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Research Paper

Design and Evaluation of a Drainage System Based On Absorption Wells on the Faculty of Engineering University of 17 Agustus 1945 Samarinda

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ABSTRACT
This research aims to design and evaluate a drainage system based on infiltration wells at the Faculty of Engineering, University of 17 August 1945, Samarinda, to overcome increased rainwater runoff. This study explores the relationship between changes in land use, increasing drainage coefficients, and the effectiveness of infiltration wells as a sustainable solution in drainage systems. The methods used include experimental approaches and hydrological modeling. Rainfall data for the last 10 years from BMKG Temindung Samarinda was used to analyze the distribution of rain frequency using the Gumbel and Log Pearson Type III methods. The analysis results show that the Gumbel method meets the test criteria for daily rainfall data distribution, with a rainfall intensity of 41.54 mm/hour for a return period of 10 years. The dimensions of the infiltration well are designed with a diameter of 1.5 m and a depth of 3 m, capable of accommodating runoff discharge of 0.04 m³/second. Calculations show that 7 units of infiltration wells are needed to handle the resulting runoff. Implementation of infiltration wells can increase infiltration and maintain groundwater levels, as well as significantly reduce the risk of local flooding. This research concludes that the use of infiltration wells is effective as a sustainable drainage component in educational environments with high levels of land conversion, and provides recommendations for the design of efficient drainage systems in faculty building development areas.

Keywords: ***drainage system, absorption wells, rainwater runoff***

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I. INTRODUCTION

With the increase in population and to meet its various needs, land conversion for roads and settlements, buildings, structures, and factories has resulted in areas absorbing abundant rainwater which will decrease their absorption capacity. A reduced water catchment area will result in greater surface flow (run-off). This has an impact on flooding or the emergence of widespread standing water in various places, both in residential areas and on roads.

The decreasing amount of green land around residential areas, especially in urban areas, makes absorbing water into the soil increasingly difficult. The direct impact felt by the community is flooding, especially if the water discharge becomes higher. This usually occurs during the rainy season, and the indirect impact is the depletion of usable water reserves.

The main problem facing the 17 August 1945 Samarinda University campus environment is the reduction in absorption land due to the conversion of empty land into lecture buildings and parking lots. This has the potential to increase rainwater runoff in the area and cause flooding. To overcome this, several efforts have been made, one of which is by building absorption wells.

According to Anatasia Anjani (2021), an absorption well is an engineering building in the shape of a well. Its function is as a water reservoir and comes from above ground. Water infiltration wells are a water conservation technology that has been widely used to reduce surface water runoff and increase groundwater infiltration. Some of the benefits of infiltration wells are efficient water management, sustainable water availability, economic benefits, plant growth, and biodiversity, prevention of groundwater level decline and seawater intrusion, and long-term benefits of infiltration wells include sustainability of water resources, and a better environment,healthy, and meeting water needs for the future (PT. Kawan Lama Sejati, 2024).

Several previous studies have highlighted the importance of an effective drainage system in controlling rainwater runoff in urban areas undergoing development. It was reported by Haryanto (2016) that the effectiveness of infiltration wells in dense urban areas showed that this technique was successful in reducing surface flow by up to 40%. Susanto (2018) studied the influence of land conversion on increasing runoff discharge and suggested the use of water conservation technology, including infiltration wells. The results of other research reported by Tarigan (2017) show that infiltration wells can collect rainwater and reduce the volume of runoff by up to 30% on land with a significant level of function transfer. Hidayat (2019) further stated that infiltration wells are effective in slowing the flow of surface water, providing sufficient time for water to seep into the ground, thus helping to maintain the groundwater level. However, these studies are still limited to residential areas and have not been specifically applied to the development of educational facilities such as universities.

Apart from that, the research will also discuss solutions for using water absorption wells to overcome runoff and maintain groundwater levels, and will also explore the relationship between land conversion, increasing the drainage coefficient, and the efficiency of using water absorption wells as part of a sustainable drainage system.

