	**Replacement of pumps at PS 2**	56 093	1 242 453	4.5%	816 585	8.1
3	**Replacement of pump at PS 3**	48 253	1 242 453	3.9%	421 575	4.9
4	**Sewage pump for SPS Main**	38 850	1 242 453	3.1%	509 850	7.3
5	**Replacement of damaged disk aerators at WWTP**	27 000	1 242 453	2.2%	320 000	6.6

The overall amount of proposed EMP investments for Floresti is 2,242,200 MDL or **230,243 USD** (USD exchange rate 11.91).

Consultant will prepare the following submittals for the selected ECMs:

- BoQ and Cost estimate for Goods, Works and associated services;
- Technical Specifications for Goods and Works within proposed EMP;
- EMP schedule of implementation

2. WATER SERVICES IN THE TOWN OF FLORESTI

2.1 General

The Town of Floresti is located in the Northern part of Moldova, some 130 km from Chisinau. The Town of Floresti is the administrative and commercial center of Floresti rayon (district) with about 90,000 inhabitants.

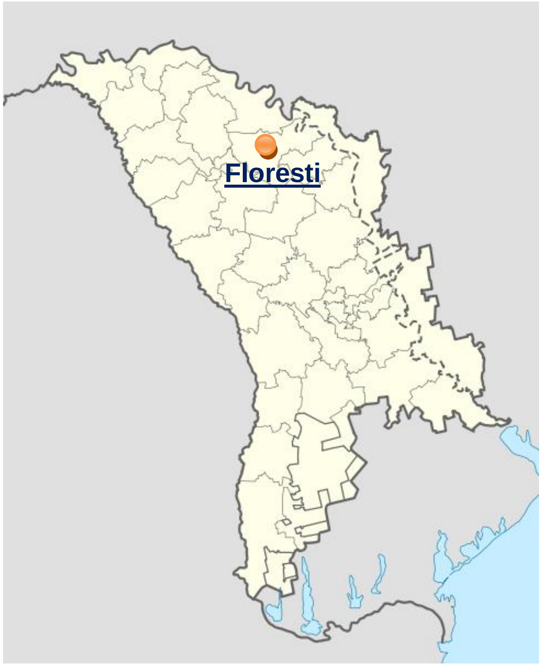

Figure 2-1 *Location of Floresti*

Floresti is located along the RautRiver at the altitudes of 80-155 m above sea level, highest regions being situated in the Northern part of Floresti.

The RautRiver, a tributary to the NistruRiver, flows (SW-SE) along the City. The railroadruns through the Southern part of the City.

2.2 Service Area Definition

The Town of Floresti is provided with water services by a joint-stock company SA "Servicii Comunale Floresti" covering main part of the Town and several neighboring villages and towns, including:

- Town of Floresti
- Town of Marculesti
- Town of Ghindesti
- Village of Marculesti
- Village of Lunga

- Village of Varvareuca
- Village of Ghindesti.
- Village of Cenusa

All supplied localities, except three, Cenusa and Ghindesti Villages and Ghindesti Town, are provided with water from a single groundwater source (G.Cainarului Intake) located nearby Gura Cainarului Village. Two parallel water mains from the Main PS located at Gura Cainarului wellfieldprovide water to the water systems' inlets in these localities, as follows:

- Marculesti Town and Marculesti Village are supplied by gravity network from the buffer tanks located North of Marculesti Village;

- The Lunga Village network is connected to the pressure main from the Main PS via reservoirs located in the nortern part of village Marculesti. Water supply from reservoirs goes by gravity;

- Town of Floresti is supplied from 2 (two) pumping stations (PS3 and PS4), located in the Northern part of the City. Currently, only PS3 is in regular operation. A part of Floresti Town and Varvareuca Village are supplied by gravity from the tanks located at M.Viteazul PS4 and Independentei PS3 in Floresti.

Both town of Ghindesti and village of Ghindesti Noi are supplied from a separate wellfield.Ghindesti Village has its own deep well. The Village of Cenusa has its own well, but it is planned to be connected to Ghindesti wellfield in the near future.

The estimated extent of water services provided by S.A. Servicii Comunale Floresti is presented in the following figure:

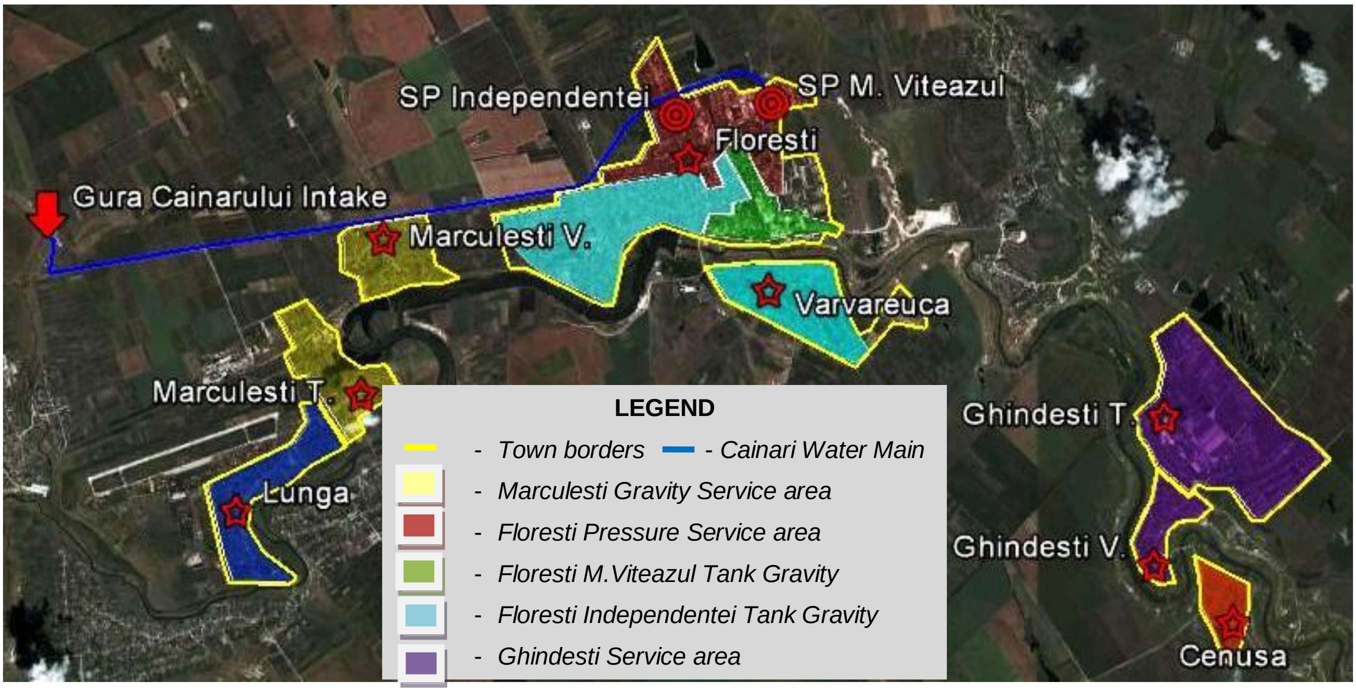

Figure 2-2 *Estimated Extent of Water Service Areasfor S.A. Servicii Comunale Floresti*

This study covers S.A. Servicii Comunale Floresti (Water Utility) operations only. The possibilities of future water supply of uncovered areas by Water Utility shall be studied separately.

2.3 Population

The official population records for the Towns of Floresti, Marculesti and Ghindestiare summarized in the table below:

Table 2-1 *Urban resident population, as of January1 by Years*[1]**,** *thou. people*

Town/Year	2005	2006	2007	2008	2009	2010	2011
Floresti Rayon	93.1	92.4	92	91.5	91	90.6	90
FlorestiTown	15.4	15.3	15.3	15.3	15.3	15.3	15.4
GhindestiTown	2.0	1.9	1.9	1.9	1.9	1.9	1.9
MarculestiTown	1.9	2.0	2.0	2.0	2.0	2.0	2.0

As shown in the table, the official urban population number has been being relatively constant over the last 7 years. Considerable changes (especially growth) in population are not expected in the next years, as the average population growth rate for Moldova is estimated at -0.072% for 2011[2].

The official data records on rural population covered by Floresti Water Utility are presented in the following Table:

Table 2-2 *Resident population in rural localities*[3]

Rural Locality	Official Population, people
Ghindeşti	1,528
Lunga	1,980
Mărculeşti	866
Cenuşa	935
Vărvăreuca	3,036

The number of rural population is in slight decrease over the last several years. The total population of the Floresti Water Utility service area is some 27,650 people. Notwithstanding the official statistical data, and taking into account high level of immigration, the real number of population (and consequently consumers) living in Floresti service area is expected to be lower.

2.4 Customers

The following data and assessments are derived from the billing system reports.The number of contracts (connections) by service areas operated by the Water Utility is summarized in the following table.

[1] National Bureau of Statistics of the Republic of Moldova
[2] Central Intelligence Agency, the World Factbook
[3] National Census, 2004. National Bureau of Statistics of the Republic of Moldova

Table 2-3 *Water Supply Customers – Water Utility Floresti*

Supply Area	No of Water Customers (Contracts)	Estimated No. of population connected to water services (people)	No of Sewerage Customers (Contracts)	Estimated No. of population connected to sewerage (people)
FlorestiTown		**13,173**		
Households	5,295		2,916	**5,282**
Economic Agents	157		125	
Budgetary Institutions	13		10	
MarculestiTown		**2,049**		
Households	420			
Economic Agents	6			
Budgetary Institutions	3			
MarculestiVillage		**810**		
Households	85			
Economic Agents	-			
Budgetary Institutions	1			
VarvareucaVillage		**2,977**		
Households	544			
Economic Agents	4			
Budgetary Institutions	1			
GhindestiTown		**1,818**		**434**
Households	518		308	
Economic Agents	6			
Budgetary Institutions	1		1	
GhindestiVillage		**1,420**		
Households	331			
Economic Agents	1			
Budgetary Institutions	1			
Total:	**7,387**	**22,247**	**3,360**	**5,716**

As can be seen from the Table, the major number of consumers is located in FlorestiTown.In total, some 80% of the area official population is provided with water by Water UtilityFloresti.

S.A. Servicii Comunale Floresti has registered a substantial increase in number of consumers due to the extension of water services to the neighbouring villages over the last decade. However, this Audit Report covers ECMs for current consumption conditions only and does not envisage any considerable future extensions in terms of consumers.

Though Floresti Water Utility supplies water to a number of neighbouring towns and villages, only Floresti and GhindestiTowns are covered by sewerage services.

As can be noticed from the previous Table, only some 21% of total service area population and some 35% of population in Floresti Town are provided with sewerage services.

2.5 Preliminary Water Balance

Historical water balance for 2007-2011 (SA “Servicii Comunale Floresti” data)

Table 2-4 *Reported Water Balance for S.A. Servicii Comunale Floresti*

No	Name	2007	2008	2009	2010	2011/6
1	**Water produced**	***725,645***	***735,110***	***732,871***	***757,079***	***497,503***
	Gura Cainarului Intake	725,645	735,110	713,283	686,250	435,488
	V. Ghindesti Intake			12,405	19,947	21,388
	T. Ghindesti Intake			4,272	36,159	30,929
	Cenusa Intake			2,911	14,723	9,698
2	**Water supplied**	***685,210***	***717,595***	***723,993***	***752,200***	***493,555***
	Floresti M. Viteazul PS4	108,166	140,706	113,247	113,331	96,775
	Floresti Independentei PS3	482,095	497,886	508,590	494,739	286,708
	Marculesti Town	59,168	58,784	64,064	57,937	39,367
	Marculesti Village	23,250	6,178	6,155	7,120	4,115
	Lunga Village	12,531	14,041	12,349	8,244	4,575
	Ghindesti Village			12,405	19,947	21,388
	Ghindesti Town			4,272	36,159	30,929
	Cenusa Village			2,911	14,723	9,698
3	**Water Billed**	***310,443***	***320,662***	***358,102***	***368,815***	***241,093***
	Population	202,368	188,272	247,000	272,224	184,777
	Economic Agents	108,075	132,390	111,102	96,591	56,316

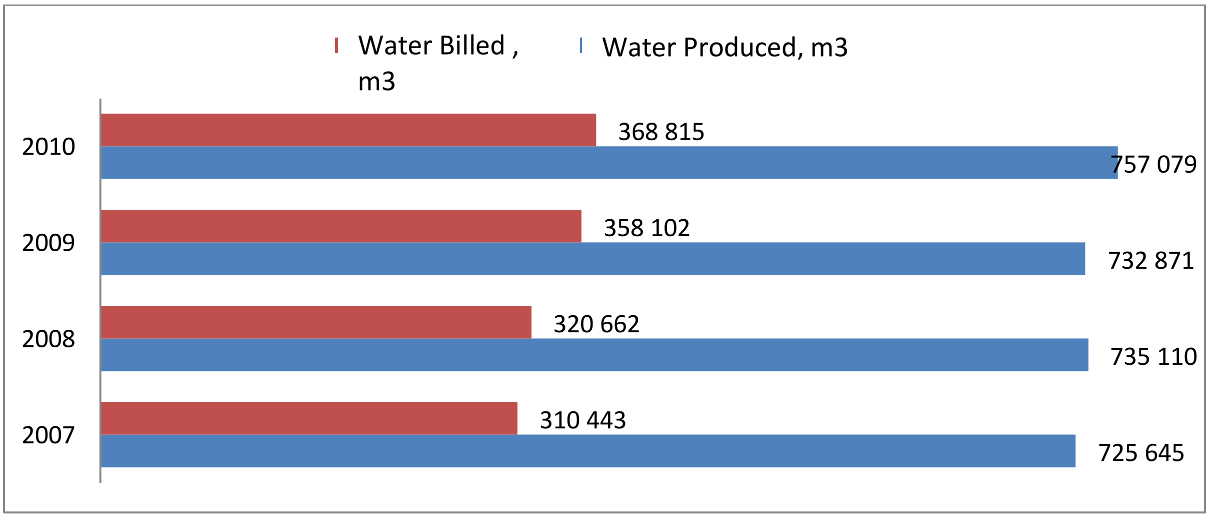

Figure 2-3 *Reported water balance for 2007-2010*

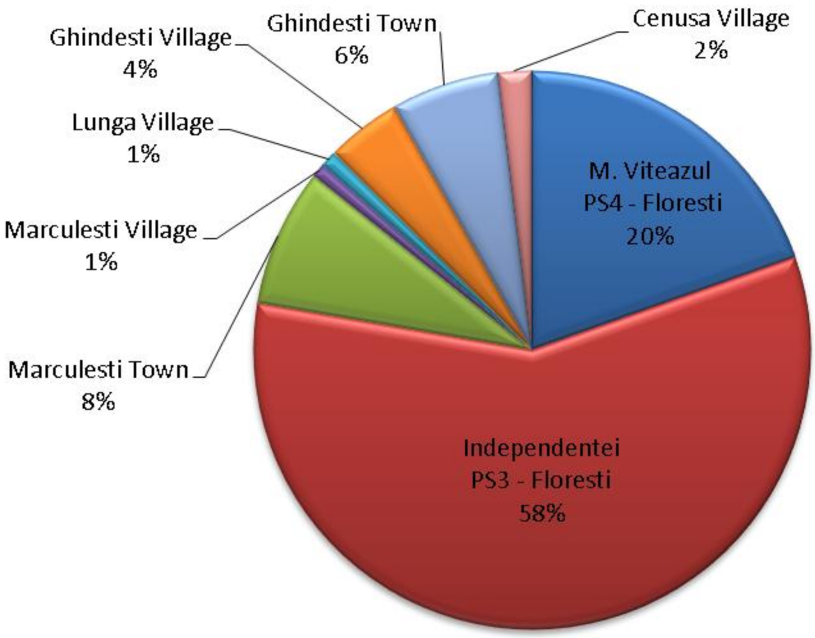

Figure 2-4 *Shares of water supplied to different service areas in 2011*

It is of note that some 78% of all water supplied is delivered to the Town of Floresti. Some 90% of all water produced is abstracted from the Gura Cainarului Intake.

