

Research Article

Planning of High Water Levels in Secondary Channels on the Serayu Irrigation D.I Cilacap Regency, Central Java

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Abstract: Cilacap Regency in Central Java Province is recognized as an important contributor to national food production due to its extensive agricultural land and reliance on technical irrigation systems. The performance of irrigation networks, particularly secondary channels in the Serayu Irrigation Area (DI), is essential in regulating water levels to support agricultural activities in Sampang and Karangasem Villages. Variations in rainfall and field conditions often create water level differences that disrupt irrigation distribution, reducing water flow efficiency to rice fields and lowering productivity, especially during the dry season. This study aims to design secondary irrigation channels capable of maintaining stable water levels based on irrigation requirements. The research applies a descriptive quantitative method using rainfall data from BMKG, along with land area and elevation data interpreted from Google Earth imagery in 2025. The data were analyzed using probability and Thiessen polygon methods to estimate design rainfall, determine water availability, calculate irrigation demand, and plan channel dimensions. The analysis shows that Secondary Channel BGS 4.B serves an irrigation area of 103.57 hectares with a planned discharge capacity of 0.0343 m³/s. The channel design includes a base width of 0.65 meters and a water depth of 0.65 meters, with water surface elevations of 14.27 meters upstream and 13.15 meters downstream. Evaluation using a 10-year rainfall return period of 151.677 mm shows the channel can convey discharge effectively while maintaining water levels below the embankment, ensuring reliable irrigation distribution.

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Keywords: DI Serayu; Irrigation; Planned Debit; Secondary Channels; Water Level.

1. Introduction

The sustainability of the agricultural sector in the western region of Central Java Province is highly dependent on the availability of water resources. Agricultural systems with high planting intensity, especially in areas dominated by rice fields, have long been supported by the use of large river flows as a source of irrigation water. Good irrigation facilities and systems must support water supply (Rustan dkk., 2023). The resilience of irrigation networks that utilise river flows is crucial for food production sustainability, particularly in maintaining a stable water supply for agricultural land that depends on technical irrigation. (Rahayu dkk., 2017) found that the ability to distribute water to agricultural land depends on the resilience and efficiency of the irrigation network, especially in secondary channels, because channel efficiency affects the volume of water that can be used by rice fields. In this context, the Serayu Irrigation Area (DI) is one of the main irrigation systems supporting agricultural operations in the western part of Central Java Province, including Cilacap Regency. The 20,795 ha Serayu DI area is managed by the central government with the intake gate located at the Serayu Dam in Gambarsari Village, Kebasen District, Banyumas Regency (Sulistiawan dkk.,

2020). This area consists of three districts, namely Banyumas, Kebumen and Cilacap. The Serayu Main Canal consists of Sumpiuh, Cilacap, Maos, Dopleng, and Binangun.

One of the efforts to achieve the national food security programme is to provide water for irrigation needs (Susmono dkk., 2023). To meet irrigation needs, the Serayu Dam is utilised through a network of channels that reach various agricultural areas. The network's ability to regulate flow and water level greatly affects the performance of the irrigation system in this region, especially for secondary channels, which distribute water from the main network to agricultural land. Proper management of secondary channels plays an important role in maintaining equitable water distribution and supporting sustainable agricultural production (Mangrio dkk., 2014).

With its vast area and intensive cropping patterns, Central Java is known as one of the national centres of rice production. The rice farming system in this region is highly dependent on the distribution and availability of irrigation water. The water supply system for rice fields and the level of irrigation services received by farmers are influenced by the management of the irrigation network (Attamimi dkk., 2022). To maximise water distribution to rice fields, irrigation channels must be in good condition and well maintained. Without a good irrigation system, agricultural productivity will decline and could jeopardise national food security (Saridewi & Salsabila, 2025)

The agricultural areas in Cilacap Regency depend on the Serayu irrigation system to meet the water needs of their rice fields. Secondary channels connect the main network to the rice fields. The flow and water level of the secondary channels greatly affect the ability of water to reach the entire agricultural area evenly, so their management has a direct impact on agricultural yields. In addition, due to the poor performance of the system, water distribution in the secondary channels can be uneven, which affects the water supply to agricultural land (Mangrio dkk., 2014).

