

# Identification of Surface Water Treatment Plant (WTP) Effluent and Distribution Water Quality in Wonogiri Regency, Central Java

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**Abstract.** This study analyzed the water treatment system into drinking water, and the quality of raw water and distribution results at Perumda Air Minum Giri Tirta Sari, Wonogiri Regency. The water treatment plant's (WTP) for surface water consists of intake, pre-sedimentation, coagulation, flocculation, sedimentation, filtration, reservoir storage, and distribution. The sludge resulting from the deposition process is still not managed. Further planning is needed to control environmental pollution that may occur due to dumping sludge into streams. The quality of river raw water that has not met the quality standard is total coliform and color. Measurement of water on the customer's tap shows that all the quality standards of drinking water have met the criteria to be safe for use by residents.

Keywords: drinking water, environment, sludge, water quality, WTP

## 1. Introduction

The availability of clean water is an absolute aspect to support all human activities. Sufficient water availability in terms of quality, quantity, and continuity is essential for human survival [1]. Based on Government Regulation Number 16 of 2005, to meet the community's need for clean water with a stipulated minimum service standard is the responsibility of the district/city government.

Increasing water needs and conditions make it impossible for people to use groundwater and surface water directly. To get groundwater, people have to dig deep wells. Using surface water directly is impossible because the water quality conditions do not physically meet clean water requirements [2]. The Regency/City Government formed a regional company called the Regional Drinking Water Company (PDAM) from these problems. PDAM is a Regional Owned Enterprise (BUMD) that provides clean water for profit to residents in an area [3]. Perumda Air Minum Giri Tirta Sari is a regional company providing clean water serving the Wonogiri Regency. Perumda Air Minum Giri Tirta Sari

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utilizes three raw water sources: surface water, groundwater, and spring water to meet the clean water supply. However, municipal activities will increase water pollution [4], [5]. It is necessary to process the raw water to meet health requirements and is suitable for consumption. The process of processing raw water into clean water varies with each source of raw water used. Various pollutants in streams water sources need more techniques to meet quality standards [6], [7]. Based on this background, a performance study of the water treatment plant (WTP) was conducted at Perumda Giri Tirta Sari Drinking Water to meet clean water needs in the Wonogiri Regency. This study aims to analyze implementing the practice of processing raw water into clean water and the quality of drinking water produced from Perumda Drinking Water Giri Tirta Sari.

## 2. Material and Methods

Field observation activities were carried out by looking at the entirety of the water treatment plant (WTP) building. The WTP building is at the Kajen WTP located on Jalan Jambu Air No. 1, Kajen, Giriprwo, Wonogiri Regency, and Grobog WTP located in Wonogiri District. This activity aims to learn about the work environment and water treatment in the Kajen WTP and the Grobog WTP. The author made joint observations with one of the staff from the production department. The activities started from the intake building to the reservoir and WTP supporting facilities such as storage rooms for chlorine gas cylinders, storage tanks, and pump rooms.

Literature studies were carried out through direct interviews with agency supervisors and production staff. This activity aims to obtain information about the water treatment process at Perumda Giri Tirta Sari Drinking Water and water treatment in general. Literature studies, both interviews and online article sources, were carried out during this study. Water quality data is taken from the monthly report of the Perumda Air Minum Giri Tirta Sari production section. The method of measuring water quality can be seen in Table 1. This measurement method is carried out in a laboratory that has been standardized by the National Standardization Agency (BSN) so that the method used is adjusted to existing standards in Indonesia.

Table 1. Method of Measuring Water Quality Parameters

Parameters	Method
Total Coliform	Dual Tube MPN
Odor	Organoleptic
TDS	TDS Meter
Turbidity	Turbidimeter
Taste	Organoleptic
Temperature	Digital
Color	Spectrophotometry
Fe	Spectrophotometry
Mn	Spectrophotometry
Nitrate as N	Spectrophotometry
Nitrite as N	Spectrophotometry
Chloride	Spectrophotometry
pH	pH Meter
Organic Substances (KMnO <sub>4</sub> )	Titrimetry
Hardness (CaCO <sub>3</sub> )	Titrimetry

## 3. Result and Discussion

### 3.1 Surface Water Treatment System

Kajen WTP is the Perumda Air Minum Giri Tirta Sari which utilizes the Bengawan Solo River as a raw water source. The water treatment process uses physical and chemical processing. The water treatment process can be seen in Figure 1. Water from the Bengawan Solo River is flowed to the intake building using three pumps, each of which can flow water with a discharge of 29 L/sec, 22 L/sec, and

18 L/sec. The intake building is equipped with a chlorine affixing process to prevent moss growth on the installation unit. The water from the intake has then flowed into the coagulation tub with the waterfall system. The coagulant used is a liquid alum (CMA) at a dose of 10 mL/s. The water is flown into a slow lane which aims to form larger flocks. There is a deposition of solids in the sedimentation unit in sludge, also known as production waste. The sedimentation basin is equipped with a settler which functions to accelerate the deposit. The water separated from the solid is drained to the filtration basin to be filtered using three medium sand media. These conditions aim to capture small particles that are difficult to settle. Clean water from the filtration tub has flowed to the reservoir, and then chlorine is added as a disinfectant. Some clean water reservoirs have flowed for distribution purposes, and some are stored for the tub's washing process.