The volume of abstracted water is in slight decrease over the last years due to continuous installation of individual water meters.

In respect of the water supply system, it is of note that the non-revenue water rate as estimated on the basis of the reported values has substantially high values of produced water. High NRW rates are subject to this Energy Audit and a general NRW analysis is presented in the following Sections.

The reported volumes of the collected wastewater are presented in the Table below.

Table 2-5 *Collected wastewater for 2008-2010*

	2008	2009	2010
Received Wastewater, thou m^3	255.6	241.3	231.2
Including from households	89.5	97.1	113.3
Household sewerage Return rate, %	48%	39%	42%

Overall the wastewater return rate remains low reflecting the much lower level of development of wastewater services.

3. WATER SUPPLY SYSTEM

3.1 General

The existing current water supply network in Floresti Town has been presented in the Annex Drawing.

S.A. Servicii Comunale Floresti provides water to its service areas from four (4) groundwater intakes:

- Gura Cainarului Wellfield (Main Water Intake) - covering 2 towns, including Floresti, and 3 villages;
- Ghindesti Wellfield – covering Ghindesti Town and Ghindesti Village;
- Ghindestii Noi deep well – supplying a new area of Ghindestii Village;
- Cenusa deep well – covering Cenusa Village. However, this intake is reported to be closed down due to certain technical reasons and the village water supply will be switched to Ghindesti wellfield.

Most of town networks and pressure mains are in poor condition due to its age and heavy use, generating high amounts of leakages.

3.2 Water Production

Main Water intake consists of one wellfield located some 8 km West of Floresti center, along theleft bank of the Cainari River, a tributary to the Raut River. The wellfield area is located at ground elevation of some 80-85 m a.s.l. and includes eight (8) deep wells, out of which only four (Wells No.1461, 4181, 4277 and 1560) are in regular use andthe other wells are used as reserve. Deep well No.4182 is taken out of operation due to inadequate operating conditions (low groundwater level). All operated deep wells have submersible pumps, type ЭЦВ (ECV), manufactured in Moldova.

According to existing well passports, all wells from Cainari wellfield are fed from the same aquifer at depth of some 20 m (hydrostatic water level). All submersible pumps in use lift water at a constant pressure head directly into two (2) existing water tanks from the Main PS, at elevation of 94 m a.s.l.

In Ghindesti, a separate wellfield formed of two (2) deep wells (1 in operation, 1 - reserve) is used to produce water for both Ghindesti Town and Village. The village of Cenusa and part of Ghindesti village are supplied from their own separate deep wells.

General data on installed pumping equipment are presented in the following Table.

Table 3-1 *Design parameters of the existing pumping equipment at the water intakes in Floresti*

#	Well No	Model	Design Flow rate	Design Head	Design Motor Data					Opera-ting	Depth of instal-lation	Year of instal-lation
					P	Voltage	Speed	cosφ	In			
			m^3/h	m	kW	V	rpm		A	hrs /day	m	
					Floresti Main Wellfield							
1	1461/5	ЭЦВ10-63-110	63	110	22	380	3000	0.8	48	7	48	2009
2	1462/6	-	-	-	-	-	-	-	-	reserve	-	-

#	Well No	Model	Design Flow rate	Design Head	Design Motor Data					Opera-ting	Depth of instal-lation	Year of instal-lation
					P	Volt age	Speed	cosφ	In			
			m^3/h	m	kW	V	rpm		A	hrs /day	m	
3	4181/7	ЭЦВ10-63-80	63	80	22	380	3000	0.8	47.4	7	48	2009
4	4182/8	-	-	-	-	-	-	-	-	closed	-	-
5	4183/9	-	-	-	-	-	-	-	-	reserve	-	-
6	4277/10	ЭЦВ10-63-110	63	110	22	380	3000	0.8	48.3	7	48	2010
7	4278/11	-	-	-	-	-	-	-	-	reserve	-	-
8	1560/12	ЭЦВ10-63-110	63	110	22	380	3000	0.8	48	7	40	2010
					Ghindesti Town Wellfield							
9	1	ЭЦВ8-16-140	16	140	11	380	3000	0.83	24.2	reserve	16	2009
10	2	ЭЦВ8-25-150	25	150	16	380	3000	0.81	38.5	8	20	2009
					Ghindestii Village							
11	1	ЭЦВ6-10-140	10	140	8	380	3000	0.83	18.3	3	24	2009
					Cenusa Village							
12	1	ЭЦВ6-10-235	10	235	11	380	3000	0.83	24.8	4	185	2010

A number of separate deep wells in Varvareuca and Cuhuresti were also reported to be operated by SA "Servicii Comunale Floresti".

At the Cainari Main Water Intake, all pumps are operated automatically, function of the Main PS tanks water level.In total, there are two (2) tanks of V=250m^3 in use.

According to Floresti Water Utility, some of submersible pumps have a considerably lower flow rate as compared to the design parameters. This can result in low efficiency rate and is subject to further Audit measurements.

The water production at the Main Water Intake is metered by flowmeters of type BT100 – 3 units and BT 80- 4 units.

Existing pressure mains within wellfield area are from 1980's.Water from all deep wells is concomitantly pumped through common pressure pipelines, which requires a finely balanced hydraulic condition. The pressure pipelines are made of steel pipes and are considered to be in an acceptable working condition.However, being at the end of life cycle,pressure pipelines can generate considerable amounts of leakages in future and need to be monitored.

The walk-through analysis has identified some problems in selection and operation of the existing submersible pumps and further measurements and analysis are presented in the next Chapters.

Historical Energy Consumption

The present section represents historical energy usage and associated Apa-Canal costs. It is important to establish at least 3 years patterns of mainly electric, as well as gas usage, if relevant, in order to be able to identify areas in which energy consumption can be reduced.

The following summary of historical energy consumption registered by Water Utility is provided in the Table below.

Table 3-2 *Historical Energy Consumption Reported by Floresti Water Utility*

No	Facility	2008	2009	2010	2011 (6 months)
	FLORESTI				
	Gura Cainarului Intake				
1	Deep Well No5	126,088	114,738	87,989	49,146
2	Deep Well No 7	41,181	90,918	51,560	46,740
3	Deep Well No 10	126,206	88,605	101,706	56,529
4	Deep Well No 12	129,963	94,409	104,221	50,998
	PS 2				
1	PS 2	303,116	273,660	289,784	177,588
	MarculestiTown				
1	Local PS	3,051	2,740	3,800	2,438
2	Lighting	2,506	1,735	3,987	2,927
	PS 3 Independentei				
1	PS 3	102,387	96,820	112,410	71,280
2	Lighting	6,102	4,665	3,047	-
	PS 4 M. Viteazul				
1	PS 4	280	3,040	8,920	6,440
2	Lighting	7,570	3,184	-	-
	Sewerage				
1	WWTP	217,382	181,598	170,305	74,822
2	Floresti Main SPS	107,103	96,884	88,044	60,819
3	Floresti Local SPS	107,103	7,420	28,320	4,360
4	Lighting	13,943	6,892	-	-
	Offices/Workshops				
1	Stefan cel Mare 57	3,609	2,476	3,883	2,889
2	Dacia 20	11,453	16,129	17,178	10,030
3	Dacia 32	757	3,295	2,815	1,716
4	Lighting	1,994	1,736	1,540	1,056
5	Garage park	11,330	17,759	19,471	11,662
	Other villages/towns				
1	Varvareuca Deep Well		4,399	6,944	2,770
2	Ghindesti Deep Well	5,080	19,581	18,650	8,093
3	Ghindesti Deep Well 1		17,912	86,113	14,700
4	Ghindesti Deep Well 2		-	-	10317
5	Cenusa Deep Well		5,050	23,046	12,653
6	Ghindesti Local SPS		4,000	8,720	4,128
8	Cuhuresti Deep Well		-	-	-
	TOTAL	**1,328,204**	**1,159,645**	**1,242,453**	**684,101**

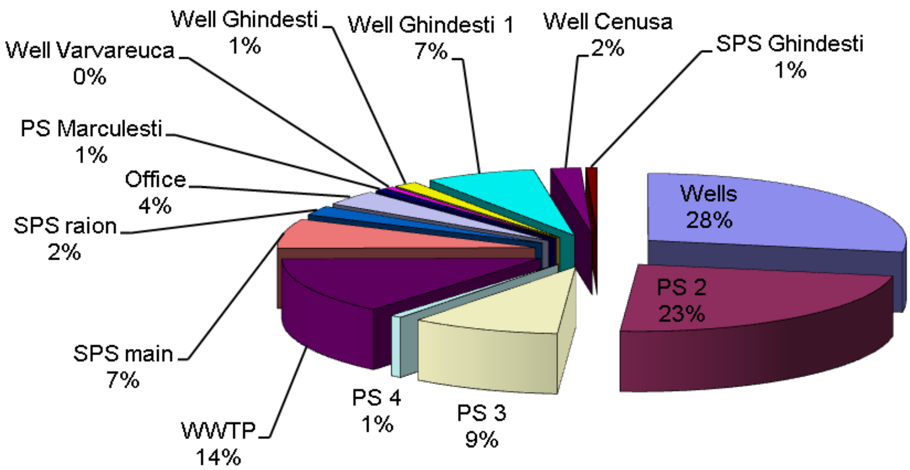

Figure 3-1*Shares of energy consumption reported by Floresti Water Utility, 2010*

As can be seen from the Table above, the mainenergy consuming facilities are Gura Cainarului Intake (28%), Main PS2 (23%) and Floresti WWTP (14%). The main focus of this Energy Audit will be aimed at these major energy consumers.

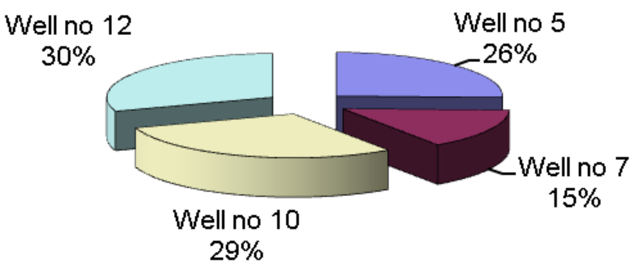

Figure 3-2*Distribution of energy consumption within Gura Cainarului wellfield, 2010*

3.3 Water Treatment

Acording to the water quality test results provided by Floresti Water Utility, the bacteriological parameters of the abstracted ground water from the Main Water Intake are in accordance with the National Standard Requirements, thus the only treatment provided is chlorination with gas chlorine at the Main PS, using chlorination equipment with a capacity of 1 kg/h. Chlorination is done only in case of necessity or a risk of water pollution.

Currently the water is not chlorinated as the microbiological analyses correspond to the sanitary requirements.

3.4 Water Pumping

3.4.1 Main PS

The Main PS (also known as PS2) is used to provide water to the whole service area from the Main Water Intake in Gura Cainarului. Pumping equipment includes one main pump group built of 4 parallel pumps of typesД200/90and 1Д 315-71 a.The pumps intake water from two (2) underground water

tanks with capacity of 250 m^3 each, located at the PS2 territory, and pump water through two parallel pressure mains to the service area.
General data on installed pumping equipment are presented in the following Table.

Table 3-3 *Design parameters of the existing pumping equipment at the Main PS in Floresti*

Pump No	Model	Qty	Design Flow rate	Design Head	Design Motor Data					Control Panel	Operating	Year of instal-lation
					P	Voltage	Speed	cosϕ	In			
			m^3/h	m	kW	V	rpm		A		hrs /day	
1	Д200/90	1	290	90	90	3x400	2,950	0.91	159	Y	Stand-by	2008
2	Д200/90	1	290	90	90	3x400	2,950	0.91	159	Y	Stand-by	2008
3	1Д 315-71 a	1	300	63	90	3x400	2,950	0.9	162	Y	7	2008
4	1Д 315-71 a	1	300	63	90	3x400	2,950	0.9	162	Y	7	2008

All installed pumps are in poor physical condition and are expected to have low energy efficiency rates.

Currently, due to low water demand, only two pumpsare in regular use and the other pumps are used as reserve.

It is of note that the pumpsdeliver water to only Independentei PS3 tank, located at the elevation of some 141 m a.s.l.

Further Audit measurements are required in order to identify whether existing pumps operate in their best efficiency ranges. The detailed analysis is provided in the next Chapters.

The pressure main from the Main PS to Florestiis made mainly of 2 parallel steel pipes of DN300, having length of some 8.0 km. Current condition of the existing pressure mains is considered to be poor and an additional leak detection measurements need to be carried out.

In addition, two (2) buffer tanks from the Town of Marculestiand a bulk water main from Lunga village are connected directly to the pressure main.

Main PS Historical Energy Consumption

The following summary of historical energy consumption registered by Water Utility is provided in the Figure below.

