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UTILIZATION OF THE HEC-RAS METHOD IN ANALYZING INUNDATION AT SUNTER JAYA

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ABSTRACT

Sunter Jaya channel is one of the channels located in Tanjung Priok District, North Jakarta City which is geographically located at 6 ° 09'31 "South Latitude and 106 ° 52'08" East Longitude. Sunter Jaya area often occurs inundation when the rainy season arrives when Lake Sunter and Lake Agung excess water capacity. Sediment/sediment factors and lack of awareness of the local community to dispose of garbage in their place. In addition, the growth of some wild plants in the waterways also has the potential to cause disruption to the drainage channel. By conducting an analysis using the Pearson III log distribution method and normal logs and the highest plan of rainfall is taken in the 5 -year period using 28 -year rainfall data obtained from the Kemayoran Rainfall Station which is then calculated by the

Thiessen method, it can be found that there are 4 Rainfall Intensity that occurs in the 5 -year period is 192.16 mm in the normal log distribution method, then the mononobe equation is used to find rainfall intensity per hour. , 3,7,8 cannot accommodate rainwater discharge. Therefore, there is a need for additional dimensions to channels 2 from 0.75m x 0.24m to 0.75m x 1m, channel 3 from 0.57m x 0.15m to 0.57m x 0.70m, channel 7 from 0.60m x 0.25m to 0.60m x 1.2m, and channel 8 from 0.50m x 0.28m to 0.50 x 1.2m. With the addition of these dimensions, the channel will be able to work optimally.

Keywords: channels, sediment/sedimentation, inundation, thiessen method

1. PRELIMINARY

DKI Jakarta as the Capital of the State of Indonesia, is an area that has an area of 7659.02 km². Of this area, 661.52 km² is the land which includes 110 islands, while the other 6997.50 km² is the ocean. As the center of government and economic activity, DKI Jakarta continues to experience development in various fields including infrastructure, which is one of the main concerns of the local government. However, behind the progress of development, DKI Jakarta also faces various problems, one of which is the problem of standing water. The problem of inundation is often complained of by Jakarta residents, and two main problems that often occur are traffic jams and floods. Floods, in particular are not only influenced by natural factors such as high rainfall, but also by factors of human activity. The Sunter Jaya area, located in Tanjung Priok District, North Jakarta City, is one of the areas that experienced a puddle problem. Its densely populated geographical location and inadequate drainage systems cause puddles to become a problem every time the rainy season arrives. The Sunter Jaya channel has an important role in flowing water from Lake Agung to Kali Sunter. However, the capacity of this channel has not been able to accommodate high water discharge, so it often causes arterial paths and residential areas to be flooded. The factors causing inundation in the Sunter Jaya area are as follows: Inadequate drainage systems make the channel unable to drain water to the Sunter River, the difference in channel dimensions causes water buildup at a smaller point, so that water overflows and inundates the roads that are often passed by the population, high sedimentation from mud and plastic waste causes reduced channel capacity, so that water is not accommodated and overflowed, damage to the water gate when it rains due to corrosion in the gear box. Channels, especially on Street H. Amsir, and mouse traps on Jalan Instalkes, cause blockages. Departing from the problems above, the author wants to analyze whether the capacity of the drainage channel in Sunter Jaya is enough to overcome standing water. The author will also provide input to the government to make direct repairs to the location of the channel.

2. THEORETICAL BASIS

Definition of Hidrology

According to Soemarto (1986) that hydrology is a science that explains the state and movement of water in our nature. This situation includes the form of water that involves changes between the liquid, solid and gas in the atmosphere above or below the ground surface. The next opinion according to Joyce Martha W. (1982) Hydrology is the study of the occurrence of the movement and distribution of water on earth, both above and below the surface of the earth, about physical nature, water chemistry and its reaction to the environment and its relationship with life.

Definition of Drainage

Drainage is a water regulation system that is used to reduce excess water or drain rainwater from certain areas such as home yards or agricultural land. This includes the use of trenches, channels, or pipe systems to help drain water to the destination place (David A. Impellitor, 2005).

Drainage is an action or process of draining or removing water from an area or environment to prevent standing water and ensure groundwater balance. This can involve the construction of channels, infiltration wells, or pipe systems to drain water to a safer or more appropriate location (S. P Novak, 2010).

General drainage function The following is the function of drainage according to James N. Luthin, 2004:

1. Dry the city area of the inundation to avoid negative impacts
2. Dreaming the surface water of the nearest recipient water as soon as possible.
3. Controlling excess surface water that can be used for water supply and aquatic life.
4. Responding to surface water to preserve groundwater (water conservation).
5. Protect the facilities and infrastructure that have been built.

Types of drainage

The following types of drainage according to Andy D. Ward, 2012:

1. According to the history there are 2, namely: Natural Drainage and Artificial Drainage
2. According to the location of the building there are 2, namely: surface drainage and underground drainage.

3. According to its function there are 2, namely: Single Purpose and Multi Purpose
4. According to the construction there are 2, namely: Open channels and closed channels

Definition of Flood

According to Corlin R. Thorne (2005) flooding is a condition when certain areas or regions are flooded that exceeded its normal limits. Floods can occur due to high rainfall, river overflow, or other consequences such as drainage systems.

