BioLink : Jurnal Biologi Lingkungan, Industri dan Kesehatan, Vol. 11 (1) August (2024)
ISSN: 2356- 458X (print) ISSN: 2597-5269 (online)
DOI: 10.31289/biolink.v11i1.12499

BioLink
Jurnal Biologi Lingkungan, Industri, Kesehatan

Available online http://ojs.uma.ac.id/index.php/biolink

EVALUATION OF THE WASTE WATER TREATMENT INSTALLATION OF THE SELE BE SOLU REGIONAL PUBLIC HOSPITAL SORONG CITY

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Submitted: 16-07-2024; Reviewed: 17-07-2024; Accepted: 12-08-2024

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Abstract

The Hospital Wastewater Treatment Plant (WWTP) is a system of hospital wastewater treatment designed based on the characteristics of waste water entering from several sources of waste discharge. The research location is at Sele Be Solu Regional Hospital, Sorong City, West Papua. The land owned by Sele Be Solu Regional Hospital is approximately 120,000 m2, and the number of beds is 158. This study uses laboratory tests to measure the quality of wastewater and the wastewater treatment plant. From the calculated results, the maximum discharge produced by Sele Be Solu Regional Hospital is 4343 m3/month. With the actual pollution load for the BOD parameters of 26.36 kg/month, COD of 157.98 kg/month, and TSS of 38,343 kg/month, all three are greater than the maximum pollution load allowed, namely for the BOD of 12,708 kg/month, COD of 105.9 kg/month, and TSS of 211.8 kg/month. The quality of wastewater from the Sele Be Solu Regional Hospital's wastewater treatment plant in 2017, which was tested by PT. Kehati Lab Indonesia, showed that all parameters met the quality standard requirements of the Minister of Environment Regulation Number P.68 of 2016. Meanwhile, the quality of processed wastewater in 2019 and 2021 showed that the parameters for Coli Group germs exceeded the permitted quality standards, while other parameters still meet the quality standards.

Keywords: *Evaluation; WWTP; Wastewater Quality*

How to Cite: *Dwangga, M., Asriadi, & Irawan, M.A.N. (2024). Evaluation of The Waste Water Treatment Installation Of The Sele Be Solu Regional Public Hospital Sorong City. BioLink: Jurnal Biologi Lingkungan, Industri, Kesehatan, Vol.11 (1): 41-52*

INTRODUCTION

Hospital Waste Water Treatment Installation (IPAL) is a hospital waste water treatment designed based on the characteristics of waste water entering from several waste sources (Mahera, 2019; Rohana & Umar, 2020; Widyasari *et al*., 2023). The goal of having an IPAL in a hospital is to prevent environmental pollution and health problems for visitors/patients, especially waste workers and the community around the hospital who are at risk of being contaminated by medical waste water produced by the hospital (Purwanto, 2019).

Based on the Decree of the Minister of Environment of the Republic of Indonesia Number P. 68 of 2016, concerning domestic waste water quality standards, hospitals are required to provide facilities for managing liquid and solid waste so that all waste that will be disposed of into channels meets the waste quality standards determined according to regulations. in force and based on the Regulation of the Minister of Health of the Republic of Indonesia Number 7 of 2019 concerning Hospital Environmental Health, it is necessary to have a Waste Water Treatment Plant (IPAL) with the right technology and waste water processing capacity design that is appropriate to the volume of waste water produced. On that basis, it is necessary to have a wastewater treatment installation, namely a water building that functions to process all waste originating from activities in the hospital (Tonis *et al*., 2020).

As one of the health service centers in Sorong City, the Sele Be Solu Regional General Hospital (RSUD) is included in the Type C Hospital and is one of the referral hospitals in Sorong City. Sele Be Solu Hospital, Sorong City, is one of the hospitals in Sorong City which already has its own Waste Water Treatment Plant (IPAL).

Based on the existing problem formulation, the objectives of this research are: (a) To analyze the quantity of waste water produced at Sele Be Solu Regional Hospital; and (b) To analyze the quality of waste water produced at Sele Be Solu Regional Hospital compared to waste water quality standards.

RESEARCH METHODS

The research location was at Sele Be Solu Regional Hospital, Sorong City, West Papua. The land owned by the Sele Be Solu Regional Hospital covers an area of around 120.000 m^2 and the total patient capacity that can be accommodated is 158 peoplerecorded at the end of 2020. This research lasted for 3 months starting

from mid-October 2021 to mid-February 2022.