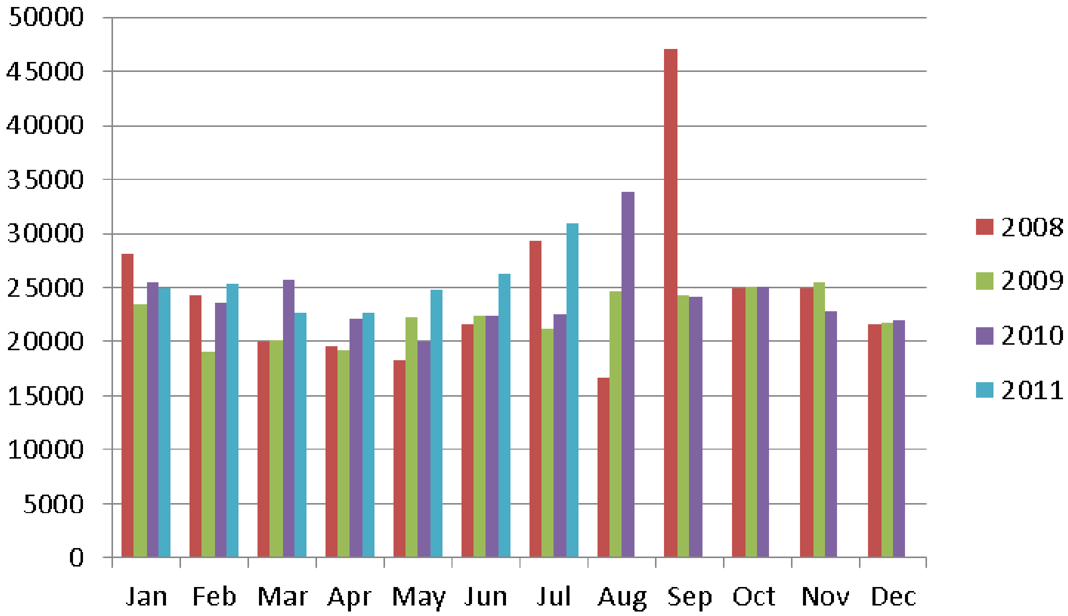

Figure 3-3*ReportedHistorical Energy Consumption of the PS2*

Since the PS2 is one of the major energy consuming facilities in Floresti, it is subject to further Energy Audit analysis.

3.4.2 FlorestiTown Pumping Stations (PS3 and PS4)

The Town of Floresti is provided with water from two (2) pumping stations:

- Independentei PS3, located at Independentei Street, in the North-Western part of the Town; and

- M. Viteazul PS4, located at M. Viteazul Street, in the North-Eastern part of Floresti.

Both pumping stations are designed to supply water to the town and are connected to a common looped distribution network. Currently, only Independentei PS3 is used to deliver water in the pressure network, while M. Viteazul PS4 is used as stand-by.

Independentei PS3

The abstracted water delivered by the Main PS is stored at Independentei PS3 inlet tank with capacity of 2,000 m^3. This PS3 is equipped with 2 groups of pumps. First group is built of 2 parallel centrifugal pumps (1 – operating and 1 in stand-by), used to deliver water directly into the town network.The second group is used to supply water to the northern isolated district.

General data on installed pumping equipment at Independentei PS3 are presented in the following Table.

Table 3-4 *Design parameters of the existing pumping equipment at Independentei PS3 in Floresti*

Pump No	Model	Qty	Design Flow rate	Design Head	Design Motor Data					Control Panel	Operating	Year of instal-lation
					P	Voltage	Speed	cosφ	In			
			m^3/h	m	kW	V	rpm		A		hrs /day	
1	Д 320-50 a	2	320	50	55	380	1,500	0.87	104	Y	24/Stand-by	1983
2	CO-3MHI-406/ER-RBI	3	10	50	1.1	380	2950		2.7	CO-ER3	24	2010

Independentei PS3 is operated permanently for up to 24 hours per day. Due to uneven daily consumption pattern, the pumps Д 320-50aare equipped with a frequency converter „Danfoss" of type VLT6000HVAC which regulates the pump's operation, function of end-point pressure, currently set to 26 m.

It is of note that PS3covers the northern part of the town, including areas of multi-storey buildings, as well as private house areas. Also, the M.Viteazul PS4 tank is fed by water from the same pressure network. The lower (Southern) part of the town is supplied by gravity from both tanks – PS4 and PS3. In a number of cases the possibility of direct supply from Independentei PS3 tank, instead of PS4 tank, were identified. This will avoid additional unnecessary pumping of water from PS3 to PS4. The possibilities of provision of lower areas with water by gravity from the Independentei tank is subject to further Audit analysis.

M. Viteazul PS4

The abstracted water delivered by the Main PS is stored at Independentei PS3 inlet tank with capacity of 2,000 m^3. The PS3 delivers water to the upper town network, including the PS4 inlet tank. The M.Viteazul PS4 is located at the elevation of some 145 m a.s.l. and is equipped with two (2) groups of two (2) parallel centrifugal pumps each (currentlyall in stand-by), used to deliver water directly into the town network.

General data on installed pumping equipment at M. Viteazul PS4are presented in the following Table.

Table 3-5 *Design parameters of the existing pumping equipment at M. Viteazul PS4 in Floresti*

Pump No	Model	Qty	Design Flow rate	Design Head	Design Motor Data					Control Panel	Operating	Year of instal-lation
					P	Voltage	Speed	cosφ	In			
			m^3/h	m	kW	V	rpm		A		hrs /day	
1	D 320/50	2	320	50	55	380	3,000	0.87	104	Y	Stand-by	1984
2	КМ 80-50-200/2-5	2	50	50	15	380	3,000			Y	Stand-by	1984

PS4 is currently used as stand-by station and is operated only when PS3 is stopped. Currently, water is stored in a 2,000 m^3 water tank and is supplied by gravity to the lower districts of Floresti.

Floresti TownPSs Historical Energy Consumption

The following summary of historical energy consumption by Independentei PS3 registered by Water Utility is provided in the Figure below.

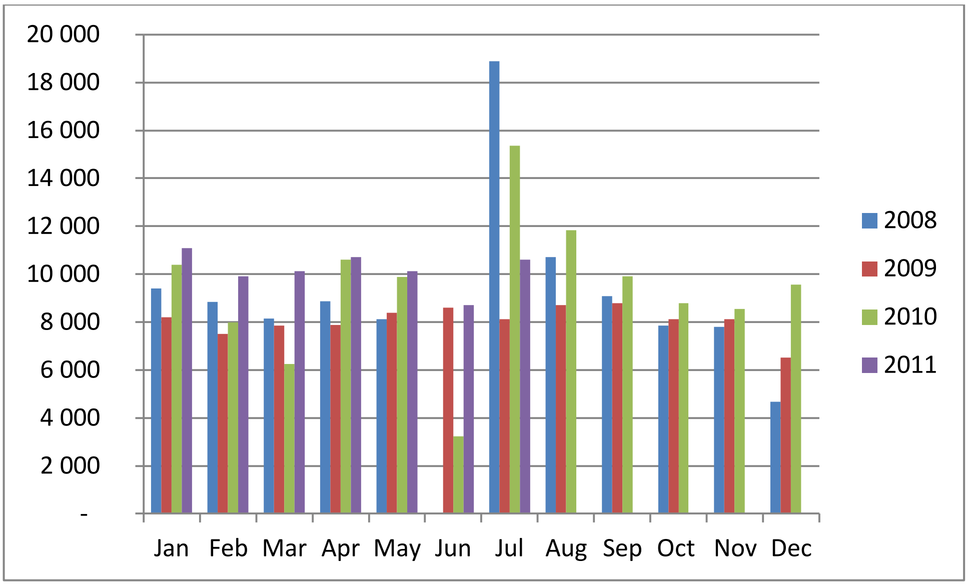

Figure 3-4 *Floresti PS3 - Reported Energy Consumption for 2008-2011.*

M. Vitezul PS4 is used as a reserve PS and no significant energy consumption by PS4 was registred during last 3 years.

3.4.3 Rural Pumping Stations

In Ghindesti, the town pumping station (known as Ghindesti PS2) is used to provide water to the whole Town of Ghindesti from the Ghindesti wellfield, located on the left bank of the Raut River. The water from the wellfield is stored directly in the PS2 water tank, situated at the territory of the local Sugar Refinery. From the reservoir, water is partially supplied by gravity to Ghindestii Village, while the major volume is delivered to Ghindesti Town by the local PS2. A buffer tank (counter-tank) is used during peak hours to insure the necessary pressure in Ghindesti Town network.Pumping equipment includes one main pump group built of 4 parallel pumps of type WILO COR-4 MHI 406/VRO-RBI.

Additionally, a separate PS is used to supply a part of Ghindesti Village.

General data on installed pumping equipment are presented in the following Table.

Table 3-6 *Design parameters of the existing pumping equipment at the PS*

Pump No	Model	Qty	Design Flow rate	Design Head	Design Motor Data					Control Panel	Operating	Year of instal-lation
					P	Voltage	Speed	cosφ	In			
			m^3/h	m	kW	V	rpm		A		hrs /day	
1 – Ghin-desti	WILO COR-4 MHI 406/VRO-RBI	1 (group of 4 pumps)	15	50	1.5	380	2950		3.8	VR-4, freq. converter	24	2010

All installed pumps are in reasonably good physical condition. The pumps in Ghindesti are equipped with a frequency converter.

3.5 Water Pumping – Booster PS

There are no booster pumping stations operatedby Floresti Water Utility. All water is supplied to the consumers by the pumping stations described above.

3.6 Water Distribution Network

FlorestiTown

Town water distribution network in Floresti is divided into three (3) separate service areas – 1 pressure (north) and 2 gravity (both - south). Two separate gravity networks are supplied from two tanks located at M.Viteazul PS4 and Independentei PS3 respectively.

Northernservice area is provided with water by direct pumping from Independentei PS3. The outlet pressure at the PS is kept at 2.6 bar at the end-user. The M. Viteazul PS4 tank is also supplied from this pressure network.

Main Gravity network is supplied from a 2,000 m^3 tank located at PS3. The gravity network covers South-Western part of the town and Varvareuca village, located south of Floresti town.

A separate south-eastern area of Floresti is supplied by gravity from the PS4 tank.

Main data about existing water pipelines are shown in the following Table.

Table 3-7 *Water Supply Networks operated by S.A. Servicii Comunale Floresti*

Material	D , mm	<10 years, m	10-20 years, m	20-30 years, m	40 years, m
		FLORESTITOWN			
Steel	32-300				21,516
Ductile Iron	50-300			16,082	
Asbestos	100-300			13,546	
HDPE	32-160	26,217			
Sub-Total		26,217		29,628	21,516
					77,361
		GHINDESTITOWN			
Steel	50-150				3,932
Ductile Iron	100-150			2,047	
HDPE	32-160	7,822			
Sub-Total		7,822		2,047	3,932
					13,801
		MARCULESTITOWN			
Steel	32-150				3,333
Asbestos	150			3,190	
HDPE	32-90	4,621			
Sub-Total		4,621		3,190	3,333
					11,144
		MARCULESTITOWN			
Steel	100				500
HDPE	32-110	2,620			
Sub-Total		2,620			500
					3,120
		GHINDESTIINOIVILLAGE			
Steel	100				1,500
HDPE	32-110	6,494			
Sub-Total		6,494			1,500
					7,994

Material	D , mm	<10 years, m	10-20 years, m	20-30 years, m	40 years, m
			LUNGAVILLAGE		
Asbestos	150			2,000	
HDPE	63-160	5,000			
	Total	5,000		2,000	
					7,000
			GHINDESTIVILLAGE		
Steel	50-89				3,316
Ductile Iron	50-150			1,921	
HDPE	32-63	1,047			
Sub-Total		1,047		1,921	3,316
					6,284
			VARVAREUCAVILLAGE		
HDPE	32-160	5,034	4,86		
Sub-Total		5,034	4,86		
					9,894
			CENUSAVILLAGE		
Steel	32-50				3,903
HDPE	32-110	0,400	0,300		
Sub-Total		0,400	0,300		3,903
					4,603
GRAND-TOTAL					**141,201**

The NWSSP has recently finished renovation of parts of existing water networks in FlorestiTown. Some 8 km (out of 77 km) of network mains were replaced with new HDPE pipes. Still, only some 11% of networks were renovated and a good energy saving potential is seen in further renovation of the central and southern parts of the network.

It is of note that the main part of the existing networks in rural localities has been recently reconstructed, using new HDPE pipes, and is considered to be in good working condition.

It is expected that current leakage rate is considerably high and a selective Leak Detection Campaign to prevent network leakages in the most emergency segments is subject to further Audit.

Beginning of year 2011 there were some 7,320household individual meters installed in all service areas covered by Floresti Water Utility. Also, 252 water meters are installed for economic agents, 38 pcs – for community buildings. There are 211 bulk meters in use.

4. SEWERAGE SYSTEM

4.1 General

Currently, FlorestiTown sewerage collection system consists of four (4) drain areas and two (2) SPSs,pumping collected wastewater to the existing WWTP, located in the South-Eastern part of the town at an inlet elevation of 120 m a.s.l.

A separate local SPS is used to pump collected wastewater from GhindestiTown to a local WWTP.

Given to the FlorestiTown geographic situation, all wastewater is collected by gravity at the lowest points along the RautRiver, and thereafter pumped to the WWTP.

The estimated extent of sewerage drain areas in FlorestiTown is presented in the following figure:

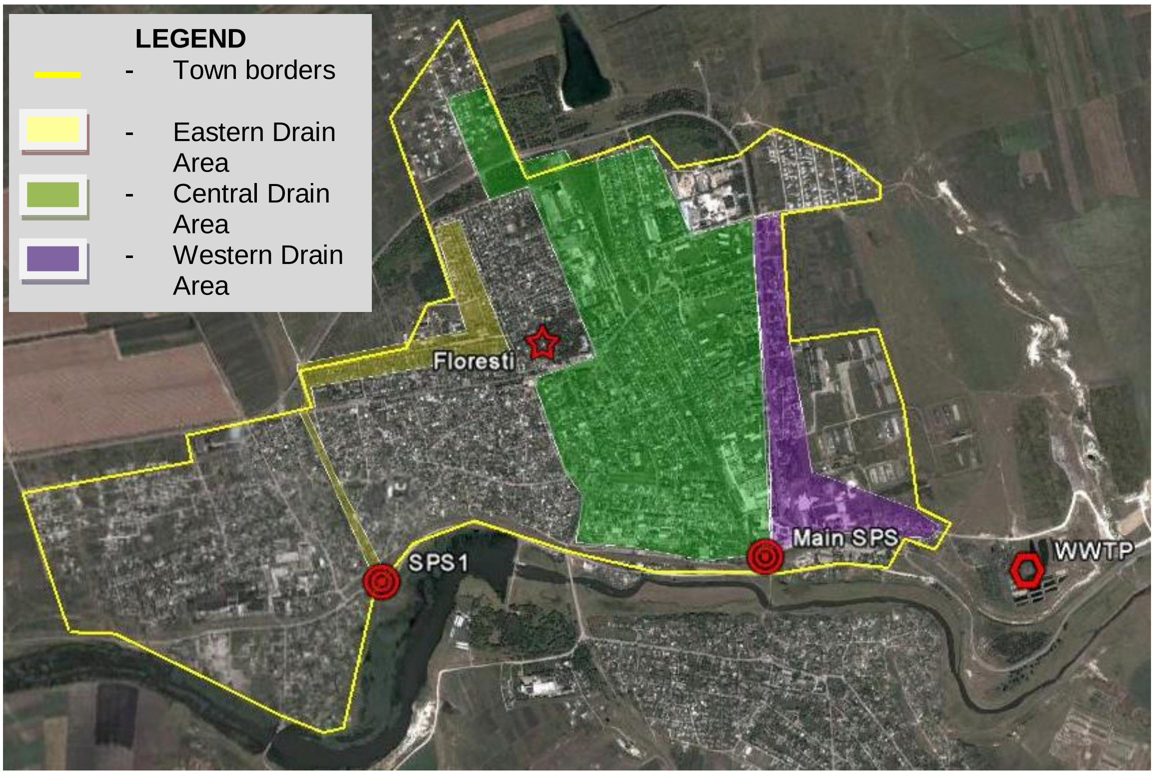

Figure 4-1 *Estimated Extent of Sewerage Drain Areas in Floresti*

As can be seen from the picture above, only some 40% of the Town water consumers are covered by the sewerage services.The wastewater is collected from most of industrial entities, schools, kindergartens and other organizations and multistorred houses, while most of private houses are not covered by sewerage networks at all.