Flooding in a general sense is a high amount of river water flow discharge, or the flow of water flow in the river is relatively greater than the normal conditions due to the rain that falls upstream or in a certain place occurs continuously, so that the water cannot be accommodated by the existing river grooves, the water is abundant and inundated the surrounding area (Regulation of the Director General of RLPS No. 04 yrs 2009).

Causes of Floods

According to P.P. Mujumdar (2013) Causes of floods can vary, including high rainfall, river overflow, high sea tides, inappropriate development, and inadequate drainage systems.

Research sites

The location where this research is located in North Jakarta is along the channel that entered the Sunter River.

Figure 1. Research Locations

Data collection technique

Data collection techniques in this research report are:

1. Literature study

   Used to find reference theory that is relevant to the case or problem found. The literature study consists of: Final Project, Book, Journal.
2. Field survey

   Direct review to the field with the aim of knowing the location of the case study, namely in the Sunter Jaya area.
3. Primary data collection Primary data collection is obtained directly in the field which includes, among others: Knowing the shape and dimensions of drainage channels in the Sunter Jaya area channel.

   Knowing the condition of the Sunter Jaya area channel.
4. Secondary data collection Secondary data collection is obtained from agencies that have links in planning, controlling, and handling floods which include: Determining the area of the catchment area is obtained by digitizing using Google Earth, rainfall data obtained from the Climatology and Geophysical Meteorology Agency or we can called (BMKG) Kemayoran Kusuma 1996-2023, Map of land use maps obtained using Googleearth.

3. RESULTS AND DISCUSSION

Analysis of Rainfall Data

The maximum daily rainfall data is obtained from the Meteorology, Climatology and Geophysics Agency (BMKG). Observation Location of Kemayoran Lintang Rainfall

Station 06 ° 09'36''LS and 106 ° 51 '12''BT. To find rainfall data, average rainfall (X), standard deviation (SD), variation coefficient (CV), slope coefficient (CS), sharpness coefficient must be calculated first.

Table. 1 Rainfall distribution

No	Xi	Xi-X	$(Xi-X)^2$	$(Xi-X)^3$	$(Xi-X)^4$
1	72	-76.65	5875.77	-450399	34524673.24

2	79.50	-69.15	4782.22	-330707	22869594.09
3	82.2	-66.45	4416.08	-293464	19501737.44
4	90.5	-58.15	3381.84	-196666	11436827.38
5	93	-55.65	3097.32	-172377	9593391.26
6	94.1	-54.55	2976.09	-162356	8857124.52
7	94.8	-53.85	2900.21	-156187	8411201.55
8	104.6	-44.05	1940.72	-85496	3766383.08
9	105.2	-43.45	1888.21	-82050	3565347.84
10	119.2	-29.45	867.51	-25551	752578.58
11	122.5	-26.15	684.01	-17889	467868.72
12	124.1	-24.55	602.88	-14803	363461.73
13	124.5	-24.15	583.40	-14091	340349.74
14	125.6	-23.05	531.47	-12252	282457.34
15	129.3	-19.35	374.56	-7249	140295.74
16	147.2	-1.45	2.11	-3	4.46
17	147.9	-0.75	0.57	0	0.32
18	162.2	13.55	183.51	2486	33674.35
19	168.5	19.85	393.88	7817	155142.03
20	179.7	31.05	963.88	29925	929066.06
21	192.7	44.05	1940.09	85454	3763940.94
22	193.4	44.75	2002.24	89593	4008976.51
23	199.7	51.05	2605.74	133014	6789869.85
24	204	55.35	3063.23	169539	9383360.61
25	216.2	67.55	4562.52	308182	20816588.87
26	234.7	86.05	7403.99	637087	54819036.38
27	277.5	128.85	16601.40	2139031	275606553.53
28	277.5	128.85	16601.40	2139031	275606553.53
Σ	4162.30	0.00	91226.83	3719618	776786059.68
X	148.65				

Source : Calculation Results

1. Average rainfall

Based on table 1 the average maximum rain value can be searched with the following formula:

$$\text{Average value } (\bar{X}) = \frac{\sum_{i=1}^{n} Xi}{n} = \frac{4162,30}{28} = 148,65$$

2. Standard Deviation

Based on table 1, the standard deviation can be searched using the following formula:

$$\text{Standar deviasi (Sd)} = \sqrt{\frac{\sum_{i=1}^{n}(Xi-\bar{X})^2}{n-1}} = \sqrt{\frac{91226,83}{28-1}} = 58,13$$

3. Variation Coefficient

Based on the average value and standard deviation that has been sought, the coefficient of variation can be searched using the following formula:

$$\text{Variation Coefficient (Cv)} = \frac{\bar{X}}{Sd} = \frac{148,65}{58,13} = 0,39$$

4. Slope Coefficient

Based on table 1, the slope coefficient can be searched using the following formula:

$$\text{Koefisien (Cs)} = \frac{n \; x \; \sum_{i=1}^{n}(Xi-\bar{X})^3}{(n-1)\; x \;(n-2)\; x \; Sd^3}$$

$$= \frac{28 \text{ x } 3719618{,}41}{(28\text{-}1) \text{ x } (28\text{-}2) \text{ x } 58{,}13^3}$$

$$= 0{,}76$$

5. Sharpess Coefficient

Based on table 1 the sharpness coefficient can be searched using the following formula:

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

$$= \frac{28^2 \text{ x } 776786059{,}68}{(28\text{-}1) \text{ x } (28\text{-}2) \text{ x } (28\text{-}3) \text{ x } 58{,}13^4}$$

$$= 3{,}03$$

Distribution Method

Based on the parameters obtained, then searched for the distribution method that suits the needs. The following table calculation results to determine the distribution method:

Table 2. Results of Calculation of Distribution Methods and Distribution Method Terms

No	Distribusi	Syarat	Hitungan	Ket
1	Gumbel	Cs ≈ 1,4	0.7554	Doesn't Meet
		Ck ≈ 5,4	3.0396	
2	Normal	Cs = 0	0.7554	Doesn't Meet
		Ck = 3	3.0396	
3	Log Normal	Cs ≈ 3 Cv = 0.9696, atau	0.7554	Meet
		Cs/Cv ≈ 3	3.0396	
4	Log Pearson III	Selain dari nilai di atas	-	Doesn't Meet

Source : Departemen Pekerjaan Umum, 2010

Table 3. Results of Calculation of Distribution Methods and Distribution Method Terms

No	Distribusi	Syarat	Hitungan	Ket
1	Gumbel	Cs ≈ 1,4	0.7554	Doesn't Meet
		Ck ≈ 5,4	3.0396	
2	Normal	Cs = 0	0.7554	Doesn't Meet
		Ck = 3	3.0396	
3	Log Normal	Cs = Cv^3+3 Cv = 1,0033	0.7554	Doesn't Meet
		Ck = Cv^8+6Cv^6 +15Cv^4+ 16Cv^2+3= 4,8419	3.0396	
4	Log Pearson III	Selain dari nilai di atas	-	Meet

Source : Departemen Pekerjaan Umum, 2010

Judging from Table 2. then to find rainfall plans the method that can be used is the normal log method and the Pearson III log method.

Rainfall Plan Normal Log Method

After calculating rainfall, standard deviation, slope coefficient and sharpness coefficient. Next, calculate the repeat period according to the methods that meet the requirements.

Table. 4 Rainfall Plan Normal Log Method

No	Xi	Log Xi	(LogXi – Log X)²
1	72	1.8573	0.0806
2	79.50	1.9004	0.0580
3	82.2	1.9149	0.0513
4	90.5	1.9566	0.0341
5	93	1.9685	0.0299
6	94.1	1.9736	0.0281
7	94.8	1.9768	0.0271
8	104.6	2.0195	0.0148
9	105.2	2.0220	0.0142
10	119.2	2.0763	0.0042
11	122.5	2.0881	0.0028
12	124.1	2.0938	0.0023
13	124.5	2.0952	0.0021
14	125.6	2.0990	0.0018
15	129.3	2.1116	0.0009
16	147.2	2.1679	0.0007
17	147.9	2.1700	0.0008
18	162.2	2.2101	0.0047
19	168.5	2.2266	0.0469
20	179.7	2.2545	0.0356
21	192.7	2.2849	0.0251
22	193.4	2.2865	0.0246
23	199.7	2.3004	0.0204
24	204	2.3096	0.0179
25	216.2	2.3349	0.0118
26	234.7	2.3705	0.0525
27	277.5	2.4433	0.0912
28	277.5	2.4433	0.0912
∑	4162.30	59.9559	0.7757
X	148.65	2.1413	

Source: calculation results

1. Calculate The Average Log X Value Log X on average is calculated using the following formula:

   Nilai rata-rata $\overline{X}$ Log x $= \frac{\sum_{i=1}^{n} \log Xi}{n}$

   $= \frac{59,9559}{28}$

   $= 2,1415$

2. Calculating the standard deviation of the normal log
   The standard deviation of log x is calculated using the following formula:

   $(Sd)\ \text{Log x} = \sqrt{\frac{\sum_{i=1}^{n} (\text{Log Xi} - \text{Log } \overline{X})^2}{n-1}}$

   $= \sqrt{\frac{0,7757}{28-1}}$

   $= 0,1695$

The following is looking for the value of the KT frequency factor for normal log distribution using a table that can be seen in Table 5.

Table. 5 Frequency Value (KT) Normal Log Distribution

Periode (T)	Peluang	KT
2	0.500	0.00
5	0.200	0.84
10	0.100	1.28
20	0.050	1.64
50	0.020	2.05
100	0.010	2.33
200	0.005	2.58

Source : Soewarno, 1995

Rainfall Plans Pearson Log Method III

After calculating rainfall, standard deviation, slope coefficient and sharpness coefficient. Next, calculate the repeat period according to the methods that meet the requirements.

