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Using HEC-RAS Program to Predict the Effect of Water Level Changes in Kiwal Retention Pond of Buah River

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Abstract— The Based on the division of river areas in the city of Palembang, there are 21 sub-watersheds, but only 18 sub-watersheds that lead directly to the Musi river, namely the Rengas Lacak, Gandus, Lambidaro, Boang, Sekanak, Bendung, Lawang Kidul, Buah, Juaro, Batang sub-watersheds, Keramasan, Kertapati, Kedukan Ulu, Aur, Sriguna, Jakabaring and Plaju. The area of Palembang city which always experiences floods every year, among others, is the watershed area of the Buah River. The Buah River, with the main river being 7.93 km long, has many meanders and a river wall reinforcement has been built. The research was conducted to see changes in the water level in the Buah river using the HEC-RAS ver.4.1.0 program.

The results showed the pattern of water level movement at each station in the cross section of the river under study, where at Sta. 6+860.5 and Sta. 6+850 there is no rise in the water level in the Sungai Buah. This condition is due to the influence of the Kiwal retention pond to lower the water level in the Buah river. But at Sta. 6 + 800 to Sta. 6+450 there is a water level fluctuation with a significant increase in the river, after which there is a decrease in the water level in the river, namely at Sta. 6+400 up to Sta. 6+350. This is a condition where the river does not affect the Kiwal retention pond.

Keywords—The Buah river; Flood discharge; IDF curve; HEC-RAS program; Water level fluctuation.

I. INTRODUCTION

There are 4 (four) major rivers that cross the city of Palembang, namely the Musi River, Komering River, Ogan River, and Keramasan River. The main river of the 4 (four) major rivers mentioned above is the Musi river which has an average width of 504 meters and a maximum width of 1,350 meters around Kemaro Island. (Syarifudin, A, et al, 2018). The city of Palembang as the capital of the province of South Sumatra has 108 tributaries consisting of 21 sub-watersheds, but only 18 sub-watersheds in the city of Palembang which empties directly into the Musi river, namely the Rengas Lacak, Gandus, Lambidaro, Boang, Sekanak, Wendung, Lawang Kidul sub-watersheds. , Fruit, Juaro, Batang, Sei Lively, Keramasan, Kertapati, Kedukan Ulu, Aur, Sriguna, Jakabaring and Plaju. (Department of PUPR of Palembang city, 2018)

Water resource problems such as drought, flooding, and difficulties in utilizing water resources in the city of Palembang, especially in urban areas. Almost at the beginning of the dry season, residents' wells and almost all rivers or streams of water as well as under and reservoirs experience a sharp decrease in water volume. On the other hand, during the rainy season, some of the Buah Watershed experience problems with flooding due to scouring and sedimentation from the Buah river, as well as factors that change land function which causes water to not seep into the ground.

Flood is a disaster that often strikes an area in Indonesia, especially urban areas so that it can harm human activities and other living things. The first step in predicting flooding is by hydrological modeling. The hydrological model is a simple description of the watershed (DAS) of a complex hydrological system to predict hydrological events that will occur such as floods. (Sri Harto, 1993).

In hydrology, rain is an important input component in the hydrological process. Analysis of rain data in the review of hydrological planning aspects is used as an approach in estimating the amount of flood discharge that occurs in a watershed. The approach to estimating flood discharge that occurs from rain data is carried out if the watershed concerned is not equipped with an Automatic Water Level Recorder (AWLR) water gauge. To obtain the amount of rain that can be considered as the actual depth of rain that occurs throughout the watershed, it is necessary to have a number of rain stations that can represent the amount of rain in the watershed.

In addition to rain data, surface runoff is one of the important factors in the transport system of various materials that will be carried into river flows. If the intensity of this rainfall exceeds the infiltration rate, then excess water begins to accumulate as surface reserves. When the surface reserve capacity is exceeded, the surface runoff begins as a thin layer flow. Surface runoff is the part of runoff that passes above the ground surface into river channels (Seyhan 1990).