In Ghindesti, all town wastewater is collected at the lowest point and pumped by the local SPS to the local biological ponds, located at a higher elevation north of the Town.

Detailed information on consumers is provided in the previous Chapters.

4.2 Wastewater Collection

FlorestiTown wastewater collection is separated in three (3) main drain areas, thereof collected wastewater is led to the WWTP through two (2) sewerage pumping stations.

The areas are, as follows:

- Western part – area of multi-storey buildings and industry. Collected wastewater is collected and led by gravity to the Main SPS, which delivers wastewater directly to the WWTP;
- Central part – area of mixed private houses, multi-storey buildings and industry. All wastewater is collected at the Main SPS;
- Eastern part – area of multi-storey and private houses. All wastewater is collected at the local SPS1 and therefrom is pumped directly to the Main SPS;

Main data on existing sewerage collectors are shown in the Table below:

Table 4-1 *Sewerage networks operated by Floresti Water Utility*

No	Material	DN, mm	Length, km	Year of construction	Note
			FLORESTI TOWN		
1	HDPE	225	0.840	2010	Pressure pipe
2	HDPE	160	1.0	1980	Pressure pipe
3	Steel	219	1.20	1979	Pressure pipe
4	Cast Iron	300	1.2	1989	Pressure pipe
5	Steel	300	1.0	1980	Pressure pipe
6	Concrete	800	0.150	2010	Gravity pipe
7	HDPE	160	0.30		Gravity pipe
8	Ceramics	150	7.914	1969	Gravity pipe
9	Ceramics	200	4.664	1972	Gravity pipe
10	Ceramics	300	2.339	1972	Gravity pipe
11	Ceramics	400	1.820	1972	Gravity pipe
	Total		**22.427**		
			GHINDESTI TOWN		
12	Steel	150	2.0	NA	Pressure pipe
13	Steel	300	2.00	NA	Pressure pipe
14	Ceramics	150-200	6.9	NA	Gravity pipe
	Total		**10.9**		

The main sewerage network originates from the 1970-80's and has not been renovated since. Most parts of networks are worn out generating high amounts of leakages. However, it is assumed that a considerable amount of groundwater infiltrations occur in the lower areas of the networks, dissolving pollutant content of the wastewater.

The existing sewerage gravity collection scheme is considered to be rather efficient and only interventions to the existing pumping equipment are subject to the Audit Report.

4.3 Wastewater Pumping

In total, there are two (2) wastewater PSs in use in FlorestiTown, and 1 SPS in Ghindesti. General data on installed wastewater pumps in use are presented in the following Table.

Table 4-2 Design parameters of the existing pumping equipment

PS	Model	Qty	Design Flow rate	Design Head	Design Motor Data					Operating	Instal-lation	Inlet chamber
					P	Voltage	Speed	cosф	In			
			m^3/h	m	kW	V	rpm		A	hrs /day		m3
Floresti Local SPS	ФГ 81/31	2	50	20	17	380	1,450			4.5	dry	50
Floresti Main SPS	ФГ 144/46	4	144	56	37	380	1,450			4.5	dry	100
	ФГ 450/56	1	450	56	132	380	1,450			standby	dry	100
Ghindesti SPS	CM 100-65-200/2	1	125	47	37	380	1,450			1	dry	50
	CM 150-125-315/4	1	200	32	45	380	1,450			0.5		

All existing SPSs in Floresti are in critical condition. Basically, due to its age and high level of use, all existing pumping equipment should be replaced by a modern one.

4.4 Wastewater Treatment

The existing WWTP receives wastewater from the whole Town of Floresti, and is located in the South-Eastern part of the town, left bank of the RautRiver. The WWTP inlet is situated at the elevation of some 120 m a.s.l.

The WWTP is fed with wastewater from the Main SPS.

Treatment chain is designed for 5,300 m^3/day and consists of two stages, as follows:

1. Mechanical tretament stage, including

   - Inlet Chamber
   - Grit Removal– 2 units
   - Clarifying and decomposition sedimentation tanks – 4 pcs.

2. Biological treatment stage:

   - Aeration tanks – 5 units
   - Secondary clarifiers – 5 units
   - Sludge drying beds
   - 3 biological ponds (the last pond serves as the contact tank for chlorination).

Currently, both mechanical and biological treatment is in use. However, a poor condition of existing infrastructure is of note.

WWTP Historical Energy Consumption

The major consumers at the WWTP are air blowers. The total energy consumption by the WWTP is shown in the Figure below:

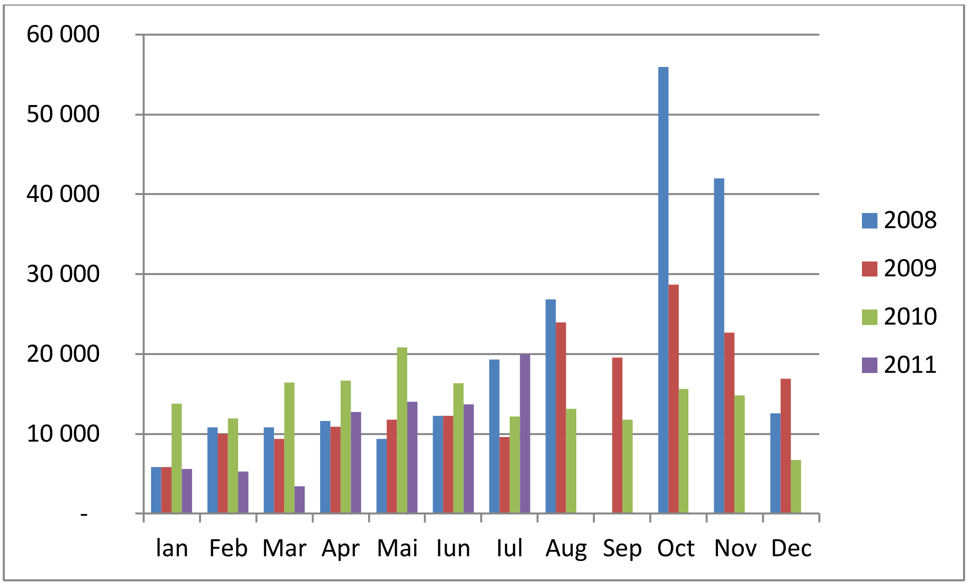

Figure 4-2 *Reported WWTP Energy Consumption for 2008-2011*

The existing WWTP is considered to be in a poor condition and according to the WB Feasibility Study the WWTP "shall be renovated or replacedaccording to design prepared"[4]. In given circumstances, when there is no clear decision whether the existing WWTP shall be renovated or rebuilt, and the existing energy consumption is significantly high, the Consultant is of opinion that some urgent renovations are needed in short-term. Therefore, the existing WWTP is considered to be subject to this Audit Report.

[4] Feasibility Study for Floresti, 2007. SWECO International AB, financed by the World Bank

5. SITE MEASUREMENTS

5.1 Methodology

In order to assess the operating efficiency of the existing water and waste water systems and their elements and to identify energy saving potential, a comprehensive site measurement campaign was organized by the Consultant. The measurement campaign was carried out in August – September 2011.

The Consultant has performed flow measurementsat all water sources, all water and sewage pumping stations.

We have also carried outflow measurements of individual water and sewage pumpsto register actual pump flow rate to evaluate actual performance of pumping equipment.

Energy consumption of individual pumps and air blower was measured in details by a power analyzer. Actual power, as well as reactive, apparent, power factor, voltages and current on each phase have been measured and registered.

The Consultant's team used pressure measurements equipment at individual pumps suction and pressure sides in order to evaluate actual performance of pumps and pressure piping.

Acoustic leak detection using correlator in selected pipelines of Floresti water distribution network has been performed.

The flow consumption of selected multistory block was also analyzed.

Flow Measurement Sites

Flow measuring equipment was installed at the following sites:

- Well No.5;
- Well No.7;
- Well No.10;
- Well No.12;
- Two PS 2 discharge pipelines DN300;
- PS 3 pipeline to gravity service area;
- PS 3 pipeline to pressure service area;
- PS 3 pipe to hospital high located area;
- PS 4 pipeline to gravity service area;
- PS 4 pipeline to pressure service area;
- Well Cenusa;
- Well Ghindesti noi;
- Well Ghindesti 2;
- Ghindesti PS
- SPS 1 discharge pipeline;
- SPS Main discharge pipeline;
- SPS Ghindesti discharge pipeline

Flow measurements protocols are presented in the electronic external Appendix to this Report.

Pressure measurements sites

Electronic pressure transducers were installed at the following sites:

- PS 2 discharge pipe pump no. 1;
- PS 2 discharge pipe pump no. 3;
- PS 2 discharge pipe pump no. 4;
- PS 3 discharge pipeline to the pressure service area;
- PS 3 discharge pipeline to the hospital high located area;
- SPS 1 discharge pipeline;
- SPS Main discharge pipeline;
- Ghindesti PS discharge pipeline;
- SPS Ghindesti discharge pipeline

Pressure measurements protocol can be found in the electronic external Appendix to this Report.

Pressure manometers were installed at:

- Well no.5;
- Well No.7;
- Well No.10;
- Well No.12;
- Well Cenusa discharge pipeline;
- Well Ghindesti noi discharge pipeline;
- Well Ghindesti 2 discharge pipeline

Electrical power measurements sites

The power measurements were performed at the following sites:

- Well no.5;
- Well No.7;
- Well No.10;
- Well No.12;
- PS 2 pump no.1 D200-90
- PS 2 pump no.3 D315-71
- PS 2 pump no.4 D315-71
- PS 3 Pump no.1 D320-50
- PS 3 Wilo group of pumps (hospital area)
- SPS 1 sewage pump ФГ 81/31
- SPS Main sewage pump ФГ 144/46
- Well Cenusa;
- Well Ghindesti noi;
- Well Ghindesti 2;
- SPS Ghindesti

Detailed power characteristic of each measurement point contains:

- frequency,
- phase voltage on each phase,
- linear voltage on each phase,

- current of each phase,
- active power consumption for each phase and all phases,
- reactive power consumption for each phase and all phases
- apparent power consumption for each phase and all phases
- power factor of each phase and all phases
- displacement factor or cos φ of each phase and all phases.

Power measurements protocols can be found in the electronic external Appendix to this Report.

Also, the Consultant performed leak detection on selected pipelines of Floresti distribution network. Several leaks have been identified and confirmed by water utilitystaff. Leak detection protocols are included in the electronic external Appendix to this Report.

Equipment used for site measurements

Power analyzer	**QualistarCA 8334 (Chauvin-Arnoux)**
Portable flow meter	**Prosonic Flow 93T (Endress + Hausser)**
Fixed-installation flow meter big size	**DigitalFlow DF868 (GE Measurement&Control Solutions)**
Pressure transducer	**Cerabar T PMP 131 (Endress + Hausser)**
Data storage	**Memorgaph M RSG40 (Endress + Hausser)**
Non-contact infrared thermometer	**OS562 (Omega Engineering)**
Leak detection correlator	**LC – 2500 (Fuji Tecom)**
Acoustic leak detector	**DNR – 18 (Fuji Tecom)**
Pipe locator	**SR – 20 (Seek Tech)**

All equipment used complies with the accuracy requirements and international technical standards.

5.2 Site measurement and analyses

Flow measurements at PS 3 - main pipeline to gravity supply area

The measurements were started on September 26, 2011 at 14:24 and finished on September 27 at 14:17. The time interval between instant flow measurements was set to 1 minute.

Prior to measurements taken it was reported by water utility staff that recently installed mechanical water meter DN80 on the gravity outlet pipe is undersized, creates big pressure drop and therefore limits the heads in the network.

In order to maintain necessary pressures in the gravity network, water utility has to use PS 4 as main supplier to the area previously supplied by PS 3. We consider this temporary solution as excessive energy consuming exercise, since all amount of water shall be lifted to the PS 4 and then gravitated to the gravity area, thus creating higher pressures in the lower parts of network.

Below graph illustrates gravity flow pattern from PS 3:

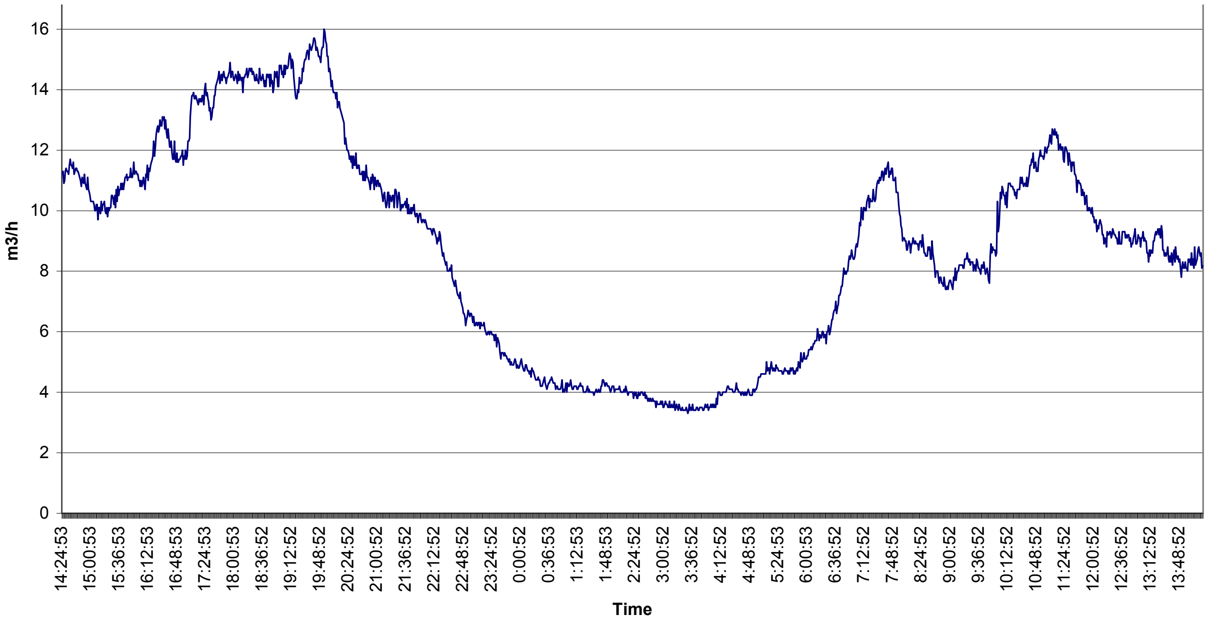

Figure 5-1 *Flow measurement results – Floresti PS3 gravity main*

The maximum registered evening peak is 16 m^3/h, and minimum night flow is around 3.5 m^3/h.

