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# ANALYSIS OF RESIDENTIAL RESERVOIR CAPACITY ANALYSIS MUTIARA PURIHARMONI 2 CIKARANG

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**Abstract**

Cikarang is one of the areas in the administrative city of Bekasi Regency, which has several flood-prone areas. Every year, several areas of Cikarang often experience flooding, including the North Cikarang area. Precisely in Karanganyar Village, Karang Bahagia Subdistrict, where most of the land has been converted from rice fields to densely populated housing. Over time, Karang Bahagia Subdistrict became familiar with floods and puddles. Mutiara Puri Harmoni 2 Housing is one of the densely populated residential areas in the Karang Bahagia District. From the observation of the drainage system made by Mutiara Puri Harmoni 2 Housing, there is a lot of sedimentation and some of the sections have a lot of narrowing due to increased development in the housing area. For the drainage before it is drained into the nearest river, namely the Gemboro river, the Mutiara Puri Harmoni 2 housing drainage system creates a reservoir as a storage. By analyzing the reservoir section using the rainfall distribution method and the Log Pearson III method, the resulting 2-years rainfall intensity is 74.374 mm/hour with the resulting discharge of 3.339 $m^3$/second. From the calculation results, the reservoir storage is 6057.216 $m^3$/second with a cross section of 62.4 m x 55.62 m. Taking into account the reservoir water balance using 17 years of rainfall data, the maximum discharge in February is 18323 $m^3$ and the lowest discharge is in August of 3038 $m^3$. Therefore, the results of the capacity analysis needed to avoid flooding are to deepen and expand the reservoir and/or add a pump so that the concentration time is not too long.

**Keywords:** flooding; drainage system; reservoir; population; residential.

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## INTRODUCTION

Cikarang is one of the areas in the Administrative City of Bekasi Regency, which has several flood-prone areas. Every year several areas of Cikarang are often hit by floods, including the North Cikarang area. Precisely in Karang Bahagia District, most of the land has been converted from rice fields to densely populated housing. Over time, Karang Bahagia sub-district became familiar with flooding and inundation. Mutiara Puri Harmoni 2 Housing is one of the densely populated residential areas in the Karang Bahagia District.

A well-organized housing area must also be followed by an arrangement of a drainage system that functions to reduce or remove excess water from an area or land so that it does not cause stagnation of water that can disrupt community activities and can even cause socio-economic losses, especially those concerning aspects, residential environmental health.
To solve the inundation problem, adequate canals and reservoirs are needed which are planned in detail and thoroughly. So a hydrological analysis is needed to be able to determine the size of the planned discharge. Then rainfall data is needed to determine the intensity of rain in 2 years, and to determine the maximum water discharge at the highest rainfall intensity. Then it can be seen how many effective canal needs for that area.

**Research Purposes**

1. Knowing the causes of inundation in the Puri Harmoni 2 Cikarang housing area.
2. Providing input to authorized agencies to resolve flood problems in the Puri Harmoni 2 Cikarang housing area.
3. Look for alternatives and provide recommendations on the results of evaluation of existing drainage & reservoir capacity. As well as overcoming the puddles that exist around residential areas.

In this paper, the author wants to analyze the capacity of the reservoir made in the Mutiara Puri Harmoni 2 housing area which functions as a reservoir, before it will flow into the Gemboro river.

Flood is the event of the sinking of land (which is usually dry) due to the increased volume of water. Flood there are two events. The first is a flood or inundation event that occurs in areas where there is usually no flood. Both flood events occur due to flood water runoff from the river because the flood discharge cannot be flooded by the river flow or the flood discharge is greater than the existing river drainage capacity (Suripin, 2004).

Flood routing or flood tracking is a hydrograph forecasting at one point in a stream or part of a river based on hydrograph observations at another point. Flood hydrographs can be traced through a riverbed or through a reservoir. The objectives of tracking floods are as follows:

1. Short-term flood forecasting.
2. Calculation of the unit hydrograph at various points along the river from the unit hydrograph at a point on the river.
3. Forecasting the behavior of the river after a change in the condition of the riverbed (for example, due to the construction of a dam or construction of embankments).
4. Derived synthetic hydrograph.