Table. 6 rainfall of the Pearson log method

No	Xi	Xi-X	$(Xi-X)^2$	$(Xi-X)^3$	$(Xi-X)^3$
1	72	-76.65	5875.77	-450399	34524673.24
2	79.50	-69.15	4782.22	-330707	22869594.09
3	82.2	-66.45	4416.08	-293464	19501737.44
4	90.5	-58.15	3381.84	-196666	11436827.38
5	93	-55.65	3097.32	-172377	9593391.26
6	94.1	-54.55	2976.09	-162356	8857124.52
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9	105.2	-43.45	1888.21	-82050	3565347.84
10	119.2	-29.45	867.51	-25551	752578.58
11	122.5	-26.15	684.01	-17889	467868.72
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13	124.5	-24.15	583.40	-14091	340349.74
14	125.6	-23.05	531.47	-12252	282457.34
15	129.3	-19.35	374.56	-7249	140295.74
16	147.2	-1.45	2.11	-3	4.46
17	147.9	-0.75	0.57	0	0.32
18	162.2	13.55	183.51	2486	33674.35

19	168.5	19.85	393.88	7817	155142.03
20	179.7	31.05	963.88	29925	929066.06
21	192.7	44.05	1940.09	85454	3763940.94
22	193.4	44.75	2002.24	89593	4008976.51
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24	204	55.35	3063.23	169539	9383360.61
25	216.2	67.55	4562.52	308182	20816588.87
26	234.7	86.05	7403.99	637087	54819036.38
27	277.5	128.85	16601.40	2139031	275606553.53
28	277.5	128.85	16601.40	2139031	275606553.53
∑	4162.30	0.00	91226.83	3719618	776786059.68
X	148.65		5875.77	-450399	34524673.24

1. Calculate the Average Log X Value

Log $\overline{X}$ on average is calculated using the following formula:

$$\text{Average value } \overline{X} \text{ Log x} = \frac{\sum_{i=1}^{n} \log Xi}{n}$$

$$= \frac{59{,}9559}{28}$$

$$= 2{,}1413$$

2. Calculating the standard deviation of the Log Pearson III

The standard deviation of LOG X is calculated using the following formula:

$$\text{(Sd) Log X} = \sqrt{\frac{\sum_{i=1}^{n} (\text{Log Xi} - \text{Log } \overline{X})^2}{n-1}}$$

$$= \sqrt{\frac{0{,}7463}{28-1}}$$

$$= 0{,}1663$$

3. Calculate the value of the tilt coefficient (Cs)

The slope value is calculated using the following formula :

$$\text{(Cs) Log X} = \frac{n \times \sum_{i=1}^{n} (\text{LogXi} - \text{Log } \overline{X})^3}{(n-1) \times (n-2) \times Sd^3}$$

$$= \frac{28 \, x \, 0{,}0183}{(28-1) \, x \, (28-2) \, x \, 0{,}1663^3}$$

$$= 0{,}1588$$

The following is looking for the value of the KT frequency factor for normal log distribution using a table that can be seen in Table 7.

Tabel. 7 Nilai faktor frekuensi (KT) distribusi Log Pearson III

Periode	CS	G
2	0.1588	-0.026
5	0.1588	0.832
10	0.1588	1.297
25	0.1588	1.804
50	0.1588	2.138
100	0.1588	2.442
200	0.1588	2.725

Source: calculation results

Maximum rainfall return period

Table 8 Hydrological design criteria of urban drainage systems

Tipologi Kota	Daerah Tangkapan Air (HA)			
	<10	10-100	101-500	>500
Kota Metropolitan	2Th	2Th-5Th	5Th-10Th	10Th-25Th
Kota Besar	2Th	2Th-5Th	2Th-5Th	5Th-20Th
Kota Sedang	2Th	2Th-5Th	2Th-5Th	5Th-10Th
Kota Kecil	2Th	2Th	2Th	2Th

Source: Permen. PU No. 12 regarding the implementation of the 2014 urban drainage system

Based on the catchment area that has been plotted from Google Earth has an area of 20.2 ha, so based on table 8 the repeat period used is the five -year repellent period.

The maximum rainfall for the normal login method is calculated using the following formula:

Log XT = Log X + (KT . Sd Log X)

Log X5 = 2,1415 + (0,84 . 0,1695)

= 2.2838

The formula for calculating rainfall for the repeat period is the opposite of the XT log or

antilog XT

XT = Antilog XT

= Antilog 2.2838

= 192,16 mm/jam

Table 9 The maximum rainfall of the normal log re -period

Periode (T)	Faktor frekuensi (Kt)	Rata-rata Log Xi	Sd	Log X	Hujan Rencana (mm) (Xt)
2	0.00	2.1509	0.1620	2.1509	141.54
5	0.84	2.1509	0.1620	2.2869	193.61
10	1.28	2.1509	0.1620	2.3582	228.14
20	1.64	2.1509	0.1620	2.4165	260.92
50	2.05	2.1509	0.1620	2.4829	304.02
100	2.33	2.1509	0.1620	2.5282	337.48
200	2.58	2.1509	0.1620	2.5687	370.46

Source: calculation results

The maximum rainfall for the re -period of the Pearson III log method is calculated using the following formula:

Log XT = Log X + G . Sd Log X

= 2,1413 + (0,83 . 0,1663)

= 2,2797

The formula for calculating rainfall for the repeat period is the opposite of the XT log or antilog XT

XT = Antilog XT

= Antilog 2,2797

= 190,41 mm/jam

Table. 10 Maximum rainfall of the Pearson III Log Repeat Periode

Periode (T)	(rata - rata Log X)	Nilai (G)	Sd log X	Log T tahun	Hujan Rencana (mm)
2	2.1509	-0.0906	0.1620	2.1362	136.8436
5	2.1509	0.8060	0.1620	2.2814	191.1721
10	2.1509	1.3295	0.1620	2.3662	232.3906
25	2.1509	1.9276	0.1620	2.4631	290.4584
50	2.1509	2.3382	0.1620	2.5296	338.5168
100	2.1509	2.7228	0.1620	2.5919	390.7204
200	2.1509	3.0889	0.1620	2.6512	447.8746

Source: calculation results

So from the results of the calculation of rainfall the plan method of the Normal Log and
Pearson III log was the highest value was taken for the reference for the value of the intensity of the rainfall of 5 years and the highest value in the normal log method.

