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Original Article

Analysis of the Construction of Infiltration Wells in Pondok Jati Housing, Sidoarjo to Reduce Surface Flow for Flood Prevention Efforts

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Abstract

Water stored on the surface generally turns into runoff and much faster than groundwater considering the very low flow rate of the latter. Drainage of the Pondok Jati residential area is less able to receive or accommodate rainwater discharge because the development and growth of a city is one of the triggers for increasing the volume of discharge that passes through the residential area. Land use will affect the percentage of water that seeps into the soil with surface flow. Land with dense populations and many buildings, infiltration wells must be made more and larger in volume. Either with individual infiltration wells or with infiltration wells collectively for several houses, the need for infiltration wells from each block to reduce runoff that occurs with a 10-year return period plan. For the specifications of this infiltration well, concrete pipes are used. This infiltration well itself has concrete pipe walls with a diameter of 100 cm (1 meter) with the depth of the infiltration well is 300 cm (3.0 meters) and the number of points needed. The cost of making an infiltration well with a total of 210 infiltration wells in the Pondok Jati Sidoarjo housing complex is Rp. 696.358.600,- .

Keywords: Drainage, Housing, Infiltration Well, Overflow.

1. Introduction

Climate change and rapid urbanisation have led to increased volumes of stormwater runoff in various areas, including the Pondok Jati residential area. Runoff is the process of water movement from higher to lower ground after rainfall, which flows through drainage channels. Although some rainwater infiltrates into the ground, most rainwater flows on the ground surface as faster runoff, risking increasing the volume of water that must be accommodated by the drainage system. However, the drainage channels in the Pondok Jati residential area are less able to accommodate the increasing rainwater discharge due to the rapid development and growth of the city. Land use change, such as the conversion of green land to built-up land, exacerbates this problem by reducing water catchment areas (Pattiruhu et al., 2019). In addition, the quality and quantity of drainage deteriorates as more rubbish blocks the flow of water and causes siltation.

Re-drainage planning is costly and time-consuming. Therefore, one solution that can be applied to overcome flooding due to rainwater runoff is to utilise land use for the construction of infiltration ponds. Infiltration ponds are one of the environmentally friendly drainage systems that can control water flow, both to overcome floods and droughts.

This drainage problem is not new, especially in Pondok Jati Housing. Less than optimal drainage and rapid land use changes have resulted in a decrease in the quality of water flow, disrupting the route of water flow that should lead to the River. In addition, rubbish problems that cause siltation exacerbate this condition, so that the existing drainage system no longer functions optimally.

Poorly managed land use change leads to continuous land degradation and threatens environmental sustainability. It also impacts water resources, with increased surface runoff and decreased groundwater recharge. This decrease in water infiltration capacity has even reached 34.9% due to land conversion (Kimbi et al., 2024). The transformation of land into residential areas exacerbates the potential for flooding and drought in some major cities, such as Karachi, which experiences severe flooding due to natural flows being blocked by urban development.

In the face of these problems, soil and water conservation is an important measure to preserve natural resources. Forest and land rehabilitation (RHL) techniques such as reforestation and terracing can help reduce the negative impacts of land conversion and improve environmental quality (Asnake, 2024). An integrated water resources management (IWRM) approach is also important for balancing development and environmental sustainability, and ensuring that water resources are managed effectively (Kimbi et al., 2024). Thus, the expansion of poorly planned urban development and inadequate land management can lead to further degradation, which requires a holistic approach to environmental planning and governance.

Based on this background, this study aims to analyse the capacity of drainage in Pondok Jati Sidoarjo residential area to handle increased stormwater discharge due to urban development, and to assess the need and efficiency of infiltration ponds as a solution to reduce stormwater runoff in the area.

2. Literature Review

2.1. Flood control

Basically, flood control is a simple thing. Its engineering dimension involves many engineering disciplines including: hydrology, hydraulics, watershed erosion (DAS), river engineering, river morphology & sedimentation, flood control system engineering, city drainage system, other water structures (Firmansyah et al., 2022). In addition, the success of the flood control program also depends on other aspects concerning social, economic, environmental, institutional, institutional, legal and others (Kodoatie, 2007). Meanwhile, according to technical aspects, flood control can be divided into two:

a) Flood Control Structures, for example:
   1. Dam
   2. Retention pond
   3. Check Dam

b) Groundsill dan Drop structure:
   1. Retarding basin
   2. Polder construction Structural Method
   3. Infiltration wells.