Drainage which comes from the English language drainage means to drain, drain, remove, or divert water. Drainage in general can be defined as a technical measure to reduce excess water, either from rainwater, seepage, or excess irrigation water from an area/land, so that the function of the area/land is not disturbed. Drainage can also be interpreted as an attempt to control groundwater quality in terms of salinity. So, darinage concerns not only surface water but also ground water (Suripin, 2004). Types of drainage can be grouped as follows (Hadi Hardjaja, in the journal Kusumo 2009):

1. Drainage According to the History of Its Formation
   a. Principle of Natural Drainage (Natural Drainage) Naturally formed drainage and there are no supporting buildings, this canal is formed by scouring of moving water due to gravity which gradually forms a permanent waterway such as a river. Areas with relatively good natural drainage will require less protection than low areas which act as catching basins for flow from large tributary areas.
   b. Artificial Drainage Drainage is made with a specific purpose and purpose so that it requires special buildings such as masonry gutters, culverts, and pipes.
2. Drainage According to the Location of the Building
   a. Surface Drainage A drainage canal that is above the soil surface which functions to drain surface runoff. Flow analysis is an analysis of open canal flow (open canal flow).
   b. Subsurface Drainage Drainage canals that aim to drain surface runoff through underground media (pipes) for certain reasons. This is because of the artistic demands, the demands of the function of the ground surface which do not allow the canal on the surface of the ground such as football fields, airfields and parks.
3. Drainage According to the Construction

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a. Open Canals Canals that are more suitable for rainwater drainage are located in areas that have a sufficient area, or for non-rainwater drainage that does not endanger health or disturb the environment.
b. Closed Canals Canals that are generally often used for dirty water flow (water that is detrimental to health or the environment) or for canals located in the middle of the city.

Reservoir in general terms is a place on the surface of the ground which is intended to store/store water when there is excess water/rainy season, then the abundant water is used for agricultural purposes and various other purposes during the dry season.

The main function of a reservoir is to provide a water source to be used when needed. The storage needed in a river to meet certain demands depends on three factors, namely:

1. Flow variability.
2. Size request.
3. Level of constraint from fulfilling requests.

Buildings with less strong foundation conditions will cause the upper part of the construction to be damaged, in this case if the foundation is disturbed, the buildings above it will also shift, shifting based on field conditions. A very supportive field condition is concrete that functions properly because the foundation will experience a reduction in its compressive strength (M. Marwahyudi, 2020); S. Syaiful, 2020).

## RESEARCH METHODS

### Time and Place

This research was conducted in January - March 2020 in the Puri Harmoni 2 Cikarang housing area figure 1 below.

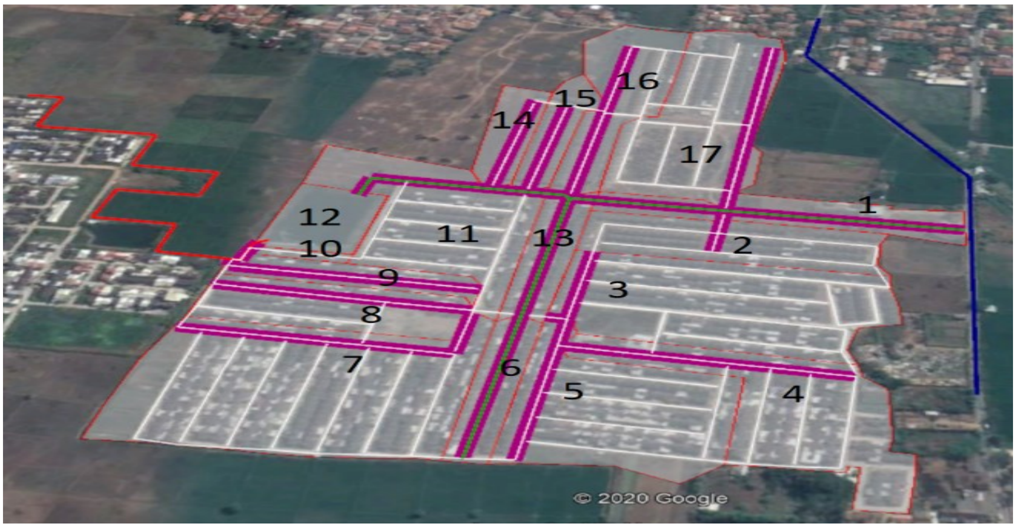


**Figure 1**. Research location

### Data Collection Method

The methods used in this research are:

### The Preparation Stage

In this stage, prepare for data collection, data analysis and make a map of the location you want to review.

1. Literature Study
   Literature study is intended to open insights and get direction to facilitate data collection, data analysis and reporting.
2. Field observations
   Field observations are intended to find out where the channel location or place of review and the state of the channel.

**Data Collection**

The data collected are primary data and secondary data. This study refers to or is influenced more by secondary data. The data are as follows:

1. Primary data, namely data obtained directly from measurements in the field:
   a. Canal length
   b. Canal width
   c. Canal depth
   d. Canal slope
   e. Length of reservoir
   f. Width of the reservoir
   g. Depth of reservoir
   h. The slope of the reservoir
2. Secondary data, namely data obtained from related agencies including:
   a. Rainfall data
   b. Geographical data

**Data Analysis**

The data analysis stage is carried out by calculating the data with a formula in accordance with its use.

