# CONSIDERATIONS REGARDING MONITORING THE QUALITY OF DRINKING WATER

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***Abstract***
*Drinking water must be sanogenic and clean, so water treatment is essential for the health of the human body. Drinking water must be free of microorganisms, parasites or substances which by number or concentration may constitute a potential hazard to human health. Water quality monitoring is important because in the absence of drinking conditions, water can cause serious damage and can be a way of transmitting different toxic chemicals to the body. Water quality assessment depends on the quality of the results obtained in the control program. The quality of the results depends entirely on the accuracy of the analysis method, the quality control being fundamental to the success of the monitoring program. Quality indicators that need to be investigated in water in the distribution network are: microbiological indicators, free residual chlorine, turbidity, physico-chemical indicators and indirect indicators of organic pollution such as: CCO-Mn, ammonium, nitrites, nitrates. Health expertise of drinking water will also be mandatory in the following situations: choosing new sources, when laboratory tests indicate a risk to the health of consumers, in case of suspected illness of aquatic origin, whenever there is a significant change or an event that can affect water quality (floods, building new targets). In the present paper is presented relevant aspects regarding monitoring the quality of drinking water and as well as a case study on monitoring the quality of drinking water distributed in the city of Rovinari in Gorj county.*

**Keywords**: drinking water, quality indicators, monitoring

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## 1. INTRODUCTION

The drinking water quality conditions are organoleptic (taste and smell), bacteriological conditions, the first and most important bacteriological condition of drinking is the total lack of pathogenic germs in the water, to which are added the physical conditions of drinking that are usually determined with various devices or instruments that make them objective. As such, although they have psychological value and can limit the use of water, they are also considered as water pollution indices. The most important physical conditions are:

- water temperature that has a double sanitary value. First, water temperature directly affects the human body and water consumption. Cold water below 5°C produces a decrease in local resistance of the body against infections, favoring the production of tonsils, pharyngitis, laryngitis, etc.
- turbulence of water produced by water-insoluble substances.
- the water color is given by the substances dissolved in water. Color, like turbidity, can limit the use of water with a psychological role, but it is also a valuable indicator of water pollution.
- the electrical conductivity of water is the result of the degree of water mineralization; it should not be too large, because it changes the organoleptic characters and / or can have unintended consequences in case of long consumption on the stomach, kidney or liver.

Chemical drinking water conditions address a large number of substances that may be present in water. The different sanitary value of these substances led World Health Organization to their classification into several groups, namely:

- harmful substances that are most often toxic. These substances usually come from the outside, through pollution, and have a very tolerable maximum limit

- substances which have undesirable adverse effects but their presence changes the organoleptic characteristics of water by the water unfit for consumption water.

The definition of toxic substances in water is difficult because any substance in certain circumstances or above certain concentrations, can be toxic, this is true even of substances which are typically required by the body.

The factors on which the toxic chemical substances in water may be summarized as follows:

- the concentration of the substance in the sense that a substance is at a higher concentration, the more its toxic effect is stronger. The real toxic substances are those in which the effect occurs at lower concentrations than those that change the water quality.
- solubility of the substance is another factor that influences the sense that the higher toxicity of a substance is soluble in water so it is better transported or carried by the water and so can better exercise their toxic effect.
- stability of the substance in water, meaning the time that a substance permeated water retains its physical and chemical characteristics unchanged.
- the concomitant presence of more toxic substances in water is a more and more common phenomenon. In this case, concomitant substances can neutralize each other, but most often they increase their toxicity, a phenomenon known as potentiation. The most frequent potentiation is the summation or, in other words, the increase in toxicity in proportion to the number of concomitant substances in water.
- the presence of the same substances in another environmental, air, food, workplace, etc. In this case, the penetration into the body is done through several channels and the concentration in the body increases, which leads to the increase of the toxic effect.

The importance of monitoring drinking water quality is supported by the fact that contaminated water consumption can have serious health repercussions. Chlorine water can cause diseases such as asthma, heart disease, cancer, parasites can cause stomach problems, and sand and gravel can cause kidney problems. The number of bacterial diseases such as typhoid fever, dysentery, cholera etc., transmitted or possibly transmitted by water is quite high. The most common viral diseases transmitted by water are: polio, epidemic hepatitis and basal conjunctivitis. Parasitic diseases, Amibiasis, Trichomoniasis, etc. also recognize the possibility of their being transported by water. (Traistă and Madear, 2000; Cîrțînă, 2005; Varduca, 2000; Pătroescu and Gănescu, 1980; Căpățînă and Lazăr, 2004; Cîrțînă and Căpățînă, 2017).