2.2. Infiltration Wells

Land use will affect the percentage of water that seeps into the soil with surface flow. Land with dense population and many buildings, infiltration wells must be made more and larger in volume. Either with individual infiltration wells or with collective infiltration wells for several houses (Saputra et al., 2018; Widarmano et al., 2022). Water conservation programs through infiltration wells must be carried out through a socio-economic, community and socio-cultural approach. For example, in order to increase public awareness and knowledge of the importance of environmental conservation, especially the application of infiltration wells, with intensive outreach through methods that are appropriate to the lives of the community (Bahunta & Waspodo, 2019).

2.3. Infiltration Well Planning

Accroding to Ikbal (2020) the requirements for planning infiltration wells are divided into two, the first is the general and technical requirements that must be met. The following are the general requirements:s

a. Rainwater infiltration wells are placed on relatively flat land (having different elevations).
b. Water that enters the infiltration well is unpolluted rainwater
c. Placement of rainwater infiltration wells must consider the safety of surrounding buildings.
d. Must pay attention to local regulations.
e. Matters that do not meet these provisions must be approved by the authorized agency

The technical requirements that must be met are as follows:

a. Depth of groundwater

The minimum groundwater depth is 1.50 m during the rainy season.

b. Soil permeability

The soil structure that can be used must have a soil permeability value of ≥ 2.0 cm/hour, with the following classification:

1. Medium soil permeability (silty loam, 2.0 - 3.6 cm/hour or 0.48 -0.864 m^3/m^2/day);
2. Soil permeability is quite fast (fine sand, 3.6 - 36 cm/hour or 0.864-8.64 m^3/m^2/day);
3. Fast soil permeability (coarse sand, greater than 36 cm/hour or 8.64 m^3/m^2/day).

c. Distance to building

The distance of the rainwater infiltration well placement to the building can be seen in the table below:

Table 1. Minimum Distance of Rainwater Infiltration Wells to Buildings

No	Type of building	Minimum distance from infiltration well (m)
1	Rainwater absorption well/clean water well	3
2	Building Foundation	1
3	Infiltration field/sapticktank infiltration well	5

Source: Author's Processed Data, 2024

2.4. Determination of Infiltration Wells

The procedures for planning rainwater infiltration wells refer to: SNI 03-2453-2002 (Nasional, 2002). The calculation of the volume of flood contribution and the number of wells needed is done using the following equation.:

$$V_{ab} = 0{,}855 \,.\, C_{container} \,.\, A_{container} \,.\, R$$

Annotation:

Vab : the volume of flood contribution that will be accommodated by the infiltration well (m^3)

$C_{container}$: Runoff coefficient from land area (without units)

$A_{container}$: Land area (m^2)
R : Average rainfall height (m^2/day)

2.5. Classification of Infiltration Wells

The use and construction of infiltration wells must be in accordance with SNI 03-2453-2002 as follows:

1. Type I rainwater infiltration wells with soil walls, for silty loamy soil and can be applied to a maximum depth of 1.5 m.
2. Type II rainwater infiltration wells with unplastered brick or red brick walls and holes between the walls, and applied to all types of soil with a maximum depth of 3 m.
3. Type III rainwater infiltration wells with porous or non-porous concrete pipe walls, at the end of the joint a hole gap is provided and can be applied to a maximum depth up to the groundwater level.
4. Type IV rainwater infiltration wells with perforated concrete pipe walls and can be applied to a maximum depth up to the groundwater level.

2.6. Soil Permeability

Soil permeability is the ability of the soil to pass/pass water or air. Soil permeability is influenced by the texture, structure, and porosity of the soil. In determining soil capacity, there is a soil permeability test that can be done theoretically by analyzing the soil itself.

3. Methods

3.1. Flow Chart

This flowchart illustrates the sequence of stages in the research starting with a literature study to understand relevant theories, followed by data collection which includes rainfall data, documentation, channel dimensions, and spatial maps of the area. Next, hydrological analysis is conducted to understand water flow and hydraulic analysis to evaluate flow conditions in the channel. The results of both analyses are then discussed in the results and discussion stage, which ends with conclusions and suggestions that provide recommendations based on the research findings, before finally ending the process with the ‘Finish’ stage.