Another term for surface runoff that is often used by experts is runoff over land or runoff. Rain duration, intensity and distribution of rain affect the rate and volume of surface runoff. Total surface runoff for a given rainfall is directly related to the length of time it rains for a given rainfall intensity. Rain with the same intensity and for a longer time will produce a larger surface runoff. Rain intensity will affect the rate and volume of surface runoff. In high-intensity rain, the total volume of surface runoff will be greater than at low intensity even though the total rainfall received is the same. Topographical forms such as the slope of the land will affect the surface runoff. A watershed with a high slope will result in a larger surface runoff. The presence of vegetation can increase the amount of water retained on the surface, thereby reducing the rate of surface runoff.

HEC-RAS itself is a software program that can model unsteady flow with a one-dimensional view with more accurate geometric modeling because the approach points for modeling river cross sections can be made more than some other one-dimensional unsteady flow programs that are often used. Thus, the depiction of each cross section of each profile using the HEC-RAS program will be closer than before. (Baitullah, 2014) .

Simulation with HEC-RAS aims to determine the longitudinal profile of the river, maximum water level elevation, and flow velocity. In addition, with this model, it is also possible to modify the appearance of the channel to get a channel view that can anticipate the planned flood discharge. The model that will be discussed consists of 3 studies, namely the existing model, the sluice gate and the pump system. (Baitullah, 2014).

II. Research Methods

2.1 Materials and tools

The materials and tools used in this study were to collect rainfall data to analyze rainfall with a certain return period covering a return period of 2 years, 5 years, and 10 years, after which the intensity of rainfall was calculated for the first time the concentration time was calculated. Then the rainfall intensity intensity (IDF) curve is made and calculate the planned discharge for each certain return period.

The HEC-RAS 4.1.0 program was carried out to predict the overflow of water in the channel/river at each cross-section based on the results of the survey of the cross-section and the longitudinal profile of the river. (Baitullah, 2016).

2.2 Research methods

This research was conducted using an empirical approach, including hydrological analysis and hydraulics analysis, then simulation was carried out using the HEC-RAS program. Hydrological analysis to determine the design rain with a certain return period and get a picture of the IDF (Intensity Duration Curve) curve as well as channel hydraulics analysis to calculate flood discharge and then a simulation is carried out with the help of the HEC-RAS 4.1.0 software program. (Baitullah, 2016)

In the hydraulic analysis, the water level profile is calculated using some data on the design flood discharge and drainage channels in the Jakabaring Sport City (JSC) main channel to obtain a water level profile. In this analysis also used the application program

HEC-RAS 4.1.0. After getting the direct runoff discharge, the results of the calculations on the existing channel are simulated using HEC-RAS 4.1.0. (Baitullah, 2016)

2.3 Process and Data Analysis

After the data is collected, it is processed as follows:

a) Rainfall analysis is analyzed using frequency analysis, then the selection of frequency distribution with the normal distribution method, normal log, pearson type III log, and gumbel

Then the suitability test to determine the difference in discharge from the calculation results. Conformity test using chi-squared and rainfall intensity with smirnov-kolmogorov

b) Design Flood Discharge Analysis

Calculating the design flood discharge using the rational equation method previously determined the intensity of rain, time of concentration and runoff.

c) Hydraulic Analysis

This analysis is carried out by calculating the planned flood discharge using the rational formula

d) The HEC-RAS program version 4.1.0 (open source) is used for modeling the Jakabaring Sport City (JSC) Main Channel to determine the ability of the trough/channel body to accommodate flood discharge within a certain return period.

2.4 Research preparation

This research was conducted using a laboratory approach method with various variations in the flow rate, flow rate and time. The standard channel (flume standard), most of its components are made of glass and have important parts, namely:

a. The aqueduct, the main place in this experiment, to drain the water. In the form of water flume with a size of 4.00 x 20 x 15 meters. This channel has transparent walls for easy to observed phenomena of the scoring depth,

b. A reservoir that functions to accommodate water that will be flowed into the channel or out,

c. Water pump, used to pump water so that it can be distributed along the gutter,

d. Discharge faucet, functions to regulate the discharge that comes out of the pump. Has a discharge scale of 6-9 range,

e. The tilt adjustment wheel, located upstream and downstream of the channel, can be manually turned to adjust the desired bed slope. This bed slope adjustment wheel has a scale for maximum positive bed slope + 3.0% and maximum negative bed slope - 1.0%.

