

Evaluation of Wastewater Pipeline Network Discharge in the Area of Patimura Street to Prapanca Raya Street, South Jakarta

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Abstract: This study evaluates and plans a wastewater pipeline network to support sustainable urban wastewater management in the Pattimura Street–Prapanca Raya area. The analysis uses a gravity-flow hydraulic approach that considers domestic wastewater discharge, infiltration, peak factors, and pipe filling conditions. The results indicate that the maximum design discharge of 0.7296 m³/s can be accommodated by the planned pipeline network. The calculated pipe diameter was adjusted to a standard size of 250 mm to ensure sufficient capacity and safe operation. Flow velocities meet technical requirements, preventing sedimentation and pipe damage. An 80% pipe filling ratio provides reserve capacity for future flow increases, while the design discharge remains within the capacity of the existing wastewater treatment plant. Therefore, the proposed wastewater pipeline network is optimally designed and suitable as a connection point for future network development

Keywords: wastewater pipeline network, design flow, pipe capacity, wastewater treatment system, hydraulic design

INTRODUCTION

Perumda Paljaya is a regional public enterprise responsible for wastewater management in DKI Jakarta. Currently, centralized sanitation services are limited to Zone 0, with sewer network coverage reaching only 14.02% of the population, indicating significant potential for system expansion. Centralized wastewater pipeline systems provide environmental and technical advantages by directly conveying wastewater to treatment plants, eliminating the need for on-site treatment facilities. To expand service coverage, Perumda Paljaya plans to develop a wastewater pipeline network in the Pattimura Street–Prapanca Raya area (Zone 11), which is proposed to be integrated into Zone 0 due to its proximity. The planned network will connect to the existing 600 mm reinforced concrete sewer on Senopati Street, which currently conveys wastewater to the Krukut Wastewater Treatment Plant with a capacity of 8,000 m³/day. Given the capacity limitations of the existing treatment system, the development of a Detailed Engineering Design (DED) is required to ensure that the proposed network is technically feasible, sustainable, and compatible with the existing wastewater infrastructure.

RESEARCH METHOD

The data analysis method in this study was conducted to process and evaluate secondary data in the form of daily wastewater discharge obtained during the observation period. The analysis was carried out quantitatively to identify flow characteristics and to

determine the planning parameters required for the evaluation of the wastewater management system.

The main CPT data consist of cone resistance (q_c) and sleeve friction (f_s). The correlation between cone resistance and undrained shear strength (C_u) is expressed as:

$$C_u = C / QN$$

where N is the correlation factor (10–30).

Pile bearing capacity is calculated from the contribution of end bearing resistance and skin friction resistance End bearing resistance:

$$Q_b = A_b \times Q_c / f_s 1$$

Skin friction resistance:

$$Q_f = f_s \times 0 / f_s 2$$

Wastewater discharge is calculated based on the number of served population and the average wastewater generation per capita. The discharge in each pipe segment is accumulated from upstream to downstream

$$Q_{pipe} = N \times q_{rt}$$

where:

Q_{pipe} : wastewater discharge in pipe segment (L/s)

N : served population (persons)

q_{rt} : wastewater discharge per capita (L/s/person)

Hydraulic planning of wastewater pipeline networks aims to ensure smooth wastewater conveyance without sedimentation or overflow, while complying with design capacity and applicable technical standards. The planning is based on Indonesian National Standards (SNI) and technical guidelines issued by Perumda Paljaya for urban wastewater pipeline systems. Domestic wastewater quantities are calculated in accordance with SNI 9294:2024, which defines the relationship between wastewater discharge, clean water consumption, and peak flow factors. In addition, SNI 03-7065:2005 and SNI 03-6481-2000 provide design parameters for building drainage systems based on plumbing units and fixtures. These standards serve as the national basis for determining wastewater discharge and pipeline requirements.

