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Rehabilitation and Retrofitting of Water Supply Systems in Western Part of Romania

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Abstract. In Romania, there are more than 13,000 localities of which only 10% are equipped with centralized water supply systems at European standards. In the western area of Romania, there is a district operator, which manages the water supply and sewerage systems. It started working on upgrading and rehabilitating water supply systems by accessing European funds, to meet the quality requirements imposed by European legislation. In the first stage, 15 water supply systems were refurbished with works performed in urban and rural parts of western part of Romania. In the second and third stages, investments will continue for the rehabilitation and upgrading of all the western localities, which do not meet the quantitative and qualitative conditions of potable water with European standards. Water resources need to be managed very well, especially in the context of climate change, with water sources having to provide ever growing flow to consumers. The paper shows what are the problems of the centralized water supply system of three localities in western Romania, and how we resolved them. The aim of the study is to analyse the efficiency of the current water supply system and to identify the causes that lead to the qualitative deterioration of drinking water distributed to consumers in populated centres. Laboratory determinations for samples of treated water were performed. Based on these laboratory determinations, corrections were made to ensure that the drinking water complies with current regulations (458/2002 Drinking Water Act and completed with Law 311/2004). The retrofitting and rehabilitation of the existing water supply system of the locality resulted on the basis of these analyses. The flow captured from underground source should be increased. To ensure the flow of water to consumers, the existing drilling and extension of the capture front will be rehabilitated. Rehabilitation of the water supply system will bring a real benefit in terms of quality of life according to environmental restrictions under Directive 98/83 / EC.

1. Introduction

Earth's population could grow by three billion in the next 50 to 75 years. Thirstier people means an even greater demand on already-scarce resources and, paradoxically, a greater chance that existing water sources will become polluted. Many of the world's major aquifers are being over-pumped, and in some river basins governments have allocated more water than is available. Booming "megacities," the focal point of growth in the developing world, are concentrating people without proper sanitation systems so that they often pollute water sources with their own waste. The industrial and agricultural growth on which those new billions of people depend add their own pollutants to many water supplies [1].

In Romania, there are more than 13,000 localities of which only 10% are equipped with centralized water supply systems at European standards. In the western area of Romania, there is a district operator, which manages the water supply and sewerage systems. It has the resources to upgrade and rehabilitate water supply systems by accessing European funds, to meet the quality requirements imposed by



European legislation. The first stage covered 15 water supply systems, that were refurbished, works performed in urban and rural part of western part of Romania. For the second and third stages, investments will be continuing for the rehabilitation and upgrading of all the western localities that do not meet the quantitative and qualitative conditions for potable water at European standards. Fresh water resources need to be managed very well, in the context of climate change, with fresh water sources having to ensure ever growing flow to consumers. [2,3].

2. Presentation of water supply systems in the Western area of Romania

The paper presents the water supply systems for three localities in Timis County, with severe deficiencies regarding exploitation, quantity and quality of raw water.

Deta city is in the southern part of Timis County, at approx. 39 km from Timișoara (located to the north). The town of Deta has 5,874 inhabitants and a density of 1727.6 inhabitants / km².

In Deta, there is currently a water supply system with deficiencies in the amount of water collected, the adduction line feeding the Deta treatment plant and the treatment station.

The water supply system of the detached settlement is composed of:

- capture through 2 drillings from the Jebel source;
- capture through 9 drills from the Deta source, of which 5 drillings are in operation, with a very low flow rate;
- adduction pipe from boreholes to treatment plant;
- treatment station;
- chlorination station;
- storage tanks with a total capacity of 2500 mc (2 x 1000mc and 1 x 500mc);
- pumping station;
- distribution network with a total length of 22.9 km.

Recaș is located in the central area of Timis County, 20 km away from Timișoara, and has a surface of 5.2 km² and a number of 4891 inhabitants.

The water supply of the inhabitants of Recaș is currently carried out through a water supply system that captures water through 14 drillings. The water supply system consists of:

- capture through 14 drillings;
- adduction pipeline from catchment to water supply;
- water house;
- storage tanks with a total capacity of 900 cubic meters;
- pump station;
- distribution network with a total length of 9.25 km.

Gătaia is located in the south of Timiș County, 40 km away from Timișoara, and it has an area of 5.01 km² and a number of 5052 inhabitants.

The water supply of the inhabitants of Gătaia is currently made up of a water supply system that captures the water from the deep underground by means of 6 drillings out of which 4 are in operation.

The water supply system consists of:

- capture through 6 drillings;
- adduction pipeline from catchment to water supply;
- water house;
- storage tanks with a total capacity of 400 cubic meters;
- pump station;
- distribution network.