Drinking water quality monitoring can be defined as "the continuous and careful assessment and control of public and private drinking water supply systems in terms of public health, hygiene and water quality provided to the population."

Water quality monitoring involves two components:

1) Continuous (routine) water quality control that seeks to ensure that the source, treatment, storage, and distributed water quality corresponds to objectives and regulations. This control must be done by the water manufacturer.

2) Periodic inspection, sanitary inspection and laboratory determinations for the entire source water supply system, treatment plant, storage system and water to the consumer. This control will be performed by the public health authority.

The methodological norms for health surveillance of water quality constitute the legal and technical framework for laboratory inspection and control of public, national and local public health authorities. (Cîrțînă and Căpățînă, 2017; Cîrțînă and Căpățînă, 2015; Ianculescu and Ionescu, 2002; Săndoiu, 2013).

## 2. MATERIALS AND METHODS

In the methodological norms for sanitary expertise and supervision of the distribution network is defined the sanitary expertise as the sanitary inspection and laboratory control of the entire water supply system. This activity includes:

- health expertise at the source, treatment plant, storage tank and entry into the distribution network;
- overseeing the distribution network.

The health expertise will take place for at least 2 consecutive days and will take into account the following aspects:

a) Frequency of health expertise (minimum periodicity of health expertise is established in relation to the type of source);

b) Laboratory control, respectively the quality indicators to be analyzed in the sanitary expertise;

c) Assessment of the overall efficiency of the treatment plant to be done on the water resulting from treatment (sedimentation/ coagulation and filtration) before disinfection based on the following mandatory indicators: turbidity, total coliforms and faecal coliforms.

With regard to oversight of the distribution network, this consists of the laboratory water control at the network entrance and at representative points. Two important issues are to be considered:

- harvesting frequency
- indicator tracking and method used

The minimum harvesting frequency at the entrance to the distribution network depends on the type and quality of the source, is the following and is a 14-day sample for treatment plants that process water from depth sources and a 7-day sample for the treatment plants surface water.

In the distribution network, harvest points will be set randomly each month and will be set up at both fixed points (reservoirs, pumping stations) and alternative points (network heads, large human clusters, high risk areas of contamination).

The minimum collection frequency for drinking water at representative points in the distribution network is a function of the population served. The maximum interval between two successive samplings is one month for a serving population of less than 5000, five days for a population served between 5000-100000 and one day for a serving population of more than 100000.

Laboratory control within the health expertise should be performed in the laboratory using standardized analytical methods. Water quality monitoring in distribution networks can be done using rapid analysis kits, because it is possible to obtain quick results, which can be validated in the laboratory.

## 3. RESULTS AND DISCUSSION

In the present paper is presented as a case study, monitoring the quality of drinking water distributed in the city of Rovinari in Gorj county.

For monitoring the quality of drinking water distributed in Rovinari, the following parameters were followed:

- *Organoleptic indicators*
- *Physico-chemical indicators*
- *Chemical indicators*
- *Bacteriological parameters*

For the water samples harvested at the Rovinari treatment plant from the network and drilling, the organoleptic indicators: smell, taste, color, meet the requirements.

The values of the physico-chemical indicators monitored, namely: pH, conductivity, turbidity and temperature, for water samples collected from the city water station, network (june/august/september), drilling (july – S1) and network (july – S2) are presented in Table 1. The values of the monitored chemical indicators, namely: the index of permanganate, ammonium ($NH_4^+$), nitrates ($NO_2^-$), nitrates ($NO_3^-$), chlorides ($Cl^-$), residual chlorine ($Cl_2$) free and total are presented in Table 2. Data was taken from the Annual report on drinking water quality monitoring in the Rovinari distribution network.

*Bacteriological parameters:* Escherichia coli, Intestinal enterococci, Coliform bacteria, Colonies at 22°C and 37°C were analyzed in the Laboratory of the Gorj Public Health Department and were included in the values regulated by STAS 1342-91 with the amendments to the Law no. 458/2002, supplemented by Law 311/2004.

