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Study of Adequacy of Drainage Channels in Suburban Residential Areas
(A Case Study of Residential Wirolegi Regency 2 Jember City, of Indonesia)

Noor Salim

Civil Engineering Study Program, Faculty of Engineering,

Muhammadiyah University of Jember

Indonesia

ABSTRACT

Wirolegi Regency 2 Housing is located on the outskirts of the city which is located in Pakusari District, Jember Regency, when there is quite heavy rain, puddles of water often occur, this is caused by environmental damage. The impact of environmental damage can be of various kinds, one of which is due to climate change. In the dry season, it can have an impact on drought and in the rainy season, it can have an impact on flooding. When there is high rainfall, it has the potential to cause flooding in the residential area. Another factor is the condition of the existing drainage channels which are inadequate and affect the occurrence of flooding in the housing area. On the basis of the above, it is necessary to conduct a research entitled "Study on Adequacy of Drainage Channels in Suburban Residential Areas". From the results of the study, it was concluded that the watershed in the residential area of Wirolegi Regency II Jember has a watershed area of 148.75 km2. The value of rainfall intensity at the 5-year return period is 9.02 mm/hour, the design flood discharge value is 12131.7 m3/second, the runoff discharge value is 1473.8 m3/second, the total discharge is 157.280 m3/sec, dirty water discharge is 7.058 m3/second, total capacity discharge is 84.7 m3/second. For the drainage network, there are primary, secondary, and tertiary canals, totaling 3 outlets where all outlets lead to rivers. For channels that are not able to accommodate discharge, namely channels F, G, H, I, J, K, L, and M channels. For channels that require repairs, the dimensions of the channel are changed from 0.8 meters to 1 meter. It is recommended for each housing estate to pay attention to the discharge flowing in each channel by using a calculation formula that is in accordance with the conditions and criteria requirements of the formula and method used.

Keywords: Drainage Channels, Residential Area, Rainwater.

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1. INTRODUCTION

Jember Regency is one of the cities in East Java Province which is experiencing rapid development. Jember Regency is part of the province of East Java, has regional boundaries, among others, in the west by Lumajang Regency, in the north by Bondowoso Regency, in the east by Banyuwangi Regency, and in the south by the Indonesian Ocean. It is one of the most densely populated areas.

Population density is one of the factors influencing housing development. Rainwater that falls to the ground surface will be difficult to seep into the ground because the land which was originally a natural environment that can absorb rainwater has now turned into a residential area. Because the imbalance between road distribution and resistance is getting smaller, the portion of rainwater runoff increases and causes critical flow in existing channels. Critical flow in open channels can occur due to elevated channel bottoms [1,2], reduced channel cross-section [3,4] and reduced channel bottom elevation[5,6].

Wirolegi Regency 2 Housing is located on the outskirts of the city which is located in Pakusari District, Jember Regency, when there is quite heavy rain, puddles of water often occur, this is caused by environmental damage. The impact of environmental damage can be of various kinds, one of which is due to climate change. In the dry season it can have an impact on drought and in the rainy season it can have an impact on flooding. Where the condition when water enters the road structure, road pavement, and subgrade becomes weak, will cause road construction to be more sensitive to traffic flow damage.[7].

When there is high rainfall, it has the potential to cause flooding in the residential area. Another factor is that the condition of the existing drainage channels also greatly influences the occurrence of flooding in the residential area. Drainage Applied area is a drainage science that is applied to specialize in the study of urban areas which are closely related to the socio-cultural environmental conditions that exist in urban areas.[8] In general, drainage canals are defined as a series of water structures that function to reduce and remove excess water from an area or land, so that the land can be used optimally. One of the functions of drainage is to dry the part of the city area that has a low land surface from inundation so that it does not cause negative impacts in the form of damage to city infrastructure and public property. [9] Drainage is also defined as an attempt to control groundwater quality in relation to salinity. [10]. On the other hand, low water velocity in drainage structures encourages sedimentation which results in narrowing and blockage [11].

Therefore, this problem needs to be studied on the housing with comprehensive parameters. On the basis of the above, it is necessary to conduct a research entitled "Study on Adequacy of Drainage Channels in Suburban Residential Areas"

2. METHODOLOGY

2.1 Research Site

The research location is in the Wirolegi Regency II Jember Housing, precisely on Jl. Sritanjung, Kaliwining, Wirolegi Village, Sumbersari District, Jember Regency.