Table 11 Comparison of Plan Rainfall Value

Periode (T)	Metode Perhitungan Curah Hujan Rencana (mm)	
	Log Pearson III	Log Normal
2	137.05	138.45
5	190.41	192.16
10	227.49	228.16
25/20	276.24	262.57
50	313.81	308.14
100	352.65	343.72
200	392.90	378.94

Source: calculation results

Calculate concentration time (Tc)

To calculate the concentration time (TC) can use the formula:

$$c = \frac{0{,}0195 \ x \ L^{0{,}77}}{S^{0{,}385}}$$

Where:

Tc = Concentration time (minutes)

L = The length of the water path from the farthest point to the point reviewed (m)
S = River slope
The slope of the channel (S) and (TC) is obtained by the following calculations:

$$S = \frac{\Delta H}{L}$$

Where:
S = Channel slope
ΔH = The height of the farthest point and the drainage area
L = Channel length

Table. 12 Channel Slope (S) And Concentration of Time (TC)

Lokasi	Saluran (m)			S	TC	
	H(Awal)	H(Akhir)	L		Menit	Jam
1	7	2	129	0.0388	2.8752	0.0479
2	5	3	135	0.0148	4.3119	0.0719
3	6	3	288	0.0104	8.8500	0.1475
4	6	3	300	0.0100	9.2772	0.1546
5	8	3	473	0.0106	12.8942	0.2149
6	6	4	271	0.0074	9.6431	0.1607
7	7	4	390	0.0077	12.5610	0.2093
8	5	2	788	0.0038	28.3029	0.4717
9	5	3	129	0.0232	2.5649	0.0427

Source: calculation results

Rainfall intensity

The intensity of rainfall is calculated using the mononobe equation:

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

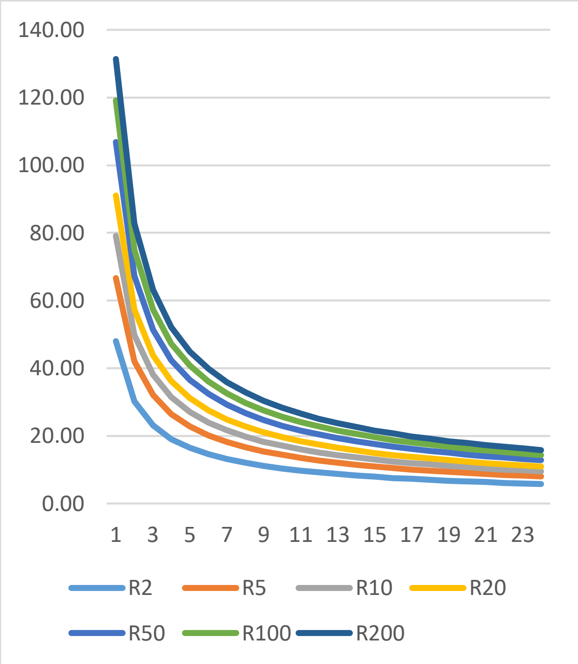
Where:
R24 = Maximum rainfall in 24 hours (mm)
t = Duration of rainfall (hours)
I = Rainfall intensity (mm/hour) By using the maximum rainfall data of the repeat period using the normal log method, it can be calculated that the rainfall intensity data can be calculated with the duration of rain per hour.

Table. 13 Rainfall intencity calculation

t	R24						
	R2	R5	R10	R20	R50	R100	R200
	138.45	192.16	228.16	262.57	308.14	343.72	378.943
1	48.00	66.62	79.10	91.03	106.82	119.16	131.37
2	30.24	41.97	49.83	57.34	67.30	75.07	82.76
3	23.07	32.03	38.03	43.76	51.36	57.29	63.16
4	19.05	26.44	31.39	36.12	42.39	47.29	52.14
5	16.41	22.78	27.05	31.13	36.53	40.75	44.93
6	14.54	20.18	23.95	27.57	32.35	36.09	39.79
7	13.12	18.20	21.62	24.88	29.19	32.56	35.90
8	12.00	16.65	19.77	22.76	26.71	29.79	32.84
9	11.09	15.40	18.28	21.04	24.69	27.54	30.36
10	10.34	14.35	17.04	19.61	23.01	25.67	28.30
11	9.70	13.47	15.99	18.40	21.60	24.09	26.56
12	9.16	12.71	15.09	17.37	20.38	22.73	25.06
13	8.68	12.05	14.31	16.46	19.32	21.55	23.76
14	8.26	11.47	13.62	15.67	18.39	20.51	22.62
15	7.89	10.95	13.00	14.97	17.56	19.59	21.60
16	7.56	10.49	12.46	14.34	16.82	18.77	20.69
17	7.26	10.08	11.96	13.77	16.16	18.02	19.87
18	6.99	9.70	11.52	13.25	15.55	17.35	19.13
19	6.74	9.36	11.11	12.78	15.00	16.74	18.45
20	6.51	9.04	10.74	12.35	14.50	16.17	17.83
21	6.31	8.75	10.39	11.96	14.03	15.65	17.26

22	6.11	8.48	10.07	11.59	13.61	15.18	16.73
23	5.93	8.24	9.78	11.26	13.21	14.73	16.24
24	5.77	8.01	9.51	10.94	12.84	14.32	15.79

Source: Calculating Resource



Picture. 2 Graph of relationship intensity Rainfall Intensity and Rain Duration

To calculate the intensity of the rainfall that occurs in the channel the mononobe equation is used with rainfall plans for the 5 -year re period of the normal log and rainfall duration with a concentration time (TC) with the Kirpich equation.