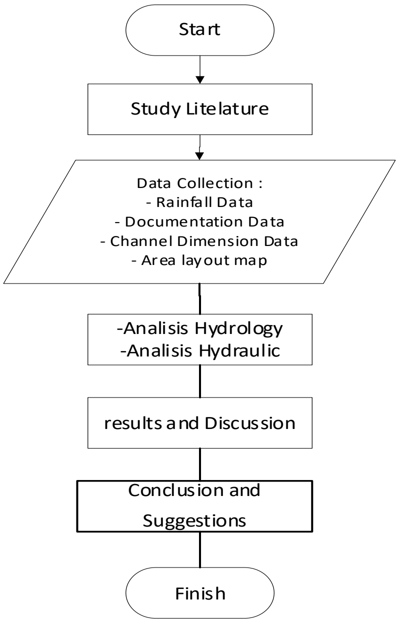

Figure 1. Research Flowchart

3.2. Hydrological Analysis

Hydrological analysis is an initial analysis in handling flood control and to determine the amount of discharge to be discharged and the characteristics of the rain used as an analysis of the implementation of detailed planning. The amount of discharge that will be used as a basic reference for planning, especially in flood control, is the design discharge obtained from the addition of the planned rainfall discharge at a certain return period with the discharge of wastewater from the area. Determining the amount of the planned flood is a matter of hydroeconomic consideration. Knowledge of hydrological analysis has a very important role in predicting the amount of the appropriate planned flood. Hydrological analysis calculations can use discharge data on a river, channel or rainfall which will later be processed into a planned discharge.

3.3. Rainfall Analysis

Rainfall analysis is needed to prepare a flood control plan where the average rainfall data throughout the area will be examined, and not just rainfall at a certain point. This rainfall is called regional rainfall which is expressed in mm units (Sosrodarsono & Takeda, 1980). To obtain high rainfall data in a region, there is a rain gauge that will be analyzed to become the amount of rainfall for the region. In this research calculation, the method used is the Thiessen Polygon method. This method is the closest to the value in calculating the average rainfall in a region. Measurements taken at several stations at the same time are added up and then divided by the number of stations.

$$\bar{P} = \frac{\sum An\ Pn}{\sum An}$$

Annotation:

P	= Average rainfall area
Pn, Pn, ..., Pn	= Rainfall level at the station 1, 2, 3, ..., n
An	= The area affected by the station

3.4. Planned Rainfall Analysis

The calculation of the planned rainfall is processed based on the amount of planned rainfall, the amount of rainfall intensity to calculate the planned flood discharge in order to be calculated. The calculation of planned rainfall using frequency analysis can be done using normal distribution, log normal distribution, Log Pearson type III distribution and Gumbel distribution.

3.5. Frequency Analysis

a. Chi-Square Test

Chi Square Test is intended to determine whether the chosen probability distribution equation can represent the statistical distribution of the analyzed data sample. This goodness-of-fit test can be seen in the following equation:

$$X_{i=1}^{k} = \frac{(O_i - E_i)^2}{E_i}$$

Annotation:
k : number of subgroups
Oi : number of observation values in subgroup i
Ei : number of theoretical values in subgroup i

b. Smirnov-Kolmogorv Test

Smirnov Kolomogorov test often called a non-parametric suitability test, because the test does not use a specific distribution function. The procedure is as follows:

$$D_n = \max |P(x) - P_o(x)|$$

Annotation:

Dn : vertical / maximum distance between observation and theoretical

P(x) : probability of data sample

Po(x) : theoretical probability

3.6. Flow Coefficient

Accroding to Wesli (2008) Runoff coefficient is the ratio between the amount of rainwater flowing or overflowing over the surface of the land (surface runoff) with the amount of rainwater falling from the atmosphere. The value of the runoff coefficient ranges from 0 to 1 and depends on the type of soil, type of vegetation, characteristics of land use and construction on the surface of the land such as asphalt roads, roofs of buildings and others that cause rainwater to not be able to reach the surface of the land directly so that it cannot infiltrate, it will produce a surface runoff of almost 100%.

$$C = \frac{Q}{R}$$

Annotation:

C : Flow coefficient

Q : Amount of runoff

R : Amount of rainfall

3.7. Rainfall Intensity Analysis

Accroding to Wesli (2008), rainfall intensity is the amount of rain expressed in the height of rain or the volume of rain per unit of time. The amount of rain intensity varies, depending on the duration of the rainfall and its frequency. Rain intensity is obtained from statistical and empirical analysis of rain data. Usually, rain intensity is associated with short-term rain durations such as 5 minutes, 30 minutes, and 60 minutes. This short-term rain data is only obtained from automatic time recording devices. If only this daily rain data is available, then the rain intensity can be estimated using the Mononobe formula.