Figure 1 :Research Location

2.2. Research Activity Flowchart

Broadly speaking, the plan for this research activity is as follows:

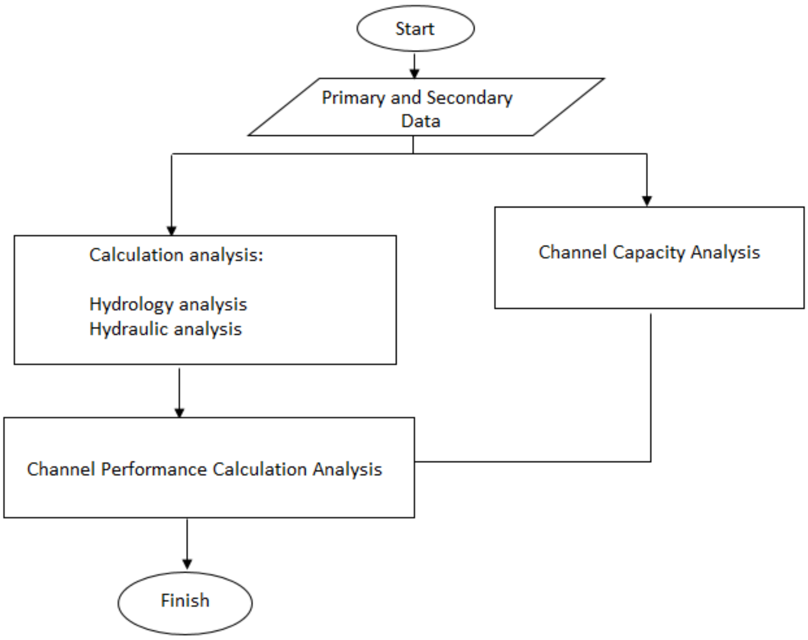

Figure 2. Flowchart of Research Activitie

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2.3 Data Types And Data Sources

The data used are primary and secondary/indirect data.

- Primary data

In the form of data obtained from direct observations and measurements in the field Primary data obtained consists of: in the form of photos and measurements of conditions at the research site

- Secondary Data

Data obtained through written materials, as well as other information that is closely related to the object of research, namely:

a. Rain data
b. Channel dimension data

2.4 Data Analysis and Processing Method

Data processing includes accumulation activities followed by grouping based on the type of data and then carried out by analysis.

a) Hydrological Analysis

This hydrological analysis was conducted to determine the planned flood discharge due to rainfall in the watershed in the research area. Hydrological analysis is not only needed in the planning of various water structures such as dams, flood control buildings, and irrigation buildings, but is also needed for highways, airports, and other buildings. [12]

b) Hydraulic Analysis

The hydraulics analysis is intended to find out how much impact the water has from entering the existing channel to overcome the flood.

3.RESULTS AND DISCUSSION

3.1 Research Data

The data collection is divided into 2, namely: primary data collection and secondary data collection. Primary data collection is field survey data, field mapping, elevation measurements, observations of river flows, existing drainage channels and observations of infiltration wells or groundwater at the Wirolegi Regency II housing location, while secondary data is data sourced from internet searches. Before doing further calculations, it would be nice to know the site plan of the Wirolegi Regency II Jember housing. The following is the site plan for the Wirolegi Regency II Jember housing.

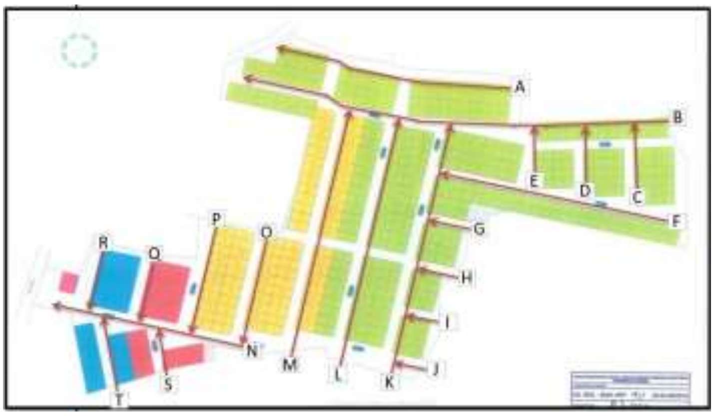

Figure 3. Housing Site Plan

3.2 Determination of Watershed (DAS)

Determination of watersheds (DAS) is done based on the map of the earth. Wirolegi Regency II Jember Housing Watershed, precisely on Jl. Sritanjung, Kaliwining, Ex. Wirolegi, Kec. Sumbersari, Kab. Jember based on the map has an area of 148.75 km2. It can be seen that the area of the Wirolegi rain station is 27.05 km2, the Jember rain station is 27.05 km2, the tempurejo rain station is 48.65 km2, and the Renes rain station is 46 km2. With this area, the coefficient value can be known by using the following formula:

$$\text{Coef. Value} = \frac{\text{Rain Station Area}}{\text{Total Rain Station Area}}$$

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Figure 4. Watershed

The following is the distribution of the coefficients according to the distribution of the rain station area according to its watershed.