Based on the above, this research can provide scientific novelty by applying the concept of water absorption wells as a water conservation solution in the context of developing educational facilities, especially universities. In contrast to previous research which focused mostly on housing or residential areas, this research examines the effectiveness of infiltration wells in dense and developing areas that are threatened by increased rainwater runoff.

The research aims to analyze the impact of land conversion on rainwater runoff at the Faculty of Engineering, Untag Samarinda, evaluate the effectiveness of water absorption wells in reducing rainwater runoff and increasing water infiltration into the ground, and provide recommendations for sustainable drainage system design for hospital development areas,able to control runoff discharge efficiently.

II. RESEARCH METHODS

The research was carried out in the Faculty of Engineering building area, University Campus 17 August 1945 Samarinda from May – July 2024. This research uses quantitative methods with an experimental approach and hydrological modeling to design and evaluate drainage systems at the Faculty of Engineering, University of 17 August 1945 Samarinda. The methods used include field data collection, hydrological analysis, and modeling simulations to evaluate the effectiveness of water absorption wells in reducing rainwater runoff and increasing water infiltration into the soil.

The stages of research activities are preparation, observation, collection of primary and secondary data, data processing and analysis, and reporting.

The data required was (1) rainfall data for the last 10 years obtained from the Meteorology, Climatology, and Geophysics Agency at the Class III Temindung - Samarinda meteorological station, as well as land use data and hydrological maps from relevant government agencies, (2) Measurements This was carried out directly in the field to obtain topographic data, soil characteristics, rainfall and runoff in the Faculty of Engineering area. Topographic data was obtained through surveys using Global Positioning System (GPS) and Total Station tools to map the research area, and (3) soil infiltration data was measured using the infiltration test method to determine the level of soil infiltration in the research area, especially in areas that will be converted into lecture buildings.

Data analysis includes: (1) calculating the average planned rainfall using the Gumbel Method; (2) calculating the average planned rainfall using the Type III Log Person Method, (3) testing the frequency suitability or data suitability test using the Smirnov Kolmogorof Test, (4) to test the deviation in the vertical direction using the Chi Square Test, (5)) to calculate rainfall intensity using the Mononobe Method, and (6) to estimate peak surface flow rates using the USSCS Rational method (1973).

III. RESULTS AND DISCUSSION

3.1. Rainfall Data Analysis

This plan uses daily rainfall data from the Meteorology, Climatology, and Geophysics Agency at the Class III Temindung - Samarinda meteorological station from 2014 to 2023 (10 years) which is presented in Table 1. In processing this rainfall data, rainfall is used,maximum daily rainfall (mm) each year.

Table 1. 10-Years Average Daily Rainfall

No.	Year	Rainfall Maximum Daily (mm)
1	2014	98,90
2	2015	84,30
3	2016	102,50
4	2017	78,80
5	2018	120,10
6	2019	102,30
7	2020	101,50
8	2021	99,70
9	2022	94,10
10	2023	105,50

(Source: Temindung Meteorological and Geophysical Station, 2024)

The Gumbel distribution is used for maximum data analysis, for example for flood frequency analysis. The Gumbel distribution has a coefficient of skewness (Coefficient of Skwennes) or Cs ≈ 1.14 and a Coefficient of Curtosis or Ck ≈ 5.40. This method usually uses a distribution and extreme values with a double exponential distribution.The results of calculating the average planned rainfall using the Gumbel Method are presented in Table 2.