Irrigation meets the water requirements of food crops for agriculture (Muji Rifai, 2024). High water level discrepancies in secondary channels, influenced by rainfall variations and field conditions, are one of the problems in the Serayu irrigation network in Cilacap Regency. The difference in water levels causes irrigation water distribution to be less effective, especially during the dry season. As a result, most rice fields lack water. This condition has the potential to reduce agricultural productivity and indicates that irrigation network management must be carried out in a more technically planned manner.

To ensure the overall efficiency and effectiveness of the irrigation system, it is essential to plan secondary irrigation channels correctly (Fajrinia, 2024). The planning of secondary channels tailored to field conditions in the Serayu service area is the focus of efforts to resolve this issue. Water availability analysis based on rainfall data, calculation of water requirements for rice field irrigation, and analysis of the suitability of the topography of the area are used for planning. A channel design planning approach based on water requirements and field conditions is considered effective in improving irrigation network performance and water level stability.

The design of secondary channels with appropriate water level settings is expected to increase irrigation water utilisation and maintain water availability for agriculture in the Serayu DI service area. Farmers' welfare will improve with good irrigation water distribution. (Kinasih dkk., 2023). This method shows that planning the water level of secondary channels can be an effective technical solution to support agricultural sustainability in DI Serayu, Cilacap Regency, Central Java.

2. Literature Review

2.1. Irrigation Network

Rice field agricultural production is greatly influenced by the availability of sustainable water, especially in areas with high planting intensity. Improving irrigation systems is one way to increase agricultural yields. Therefore, it is very important to have an irrigation network system that makes it easier to ensure better water availability (Bolango & Gorontalo, n.d.). Judging from the factors of efficiency and effectiveness, the irrigation system can be said to be successful in its management (Trimalino dkk., 2024).

An irrigation network consists of main channels and ancillary structures that form a single unit and require irrigation water management. An irrigation area is an area of land that receives water from an irrigation network (Harifin dkk., 2019). This network starts from a single area that receives water from the irrigation network and has an irrigation area to supply,

distribute, provide, use and dispose of irrigation water (Ariyanto, 2019). The right amount of water is needed for each field of agriculture and plantation. To meet these needs, water can be provided as needed to stimulate plant growth and improve water use efficiency (Prasetyo dkk., 2024).

2.2. Secondary Channel

One of the technical irrigation systems in Central Java that uses the Serayu River as its main water source is DI Serayu. The reliability of this system is highly dependent on the network of channels, especially secondary channels, in maintaining stable flow and water levels to ensure even water distribution to agricultural areas, including Sampang Village and Karangasem Village.

Secondary channels carry water from primary channels to tertiary plots served by primary channels. The final tapping structure marks the end of this channel (Tuanany dkk., 2023). Secondary channels begin distributing water to various service areas, so the stability of the flow and water level of secondary channels is very important to ensure even distribution of irrigation water.

2.3. Water Level

One of the most important hydraulic parameters in the planning and management of irrigation channels is the water level, which is measured as the vertical distance between the water surface and the bottom of the channel at a specific cross-section. The shape, slope of the bottom, and roughness of the channel walls affect the water level value. The water level of a channel is the height of the water surface measured from an existing reference point (Sa'adah dkk., 2020).

Water level is very important in irrigation networks, especially in secondary channels, to ensure that water can be conveyed and distributed evenly to the service area. Water levels that are too low can prevent water from reaching tapping structures or tertiary channels, while water levels that are too high can cause runoff and damage to channels.

In addition to hydraulic factors, the operational conditions of the irrigation network, such as how the sluice gates are regulated and how the discharge at the tapping structure affects the water level. Ineffective management can cause high water level differences in some parts of the channel, resulting in inefficient water distribution. Although the impact on water loss due to seepage and evaporation is not too significant, some points in the channel sometimes have very high seepage values. This is due to the physical condition of the channel, which has damaged the waterways, allowing water to seep out easily. The results of the analysis (Najimuddin dkk., 2025) show that leaks in the channels, the accumulation of rubbish in the channels, and the growth of plants around the channels are the biggest sources of water loss.

2.4. Basis for Planning the Water Level of Secondary Channels

In order for the channel to drain water as needed without overflow, the water level of the secondary channel must be planned based on the discharge plan obtained from an analysis of water distribution needs and the hydrological conditions of the area.