$$I = \frac{R_{24}}{24}\left[\frac{24}{t}\right]^{2/3}$$

Annotation:

I = Rain Intensity (mm/hour)

R_{24} = Maximum daily rainfall for 24 hours (mm)

tc = Concentration time (hours)

3.8. Flood Discharge Plan Analysis

The design flood discharge is the maximum amount of water that is estimated to flow into a place or watershed during a flood. This discharge is needed to determine the capacity and dimensions of buildings in rivers or drainage. The design flood discharge is influenced by the flow coefficient, rainfall distribution coefficient, rainfall intensity, and watershed area that enters the channel (Saves, 2020). To calculate the planned flood discharge, the rational method is used with the following equation.

$$Q = 0{,}278 \times C \times I \times A$$

Annotation:
Q : Design flood discharge
C : Surface flow coefficient
I : Rain intensity during concentration time (mm/hour)
A : Water catchment area (km^2)

3.9. Drainage Capacity Analysis

Drainage channel capacity is the capacity of the channel to drain water discharge. Drainage channel capacity is influenced by several factors, including; Cross-sectional area, Flow velocity, Channel dimensions, Catchment area, Flow coefficient, Land slope. In the flow coefficient using the Manning coefficient (n) with a value that can be seen in the image below:

Table 2. Manning Coefficient

Channel	Description	n Manning
Soil	Straight, new, uniform, sloping and clean	0.016 - 0.033
	Winding, sloping and stacked	0.023 - 0.040
	Unkempt and dirty	0.050 - 0.140
	Rocky, rough and irregular ground	0.035 - 0.045
Pair	Empty stone	0.023 - 0.035
	Split stone masonry	0.017 - 0.030
Concrete	Smooth, good and even joints	0.014 - 0.018
	Less smooth and uneven joints	0.018 - 0.0

3.10. Hydraulic Analysis

Hydraulic analysis is carried out to obtain the channel capacity according to the existing channel conditions. The following is a formula that can be used as follows.

$$Q = V. A$$

Annotation:
Q : Hydraulic discharge (m^3/sec)
A : Channel cross-sectional area (m^2)
V : Flow velocity (m/sec)

3.11. Cost Budget Plan

A cost budget plan or RAB is a plan in the form of a document containing an estimate of the costs planned for financing a project or activity. According to Sari et al. (2021) the Cost Budget Plan (RAB) is one of the main processes in a project because it is the basis for making a payment system offer and an estimation framework that will be issued. RAB is generally prepared by an agency or organization to plan the budget that is issued or auctioned before the project begins and is used as a guide in controlling resources and expenditures appropriately. By considering the value of three aspects, namely; Cost, Quality, and Time.

4. Results and Discussion

4.1. Rainfall Analysis

The method used is the Thiessen Polygon method with the results of calculating the average rainfall station as follows:

Table 3. Average rainfall

No.	Year	*P* (mm)
1	2014	87.00
2	2015	89.19
3	2016	167.58
4	2017	125.06
5	2018	99.24
6	2019	95.81
7	2020	101.55
8	2021	99.56
9	2022	92.66
10	2023	74.74

Source: Author's Processed Data, 2024

4.2. Planned Rainfall Analysis

Based on the comparative calculation of the Normal, Log Normal, Gumbel and Log Person Type III distributions, the following recurrence period values were obtained:

Table 4. Recapitulation of Planned Rain Calculations

Repeat Time	Distributions			
(Tr)(Year)	Normal	Log Normal	Gumbel	Log Person Type III
2	103.24	100.80	99.71	95.91
5	151.10	151.48	130.76	117.85
10	136.53	133.82	151.31	135.51

Source: Author's Processed Data, 2024

4.3. Flow Coefficient

Calculation and use of land use based on C value and area (Ha) can be seen in the table below:

Table 5. Calculation of Flow Coefficient

No	Land use	Information	Mark C	Area (Ha)	$C_{average}$
1	Housing area	Dense Settlement	0,70	30,27	
2	pavement	Aspal	0,70	2,08	
3	pavement	Paving	0,75	5,12	0,69
4	Parks	Public Facilities / Parks	0,20	0,39	
5	Empty land	Empty land	0,10	0,94	
		Total		38,8	

Source: Author's Processed Data, 2024

After getting the average value of the catchment area land use, the next step is to calculate the hourly rainfall distribution where the concentration of the duration of rain in Indonesia is 6 hours, so it is known that t = 6 hours.