Table 2. Calculation of Average Planned Rainfall using the Gumbel Method

No	Year	Rainfall (mm)	(Xi - X)	$(Xi - X)^2$	$(Xi - X)^3$	$(Xi - X)^4$
1	2014	98,90	0,13	0,02	0,00	0,00
2	2015	84,30	-14,47	209,38	-3.029,74	43.840,36
3	2016	102,50	3,73	13,91	51,90	193,57
4	2017	78,80	-19,97	398,80	-7.964,05	159.042,16
5	2018	120,10	21,33	454,97	9.704,49	206.996,70
6	2019	102,30	3,53	12,46	43,99	155,27
7	2020	101,50	2,73	7,45	20,35	55,55
8	2021	99,70	0,93	0,86	0,80	0,75
9	2022	94,10	-4,67	21,81	-101,85	475,63
10	2023	105,50	6,73	45,29	304,82	2.051,45
Amount		987,70	0,00	1.164,96	-969,30	412.811,43
Average		98,77				

(Source: calculation results)

- Standard Deviation (S)

$S = \left[\frac{1}{n-1}\sum_{i=1}^{n}(X_i - \bar{x})^2\right]^{\frac{1}{2}}$ = (1 / 10-1 x 1.164,96)$^{1/2}$ = 11,38

- Density Coefficient, Cs or G

$Cs = \frac{n\sum_{i=1}^{n}(X_i - X)^3}{(n-1)(n-2)s^3}$= 10 x (- 969,30) / (10- 1) x (10-2) x 11,38^3 = **- 0,09**

- Kurtosis Coefficient, (Ck)

Ck = $\frac{n^2 \sum_{i=1}^{n}(X_i - X)^4}{(n-1)(n-2)(n-3)s^4}$ = 10^2 x (412.811,43) / (10- 1) x (10-2) x (10-3) x $11{,}38^4$
= **4,89**

Table 3. Recapitulation of Calculations using the Gumbel Method

Distribution Type	Term or Condition	Result	Description
Gumbel Method	**Cs = 1,14** **Ck = 5,40**	Cs = -0,09 Ck = 4,89	Accepted

(Source: calculation results)

From the results of calculating rainfall distribution using the Gumbel method above, the values Cs = - 0.09 and Ck = 4.89 are obtained, while the requirements for the Gumbel method are Cs = 1.14 and Ck = 5.40, so it can be concluded that the Gumbel method can be used because the requirements for this method are met.

- So the magnitude of X with a return period of 2 years was :

$Xtr = b + \frac{1}{a}Ytr$, X2 = 92,88 + $\frac{1}{0{,}08}$ 0,3665 = **97,27** mm

- So the magnitude of X with a return period of 5 years was :

$Xtr = b + \frac{1}{a}Ytr$, X5 = 92,88 + $\frac{1}{0{,}08}$ 1,4999 = **110,85** mm

- So the magnitude of X with a return period of 1 years was :

$Xtr = b + \frac{1}{a}Ytr$, X10 = 92,88 + $\frac{1}{0{,}08}$ 2,2502 = **119,84** mm

The Log Person Type III distribution can be used to calculate the amount of design rain that occurs with a return period of T-years (Ibn Hi, 2021). The Log Person Type III distribution is used for all data distributions without having to meet the requirements for the skewness coefficient and kurtosis coefficient. The Log Person III distribution has a coefficient of skewness (Coefficient of Skwennes) or Cs, a kurtosis coefficient (Coefficient of Curtosis) or Ck, and a coefficient of variance or Cv with independent values. Calculations of Average Planned Rainfall using the Person Log Type III Method are presented in Table 4.

Table 4. Calculation of Average Planned Rainfall using the Log Person Type III Method

No.	Year	X (mm)	Log X (mm)	log Xi - log x	$(\text{Log Xi - log x})^2$	$(\text{Log Xi – log x})^3$
1	2014	98,90	2,00	0,003	0,0000	0,00000
2	2015	84,30	1,93	-0,066	0,0044	-0,00029
3	2016	102,50	2,01	0,019	0,0004	0,00001
4	2017	78,80	1,90	-0,095	0,0091	-0,00087
5	2018	120,10	2,08	0,088	0,0077	0,00067
6	2019	102,30	2,01	0,018	0,0003	0,00001
7	2020	101,50	2,01	0,014	0,0002	0,00000
8	2021	99,70	2,00	0,007	0,0000	0,00000
9	2022	94,10	1,97	-0,018	0,0003	-0,00001
10	2023	105,50	2,02	0,031	0,0010	0,00003
Jumlah			19,92	3,55,E-15	0,023	-0,00045