Next, an open channel hydraulic analysis was conducted to determine the planned water level. This analysis links the relationship between flow discharge, cross-sectional area, base slope, and channel roughness. The rice fields in Laliseng Village, which use surface irrigation, also use a hydraulic approach in the planning and management of the irrigation system. In this system, gravitational force is used to distribute water to agricultural land. As a result, water flows through channels and is allowed to flow naturally over the land. The flow characteristics of surface irrigation are highly dependent on the hydraulic conditions of the channel, such as discharge and water level. Therefore, a hydraulic approach is essential to ensure even water distribution (Rifaldi dkk., 2024).

To maintain flow stability and channel operational safety against discharge fluctuations and the effects of local hydrological conditions, water level planning also considers the establishment of a water level plan. To ensure that the channel continues to operate reliably under various flow conditions and supports sustainable irrigation water distribution, the establishment of this water level is very important.

2.5. Efficiency and Performance of Secondary Lines

The ability of a channel to optimally distribute irrigation water from the main channel to the service area is known as secondary channel efficiency. The physical condition of the channel, high water levels, water loss due to seepage and leakage, and proper flow regulation affect this efficiency. Uneven water distribution can occur due to decreased secondary channel efficiency. The quantity of water changes from upstream to downstream, causing water loss (Prasetyo dkk., 2024)

The ability of the channel to maintain flow stability according to plan is another factor that determines the performance of secondary channels. Water levels that do not match the plan can disrupt water distribution and reduce the quality of irrigation services. In addition, fluctuations in water levels can cause runoff in some parts of the channel. This can damage the channel construction and disrupt the operation of the irrigation network.

3. Research Methods

3.1. Research Location



Figure 1. Research Location Map in the Serayu Irrigation Area (DI).

The focus of this study is the agricultural area included in the Serayu Irrigation System (DI), which covers the districts of Banyumas, Cilacap, and Kebumen. However, this study only discusses the agricultural area in Cilacap District that receives irrigation water from the Serayu Dam through a network of secondary channels. The research location is focused on the areas of Sampang Village and Karangasem Village, Sampang Subdistrict, Cilacap Regency.

3.2. Rainfall Data and NFR

This study utilised rainfall data from three nearby rain stations, namely the Banjarnegara Geophysical Station, the Tegal Maritime Station, and the Tunggul Wulung Station. The purpose of using more than one station was to represent rainfall variations in the study area. For this analysis, the maximum rainfall values from the three stations were calculated for the same period. This method is used to anticipate the highest rainfall levels, which can affect discharge channel planning and water availability for irrigation, thereby making the resulting calculations safe (conservative).

The purpose of using more than one rain station is to obtain rainfall data that is more spatially representative. According to (Amin dkk., 2024), The distribution and number of observation stations affect the level of detail of rainfall data produced in the region. Therefore, this method is used to support hydrological analysis in this study.

Mathematically, the following equation can be used to calculate the expected rainfall:

$$R = \max (R_1, R_2, R_3)$$

with:

R = planned rainfall (mm)

R_1, R_2, R_3 = rainfall from each station (mm)

The Normalised Factor of Rainfall (NFR) method is used to compare actual annual rainfall with long-term average annual rainfall, thereby indicating the annual hydrological conditions of the study area. NFR is one of the simplest indices used to assess drought indices. The amount of rainfall at a given time is divided by the average rainfall to produce a normalised index percentage (Soimah dkk., 2024). The NFR calculation is performed using the following equation:

$$NFR = \frac{P_i}{\bar{P}} \times 100\%$$

with:

P_i = total annual rainfall in year i (mm/year)

\bar{P} = average annual rainfall during the observation period (mm/year)

3.3. Planning of Base Width (b) and Water Level Height (h)

The base width (b) and water level height (h) of the channel are determined through a planning process that takes into account the planned discharge and geometric conditions of the channel. The determination of the channel cross-sectional dimensions refers to the KP-03 Irrigation Planning Standard (Channel Planning Criteria) issued by the Directorate General of Water Resources, Ministry of Public Works.

KP-03 explains that the b/h ratio, which measures the relationship between the base width of a channel and the water level, can be used as a standard for planning channel cross-sections to meet the requirements of flow stability, safety, and flow efficiency. The following is the formula for this relationship:

$$\frac{b}{h} = n \text{ or } b = n \times h$$

with:

b = channel base width (m)

h = water level in the channel (m)

n = b/h ratio

The $\frac{b}{h}$ ratio is used as a reference in planning the cross-sectional dimensions of the channel and is applied in accordance with the ratios recommended in Table 5. Therefore, the planned channel dimensions are still within a safe and efficient range for carrying the planned discharge.