Flow measurements at PS 3 on the pipeline to pressure supply area

The measurements were started on August 22, 2011 at 19:00 and finished on August 24 at 10:36. The time interval between instant flow measurements was set to 1 minute.

Below graph illustrates pumping flow pattern:

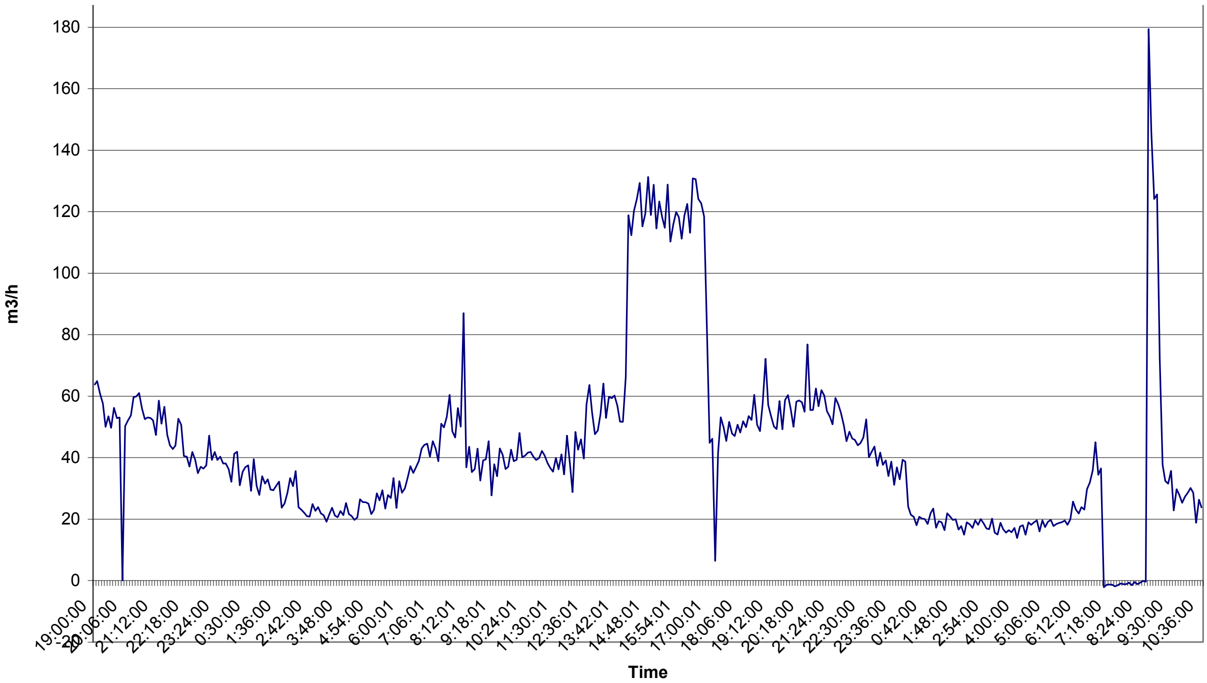

Figure 5-2*Flow measurement results – Floresti PS3 pressure main*

The peak in the middle with flow of 120 - 130 m^3/h represents filling the reservoirs at PS 4. Second peak of 180 m^3/h occurs after pump stoppage and represents filling of empty pipes of service area.

Except the first peak one can notice that maximum morning/evening demand peaks are around 80 m^3/h and night flow is around 20 m^3/h.

Flow measurements at PS 3 on the pipeline to the hospital supply area (WILO group of pumps)

The measurements were started on August 22, 2011 at 18:00 and finished on August 24 at 10:36. The time interval between instant flow measurement was set to 6 minutes.

Below graph illustrates pumping flow pattern of WILO group of pumps:

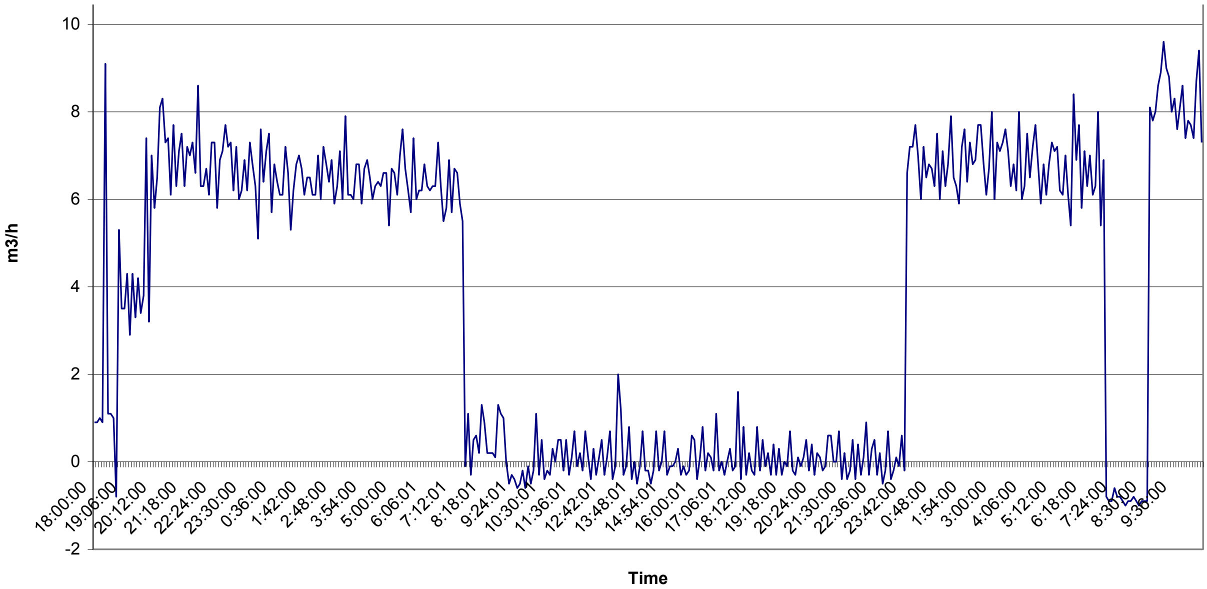

Figure 5-3 *Flow measurement results – Floresti PS3 – hospital pressure main*

Wilo group of three pumps delivers water to the high located area and hospital, which is the main water consumer. Pre-set pumping pressure is 3.8 bar.Water was pumped during the night.

During pump stoppage a little backflow was registered. We recommend inspecting check valve to avoid the backflow.

Flow measurements at PS 4 on the pipeline to gravity supply area

The measurements were started on September 21, 2011 at 19:39 and finished on September 22 at 19:39. The time interval between instant flow measurements was set to 1 minute.

Since PS 4 is presently the main source for gravity water supply to Floresti, the registered flows are higher than at PS 3.

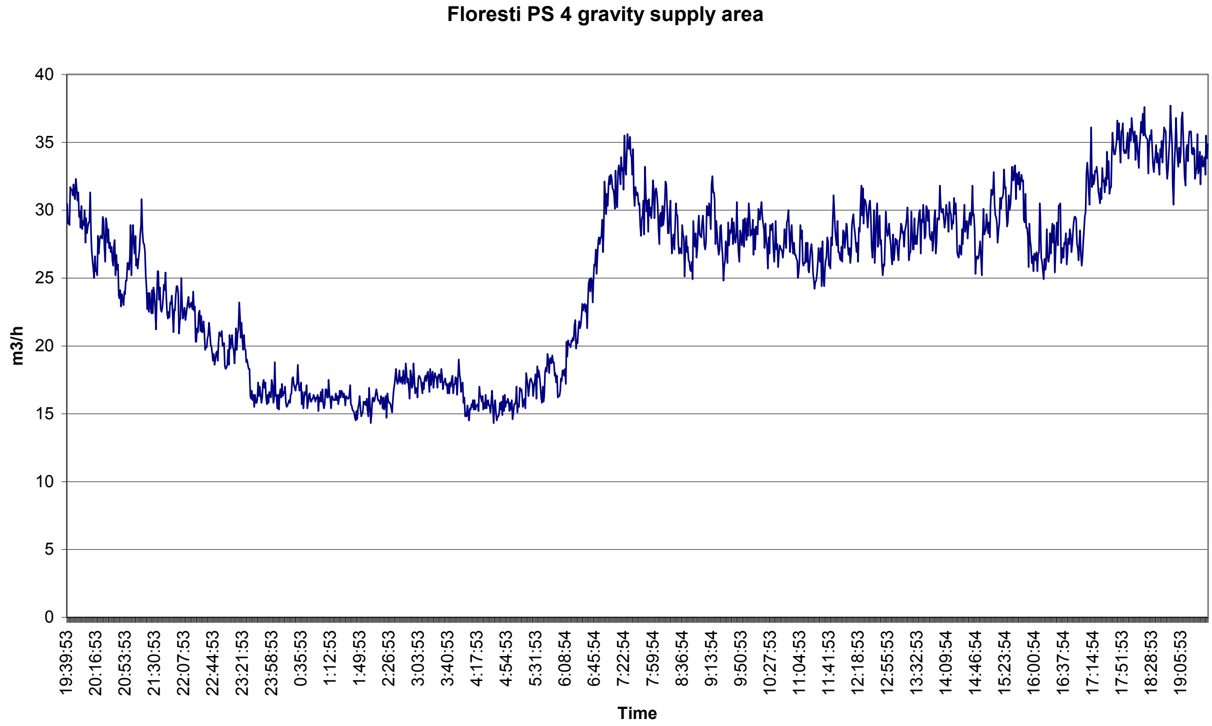

Figure 5-4 *Flow measurement results – Floresti PS4 gravity main*

The maximum morning/evening peak is 37 m^3/h, while the night flow is 15 m^3/h.

Analysis of multistory block building water consumption

The analysis of multistory block water consumption was performed on the basis of recently installed block water meter data collected from the water utility. Below graph illustrates daily consumption of 6-storey, 32 apartments block str. Mihai Viteazul 29:

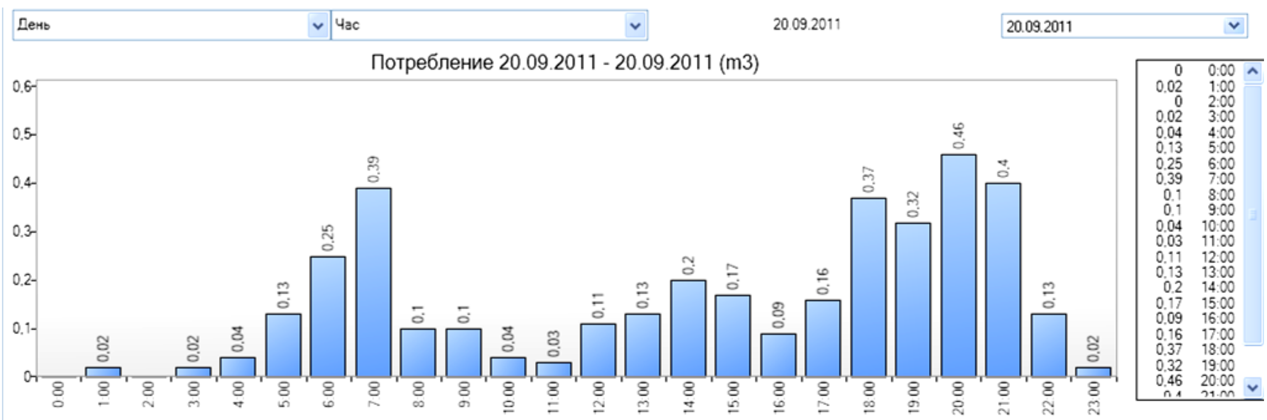

Figure 5-5 *Multi-storey block flow measurements*

Currently only 15 apartments are occupied. The number of inhabitants is 24 people in total. The daily block demand is 3.32 m^3, or 138 l per capita per day (lpcd). The night flow is very limited, so internal block leakages might be neglected.

Leak Detection

In order to demonstrate the existence of water leakages from the distribution networks, Leak Detection measurements for selected network segments were done by the Consultant.

It shall be mentioned that in order to have a clear picture on existing network leakages, a permanent comprehensive monitoring system should be in place. The Consultant in cooperation with SA "Servicii Comunale Floresti" identified a number of selected network segments for future measurements, having the main objective to identify possible existing leakages and to prove the poor condition of some "problematic" water pipes.

Leak Detection team carried out field measurements in August 27-28, 2011. Though a considerable amount of water leakages was detected, still a large amount of leakages persist in Floresti and Marculesti. The identification of all existing water leakages was not a subject to this Energy Audit.

Summary data on the network leakages detected is presented in the following Table.

Table 5-1 *Detected Network Leakages*

No	Street	Measured Segment Length, m	Leakage Detected	Pipe located, m
1	**St. cel Mare str., Marculesti**	10	1	-
2	**St. cel Mare str., Marculesti**	18	1	-
3	**St. cel Mare str., Marculesti**	9	1	-
4	**St. cel Mare str., Marculesti**	106	-	-
5	**Irimita str.**	113	1	-
6	**Decebal str.**	124	-	124
Total			**4**	

The obtained results demonstrate poor condition of existing pipelines, as well as existence of large amount of leakages. It is strongly recommended that FlorestiWater Utility shall carry out a comprehensive leak detection campaign in order to reduce leakages.

