

## STUDY OF FLOODING IN THE PANDANWANGI AREA IN WATERSHED KALISARI USING SWMM 5.1 APPLICATION

**Mohammad Zainul Arif<sup>1</sup>, Winda Harsanti<sup>2</sup>**

Mahasiswa Program Diploma IV-Manajemen Rekayasa Konstruksi, Jurusan Teknik Sipil Politeknik Negeri Malang<sup>1</sup>, Dosen Program Diploma IV-Manajemen Rekayasa Konstruksi, Jurusan Teknik Sipil Politeknik Negeri Malang<sup>2</sup>, Dosen Program Diploma IV-Manajemen Rekayasa Konstruksi, Jurusan Teknik Sipil Politeknik Negeri Malang<sup>3</sup>  
Email: Izainul68@gmail.com<sup>1</sup>, winda.harsanti@polinema.ac.id

---

### ABSTRACT

This study focuses on flooding issues in Pandanwangi area, particularly at the LA Sucipto-Gang Makam intersection in Malang City, which is part of the Kalisari watershed. Due to rapid urban development, the percentage of flooding has increased, possibly due to inadequate drainage or drainage systems that are unable to accommodate continuous rainfall. It is necessary to analyze the exact causes of flooding, therefore this study aims to analyze flood discharge using Gumbel Method, existing channel capacity, calculate the budget plan for redesign, and determine the influence of the watershed area on the Kalisari River Basin. The analysis methods used are hydrological and hydraulic analysis for calculations using three rainfall stations: Ciliwung, Singosari, and Jabung. Flood flow analysis and modeling are conducted using the EPA SWMM 5.1 application. Calculations for existing channels and redesign must be controlled to ensure that the calculations are accurate. Results After calculating the 10-year design rainfall using the Gumbel method, the result was 106.752 mm/day. Analysis using SWMM 5.1 software and calculations for existing channels and redesign revealed flooding from point S-R to point O-N. The new dimensions capable of accommodating flood discharge are a height of 1.2 m and a width of 0.4 m. The estimated budget for the redesign at that point is approximately Rp. 189,075,905.55.

**Keywords :** Flood, hydrology, hydraulics, SWMM

---

## 1. INTRODUCTION

Pandanwangi is a subdistrict in Malang City that is developing rapidly, especially in the areas of housing, industry, and infrastructure. However, this development has also caused problems, particularly relate to drainage. Several areas in this region, such as the intersection of LA Sucipto and Gang Makam Perumahan De Cluster Nirwana, often experience flooding because the existing drainage channels are unable to accommodate the increasing amount of rainwater (Anonim, 2023).

Pandanwangi area is located within the Kalisari River Basin. However, due to the continuously increasing population, surface water flow has become higher, and the risk of flooding has increased.

The main issue according to news (Anonim, 2023) in Pandanwangi area is that drainage channels are either too small or poorly maintained. Many channels are blocked by trash and sediment, hindering water flow.

## 2. METHOD

The methods used in this study are:

1. The rainfall data used is the annual rainfall data from the Ciliwung, Singosari, and Jabung stations from 2015 to 2024.
2. Rainfall data consistency testing can be performed using the double mass curve method. This technique involves comparing the rainfall accumulation from the station being analyzed with the average rainfall accumulation from several other nearby stations.

$$M = \frac{n \sum xi. yi - (\sum xi)(\sum yi)}{n \sum xi^2 - (\sum xi)^2}$$

$$F = \frac{M2}{M1}$$

F = Correction Factor  
 n = Amount of Data  
 M1, M2 = Regression coefficient (slope of the regression line)  
 xi = Independent variable values that have specific values.  
 yi = Predicted dependent variable value.

3. Calculate the average rainfall in the area using the Algebraic method. The following is the formula of the Algebraic method (Erna Tri Asmorowati, 2021):

$$P = \frac{P_1 + P_2 + P_3 + \dots + P_n}{n} = \frac{\sum_{i=1}^n P_i}{n}$$

Where:

P = Average rainfall (mm)  
 P<sub>1</sub>, P<sub>2</sub>, P<sub>3</sub>, ..., P<sub>n</sub> = Rainfall height at station i (mm)  
 n = Number of rainfall stations.

