



## **Wastewater Quality Characteristics Test in Domestic Wastewater Treatment Plant Dinas Lingkungan Hidup Kota Semarang**

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### *ABSTRACT*

The purpose of this study was analyze the characteristics of wastewater quality at the Domestic Wastewater Treatment Plant Dinas Lingkungan Hidup Kota Semarang. The research method is to test the parameters pH, BOD, COD, TSS, and Ammonia at the inlet and outlet. The test showed the average value of the waste quality parameters decreased after the treatment process, so that the average value of the parameters at the outlet smaller than inlet. The average value of the water quality parameters at the inlet with a pH value of 7,77, a BOD value of 14,5 mg/L, a COD value of 29,5 mg/L, a TSS value of 13 mg/L, and an Ammonia value of 0,0145 mg/L. The quality of the water samples at the outlet with a pH value of 7,62, a BOD value of 11,5 mg/L, a COD value of 25,5 mg/L, a TSS of 9 mg/L, and an Ammonia value of 0,0059 mg/L. Based on the test result, the quality of the wastewater meets the quality standard of Peraturan Menteri Lingkungan Hidup dan Kehutanan No.68 Tahun 2016. With this in mind, the wastewater from wastewater treatment is suitable for disposal into the environment.

**Keywords:** Domestic wastewater, domestic wastewater treatment plant, water quality characteristics

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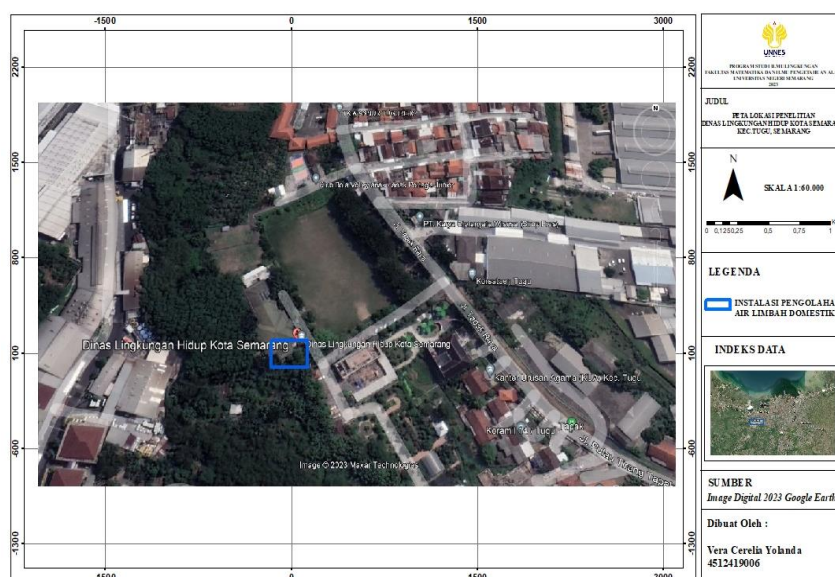
### **1. INTRODUCTION (Calisto MT, 12)**

According to Peraturan Menteri Pekerjaan Umum dan Perumahan Rakyat Republik Indonesia Nomor 04/PRT/M/2017 on the regulation of domestic wastewater management systems, a domestic wastewater treatment plant that can be used for processing domestic wastewater. The effluent quality produced from domestic wastewater treatment should be under quality (Nama et al., 2017) The treated water in the Domestic Wastewater Treatment Plant that is discharged into surface water bodies must meet the quality standards of domestic wastewater in accordance with the provisions of the Peraturan Menteri Lingkungan Hidup dan Kehutanan Republik Indonesia Nomor 68 Tahun 2016 concerning Domestic Wastewater Quality standards (Said, 2017). Dinas Lingkungan Hidup (DLH) Kota Semarang in 2020 built a Domestic Wastewater Treatment Plant unit that has a capacity of 9m<sup>3</sup> with a physical, chemical and biological

treatment system that functions to treat wastewater from the domestic activities of the Dinas Lingkungan Hidup Kota Semarang including bathrooms, prayer rooms and pantries so that the output is in accordance with environmental quality standards when discharged into water bodies. The quality of wastewater produced by Domestic Wastewater Treatment Plant Dinas Lingkungan Hidup Kota Semarang is expected to meet the quality standards of the Peraturan Menteri Lingkungan Hidup dan Kehutanan No.68 Tahun 2016 concerning domestic wastewater quality standards, so that domestic wastewater can be discharged into the environment. This study aims to analyze the characteristics of wastewater quality before and after the treatment process at Domestic Wastewater Treatment Plant Dinas Lingkungan Hidup Kota Semarang by testing the levels of pH, BOD, COD, TSS, and Ammonia. The test results of these parameters can be used to increase or improve the quality of service of the Domestic Wastewater Treatment Plant Dinas Lingkungan Hidup Kota Semarang.