The intake is a building used to flow raw air to the reservoir before entering the water treatment process. The intake building is equipped with a bar screen or filters helpful in holding or filtering trash or leaves from entering the pump and clogging the air suction. The type of intake found in the Kajen WTP is a channel type. The coagulation process in water treatment is collecting small particles such as clay, turbidity, and organic matter into larger particles separated by sedimentation, conventional filtration, or membranes [8]. Coagulation in Kajen WTP is done by adding chemicals (coagulants) to raw water. This affixing aims to bind the particles in the raw water at Perumda Giri Tirta Sari; drinking water uses liquid alum (CMA) as a coagulant.

The sedimentation basin consists of 2 parts, namely the settling basin and the settler bath. The use of settlers aims to help settle small flocks to not carry over to the following process [8]. The type of settler used is a tube settler. The sediment in the sedimentation basin is in the form of sludge, also known as production waste. Kajen WTP uses a rapid sand filter type of filtration with three media: quartz sand, gravel, and a filtering membrane. The filtering media's replacement is carried out for 2-3 years to maximize the filtering results.



**Figure 1.** Flow Chart of River Water Treatment to Drinking Water

In the Kajen WTP, the resulting sludge is not treated before being discharged into the environment. Some of the suggestions given are planning for storage and processing of production sludge, testing the

chemical content of production sludge before being discharged into water bodies, and reusing production sludge as a mixture of building materials [9]. However, before it is further utilized, the sludge originating from the sediment tank and filter tub has flowed to the collector as a place to fill the sludge temporarily, gravity thickening unit, dewatering unit, and conditioning [10]. Sewerage sludge also can contribute to carbon emissions and cause greenhouse impacts [11]. However, this requires further research regarding the chemical content contained in the production sludge.

Before being distributed, the treated water is collected in a reservoir and then disinfected. There are three types of disinfectants used, namely chlorine powder, chlorine tablets, and chlorine gas. There is a disinfection process in the reservoir at Kajen WTP by flowing chlorine gas ( $\text{Cl}_2$ ) to kill bacteria in the treated water. However, when the chlorine gas supply runs out or is under repair, usually the disinfection process uses chlorine powder.

Table 2. Results of Raw Water Quality Inspection at Grobog [15]

No	Parameters	Raw Water Quality	Distribution Water Quality	Removal Efficiency (100%)	Standard PERMENKES No. 32 of 2017	Unit
<b>A. Biology</b>						
1.	Total Coliform	460	0	100	<50	/100 mL sample
<b>B. Physics</b>						
1.	Odor	Odorless	Odorless	-	Odorless	-
2.	TDS	97	105	-	1000	mg/L
3.	Turbidity	5.44	0.77	85.8	25	NTU
4.	Taste	Tasteless	Tasteless	-	Tasteless	-
5.	Temperature	28.8	28.9	-	Air temperature $\pm 3$	$^{\circ}\text{C}$
6.	Color	70	<1	>98.6%	50	TCU
<b>C. Chemistry</b>						
1.	Fe	0.15	0.04	73.3	1	mg/L
2.	Mn	0.4	0.05	87.5	0.5	mg/L
3.	Nitrate as N	<1	1.8	-	10	mg/L
4.	Nitrite as N	0.01	<0.01	-	1	mg/L
5.	Chloride	14.08	11.66	17.2	800	mg/L
6.	pH	8.7	7.3	-	6.5-8.5	-
7.	Organic Substances ( $\text{KMnO}_4$ )	-	4.18	-	10	mg/L
8.	Hardness ( $\text{CaCO}_3$ )	-	79.8	-	500	mg/L

### 3.2 Raw Water and Water Treatment Quality

Before going through the processing process, the quality of raw water originating from surface water is not good enough. For example, from the examination results of the Grobog WTP raw water from Gajah Mungkur Reservoir, three parameters exceed the quality standard, namely total coliform with a content of 460 per 100 mL color with a range of 70 TCU and pH of 8.7. Fathoni et al. stated that population density is an early indicator of bacteria used to determine whether water is safe or not for consumption [12]. The absence of coliform bacteria is an indicator of the quality and safety of drinking water. The lack of these bacteria is expected to indicate the absence of other pathogens [13]. The inspection of raw water quality from the Grobog WTP in May 2020 can be seen in Table 2.

From the results of laboratory examinations carried out as in Table 2, the microbiological parameters, color, and pH do not meet the quality standards contained in Permenkes No. 32 of 2017 for microbiological parameters of <50 per 100 mL sample, 25 NTU color parameters, and a pH of 6.5-8.5 [14]. After it is processed and distributed to the community, water quality measurements have met the required biology, physics, and chemistry requirements.

#### 4. Conclusions

Treatment of raw water into clean water has a different process according to the raw water quality. Treatment of raw water originating from surface water requires the installation of an intake unit, coagulation, flocculation, sedimentation, filtration, and disinfection. Water from springs only requires installing a ground capturing unit, a press release bath, filtration, and disinfection. Meanwhile, water from deep wells only involves the installation of a water tapping and disinfection unit. The efficiency of water treatment on the parameters of turbidity, color, Fe, Mn, and Chlorine reached 85.8%, >98%, 73.3, 87.5, and 17.2%, respectively. After going through the processing process, raw water that contains parameters that exceed the quality standard has met the clean water standard following the Minister of Health Regulation No. 32 of 2017 concerning Environmental Health Quality Standards and Water Health Requirements for hygiene, sanitation, swimming pools, souls per aqua, and public baths.

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