Table 1. Rain Station Coefficient

No	Initial	Rainfall Station Name	District	Area (km2)	Coefficient
1	A.	Wirolegi	Sumbersari	27.05	0.18
2	B.	Jember	Sumbersari	27.05	0.18
3	C.	Tempurejo	Tempurejo	48.65	0.33
4	D.	Renes (ajung)	Ajung	46.00	0.31
	Amount			148.75	1.00

From the data above, the coefficient of the Wirolegi rain station is 0.18, the Jember rain station is 0.18, the Tempurejo rain station is 0.33 and the Rense rain station is 0.31.

3.3 Maximum Annual Rainfall

The calculation begins by calculating the monthly rainfall which will then obtain the annual rainfall value. From the results of these calculations, it can be seen that the average value of the highest monthly rainfall occurs at the Jember rain station with a total of 2524.2. After the monthly rainfall is obtained, the next step is to calculate the annual rainfall value. The following is the annual rainfall value for each station.

Table 2. Maximum Annual Rainfall

No	Year	RAINFALL STATION (mm)			
		Wirolegi	**Jember**	**Tempurejo**	**Renes (Ajung)**
		R1	R2	R3	R4
1	2009	924.0	1,250	1,348.0	1,479.00
2	2010	1,620.	2,714	3,265.0	3,257.00
3	2011	1,333.	1,930	2,024.0	2,435.00
4	2012	856.0	1,568	1,756.0	2,093.00
5	2013	1,174.	2,095	2,562.0	2,550.00
6	2014	2,088.	1,947	2,007.0	1,747.00
7	2015	743.0	2,233	1,374.0	1,441.00
8	2016	1,352.	2,909	2,627.0	2,586.00
9	2017	1,579.	2,359	1,830.0	1,688.00
10	2018	1,486.	4,617	1,973.0	1,200.00
Average		1,315.	2,362	2,076.6	2,047.60
		50	40	0	

Source: calculation results

From the results of the calculation of the maximum annual rainfall above, it can be seen that the average value of annual rainfall at each rain station is known. For the Wirolegi rain station it is 1315.5 mm, the Jember rain station is 2362.4 mm, the Tempurejo rain station is 2076.6 mm, and for the Renes rain station it is 2047.6 mm.

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3.4 Rain Data Processing Thiesen Polygon Method

Rain data processing using the Polygon Thiesen method, the data that must be prepared is the coefficient value for each rain station. With the data that has been obtained previously, namely the annual rainfall value for each rain station and the previously calculated coefficient value, it is possible to know the average rainfall value. It can be seen that the maximum annual rainfall value occurred in 2014 which was 170.5 mm.

Table 3. Average Rainfall

No	Year	RAINFALL STATION (mm)				Rainfall Average
		Wirolegi 0.18	Jember 0.18	Tempurejo 0.33	Renes (Ajung) 0.31	
1	2009	89	78.0	67	70.0	76.0
2	2010	126	101.5	77	85.0	97.4
3	2011	72	100.0	100.0	125.0	99.3
4	2012	117	95.0	95	121.0	107.0
5	2013	83	103.0	103.0	105.0	98.5
6	2014	173	196.0	196.0	117.0	170.5
7	2015	67	115.0	63	72.0	79.3
8	2016	206	67.0	90	68.0	107.8
9	2017	103	80.0	67	37.0	71.8
10	2018	83	67.0	171.0	91.0	103.0

Source: calculation results

In determining the rainfall distribution method that can be used to find out what method is suitable for use as the next calculation. The following is a calculation to determine the value of Cs which can later be used to use the method used.

Table 4. Design of Rainfall

No.	Year	Ri	P	(Ri - R)	(Ri -	[illegible]3	[illegible]4
1	2009	76.00	9.09	-25.04	626.88	-	392974.0
2	2010	97.38	18.18	-3.66	13.41	15695.42	3
3	2011	99.25	27.27	-1.79	3.20	-	179.9
4	2012	107.0	36.36	5.96	35.55	49.13	3
5	2013	0	45.45	-2.54	6.44	-5.71	10.2
6	2014	98.50	54.55	69.46	4825.0	211.9	1
7	2015	170.5	63.64	-21.79	4	8	1263.9
		0			[illegible]	-	0
	Rerata	101.03			6891.88	284450.6	24638598.6

STD.DEV = 27.672
Cs =

Source: calculation results

Based on the results of the calculation of the design rainfall value, the Cs value of 1.864 is obtained. Based on the provisions, the suitable method to use is the Log Normal method with the following results.