4. The distribution selection for calculating the design rainfall is determined based on the skewness coefficient and kurtosis coefficient values. The skewness coefficient value Cs ≤

1.1396 and the kurtosis coefficient value Ck ≤ 5.4002.

$$S = \sqrt{\left[ \frac{\sum_{i=1}^n (Xi - X)^2}{n - 1} \right]}$$

$$Cs = \frac{\frac{n}{(n-1)(n-2)} \sum_{i=1}^n (Xi - X)^3}{S^3}$$

$$Ck = \frac{\frac{n^2}{(n-1)(n-2)(n-3)S^4} \sum_{i=1}^n (Xi - X)^4}{n^2}$$

Ck = Coefficient kurtosis

n = Total data

S = Standard deviation

X = Mean value

Xi = The value of the i-th variant

For rainfall design, use the following Gumbel method for its formulation:

$$X = X_n + (Y_t - Y_n) \frac{S}{S_n}$$

Y<sub>n</sub> = reduced mean, which depends on the number of samples or data n

S = Standard deviation

S<sub>n</sub> = reduced standard deviation which also depends on the number of samples/data n

Y<sub>Tr</sub> = reduced variate

5. Perform distribution suitability tests using the Chi-Square Method and the Smirnov-Kologmogrov Method.
6. Determine the influence of the watershed area on the Kalisari River
7. Calculate Hourly Rainfall Distribution for Modeling in SWMM 5.1 Application. Here is the formulation to calculate hourly rainfall (Wahyudi, 2016):

$$R_t = \frac{R_{24}}{T} \left( \frac{T}{t} \right)^{2/3}$$

R<sub>t</sub> = Average rainfall from the beginning to hour t (mm)

R<sub>24</sub> = Daily rainfall in 24 hours (mm)

t = Rainfall time (hours)

T = Duration of concentrated rainfall (hours)

8. Calculate the capacity of the existing channel. Calculate the capacity of a square channel, starting from the area (A), perimeter (P), radius (R), velocity (V), discharge (Q), and Froude number (Fr). After obtaining the calculation results, a check must be performed for the flow velocity (V), discharge (Q), and Froude number (Fr).
9. Calculate the dimensions of the channel by comparing the cumulative discharge of the channel with the existing channel capacity, and then it can be concluded whether the channel needs to be repaired or not. If the cumulative discharge of the channel exceeds the existing capacity, then the

channel needs to be redesigned. If the cumulative discharge does not exceed the channel capacity, then there is no need to redesign it.

10. Modeling using the SWMM 5.1 application to see which points exceed the channel capacity. The data entered use hourly rainfall calculations and survey dimension data.
11. Cost calculations and budgeting for channel redesign. Cost budgeting is a process that involves calculating the volume of work and the prices of various types of materials and services required in construction. Since these calculations are performed before the project begins, the resulting cost is referred to as an “estimated cost” rather than an “actual cost.” (s, 1984).

12. Flow Chart

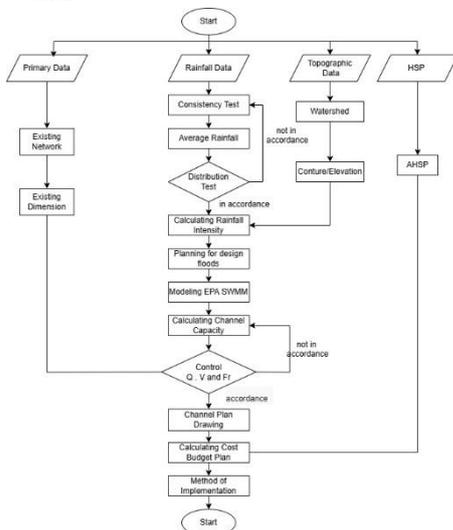


Figure 1 Flow Chart

3. THE RESULT AND DISCUSSION

1. Selection of rainfall data

The rainfall data used are from the nearest rainfall station to the research location, namely the Ciliwung, Singosari, and Jabung stations, for the last 10 years from 2015 to 2024.

Table 1 Annual Rainfall Data

No	Year	Annual Rainfall Data		
		Stasiun Ciliwung	Stasiun Singosari	Stasiun Jabung
1	2015	1505	1653	1440
2	2016	2610	3249	2167
3	2017	2612	2740	1712
4	2018	2164	2182	1418
5	2019	2243	1699	1433
6	2020	657	2,256	2,197
7	2021	3048	2208	3170
8	2022	3421	3252	2,864
9	2023	2438	2502	1563

10	2024	2403	3124	2062
----	------	------	------	------

Source: Data

2. Consistency Test

Consistency test was performed using the double mass curve method, which aims to identify data that are considered inconsistent.