(Source: calculation results)

Based on the calculation results, the value of the Density Coefficient, Cs is obtained:

$$Cs = \frac{n \sum_{i=1}^{n}(X_i - X)^3}{(n-1)(n-2)s^3} Cs = \frac{10\ x(-0{,}00045)}{(10-1)(10-2)\ 0{,}05^3}$$

$Cs = -0{,}47$

Table 5. Recapitulation of Calculations using the Log Person Type III Method

Distribution Type	Term or Condition	Result	Description
Distribution of Log Person Type III	**Cs ≠ 0**	Cs = - 0,47	Acceptable

(Source: calculation results)

From the results of rainfall distribution calculations using the log person type III method above, the value Cs = -0.47 is obtained, while the requirements for the Type III Log Person method are Cs ≠ 0, so it can be concluded that the log person type III method can be used because of the requirements for this method fulfill.

- For a return period of 2 years

Log X_2= 1,99+ 0,08. 0,05 = 1,99
X_2= anti-Log 1,99 = **99,07** mm

- For a return period of 5 years

Log X_5 = 1,99 + 0.86. 0,05 = 2,04
X_5= anti-Log 2,04 =**108,54** mm

- For a return period of 10 years

Log X_{10} = 1,99 + 1,22. 0,05 = 2,05
X_{10}= anti-Log 2,05 =**113,30** mm

Table 6. Recapitulation of Design Rain Calculation Results

No.	Return Period	Design Rain (mm) Log Person Type III Method	Design Rainfall (mm) Gumbel Method
1	2	99,07	**97,27**
2	5	108,54	**110,85**
3	10	113,30	**119,84**

(Source: calculation results)

From the results of rainfall distribution calculations using the Gumbel Method and Type III Log Person Method above, the design used is the Gumbel Method (because the design rainfall is the largest).

3.2. Frequency Suitability Test or Data Suitability Test

The frequency suitability test or data suitability test uses the Kolmogorof-Smirnov test. Quraysi (2020) stated that to prove whether data is normal or not can be done using Kolmogorof – Smirnov analysis. This test is set to test deviations in the horizontal direction, the calculation steps are as follows:(1) rain data is sorted from smallest data to largest data; (2) convert the data into the logarithmic form, X = log; and (3) calculate the empirical probability by entering data serial numbers from smallest to largest. The results of the Smirnov Kolmogorof test are presented in Table 7.

Table 7. Results of the Kolmogorof-Smirnov Test

No.	X (mm)	P(x) = M/(n+1)	P(x<)	f(t) = (Xi-Xrt)/Sd	P'(x) = M/(n-1)	P'(x<)	Δ_{maks} = │P(x<) - P'(X<)│ (%)
1	**2**	**3**	**4 = 1-3**	**5**	**6**	**7 = 1-6**	**8 = 5-7**

1	78,80	0,09	0,91	-1,76	0,11	0,89	0,02
2	84,30	0,18	0,82	-1,27	0,22	0,78	0,04
3	94,10	0,27	0,73	-0,41	0,33	0,67	0,06
4	98,90	0,36	0,64	0,01	0,44	0,56	0,08
5	99,70	0,45	0,55	0,08	0,56	0,44	0,10
6	101,50	0,55	0,45	0,24	0,67	0,33	0,12
7	102,30	0,64	0,36	0,31	0,78	0,22	0,14
8	102,50	0,73	0,27	0,33	0,89	0,11	0,16
9	105,50	0,82	0,18	0,59	1,00	0,00	0,18
10	120,10	0,91	0,09	1,87	1,11	-0,11	**0,20**

(Source: calculation results)

Δmax = 0.20 %
Δtable = 0.41 %
Conclusion: The value of Δmax = 0.20 < Δtable = 0.41 means the data is acceptable and meets the requirements.