Table 5. Classification of Data Distribution

No	Distribution Kind	Conditon	Calculation Result	Remark
1	Normal Log	Cs > 0 Ck > 0	Cs = 1	Don’t fulfill
2	Log Person Type III	0 < Cs < 0,9	Cs = 1	Fulfill

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3	Gumbel	Cs ≤ 1,1396 Ck ≤ 5,4002	Cs = 1 Ck = 5,2	Don't fulfill
4	Normal	Cs ≈0 Ck = 0	Cs = 1 Ck = 5,2	Don't fulfill

Table 6. Normal Log Method

No	Year	Xi	Log Xi	Log Xi - Log	(Log Xi - Log X)^2	(Log Xi - Log X)^3	Calculation Result	Remark
1	2009	76.00	1.881	-0.111	0.012	-0.001	Log Q =	
2	2010	97.4	1.988	-0.004	0.000	0.000	1.992	
3	2011	99.3	1.997	0.005	0.000	0.000	S =	
4	2012	107.0	2.029	0.037	0.001	0.000	0.106	Table
5	2013	98.5	1.993	0.001	0.000	0.000	Cs =	Table
6	2014	170.5	2.232	0.240	0.057	0.014	1.080	
7	2015	79.3	1.899	-0.093	0.009	-0.001	G(2) =	Table
8	2016	107.8	2.032	0.040	0.002	0.000	(0.164) G(5)	Table
n =	10	Amount Log X	19.921 1.992	0.000	0.101	0.009		

Source: calculation results

3.5 Run Off Coefficient

The value of the drainage area coefficient of the river flow is needed to carry out further calculations. For this analysis, a flow coefficient table is used which is presented in Table 7. From the table it can be seen that the flow coefficient value is 0.73 this is because the watershed area (Watershed Area) has more rice fields. After the coefficient value has been obtained, it can then calculate the value of rain intensity and others.

Table 7. Flow and River Coefficient

Flow and River Area Condition	C Value
- Steep mountain Area	0,75 - 0,9
- Tertiary mountain Area	0,70 - 0,8
- Wavy ground and forest	0,50 -0,75
- Cultivated land	0,45 - 0,60
- Irigated field	0,70 - 0,80
- River in mountain area	0,75 - 0,85
- Small river in land	0,45 - 0,75
- Big river more than half of their flow area is land	0,50 - 0,75

3.6 Rain Intensity

In this calculation, the data required is tc and the maximum rainfall value. Rainfall intensity is the amount of rain that falls expressed in high rainfall or rainfall volume per unit time. The amount of rain intensity varies, depending on the duration of rainfall and the frequency of occurrence. The following is the value of the intensity of rain with several repetitions.

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Table 8. Rain Intensity With Repeat Period

No	Return Period (Year)	C	I (mm/hour)
1	2	0.73	7.212
2	5	0.73	9.026
3	10	0.73	10.399
4	25	0.73	12.339
5	50	0.73	13.932
6	100	0.73	15.659

Source: calculation results

In the 2-year return period, the rainfall intensity value is 17.212 mm/hour, the 5-year return period is 9.026 mm/hour, the 10-year return period is 10.399 mm/hour, the 25-year return period is 12.3339 mm/hour, and the 10-year return period is 50. yearly period of 13,932 mm/hour, the return period of 100 years is 15,659 mm/hour.

3.7 Design Flood Discharge

The following is the design flood discharge value using the Nakayasu method with several repeat times, namely as follows.

Table 9. Design Flood Discharge

No	Return Period (Year)	C	I (mm/hour)	A (ha)	Qp (m^3/s)
1	2	0.73	7.212	80460.0	9693.5
2	5	0.73	9.026	80460.0	12131.7
3	10	0.73	10.399	80460.0	13977.6
4	25	0.73	12.339	80460.0	16585.5
5	50	0.73	13.932	80460.0	18727.0
6	100	0.73	15.659	80460.0	21047.3

Source: calculation results

From the calculation results above, it can be seen that the design flood discharge value always increases every time it is repeated. For a 10-year return period, the design flood discharge value is 13977.6 m3/s, for a 25-year return period of 16585.5 m3/s, for a 50-year return period of 18727.0 m3/s and for a 100-year return period of 21047. ,3 m3/s.

3.8 Runoff Discharge

Runoff discharge is when the intensity of rain falling in a watershed exceeds the infiltration capacity after the infiltration rate is met, the water will fill the basins on the ground surface. To calculate the runoff discharge there are also several methods but in this study we use the rational method in calculating the runoff discharge, the following is the formula and the results of the calculation of the runoff discharge rational method. The following is the runoff discharge value with several returns.

Table 10. Runoff Flow Calculation

No	Return Period (Year)	C	I (mm/hour)	A (km2)	Qp (m^3/s)
1	2	0.73	7.212	804.6	1177.6
2	5	0.73	9.026	804.6	1473.8
3	10	0.73	10.399	804.6	1698.0
4	25	0.73	12.339	804.6	2014.8
5	50	0.73	13.932	804.6	2274.9
6	100	0.73	15.659	804.6	2556.8

Source: calculation results

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From the calculation table above, it can be seen that the runoff rate at the 2-year return period is 1177.6 m3/s, at the 5-year return period is 1473.8 m3/s, at the 10-year return period it is 1698 m3/s, and at the 25-year return period. annual rate of 2014,8 m3/s, on return 50 years at 2274.9 m3/s, and at the 100-year return period the runoff discharge is 2556.8 m3/s.