Table 2 Jabung Station Against Ciliwung and Singosari Station before Correction

No	Year	Sta Jabung	CUM	AVG Ciliwung Singosari	CUM
1	2015	1440	1440	1579	1579
2	2016	2167	3607	2930	4509
3	2017	1712	5319	2676	7185
4	2018	1418	6737	2173	9358
5	2019	1433	8170	1971	11329
6	2020	2197	10367	1457	12785
7	2021	3170	13537	2628	15413
8	2022	3421	16958	3337	18750
9	2023	1563	18521	2470	21220
10	2024	2062	20583	2764	23983

Source: Calculation



Figure 2 Double Mass Curve before correction Based on consistency test of the Jabung Station with the Ciliwung and Singosari Stations, an R<sup>2</sup> value of 0.9888 and an F value of 1.3225 were obtained before correction.

Table 3 Jabung Station Against Ciliwung and Singosari Station after Correction

No	Year	Sta Jabung	CUM	AVG CS	CUM
1	2015	<b>1909</b>	1909	1579	1579
2	2016	<b>2873</b>	4782	2930	4509
3	2017	<b>2270</b>	7051	2676	7185
4	2018	<b>1880</b>	8931	2173	9358
5	2019	<b>1900</b>	10831	1971	11329
6	2020	2197	13028	1457	12785
7	2021	3170	16198	2628	15413
8	2022	3421	19619	3337	18750
9	2023	1563	21182	2470	21220
10	2024	2062	23244	2764	23983

Source: Calculation

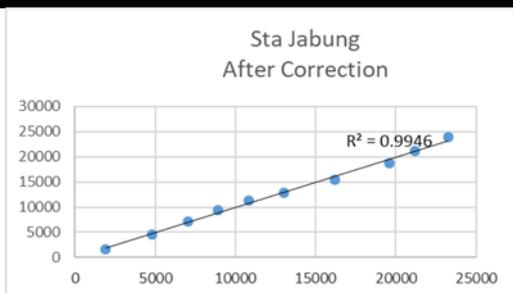


Figure 3 Double Mass Curve after correction  
After the data were corrected, the  $R^2$  value increased to 0.9946, indicating that the line on the graph became straighter and the F value was 1. Based on this, the rainfall data can be declared consistent; therefore, no further corrections are necessary.

Table 4 Ciliwung Station Against Singosari and Jabung Stations

No	Year	Sta Ciliwung	CUM	AVG Singosari Jabung	CUM
1	2015	1505	1505	1547	1547
2	2016	2610	4115	2708	4255
3	2017	2612	6727	2226	6481
4	2018	2164	8891	1800	8281
5	2019	2243	11134	1566	9847
6	2020	657	11791	2227	12073
7	2021	3048	14839	2689	14762
8	2022	3421	18260	3058	17820
9	2023	2438	20698	2033	19853
10	2024	2403	23101	2593	22446

Source: Calculation

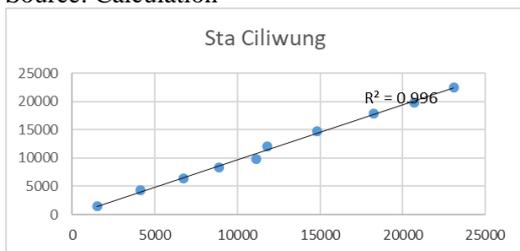


Figure 4 Double Mass Curve of Ciliwung  
For Station Ciliwung, there was no correction because the value of  $R^2$  is appropriate.