Measured Current Water Balance

Water balance based on real measurements of losses in water supply system is shown in the following table:

Table 5-2 *Measured Current Water Balance in Floresti*

<table>
<tr><th colspan="2" rowspan="2"></th><th colspan="2" rowspan="2">Supply area</th><th colspan="3">Real losses</th><th rowspan="2">Apparent losses + unbilled</th><th rowspan="2">Revenue Water</th><th rowspan="2">Non-revenue water</th></tr>
<tr><th>Trunk main</th><th colspan="2">Distribution</th></tr>
<tr><td rowspan="3">Water production Floresti only, m3/day</td><td rowspan="3">1,760</td><td>PS 3 pressure zone</td><td>1,266</td><td rowspan="3">79</td><td>336</td><td>PS 3 pressure zone</td><td rowspan="3">285</td><td rowspan="3">700</td><td rowspan="3">1,060</td></tr>
<tr><td>PS 3 gravity zone</td><td>332</td><td>84</td><td>PS 3 gravity zone</td></tr>
<tr><td>PS 3 hospital</td><td>84</td><td>360</td><td>PS 4 gravity zone</td></tr>
<tr><td colspan="4"></td><td colspan="3">775</td><td colspan="3"></td></tr>
<tr><td colspan="4">Revenue water</td><td colspan="6">40%</td></tr>
<tr><td colspan="4">Apparent losses</td><td colspan="6">16%</td></tr>
<tr><td colspan="4">Real losses</td><td colspan="6">44%</td></tr>
<tr><td colspan="4">Overall non-revenue water</td><td colspan="6">60%</td></tr>
</table>

Measurements of operating parameters of pumping equipment

The summary table of design and actual operating parameters of existing pumping equipment:

Table 5-3 *Data on pumps in use in Floresti Water Supply System*

Design parameters	Units	Well no. 5	Well no. 7	Well no. 10	Well no. 12	Pump no. 1	Pump no. 3	Pump no. 4
		Gura Cainarului Wellfield				PS2		
Pump type		ЭЦВ 10-63-110	ЭЦВ 10-63-110	ЭЦВ 10-63-110	ЭЦВ 10-63-110	Д 200-90	1Д 315-71 а	1Д 315-71 а
Flow	m3/h	63	63	63	63	200	300	300
Head	m	110	110	110	110	90	63	63
Impeller diameter	mm	-	-	-	-	280	222	222
Number of impellers		5	5	5	5	1	1	1
Shaft power	kW							
Pump Efficiency %	%	58	58	58	58	78,5	80	80
		Motor type						
Rated power	kW	22	22	22	22	90	90	90
Nominal voltage	V	380	380	380	380	380	380	380
Nominal current	A	48	48	48	48	159	162	162
Rotation Speed	rpm	3,000	3,000	3,000	3,000	2,950	2,950	2,950
Cos ϕ		0.84	0.84	0.84	0.84	0.91	0.9	0.9
Motor Efficiency %	%	0.87	0.87	0.87	0.87	75	82	82
		Measured parameters pump						
Actual flow	m3/h	24.46	45.49	55	45	177	120	159.44
Suction pressure/dynamic level	m	17.84	19.97	19	20.44	5	4	4
Discharge pressure	m	27	14	34	50	66	91	67
Actual pump head	m	45.44	35.77	55.6	72.16	61	87	63
Active power consumption	kW	14.34	25.73	30.16	25.11	59.46	80.91	62.94
Reactive power consumption	kVAr	23.32	31.71	20.83	33.54	34.62	44.98	33.38
Apparent power	VA	27.4	40.9	36.75	41.95	68.97	93.1	71.4
Power factor		0.52	0.63	0.82	0.6	0.86	0.87	0.88
		Calculated pumping efficiency						
Hydraulic power	kW	3.03	4.43	8.33	8.84	29.40	28.43	27.35
Overall pumping efficiency	%	0.21	0.17	0.28	0.35	0.49	0.35	0.43
Pump Efficiency	%							
Specific power consumption	kW/m3	0.59	0.57	0.55	0.56	0.34	0.67	0.39

Table 5-4 *Data on pumps in use in Floresti Water Supply System*

Design parameters	Units	Max demand (pump 1)	Min demand (pump 1)	Wilo pump 1	Wilo pump 2	Wilo pump 3	Group 1 (pump 1+2)	Group 2 (pump 3+4)	Pump 5
				PS3				SPS	
Pump type		Д 320-50 а	Д 320-50 а	MHI-406N	MHI-406N	MHI-406N	ФГ 144/46	ФГ 144/46	ФГ 450/56
Flow	m3/h	300	-	10	10	10	144	144	450
Head	m	40	-	50	50	50	46	46	56
Impeller diameter	mm	200					388	388	435
Number of impellers		1	-	6	6	6	1	1	1
Shaft power	kW			1.1	1.1	1.1			
Pump Efficiency %	%	77		60	60	60			
					Motor type				
Rated power	kW	55	-	1.1	1.1	1.1	37	37	132
Nominal voltage	V	380	-	380	380	380	380	380	380
Nominal current	A	104		2.7	2.7	2.7			
Rotation Speed	rpm	1,500	-	2,900	2,900	2,900	1,450	1,450	1,450
Cos ф		0.87							
Motor Efficiency %	%	92.5							
					Measured parameters pump				
Actual flow	m3/h	130	17	3.5	4.3	3.4	122.43	250.7	302.55
Suction pressure/dynamic level	m	1	1	1	1	1	1	1	1
Discharge pressure	m	23	23	36	35	36	41	43	40
Actual pump head	m	22	22	35	34	35	40	42	39
Active power consumption	kW	22.8	10.5	1.72	1.71	1.73	61.57	69.65	58.9
Reactive power consumption	kVAr	3.11	1.34	1.98	1.87	1.98			29.6
Apparent power	VA	26.94	14.07	2.63	2.47	2.63			66.56
Power factor		0.84	0.74	0.65	0.61	0.66			0.85
					Calculated pumping efficiency				
Hydraulic power	kW	7.79	1.02	0.33	0.40	0.32	13.34	28.67	32.13
Overall pumping efficiency	%	0.34	0.10	0.19	0.23	0.19	0.22	0.41	0.55
Pump Efficiency	%								
Specific power consumption	kW/m3	0.18	0.62	0.49	0.40	0.51	0.50	0.28	0.19

Table 5-5 *Data on pumps in use in Floresti Water Supply System*

Design parameters	Units	SPS rayon	Cenusa well	Gh noi well	Gh well no 2	Gh Wilo group	SPS Ghindesti	
							Pump 1	Pump 2+3
Pump type		ФГ 81/31	ЭЦВ 6-10-235	ЭЦВ 6-10-140	ЭЦВ 8-25-150	WILO COR-4 MHI 406/VRO-RBI	CM 150-125-315/4	CM 100-65–200a/2
Flow	m3/h	81	10	10	25	15	200	125
Head	m	31	235	140	150	50	32	47.5
Impeller diameter	mm						315	200
Number of impellers		1				6	1	1
Shaft power	kW							
Pump Efficiency %	%							
Motor Type								
Motor type								
Rated power	kW	17	11	8	16	1.5x4	45	37+37
Nominal voltage	V	380	380	380	380	380	380	380
Nominal current	A		24.8	18.3	38.5	3.8		
Rotation Speed	rpm	1450	2900	2900	2900	2950	1450	2950
Cos ɸ			0.83	0.83	0.81			
Motor Efficiency %	%			53	54	60		
Measured parameters pump								
Actual flow	m3/h	45.5	6	6	42	6	112	57.34
Suction pressure/dynamic level	m	1	88.69	12	3	2	1	1
Discharge pressure	m	14	17	72	80	51	75	66
Actual pump head	m	13	115.69	88	85	63	86	77
Active power consumption	kW	5.80	13.35	6.60	22.00	1.43	44.67	19.89
Reactive power consumption	kVAr	3.7	8.36	7.24	17.84	0.21		
Apparent power	VA	19.68	15.82	9.84	28.46	1.89		
Power factor		0.3	0.84	0.67	0.77			
Calculated pumping efficiency								
Hydraulic power	kW	1.61	1.89	1.44	9.72	1.03	26.23	12.02
Overall pumping efficiency	%	0.28	0.14	0.22	0.44	0.72	0.59	0.60
Pump Efficiency	%							
Specific power consumption	kW/m3	0.13	2.23	1.10	0.52	0.24	0.40	0.35

6. PROPOSED ENERGY CONSERVATION MEASURES

6.1 Proposed ECM1 - Replacement of submersible pumps in the wells Nos. 5, 7, 10, 12

Present situation

All wells deliver water to the PS 2 reservoirs through two collectors DN200.

Existing submersible pumps at all four wells ЭЦВ 10-63-110 of 5 stages equipped with motor of rated power 22 kW. Pumps are installed at 64 m depth. Rising pipes D = 114 mm.

Operation of submersible pumps reported to be not reliable. Hydraulic parts of pumps being replaced in average every third month. Motors are replaced approximately once a year.

Measurements results

Well no. 5

The measured actual pumping flow Q =**24.46 m^3/h**.

The measured dynamic water level in the well **17.84 m** from the wellhead level. Please note that water level measurement were taken in August 18, 2011 at the summer lowest water table of the aquifer.

The measured discharge pressure **27 m**. Taken headloss in the rising pipes DN100 L=64 m is **0.6 m** (q= 6.8 l/s; v = 0.67 m/s; 1000i = 8.74 m).

The overall pumping head is H = 17.84 + 0,6 + 27 = **45.44 m.**

The measured active power consumption in the operating regime P_{con} = **14.34 kW.**

Calculation of pumping efficiency of well no. 5

The calculated hydraulic power P_{hyd} = Q x H/367,2 = **3.03 kW**

The actual pumping efficiency of existing submersible pump P_{hyd} / P_{con} = **21 %**

The main reason of low pumping efficiency is in pump operation outside of its duty range. The actual pumping head of 45 m is far away from design head of 110 m. The actual flow of 24 m3/h is much lower than design flow of 63 m3/h. The working duty point is moved to the low efficiency area of pump curve. Moreover it was reported that hydraulic part of submersible pump is damaged and should be replaced. This might be the reason of reduced pump flow.

Well no. 7

The measured actual pumping flow Q =**45.49 m^3/h**.

The measured dynamic water level in the well **19.97 m** from the wellhead level. Please note that water level measurement were taken in August 18, 2011 at the summer lowest water table of the aquifer.

The measured discharge pressure **14 m**. Taken headloss in the rising pipes DN100 L=64 m is **1.8 m** (q= 12,75 l/s; v = 1,25 m/s; 1000i = 28,1 m).

The overall pumping head is H = 19,97 + 1,8 + 14 = **35.77 m.**

The measured active power consumption in the operating regime P_{con} = **25.73 kW.**

Calculation of pumping efficiency of well no. 7

The calculated hydraulic power P_{hyd} = Q x H/367,2 = **4.43 kW**

The actual pumping efficiency of existing submersible pump P_{hyd} / P_{con} = **17 %**

The main reason of low pumping efficiency is in pump operation outside of its duty range. The actual pumping head of 35,77 m is far away from design head of 110 m. The working duty point is moved to the low efficiency area of pump curve.

Well no. 10

The measured actual pumping flow Q = **55 m^3/h**.

The measured dynamic water level in the well **19 m** from the wellhead level.

The measured discharge pressure **34 m**. Taken headloss in the rising pipes DN100 L=64 m is **2.6 m** (q= 15.5 l/s; v = 1.52 m/s; 1000i = 41.5 m).

The overall pumping head is H = 19 + 34 + 2.6 = **55.6 m.**

The measured active power consumption in the operating regime P_{con} = **30.16 kW.**

Calculation of pumping efficiency of well no. 10

The calculated hydraulic power P_{hyd} = Q x H/367.2 = **8.33 kW**

The actual pumping efficiency of existing submersible pump P_{hyd} / P_{con} = **28 %**

The main reason of low pumping efficiency is in pump operation outside of its duty range. The actual pumping head of 55.6 m is far away from design head of 110 m. The working duty point is moved to the low efficiency area of pump curve.

Well no. 12

The measured actual pumping flow Q =**45 m^3/h**.

The measured dynamic water level in the well **20.44 m** from the wellhead level. Please note that water level measurement were taken in August 18, 2011 at the summer lowest water table of the aquifer.

Taken headloss in the rising pipes DN100 L=64 m is **1.72 m** (q= 12.5 l/s; v = 1.22 m/s; 1000i = 27 m).

The overall pumping head is H = 20.44 + 1.72 + 50 = **72.16 m.**

The measured active power consumption in the operating regime P_{con} = **25.11 kW.**

Calculation of pumping efficiency of well no. 12

The calculated hydraulic power P_{hyd} = Q x H/367.2 = **8.84 kW**

The actual pumping efficiency of existing submersible pump P_{hyd} / P_{con} = **35 %**

The main reason of low pumping efficiency is in pump operation outside of its duty range. The working duty point is moved to the low efficiency area of pump curve.

Proposed Improvement

Since all existing submersible pumps operate at very low efficiency rate, we propose to replace existing inefficient pumps with new pumps Q = 45 m3/h, H = 50 m (analogue Z646 06-L6Wwith rated motor power of 9.2 kW).

Estimation of Savings

Estimated power consumption of existing pumps	= 391,024 kWh/year
Estimated power consumption of new pumps	= 178,879 kWh/year
Power saving	= 212,145 kWh/year
Assuming 1.8 MDL per 1 kWh	= **381,861 MDL/year**

Estimation of investment cost

Table 6-1 *Estimation of Investment Costs*

No.	Description	Unit	Qty	Unit price, EUR	Total price, EUR
	Mechanical				
1	Submersible pump/motor set Q=45 m3/h H=50 m including submerged cable	pcs	4	3,000	12,000
2	Rising pipe 4" 50 m each well	m	200	40	8,000
3	Piping in the wellhead building DN100	set	4	200	800
4	Gate valve DN100	pcs	8	150	1,200
5	Check valve DN100	pcs	4	200	800
6	Water meter DN100	pcs	4	600	2400
7	Pressure gauge mechanical	pcs	4	100	400
	Electrical				
8	Pump control unit	pcs	4	1,200	4,800
9	Earthing and cable connection	set	4	600	2,400
	Auxillary				
10	Installation	Lump sum	4	1,000	4,000
11	Tools	set	1	200	200
12	Consumables	set	4	140	560
13	Mandatory spare parts	set	4	800	3,200
14	O&M manuals	set	1	100	100
	Grand total				**40,860**
	Grand total MDL				**674,190**

Payback period	**= 1.8 years**

This ECM anticipates replacement of submersible pumps in four wells only. In order to ensure more reliable operation of wellfield it is necessary to equip three more wells (nos.6,9,11). These three wells will operate as standby source in case of maintenance works or failure of main wells 5, 7,10,12. As standby wells do not contribute to saving of energy, rehabilitation of wells no.6, 9 and 11 is not subject to ECM proposal.

6.2 Proposed ECM2 - Replacement of pumps at PS 2

Present situation

Water from the wellfield Gura Cainarului is collected in two reservoirs 250 m^3 each at the territory of PS 2. From reservoirs water is pumped to the city through two trunk mains DN300.