3.9 Concentration Time

Concentration time is the time it takes to flow from the end of channel I to the end of channel II. Or the time it takes for rainwater to reach the drain. Concentration time (tc) is the time required by the point of rain that falls furthest on the soil surface in the Catchment Area to the nearest channel (to) and added time to flow to a point in the drainage channel under consideration (td). The following is an example of calculating Tc on channel A1. The maximum Tc value that we got after doing the calculations was 0.733 hours or about 44 minutes

3.10 Drainage Network

After the value of the flood discharge and runoff discharge at each return period has been obtained and which channels are capable and which are not capable of holding water, the next stage is the planning of drainage channels. The following is the drainage channel planning in the Wirolegi Regency II Jember housing after inputting all the data.

Table 11. Existing Drainage Network Data

No	Segment Channel	Criteria	Length (m)	AH (m)	DTA \((km^2)	Coef Run Off (C)	S	Concentration Time	Rain Intensity
1	A-A'	Primery	36.00	1.5	3.1104	0.7	0.042	3.98	9.026
2	B-B'	Primery	38.00	1.5	3.2832	0.75	0.039	4.21	9.026
3	C-C'	Secondary	36.00	1.5	3.1104	0.8	0.042	3.98	9.026
4	D-D'	Secondary	36.00	1.5	3.1104	0.72	0.042	3.98	9.026
5	E-E'	Secondary	36.00	1.5	3.1104	0.7	0.042	3.98	9.026
6	F-F'	Tersier	66.00	1.5	5.7024	0.77	0.023	7.31	9.026
7	G-G'	Tersier	60.00	1.5	5.184	0.72	0.025	6.64	9.026
8	H-H'	Tersier	60.00	1.5	5.184	0.75	0.025	6.64	9.026
9	I-I'	Tersier	60.00	1.5	5.184	0.8	0.025	6.64	9.026
10	J-J'	Tersier	60.00	1.5	5.184	0.72	0.025	6.64	9.026
11	K-K'	Secondary	90.00	1.5	7.776	0.7	0.017	9.97	9.026
12	L-L'	Secondary	90.00	1.5	7.776	0.8	0.017	9.97	9.026
13	M-M'	Secondary	90.00	1.5	7.776	0.8	0.017	9.97	9.026
14	N-N'	Primery	26.00	1.5	2.2464	0.73	0.058	2.88	9.026
15	O-O'	Secondary	24.00	1.5	2.0736	0.73	0.063	2.65	9.026
16	P-P'	Secondary	24.00	1.5	2.0736	0.7	0.063	2.65	9.026
17	Q-Q'	Secondary	19.00	1.5	1.6416	0.7	0.079	2.10	9.026
18	R-R'	Secondary	19.00	1.5	1.6416	0.7	0.079	2.10	9.026
19	S-S'	Secondary	26.00	1.5	2.2464	0.7	0.058	2.88	9.026
20	T-T'	Secondary	30.00	1.5	2.592	0.8	0.050	3.32	9.026

