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Planning Study of Wastewater Treatment Plant Communal Settlement Perumnas III Waena Yabansai Village Heram District Jayapura City

Alberth Einstein Stevann Abrauw [1*], Alfred Benjamin Alfons[1]

[1] Department of Environmental Engineering, Faculty of Civil Engineering and Planning, Universitas Science and Technology Jayapura University, Indonesia.

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Corresponding Author:
I Made Alberth Einstein Stevann Abrauw
albertabrauw@gmail.com

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Abstract: The effect of population growth in the residential area of Perumnas III Waena which is lack of planning has an impact on groundwater pollution caused by domestic waste water which affects the quality of dug well water. Household domestic waste water that comes from the combination of cleaning activities, namely waste from kitchen, bathroom, toilet, and laundry with the composition of liquid waste containing organic materials and mineral compounds from food scraps, urine and soap. The objective of this research is to make plans for Waste Water Treatment (IPAL) Communal Plants at Perumnas III Waena which can serve waste water treatment in these settlements. The data analysis method used is the calculation of the population, analysis of water discharge, determination of water discharge and technical planning of Waste Water Treatment (IPAL) Communal Plants. The results show that the discharge of the entire settlement is 0,04780 m3 / second, the distribution planning system in the residential area III Waena is designed with a Small Bore Sawer system equipped with an inceptor tank at the end of the house channel, a communal wastewater treatment plant (IPAL) with an Off-Site system with Aerobic Anaeorob Reactor Biofilter technology.

Keywords: Discharge; Domestic waste water; Settlement; Water quality

Introduction

Sanitation is part of the basic human needs that must be met (Afandi et al., 2013; Alam & Mondal, 2019; Tortajada, 2020). The problem of sanitation, especially urban sanitation, is a crucial issue and always attracts the attention of many parties today, because the problem is complex and plays a major role in efforts to improve the degree of life and health of the community, especially at the lower levels of society related to handling household wastewater from bathing, washing, and fecal waste from latrines/Water Closet (WC) (Wulandari, 2015). Environmental health of settlements related to waste water is one of the fields of study that attracts attention both globally and nationally (Freeman et al., 2020; Tian et al., 2021; Ulya & Marsono, 2014). Wastewater if not managed properly will be very detrimental and is the biggest contributor to environmental pollution. Wastewater produced by the community, especially those containing human excreta, can carry very dangerous pathogens (Fouz et al., 2020; Manimekalai et al., 2023).

The influence of population growth in an unplanned residential area has an impact on groundwater pollution caused by domestic wastewater which affects the quality of dug well water (Boateng et al., 2019; Mayangsari et al., 2016). In line with this, Rakhmananda et al. (2016) said that high population growth can have a serious impact on the carrying capacity of the environment because the increase in population is directly proportional to the amount of wastewater produced, so that if it is not managed properly, it will have an impact on environmental pollution.

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Domestic wastewater is human waste water that comes from housing, commercial areas, institutions and similar facilities (Al Kholif et al., 2018; Hajj-Mohamad et al., 2019). The characteristics of domestic wastewater produced by settlements based on the results of the study show that the content of Bioligical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Suspended Solid (TSS), and mixed particles exceed the established quality standards (Al Kholif et al., 2018).

Household domestic wastewater is waste water that comes from combined cleaning activities (Manikandan et al., 2022; Sikosana et al., 2019), namely kitchen waste, bathrooms, toilets, laundry with an average liquid waste composition containing organic matter and mineral compounds derived from food waste, urine and soap, with a general composition in the form of TSS 25 - 183 mg / l, COD 100 - 700 mg / l, BOD 47 - 466 mg/ l, and Total Coliform 56 - 8.03x107 CFU/100 ml (Prameswari & Purnomo, 2014).