3.3. Test the Deviation in the Vertical Direction

To test the deviation in the vertical direction using the Chi-Square test, the results of the Chi-Square test are presented in Table 8.

Table 8. Chi-Square Test Results

No.	Sub Group Limit Value			Data Amount		(Oi-Ei)	$(Oi-Ei)^2$ / Ei
				Oi	Ei		
1	73,64	< P <	1,919	1	2	1	0,50
2	83,96	< P <	1,965	2	2	0	0,00
3	94,29	< P <	2,011	4	2	4	2,00
4	104,61	< P <	2,057	2	2	0	0,00
5	114,94	< P <	2,102	1	2	1	0,50
Amount				10	10		**3,00**

(Source: calculation results)

Chi-Square Price = 3.00 %
Critical Chi-Square Price = 5.991 %
Interpretation of Results = Chi – Square Price 3.00< 5.991 Critical Chi-Square Price The theoretical distribution equation is acceptable.

3.4. Analysis of Catchment Area

The catchment area is a drainage area that receives rainfall during a certain time (Rain Intensity) giving rise to runoff discharge which must be accommodated by the channel until it flows to the end of the channel (outlet). The results of the Catchment Area calculation are presented in Table 9.

Table 9. Catchment Area Calculation Results (A)

No.	Channel	**Building**	**Length (Km)**	**Catchment Area (Ha)**
1.	Channel 1	A	0,045	0,002
2.	Channel 2		0,042	0,189
3.	Channel 3		0,007	0,001
4.	Channel 4	B	0,038	0,024
5.	Channel 5		0,008	0,001

6.	Channel 6		0,025	0,016
7.	Channel 7	C	0,052	0,270
8.	Channel 8		0,008	0,001
9.	Channel 9		0,008	0,002
10.	Channel 10		0,006	0,001
Amount			**0,239**	**0,507**

(Source: calculation results)

Based on the calculation results, the length of the catchmentarea is 0.239 km and the area is 0.507 hectares.

3.5. Calculation of Concentration Time (Tc)

Concentration time is calculated by adding up two components, namely (to) the time required for water to flow over the land surface to the nearest channel and (td) the travel time from first entering the channel to the outlet point, concentration time can be calculated using the formula: tc = to + earlier. The results of concentration time calculations are presented in Table 10.

Table 10. Calculation of Concentration Time (Tc)

No.	Channel	Building	Length (m)	Existing Data – Concentration Time (minutes)					
				nd	**v**	**s**	**to**	**td**	**Tc**
1.	**Channel** 1	A	45,00	0,013	0,50	0,01	0,68	1,50	2,18
2.	**Channel** 2		42,00	0,013	0,50	0,01	2,35	1,40	3,75
3.	**Channel** 3		7,00	0,013	0,50	0,01	0,76	0,23	1,00
4.	**Channel** 4	B	38,00	0,013	0,50	0,01	1,66	1,27	2,93
5.	**Channel** 5		8,00	0,013	0,50	0,01	0,76	0,27	1,03
6.	**Channel** 6		25,00	0,013	0,50	0,01	1,66	0,83	2,49
7.	**Channel** 7	C	52,00	0,013	0,50	0,01	1,48	1,73	3,21
8.	**Channel** 8		8,00	0,013	0,50	0,01	0,76	0,27	1,03
9.	**Channel** 9		8,00	0,013	0,50	0,01	0,92	0,27	1,19
10.	**Channel** 10		6,00	0,013	0,50	0,01	0,86	0,20	1,06

(Source: calculation results)

3.6. Calculation of Rainfall Intensity

To calculate rainfall intensity using the Mononobe Method formula with the formula (Suripin, 2004): $I = \frac{R}{24}(\frac{24}{tc})^{2/3}$. The results of calculating rainfall intensity are presented in Table 11.