Source: calculation results

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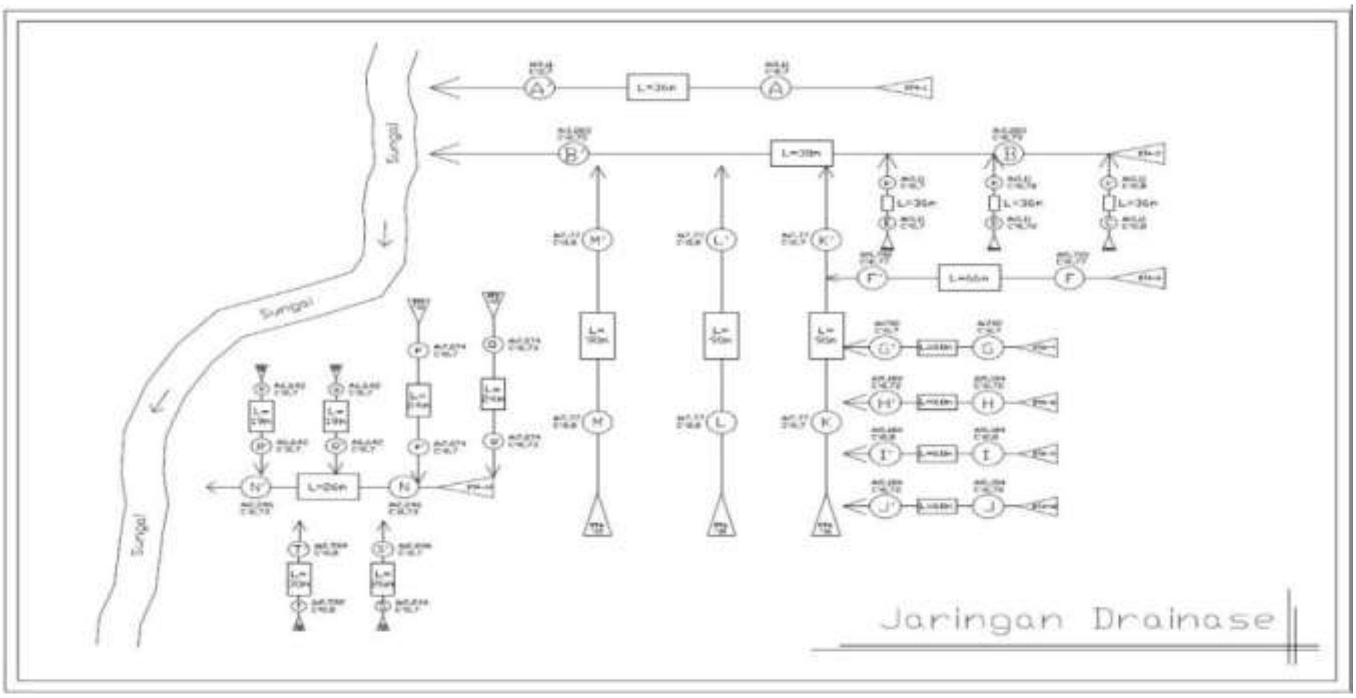

Figure 5. Wirolegi Regency II Jember Residential Drainage Network

From the calculation results above, it can be seen that the Wirolegi Regency II Jember housing consists of primary drainage channels and secondary drainage channels and there are several channels that are included in the category of tertiary drainage. The rainfall intensity value used is a 25-year return period in accordance with PU regulations on residential drainage channel planning, which is 9.026 mm/hour. From the calculation above, it can also be seen the value of the time of concentration (tc) in each channel. The highest concentration time value (tc) occurred in the K, L and M channels, which was in the range of 9.0 minutes. After knowing which channel has the largest Tc value in the channel in the Wirolegi Regency II Jember housing, then the next step is to calculate the value of the discharge discharged in each channel. The discharge calculation is based on the number of houses in each channel.

Table 12. Discharge discharged in each channel.

No	Segment Channel	**Criteria**	**Debit (m^3/s)**	Number of Houses	Wdirty ater discharge (m^3/s)	**Q (m^3/s)**	Discharged debit (m^3/s)
1	A-A'	Primery	4.268	21	0.408	5.463	5.871
2	B-B'	Primery	4.043	37	0.719	6.178	6.898
3	C-C'	Secondary	4.268	12	0.233	6.244	6.477
4	D-D'	Secondary	4.268	10	0.194	5.619	5.814
5	E-E'	Secondary	4.268	8	0.156	5.463	5.619
6	F-F'	Tertiary	2.328	16	0.311	11.017	11.328
7	G-G'	Tertiary	2.561	29	0.564	9.365	9.929
8	H-H'	Tertiary	2.561	8	0.156	9.755	9.911
9	I-I'	Tertiary	2.561	6	0.117	10.406	10.523
10	J-J'	Tertiary	2.561	6	0.117	9.365	9.482
11	K-K'	Secondary	1.707	25	0.486	13.658	14.144
12	L-L'	Secondary	1.707	25	0.486	15.609	16.095
13	M-M'	Secondary	1.707	50	0.972	15.609	16.581
14	N-N'	Primery	5.909	0	0.000	4.115	4.115
15	O-O'	Secondary	6.402	37	0.719	3.798	4.518
16	P-P'	Secondary	6.402	24	0.467	3.642	4.109
17	Q-Q'	Secondary	8.086	14	0.272	2.883	3.156
18	R-R'	Secondary	8.086	14	0.272	2.883	3.156

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19	S-S'	Secondary	5.909	9	0.175	3.946	4.121
20	T-T'	Secondary	5.121	12	0.233	5.203	5.436

Source: calculation results

From the calculation above, it can be seen that the discharge value is discharged in each channel. The primary channel will get the discharge discharge from the secondary and tertiary channels. The largest discharge discharge occurs in channel M, which is a secondary channel, which is 16.581 m3/sec. For the discharge discharged in each channel, the smallest is in channel S, which is 3.156 m3/sec. The following is a site plan for the drainage channel at the Wirolegi Regency II Jember housing.

3.11 Channel Dimensions

With the existing design flood Q, the cross-sectional capacity will remain even though the cross-sectional shape is changed, so it is necessary to pay attention to the stable cross-sectional shape of the channel. In the Wirolegi Regency II Jember housing using a square type channel, namely as follows.