1. Hydrological analysis
   Hydrological analysis is used to determine the size of the planned flood discharge in water construction planning. The data used in this inundation analysis is from rainfall data, where rainfall is one of the data that can be used to determine the planned flood discharge.
2. Hydraulic Analysis
   Hydraulic analysis is used to determine how big the cross section of the canal accommodates the planned flood discharge. From the hydraulic analysis, data will be obtained slope and flow velocity of the canal section.

**Research Procedure**

1. Calculating the intensity of rainfall for 2 years using the distribution formula.
2. Calculating the flood discharge plan for 2 years using the Pearson III Log Method
3. Determine the Catchman Area
4. Calculating the Run Off coefficient
5. Calculating the channel capacity

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6. Field observations are intended to find out where the reservoir location or place of review calculates the cross section with the required hydraulic formula.
7. Calculating the capacity of the existing reservoir which functions as a temporary storage which will later flow into the Gemboro river.
8. Calculating reservoir water balance

**RESULTS AND DISCUSSION**

In order to conduct research at Mutiara Puri Harmoni 2 Housing, various data are required, including:

1. Topographic data
2. Dimensions of channels and reservoirs
3. Flow direction

The measurement results in the field are as follows:

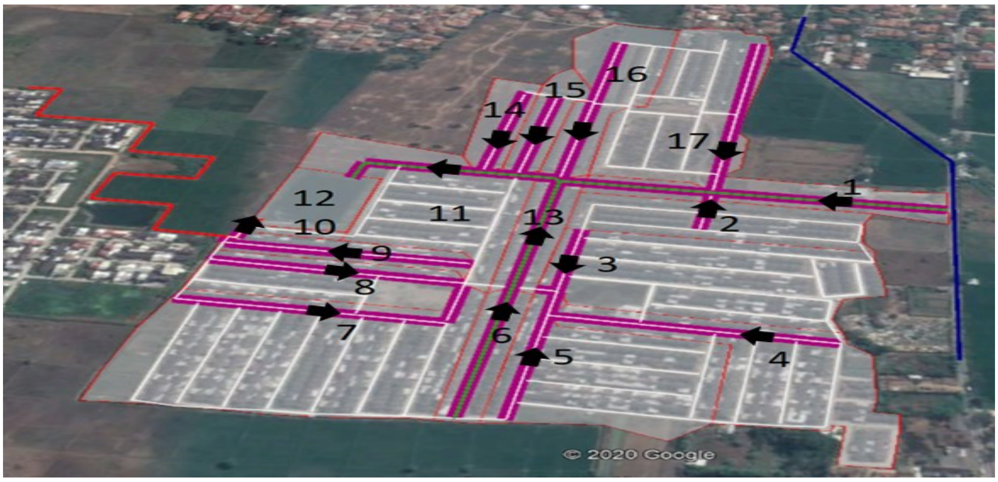


**Figure 2**. A view of the situation and direction of flow

The next data is obtained from the calculation of the maximum daily rainfall for the last 17 years. Maximum monthly rainfall data is taken from the observation of the Halim Perdana Kusuma rainfall station.

**Table 1.** Maximum monthly rainfall data

| ANNUAL RAINFALL DATA | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Month | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 |
| January | 1,1 | 96,6 | 22,2 | 48,5 | 33,7 | 7,8 | 86,4 | 21,6 | 85,3 | 161 | 120,8 | 0,2 | 61,2 | 43 | 90,6 | | 377 |
| February | 32 | 36 | 41,5 | 217,6 | 136,1 | 26 | 61,3 | 305 | 90,6 | 43,8 | 102,7 | 124,6 | 62,4 | 136,3 | 47,9 | | |
| March | 39,8 | 54,5 | 88,5 | 32 | 35 | 15,4 | 31,7 | 23,5 | 59,8 | 87,7 | 100,8 | 124,5 | 0 | 42,2 | 42 | | |
| April | 6 | 16 | 29,8 | 32,4 | 19,8 | 140,4 | 40 | 19,4 | 42 | 73,7 | 37,4 | 92,6 | 111,6 | 91,6 | 102,2 | | |
| May | 12,5 | 5 | 0 | 11 | 16,5 | 64,2 | 83,1 | 64,2 | 36,3 | 41,5 | 47,7 | 26,8 | 54 | 26,2 | 41,2 | | |
| June | 2,5 | 25,1 | 41,9 | 0 | 27,6 | 19,2 | 34,7 | 18 | 49,3 | 18,6 | 54,5 | 28 | 85,6 | 24,4 | 16,1 | | |
| July | 0 | 10,5 | 0 | 37 | 0 | 0 | 45 | 12,3 | 0,8 | 67 | 60,9 | 0 | 41,8 | 4,9 | 1,4 | | |
| August | 0 | 0 | 0 | 0 | 19,7 | 95 | 37,8 | 0 | 0 | 0,2 | 42,7 | 1,7 | 51,4 | 19 | 0 | | |
| September | 0 | 90,5 | 0 | 1,4 | 18 | 0 | 95 | 5,6 | 0 | 3,2 | 18,5 | 0 | 78,4 | 2 | 0 | | |
| October | 0 | 16,8 | 6,2 | 14,5 | 0 | 20,1 | 96,8 | 32,4 | 39,4 | 24,5 | 0 | 1,2 | 54,2 | 55 | 62,7 | | |