RESULT AND DISCUSSION

Soil cone penetration test (CPT) data analysis was conducted to determine soil characteristics and bearing capacity at the wastewater pipeline planning location. CPT data were used to identify cone resistance (q_c) and sleeve friction (f_s), which represent subsurface soil conditions along the pipeline alignment. The results of this analysis provide the basis for determining pipe installation depth, soil reinforcement requirements, and appropriate excavation methods to ensure construction stability and safety.

The soil bearing capacity is calculated using the following equation:

$$qu = \frac{qc + fs}{16} = qu = \frac{2 + 16}{16} = 2 \text{ ton}$$

Table 1. Recapitulation of Soil CPT Data Analysis

Depth (m)	Number of Points	Minimum qu (kg/cm ²)	Maximum qu (kg/cm ²)	Average qu (kg/cm ²)	Soil Classification
0 – 1	7	0.81	1.38	1.13	Soft – Medium
>1 – 3	12	1.13	1.75	1.43	Medium
>3 – 5	12	1.63	2.56	2.02	Medium – Stiff
>5 – 7	8	2.31	2.75	2.52	Stiff
>7 – 10	11	2.81	8.13	3.96	Stiff – Very Stiff

Based on the soil CPT data, the soil bearing capacity (qu) increases with depth. At a depth of 0–1 m, qu values range from 0.81 to 1.38 kg/cm², indicating soft to medium soil conditions. At depths greater than 1–3 m, qu values increase and are predominantly classified as medium soil.

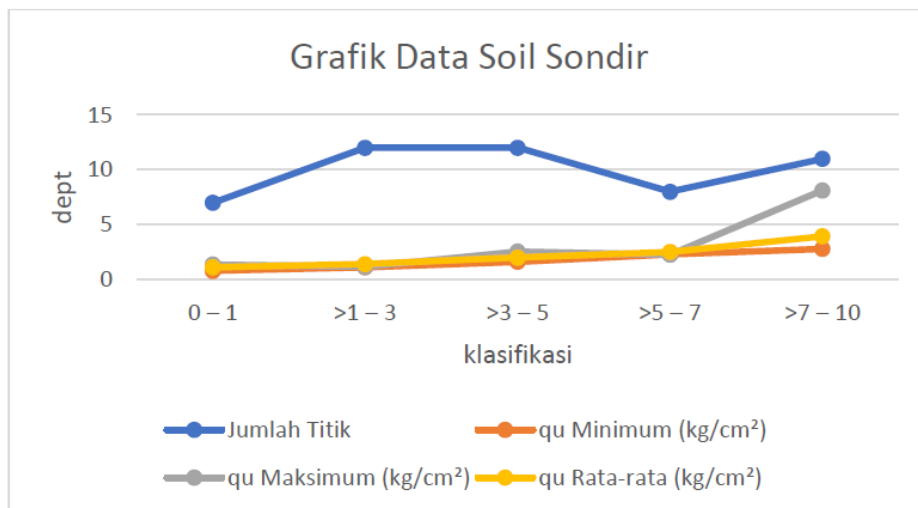


Figure 1. Grafik Soil Sondir

Source: Data Analysis, 2025

Wastewater discharge analysis was conducted to determine the required flow capacity of the pipeline network in the planning area. The calculation is based on the served population, clean water consumption, and domestic wastewater generation factors, while also considering usage fluctuations and peak hour factors to ensure the network can accommodate maximum flow conditions.

$$Q_{average\ Des} = \frac{312770.4}{31} = 10089.37$$

Table 2. Monthly Discharge Recapitulation

No	Month	Total Volume (m ³ /det)	Daily Average (m ³ /day)
1	December	312770.4	10089.37
2	January	298048.1	9614.45
3	February	182029.3	5871.91
4	March	324265.7	10460.18

Source: Data Analysis, 2025

Based on the daily wastewater discharge data from December 2023 to March 2024, the average discharge was 9,077.94 m³/day, equivalent to 105 L/s. Considering a peak factor of 1.5, the peak discharge used for the wastewater pipeline network design is 157.5 L/s. This discharge value serves as the basis for determining the dimensions and capacity of the wastewater pipeline network in the planning area.