Table of rainfall intensity for 5 years received period

Lokasi	Periode Ulang (T)	Hujan Rencana		Intensitas Curah Hujan (I)
		Tc (Jam)	Log Normal	Log Normal
1	5	0.0479	192.16	505.99
2	5	0.0719	192.16	385.39
3	5	0.1475	192.16	238.63
4	5	0.1546	192.16	231.25
5	5	0.2149	192.16	185.68
6	5	0.1607	192.16	225.36
7	5	0.2093	192.16	188.95
8	5	0.4717	192.16	109.93
9	5	0.0427	192.16	544.89

Source: calculation results

Calculating the Run Off coefficient

Based on the existing situation of channels that have different dimensions and the location of the channels that are between residents' housing, shops, government buildings and highways, the catchment area is divided into 9 parts as follows:

Table. 14 Run off Koefisien calculation

No	Saluran	Luas (Km2)	Koefisien Pengaliran
1	1	0.008042	0.600
2	2	0.008163	0.715
3	3	0.016316	0.735
4	4	0.024811	0.260
5	5	0.024737	0.272
6	6	0.035710	0.258
7	7	0.028968	0.262
8	8	0.036760	0.272
9	9	0.002551	0.294

Source: calculation results

Plan Rain Discharge (Qt)

The planned rainfall discharge is calculated using the following formula:

Q = 0,278 . C . I . A

Where:

Q = Surface runoff peak discharge (m^3/sec)

C = Run Off coefficient

I = Rainfall intensity (mm/hour

A = The area of the drainage (km^2)

Table. 15 Rainfall Plans (QT)

Saluran	Periode Ulang (T)	Rumus	Koef. Run Off (C)	Intensitas Curah Hujan (I)	Catchment Area (A)	Debit Hujan Rencana (Q)
				Mm/jam	(Km2)	(m3/detik)
1	5	0.278	0.600	505.99	0.008042	0.679
2	5	0.278	0.715	385.39	0.008163	0.625
3	5	0.278	0.735	238.63	0.016316	0.796
4	5	0.278	0.260	231.25	0.024811	0.415
5	5	0.278	0.272	185.68	0.024737	0.348
6	5	0.278	0.258	225.36	0.035710	0.578
7	5	0.278	0.262	188.95	0.028968	0.399
8	5	0.278	0.272	109.93	0.036760	0.306
9	5	0.278	0.294	544.89	0.002551	0.114
Jumlah			0.367		0.186	4.259

Source: calculation results

Existing channel capacity (QS)

After receiving rainfall discharge (QT) then look for existing channel discharge (QS) .

Table. 16 existing channel discharge (QS)

Lok	L	S	b	h	A	P	R	n	V	Qs
1	129	0.0388	0.60	0.67	0.402	1.940	0.207	0.013	5.300	2.131
2	135	0.0148	0.75	0.24	0.180	1.230	0.146	0.013	2.598	0.468
3	288	0.0104	0.57	0.15	0.086	0.870	0.098	0.013	1.671	0.143
4	300	0.0100	0.55	0.60	0.330	1.750	0.189	0.013	2.528	0.834
5	473	0.0106	1.15	0.25	0.288	1.650	0.174	0.013	2.466	0.709
6	271	0.0074	0.60	0.62	0.372	1.840	0.202	0.013	2.275	0.846
7	390	0.0077	0.60	0.25	0.150	1.100	0.136	0.013	1.786	0.268
8	788	0.0038	0.50	0.28	0.140	1.060	0.132	0.013	1.230	0.172

Source: calculation results

Based on rain discharge data and existing channel capacity, it can be compared to find out the capacity of the channels capable or not to accommodate the rain discharge.

Table. 17 Comparison of Hydrological and Hydraulic Rain Discharges

Saluran	Debit Hujan Rencana	Debit Sal. Eks	Ket.
1	0.679	2.131	MAMPU
2	0.625	0.468	TIDAK MAMPU
3	0.796	0.143	TIDAK MAMPU
4	0.415	0.834	MAMPU
5	0.348	0.709	MAMPU
6	0.578	0.846	MAMPU
7	0.399	0.268	TIDAK MAMPU
8	0.306	0.172	TIDAK MAMPU
9	0.114	8.719	MAMPU