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| November | 5,6 | 14,3 | 0 | 13,2 | 23,2 | 82,1 | 50,1 | 89,6 | 52,5 | 66 | 57,8 | 36 | 74,8 | 39 | 71,6 | | |
| December | 13,2 | 36,8 | 83 | 64 | 20 | 24 | 37,1 | 22 | 94,4 | 31,8 | 69,5 | 80,6 | 37,8 | 62 | 34,7 | 377 | |
| Max | 39,8 | 96,6 | 88,5 | 217,6 | 136,1 | 140,4 | 96,8 | 305 | 94,4 | 161 | 120,8 | 124,6 | 111,6 | 136,3 | 102,2 | 377 | 377 |

Source: Meteorology, Climatology and Geophysics Agency

**Table 2.** Distribution calculations for rainfall

| Year | Xi | Xi-X | $(Xi-X)^2$ | $(Xi-X)^3$ | $(Xi-X)^4$ |
|---|---|---|---|---|---|
| 2004 | 39,8 | -121 | 14529 | -1751228,014 | 211084783,7 |
| 2005 | 96,6 | -64 | 4062 | -258904,7289 | 16501369,04 |
| 2006 | 88,5 | -72 | 5160 | -370692,3493 | 26628793,94 |
| 2007 | 217,6 | 57 | 3279 | 187785,0886 | 10753457,87 |
| 2008 | 136,1 | -24 | 587 | -14234,58742 | 344979,4128 |
| 2009 | 140,4 | -20 | 397 | -7922,603881 | 157939,4386 |
| 2010 | 96,8 | -64 | 4037 | -256475,0565 | 16295218,15 |
| 2011 | 305 | 145 | 20928 | 3027525,189 | 437976041,1 |
| 2012 | 94,4 | -66 | 4347 | -286651,2523 | 18900434,63 |
| 2013 | 161 | 1 | 0 | 0,293689599 | 0,195217204 |
| 2014 | 120,8 | -40 | 1563 | -61795,2256 | 2443092,419 |
| 2015 | 124,6 | -36 | 1277 | -45634,37246 | 1630757,722 |
| 2016 | 111,6 | -49 | 2375 | -115752,6052 | 5641237,257 |
| 2017 | 136,3 | -24 | 578 | -13885,07797 | 333731,9328 |
| 2018 | 102,2 | -58 | 3380 | -194680,5757 | 11422456,06 |
| 2019 | 377 | 217 | 46944 | 10171020,16 | 2203701090 |
| 2020 | 377 | 217 | 46944 | 10171020,16 | 2203701090 |
| Total | 2725,7 | 0 | 160388 | 20177694 | 5167516474 |
| Average | 160,3353 | | | | |

**Rainfall is Average**

Rainfall is average$(\bar{X})$ $= \frac{\sum_{i=1}^{n} xi}{n}$

$= \frac{2725,7}{17}$

$= 160,335$

**Standar Deviation**

Standar deviation (Sd) $= \sqrt{\frac{\sum_{i=1}^{n}(xi-\bar{x})^2}{n-1}}$

$= \sqrt{\frac{160388}{16}}$

$= 100,121$

**Coefficient of Variation**

Coefficient of variation (Cv) $= \frac{160,335}{100,121}$

$= 0,625$

**Slope coefficient**

Slope coefficient (Cs) $= \frac{n\sum_{i=1}^{i}(xi-\bar{x})^3}{(n-1)\ x\ (n-2)\ x\ (Sd)^3}$

$= \frac{17\ x\ 20177694}{16\ x\ 15\ x\ (100,12)^3}$

$= 1,424$

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**Kurtosis coefficient**

Kurtosis coefficient (Ck) $= \frac{n^2 \sum_{i=1}^{i} (xi-\bar{x})^4}{(n-1) \, x \, (n-2) \, x \, (n-3) x \, (Sd)^4}$

$= \frac{17^2 \, x \, 5167516474}{16 \, x \, 15 \, x \, 14 \, x \, (100{,}12)^4}$

= 4,423

**Distribution Method**

Based on the calculation and analysis of rainfall data, the method that meets the requirements is the Pearson III log. The following is a table of calculation results to determine the distribution method.