Table 5 Singosari Station Against Ciliwung and Jabung Station

No	Year	Sta Singosari	CUM	AVG Ciliwung Jabung	CUM
1	2015	1653	1653	1473	1473
2	2016	3249	4902	2389	3861
3	2017	2740	7642	2162	6023
4	2018	2182	9824	1791	7814
5	2019	1699	11523	1838	9652
6	2020	2256	13779	1427	11079
7	2021	2208	15987	3109	14188
8	2022	3252	19239	3143	17331

No	Year	Sta Singosari	CUM	AVG Ciliwung Jabung	CUM
9	2023	2502	21741	2001	19331
10	2024	3124	24865	2233	21564

Source: Calculation

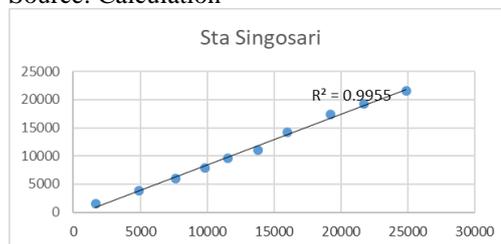


Figure 5 Double Mass Curve Of Singosari  
For Station Ciliwung, there was no correction because the value of  $R^2$  is appropriate.

### 3. Regional Rainfall

Regional Rainfall calculations using Algebraic Method, for the region use maximum rainfall data from 10 years at 3 stations. The result of calculation is shown in table 6.

Table 6 Regional Rainfall

Year	Date	Ciliwung	Singosari	Jabung	AVG	Max
1.32						
2015	3-mei	98.00	82.00	35.71	71.90	88.63
	19-Mar	86.00	86.00	93.90	88.63	
	02-Mar	0.00	45.00	111.10	52.03	
2016	12-Apr	64.00	7.00	26.00	32.26	93.89
	10 okto	48.00	153.00	80.68	93.89	
	11-Apr	0.00	0.00	161.35	53.78	
2017	04-Apr	104.00	97.00	0.00	67.00	88.20
	22-Apr	0.00	100.00	0.00	33.33	
	25-Jan	79.00	56.00	129.61	88.20	
2018	21-Juni	97.00	97.00	13.23	69.08	69.08
	3-Des	0.00	126.00	9.26	45.09	
	19-Jan	59.00	20.00	108.45	62.48	
2019	11-Feb	82.00	51.00	9.26	47.42	64.16
	07-Apr	80.00	90.00	22.48	64.16	
	19-Mar	2.00	1.00	95.23	32.74	
2020	28-Feb	79.00	75.00	56	70.00	70.00
	04-Apr	-	81.00	2.00	41.50	
	13-Des	0.00	0.00	96.00	32.00	
2021	06-Jan	123.00	12.00	17.00	50.67	50.67
	17-Nov	27.00	78.00	32.00	45.67	
	16-Mar	10.00	10.00	111.00	43.67	
2022	15-Mar	115.00	123.00	26.00	88.00	88.00

	15-Mar	115.00	123.00	26.00	88.00	
	01-Apr	50.00	0.00	95.00	48.33	
	09-Feb	102.00	5.00	34.00	47.00	71.00
2023	28-Nov	23.00	127.00	63.00	71.00	
	25-Mar	78.00	46.00	79.00	67.67	
	03-Apr	94.00	2.00	9.00	35.00	98.67
2024	09-Apr	43.00	186.00	67.00	98.67	
	01-Feb	41.00	75.00	96.00	70.67	

Source: Calculation

4. Design Rainfall

The type of distribution is determined by considering the values of the skewness coefficient and the curtosis coefficient.

Table 7 Design Rainfall Gumbel Method

Year	X	P	X rata	x <sup>2</sup>	x <sup>3</sup>	x <sup>4</sup>
2015	98.66	9.09%	10	108	1126	11717
2016	93.89	18.18%	16	245	3842	60175
2017	88.63	27.27%	10	99	992	9896
2018	88.20	36.36%	-9	83	-767	7024
2019	88.00	45.45%	-14	197	-2784	39177
2020	71.00	54.55%	-8	67	-557	4588
2021	70.00	63.64%	-28	759	-20941	577203
2022	69.07	72.73%	10	95	933	9111
2023	64.16	81.82%	-7	52	-378	2732
2024	50.66	90.91%	20	417	8535	174437
Avg	78.23					
Sd	15.37					
Cs	-0.38					
Ck	-0.83					

Source: Calculation

From the calculation results of Cs and Ck, Cs = -0.38 and Ck = -0.83, so the Gumbel method can be chosen because it meets the distribution requirements and provides reliable results for extreme rainfall analysis

Table 8 Calculation R design

Tr (Return Period)	Y	X Design	P Empiris
1.0101	-1.5272011	45.473531	99%
<b>10</b>	<b>2.25036733</b>	<b>106.75215</b>	<b>10%</b>
30	3.38429449	125.08948	3%
50	3.90193866	133.48055	2%
100	4.60014923	144.79863	1%

Source: Calculation

This is calculation for Return Period (Tr) 10 years

$$X = X + (Yt - Yn) \frac{S}{Sn}$$

$$X = 78.23 + (2.250 - 0.4925) \frac{15.37}{0.9496}$$

$$X = 106,752 \text{ mm/day}$$

And for a 10-year return period, the rainfall design obtained is 106.752 mm/hour.