In addition to referring to the KP-03 standard, the determination of the channel dimensions is also supported by the results of research conducted by (Attamimi dkk., 2022) In the planning of the Samal Kiri irrigation canal in Central Maluku Regency, the width and water level of the canal were selected using a cross-sectional ratio approach in accordance with irrigation canal planning criteria, resulting in an effective and efficient canal system for distributing irrigation water.

3.4. Research Flow Chart

The research flowchart shows the research process arranged systematically, starting from the data collection stage, data analysis, to the planning and technical verification of the channel design. This flowchart is used as a guideline in conducting research to ensure that each stage is interrelated and produces a channel design that meets technical requirements.



Figure 2. Research Flow Chart.

4. Results and Discussion

4.1. Analysis of Rainfall Station Impact Area

The results of the regional rainfall analysis were produced using the Thiessen method with data from three rain stations, namely the Banjarnegara Geophysical Station, the Tegal

Maritime Station, and the Tunggul Wulung Station. These stations were selected because they are located near the irrigation areas under review and are considered representative of rainfall conditions in the study area.

A summary of the annual maximum rainfall for each rain gauge station was compiled as the basis for calculating regional rainfall. This maximum rainfall data was used as the main input in calculating regional rainfall, which is presented in Table 1.

Table 1. Annual Maximum Rainfall Data at Each Rainfall Station.

Year	Maximum Rainfall		
	Station 1	Station 2	Station 3
2014	54	109	193,9
2015	78,6	80	146,6
2016	149,5	134,5	181,3
2017	117,8	115,6	179,6
2018	122,9	88,5	199,5
2019	112,7	114,8	134,6
2020	135	189,1	133,2
2021	107	144,2	132,5
2022	119,5	110,2	206,8
2023	84	69,3	356
2024	156	159,5	197,8

Furthermore, in calculating regional rainfall, an analysis of the Thiessen area influence of the three rainfall stations was used as a weighting factor. A summary of the influence area of each rainfall station is presented in Table 2.

Table 2. Rainfall Station Influence Area Based on Thiessen.

	Station 1	Station 2	Station 3
Area	2951,55	2485,64	1997,21
Total Area	7434,40		

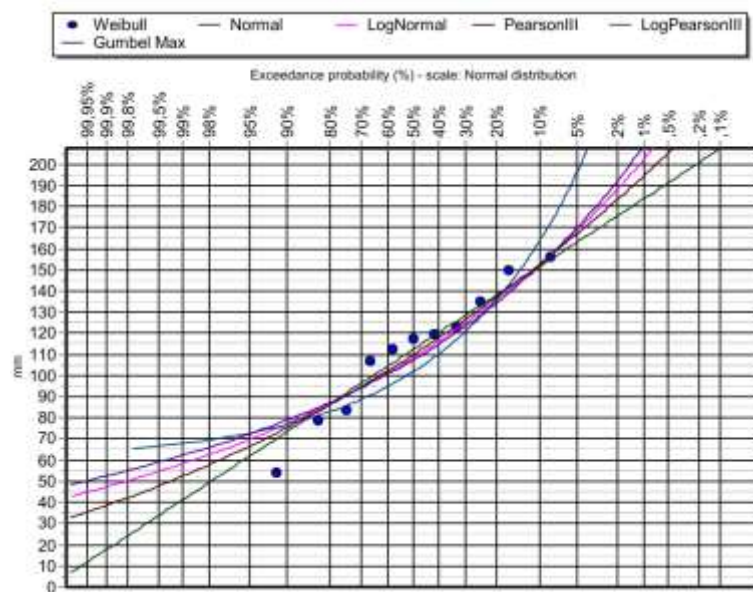


Figure 3. Graph of the Relationship between Probability and Annual Maximum Rainfall in Various Distributions.

Based on the graph of maximum annual rainfall probability in Figure 3, it can be seen that in several statistical distributions, the distribution of rainfall data tends to follow a relatively linear upward pattern. The curve trends in the Normal, Log Normal, Pearson III, Log Pearson III, and Gumbel Max distributions show a tendency for the curve to be relatively close to the observed data points, especially in the medium to high probability range. This indicates that these distributions can visually represent the distribution pattern of annual maximum rainfall in the study area.