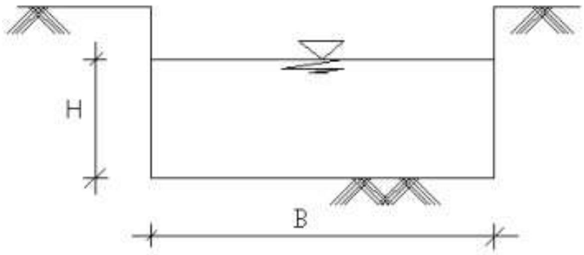

Figure 6.. Channel Square

3.12 Existing Channel Dimensions

From the calculation results presented in Table 13, it can be seen that there are several canals that cannot accommodate water from the housing, therefore they need to be repaired. For channels that are still unable to accommodate water are channels F, G, H, I, J, K, L and M channels. Later on channels that are not able to accommodate water will be enlarged in dimensions until they are able to accommodate water again.

Table 13. Existing Capacity of Drainage Channels

No	ChanelName	B (m)	H (m)	As (m^2)	P	R	n	S	L (m)	V (m/dtk	Qs (m^3/dtk	Qt (m^3/dtk	Result
1	A-A'	0.6	0.6	0.36	2.69	0.13	0.0035	0.1	36.0	23.65	8.51	5.87	sufficient
2	B-B'	0.6	0.6	0.36	2.69	0.13	0.0035	0.1	38.0	23.65	8.51	6.90	sufficient
3	C-C'	0.6	0.6	0.36	2.69	0.13	0.0035	0.1	36.0	23.65	8.51	6.48	sufficient
4	D-D'	0.6	0.6	0.36	2.69	0.13	0.0035	0.1	36.0	23.65	8.51	5.81	sufficient
5	E-E'	0.6	0.6	0.36	2.69	0.13	0.0035	0.1	36.0	23.65	8.51	5.62	sufficient
6	F-F'	0.6	0.6	0.36	2.69	0.13	0.0035	0.1	66.0	23.65	8.51	11.33	raised
7	G-G'	0.6	0.6	0.36	2.69	0.13	0.0035	0.1	60.0	23.65	8.51	9.93	raised
8	H-H'	0.6	0.6	0.36	2.69	0.13	0.0035	0.1	60.0	23.65	8.51	9.91	raised
9	I-I'	0.6	0.6	0.36	2.69	0.13	0.0035	0.1	60.0	23.65	8.51	10.52	raised
10	J-J'	0.6	0.6	0.36	2.69	0.13	0.0035	0.1	60.0	23.65	8.51	9.48	raised
11	K-K'	0.6	0.6	0.36	2.69	0.13	0.0035	0.1	90.0	23.65	8.51	14.14	raised
12	L-L'	0.6	0.6	0.36	2.69	0.13	0.0035	0.1	90.0	23.65	8.51	16.09	raised
13	M-M'	0.6	0.6	0.36	2.69	0.13	0.0035	0.1	90.0	23.65	8.51	16.58	raised
14	N-N'	0.6	0.6	0.36	2.69	0.13	0.0035	0.1	26.0	23.65	8.51	4.11	sufficient
15	O-O'	0.6	0.6	0.36	2.69	0.13	0.0035	0.1	24.0	23.65	8.51	4.52	sufficient
16	P-P'	0.6	0.6	0.36	2.69	0.13	0.0035	0.1	24.0	23.65	8.51	4.11	sufficient
17	Q-Q'	0.6	0.6	0.36	2.69	0.13	0.0035	0.1	19.0	23.65	8.51	3.16	sufficient
18	R-R'	0.6	0.6	0.36	2.69	0.13	0.0035	0.1	19.0	23.65	8.51	3.16	sufficient
19	S-S'	0.6	0.6	0.36	2.69	0.13	0.0035	0.1	26.0	23.65	8.51	4.12	sufficient
20	T-T'	0.6	0.6	0.36	2.69	0.13	0.0035	0.1	30.0	23.65	8.51	5.44	sufficient

Source: calculation results

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3.13 Channel Planning Dimensions

From the calculations from the table presented in Table 14, it can be seen that all drainage channels in the Wirolegi Regency II Jember housing after evaluating the dimensions of the channel can accommodate water and the information is sufficient. For the enlargement of the dimensions of the channel, which was originally a channel height of 0.8 meters, it was changed to 1 meter.