**Table 3.** Results of calculation of distribution method and distribution method requirements

| No | Distribution | Terms | Result | Conclusion |
|---|---|---|---|---|
| 1 | Gumbel | Cs ≤ 1.1396 | Cs = 1.42 | Doesn't match the condition |
| | | Ck ≤ 5.4002 | Ck = 4.42 | According to the requirements |
| 2 | Normal | Cs = 0 | Cs = 1.42 | Doesn't match the condition |
| | | Ck = 3 | Ck = 4.42 | Doesn't match the condition |
| 3 | Log Normal | Cs = 3 or 3Cv | Cs = 1.42 | Doesn't match the condition |
| | | | Cv = 0.63 | Doesn't match the condition |
| 4 | Log Pearson III | Has no Condition | Cs = 1.42 | According to the requirements |
| | | | Cv = 0.63 | According to the requirements |

Based on the rain frequency test and distribution suitability test that has been carried out, then the calculation of the existing drainage capacity will use the log Pearson III method of rainfall.

**Pearson's Log Method III**

The Pearson III log method has no characteristic or criteria for the value of the slope coefficient and the kurtosis coefficient to calculate the planned rainfall. The following are the steps for calculating the rainfall plan for the Pearson III log method.

**Table 4**. Rainfall plan pearson log method III

| Year | Xi | (LogXi - LogX)² | (LogXi - LogX)³ |
|---|---|---|---|
| 2004 | 39,8 | 0,288212789 | -0,154728342 |
| 2005 | 96,6 | 1,984977 | -0,003495232 |
| 2006 | 88,5 | 1,946943 | -0,00683675 |
| 2007 | 217,6 | 2,337659 | 0,008111064 |
| 2008 | 136,1 | 2,133858 | -2,38749E-08 |
| 2009 | 140,4 | 2,147367 | 1,20099E-06 |
| 2010 | 96,8 | 1,985875 | -0,003433537 |
| 2011 | 305 | 2,4843 | 0,041985347 |
| 2012 | 94,4 | 1,974972 | -0,004233101 |
| 2013 | 161 | 2,206826 | 0,000344299 |
| 2014 | 120,8 | 2,082067 | -0,000163404 |
| 2015 | 124,6 | 2,095518 | -7,00342E-05 |
| 2016 | 111,6 | 2,047664 | -0,000706715 |
| 2017 | 136,3 | 2,134496 | -1,12658E-08 |
| 2018 | 102,2 | 2,009451 | -0,002062287 |
| 2019 | 377 | 2,576341 | 0,084954062 |
| 2020 | 377 | 2,576341 | 0,084954062 |

| | | | |
|---|---|---|---|
| Total | 2725,7 | 36,32454 | 0,044620597 |
| Average | 160,3353 | 2,136738 | |

**Calculates the Log x Average Value**

The log $\bar{x}$ or log x average is calculated by the following formula

Log $\bar{x}$ $= \frac{\sum_{i=1}^{n} Log\ Xi}{n}$

$= \frac{36,32454}{17}$

= 2,137

**Compute the Standard Deviation of Log Pearson III**

The standard deviation of log x is calculated by the following formula

$S_d$ log x $= \left[\frac{\sum_{i=1}^{n}(\log Xi - \log \bar{X})^2}{n-1}\right]^{0,5}$

$= \left[\frac{0,97772781}{16}\right]^{0,5}$

= 0,247

**Calculating the Slope Value (Cs)**

The kepencengan value is calculated by the following formula

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

$= \frac{17\ x\ 0,044620597}{16\ x\ 15\ x\ 0,25}$

= 0,01074

Next is to find the value of the frequency factor (KT) for the log pearson III distribution.

**Table 5.** Maximum rainfall for return period

| Period (T) | Log Xi | Score (KT) | Sd Log X | Log T Year | Rain Plan |
|---|---|---|---|---|---|
| 2 | 2,136738 | -0,002 | 0,2472003 | 2,136254253 | 136,8529783 |
| 5 | 2,136738 | 0,852912 | 0,2472003 | 2,345693838 | 221,6633223 |
| 10 | 2,136738 | 1,2889564 | 0,2472003 | 2,455368012 | 285,3435183 |
| 25 | 2,136738 | 1,7611368 | 0,2472003 | 2,572091147 | 373,3285014 |
| 50 | 2,136738 | 2,064081 | 0,2472003 | 2,646979044 | 443,5872386 |
| 100 | 2,136738 | 2,3392939 | 0,2472003 | 2,715011765 | 518,8140933 |

**Maximum Rainfall Return Period**

The maximum rainfall for the return period is calculated using the following formula

$Log\ X_T \quad = Log\ \bar{x} + K_T * Sd\ \log x$

$Log\ X_T$ = 2,137 + ( -0,002*0,247 )

= 2,136

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

$X_T$ = antilog $X_T$

= antilog 2,136

= 136,853

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**Table 6**. City typology by catchment area

| Large Catchment Area (km)² | Year birthday period (year) |
|---|---|
| Less than 0,1 | 1 |
| 0,1 - 1,0 | 2 |
| 1,0 - 5,0 | 5 |
| More than 5,0 | 10 |

Source: Candy. PU. No.12 concerning the implementation of the urban drainage system in 2014

Mutiara Puri Harmoni II Housing Area, Cikarang, is included in the city of Cikarang which is a medium city category. Based on the catchment area plotted from Google is 19.2117 ha, so based on table 6 the return period used is a return period of 2 years.