There are five pump plinths. In operation three pumps no.1, 3, 4. Pump no.2 is partially dismantled. Pump plinth no. 5 has no pump, piping and fittings.

Pump no.1. Type D 200-90. Motor is of 90 kW.

Pump no.3 and 4. Type D 320-70. Motor is of 90 kW.

In normal regime just one pump in operation 7-8 pumping hours per day

Separate group of pumps for Gura Cainarului village installed in pumping room. These pumps are equipped with individual power and water meters.

Measurements results

Pump no.1

The measured actual pumping flow Q =**177 m^3/h**.

The pressure in the suction pipe **5 m.** The pressure in the discharge pipe **66 m**.Therefore the overall pumping head is H = **61 m.**

The measured active power consumption in the operating regime P_{con} = **59.46 kW.**

Calculation of pumping efficiency of pump no.1

The calculated hydraulic power P_{hyd} = Q x H/367.2 = **29.40 kW**

The actual pumping efficiency of pump P_{hyd} / P_{con} = 49 **%**

The main reason of low pumping efficiency is in pump operation outside of its duty range. The actual pumping head of 66 m is far away from design head of 90 m. The working duty point is moved to the low efficiency area of pump curve. Moreover the existing pump is worn out to a high degree and subject to frequent repairs.

Pump no.3

The measured actual pumping flow Q =**120 m^3/h**.

The pressure in the suction pipe **4 m.** The pressure in the discharge pipe **91 m**.Therefore the overall pumping head is H = **87 m.**The higher discharge pressure is due to the one closed trunk main DN300. During measurements water was pumped through one pipeline only.

The measured active power consumption in the operating regime P_{con} = **80.91 kW.**

Calculation of pumping efficiency of pump no.3

The calculated hydraulic power P_{hyd} = Q x H/367.2 = **28.43 kW**

The actual pumping efficiency of pump P_{hyd} / P_{con} = 35 **%**

The main reason of low pumping efficiency is in pump operation outside of its duty range. The existing pump is worn out to a high degree and subject to frequent repairs.

Pump no.4

The measured actual pumping flow Q =**159.44 m3/h**.

The pressure in the suction pipe **4 m.** The pressure in the discharge pipe **67 m**.Therefore the overall pumping head is H = **63 m.**

The measured active power consumption in the operating regime P_{con} = **62.94 kW.**

Calculation of pumping efficiency of pump no.4

The calculated hydraulic power P_{hyd} = Q x H/367.2 = **27.35 kW**

The actual pumping efficiency of pump P_{hyd} / P_{con} = 43 **%**

The main reason of low pumping efficiency is in pump operation outside of its duty range. The actual pumping flow of 160 m^3/h is far away from design flow of 320 m. The working duty point is moved to the low efficiency area of pump curve. Moreover the existing pump is worn out to a high degree and subject to frequent repairs.

Proposed Improvement

Since all existing pumps operate at low efficiency rate, we propose to replace existing inefficient pumps with two new pumps (one working and one standby) of following parameters of each pump (analogue TDB 12001/1A):

Rated flow = 140 m^3/h
Rated head = 63 m*
Motor rated power =45 kW
Actual power at duty point =33 kW

*Pumping head of 63 m is calculated for present pumping regime PS 2 – PS 3. Any modification to the destination of trunk main from PS 2 will influence the pumping head

Estimation of Savings

Estimated power consumption of existing pumping regime = 173,623 kWh/year

Estimated power consumption of new pumping regime = 117,530 kWh/year

Power saving = 56,093 kWh/year

Assuming 1.8 MDL per 1 kWh =**100,968 MDL/year**

Estimation of investment cost

Table 6-2 *Estimation of Investment Costs*

No.	Description	Unit	Qty	Unit price, EUR	Total price, EUR
	Mechanical				
1	Pump/motor set Q=140 m3/h H=63 m	psc	2	12,000	24,000
2	Expansion joints DN125	psc	2	200	400
3	Expansion joints DN100	psc	2	160	320
4	Gate valve DN200	psc	2	200	400
5	Gate valve DN250	psc	2	400	800
6	Check valve DN200	psc	1	200	200
7	Pipework and fittings	set	2	1,700	3,400
8	Pressure transducer	psc	1	1,500	1,500
9	Pressure gauge mechanical	psc	2	100	200
	Electrical				
10	Pump control unit with softstarter	psc	1	12,000	12,000
11	Power and signal cables	set	1	2,000	2,000
12	Earthing	set	1	500	500
	Auxillary				
13	Installation	Lump sum			2,300
14	Tools	set	1	200	450
15	Consumables	set	1	140	220
16	Mandatory spare parts	set	1	500	700
17	O&M manuals	set	1	100	100
	Grand total EUR				**49,490**
	Grand total MDL				**816,585**

Payback period **= 8.1 years**

6.3 Proposed ECM3 - Replacement of pump at PS 3

Present situation

PS 3 delivers water to the pressure service area of Floresti. One pump D 320-50 with frequency converter operates continuously 24/24. Below graph illustrates pumping flow pattern:

The pumping flow graph (please see above) clearly indicates that existing pump is oversized to the required water demand in the hydraulic system. Frequency converter allows to reduce the power consumption to some extent, but we consider the most efficient way to optimize power requirements is to size pump correctly to the actual demand.

Measurements results

To make proper analysis of variable operation regime we took maximum and minimum measurements of pumping parameters and power.

Maximum flow (second peak of filling the pipes was not taken into account)

The measured actual pumping flow Q =**130 m^3/h**.

The pressure in the suction pipe **1 m.** The pressure in the discharge pipe **23 m**.Therefore the overall pumping head is H = **22 m.**

The measured active power consumption in the operating regime P_{con} = **22.8 kW.**

Minimum flow

The measured actual pumping flow Q =**17 m^3/h**.

The pressure in the suction pipe **1 m.** The pressure in the discharge pipe **23 m**.Therefore the overall pumping head is H = **22 m.**

The measured active power consumption in the operating regime P_{con} = **10.5 kW.**

Calculation of pumping efficiency at maximum flow

The calculated hydraulic power P_{hyd} = Q x H/367.2 = **7.79 kW**

The actual pumping efficiency of pump P_{hyd} / P_{con} = **34 %**

Calculation of pumping efficiency at minimum flow

The calculated hydraulic power P_{hyd} = Q x H/367.2 = **1.02 kW**

The actual pumping efficiency of pump P_{hyd} / P_{con} = **10 %**

The main reason of low efficiency is the oversize of the pump. Even the maximum flow 130 m^3/h is 2.5 times lower than nominal pump flow 320 m^3/h. Minimum flows are almost 20 times lower than nominal flow. Frequency converter cannot keep the pump efficiency at its best range if pump operates at low efficiency point.

Below graph of power consumption proves that even at low flows consumption of power is not reduced accordingly:

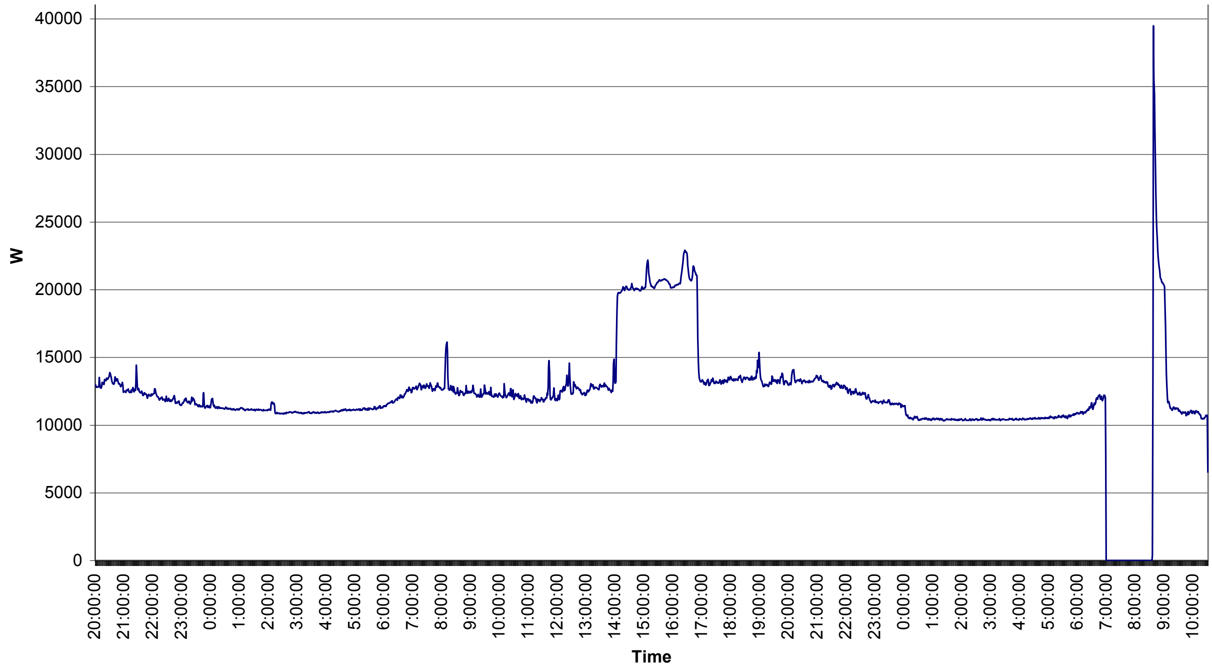

Figure 6-1*MeasuredPS3 Consumption Power*

Proposed Improvement

We propose to replace existing inefficient pump with two new pumps with the following parameters of each pump (analogue GHV20/66SV2/2AG075T):

Rated flow	= 60 m^3/h
Rated head	= 25 m
Motor rated power	= 2 x 7.5 kW
Actual power at duty point max	= 15.2 kW
Actual power at duty point min	= 6 kW
Actual power at duty point aver	= 7.5 kW

Pump set shall be equipped with frequency converter to maintain the minimum required pressure in the system at various water demands during the day and night.

Estimation of Savings

Estimated power consumption of existing pumping regime	= 113,624 kWh/year
Estimated power consumption of new pumping regime	= 65,371 kWh/year
Power saving	= 48,253 kWh/year
Assuming 1.8 MDL per 1 kWh	=**86,855 MDL/year**

Estimation of investment cost

Table 6-3 *Estimation of Investment Costs*

No.	Description	Unit	Qty	Unit price, EUR	Total price, EUR
	Mechanical				
1	Pumping booster set of 2 pumps Q=60 m3/h H=25 m each pump	pcs	2	8,000	16,000
2	Piping and fittings	set	1	700	700
3	Gate valve DN100	pcs	2	150	300

No.	Description	Unit	Qty	Unit price, EUR	Total price, EUR
4	Gate valve DN150	pcs	2	200	400
5	Check valve DN100	pcs	2	200	400
6	Pressure gauge mechanical	pcs	1	100	100
	Electrical				
7	Pump control unit with frequency converter	pcs	1	5,000	5,000
8	Earthing and cable connection	set	1	500	500
	Auxillary				
9	Installation	Lump sum			1,500
10	Tools	set	1	200	200
11	Consumables	set	1	150	150
12	Mandatory spare parts	set	1	200	200
13	O&M manuals	set	1	100	100
	Grand total EUR				**25,550**
	Grand total MDL				**421,575**

Payback period	**= 4.9 years**

6.4 Proposed ECM4 - Replacement of damaged disc aerators at WWTP

Present situation

WWTP was renovated in 1985. Finnish contractor Nokia installed new aeration system, including dissolved oxygen controls. Air pipes are made of stainless steel and are in perfect condition. Nokia installed disk fine bubbles aerators in three aeration tanks and pipe aerators in two tanks. Presently only three tanks with disk aerators are in operation. Nokia introduced also air blower speed control system with dissolved oxygen sensor that worked in the beginning only for several months and never worked since then.

Existing air blower TB 42 – 1.4 with the following parameters:

- air capacity 1 m^3/s
- discharge pressure rating 1,4 kgf/cm^2
- suction pressure rating 1 kgf/cm^2
- motor power 90 kW

operates continuously and delivers air to three working aeration tanks and two airlifts for sludge removal from secondary clarifiers.

We noticed that significant amount of air being constantly lost through damaged aerators. Operating staff reported that many aerators are cracked and air is released in big quantities just in the beginning of air distribution system. Far ends of air distribution piping do not release air due to the significant pressure drop in the beginning.

Bottom air distribution pipes are made polyethylene OD90. Plastic disc aerators are installed on the top of the pipes with “quick connect saddle”. Dismantling and installation of aerator is simple and fast.

Proposed Improvement

It is proposed to replace damaged aerators with modern disc membrane fine bubbles diffusers. The connection of proposed diffusers shall be similar to the existing disc aerators:

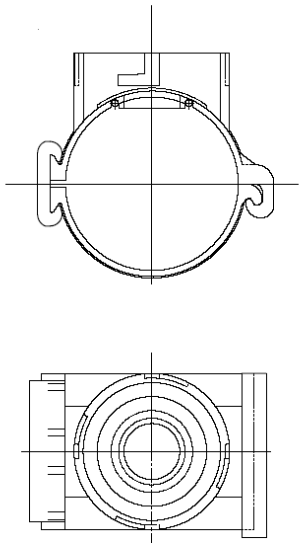

Figure 6-2*Proposed disc aerators*

The number of damaged aerators is unknown. The approximate number of existing aerators per tank is 250 pcs (detailed design was not provided by the Client). Therefore the overall number of aerators is 750 pcs.

We propose to replace 500 aerators with membrane air diffusers D=225 mm of rated capacity 1.5 – 4 m^3/h. New aerators shall be “quick connect saddle” type. Floresti communal utility staff will be able to install new air diffusers by their own staff. The proposed amount of air diffusers shall be sufficient for 2 aeration tanks. If necessary existing aerators in good condition can be installed in third aeration tank.

Estimation of Savings

Estimated power saving 15% of current power consumption 180 000 kW/year	= 27,000 kWh/year
Assuming 1.8 MDL per 1 kWh	= **48,600 MDL/year**

Estimation of investment cost

Procurement of 500 membrane air diffusers	= 250,000 MDL
Emptying of tanks and dismantling of existing aerators	= 20,000 MDL
Installation of new air diffusers	= 50,000 MDL
Total investment cost	**= 320,000 MDL**
Payback period	**= 6.6 years**

6.5 Proposed ECM5 - Installation of sludge pumps in secondary clarifiers

Present situation

Please see the description of WWTP operation in previous sections. Part of air from existing blower is used to remove sludge from secondary clarifiers via two airlifts. During the operation of airlifts air is not delivered to aeration tanks due to the limited capacity of air blower. This practice reduces the treatment quality. Moreover the efficiency of air lift is very limited and in most cases less than 15%.