From the results of the field survey obtained, you can find out the results of the data analyzed as follows:

1. Observe and record the hospital's waste water discharge, then calculate the maximum allowable waste water discharge and the actual waste water discharge. Therefore you can find out whether the waste water from the Sele Be Solu Regional Hospital, Sorong City, exceeds or not the maximum allowable limit (Purwanto, 2019).
2. Calculate the maximum pollution load and actual pollution. Thus it can be seen whether the existing waste water pollution load meets the requirements or not.
3. Calculate the efficiency of reducing BOD5, COD and TSS levels to determine the levels of these parameters using the following equation (Shobriyah *et al*., 2022):

$$\% \text{ BOD(i) reduction efficiency} = \frac{(Inlet(i) - Outlet(i))}{Inlet(i)} \text{x } 100\%$$

Compare the parameters of waste water originating from hospital IPAL outlets with quality standards used as a reference by all hospitals in Indonesia to determine the ability of IPALs to process waste water (Ferdiaz, 2016).

RESULTS AND DISCUSSION

1. Waste Water Quantity

Quantity can be done by calculating the waste water discharge and pollution load. For quality analysis by calculating the efficiency of reducing levels for each parameter. Calculation of waste water discharge, pollution load, and reduction efficiency are as follows:

a. Debit

The debit is calculated based on clean water consumption in the hospital based on the number of patient capacities that can be accommodated, the number of employees, patient families, and clean water consumption for patient needs. Clean water consumption in hospitals can be seen according to Minister of Environment Regulation No. P68 of 2016 concerning Domestic Wastewater Quality Standards, calculation of the maximum and permitted waste water discharge or volume (Wardhani *et al*., 2023).

Table 1. Maximum Clean Water Requirements

Type of need	Number of TT/ Person/ patient (Pb)	Total clean water requirement (Dm)	Total clean water need (DM)
King's Patient	98	7.5	735
Per-Bed	158	300	47.400
patient's family	158	160	25.280
The patient's drinking water needs	158	30	4.740

Medical personnel	39	120	4.680
Paramedics	207	120	24.840
Non-Medical Personnel	309	120	37.080
Total water requirements			**144.755**

Source: Analysis Results, 2020

Therefore the maximum waste water discharge per day based on the calculations in Table 1 is 144.755 liters/day. Based on data from the hospital, it is known that the hospital occupancy rate (BOR) in 2020 was 50.6% and the patient capacity was 158 people.

Table 2. Calculation of Actual Waste water Discharge

Type of need	Number of TT/ Person/ patient (Pb)	Total clean water requirement (Dm)	Total clean water need (DM)
Per-Bed	158	300	47.400
patient's family	158	160	25,280
The patient's drinking water needs	158	7.5	1.185
Total water requirement for hospitalization x			**77,420**
King's Patient	98	30	490
Medical personnel	39	120	4.680
Paramedics	207	120	24.840
Non-Medical Personnel	309	120	37.080
Total water needs Rajal needs + human resources			**67.335**

Source: Analysis Results, 2020

Based on the hospital inpatient occupancy rate (BOR) in 2020 of 50.6%, to calculate DA is to use the total water requirement for inpatient care multiplied by the BOR value and the total water requirement for human resources and also outpatient care and the total multiplied by assuming that waste water discharge is 75% of clean water use).

The assessment for waste water discharge is that DA (actual waste water discharge) must not be greater than DM (maximum waste water discharge/volume). In calculating the waste water discharge for the Sele Be Solu Regional General Hospital, Sorong City, the DA does not exceed the DM so it still meets the requirements.

b. Pollution Load

According to river water quality standards, it refers to PP No. 82 of 2001 concerning water quality management and control of Class II river water pollution. The assessment for calculating the pollution load is that BPA cannot be greater than BPM (Lusiana *et al.*, 2020). The results of calculations and assessments for pollution loads can be seen in Table 3.