III. RESULTS AND DISCUSSION

The results of the calculation of the intensity of rain for each return period in a span of 10 minutes. So that IDF curves can be made with the help of Ms. Excel. The following is the shape of the IDF curve from the rain intensity data that has been obtained, which is shown in Figure 1.

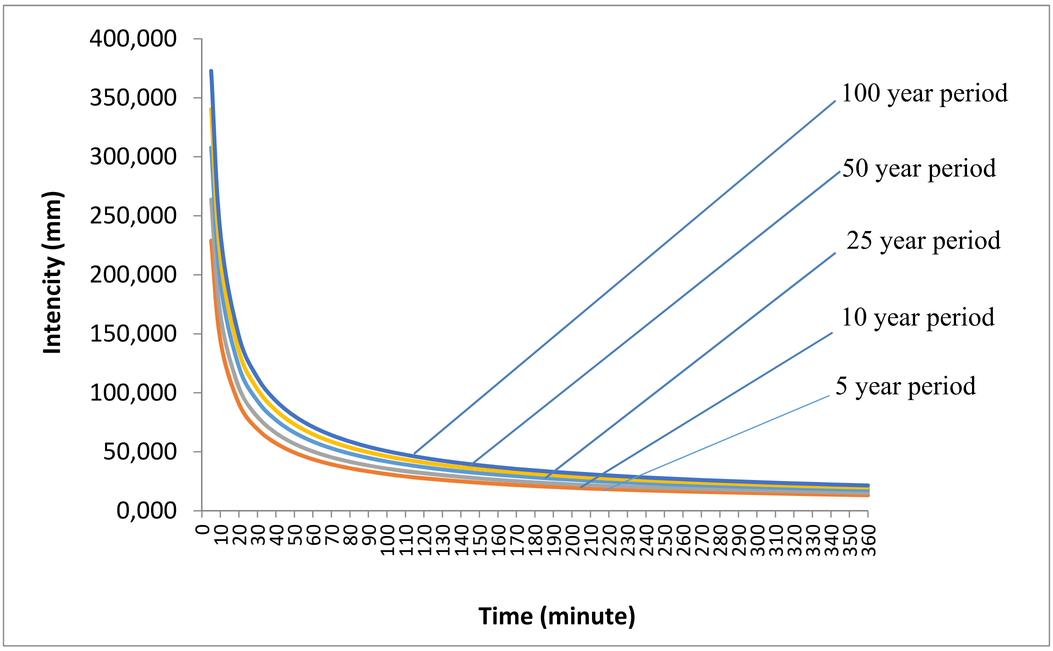

Fig. 1. Intencity Duration Frequency - Curve

3.1 Buah river discharge

To calculate the runoff discharge (Run Off) using the Rational Formula. The results are as in table 1.

TABLE I. EXPERIMENTAL RESULTS IN THE LABORATORY

Return Period (years)	C	I (mm/jam)	A (km^2)	Q (m^3/det)
2	0,5864	257,1460	8,458	9,84
5	0,5864	296,2446	8,458	11,34
10	0,5864	345,6414	8,458	13,22
20	0,5864	382,2866	8,458	14,63
50	0,5864	418,6661	8,458	16,02

3.2 Simulation Results

After all data is entered into the HEC-RAS Program, then it is run and the data results are seen. Each return period discharge is seen in each cross section.

The pattern of water level movement in the Buah river/channels and its effect on the presence of the Kiwal retention pond can be seen as shown in the image below:

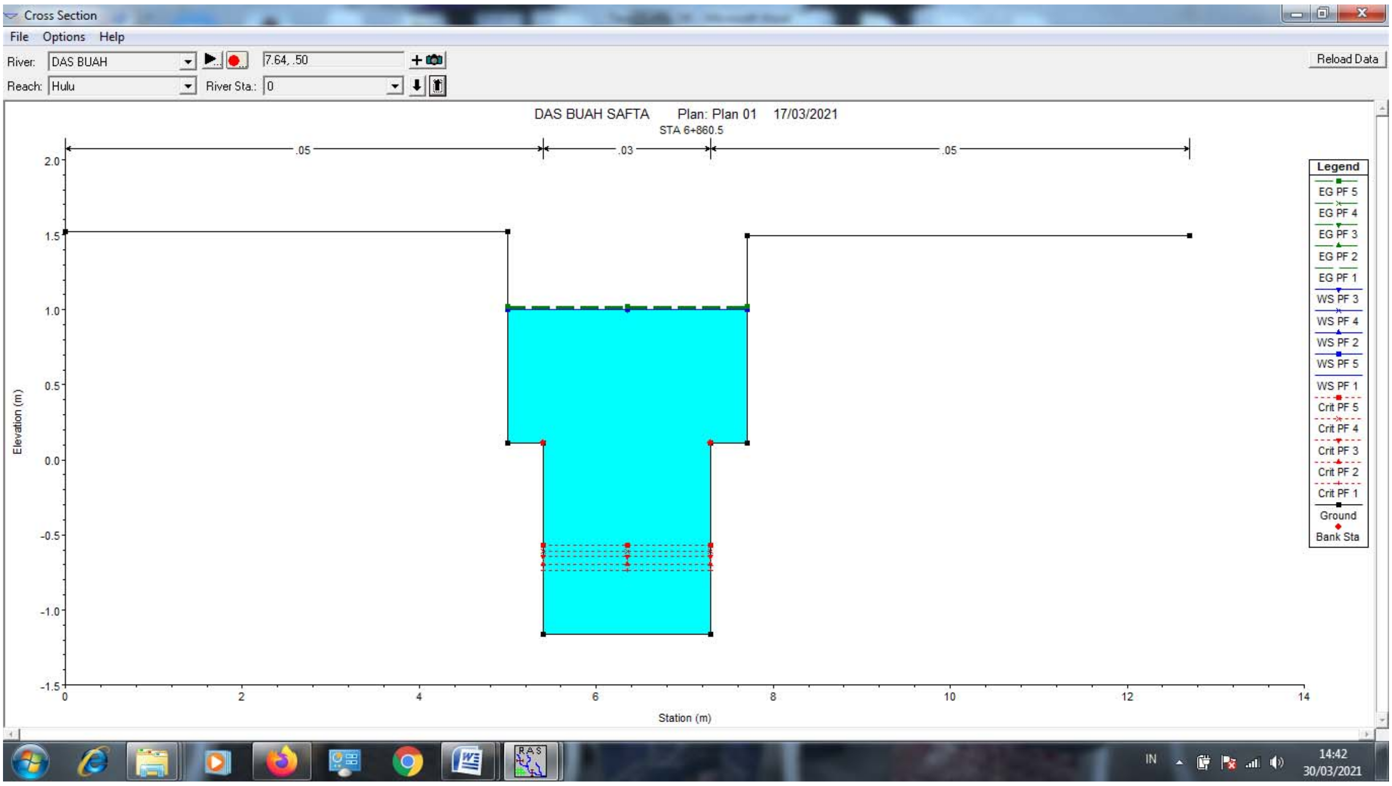

Fig. 2. The pattern of water flow movement in the Buah river Sta.6+860.5

In Figure 2. it can be seen that at Sta.6+860.5 there is no water level rise in the Buah River. This means that at Sta 6+860.5 there is no overflow and this condition is due to the influence of the Kiwal retention pond.