**Table 1. Physico-chemical indicators for drinking water.**

| Sample / Indicators | June 2016 | July 2016 | | August 2016 | September 2016 | Admissible values | Measurement units |
|---|---|---|---|---|---|---|---|
| | | Sample (S1-drilling) | Sample (S2-network) | | | | |
| pH | 7,6 | 7,9 | 7,4 | 7,9 | 7,8 | 6,5-9,5 | pH units |
| Electrical conductivity | 428,632 | 321,32 | 450,642 | 339,301 | 442,176 | ≤2500 | µS/cm |
| Turbidity | 0,62 | 1,41 | 1,85 | 0,93 | 0,84 | ≤5 | NTU |
| Temperature | 22,3 | 19,9 | 19,5 | 20,8 | 18,5 | - | °C |

**Table 2. Chemical indicators for drinking water.**

| Sample / Indicators | | June 2016 | July 2016 | August 2016 | September 2016 | Admissible values |
|---|---|---|---|---|---|---|
| The permanganate index ($O_2$) mg/l | | 0,96 | 1,09 | 1,28 | 0,82 | ≤5 |
| Ammonium ($NH_4^+$) mg/l | | <0,032 | 0,041 | 2,888 | 0,111 | ≤ 0,5 |
| Nitrites ($NO_2^-$) mg/l | | <0,014 | <0,014 | <0,014 | <0,014 | ≤0,5 |
| Nitrates ($NO_3^-$) mg/l | | <0,04 | 0,159 | <0,04 | <0,04 | ≤ 50 |
| Residual chlorine ($Cl_2$) mg/l | free | 0,5 | 0,22 | – | 0,3 | ≤0,5 |
| | total | 0,5 | 0,28 | – | 0,56 | ≥5 |

Here are the graphical representations of the variation of certain drinking water quality indicators: pH (Figure no. 1), conductivity (Figure no. 2), turbidity (Figure no. 3), permanganate index (Figure no. 4) and ammonium (Figure no. 5) at the network entrance.

The determined values have been reported to those stipulated in the Law no. 458/2002 on the quality of drinking water, modified and supplemented by Law 311/2004.