Table 3. Maximum Pollution Load and Pollution Load in 2020

PARAMETER	BPM (Kg/month)	CPA (Kg/month)	INFORMATION BPM>CPA
BOD	13,028	26,361	Not eligible
COD	108.57	157.98	Not eligible
NH3 Free	0.26	3,451	Not eligible
PO_4	0.87	0.479	Qualify
TSS	217.133	38.343	Qualify

Source: Analysis Results, 2020

From Table 3, the actual pollution load calculation results for the PO4 and TSS parameters, the pollution load does not exceed the maximum pollution, while for the parameters BOD, COD and Free NH_3 it exceeds the maximum pollution load. Thereforre the waste water pollution load at Sele Be Solu Regional Hospital, Sorong City does not meet the standards for several parameters.

c. Derating Efficiency

Calculate the efficiency of reducing levels of each parameter of treated wastewater to determine the performance of the IPAL (Lumunon *et al*., 2021; Gafur, 2015). The data used was test result data carried out by Sele Be Solu Regional Hospital from 2017 to 2021. The test result data is presented in Table 4.

Table 4. Testing Results for WWTP Outlets at Sele Be Solu Regional Hospital, Sorong City

Parameter	unit	Inlets			Outlets		
		2017	2019	2021	2017	2019	2021
BOD	Mg/l	66	23.31	8.5	11	7.18	7.2
COD	Mg/l	205	46.37	71,826	38	10.53	65,917
TSS	Mg/l	631	20	29	16	6	16

Source: Analysis Results, 2020

From the table of testing results for Waste Water Quality Standards at the Sele Be Solu Regional Hospital, Sorong City, the efficiency reduction is as follows:

Table 5. Efficiency of reducing BOD, COD and TSS levels

Parameter	Decline Efficiency (%)		
	TH 2017	TH 2019	TH 2021
BOD	83.3	69.2	52.94
COD	81.5	77.29	44.83
TSS	97.46	70	44.83

Source: Analysis Results, 2020

From the calculation of the efficiency of reducing BOD, COD and TSS levels above, it shows that the efficiency of IPAL performance has decreased every year even though WWTP can still reduce several parameter levels to the specified wastewater quality standards.

2. Wastewater Quality Analysis

The parameters tested in the laboratory for waste water quality are pH,

BOD5, COD, TSS, Free NH_3, PO_4 and coli group germs (Haque, 2017; Shaleh, 2022). To evaluate wastewater processed during the last 5 years, the existing parameters are compared with the Minister of Environment Regulation Number P.68 of 2016 concerning Domestic Wastewater Quality Standards (Ernamaiyanti & Mega, 2024; Sugesti, 2020). In 2020, no testing was carried out due to the Covid-19 outbreak. The analysis results for each parameter in the last 5 years are as follows:

a. Temperature

The results of temperature checks from the IPAL outlet of Sele Be Solu Hospital, Sorong City compared to the quality standards used can be seen in Table 6.

Table 6. Inspection Results for Temperature Parameters

Year	Quality Standards (0C)	Outlets (^{0}C)
2017	38	28
2019	38	-
2021	38	-

Source: PT. Kehati Lab Indonesia & BTKL Class II Ambon

The results of temperature checks show that the temperature parameters checked in 2017 were below waste water quality standards. A wastewater temperature that is lower than the quality standard indicates that biological activity such as plants and reproduction will be slower and vice versa, if the temperature increases then biological activity will increase.

b. pH

Examiner results BOD inspection results from the IPAL outlet of Sele Be Solu Hospital, Sorong City compared to the quality standards used can be seen in Table 7 and Figure 1.

Table 7. Examination Results for pH Parameters

Year	Quality Standards	Outlets
2017	6 to 9	7.33
2019	6 to 9	7.47
2021	6 to 9	7.2

Source: PT. Kehati Lab Indonesia & BTKL Class II Ambon

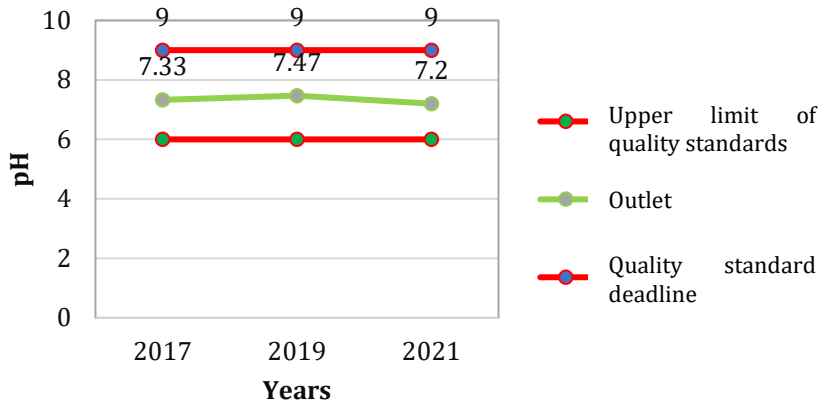

Figure 1. Comparison graph of pH examination results

The results of the examination of pH parameters from 2017 to 2021 show that the waste water produced is in an alkaline condition which is still within the specified quality standard threshold.

c. BOD

The results of the BOD inspection from the IPAL outlet of Sele Be Solu Hospital, Sorong City compared to the quality standards used can be seen in Table 8 and Figure 2.