## 2. METHODS

This research is located at the Dinas Lingkungan Hidup (DLH) Kota Semarang on Jl. Tapak Raya, Tugu, Kota Semarang, precisely at the Domestic Wastewater Treatment Plant unit (Figure 1).



**Figure 1.** Plan of Domestic Wastewater Treatment Plant Dinas Lingkungan Hidup Kota Semarang

The population used in this study was all wastewater before and after treatment at the Domestic Wastewater Treatment Plant of Dinas Lingkungan Hidup Kota Semarang. The samples in this study were 2 (two) liters each of wastewater before treatment (inlet) and wastewater samples after treatment (outlet) at the Domestic Wastewater Treatment Plant of Dinas Lingkungan Hidup Kota Semarang. This study uses variables, namely independent variables and dependent variables. The independent variable in this study is the Domestic Wastewater Treatment Plant. The dependent variable in this study is the result of the examination of pH, BOD, COD, TSS, and ammonia of wastewater. This type of research is descriptive quantitative. Wastewater sampling was carried out at two stations, namely the Inlet and Outlet of the Domestic Wastewater Treatment Plant of Dinas Lingkungan Hidup Kota Semarang. The sampling method used was grab sampling and sample collection was carried out in composite time, namely samples taken from the

same place at different times and supported by data collection techniques through observation and laboratory test. Test sampling was conducted for 2 consecutive days at the inlet and outlet. Every day at the inlet, test samples were taken at 07.00 WIB until the 2nd day. At the outlet, the test samples were taken with a time difference of 8 hours, namely taking at the outlet at 15.00 WIB until the last day (day 2). The choice of the above collection time is intended as a deposition retention time based on the wastewater flow cycle. Wastewater sampling was carried out using a plastic bucket then the wastewater samples obtained were put into sample bottles that had been labeled and immediately taken to the Dinas Lingkungan Hidup Kota Semarang water laboratory for testing.

### 3. RESULTS AND DISCUSSION

The parameters used in this study include pH, Biological Oxygen demand (BOD), Chemical Oxygen Demand (COD), Total Suspended Solid (TSS) and Ammonia. The following are the test results of pH, BOD, COD, TSS and Ammonia parameters (see Table 1 and Table 2).

Table 1. Inlet Water Test Results

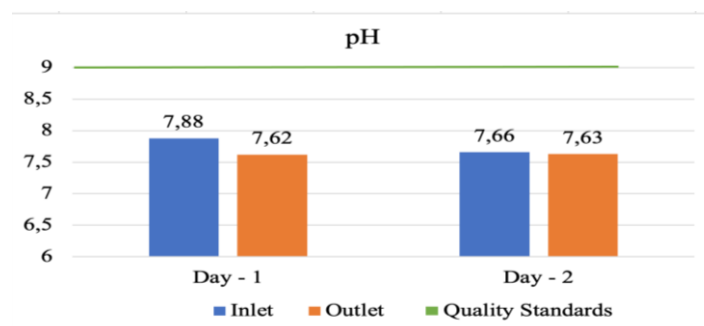
Parameters	Unit	Inlet Water		Average	Description
		Day - 1	Day - 2		
pH	-	7,88	7,66	7,77	Qualify
BOD	mg/L	13	16	14,5	Qualify
COD	mg/L	27	32	29,5	Qualify
TSS	mg/L	13	13	13	Qualify
Amonia	mg/L	< 0,01 (0,0009)	0,02	0,01046	Qualify

Table 2. Outlet Water Test Result

Parameters	Unit	Outlet Water		Average	Description
		Day - 1	Day - 2		
pH	-	7,62	7,63	7,625	Qualify
BOD	mg/L	11	12	11,5	Qualify
COD	mg/L	23	28	26	Qualify
TSS	mg/L	10	8	9	Qualify
Ammonia	mg/L	< 0,01 (0,0018)	0,01	0,0059	Qualify