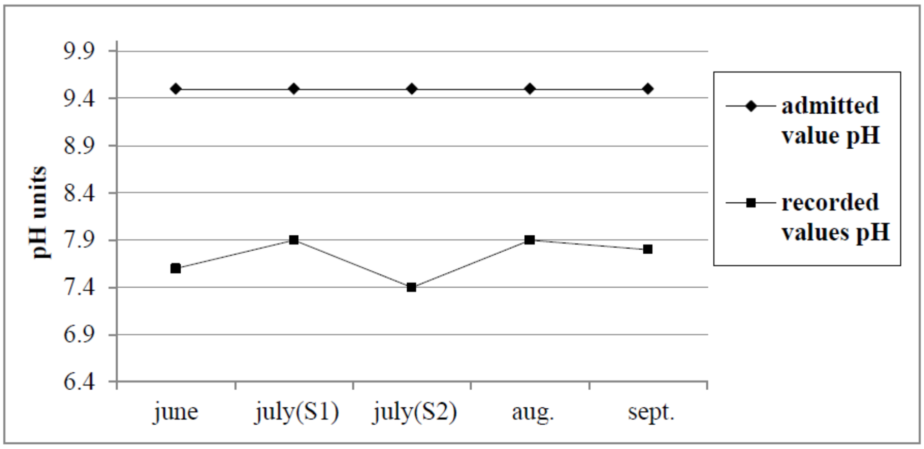


**Fig.1. Evolution of pH relative to admissible value (2016)**

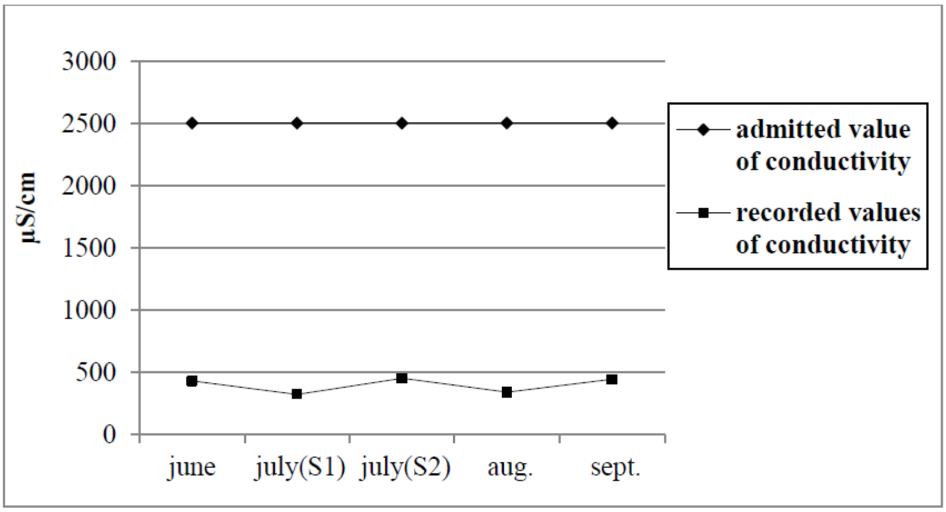


**Fig.2. Evolution of conductivity in relation to admissible value (2016)**

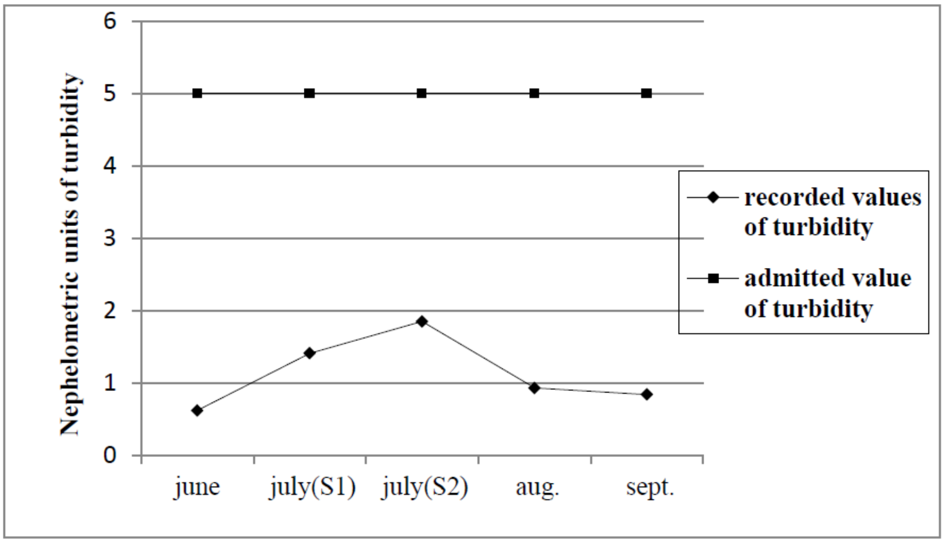


**Fig.3. Evolution of turbidity relative to admissible value (2016)**

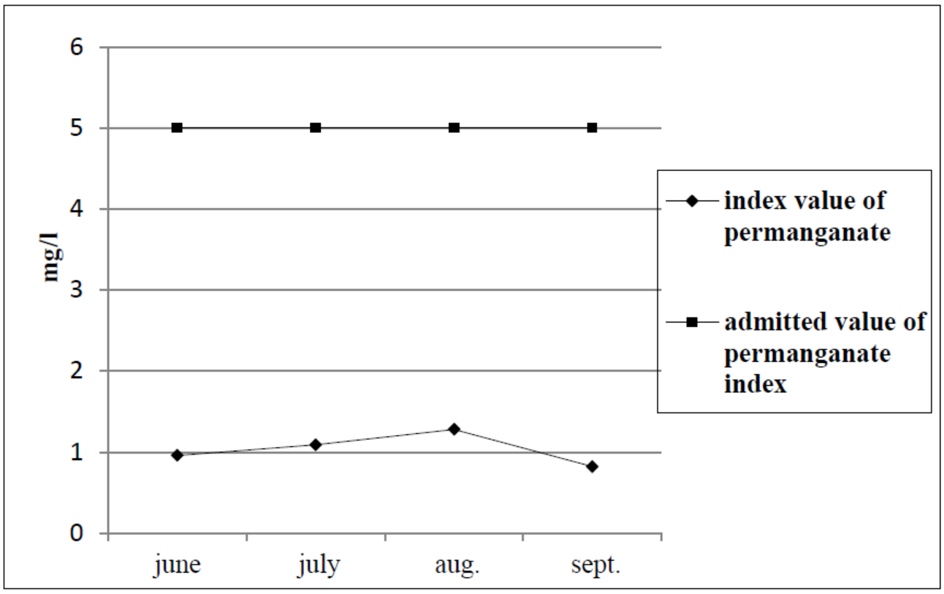


**Fig.4. Evolution of the permanganate index in relation to the admissible value (2016)**

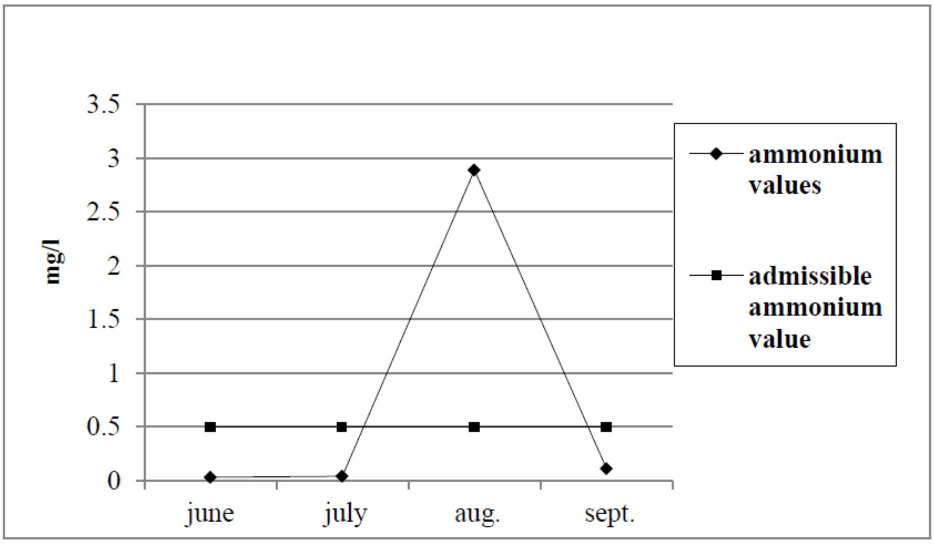


**Fig.5. Evolution of ammonium relative to admissible value (2016)**

In the monitoring indicator pH values recorded were within the limits established by law, having values within the maximum admissible range of 6,5-9,5.

The conductivity indicator represented in Figure no. 2, had values that were within the limit set by the legislation in force. Following the monitoring of the turbidity indicator, as can be seen from the Figure no. 3, the recorded values were within the limit provided by the current legislation providing for the maximum admissible concentration ≤ 5 NTUs.

In the Figure no. 4 is represented the permanganate index wich falls within the maximum permissible limit.

The ammonium value represented in Figure no. 5 exceeded the permitted limit ≤0,5 for the sample taken in august 2016, being 5,76 times higher.

## 4. CONCLUSIONS

Monitoring is a system of surveillance, forecasting, warning and intervention, which takes into account the systematic evaluation of the dynamics, the qualitative characteristics of the water in order to know the quality status and its technological significance, the evolution and the social implications of the changes, followed by measures required.

Sanitary surveillance of drinking water quality consists of the health inspection and laboratory control that is performed during the systems in terms of public health, hygiene and water quality provided to the population.

Drinking water must be sanogenic and clean, free of microorganisms and meet minimum conditions at the sampling point.

The purpose of monitoring drinking water quality is to prevent water-borne illnesses by early detection and limiting/ removing risk factors that could alter water quality and affect the health of consumers.

The monitoring of the quality of the drinking water distributed in the city of Rovinari, Gorj county, is done by determining the values of the quality parameters in certified and specialized laboratories.

The sampling of water at the entrance to the Rovinari water station and to the consumer (in the distribution network) as a result of the analyzes carried out revealed the following: all the monitored parameters, both the physicochemical and the chemical ones, were framed within the limits provided by the legislation in force, namely STAS 1342-91, as amended by Law 458/2002, supplemented by Law 311/2004.

The water produced and distributed in Rovinari city corresponds to control the organoleptic, physico-chemical and bacteriological.

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