In an effort to reduce environmental pollution of settlements due to domestic wastewater and also become a national program, the National Medium-Term Development Plan (RPJMN) 2015 - 2019 mandates that Indonesia can achieve 100 percent access to proper sanitation by 2019 through universal access targets including domestic wastewater treatment facilities, which include the construction of community-based IPAL Komunal (On Site) (Susanthi et al., 2018).

Perumnas III Waena Settlement, Yabansai Village, Heram District, Jayapura City, Papua Province, which is the research location, is a residential area directly adjacent to Campus II of Cenderawasih University Papua. The impact of the relocation of Cenderawasih University activities which were originally centered in Abepura District to the Yabansai Waena Village area. So that the concentration of population growth both permanent and temporary is high in this area with the number of people in one house is 5-15 people. With the high population density in Perumnas III Waena settlement, the pollutant load due to domestic liquid waste is very high. Likewise, the use of clean water from PDAM is decreasing with a water delivery time distribution system 3 times a week, so the alternative use of groundwater as raw water is high. Groundwater is water stored in the pore space or rock layer that periodically experiences natural addition through rain and snow which then moves back into the groundwater system into surface water (Gufran & Mawardi, 2019; Yanuar, 2013). The main problems faced by water resources include the quantity of water that is no longer able to meet the needs that continue to increase every day (Qadir et al., 2007).

With the large number of residents, the amount of waste water produced will also be large (Jones et al., 2021; Mateo-Sagasta et al., 2015; Villarín & Merel, 2020), and from the use of groundwater as a substitute raw water source for PDAM in Perumnas III Waena Settlement is certainly very vulnerable to the danger of groundwater pollution. The influence of the development of settlements that are less planned with household waste disposal systems that are not well coordinated results in the emergence of water pollution, so that well water does not meet the standards for consumption into drinking water (Mayangsari et al., 2016).

Based on the problems related to domestic wastewater, it is deemed necessary to treat domestic wastewater and the effluent of processed water can be reused as a closet or yard water in the settlement. Thus this research was conducted with the aim of planning a Communal Wastewater Treatment Plant (WWTP) in the Waena Perumans III Settlement which can serve wastewater treatment in the settlement.

Method

Research This research was conducted in 2020, with the research location at Perumnas III Waena Settlement, Yabansai Village, Heram District, Jayapura City, Papua Province. Data analysis methods used in this study: (a) Population calculation method, (b) Analysis of wastewater discharge, (c) Determination of wastewater discharge. Factor value to get the infiltration factor refers to the Averange Wastewater Flow m^3 / sec graph, (d) Technical Planning of Communal WWTP, and (e) Technical Planning of WWTP.

Result and Discussion

General Condition of the Research Area Geographical Location

The research location of Perumnas III Waena Settlement which administratively consists of 2 RW and 8 RT, namely RW 07 and RW 08 and is part of the Yabansai Village area, Heram District, Jayapura City. The result of mapping the planning area is a digitized map of the existing conditions of the Perumnas III Waena Settlement area. Based on the results of the digitization, the settlement area of Perumnas III Waena is located at coordinates E 140° 38' 43.8" and S 02° 35' 02.7" with an area of 298,992 m^2.

Population

The population of Perumnas III Waena Settlement in 2020 based on data from Yabansai Village 2020, the total population is 2153 people. The male population is the smallest population at 906 people or 46%, while the female population is 1247 people or 54%. Based on population projections for the next 10 years, it is estimated that the number of people living in this area is 2682 people, with an annual population growth rate of 1.46%.

Domestic Wastewater Discharge and Technical Planning of WWTP for Perumnas III Waena Settlement

With the calculations that have been done, the total wastewater discharge at the research location is 0.04780 m^3/second. The Wastewater Distribution System of Perumnas III Waena Settlement is carried out by identifying the Pipe Dimensions, which have been calculated to be 8.13 mm. Sewerage velocity control is 0.857 m/sec. Calculation of Ground Elevation and Pipe Planting has been done with a depth of 1 m. Furthermore, the need for complementary buildings (Manhole Needs) as many as 8 manholes.