3. Monitoring of quality parameters

The subject of this study was the analysis of the gross water collected for Gataia and Recas. From the raw water analysis report in the drilling field feeding the Recas treatment plant, the following qualitative parameters result, displayed in table 1:

Table 1. Physical, chemical and microbiological parameters of raw water for the year 2015, [4]

Parameter	U.M.	Raw water parameters			Maximum values admissible in raw water	Observations
		Minimum values	Average values	Maximum values		
Oxidability – permanganate index	mgO ₂ /l	0.54	1.19	2.66	5	According to Law 458/2002, Law 311/2004, Ordinance 11/2010 and Ordinance 1/2011 [5,6,7]
pH		7.1	7.4	7.6	6.5 - 9.5	
Turbidity	NTU	0.4	-	-	max. 1	
Ammonia	mg/l	0.05	0.08	0.194	max. 0.5	
Calcium	mg/l	57	108	128		
Alkalinity	mval/l	6.1	7.4	8.6		
Acidity	mval/l	0.2	0.4	0.5		
Iron	mg/l	0.07	0.22	0.79	max.0.2	
Manganate	mg/l	0.01	0.09	0.27	max 0.05	
Total filterable residue	mg/l	594	701	875		
Total durity	grd. G	16.6	22.9	26.9	min.5	
Coliform bacteria	nr./100 ccm.	0	0	27	0	
Enterococci	nr./100 ccm.	0	0	17	0	
Escherichia coli	nr./100 ccm.	0	0	8	0	

From the raw water analysis report from the drilling field that feeds the town of Recaş, the following qualitative parameters have exceeded values:

- Iron - Fe (dissolved) to be below 0.2 mg / l.
- Manganese - Mn (dissolved) to be less than 0,05 mg / l.
- Coliform bacteria, Enterococci and Escherichia coli in raw water can be eliminated by the process of oxidation - disinfection with chlorine dissolved in filtered water (hypochlorous acid) [4].

From the raw water analysis report in the drilling field that feeds Gataia, the following results of the qualitative parameters are displayed in Table 2.

Table 2. Physical, chemical and microbiological parameters of raw water for the year 2015 [4]

Parameter	Units	Minimum	Average	Maximum	Maximum values admissible in raw water	Observations
Oxidability – permanganate index	mgO ₂ /l	0.83	0.94	1.24	5	According to Law 458/2002, Law 311/2004, Ordinance 11/2010 and Ordinance 1/2011 [5,6,7]
pH	-	7.4	7.5	7.7	6.5 – 9.5	
Turbidity	NTU	1.6	2.9	3.8	max. 1	
Ammonia	mg/l	1.53	1.687	2.33	max. 0.5	
Calcium	mg/l	56	59	60		
Alkalinity	mval/l	6	6.6	6.9		
Acidity	mval/l	0.3	0.32	0.4		
Iron	mg/l	0.16	0.25	0.41	max. 0.2	
Manganate	mg/l	0.32	0.41	0.52	max. 0.05	
Total filterable residue	mg/l	398	413	433		
Total durity	°G	10.8	11.4	12	min. 5	
Coliform bacteria	nr./100 ccm.	0	0	25	0	
Enterococci	nr./100 ccm.	0	0	18	0	
Chlorides	mg/l	12	16	19		
Dissolved oxygen	mg/l	1.0	1.1	1.5		
Conductivity	µS/cm	568	609	626		
Nitrogenous	mg/l	0.50	0.50	0.50		
Azotizes	mg/l	0.010	0.010	0.012		
Organic Nonvolatile carbon (NPOC)	mg/l	0.78	0.88	1.03		
Magnesium	mg/l	16	19	22		
Suspended matter	mg/l	-	10.0	-		
Fixed residue	mg/l	396	413	433		
Sulphates	mg/l	5	14	35		
Esecherichia coli	Nr./100 ccm.	0	-	0		
Range of design temperatures	°C	10 ° C to 15 ° C the influence temperature is considered to remain within the limits mentioned in this period.				

The following parameters values exceed the norms:

- Turbidity, which must be below 1 NTU.
- Iron - Fe (dissolved) to be below 0.2 mg / l. The method of reducing the value below 0.2 mg / l is the oxidation of iron by aeration, precipitation thereof in the form of iron oxide and retaining in sand pressure filters;
- Manganese-Mn (dissolved) to be less than 0.05 mg / l
- Ammonium, which must be below 0.5 mg / l.
- Coliform bacteria and enterococci in raw water can be eliminated by the oxidation-decontamination process with chlorine or chlorine dioxide dissolved in water (hypochlorous acid) [4].

Following the test reports conducted by the water quality control laboratory, the following results were found, which are displayed in Table 3 and 4:

Table 3. The results of the physico-chemical and microbiological indicators from the Recas treatment plant

Parameters	Units	Determined	Maximum values admissible in raw water	Observations
pH	pH	7.6	6.5 – 9.5	Value admissible by Law 458/2002 republished [6]
Turbidity	NTU	0.4	max. 1	
Coliform bacteria	nr./100 ccm	0	0	
Enterococci	nr./100 ccm	0	0	
Free residual chlorine	mg/l	0.200	$\geq 0.1; \geq 0.5$	
Esecherichia coli	Nr.colonies/ 100 ccm	0	0	

Table 4. The results of the physico-chemical and microbiological indicators from the Gataia treatment plant