Table 14. Drainage capacity evaluation

No	Chanel lName	B (m)	H (m)	As (m²)	P	R	n	S	L (m)	V (m/s)	Qs (m³/s)	Qt (m³/s)	Result
1	A-A'	0.6	0.6	0.36	2.69	0.13	0.0035	0.1	36.0	23.65	8.51	5.87	sufficient
2	B-B'	0.6	0.6	0.36	2.69	0.13	0.0035	0.1	38.0	23.65	8.51	6.90	sufficient
3	C-C'	0.6	0.6	0.36	2.69	0.13	0.0035	0.1	36.0	23.65	8.51	6.48	sufficient
4	D-D'	0.6	0.6	0.36	2.69	0.13	0.0035	0.1	36.0	23.65	8.51	5.81	sufficient
5	E-E'	0.6	0.6	0.36	2.69	0.13	0.0035	0.1	36.0	23.65	8.51	5.62	sufficient
6	F-F'	0.6	0.8	0.48	2.75	0.17	0.0035	0.1	66.0	28.19	13.53	11.33	sufficient
7	G-G'	0.6	0.8	0.48	2.75	0.17	0.0035	0.1	60.0	28.19	13.53	9.93	sufficient
8	H-H'	0.6	0.8	0.48	2.75	0.17	0.0035	0.1	60.0	28.19	13.53	9.91	sufficient
9	I-I'	0.6	0.8	0.48	2.75	0.17	0.0035	0.1	60.0	28.19	13.53	10.52	sufficient
10	J-J'	0.6	0.8	0.48	2.75	0.17	0.0035	0.1	60.0	28.19	13.53	9.48	sufficient
11	K-K'	0.6	1	0.6	2.84	0.21	0.0035	0.1	90.0	32.08	19.25	14.14	sufficient
12	L-L'	0.6	1	0.6	2.84	0.21	0.0035	0.1	90.0	32.08	19.25	16.09	sufficient
13	M-M'	0.6	1	0.6	2.84	0.21	0.0035	0.1	90.0	32.08	19.25	16.58	sufficient
14	N-N'	0.6	0.6	0.36	2.69	0.13	0.0035	0.1	26.0	23.65	8.51	4.11	sufficient
15	O-O'	0.6	0.6	0.36	2.69	0.13	0.0035	0.1	24.0	23.65	8.51	4.52	sufficient
16	P-P'	0.6	0.6	0.36	2.69	0.13	0.0035	0.1	24.0	23.65	8.51	4.11	sufficient
17	Q-Q'	0.6	0.6	0.36	2.69	0.13	0.0035	0.1	19.0	23.65	8.51	3.16	sufficient
18	R-R'	0.6	0.6	0.36	2.69	0.13	0.0035	0.1	19.0	23.65	8.51	3.16	sufficient
19	S-S'	0.6	0.6	0.36	2.69	0.13	0.0035	0.1	26.0	23.65	8.51	4.12	sufficient
20	T-T'	0.6	0.6	0.36	2.69	0.13	0.0035	0.1	30.0	23.65	8.51	5.44	sufficient

Source: calculation results

3.12 Performance Value

After all calculations have been completed and it is known what evaluation must be done for the Wirolegi Regency II Jember housing, the final stage is an assessment of the Wirolegi Regency II Jember housing regarding the condition of the drainage channel. From the results of the evaluation of the drainage system performance criteria at the Wirolegi Regency II Jember Housing with a 5-year anniversary period. From the table above, it can be concluded that for channels that are not able to accommodate discharge, namely channels F, G, H, I, J, K, L and M channels. For channels that require repair of channel dimensions, the original 0.8 meters was changed to 1 meters.

4. CONCLUSIONS AND SUGGESTIONS

4.1 Conclusion

Based on the results of analysis and calculations, this study can be concluded as follows.

1. There are 4 rainfall stations, namely wirolegi station, jember station, tempurejo station, and renes station. Based on the watershed in the residential area of Wirolegi Regency II Jember, the watershed area is 148.75 km2.
2. During the 5-year return period, the rainfall intensity value is 9.02 mm/hour, the design flood discharge value is 12131.7 m3/s, the runoff discharge value is 1473.8 m3/s, the total discharge discharge is 157.280 m3/s, the discharge value is 157.280 m3/s. dirty water is 7.058 m3/s, the total discharge capacity is 84.7 m3/s.
3. For the drainage network there are primary, secondary and tertiary canals, the water flows to a number of outlets. The number of outlets from the Wirolegi Regency II Jember housing is 3 outlets where all outlets lead to the river.
4. For channels that are not able to accommodate the discharge, namely channels F, G, H, I, J, K, L and M channels. For channels that require repairs, the dimensions of the channel are changed from 0.8 meters to 1 meter

4.2 Suggestion

1. For each housing, it is better to pay attention to the discharge that flows in each channel by using a calculation formula that is in accordance with the conditions and criteria requirements of the formula and method used
2. It is recommended that the Wirolegi Regency II Jember housing re-evaluate its drainage channels. It is advisable to widen the drainage channel so that it can accommodate the water discharge from the housing.

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