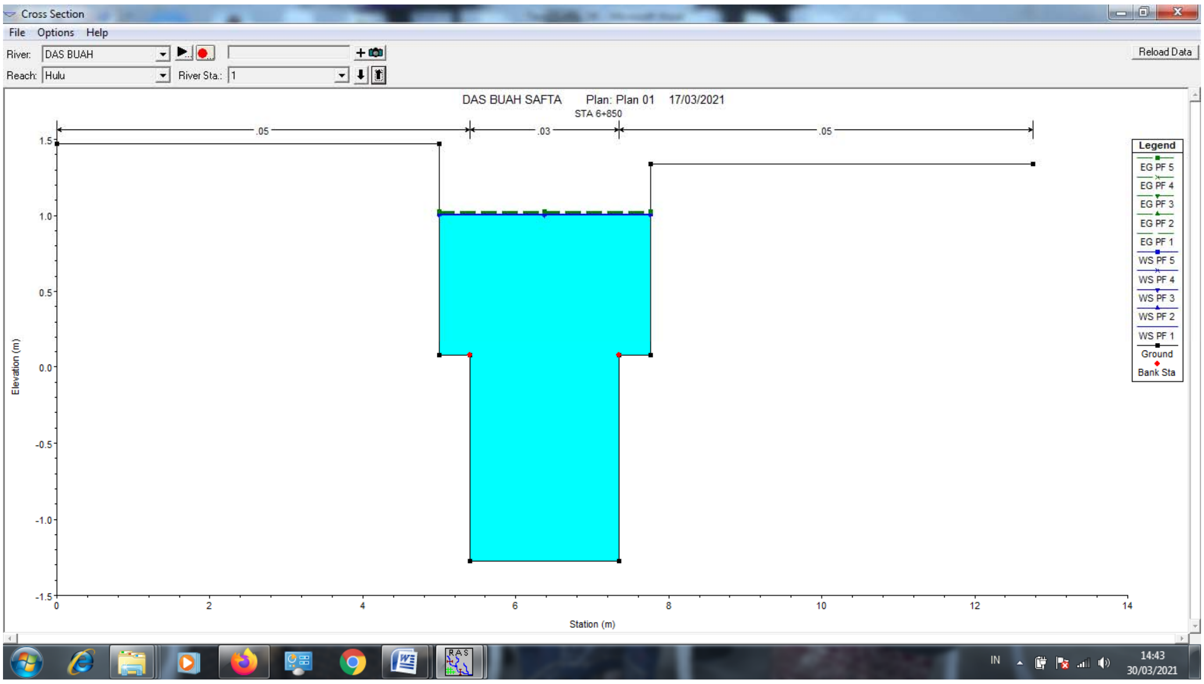

Fig. 3. The pattern of water flow movement in the Buah river Sta.6+850

In Figure 3. it can be seen that at Sta.6+850 there is no water level rise in the Buah River. This means that at Sta 6+850 there is no overflow. This condition is because it is still influenced by the Kiwal retention pond.