Proposed Improvement

It is proposed to replace inefficient airlifts with submersible sludge pumps. The efficiency of modern sludge pumps is more than 60%.

Sludge pumps parameters

The design capacity of WWTP is 5,300 m^3/d. The present inflow to the WWTP is not more than 1,000 m^3/d.

Secondary sludge is 1.15 m^3/h at current inflow and 6 m3/h at design inflow. Taken average 3 m^3/h or 72 m^3/d is to be pumped three times per day in 8 hours interval between pumping. Pumping time 1 hour. Therefore the chosen pump Q = 24 m^3/h, H = 5 m
In total two pumps shall be installed in secondary clarifiers, one pump per clarifier.

Estimation of Savings

Estimated power saving 4% of current power consumption 180 000 kW/year	= 7,200 kWh/year
Assuming 1.8 MDL per 1 kWh	= **12,960 MDL/year**

Estimation of investment cost

Submersible sludge pump 2 pcs incl. mounting frame and base	= 120,000 MDL
Pump control panel and cables	= 30,000 MDL
Emptying of tanks and dismantling of existing airlifts	= 10,000 MDL
Installation of new submersible pumps	= 40,000 MDL
Total investment cost	= 200, 000 MDL
Payback period	**= 15.4 years**

6.6 Proposed ECM6 - Speed control for air blower at WWTP

Present situation

Please see the description of WWTP operation in previous sections. Existing speed control of air blower did not operate since 1985.

As present capacity of treatment plant is around 1,000 m^3/d and waste water is not pumped continuously, the sewage concentrations may vary significantly during the day.

Proposed Improvement

We propose to establish speed control of air blower based on dissolved air concentration in aeration tanks. This measure would require installation of frequency converter, dissolvedoxygen sensor, sensor control module, signal/power line between speed control and sensor.

Actual power consumption will be reduced and recommended motor for air blower shall be rated 55 kW.

Estimation of Savings

Estimated power saving 10%
of current power consumption 180,000 kW/year = 18,000 kWh/year
Assuming 1.8 MDL per 1 kWh = **32,400 MDL/year**

Estimation of investment cost

Frequency converter for 55 kW motor	= 80,000 MDL
Dissolved oxygen sensor and control module	= 50,000 MDL
Installation and cables	= 10,000 MDL
Total investment cost	**= 140,000 MDL**
Payback period	**= 4.3 years**

6.7 Proposed ECM7 - Sewage pump for Main SPS

Present situation

There are three group of pumps at SPS Main. First and second group consists of two pumps ФГ 144/46 which operate one by one (discharge line of first pump to suction line of second pump). Third group is one big pump ФГ 450/56 which practically does not operate. It is used only in cases of heavy rains.
Sewage is pumped to WWTP through two pressure mains DN300.

Present pumping regime proved to be inefficient and our measurements clearly showed very low efficiency of pumping scheme (one by one).

Operating regime of sewage pumping is in alternating of pumping groups 1 and 2. Pumping hours of group 1 and 2 are equal.

Measurements results

First group (pump 1+2)

The measured actual pumping flow Q =**122.43 m3/h**.

The measured discharge pressure **41 m**. Suction pressure in collection sump **1 m.**

The overall pumping head is H = **40 m.**

The measured active power consumption of two pumps in the operating regime P_{con} = **61.57 kW.**

Calculation of pumping efficiency of first group

The calculated hydraulic power $P_{hyd} = Q \times H/367.2$ = **13.34 kW**

The actual pumping efficiency of first pumping group P_{hyd} / P_{con} = **22 %**
Such a low pumping efficiency shows that one pump in chain does not give any input to the pumping head. Overall pumping head of two pumps is lower than design head of one pump.

Second group (pump 3+4)

The measured actual pumping flow Q =**250.7 m^3/h**.

The measured discharge pressure **43 m**. Suction pressure in collection sump **1 m.**

The overall pumping head is H = **42m.**

The measured active power consumption of two pumps in the operating regime P_{con} = **69.65 kW.**

Calculation of pumping efficiency of second group

The calculated hydraulic power P_{hyd} = Q x H/367,2 = **28.67 kW**

The actual pumping efficiency of first pumping group P_{hyd} / P_{con} = **41 %**

This group operates more efficient than first one. Although higher flow indicates on parallel operation of pumps

Third group (pump 5)

The measured actual pumping flow Q =**302.55 m3/h**.

The measured discharge pressure **40 m**. Suction pressure in collection sump **1 m.**

The overall pumping head is H = **39m.**

The measured active power consumption of two pumps in the operating regime P_{con} = **58.9 kW.**

Calculation of pumping efficiency of pump 5

The calculated hydraulic power P_{hyd} = Q x H/367,2 = **32.13 kW**

The actual pumping efficiency of first pumping group P_{hyd} / P_{con} = **55 %**

Pump 5 is the most efficient pump at Main SPS.

Proposed Improvement

We recommend not to use pumping groups 1 and 2 since pumping chain proved to be inefficient. Moreover flow velocities in pressure sewage lines DN300 are much lower than minimum recommended 0.7 m/s in order to avoid settlement of sediments in pipes.
It is recommended to use pump 5 for sewage pumping. To ensure reliable operation of pumping station we propose to install one sewage pump Q=180 m^3/h, H=46 m.

Parameters of proposed pumped have been corrected after review of Draft Report. Capacity of pump is reduced due to the nearest plans of replacement of sewage trunk pipe Main SPS – WWTP. New pipe diameter will be 200 mm and this allows to decrease the flow and to keep minimum required flow speed in the pipe. Type of pump is not changed. Previously selected pump will efficiently operate in both existing and new pumping regimes.

Proposed pump shall be installed in dry room on existing foundation. New sewage pump shall be protected against flooding.

Estimation of Savings

Estimated power consumption of existing pumps	= 95,790 kWh/year
Estimated power consumption of new pump	= 56,940 kWh/year
Power saving	= 38,850 kWh/year
Assuming 1,8 MDL per 1 kWh	= **69,930 MDL/year**

Estimation of investment cost

Table 6-4 *Estimation of Investment Costs*

No.	Description	Unit	Qty	Unit price, EUR	Total price, EUR
	Mechanical				
1	Horizontal dry installation pump Q=180 m3/h, H=46 m	psc	1	20,000	20,000
2	Piping and fittings	set	1	1,500	1,500
3	Gate valve DN200	psc	1	200	200
4	Gate valve DN250	psc	1	400	400
5	Check valve DN250	psc	1	500	500
	Electrical				
6	Pump control	psc	1	3,000	3,000
7	Cables and float control	set	1	2,200	2,200
	Auxillary				
8	Installation	Lump sum			2,000
9	Tools	set	1	200	200
10	Consumables	set	1	300	300
11	Mandatory spare parts	set	1	500	500
12	O&M manuals	set	1	100	100
	Grand total EUR				**30,900**
	Grand total MDL				**509,850**

Payback period	**= 7.3 years**

6.8 Proposed ECM8 - Sewage pump for SPS 1

Present situation

SPS 1 collects waste water from the Eastern area of Floresti and pumps it to the Main SPS. Existing pump ФГ 81/31 with motor rated 17 kW.

Measurements results

The measured actual pumping flow Q =**45.5 m^3/h**.

The measured discharge pressure **14 m**. Suction pressure in collection sump **1 m.**

The overall pumping head is H = **13m.**

The measured active power consumption of pump in the operating regime P_{con} = **5.8 kW.**

Calculation of pumping efficiency of first group

The calculated hydraulic power P_{hyd} = Q x H/367.2 = **1.61 kW**

The actual pumping efficiency of first pumping group P_{hyd} / P_{con} = **28 %**

The low pumping efficiency is in pump operation outside of its duty range. Pumping flow and head are approx. two times lower than design values.Probable reason is that pump is worn out.

Proposed Improvement

In order to keep minimum required velocities in pressure sewage we recommend to install one pump Q=72 m^3/h, H=20 m. Proposed pump shall be installed in dry room on existing foundation. New sewage pump shall be protected against flooding.

Estimation of Savings

Estimated power consumption of existing pump	= 21,170 kWh/year
Estimated power consumption of new pump	= 10,293 kWh/year
Power saving	= 10,877 kWh/year
Assuming 1.8 MDL per 1 kWh	= **19,579 MDL/year**

Estimation of investment cost

Table 6-5 *Estimation of Investment Costs*

No.	Description	Unit	Qty	Unit price, EUR	Total price, EUR
	Mechanical				
1	Horizontal dry installation pump Q=72 m3/h, H=20 m	psc	1	5,000	5,000
2	Piping and fittings	set	1	800	800
3	Gate valve DN150	psc	1	200	200
4	Gate valve DN100	psc	1	150	150
5	Check valve DN150	psc	1	300	300
	Electrical				
6	Pump control	psc	1	2,000	2,000
7	Cables and float control	set	1	1,500	1,500
	Auxillary				
8	Installation	Lump sum			1,000
9	Tools	set	1	200	200
10	Consumables	set	1	200	200
11	Mandatory spare parts	set	1	300	300
12	O&M manuals	set	1	100	100
	Grand total EUR				**11,750**
	Grand total MDL				**193,875**

Payback period	**= 9.9 years**

Summary ECM table of pumping modifications:

Table 6-6 *Current Energy Consumption - before Improvements*

Before Improvements							
No	**Site**	**Pump type**	**Rated power, kW**	**Actual power, kW**	**Working hours per day**	**Energy used, kWh/year**	**Overall energy used, kWh/year**
1	**Well no.5**	ЭЦВ 10-63-110	22	14.34	24	125,618.40	**391,024.50**
2	**Well no.7**	ЭЦВ 10-63-110	22	25.73	6	56,348.70	
3	**Well no.10**	ЭЦВ 10-63-110	22	30.16	9	99,075.60	
4	**Well no.12**	ЭЦВ 10-63-110	22	25.11	12	109,981.80	
5	**PS2 city**	D200-90	90	59.46	8	173,623.20	
6	**PS 3**	D 320-50 maximum	55	22.8	3	24,966.00	**113,624.50**
		D 320-50 mimimum	55	10.5	5	19,162.50	
		D 320-50 average	55	11.9	16	69,496.00	
7	**SPS Main**	FG 144/46	2 x 37	61.57	2	44,946.10	**95,790.60**
		FG 144/46	2 x 37	69.65	2	50,844.50	
8	**SPS 1**	FG 81/31	17	5.8	10	21,170.00	

Table 6-7 *Estimated Energy Consumption - after Improvements*

After Improvements							
No	**Site**	**Pump type (analogue)**	**Rated power, kW**	**Actual power, kW**	**Working hours per day**	**Energy used, kWh/year**	**Overall energy used, kWh/year**
1	**Well no.5**	Z646 06-L6W	9.2	8.52	24	74,635.20	**178,879.20**
2	**Well no.7**	Z646 06-L6W	9.2	8.52	10	31,098.00	
3	**Well no.10**	Z646 06-L6W	9.2	9	10	32,850.00	
4	**Well no.12**	Z646 06-L6W	9.2	9.2	12	40,296.00	
5	**PS2 city**	TDB 12001/1A	37	32.2	10	117,530.00	
6	**PS 3**	GHV20/66SV2/2AG075T maximum	7.5	15.2	3	16,644.00	**65,371.50**
		GHV20/66SV2/2AG075T minimum	7.5	7.5	5	13,687.50	
		GHV20/66SV2/2AG075T average	7.5	6	16	35,040.00	
7	**SPS Main**	S1.100.200.650	73	52	3	56,940	
8	**SPS 1**	S1.80.100.100.4	8.62	7.05	4	10,293	

6.9 Economic Assessment of the Proposed ECMs.

The calculated payback period for the proposed ECMs is presented in the following Table.

Table 6-8 *Calculated Payback Period for the Proposed ECMs*

ECM description	Annual energy savings, kWh	Annual energy savings, MDL	Capital investment cost, MDL	Simple payback period, years	Ranking
Replacement of submersible pump in the wells nos. 5,7,10,12	212,145	381,861	674,190	1.8	**1**
Replacement of pumps at PS 2	56,093	100,968	816,585	8.1	**7**
Replacement of pump at PS 3	48,253	86,855	421,575	4.9	**3**
Replacement of damaged disc aerators at WWTP	27,000	48,600	320,000	6.6	**4**
Installation of sludge pumps in secondary clarifiers	7,200	17,960	200,000	15.4	**8**
Speed control for air blower at WWTP	18,000	32,400	140,000	4.3	**2**
Sewage pump for SPS Main	38,850	69,930	509,850	7.3	**5**
Sewage pump for SPS 1	10,877	19,579	193,875	9.9	**6**

6.10 Summary reduction in Energy Consumption

The average reductions in energy consumption for each site were estimated in previous Sections. A summary is given in the table below.

Table 6-9 *Estimated reductions in energy consumption*

Site	Estimated average yearly power demand (in kWh)	
	Before improvement	After improvement
Gura Caunarului wells	391,024	**178,879**
PS 2	173,623	**117,530**
PS 3	113,624	**65,371**
WWTP	180,000	**127,800**
SPS Main	95,790	**56,940**
SPS 1	21,170	**10,293**
Total power consumption	975,231	**556,813**
Saving in kWh	**418,418**	
Overall saving in percent	**57%**	
Estimated savings of overall SA “Servicii Comunale Floresti” power consumption (data of 2010 year 1,242,437 kWh)	**34%**	

6.11 Analysis of the Energy Saving Measures proposed by SA "Servicii Comunale Floresti" and Recommendations

In the inception phase Floresti water utilities submitted to the Consultantalist of ECM proposed to be implemented within EMP:

Description	Existing equipment	Needed equipment	Estimated savings, %
Replacement of submersible pumps at four boreholes	ЭЦВ 10-63-110	Q=50 m3/h H=50 m 2 units Q=40 m3/h H=56 m 1 unit Q=34 m3/h H=55 m 1 unit	**25 - 35**
Replacement of pumps at PS 2	D 200-90 2 units D 315-85 3 units	Q=150 m3/h H=65 m 2 units	**10**
Replacement of pumps at PS 3	D 320-50 with VSD	Q=208 m3/h H=27.3 m 3 units	**40 - 45**
Replacement of pumps at SPS Main	ФГ 144-46 4 units ФГ 450-56 1 units	Q=100 m3/h H=62 m 3 units	**10 - 15**
Replacement of pumps at SPS 1	ФГ 81-31 2 units	Q=30 m3/h H=15 m 2 units	**30 - 40**

All items from the list generally correspond to our recommendations. The flow and head parameter of initially chosen submersible pump are different from the proposed above. We based our choice of equipment on actual measurements of working parameters of equipment.

The number of proposed equipment is different from the initial list. We recommend two pumps at PS2, one pump at SPS Main and one pump at SPS1.

We proposed even more ECMs to optimize operation of WWTP (mainly air blower and aeration system).