Table 11. Calculation of Rainfall Intensity

No.	Channel	Building	Length (m)	Existing Data – Rainfall Intensity **(mm/jam)**			
				Tc	**2**	**5**	**10**
1.	**Channel** 1	A	45,00	2,18	312,95	342,89	357,91
2.	**Channel** 2		42,00	3,75	218,19	239,07	249,54
3.	**Channel** 3		7,00	1,00	526,97	577,39	602,68
4.	**Channel** 4	B	38,00	2,93	257,20	281,81	294,16
5.	**Channel** 5		8,00	1,03	515,56	564,88	589,63
6.	**Channel** 6		25,00	2,49	286,19	313,57	327,31
7.	**Channel** 7	C	52,00	3,21	257,20	281,81	294,16
8.	**Channel** 8		8,00	1,03	241,73	264,86	276,46

9.	**Channel** 9		8,00	1,19	515,56	564,88	589,63
10.	**Channel** 10		6,00	1,06	469,87	514,83	537,38

(Source: calculation results)

3.7. Calculation of Runoff Coefficient (C)

The drainage coefficient is a comparison between the amount of water that flows in an area due to rain, with the amount that falls in that area. This flow coefficient is a reflection of the characteristics of the drainage area which is expressed as a number 0 - 1 depending on many factors. Apart from meteorological factors and flow area factors, a factor that has a big influence on the flow coefficient is human intervention in planning land use. The flow coefficient in a direction is influenced by characteristic conditions. The results of calculating the runoff coefficient (C) are presented in Table 12.

Table 12. Calculation of Runoff Coefficient (C)

No.	**Channel**	**Building**	**Lenght (m)**	**Koefisien C**
1.	**Channel** 1	A	45,00	0,70
2.	**Channel** 2		42,00	0,75
3.	**Channel** 3		7,00	0,70
4.	**Channel** 4	B	38,00	0,75
5.	**Channel** 5		8,00	0,70
6.	**Channel** 6		25,00	0,75
7.	**Channel** 7	C	52,00	0,75
8.	**Channel** 8		8,00	0,70
9.	**Channel** 9		8,00	0,70
10.	**Channel** 10		6,00	0,70

(Source: calculation results)

3.7. Calculation of Flow Rate

The design flood discharge is the largest flood discharge that may occur in an area with a certain chance of occurrence. The design flood discharge for planning a drainage network system is calculated from rainwater discharge and resident waste discharge with a return period of T (years). The method for estimating peak surface flow rates that is commonly used is the USSCS Rational method (1973). This method is very simple and easy to use. This method is still quite accurate when applied to small to medium urban areas. The mathematical equation of the rational method is expressed in the form: Q = 0.278 C.I.A. The results of the 2, 5, and 10-year Return Period Flow Discharge calculations are presented in Table 13.

Table 13. Recapitulation of Flow Discharge for Return Periods of 2, 5, and 10 Years

No.	**Channel**	**Building**	**Flood Discharge(m^3/second)**		
			2 Years	**5 Years**	**10 Years**
1.	**Channel** 1	A	0,002	0,002	0,002
2.	**Channel** 2		0,085	0,096	0,104
3.	**Channel** 3		0,001	0,001	0,001
4.	**Channel** 4	B	0,013	0,015	0,016
5.	**Channel** 5		0,001	0,001	0,001
6.	**Channel** 6		0,010	0,011	0,012
7.	**Channel** 7	C	0,134	0,153	0,165
8.	**Channel** 8		0,001	0,001	0,001
9.	**Channel** 9		0,003	0,003	0,003
10.	**Channel** 10		0,002	0,002	0,002

(Source: the largest calculation results are taken for the left and right areas)

3.8. Calculation of Drainage Channel Capacity

Calculation of Drainage Channel Capacity with Plan Dimensions. Calculation of drainage channel dimensions uses the continuity formula and Manning's formula, as follows: Q = A.V

Water flow speed is an important parameter in designing channel dimensions, where the minimum speed allowed will not cause sedimentation and prevent plant growth in the channel. Meanwhile, the maximum speed allowed will not cause erosion of the channel material: $\mathbf{V} = \frac{1}{n} . R^{2/3} . S^{1/2}$

Information :B = Channel bottom width (0,60 m); H = Channel height (0,40 m);w = High Security (0,20 m);
h = Height of wet channel cross section (0,40 – 0,20 = 0,20 m); s = Channel slope (1%);
R = hydraulic radius; V = average speed; and Q = flow rate.