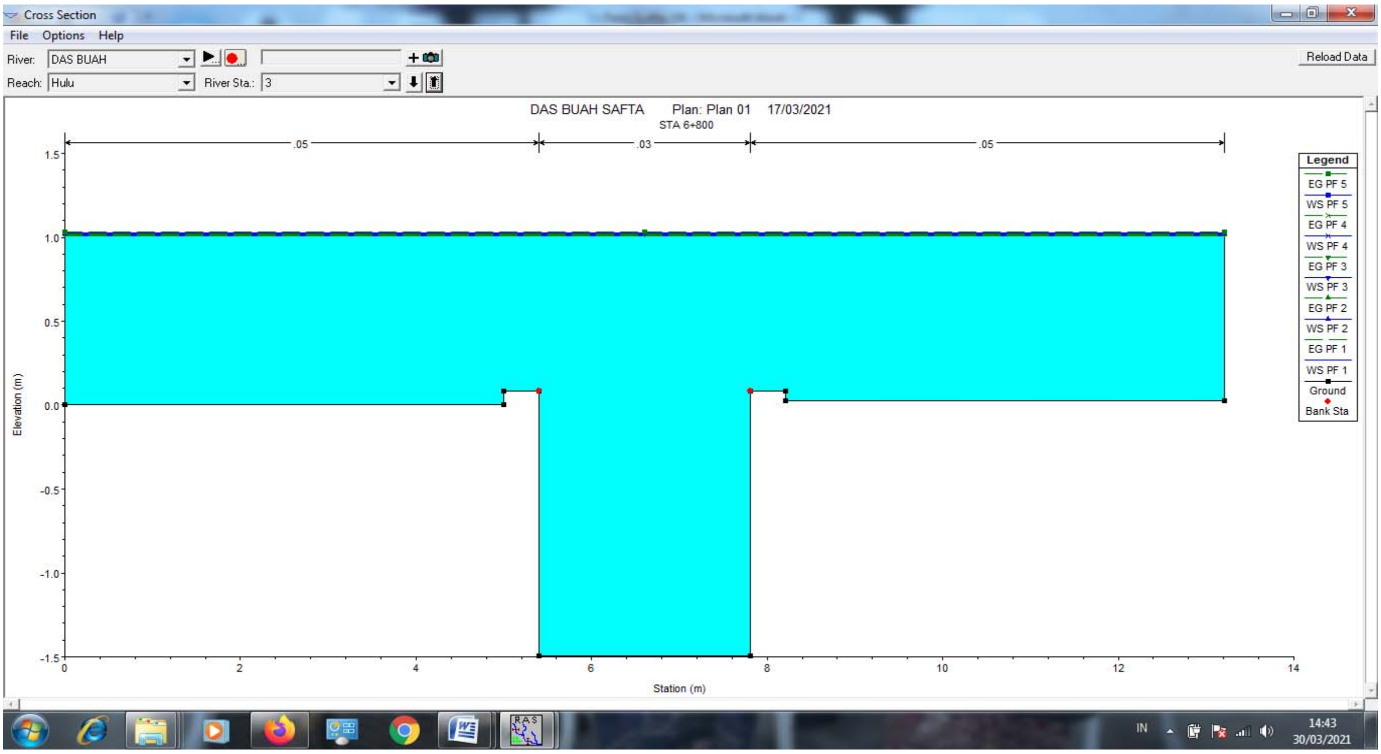

Fig. 4. The pattern of water flow movement in the Buah river Sta.6+800

In Figure 4 above can be seen that at Sta.6+800 there is an increase in the water level in the Buah River. This means that an overflow occurs at Sta 6+800 due to the influence of the existing retention pond.