5. Distribution Conformity Test

After performing the Gumbel calculation, the Distribution Conformity Test calculation was performed using the Smirnov-Kolomogorof and Chi-Square methods.

Table 9 Calculate Distribution Conformity Test Smirnov-Kolomogorof

No	Year	X	Pemp	P	Yt	Tr	Pteo	ΔP
1	2015	98.66	9.09%	26.00%	1.75	6.30	15.9%	7%
2	2016	93.89	18.18%	44.00%	1.46	4.82	20.7%	3%
3	2017	88.63	27.27%	56.00%	1.14	3.64	27.5%	0%
4	2018	88.20	36.36%	58.80%	1.11	3.56	28.1%	8%
5	2019	88.00	45.45%	62.00%	1.10	3.52	28.4%	17%
6	2020	71.00	54.55%	90.00%	0.05	1.63	61.5%	7%
7	2021	70.00	63.64%	91.20%	-0.02	1.57	63.8%	0%
8	2022	69.07	72.73%	92.15%	-0.07	1.52	65.9%	7%
9	2023	64.16	81.82%	94.50%	-0.38	1.30	76.7%	5%
10	2023	50.66	90.91%	98.40%	-1.21	1.04	96.5%	6%
Average		78.23					Max	17%
Sd		15.37						

If  $\Delta P \leq Do$  Appropriate

For Do, the amount of data, which is 10, and a confidence level of 5%. equivalent to 0.41 or 41%

Table 10 Calculate Distribution Conformity Test Chi-Square

No	Year	Tr Empiris	X Empiris	Yt Empiris	X Teoritis	x2 hit
1	2015	11.000	98.667	2.351	108.316	0.860
2	2016	5.500	93.892	1.606	96.261	0.058
3	2017	3.667	88.634	1.144	88.783	0.000
4	2018	2.750	88.204	0.794	83.113	0.312
5	2019	2.200	88.000	0.501	78.362	1.185
6	2020	1.833	71.000	0.238	74.104	0.130
7	2021	1.571	70.000	-0.012	70.069	0.000
8	2022	1.375	69.075	-0.262	66.017	0.142
9	2023	1.222	64.161	-0.533	61.619	0.105
10	2024	1.100	50.667	-0.875	56.095	0.525
Jumlah						3.317
Average		3.222				
SD		3.04991347				

Source: Calculation

The degree of freedom is obtained from the Df calculation, which is 7, and the Df value in the table is 14.046.

If the value 14.046 is greater than the value 3.317, then the result is 'suitable'.

6. To determine the watershed area using Google Earth Application and Global Mapper.

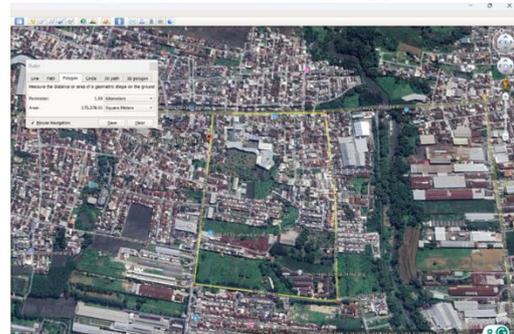


Figure 6 Watershed Location (Google Earth)



Figure 7 Result of watershed after apply in Global Mapper

7. Calculate Hourly Rainfall Distribution

Calculate Hourly Rainfall Distribution is used for Modeling in SWMM 5.1 Application. Here are the results of the calculation:

Table 11 Rainfall Distribution

Hour to-(t)	Rain Distribution	Rainfall Hourly to-	Rasio (%)	Cum (%)
	1 hourly			
1	0.550	R <sub>24</sub> 0.550	R <sub>24</sub> 55.03	55.03
2	0347	R <sub>24</sub> 0.143	R <sub>24</sub> 14.30	69.34
3	0265	R <sub>24</sub> 0.100	R <sub>24</sub> 10.03	79.37
4	0218	R <sub>24</sub> 0.080	R <sub>24</sub> 7.99	87.936
5	0,188	R <sub>24</sub> 0.067	R <sub>24</sub> 6.75	94.10
6	0,167	R <sub>24</sub> 0.059	R <sub>24</sub> 5.90	100