Based on the results of domestic wastewater tests with pH, BOD, COD, TSS, and Ammonia parameters that have been carried out, namely:

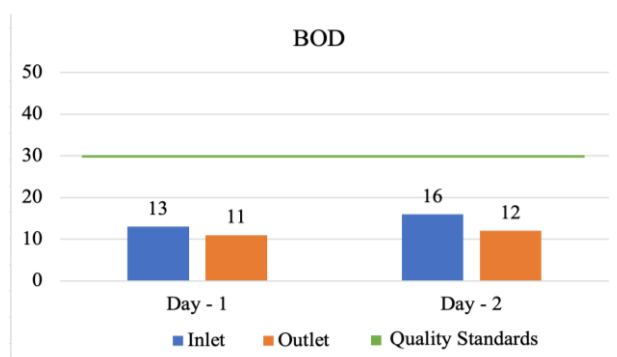
a. In testing the pH parameter, the inlet and outlet samples were directly taken to the Dinas Lingkungan Hidup Kota Semarang water laboratory for testing. The pH parameter testing method uses pH digital water, by inserting pH digital water into 200 ml of samples that have been placed in beakers or beaker glass in accordance with SNI 6989.11-2019. The results of the pH analysis of domestic wastewater from Dinas Lingkungan Hidup Kota Semarang (Figure 2).



**Figure 2.** Test results for pH levels

Based on the results of the pH analysis of domestic wastewater, it shows that the average pH of the inlet (7.77) and outlet (7.62) where the pH of the inlet sample is greater than the pH of the outlet, this happens because the inlet sample has not been treated using the Wastewater Treatment Plant, so that the organic matter in it has not been decomposed and there are more microbes in it so that it affects the biochemical processes of the waters. The pH in the outlet sample is lower than the inlet sample because treatment has been carried out at the Wastewater Treatment Plant where there is a processing process that produces acid, namely at the chlorination stage in the effluent basin, at that stage chlorine is given which functions to kill bacteria that are still in wastewater. This is in line with research (Nuraini & Darpito, 2018) which shows that there is a significant influence between chlorine on the resulting pH, where the pH in the treatment of adding chlorine tends to become acidic because chlorine in water hydrolyzes to form  $\text{Ca}(\text{OH})_2$  and  $\text{HOCl}$  compounds. Based on the Peraturan Menteri Lingkungan Hidup dan Kehutanan No.68 of 2016 concerning domestic wastewater quality standards, the maximum level for pH is 6 - 9, it can be concluded that the pH parameter test of the effluent (outlet) of the Dinas Lingkungan Hidup Kota Semarang Service Domestic Wastewater Treatment Plant is in accordance with the established quality standards. The pH value that is in accordance with the quality standards illustrates that the treatment results at the Dinas Lingkungan Hidup Kota Semarang Domestic Wastewater Treatment Plant are working well.

b. Biological Oxygen Demand (BOD) Test. In testing the Biological Oxygen Demand (BOD) parameter, inlet and outlet samples were directly taken to the Dinas Lingkungan Hidup Kota Semarang water laboratory for testing. The testing method for Biological Oxygen Demand (BOD) parameters was carried out using the winkler titration method in accordance with SNI 6989 72.2009. The results of the Biological Oxygen Demand (BOD) analysis of domestic wastewater from Dinas Lingkungan Hidup Kota Semarang (Figure 3).

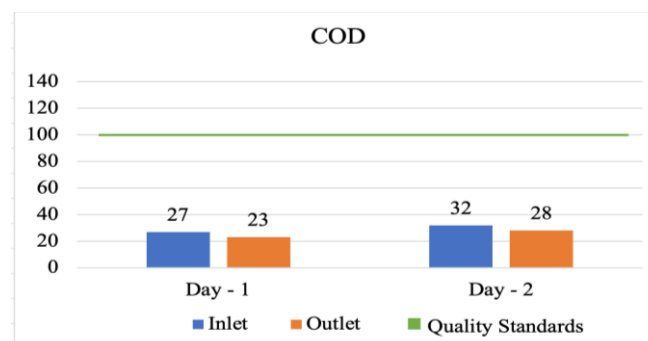


**Figure 3.** Test result for BOD levels

Based on the test results of Biological Oxygen Demand (BOD) levels of domestic wastewater, it shows a decrease in the average value of Biological Oxygen Demand (BOD) from the inlet of 14.5 mg/L to the outlet of 11.5 mg/L. The outlet Biological Oxygen