The results of calculating drainage channel capacity with planned dimensions are presented in Table 14.

Table 14. Recapitulation of Drainage Channel Capacity Calculations with Plan Dimensions

No.	Channeln	b	H	h	A	P	R	n	s	v	Q	Q_{10}	Note
		m	m	m	m^2	m	m		%	m/dt	m^3/dt	m^3/dt	
1.	Channel 1	0,600	0,400	0,200	0,240	1,400	0,200	0,015	1	2,280	0,547	0,002	Safe
2.	Channel 2	0,600	0,400	0,200	0,240	1,400	0,200	0,015	1	2,280	0,547	0,104	Safe
3.	Channel 3	0,600	0,400	0,200	0,240	1,400	0,200	0,015	1	2,280	0,547	0,001	Safe
4.	Channel 4	0,600	0,400	0,200	0,240	1,400	0,200	0,015	1	2,280	0,547	0,016	Safe
5.	Channel 5	0,600	0,400	0,200	0,240	1,400	0,200	0,015	1	2,280	0,547	0,001	Safe
6.	Channel 6	0,600	0,400	0,200	0,240	1,400	0,200	0,015	1	2,280	0,547	0,012	Safe
7.	Channel 7	0,900	0,700	0,45	0,630	2,300	0,350	0,015	1	3,311	2,086	0,165	Safe
8.	Channel 8	0,900	0,700	0,45	0,630	2,300	0,350	0,015	1	3,311	2,086	0,001	Safe
9.	Channel 9	0,900	0,700	0,45	0,630	2,300	0,350	0,015	1	3,311	2,086	0,003	Safe
10.	Channel 10	0,900	0,700	0,45	0,630	2,300	0,350	0,015	1	3,311	2,086	0,002	Safe

(Source: calculation results)

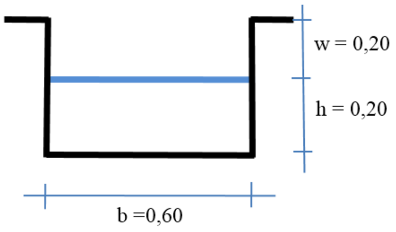
The calculation results regarding the type, shape, and dimensions of drainage channels are presented in Table 15.

Table 15. Recapitulation of Types, Shapes, and Dimensions of Drainage Channels

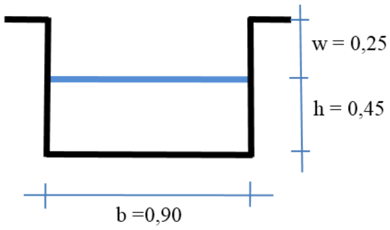
No.	Channel	Building	Channel Type	Channel Shape	Channel Length	Bottom width	Height
					m	m	m
1.	Channel 1	A	Open	Rectangle	45,00	0,60	0,40
2.	Channel 2		Open	Rectangle	42,00	0,60	0,40
3.	Channel 3		Closed	Rectangle	7,00	0,60	0,40
4.	Channel 4	B	Open	Rectangle	38,00	0,60	0,40
5.	Channel 5		Open	Rectangle	8,00	0,60	0,40
6.	Channel 6		Open	Rectangle	25,00	0,60	0,40
7.	Channel 7	C	Open	Rectangle	52,00	0,90	0,70
8.	Channel 8		Open	Rectangle	8,00	0,90	0,70
9.	Channel 9		Open	Rectangle	8,00	0,90	0,70
10	Channel 10		Open	Rectangle	6,00	0,90	0,70

(Source: Calculation Results)

Cross-sectional images of Type I and Type 2 channels are as follows :



Cross-section of Type 1 Channel
(60/40 dimensions)



Cross-section of Type 2 Channel
(90/70 dimensions)

3.9. Calculation of Water Absorption Wells with Plan Dimensions

The method for calculating water absorption wells is not much different from calculations in drainage planning. However, when planning infiltration wells, what is taken into account is the volume of water that infiltrates, not the flow of water that flows as in drainage planning. The basic concept is that the volume of the infiltration well must be able to accommodate the large volume of water that will be infiltrated.