Table 8. Inspection Results for BOD Parameters

Year	Quality Standards (mg/l)	Outlet (mg/l)
2017	30	11
2019	30	7.18
2021	30	4

Source: PT. Kehati Lab Indonesia & BTKL Class II Ambon

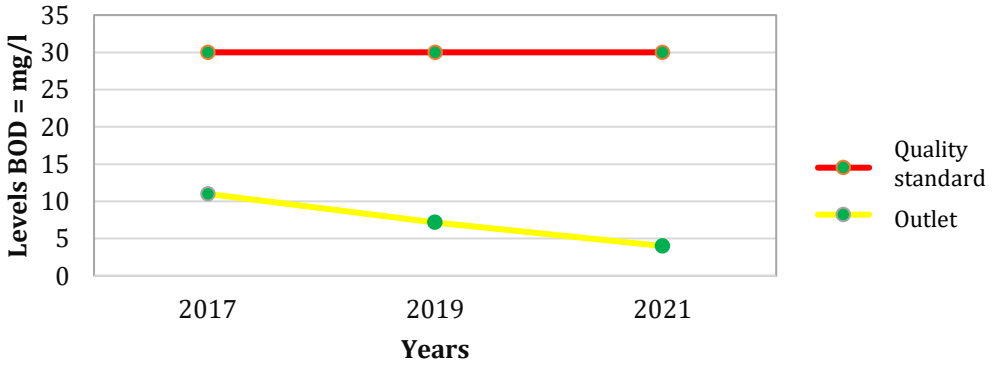

Figure 2. Comparison graph of BOD inspection results

From the graph above, it can be seen that from 2017 to 2019 the BOD parameters were still below the quality standards, which shows that the aeration process is still perfect. Aeration is an effort to remove pollutants so that the concentration of pollutants will be reduced or even eliminated. The aeration process at the Sele Be Solu Regional Hospital WWTP occurs in the biofilter unit.

d. COD

The results of the COD inspection from the IPAL outlet of Sele Be Solu Hospital, Sorong City compared to the quality standards used can be seen in Table 9 and Figure 3.

Table 9. Inspection Results for COD Parameters

Year	Quality Standards (mg/l)	Outlet (mg/l)
2017	100	38
2019	100	10.53
2021	100	65.917

Source: PT. Kehati Lab Indonesia & BTKL Class II Ambon

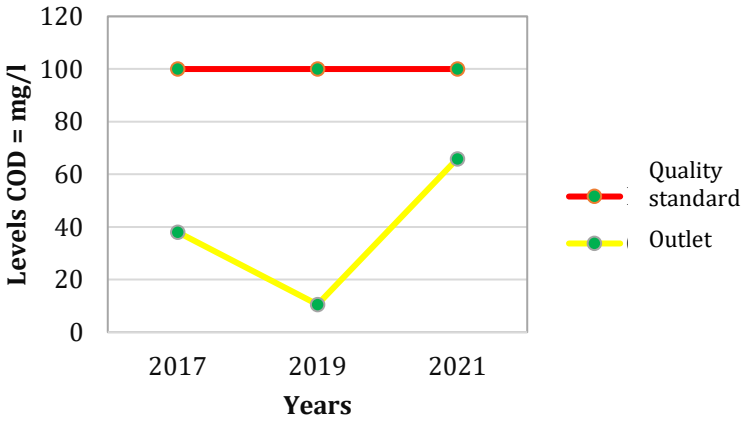

Figure 3. Comparison graph of COD inspection results

The results of the COD parameter examination from 2017 to 2021 are still below water quality standards, which means there is no pollution, because COD is another form of measuring oxygen demand in wastewater.

e. TSS

The results of the TSS examination from the IPAL outlet of Sele Be Solu Hospital, Sorong City compared to the quality standards used can be seen in Table 10 and Figure 4.