**Calculating Concentration Time (Tc)**

$Tc = 0,0195 \cdot L^{0,77} \cdot S^{-0,385}$

Note:

Tc = concentration time (minutes)
L = length of the water trajectory from the farthest point to the point under review (Km)
S = the average slope of the water's passage

The canal slope is obtained using the google earth application.
The canal slope (S) and (Tc) is obtained by the following calculation

$$S = \left(\frac{\Delta x}{L}\right)$$

Note:

S = slope of the canal
ΔX = difference in elevation (m)
L = horizontal distance (m)

$$\text{Canal slope (S)} = \left(\frac{12-10}{736}\right) = 0.0027$$

$$Tc = \frac{0,0195 \ . \ L^{0,77}}{S^{0,385}}$$
$$= \frac{0,0195 \ . \ 662^{0,77}}{0,0027^{0,385}}$$
$$= 30,576 \ minute$$
$$= 0,5096 \ hour$$

**Rainfall Intensity**

Usually the intensity of the rain is related to the duration of short-term rain. The calculation of the intensity of rain for the 2 year return period is as follows:

$$I = \frac{R24}{24} x \left(\frac{24}{tc}\right)^{2/3} \quad I = \frac{136,85}{24} x \left(\frac{24}{0,51}\right)^{2/3}$$

$$I = 74,364 \ mm/hour$$

**2-years Plan Discharge**

To find a debit plan, you can use the following formula:

$$Q = 0,278 \ x \ C \ x \ I \ x \ A$$

Note:
Q = Discharge Plan
C = run off coefficient
I = Rain intensity
A = Area

$$Q = 0{,}278 \, x \, 0.84 \, x \, 74{,}364 \, x \, 0{,}192$$

$$Q = 3{,}339 \; m3/s$$

**Calculate the Run off Coefficient**

Based on the research results, the boundaries of the catchment area were obtained. After determining the boundaries or catchment area based on research, then determining the run off coefficient for each catchment area.
The run off coefficient values used are:
Meeting settlement = 0.95
Asphalt or concrete road = 0.95
Garden = 0.40
Based on the above calculations, the run off coefficient is obtained according to the catchment area as follows:

**Table 7.** Results of the calculation of the run off coefficient

| All area | Large (km) | Score C | Large x C |
|---|---|---|---|
| Solid housing | 0,107417 | 0,95 | 0,10204615 |
| Garden | 0,0381387 | 0,4 | 0,01525548 |
| Street | 0,0465613 | 0,95 | 0,044233235 |
| Total | 0,192117 | | 0,161534865 |
| | C Average | | 0,84081505 |

**Calculating Canal Capacity**

The canal in Mutiara Puri Harmoni housing is an open channel with a rectangular shape. Based on the data in the research location, the canal is square with concrete walls, so that the value of n is 0.014

$$Q \, sal = A \, x \, V$$

$$A = B \, x \, H$$

$$P = b + 2h$$

$$R = \frac{A}{P}$$

$$V = \frac{1}{n} \, x \, R^{\frac{2}{3}} \, x \, S^{1/2}$$

Note:
A = Wet cross-sectional area
P = wet circumference
B = canal width
H = Canal height
V = Flow velocity
n = Manning Roughness
R = hydraulic radius

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S = canal slope

**Table 8.** The calculation results of the comparison of canal discharge due to rainfall (Qt) and planned canal discharge (Qsr)