Table 3. Results of the Kolmogorov-Smirnov Test for the Suitability of the Annual Maximum Rainfall Distribution.

Kolmogorov-Smirnov test for:All data	Kolmogorov-Smirnov			Attained a	DMax
	$\alpha=1\%$	$\alpha=5\%$	$\alpha=10\%$		
Normal	ACCEPT	ACCEPT	ACCEPT	99,7557%	9,5940%
LogNormal	ACCEPT	ACCEPT	ACCEPT	91,0764%	14,5790%
Pearson III	ACCEPT	ACCEPT	ACCEPT	96,3611%	12,7390%
Log Pearson III	ACCEPT	ACCEPT	ACCEPT	47,7134%	23,0440%
EV1-Max (Gumbel)	ACCEPT	ACCEPT	ACCEPT	85,0426%	16,0480%

Based on the results of the distribution suitability test using the Kolmogorov-Smirnov method presented in Table 3, each distribution tested meets the acceptance criteria at significance levels of $\alpha = 1\%$, 5% and 10% . However, the normal distribution showed the best level of conformity, reaching a value of $\alpha = 99.7557\%$, which was the highest value of all the distributions tested. These results indicate that the normal distribution has the best ability to show the distribution pattern of annual maximum rainfall data in the study area. Therefore, this distribution was selected for use in calculating planned rainfall.

Table 4. Planned Rainfall for Various Return Periods Based on Probability Distribution.

Probability Distribution	Return Period (years)		
	2	5	10
Normal	112,455	138,212	151,677
LogNormal	108,508	135,883	152,84
Pearson III	109,958	137,215	152,932
Log Pearson III	101,95	136,078	164,105
EV1-Max (Gumbel)	107,425	134,482	152,396

As presented in Table 4, rainfall plans are set for various return periods based on the selected normal distribution. A 10-year return period was selected for this planning because it was considered appropriate for the level of risk and function of the irrigation system being evaluated. The calculation results show that the planned rainfall for a 10-year return period is 151.677 mm, which is used as the main parameter in hydrological calculations and further analysis of the irrigation system under review.

4.2. Analysis of NFR Values Based on Rainfall Stations

Figure 4 shows a comparison of the annual NFR values from Station 1, Station 2, and Station 3 during the observation period, indicating variations in hydrological conditions based on the results of annual hydrological condition analysis. In general, all rainfall stations have NFR values below 1, indicating that annual hydrological conditions tend to be relatively dry. The NFR values at the three stations changed from year to year with different patterns. Station 1 showed relatively more stable variations, Station 2 experienced sharper variations, and Station 3 usually had higher NFR values, with a peak around 2023.

Although NFR values at Station 2 and Station 3 increased over several years, these conditions were not consistent and generally showed a tendency towards wet conditions rather than relatively dry conditions during the observation period.

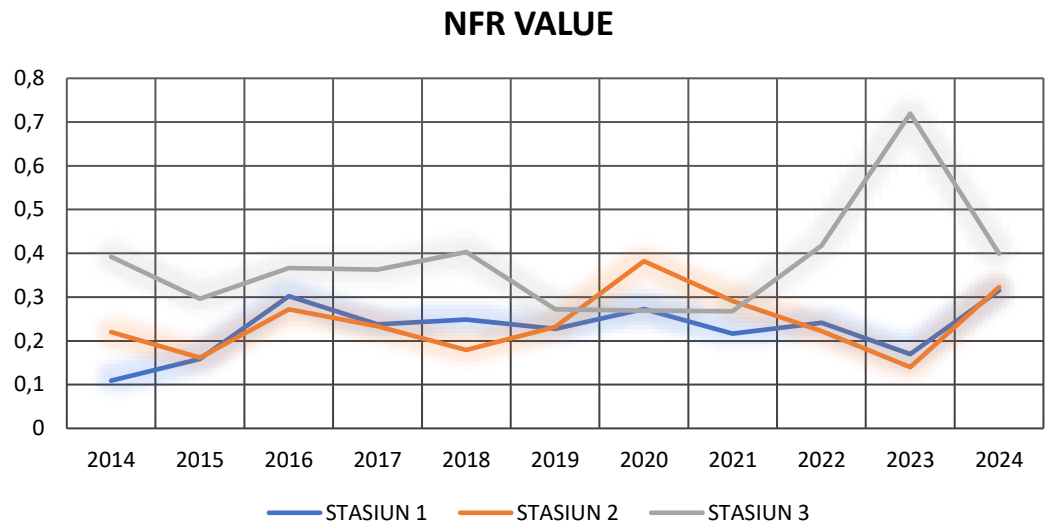


Figure 4. Graph of Annual NFR Values at Each Station.