Table 10. Inspection Results for TSS Parameters

Year	Quality Standards (mg/l)	Outlet (mg/l)
2017	30	16
2019	30	6
2021	30	16

Source: Analysis Results, 2020

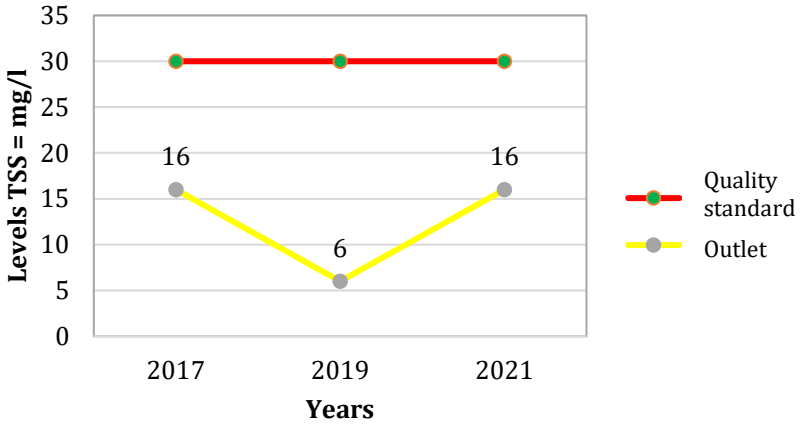

Figure 4. Comparison graph of TSS inspection results

In the table and graph above, the inspection results for TSS parameters from 2017 to 2019 meet the quality standard requirements. The decrease in TSS levels is influenced by residence time, a good residence time in the settling tank is 2 hours.

f. NH_3 Free

The results of the NH_3 Free inspection from the Sele Be Solu Hospital WWTP outlet, Sorong City compared to the quality standards used can be seen in Table 11 and Figure 5.

Table 11. Examination Results for Free NH_3 Parameters

Year	Quality Standards (mg/l)	Outlet (mg/l)
2017	10	0.5
2019	10	1.44
2021	10	0.7334

Source: PT. Kehati Lab Indonesia & BTKL Class II Ambon

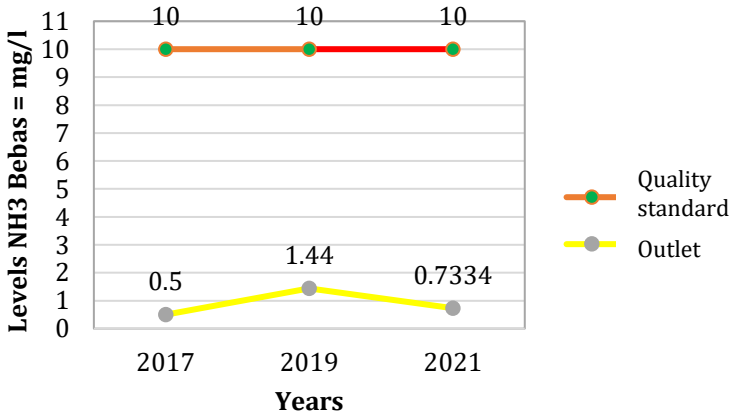

Figure 5. Comparison graph of Free NH_3 Examination Results

In the results of checking the Free NH_3 parameters, the results meet the quality standard requirements. The processes that affect free NH_3 are aerobic and anaerobic processes. So the high and low examination results for the Free NH_3 parameter could be due to non-optimal aerobic and anaerobic processes.

g. Phosphate (PO_4)

The results of the PO_4 inspection from the IPAL outlet of Sele Be Solu Hospital, Sorong City compared to the quality standards used can be seen in Table 12.

Table 12. Inspection Results for TSS Parameters

Year	Quality Standards (mg/l)	Outlet (mg/l)
2017	10	0.2
2019	10	-
2021	10	0.02

Source: PT. Kehati Lab Indonesia & BTKL Class II Ambon

For the PO_4 parameter inspection results in 2017 and 2021, the test results met the quality standard requirements, whereas in 2019 testing for the PO_4 parameter was not carried out. The decrease in PO_4 values is influenced by aerobic and anaerobic processing that occurs in the biofilter unit.

h. Coli Group Germs

The results of the examination of Coli group germs from the Sele Be Solu Hospital IPAL outlet, Sorong City compared to the quality standards used can be seen in Table 13 and Figure 6.