Demand (BOD) level is lower than the inlet Biological Oxygen Demand (BOD) level, this happens because in wastewater treatment at the Dinas Lingkungan Hidup Kota Semarang Domestic Wastewater Treatment Plant there is an aeration process. Aeration is the process of making contact between water and air to increase dissolved oxygen levels in water (Asadiya & Karnaningroem, 2018). The process can reduce Biological Oxygen Demand (BOD) levels because the provision of oxygen into wastewater will be able to increase the amount of dissolved oxygen, so that it can provide oxygen supply to decomposing microorganisms to reduce the levels of organic substances contained in the wastewater and meet the oxygen needs for oxidation of chemicals in wastewater. Aeration treatment can improve the quality of waste towards a better direction (Pramyani & Marwati, 2020). According to (Utami et al., 2019) in the presence of oxygen, aerobic microbes will oxidize organic compounds to form new cells and more stable forms that produce CO<sub>2</sub>, NH<sub>3</sub>, and H<sub>2</sub>O + new cells. The decrease in Biological Oxygen Demand (BOD) value is an indicator of improving wastewater quality towards a better direction, where there is a comparison of wastewater conditions before aeration treatment and after aeration treatment, which has a difference in value of 2 mg/L. The decrease in Biological Oxygen Demand (BOD) concentration also indicates that the organic matter contained in the wastewater is mostly biodegradable organic matter. The decrease in Biological Oxygen Demand (BOD) levels with the aeration process reaches 50 percent, while for Chemical Oxygen Demand (COD) levels the decrease can reach 62 percent (Mubarokah, 2010). Some studies mention that grease traps are able to remove up to 80% of oil and fat (United States Environmental Protection Agency, 1998) as well as 50-80% of Biological Oxygen Demand (BOD) and Total Suspended Solid (TSS), in the PUPR ministry's IPLT book states that grease traps can remove fatty oils up to 95% because organic matter is reduced (Ditjen Cipta Karya, 2018). Based on the Peraturan Menteri Lingkungan Hidup dan Kehutanan No.68 of 2016 concerning Domestic Wastewater Quality Standards, the maximum level of the Biological Oxygen Demand (BOD) parameter is 30 mg/L, it can be concluded that the Biological Oxygen Demand (BOD) parameter test from the effluent (outlet) of the Dinas Lingkungan Hidup Kota Semarang Service Domestic Wastewater Treatment Plant is in accordance with the established quality standards.

c. Chemical Oxygen Demand (COD) Test. In the Chemical Oxygen Demand (COD) parameter test, inlet and outlet samples were directly brought to the Dinas Lingkungan Hidup Kota Semarang water laboratory for testing. The test method for Chemical Oxygen Demand (COD) parameters was carried out by spectrophotometric closed reflux method in accordance with SNI 6989.2-2019. The results of the Chemical Oxygen Demand (COD) analysis of domestic wastewater from the Dinas Lingkungan Hidup Kota Semarang (Figure 4).



**Figure 4.** Test result for COD levels

Based on the test results of Chemical Oxygen Demand (COD) levels of domestic wastewater, it shows a decrease in the average value of Chemical Oxygen Demand (COD) from the inlet of 29.5 mg/L to the outlet of 25.5 mg/L, where the difference is 4 mg/L. The outlet Chemical Oxygen Demand (COD) level is lower than the inlet, the Dinas



Lingkungan Hidup Kota Semarang Domestic Wastewater Treatment Plant has a filtration process that uses wasp nest media. Chemical Oxygen Demand (COD) levels are influenced by the content of organic compounds and also inorganic compounds derived from wastewater discharges. The aerobic process in the wasp nest aims to reduce the content of organic compounds by decomposing them into methane gas which will then be discharged into the air. With a decrease in organic compounds which can be characterized by a decrease in Biological Oxygen Demand (BOD) levels, it shows that the aerobic process is able to degrade surfactants contained in wastewater. This is in line with research conducted (Sopiah, 2006) that wasp nest media is able to degrade linear alkylbenzene sulfonate (LAS) surfactant in detergent waste by using wasp nest media. In research (Ronny, 2017) also showed a decrease in Chemical Oxygen Demand (COD) levels, where the initial sample examination of liquid waste was 360 mg / L, after passing the treatment down to 133.33 mg / L. Based on the Peraturan Menteri Lingkungan Hidup dan Kehutanan No.68 of 2016 concerning Domestic Wastewater Quality Standards, the maximum level of the Chemical Oxygen Demand (COD) parameter is 100 mg/L, it can be concluded that the Chemical Oxygen Demand (COD) parameter test from the effluent (outlet) of the Dinas Lingkungan Hidup Kota Semarang Service Domestic Wastewater Treatment Plant is in accordance with the established quality standards.