4.3. Irrigation Scheme

The irrigation scheme in the figure shows that the irrigation channel analysed is the BGS 4.B secondary channel, which is divided into several markers as reference points for observation along the channel. Using these markers, the channel is divided to facilitate inspection of the channel condition, analysis of changes in discharge and water level, and evaluation of water distribution in each channel segment.

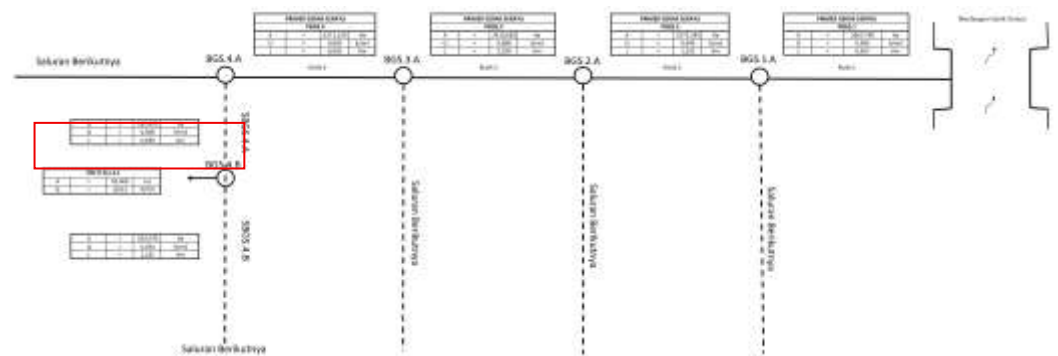


Figure 5. Irrigation Scheme.

4.4. Secondary Channel Dimension Planning

Based on the calculations in Table 5, one of the sections analysed specifically is the BGS 4.B secondary channel. This channel serves an irrigation area of 103.57 ha with a planned discharge of 0.0343 m³/dt. The BGS 4.B secondary channel is planned to use cross-sectional dimensions with a channel base width (b) of 0.65 m and a water level height (h) of 0.65 m. These dimensions are used as the basis for planning the secondary channel on the BGS 4.B section.

Table 5. Secondary Channel Dimension Planning

No	Channel Name	Area A ha	Debit Q m ³ /dt	Perb. b/h n	Slope m	Roughness k	Width b m	Hight h m	Area Tamp. F m ²	Wet Cir- cumference O m	Jari 2 Hid R m	Speed V m/dt	Slope i
1	Sekunder BGS.4E	7,64	0,0025	1,00	1,00	35,00	0,65	0,65	0,85	2,49	0,34	0,00300	0,00000

2	Sekunder BGS.4D	28,04	0,0093	1,00	1,00	35,00	0,65	0,65	0,85	2,49	0,34	0,01100	0,00007
3	Sekunder BGS.4C	78,47	0,0260	1,00	1,00	35,00	0,65	0,65	0,85	2,49	0,34	0,03078	0,00052
4	Sekunder BGS.4B	103,57	0,0343	1,00	1,00	35,00	0,65	0,65	0,85	2,49	0,34	0,04063	0,00091
5	Sekunder BGS.4A	145,97	0,0484	1,00	1,00	35,00	0,65	0,65	0,85	2,49	0,34	0,05726	0,00181

4.5. Secondary Channel Water Level Planning

Based on the results of the water level calculations presented in Table 6, one of the sections analysed specifically was the BGS 4.B secondary channel. This channel was analysed to illustrate the water level planning conditions in the secondary channels within the irrigation network under review.

The secondary channel BGS 4.B is planned to use channel dimensions with a base width (b) of 0.65 m and a water height (h) of 0.65 m. Based on the results of the water level calculations, the water level elevation at the upstream section is 14.27 m and at the downstream section is 13.15 m, as listed in Table 6. It is formed continuously from upstream to downstream in accordance with the planning that has been carried out.