Source: calculation results

Tabel. 18 Change in channel dimensions

Area	Debit	Debit	Keterangan	Eks.		Baru	
	Q	Qs		b	h	b	h
1	0.679	0.755	MENAMPUNG	0.60	0.67	1.00	1.00
2	0.625	1.032	MENAMPUNG	0.75	0.24	1.20	1.50
3	0.796	0.865	MENAMPUNG	0.57	0.15	1.20	1.50
4	0.415	0.848	MENAMPUNG	0.55	0.60	1.20	1.50
5	0.348	0.872	MENAMPUNG	1.15	0.25	1.20	1.50
6	0.578	0.728	MENAMPUNG	0.60	0.62	1.20	1.50
7	0.399	0.744	MENAMPUNG	0.60	0.25	1.20	1.50
8	0.306	0.523	MENAMPUNG	0.50	0.28	1.20	1.50
9	0.114	3.339	MENAMPUNG	1.80	0.75	1.80	1.50

Source: calculation results

Table. 19 existing channel discharge (QS) after changes in channel dimensions

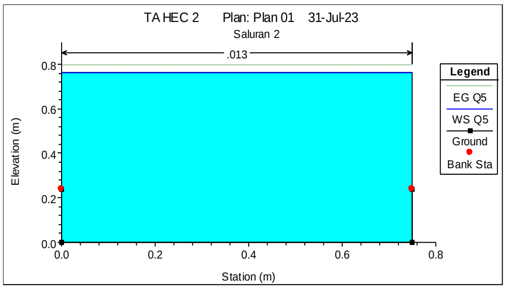
Kapasitas Saluran Baru										
Lok	L	S	b	h	A	P	R	n	V	Qs
1	129	0.03876	1.00	1.20	1.20	3.40	0.353	0.013	0.629	0.755
2	135	0.01481	1.20	1.50	1.80	4.20	0.429	0.013	0.573	1.032
3	288	0.01042	1.20	zs1	1.80	4.20	0.429	0.013	0.481	0.865
4	300	0.01000	1.20	1.50	1.80	4.20	0.429	0.013	0.471	0.848
5	473	0.01057	1.20	1.50	1.80	4.20	0.429	0.013	0.484	0.872
6	271	0.00738	1.20	1.50	1.80	4.20	0.429	0.013	0.405	0.728
7	390	0.00769	1.20	1.50	1.80	4.20	0.429	0.013	0.413	0.744
8	788	0.00381	1.20	1.50	1.80	4.20	0.429	0.013	0.291	0.523
9	86.1	0.02323	1.80	1.50	2.70	4.80	0.563	0.013	1.236	3.339

Source: calculation results

Modeling Using HEC-RAS

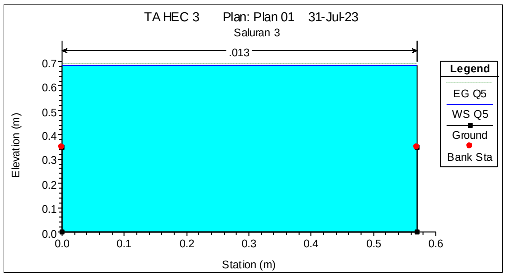
From the results of the study using rainfall for a period of 28 years, several channels were unable to accommodate rainfall discharge shown in the HEC-RAS modeling as follows:

Channel 2 on HEC-RAS



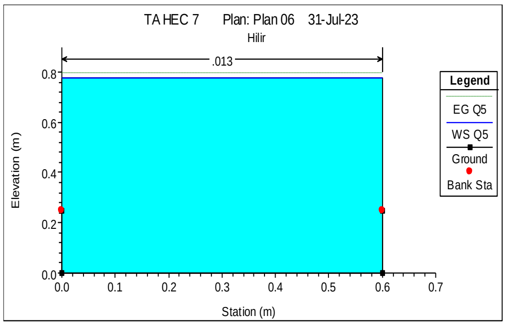
From the data above the water level is at a height of 0.45m whereas in the HEC-RAS modeling the water level is at a height of 0.98m which causes channel 2 to be unable to accommodate rainfall discharge

Channel 3 on HEC-RAS



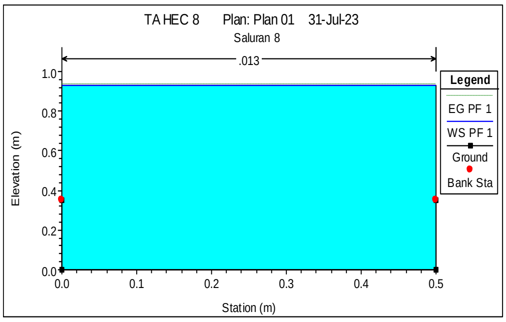
Furthermore, the water level is at a height of 0.35m whereas in the HEC-RAS modeling the water level is at a height of 0.68m which causes channel 3 to be unable to accommodate rainfall discharge.

Channel 7 on HEC-RAS



In channel 7, the water level is at a height of 0.35m, while in the HEC-RAS modeling the water level is at a height of 1.16m, which causes channel 7 to be unable to accommodate rainfall discharge.