d. Total Suspended Solid (TSS) Test. For the Total Suspended Solid (TSS) parameter test, inlet and outlet samples were directly brought to the Dinas Lingkungan Hidup Kota Semarang water laboratory for testing. The measurement method used in this test is gravimetric in accordance with SNI 6989.3-2019. The results of the Total Suspended Solid (TSS) analysis of domestic wastewater from Dinas Lingkungan Hidup Kota Semarang (Figure 5).

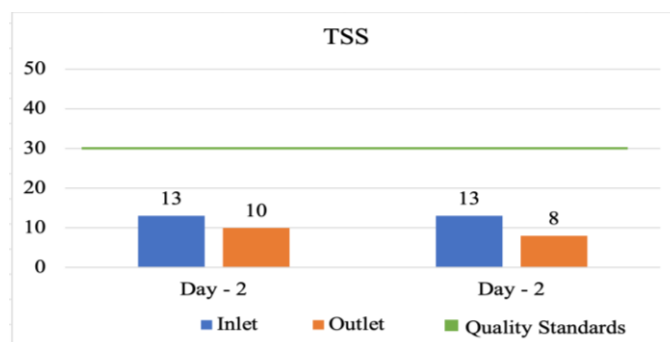
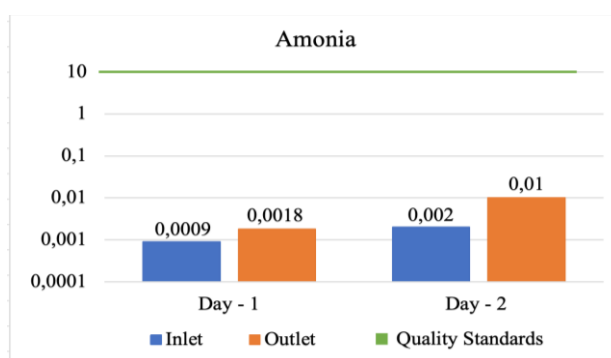


Figure 5. Test result for TSS levels

Based on the test results of Total Suspended Solid (TSS) levels of domestic wastewater, it shows a decrease in the average value of Total Suspended Solid (TSS) from the inlet (13 mg/L) to the outlet (9 mg/L) with a difference of 4 mg/L. This decrease occurred because in the Dinas Lingkungan Hidup Kota Semarang Domestic Wastewater Treatment Plant there is a grit chamber unit, where this unit filters coarse and fine particles contained in wastewater which can be in the form of large soil to sand contained in wastewater so that no deposition occurs in the channel. The grit chamber mechanism is the same as sedimentation where there is a separation of the solid part by utilizing the force of gravity so that the solid part is at the bottom of the settling pond, while the pure water is at the top. This initial stage of treatment will further reduce the burden of the next stage of treatment (Suparmin, 2019). According to (Yanita F. A, 2016) the grit chamber has a Total Suspended Solid (TSS) removal efficiency of 25%. In the Domestic Wastewater Treatment Plant (WWTP) of the Dinas Lingkungan Hidup Kota Semarang Service, there is also an aeration unit where in the process oxygen is provided to the wastewater. Providing oxygen into liquid waste can destroy clumped deposits, so as to facilitate the absorption of oxygen which causes aerobic bacteria that function as decomposers to grow well so that more decomposing bacteria can break down clumped

deposits so that the value of Total Suspended Solid (TSS) levels goes down. The more oxygen supply increases, the growth of the organism population is good, so that the process of decomposing wastewater is faster (Arsawan et al., 2007). Based on the Peraturan Menteri Lingkungan Hidup dan Kehutanan No.68 of 2016 concerning Domestic Wastewater Quality Standards, the maximum level of the Total Suspended Solid (TSS) parameter is 30 mg/L, it can be concluded that the Total Suspended Solid (TSS) parameter test from the effluent (outlet) of the Dinas Lingkungan Hidup Kota Semarang Service Domestic Wastewater Treatment Plant is in accordance with the established quality standards. The decrease in the value of Total Suspended Solid (TSS) shows that the precipitation process at the domestic wastewater treatment plant of the Dinas Lingkungan Hidup Kota Semarang Service is successful so that the Total Suspended Solid (TSS) value obtained at the outlet is smaller than the inlet.