| Waterways | Base (b) | High (c) | Large (A) | Wet Circumference (P) | Hydrolic Fingers (R) | Coeff. Manning (n) | Speed (V) | Q plan ($m^3$/dt) | Q existing ($m^3$/dt) | Terms Q |
|---|---|---|---|---|---|---|---|---|---|---|
| S17 | 0,5 | 1 | 0,5 | 2,5 | 0,2 | 0,014 | 1,520835 | 0,3623344 | 0,76041752 | Qualify |
| S16 | 0,5 | 0,3 | 0,15 | 1,1 | 0,136364 | 0,014 | 1,706286 | 0,2151886 | 0,25594288 | Qualify |
| S15 | 0,5 | 0,3 | 0,15 | 1,1 | 0,136364 | 0,014 | 1,634752 | 0,0860177 | 0,24521284 | Qualify |
| S14 | 0,2 | 0,3 | 0,06 | 0,8 | 0,075 | 0,014 | 1,077471 | 0,0631851 | 0,06464823 | Qualify |
| S13 | 0,8 | 1 | 0,8 | 2,8 | 0,285714 | 0,014 | 3,475173 | 1,6399155 | 2,78013802 | Qualify |
| S12 | | | | | | | | | | |
| S11 | 0,8 | 1,5 | 1,2 | 3,8 | 0,315789 | 0,014 | 2,72274 | 2,7555641 | 3,26728826 | Qualify |
| S10 | 0,2 | 0,3 | 0,06 | 0,8 | 0,075 | 0,014 | 3,136829 | 0,10407 | 0,18820976 | Qualify |
| S9 | 0,5 | 0,3 | 0,15 | 1,1 | 0,136364 | 0,014 | 1,372864 | 0,0882405 | 0,20592961 | Qualify |
| S8 | 0,5 | 0,3 | 0,15 | 1,1 | 0,136364 | 0,014 | 1,455664 | 0,1551184 | 0,21834953 | Qualify |
| S7 | 0,5 | 1 | 0,5 | 2,5 | 0,2 | 0,014 | 1,63218 | 0,5048174 | 0,81608981 | Qualify |
| S6 | 0,8 | 1 | 0,8 | 2,8 | 0,285714 | 0,014 | 2,47292 | 0,0858397 | 1,97833619 | Qualify |
| S5 | 0,5 | 1 | 0,5 | 2,5 | 0,2 | 0,014 | 1,868073 | 0,5515281 | 0,93403664 | Qualify |
| S4 | 0,5 | 0,5 | 0,25 | 1,5 | 0,285714 | 0,014 | 3,605398 | 0,2732349 | 0,9013495 | Qualify |
| S3 | 0,5 | 1 | 0,5 | 2,5 | 0,2 | 0,014 | 2,628059 | 0,9425166 | 1,31402944 | Qualify |
| S2 | 0,5 | 0,3 | 0,15 | 1,1 | 0,136364 | 0,014 | 2,499925 | 0,2106963 | 0,3749888 | Qualify |
| S1 | 0,8 | 1 | 0,8 | 2,8 | 0,285714 | 0,014 | 2,614097 | 0,6872658 | 2,09127796 | Qualify |

Q Rain <Q The existing channel, the channel capacity is sufficient to accommodate the maximum rain discharge.

**Calculating Reservoir Capacity**

The shape of the reservoir section, which is like a rectangular pyramid that is truncated upside down with 2 different dimensions and 2 sides with different lengths, then we calculate with the approximate volume of a triangular prism for the four slanted sides added to the volume of the beam.

$$V\ triangular\ prism = \left(\frac{a\ x\ t}{2}\right) x\ T$$

$$V\ beam = p\ x\ l\ \text{x t}$$

Note: and
a = base of triangle p = length of block
h = height of the segment l = width of the beam
T = height of the prism t = height of the beam