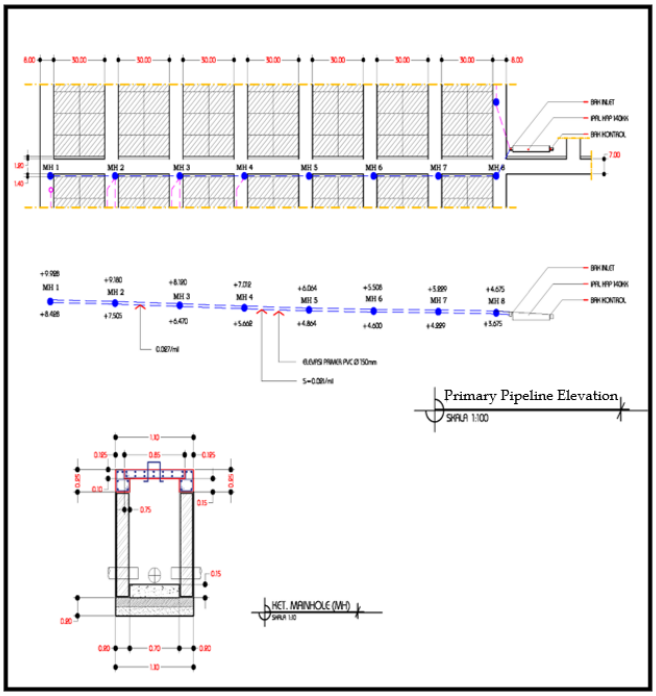

Figure 1. Planning of Wastewater Distribution System of Perumnas III Waena Settlement

Based on the existing conditions of the Waena perumnas III settlement described earlier, the wastewater treatment system that allows it to be applied to this area is an off-site system with an Aerobic Anaeorob Reactor Biofilter. With the planning of the Total capacity of the Wastewater Treatment Plant (WWTP) = The amount of waste generated at peak hours + (30% x The amount of waste generated at peak hours) which is 161.734 m3 / day. Then the planned design capacity: Processing capacity: 161.734 m3 / day, processing capacity per hour 6.739 m3 / hour and processing capacity per minute 112.3 liters / minute.

Then, the design of the planned fat / or oil separator or grase removal tub is a simple gravity type. The tub consists of two chambers equipped with a bar screen at the inlet. Planning Criteria retention time (residence time) = ± 30 minutes with the required volume of 2.339 m^3 / day.

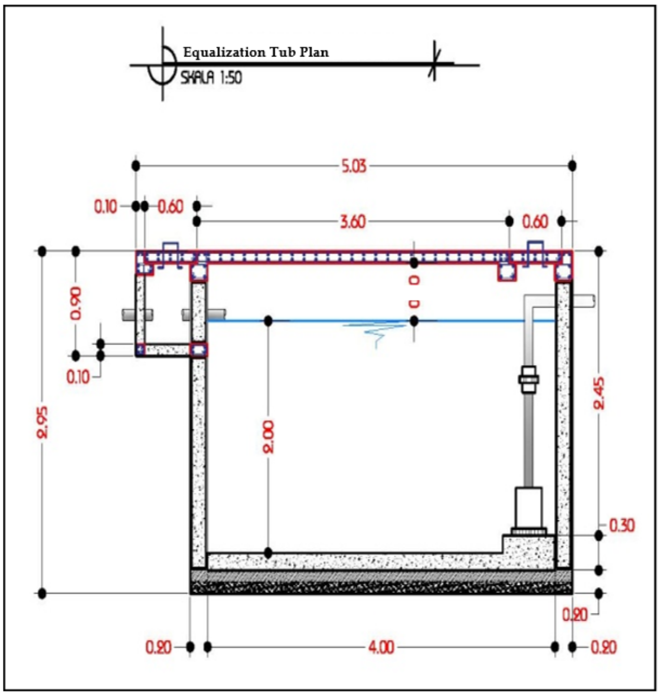

Figure 2. Fat/Oil Separation Tank Building Planning

Equalization basin with theoretical residence time in the Equalization basin is 4 - 8 hours. In this context, a retention time of 5 hours is set so that the volume of the basin required is 23, 46 m^3 / day. For Initial Settling Tubs The planning criteria according to the JWWA standard in Ratnawati & Trihadiningrum (2014) are: The average retention time is 2-5 hours. Determined residence time (retention time) 4 hours Surface loading (surface loading) 20-50 m^3 / m2. day. Then the required tub volume is 18.72 m^3.