Source: Calculation

Net rainfall = Design rainfall x runoff coefficient

Given runoff coefficient = 0.370

Net rainfall = 106.752 x 0.370 = 39.494 mm

After that, calculate the effective net rainfall

Effective net rainfall = Net rainfall x Cum (%)

$$= 39.494 \times 55.03\%$$

$$= 21.735 \text{ mm/day}$$

Next, calculate up to cum 100%. Here are the results of the calculation:

Table 12 Distribution Rain Evecive

Hour to-(t)	Rasio (%)	Netto Rain 1 Hourly (mm/hour)		
		1,0101	<b>10</b>	30
		Year	<b>Year</b>	Year
1	55.03	9.26	<b>21.73</b>	25.47
2	14.30	2.41	<b>5.65</b>	6.62
3	10.03	1.69	<b>3.96</b>	4.64
4	7.99	1.34	<b>3.15</b>	3.70
5	6.75	1.13	<b>2.66</b>	3.12
6	5.90	0.99	<b>2.33</b>	2.73

Source: Calculation

8. Calculation of the Existing Channel and Control

For the example existing channel point O-N in this point there is flooding because the Q, V, and Fr is not appropriate. Therefore, it is necessary to

redesign with new dimensions at that point so that Q, V, and Fr are appropriate and the flow at that point can flow perfectly. For the example at point O-N:

$$A = b \times h$$

$$= 0.4 \times 1.2 = 0.480 \text{ m}^2$$

$$P = b + 2 \times h$$

$$= 0.4 + 2 \times 1.2 = 2.800 \text{ m}$$

$$R = A/P$$

$$= 0.480/2.800 = 0.1714 \text{ m}$$

$$V = \frac{1}{n} \cdot R^{2/3} \cdot \sqrt{S}$$

$$= \frac{1}{0,018} \cdot 0.1714^{2/3} \cdot \sqrt{0,008} = 1.533 \text{ m/s}$$

$$Q = V \times A$$

$$= 1.533 \times 0.480 = 0.735 \text{ m}^3/\text{s}$$

$$Fr = V/\sqrt{g \cdot h}$$

$$= 1.533 / \sqrt{9,81 \times 1.2} = 0.446$$

So, after calculate we can control V, Q and Fr

$$Q = Q_{cap} < Q$$

$$= 0.380 < 0.735 \text{ is Appropriate}$$

Qcap was obtained from the results of analysis using the SWMM 5.1 application.

If Qcap more than Q is not appropriate.

$$V = V < V_{max}$$

$$= 1.533 < 3 \text{ is Appropriate}$$

If V smaller with Vmax is appropriate.

$$Fr = Fr < Fr_{Control}$$

$$= 0.446 < 1 \text{ is Appropriate}$$

If Fr smaller than FrControl is appropriate.

9. Modeling using SWMM 5.1 Application

For data modeling, only survey dimension data and net effective rainfall data are required. The following are the results of SWMM 5.1 Application modeling:

a. Modeling Existing Channel

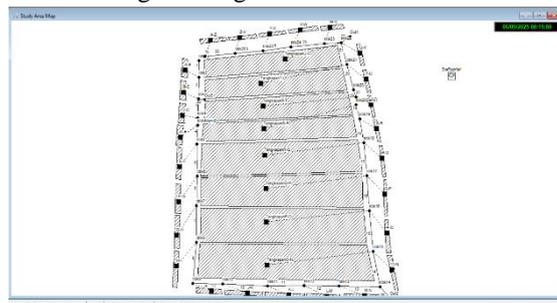


Figure 8 Detail of Point at The Location



Figure 9 Modeling Before Design

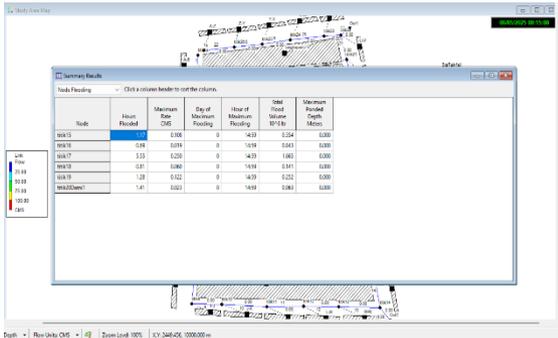


Figure 10 Node Flooding Before Design

From the results of the analysis using the SWMM 5.1 application, it was found that there was flooding at points S-R to O-N.