Table 13. Examination Results for Coli Group Germ Parameters

Year	Quality Standards	Outlets
2017	3000 MPN/100 ml	170 MPN/100 ml
2019	3000 MPN/100 ml	>16000 MPN/100 ml
2021	3000 MPN/100ml	>16000 MPN/100ml

Source: PT. Kehati Lab Indonesia & BTKL Class II Ambon

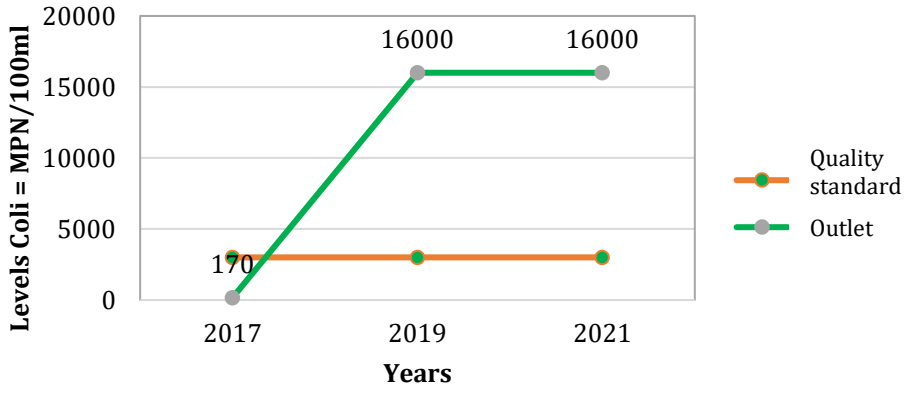

Figure 6. Comparative graph of examination results for Coli group germs

In the table and graph above, it can be seen that the value of coli group germs in 2017 met the quality standards, while in 2019 and 2021 the test results did not meet the standards. Coli group germ levels that do not meet standards can be influenced by the process in the chlorination tank which functions to disinfect waste water before it is discharged into water bodies or rivers.

3. Evaluation of Waste Water Treatment Plants

From the results of laboratory tests, it can be seen that the WWTP at Sele Be Solu Regional Hospital has experienced a decrease in the efficiency of reducing existing waste levels. It can be influenced by the lack of maintenance at the existing IPAL and the absence of Standard Operating Procedures (SOP). Based on the results of the analysis of the existing IPAL building, it can be seen that the Sele Be Solu Regional Hospital IPAL requires a redesign for the chlorination tank unit due to the residence time in the tank. .

Table 14. Comparison of Chlorination Tank Dimensions

Dimensions	Which are available	Redesign
Long	1 m	1 m
Wide	0.7m	1 m
Depth	0.5m	2 m

Source: Analysis Results, 2020

The chlorination tank functions to kill bacteria that are still dissolved in the waste water from the indicator tank (Mulyati *et al*., 2022). From the calculation results, the dimensions of the chlorination tank are as shown in table 21 with the length and width for the chlorination tank being 1 meter and a depth of 2 meters, with the chlorine required per day being around 1.4 kg/day.

The floor plan for the redesigned chlorination tank can be seen in Appendix 1. The plan uses an unreinforced concrete floor with walls made of brick masonry. The selection of concrete floors and walls is based on the Inspection Tank criteria contained in the Regulation of the Minister of Public Works and Public Housing of the Republic Number 04 of 2017 concerning the Implementation of domestic wastewater systems.

CONCLUSION

The conclusion from the results of this study is from the results of calculating the quantity of waste water produced at Sele Be Solu Regional Hospital, the maximum discharge produced by Sele Be Solu Regional Hospital is 4343m3/month. With the actual pollution load for BOD parameters of 26.36 kg/month, COD of 157.98 kg/month and TSS of 38.343 kg/month, all three are greater than the maximum allowable pollution load, namely for BOD is 12,708 kg/month, COD of 105.9 kg/month and TSS of 211.8 kg/month.

The quality of waste water processed by the Sele Be Solu Regional Hospital WWTP in 2017 has been tested by PT. Kehati Lab Indonesia shows that all parameters meet the quality standard requirements of the Minister of Environment Regulation Number P. 68 of

2016. Meanwhile, the quality of processed wastewater in 2019 and 2021 shows that the parameters for Coli Group Germs exceed the permitted quality standards, for other parameters it is still meet quality standards.

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