Table 6. Calculation of Secondary Channel Water Level Plan.

No	Channel Name	Areal (A) (ha)	Q	Channel Dimensions			El. Hilir (DWL)	El. Hulu (UWL)
	Sekunder			k	b	h		
1	Sekunder BGS.4E	7,64	0,0025	35,00	0,65	0,65	11,15	11,16
2	Sekunder BGS.4D	28,04	0,0093	35,00	0,65	0,65	12,15	12,17
3	Sekunder BGS.4C	78,47	0,0260	35,00	0,65	0,65	12,15	12,41
4	Sekunder BGS.4B	103,57	0,0343	35,00	0,65	0,65	13,15	14,27
5	Sekunder BGS.4A	145,97	0,0484	35,00	0,65	0,65	13,15	13,22

4.6. Base Elevation Secondary Channel Plan

Based on the base elevation graph of the secondary channel plan, it can be seen that the base elevation of the planned channel forms a continuous downward pattern from upstream to downstream, following the predetermined base slope. This pattern shows that the base elevation planning of the channel has been adjusted to maintain the continuity of gravity flow along the secondary channel.

In addition, the planned water level elevation is above the base elevation of the channel and forms a continuous line at each observation point. The planned embankment elevation is above the planned water level elevation along the entire channel section, so that the planned water level remains above the channel edge elevation and does not have the potential to cause overflow. This condition indicates that the planning of the base elevation and water level of the secondary channel has met the specified planning requirements.

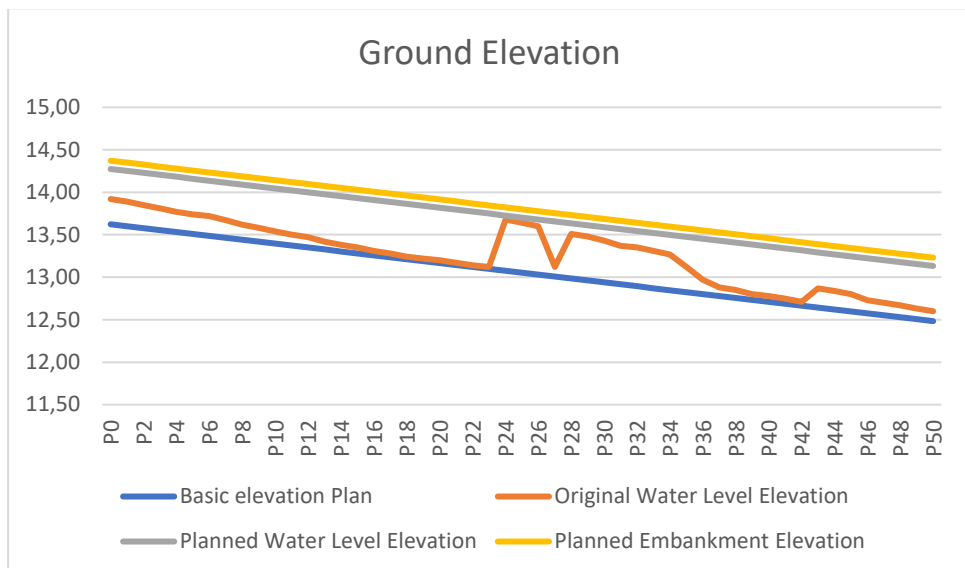


Figure 6. Graph of Planned Base Elevation, Planned Water Level Elevation, and Planned Embankment Elevation of Secondary Channels.

4.7. Planning Outcome

The image shown is a cross-section of representative stakes along the BGS 4.B secondary channel.

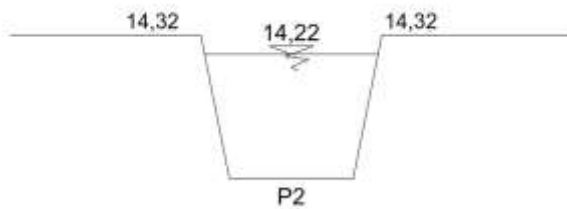


Figure 7. Cross-section of BGS 4.B secondary channel at P2 marker.