4.4. Rainfall Intensity Analysis

The following are the results of the analysis of rainfall intensity using the Mononobe formula:

Table 6. Rainfall Intensity Analysis for 2, 5, 10 Year Periods

Return Period T (Year)	R24 (mm/hours)	T (Hours)	I (mm/ Hours)
2 Years	95,91	6	10,70
5 Years	117,85	6	12,37
10 Years	135,51	6	14,23

Source: Author's Processed Data, 2024

4.5. Flood Discharge Plan Analysis

To calculate the planned flood discharge, the rational method is used. The following are the results of the calculation:

- $Q2 = 0{,}278 * 0{,}69 * 10{,}70 * 0{,}388$
  $= 0{,}79\ m^3/s$
- $Q5 = 0{,}278 * 0{,}69 * 12{,}37 * 0{,}388$
  $= 0{,}92\ m^3/s$
- $Q10 = 0{,}278 * 0{,}69 * 14{,}23 * 0{,}388$
  $= 1{,}06\ m^3/s$

4.6. Drainage Capacity Analysis

Based on these calculations, the values of Qhydrology and Qhydraulic Existing are obtained. So that the evaluation calculation can be done by comparing the larger discharge, from Q hydraulics or Q existing.

Table 7. Channel Capacity Evaluation Results

Channel Code	Q Hydraulics	Q Hydrology 10Yr	Delta Q	Informations
	m^3	m^3	m^3	
BV	0.626	1.06	-0.434	Not Accommodating
BU	0.599	1.06	-0.461	Not Accommodating
BT	0.599	1.06	-0.461	Not Accommodating
BS	0.599	1.06	-0.461	Not Accommodating
BR	0.599	1.06	-0.461	Not Accommodating
BQ	0.592	1.06	-0.468	Not Accommodating
BK	0.607	1.06	-0.453	Not Accommodating
BJ	0.601	1.06	-0.459	Not Accommodating
BH	0.601	1.06	-0.459	Not Accommodating
BG	0.594	1.06	-0.466	Not Accommodating
BI	0.580	1.06	-0.480	Not Accommodating
AV	0.555	1.06	-0.505	Not Accommodating
AU	0.571	1.06	-0.489	Not Accommodating
AT	0.547	1.06	-0.513	Not Accommodating
AS	0.539	1.06	-0.521	Not Accommodating
AQ	0.519	1.06	-0.541	Not Accommodating
AP	0.527	1.06	-0.533	Not Accommodating
AO	0.520	1.06	-0.540	Not Accommodating
AN	0.511	1.06	-0.549	Not Accommodating
AM	0.507	1.06	-0.553	Not Accommodating
AR	0.483	1.06	-0.577	Not Accommodating
BF	0.766	1.06	-0.294	Not Accommodating
AL	0.649	1.06	-0.411	Not Accommodating