Infiltration flow in the pipeline system is assumed to be 20% of the domestic wastewater discharge. This assumption is applied to account for groundwater or rainwater entering the sewer system through pipe joints, cracks, and construction gaps.

$$Q_{inf} = 0,2 \times Q_{dom}$$

$$Q_{tot} = Q_{dom} + Q_{inf}$$

$$312770.4 \times 0,2 = 62554.08$$

$$62554.08 + 312770.4 = 375324.48$$

Tabel 3. Recapitulation Peak Debit

Month	Q dom Total	Q inf (20%)	Q Tot
December	312770.4	62554.08	375324.5
January	298048.1	59609.62	357657.7
february	182029.3	36405.86	218435.2
March	324265.7	64853.14	389118.8

Source: Data Analysis, 2025

The calculation results show that in December, the total domestic wastewater discharge was recorded at 312,770.4, with an infiltration discharge of 62,554.08, resulting in a total system flow of 375,324.5. This indicates that infiltration contributes a significant portion of the total flow and must be carefully considered in the hydraulic design to ensure that the pipeline network has sufficient capacity to accommodate both domestic wastewater and additional inflow.

Pipe diameter calculation is based on the full-flow discharge and pipe slope using a gravity-flow hydraulic approach. Full-flow discharge represents the condition when the pipe is completely filled and is used as the basis for determining pipe dimensions to ensure safe and reliable wastewater conveyance.

The hydraulic pipe diameter is calculated using the following equation:

$$D_{hit} = \left(\frac{Q_{pnh} \times 0.13 \times 4}{0.397 \times \pi \times \sqrt{S}} \right)^{\frac{3}{8}} \times 100$$

$$D_{hit} = \left(\frac{72797,8 \times 0.13 \times 4}{0.397 \times 3,14 \times \sqrt{0,01}} \right)^{\frac{3}{8}} \times 100 = 204,9mm$$

Tabel 4. Pipe Diameter Calculation Parameters

Parameter	Value
Design Discharge (Q _{full})	0.7296 m ³ /s
Pipe Slope (S)	0.002
Calculated Diameter (D _{calc})	205 mm
Market Diameter (D _{market})	250 mm
Normal Flow Diameter (D _{flow})	200 mm

Source: Data Analysis, 2025

The discharge calculation results indicate that the maximum full-flow discharge occurs in March, with a value of 0.7296 m³/s. This discharge is therefore adopted as the design discharge, as it represents the most critical condition that must be accommodated by the wastewater conveyance system. The use of full-flow design discharge aims to ensure that the planned pipes are capable of safely conveying wastewater under maximum loading conditions, such as during peak water usage periods. Consequently, full-flow discharge is used as the primary parameter in determining pipe dimensions. Pipe diameter calculation is performed using a gravity-flow hydraulic approach, which considers the effects of discharge and pipe slope on flow capacity. By substituting the full-flow discharge and a pipe slope of 0.002 into the diameter equation, a pipe diameter is obtained.

CONCLUSION

The planned wastewater pipeline network is considered adequate to function as a connection point for future network development, as it is capable of conveying the calculated full-flow discharge without exceeding capacity and provides additional flow reserve through partial-flow design. The technical planning meets hydraulic criteria, with selected pipe diameters adjusted to standard market sizes that safely convey the design discharge. Flow velocities under both full-flow and normal operating conditions remain within acceptable limits, preventing sedimentation and pipe damage. Furthermore, the proposed pipeline network in the Pattimura Street–Prapanca Raya area is compatible with the capacity of the existing wastewater treatment system, allowing network expansion without the need for short-term treatment capacity upgrades.

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