Parameters	Units	Determined	Maximum values admissible in raw water	Observations
pH	unit. pH	-	6.5 – 9.5	Value admissible by Law 458/2002 republished [6]
Turbidity	NTU	-	max. 1	
Ammonia	mg/l	SLD (<1)	max. 0.5	
Calcium	mg/l	56		
Nitrites	mg/l	-	0.5	
Nitrates	mg/l	1.3	50	
Iron	µg/l	10	200	
Manganese	µg/l	60	50	
Total durity	°G	11	5	
Coliform bacteria	<1/100 ml.	<1/100 ml.	0	
Enterococci	<1/100 ml.	<1/100 ml.	0	
Chlorides	mg/l	-	250	
Residual chlorine	mg/l	1.5	0.5	
Oxidability	mg/O ₂ /l	-	5	
nitrogenous	mg/l	0.50		
Azotizes	mg/l	0.010		
Nonvolatile organic carbon (NPOC)	mg/l	0.78		
Magnesium	mg/l	16		
Suspended matter	mg/l	-		
Fix residue	mg/l	396		
Sulphates	mg/l	5		
Esecherichia coli		<1/ 100 ml.	<1/ 100 ml	

4. Dysfunctionalities rehabilitation and refitting

4.1. RECAS

The proposed works for the rehabilitation and refitting of the water supply system in the locality are:

- replacement of high-wear water networks with a length of 3945 m;
- expansion of water networks with a high degree of wear in the length of 1450 m;
- rehabilitation of the water management;
- new water farm in Gataia;
- installation of fire hydrants on the projected network DN 80 mm diameter and DN 100 mm, located at about 100 m between them;
- performing the customer branching / reconnecting to the newly designed network;
- manholes and discharge valves.



Figure 1. New chlorination station

The treatment plant must be refitted to reduce iron and manganese content with the following treatment methods:

- The method of reducing the value below 0.2 mg / l is the oxidation of iron by aeration, its precipitation in the form of iron oxide and the retention in pressure sand filters;
- The method of reducing the value below 0.05 mg / l is the oxidation of manganese in the first phase by aeration in the aeration basin, and in the second phase by oxidation and retention of manganese dioxide in the pre-sand filtering layer of the sand filters. The retention of manganese in the filter bed is also favoured by a higher value of crude water pH ranging from 7.4 to 7.6. To facilitate the filtration process, it is proposed to oxidize manganese in the second reaction chamber of the pre-treatment basin (aeration) by the injection of hyperchlorinated water over a period of time, (figure 1). During the treatment of raw water with hyperchlorinated water, active carbon filters (CAG) will be bypassed (figure 3).

4.2. GATAIA

The proposed works for the rehabilitation and refitting of the water supply system of the locality are:

- testing and repairs of four boreholes;
- upgrading of adductions between boreholes, 591 m in length;
- water rehabilitation - reservoir rehabilitation, rehabilitation of water castle, rehabilitation and equipping station for pumping drinking water, figure 2;
- extension of the distribution network with 618 m;
- rehabilitation of the 2261 m long distribution network.

The water house, located in the town's urban area, needs fencing to comply with the legislation in effect.



Figure 2. Influent pumps/wash filters



Figure 3. Sand filters + GAC filters

The treatment plant must be refitted to reduce turbidity, iron, manganese and ammonium with the following treatment methods:

- Suggested method of reduction below the value of 1 NTU to retain suspensions in pressure sand filters;
- The method of reducing the value below 0.05 mg / l is the pre-oxidation of manganese in the first stage by aeration and if necessary by treatment with Cl_2 and precipitation thereof in the form of manganese dioxide and retaining in manganese sand filters, figure 3.
- Retaining manganese in the filter layer is also favoured by a higher value of the crude water pH, which ranges from 7.4 to 7.7. In order to facilitate the filtration process, it is proposed that for a certain period of time, manganese is oxidized in the second reaction chamber of the pre-treatment basin (aeration) by the hyperchlorinated water injection. During the treatment of raw water with hyperchlorinated water, activated carbon filters (CAG) will be bypassed.
- The ammonium reduction method below 0.5 mg / l is the reaction with the chlorine gas injected into the raw water. For the formation of mono and dichloramines, the optimal pH of the treated water should be between 7-8, which is achieved by the pH value of the crude water of maximum 7.7.

5. Conclusions

Achieving the extension and rehabilitation of the public water supply system is an important step in the modernization of the infrastructure. Rehabilitation of the water supply system brings a real benefit to

the quality of life within the community by attracting investors in the area, complying with the environmental and legislative restrictions imposed by the relevant legislation. This also ensures the supply of drinking water at an adequate and uninterrupted pressure in all areas with malfunctions.

As specific objectives, the following have been pursued:

- Ensure compliance with the requirements of Directive 98/83 / EC on the quality of water intended for human consumption in the project area;
- Ensure access to quality water services based on the principle of maximizing cost effectiveness, operational quality and payable by the population;
- Reduction of water losses in the project area by rehabilitation of distribution networks, on average by 10%;

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