Channel Code	Q Hydraulics	Q Hydrology 10Yr	Delta Q	Informations
	m3	m3	m3	
AK	0.598	1.06	-0.462	Not Accommodating
H	0.307	1.06	-0.753	Not Accommodating
I	0.309	1.06	-0.751	Not Accommodating
J	0.312	1.06	-0.748	Not Accommodating
K	0.309	1.06	-0.751	Not Accommodating
L	0.305	1.06	-0.755	Not Accommodating
M	0.307	1.06	-0.753	Not Accommodating
N	0.306	1.06	-0.754	Not Accommodating
O	0.307	1.06	-0.753	Not Accommodating
P	0.308	1.06	-0.752	Not Accommodating
Q	0.194	1.06	-0.866	Not Accommodating
R	0.200	1.06	-0.860	Not Accommodating
S	0.209	1.06	-0.851	Not Accommodating
U	0.226	1.06	-0.834	Not Accommodating
V	0.285	1.06	-0.775	Not Accommodating
W	0.242	1.06	-0.818	Not Accommodating
DA	0.365	1.06	-0.695	Not Accommodating
DB	0.348	1.06	-0.712	Not Accommodating
DC	0.365	1.06	-0.695	Not Accommodating
DD	0.363	1.06	-0.697	Not Accommodating
DE	0.361	1.06	-0.699	Not Accommodating
DF	0.465	1.06	-0.595	Not Accommodating
DK	0.275	1.06	-0.785	Not Accommodating
DI	0.228	1.06	-0.832	Not Accommodating
CA	0.625	1.06	-0.435	Not Accommodating
CB	0.510	1.06	-0.550	Not Accommodating
CC	0.556	1.06	-0.504	Not Accommodating
CD	0.516	1.06	-0.544	Not Accommodating
CE	0.541	1.06	-0.519	Not Accommodating
CF	0.630	1.06	-0.430	Not Accommodating
CG	0.523	1.06	-0.537	Not Accommodating
CH	0.506	1.06	-0.554	Not Accommodating
CI	0.511	1.06	-0.549	Not Accommodating
CJ	0.523	1.06	-0.537	Not Accommodating
CK	0.507	1.06	-0.553	Not Accommodating
CL	0.373	1.06	-0.687	Not Accommodating
CM	0.356	1.06	-0.704	Not Accommodating
CN	0.359	1.06	-0.701	Not Accommodating
CO	0.351	1.06	-0.709	Not Accommodating
CP	0.375	1.06	-0.685	Not Accommodating
CQ	0.366	1.06	-0.694	Not Accommodating
CR	0.361	1.06	-0.699	Not Accommodating
CS	0.354	1.06	-0.706	Not Accommodating
BW	0.512	1.06	-0.548	Not Accommodating
BY	0.515	1.06	-0.545	Not Accommodating
BX	0.529	1.06	-0.531	Not Accommodating
BZ	0.549	1.06	-0.511	Not Accommodating

Source: Author's Processed Data, 2024

4.7. Infiltration Well Planning

For the calculation and determination of the Infiltration Well to be applied is with a Circular Cross Section. According to SNI No. 03-2453-2002, the equation used is:

$$Vab = 0{,}855 \times C_{container} \times A_{container} \times R$$

Annotation:
Value R : water discharge in the channel that is not accommodated.
Value C : runoff coefficient 0.69
Value A : total Cathment area 38800 m^2

After the Vab value of each channel is known, the planned well diameter (well) and well depth (Hplan) are then determined. So the initial assumptions are set as below.:
Dwell = 1,0 m
Hplan = 3,0 m

So, the diameter of the infiltration well is 1 m and the depth of the well is 3 m. Next, calculate the time for the volume of rainwater that is absorbed. With the following equation:

$$te = 0{,}9 \,.\, R0{,}92 / 60$$

Total Well Calculation, the well criteria used is a circle. So the equation used is:
Awelll = wall area + base area
Awelll = (2π x r x H) + (2π x r2)
Awelll = (2 x 3,14 x 0,5 x 2,0) + (2 x 3,14 x 0,52)
Awelll = 6,28 + 1,57
= 7,85 m

The permeability value is obtained from the absorption factor value at the test trial point in the field as follows:

K = 0,0072 cm/ hour = 0,00173 m/days

4.8. Analysis of Infiltration Wells with Q10 years

After getting the value of the time of the volume of rainwater that is absorbed and the Atotal well, the next step is to determine the number of infiltration wells used in each housing block. The following is a table of analysis of the calculation of infiltration wells.

Table 8. Infiltration Well Analysis

Channel Block	Vrsp	Vcitation	Htotal	n
	m^3	m^3	m	unit
BV	0.00000006610	9.88	6.30	2
BU	0.00000006998	10.52	6.70	2
BT	0.00000006998	10.52	6.70	2
BS	0.00000006998	10.52	6.70	2
BR	0.00000006998	10.52	6.70	2
BQ	0.00000007094	10.67	6.80	2
BK	0.00000006879	10.32	6.57	2
BJ	0.00000006959	10.45	6.66	2
BH	0.00000006959	10.45	6.66	2
BG	0.00000007056	10.61	6.76	2
BI	0.00000007257	10.94	6.97	2
AV	0.00000007603	11.51	7.33	2
AU	0.00000007378	11.14	7.09	2
AT	0.00000007708	11.68	7.44	2
AS	0.00000007823	11.87	7.56	3
AQ	0.00000008102	12.33	7.85	3