Next, Anaerobic Biofilter Reactor. For water treatment with the standard biofilter process, the BOD load per media volume is 0.4-4.7kg BOD/m^3.day. It was determined that the BOD load used was 1.0 kg BOD/m^3.day. The BOD load in the wastewater is 25.268 kg/day, with a residence time of 9 hours.

The Aerobic Biofilter required is 5,053 kg/day.The BOD load per volume of media required is 10.106 m^3. with a media volume of 40% of the rector volume. then the required Aerobic Biofilter reactor volume: 25,265 m^3.

The final sedimentation basin is constructed with the calculations described in this paragraph. The final settling basin is made of masonry and covered with control holes, rectangular basin shape with inlet and outlet pipes by gravity. This basin serves as a final settling basin as needed and incoming runoff water. Planning criteria according to JWWA standards in Ratnawati, (2014) are: Average residence time (retention time) = 2-4 hours, set at 3 hours. Required basin volume = (3 hours/24 hours) X 112.3 m^3 = 14.03 m^3/day.

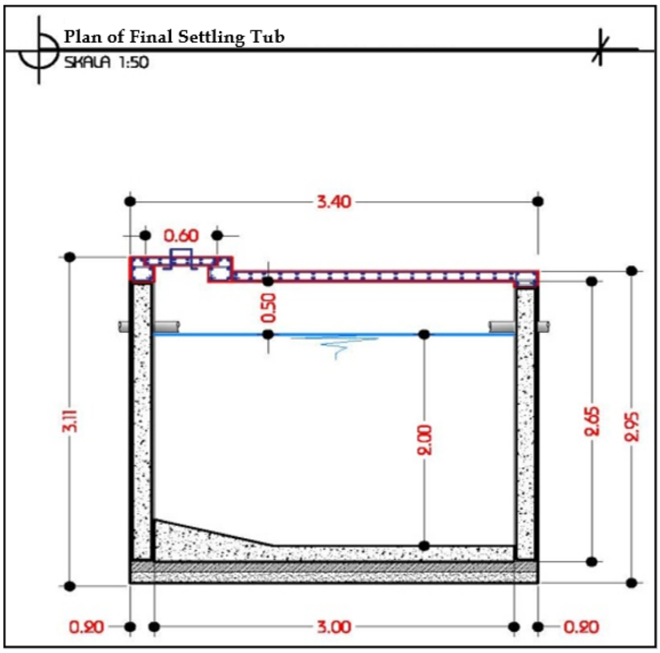

Figure 3. Tub Building Planning Final Settling

The catch basin unit (control basin) is used to accommodate processed water from the WWTP before being discharged into the water body. In this unit there is no processing and the detention time in this pool is 0.01 days.

Conclusion

Wastewater discharge in the residential area of Perumnas III Waena from the domestic sector and also non-domestic and rain infiltration factors contained in the settlement of Perumnas III Waena, then the overall discharge of the settlement is 0.04780 m^3 / sec. The distribution planning system in the settlement of Perumnas III Waena is designed with a Small Bore Sawer system equipped with an interceptor tank at the end of the house channel using PVC pipe Ø 41/2 ", as well as supporting facilities in the form of manholes as wastewater control. Communal wastewater treatment plant (WWTP) with Off-Site system with Aerobic Anaeorob Reactor Biofilter technology, which is equipped with a fat separator, qualization, initial precipitator, anaerobic, aerobic, final precipitator and control tub.

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