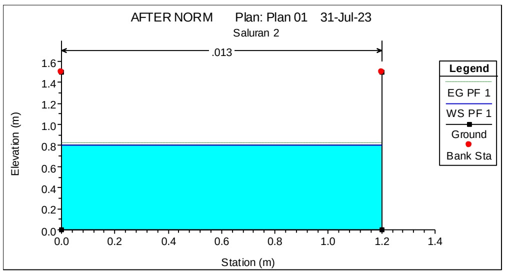
Channel 8 on HEC-RAS



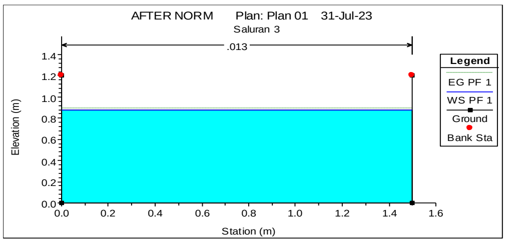
Furthermore, the water level in channel 8 is at a height of 0.35m whereas in the HEC-RAS modeling the water level is at a height of 1.2m which causes channel 8 to be unable to accommodate rainfall discharge.

After channel normalization by adding the dimensions of the existing channel to the new channel: channel 2 1.20m x 1.50m, channel 3 1.20m x 1.50m, channel 7 1.20m x 1.50m, channel 8 1.20m x 1.50m. Then the HEC-RAS modeling for the new channel can be obtained as follows:

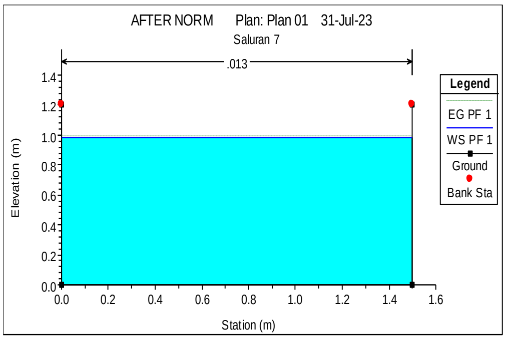
Channel 2 on HEC-RAS after normalization



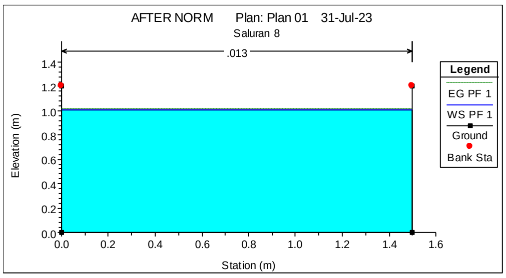
Channel 3 on HEC-RAS after normalization



Channel 7 on HEC-RAS after normalization



Channel 8 on HEC-RAS after normalization



Conclusion

Based on the results of the analysis above, several conclusions can be obtained, including:

1. 28-year rainfall data using the Thiessen method can only affect one station location, namely Kemayoran Station. With the distribution of the Pearson III log method and the normal logs taken by the highest plan rain value in the 5 -year period found in the normal log of 193.61 mm
2. Based on the calculation results obtained the average run-off coefficient and catchment area area as follows:
   Table. 20 Calculation of Run Off coefficient and Catchment Area Area

No	Saluran	Luas (Km2)	Koefisien Pengaliran
1	1	0.008042	0.600
2	2	0.008163	0.715
3	3	0.016316	0.735
4	4	0.024811	0.260
5	5	0.024737	0.272
6	6	0.035710	0.258
7	7	0.028968	0.262
8	8	0.036760	0.272
9	9	0.002551	0.294

Source: calculation results

3. Based on the calculation results obtained a plan rain discharge with a 5 -year repeat period as follows:
   Table. 21 Existing channel discharge before Normalisation

Saluran	Debit Hujan Rencana	Debit Sal. Eks	Ket.
1	0.679	2.131	MAMPU
2	0.625	0.468	TIDAK MAMPU
3	0.796	0.143	TIDAK MAMPU
4	0.415	0.834	MAMPU
5	0.348	0.709	MAMPU
6	0.578	0.846	MAMPU
7	0.399	0.268	TIDAK MAMPU
8	0.306	0.172	TIDAK MAMPU
9	0.114	8.719	MAMPU

Source : Calculation results

Table. 22 existing channel discharge after normalization

Area	Debit	Debit	Keterangan
	Q	Qs	
1	0.679	0.755	MENAMPUNG
2	0.625	1.032	MENAMPUNG
3	0.796	0.865	MENAMPUNG
4	0.415	0.848	MENAMPUNG
5	0.348	0.872	MENAMPUNG
6	0.578	0.728	MENAMPUNG
7	0.399	0.744	MENAMPUNG
8	0.306	0.523	MENAMPUNG
9	0.114	3.339	MENAMPUNG

Source: calculation results

4. It is necessary to do good improvement and maintenance such as dredging sedimentation and waste and eliminating obstacle-obstacles along the channel periodically so that the drainage capacity and water rate are maintained.

REFERENCES

[1] David A. Impellitteri. 2005. Principles of Exterior Drainage: Short Course Series: National Concrete Masonry Association

[2] S.P. Novak, B.A. White, W.S.Y. Yeo, and E.J. Plate. 2010. Principles of Urban Drainage and Flood Management: Taylor & Francis

[3] Anonim. 1997. Drainase Perkotaan. Jakarta. Gunadarma

[4] Asdak, Chay. 2002. Hidrologi Dan Pengelolaan Daerah Aliran Sungai, Jakarta: Gadjah Mada University Press.

[5] Mohammad Imamuddin, Indri Wibowo. 2019. Analisa Genangan Di Kawasan Jalan Petamburan 2 Jakarta Pusat : Fakultas Teknik Jurusan Sipil Universitas Muhammadiyan Jakarta.