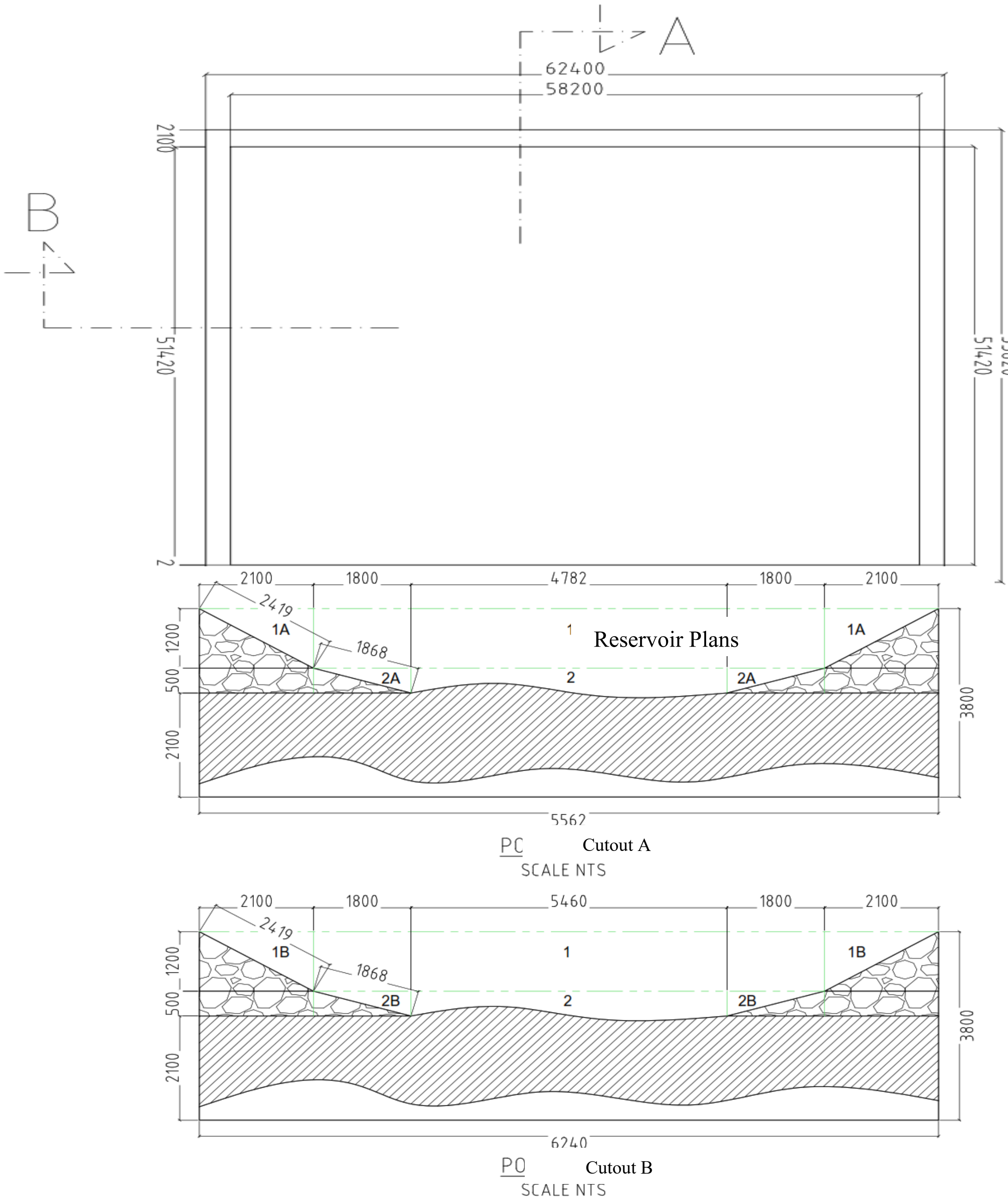


**Figure 3.** Reservoir plans and sections

Volume 1
= (2 x V. Elongated prism) + (2 x V. Transverse prism) + V. beam
= 157,248 + 140,1624 + 4164,8256
= 4462,236 $m^3$

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Volume 2
= (2 x V. Elongated prism) + (2 x V. Transverse prism) + V. beam
= 52,38 + 46,278 + 1496,322
= 1594,98 $m^3$
Total reservoir volume
= V. 1 + V. 2
= 4462,236 + 1594,98
= 6057,216 $m^3$

**The Time it Takes Until the Reservoir is Fully Filled**

To find the maximum rain time that the reservoir can tamping, the following formula can be used:

T = V reservoir / Q Rain
Note:
T = Maximum rain time
V = volume of reservoir
Q = Rain discharge

$$T = \frac{6057{,}216}{3{,}339}$$

T = 1813,839 s
T = 0,504 hour

**Calculating the Reservoir Water Balance**

**Table 9.** Reservoir water balance

| Month | Total Days | Rainfall (mm/hour) | Catchment Area (m²) | Rain Volume (m³/hour) | Total Water Supply (lt/day) | Water Supply (liter) | Supply Volume |
|---|---|---|---|---|---|---|---|
| January | 31 | 78,56 | 192117 | 15093 | 12025 | 388 | 14705 |
| February | 28,3 | 97,59 | 192117 | 18748 | 12025 | 425 | 18323 |
| March | 31 | 51,83 | 192117 | 9957 | 12025 | 388 | 9569 |
| April | 30 | 56,99 | 192117 | 10949 | 12025 | 401 | 10549 |
| May | 31 | 35,35 | 192117 | 6791 | 12025 | 388 | 6403 |
| June | 30 | 29,7 | 192117 | 5706 | 12025 | 401 | 5305 |
| July | 31 | 18,77 | 192117 | 3607 | 12025 | 388 | 3219 |
| August | 31 | 17,83 | 192117 | 3426 | 12025 | 388 | 3038 |
| September | 30 | 20,84 | 192117 | 4004 | 12025 | 401 | 3603 |
| October | 31 | 28,25 | 192117 | 5428 | 12025 | 388 | 5040 |
| November | 30 | 45,05 | 192117 | 8656 | 12025 | 401 | 8255 |
| December | 31 | 67,99 | 192117 | 13063 | 12025 | 388 | 12675 |
| **Total** | **365,3** | | | **105427** | | | |

From the above analysis, it is known that the maximum cumulative volume is 18323 $m^3$, while the minimum cumulative volume is 3038 $m^3$. So that the reservoir should ideally accommodate 18323 $m^3$ - 3038 $m^3$ = 15285 $m^3$. Meanwhile, the existing reservoir storage is 6057,216 $m^3$.

## CONCLUSION

From the results of the discussion above, we can conclude several things, namely, the water canal with a variation size according to table 8. is able to accommodate the maximum rain discharge which is 3.339 $m^3$/second. The reservoir storage volume of 6057,216 $m^3$ /s is only able to accommodate rain with a maximum rainfall rate of 3,339 $m^3$/s for 0.504 hours. The ideal reservoir capacity is 18323m³ and currently the reservoir can only accommodate 6057,216m³ of capacity.

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