Channel Block	Vrsp m³	Vcitation m³	Htotal m	n unit
AP	0.00000007986	12.14	7.73	3
AO	0.00000008089	12.31	7.84	3
AN	0.00000008212	12.51	7.97	3
AM	0.00000008270	12.61	8.03	3
AR	0.00000008594	13.15	8.37	3
BF	0.00000004624	6.70	4.27	1
AL	0.00000006298	9.38	5.97	2
AK	0.00000007011	10.54	6.71	2
H	0.00000010984	17.17	10.93	4
I	0.00000010960	17.12	10.91	4
J	0.00000010917	17.05	10.86	4
K	0.00000010951	17.11	10.90	4
L	0.00000011009	17.21	10.96	4
M	0.00000010984	17.17	10.93	4
N	0.00000010993	17.18	10.94	4
O	0.00000010984	17.17	10.93	4
P	0.00000010968	17.14	10.92	4
Q	0.00000012491	19.74	12.57	4
R	0.00000012410	19.60	12.48	4
S	0.00000012292	19.40	12.36	4
T	0.00000012176	19.20	12.23	4
U	0.00000012066	19.01	12.11	4
V	0.00000011276	17.66	11.25	4
W	0.00000011847	18.64	11.87	4
DA	0.00000010204	15.84	10.09	3
DB	0.00000010429	16.22	10.33	3
DC	0.00000010204	15.84	10.09	3
DD	0.00000010231	15.89	10.12	3
DE	0.00000010250	15.92	10.14	3
DF	0.00000008841	13.56	8.64	3
DK	0.00000011409	17.89	11.39	4
DI	0.00000012034	18.96	12.07	4
CA	0.00000006624	9.91	6.31	2
CB	0.00000008223	12.53	7.98	3
CC	0.00000007587	11.48	7.31	2
CD	0.00000008139	12.39	7.89	3
CE	0.00000007795	11.82	7.53	3
CF	0.00000006557	9.80	6.24	2
CG	0.00000008051	12.25	7.80	3
CH	0.00000008282	12.63	8.04	3
CI	0.00000008212	12.51	7.97	3
CJ	0.00000008051	12.25	7.80	3
CK	0.00000008270	12.61	8.03	3
CL	0.00000010098	15.67	9.98	3
CM	0.00000010329	16.06	10.23	3
CN	0.00000010276	15.97	10.17	3
CO	0.00000010388	16.16	10.29	3
CP	0.00000010068	15.62	9.95	3
CQ	0.00000010185	15.81	10.07	3
CR	0.00000010259	15.94	10.15	3
CS	0.00000010354	16.10	10.25	3
BW	0.00000008200	12.49	7.96	3
BY	0.00000008151	12.41	7.91	3
BX	0.00000007960	12.10	7.70	3
BZ	0.00000007693	11.66	7.42	2

Source: Author's Processed Data, 2024

It is known that the need for infiltration wells from each block is to reduce the runoff that occurs with a planned 10-year return period. For the specifications of this infiltration well, concrete pipes are used, this infiltration well itself has concrete pipe walls with a diameter of 100 cm (1 meter) with a depth of 300 cm (3.0 meters) and the number of points of need according to table 8 in each block at Pondok Jati Housing, Sidoarjo.

4.9. Cost Budget Plan

In the construction of infiltration wells, it is planned that the well construction point will be in the garden of one of the houses between each block. The infiltration well drawing can be seen on the attachment page, from the working drawing it is known the volume of work that determines the technical analysis in the budget plan. The cost of making infiltration wells with a total of 210 infiltration wells in the Pondok Jati Sidoarjo housing complex is Rp. 696,358,600, -. This cost includes wages and materials, following the current price.

5. Conclusion

5.1. Conclusion

Based on the results and discussions that have been carried out in the previous chapter, it can be concluded that:

1. The average drainage channel capacity in the Pondok Jati Sidoarjo Housing Area is 0.6624 m^3/sec.
2. The dimensions of the infiltration wells needed to overcome runoff in the Pondok Jati Sidoarjo housing area are 1 m in diameter and 3 m deep with a total of 210 well points in the catchment area.
3. The cost of making infiltration wells in the Pondok Jati Sidoarjo Housing is Rp. 696,358,600, - with a total of 210 well points in the catchment area.

5.2. Suggestion

Based on the research that has been conducted, the author submits suggestions related to infiltration wells, namely:

1. This research can be used as a reference for any party in planning infiltration wells to overcome runoff or flooding.
2. Calculation of runoff in the area will be better if household waste is added. This was not done due to limited data in this study.
3. It is necessary to clean the drainage channels periodically so that water runoff from the residential area can flow properly in the drainage channels.

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