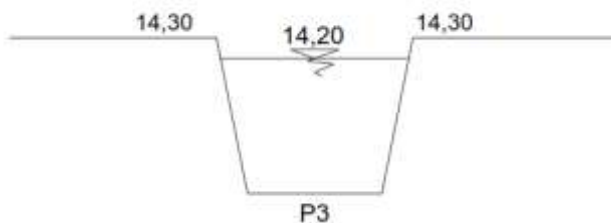


Figure 8. Cross-section of BGS 4.B secondary channel at P3 marker.

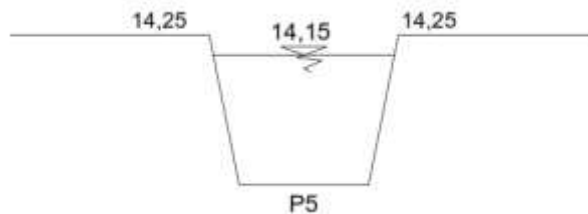


Figure 9. Cross-section of BGS 4.B secondary channel at P5 marker.

Based on cross-sections of secondary channel BGS 4.B at representative markers P2, P3, and P5, which represent the entire channel section from marker P0 to P50, it can be seen that the planned water level elevation at each marker is 14.22 m, 14.20 m, and 14.15 m, respectively. These values indicate a gradual decrease in water level elevation from upstream to downstream, in line with the direction of flow and the slope of the planned channel.

The water level formed tends to be uniform and in accordance with the planned discharge and cross-sectional dimensions of the channel. The water level profile at each cross-section is also below the channel edge elevation, so that the channel is safe from overflow. The flow is stable and representative of the flow conditions along the BGS 4.B secondary

channel, as indicated by the continuous change in water level elevation at cross sections P2, P3, and P5.

4.8. Evaluation of the Efficiency and Performance of the BGS 4.B Secondary Channel

To assess the efficiency of the BGS 4.B Secondary Channel, the planned discharge and water level profile linked to regional hydrological conditions based on a 10-year return period rainfall of 151.677 mm obtained from probability analysis and the Thiessen method were used for this evaluation. To describe the extreme conditions that may occur in the irrigation system, the recorded rainfall amount was used as the basis for evaluation.

The planning results show that the channel has sufficient capacity to convey a planned discharge of 0.0343 m³/s from upstream to downstream with a water level of approximately 0.65 m. The water level profile follows the pattern of the channel bed elevation decline without a significant rise in water level.

From a safety perspective, the planned embankment is above the planned water level across the entire channel section so that the water level remains within the channel cross-section and does not exceed the embankment edge. This indicates that the channel is safe from overflow, even during a 10-year design rainfall period.

The performance of the BGS 4.B secondary channel shows that it not only distributes water efficiently but is also hydraulically safe to support irrigation water distribution in the DI Serayu service area of Cilacap Regency.

5. Conclusion

Based on the results of water demand analysis, hydrological conditions, and hydraulic planning for Secondary Channel BGS 4.B in the Serayu Irrigation Area serving Sampang Village and Karangasem Village, Cilacap Regency, Central Java Province, a planned water discharge of 0.0343 m³/dt was obtained. This flow rate can be optimally conveyed by a channel with a base width of 0.65 m and a channel height of 0.65 m, ensuring stable flow that meets irrigation requirements.

The elevation planning results show that the channel is in a safe condition because the planned water level elevation is above the channel base elevation and remains below the embankment elevation along the entire channel section. At representative benchmarks P2, P3, and P5, the planned water levels are 14.22 m, 14.20 m, and 14.15 m, respectively, while the channel base elevations are 13.58 m, 13.55 m, and 13.51 m. The difference in elevation creates a sufficient water level without approaching the channel edge elevation, thus eliminating the potential for overflow. The resulting water level profile also shows a continuous change in elevation, indicating stable hydraulic flow conditions.

The BGS 4.B secondary channel demonstrates excellent performance in conveying a planned discharge of 0.0343 m³/dt, according to the results of an evaluation of the channel's efficiency and performance using a 10-year return period rainfall of 151.677 mm obtained from the Thiessen method and probability analysis. The water level profile remains stable along the slope of the channel bed and the overall water level elevation is lower than the planned embankment elevation. These conditions indicate that the channel works well and is safe and reliable in terms of hydrology and hydraulics to provide irrigation water in the service areas of Sampang Village and Karangasem Village.

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