b. Modeling After Redesign

Based on the result point S-R until O-N there is flooding at that point. The existing dimension for height and width channel is height 0.32 m and width 0.27 m for point S-R until Q-P and P-O until O-N height 0.25 m and width 0.27 m. So, for new dimension is height 1.2 m and width 0.4 m for all channels. After the redesign with new dimension, there is no flooding because the capacity is appropriate

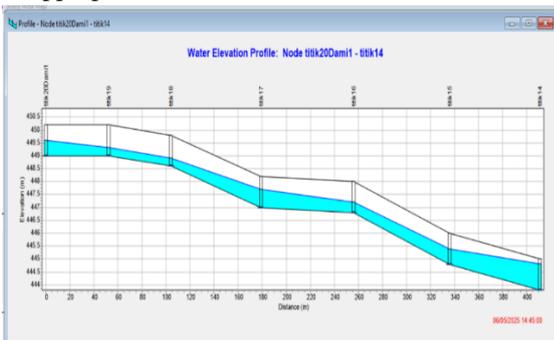


Figure 11 Modeling After Redesign

Link	Type	Maximum Flow C/M2	Day of Maximum Flow	Hour of Maximum Flow	Maximum Velocity m/sec	Max / Full Flow	Max / Full Depth
14	CONDUIT	0.711	0	15:00	3.15	0.47	0.47
15	CONDUIT	0.635	0	15:00	2.90	0.35	0.46
16	CONDUIT	0.523	0	15:00	1.94	0.50	0.56
17	CONDUIT	0.409	0	15:00	1.65	0.24	0.51
18	CONDUIT	0.266	0	15:00	1.82	0.27	0.31
19	CONDUIT	0.024	0	14:59	0.49	0.74	0.32
20	CONDUIT	0.255	0	15:00	3.27	0.44	0.61
21	CONDUIT	0.343	0	15:00	5.93	0.56	0.45
22	CONDUIT	0.017	0	15:00	1.79	0.07	0.18
23	CONDUIT	0.019	0	15:00	1.62	0.07	0.20
24	CONDUIT	0.020	0	15:00	1.60	0.10	0.30
25	CONDUIT	0.022	0	15:01	0.81	0.30	0.37
26	CONDUIT	0.023	0	15:01	1.27	0.26	0.31
27	CONDUIT	0.452	0	15:00	14.78	0.01	0.08
28	CONDUIT	0.725	0	15:01	1.86	0.52	0.50

Figure 12 Link Flow After Redesign

10. Cost Budget Plan

In calculating the cost budget plan, data on the volume of work and unit prices for each task is required. The cost budget plan is obtained by multiplying the volume of work by the unit price. The following is an example of a work breakdown at point O-N, starting with demolition with a volume of 4.50 m<sup>3</sup>, installation of bowplank with a volume of 14.40 m, excavation with a volume of 24.30 m<sup>3</sup>, backfilling with a volume of 2.14 m<sup>3</sup>, masonry with a volume of 27 m<sup>3</sup>, plastering with a volume of 12.08 m<sup>3</sup>, and site cleaning with a volume of 28.80 m<sup>3</sup>. After that, the calculated volume is multiplied by the unit price, for the example volume demolition 4.50 m<sup>3</sup> x Rp. 53,751.00 = Rp. 241,879.52. Here is an example of how to calculate everything:

Table 13 Cost Budget Plan at Point O-N

Description Work	Unit	Volume	Unit Cost (Rp)	Total Cost (Rp)
<b>Point O-N</b>				<b>Rp 35,607,136.15</b>
<b>A Demolition Work</b>				
- Channel Wall	m <sup>3</sup>	4.50	Rp 53,751.00	Rp 241,879.52
<b>B Bowplank Installation</b>				
- Installation of bowplank 3/20 cm at 3 points	m <sup>2</sup>	14.40	Rp 14,181.16	Rp 204,208.77
<b>C Excavation Work</b>				
- Excavation of drainage channel	m <sup>3</sup>	24.30	Rp 134,097.30	Rp 3,258,564.39
<b>D Backfilling Work</b>				
- Sand backfilling	m <sup>3</sup>	2.14	Rp 341,099.10	Rp 729,099.33
<b>E Masonry Work</b>				
- Red brick masonry work	m <sup>3</sup>	27.00	Rp 1,106,268.67	Rp 29,869,254.09
<b>F Plastering</b>				
- Plaster installation work	m <sup>3</sup>	12.08	Rp 82,998.43	Rp 1,002,828.55
<b>G Site Cleaning</b>				
- Excavation site cleaning	m <sup>3</sup>	28.80	Rp 10,461.86	Rp 301,301.51

Source: Calculation

The calculation results in a total budget plan of Rp. 189,075,905.55.

#### 4. CONCLUSION

Based on the calculation results, it can be concluded that:

1. The results of the hydrological analysis indicate that, at the study location, the design rainfall intensity for a 10-year return period is 106.692 mm/day.
2. Analysis using the SWMM 5.1 application shows that the flow discharge in the drainage channel in various segments is as follows: S-R = 0.266 m<sup>3</sup>/s, R-Q = 0.406 m/s, Q-P = 0.523 m<sup>3</sup>/s, P-O = 0.635 m<sup>3</sup>/s, O-N = 0.711 m/s.
3. The results of calculations and analysis using the SWMM 5.1 application show that at points S-R, R-Q, Q-P, P-O, and O-N, it is necessary to change the dimensions of the channel. After calculating the new dimensions to be used at points S-R to O-N, the channel height is 1.2 m, and the channel width is 0.4 m.
4. The result of the Cost Budget Plan for Redesign at point S-R until O-N is Rp. 189,075,905.55.

Program SWMM 5.2. Retrieved from Analisis Pengendalian Genangan dan Banjir Menggunakan Program SWMM 5.2: [https://www.researchgate.net/publication/382611377\\_Analisis\\_Pengendalian\\_Genangan\\_dan\\_Banjir\\_Menggunakan\\_Program\\_SWMM\\_52\\_di\\_Kelurahan\\_Pandanwangi\\_Kota\\_Malang](https://www.researchgate.net/publication/382611377_Analisis_Pengendalian_Genangan_dan_Banjir_Menggunakan_Program_SWMM_52_di_Kelurahan_Pandanwangi_Kota_Malang)

#### REFERENCES

- [1]Ahmad, F. H. (2023, Maret 8). *Jurnal Online Skripsi Manajemen Rekayasa Konstruksi (JOS-MRK)*. Retrieved from Jurnal Online Skripsi Manajemen Rekayasa Konstruksi (JOS-MRK): <https://doi.org/10.33795/josmrk.v4i1.1211>
- Anonim. (2023, Februari 9). *Hujan Deras, Puluhan Rumah di Kota Malang Terendam Banjir*. Retrieved from Kompas Tv: <https://www.kompas.tv/regional/376898/hujan-deras-puluhan-rumah-di-kota-malang-terendam-banjir>
- Erna Tri Asmorowati, A. R. (2021). *Drainase Perkotaan*. Cipedes Tasikmalaya: Perkumpulan Rumah Cemerlang Indonesia Anggota IKAPI JAWA BARAT.
- Rossmann, L. A. (2015, September). *Storm Water Management Model*. Retrieved from Storm Water Management Model : [https://www.epa.gov/sites/default/files/2019-02/documents/epaswmm5\\_1\\_manual\\_master\\_8-2-15.pdf](https://www.epa.gov/sites/default/files/2019-02/documents/epaswmm5_1_manual_master_8-2-15.pdf)
- s, I. (1984). *Analisa anggaran biaya pelaksanaan*. Kota Mataram: Bandung Nova.
- Sa'adah, S. (2023). PERENCANAAN ULANG SISTEM DRAINASE BERWAWASAN LINGKUNGAN PADA PERUMAHAN TAMAN BOROBUDUR KOTA MALANG. *JOS MRK*.
- Wahyudi, R. (2016). *PERENCANAAN DAN PERHITUNGAN ULANG*. Surabaya.
- Zahrok, S. N. (2023, Mei). *Analisis Pengendalian Genangan dan Banjir Menggunakan*