e. Ammonia Test. Ammonia samples were taken directly to the Dinas Lingkungan Hidup Kota Semarang water laboratory for testing. The measurement method carried out in this test uses a spectrophotometer in accordance with SNI 06-6989.30-2005. Ammonia analysis results of domestic wastewater from Dinas Lingkungan Hidup Kota Semarang (Figure 6).



**Figure 6.** Test result for Ammonia levels

Based on the test results of ammonia levels of domestic wastewater, it shows a decrease in the average value of ammonia from the inlet (0.01045 mg/L) to the outlet (0.0059 mg/L). This decrease occurred because in the Dinas Lingkungan Hidup Kota Semarang Domestic Wastewater Treatment Plant there is an aeration and chlorination process using chlorine. Ammonia compounds in water can be treated microbiologically by autotrophic and heterotrophic bacteria through the process of nitrification to form nitrites and nitrates. This nitrification process takes place under aerobic conditions, so the addition of oxygen through aeration is needed (Bitton, 2005), with the availability of oxygen through the aeration process these bacteria can work optimally which will be beneficial in reducing the concentration of organic substances in wastewater (Bary et al., 2013) besides being needed for the metabolic process of aerobic bacteria, the presence of oxygen is also useful for the oxidation process of chemical compounds in wastewater and to eliminate odors. Ammonia ( $\text{NH}_3$ ) can be removed as a gas through aeration or reaction with hypochlorous acid ( $\text{HOCl}$ ) or chlorine, so that it becomes harmless chloramine or until it becomes  $\text{N}_2$ . The reduction in ammonia levels occurs because chlorine reacts with ammonia to produce a series of chlorinated ammonia compounds called chloramines and then oxidizes ammonia to the harmless substance  $\text{N}_2$ . Hypochlorous acid is a very active oxidizing agent, it will react quickly with ammonia in wastewater. In addition, another factor that affects the reduction of ammonia levels is the nature of chlorine. The nature of chlorine, which is a disinfectant, will more quickly damage the structure of microorganisms in ammonia. In research (Mariyana et al., 2015) that there was a decrease in ammonia levels in wastewater after treatment with chlorine due to ammonia oxidation reactions. Based on the Regulation of the Peraturan Menteri Lingkungan Hidup dan

Kehutanan No.68 of 2016 concerning Domestic Wastewater Quality Standards, the maximum level of ammonia parameters is 10 mg/L, it can be concluded that the ammonia parameter test from the effluent (outlet) of Dinas Lingkungan Hidup Kota Semarang Service Domestic Wastewater Treatment Plant is in accordance with the established quality standards.

#### 4. CONCLUSIONS

From the results of the analysis and discussion that has been described, the conclusion in this study is that the wastewater entering the Domestic Wastewater Treatment Plant of the Dinas Lingkungan Hidup Kota Semarang is domestic waste generated from the office activities of Dinas Lingkungan Hidup Kota Semarang. Laboratory testing results obtained the average value of water sample quality parameters at the inlet with a pH value of 7.77, BOD value of 14.5 mg/L, COD value of 29.5 mg/L, TSS value of 13 mg/L, and Ammonia value of 0.0145 mg/L. Water sample quality at the outlet with a pH value of 7.62, BOD value of 11.5 mg/L, COD value of 25.5 mg/L, TSS value of 9 mg/L, and ammonia value of 0.0059 mg/L. Based on the test results, the average value of the test results of wastewater parameters at the inlet and outlet has met the quality standards of the Peraturan Menteri Lingkungan Hidup dan Kehutanan No. 68 tahun 2016 concerning domestic wastewater quality standards so that it is feasible to discharge into the receiving body, namely the Tapak River Jl. Tapak Tugurejo to Kali Tugurejo.

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