In the distribution analysis, it was concluded that the Gumbel Method distribution equation met the suitability test and was used in calculating the probability distribution of daily rainfall data. The rain return period used in planning the drainage system for this hospital uses a rain return period of 10 years, so it is obtained that R10 = 119.84 mm, by calculating the concentration-time (Tc) in the drainage calculation, the largest was taken, namely 3.75 minutes, then the value of Rain Intensity (I) was 41.54 mm/hour.

3.10. Land Use

The land use of the area of the Faculty of Engineering, University of 17 Agustus 1945 Samarinda is presented in Table 16.

Table 16. Percentage of Current Land Use

No.	Item	Volume (m^2)	Description	Percentage
1	Land	5.536,61	surface area	100 %
2	Building A	1.764,00	building area	31,86 %
3	Building B	280,00	building area	5,06 %
4	Building C	1.976,00	building area	35,69 %
5	Yard/Street	1.516,61	area	27,39 %

(Source: Field survey results)

3.11. Calculation of Rainwater Discharge and Number of Infiltration Wells

The planned dimensions of the infiltration well are diameter (d) 1.5 m and depth (t) 3 m. If the walls of the planned well use material that cannot absorb water then the area of the wall cannot be taken into account, meanwhile, K is the soil permeability coefficient taken 1.5.10-3 (non-solid silt).

Calculating the rainwater discharge to be infiltrated uses the formula:

$Q = 0{,}278\ C.I.A\ =\ 0{,}278 \times 0{,}74 \times 41{,}54 \times 0{,}0055$

$\mathbf{Q_{rainfall} = 0{,}04\ m^3/second}$

Calculation of infiltrated rainwater discharge uses the formula:

Tc = 3,75 minute = 0,06 hours

A_{total} = well wall area + well base area

$= (2 . \pi . r . t) + (\pi . r^2) = (2 \times 3{,}14 \times 0{,}75 \times 3) + (3{,}14 \times 0{,}75^2) = 14{,}14 + 1{,}77 = 15{,}91\ m^2$

K $= 1{,}5.10^{-3}$ cm/second = 0,13 m/day

$Q_{absorption} = \frac{Tc}{24} . A_{total} . K$

$= \frac{0{,}06}{24} \times 15{,}91 \times 0{,}13 = \mathbf{0{,}006\ m^3/second}$

Number of Infiltration Wells = $Q_{rainfall}/Q_{absorption}$

= 0,04 / 0,006 = 6,67 rounded to7 units

A picture of an infiltration well is presented below:

IV. CONCLUSION

Based on the results of research and data analysis, it can be concluded as follows:

1. Based on the calculation results, it shows that the Gumbel method meets the criteria for testing the distribution of daily rainfall data, with a rainfall intensity of 41.54 mm/hour for a return period of 10 years with a channel shape with square dimensions and sizes of 60/40 and 90/70, where Qplan = 0.547 m3/second > Qflood = 0.002 m3/second (safe), meaning that all planned drainage dimensions are quite safe against flood discharge.
2. Based on the analysis, the total number of infiltration wells required is 7 units of wells with the dimensions of the infiltration wells being designed with a diameter of 1.5 m and a depth of 3 m, capable of accommodating a runoff discharge of 0.04 m³/second to handle the resulting runoff discharge.
3. Implementation of infiltration wells can increase infiltration and maintain groundwater levels, as well as significantly reduce the risk of local flooding.

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