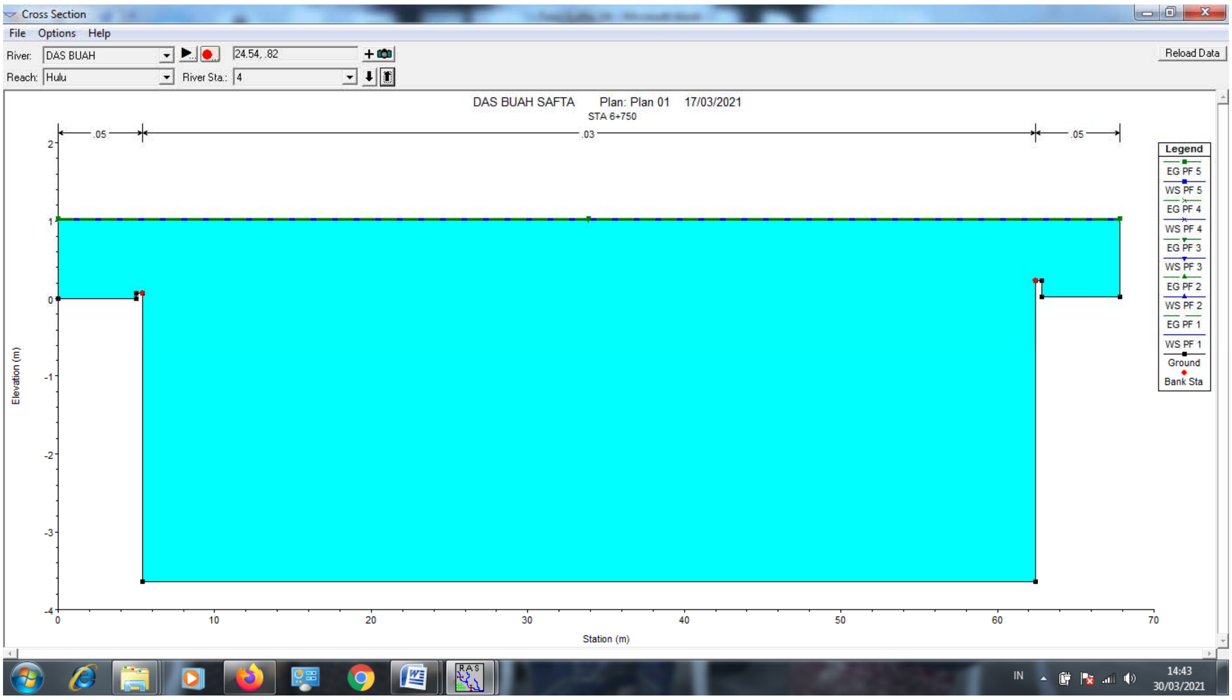

Fig. 5. The pattern of water flow movement in the Buah river Sta.6+750

In Figure 5. it can be seen that at Sta.6+750 there is an increase in the water level in the Buah River. This means that an overflow occurs at Sta 6+750 due to the influence of the existing retention pond.

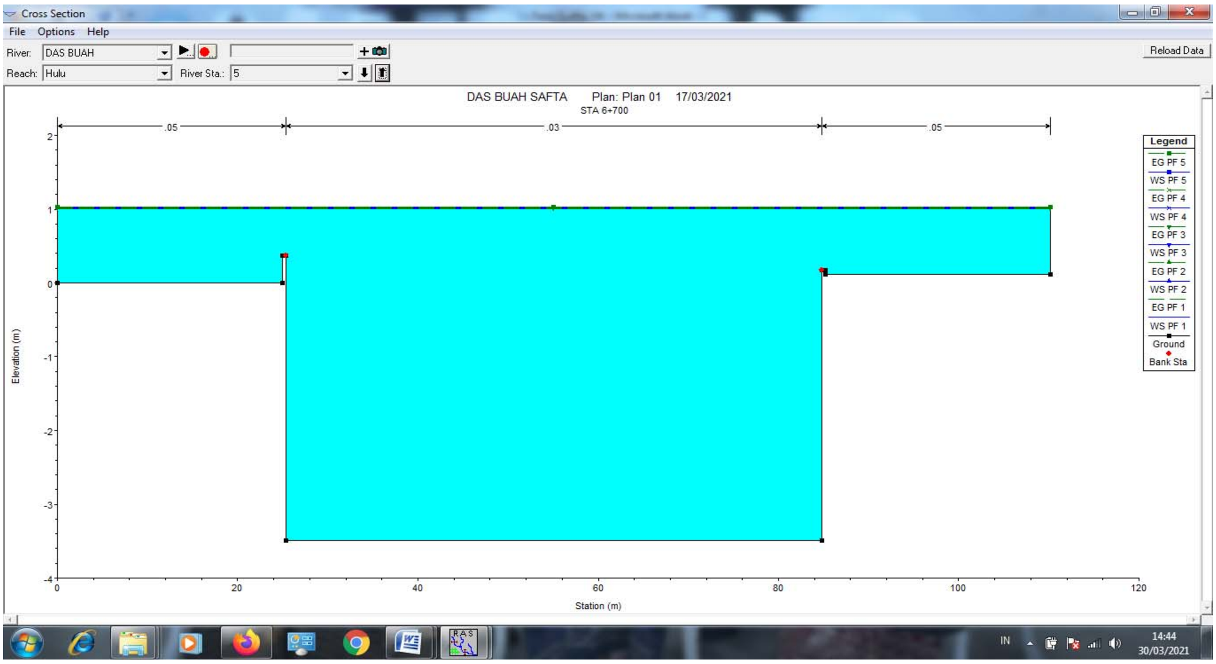

Fig. 6. The pattern of water flow movement in the Buah river Sta.6+700

In Figure 6. it can be seen that at Sta.6+700 there is an increase in the water level in the Buah river. This means that an overflow occurs at Sta 6+700 due to the effect of the existing retention pond.

Fig. 7. The pattern of water flow movement in the Buah river Sta.6+650

In Figure 7. it can be seen at Sta.6+650 that the water level rises in the Buah River. This means that there is an overflow at Sta 6+650 so that it will affect the elevation in the existing retention pond.

Fig. 8. The pattern of water flow movement in the Buah river Sta.6+600

In Figure 8. it can be seen that at Sta.6+600 there is an increase in the water level in the Buah river. This means that an overflow occurs at Sta 6+600 so that it will affect the water level elevation in the retention pond.

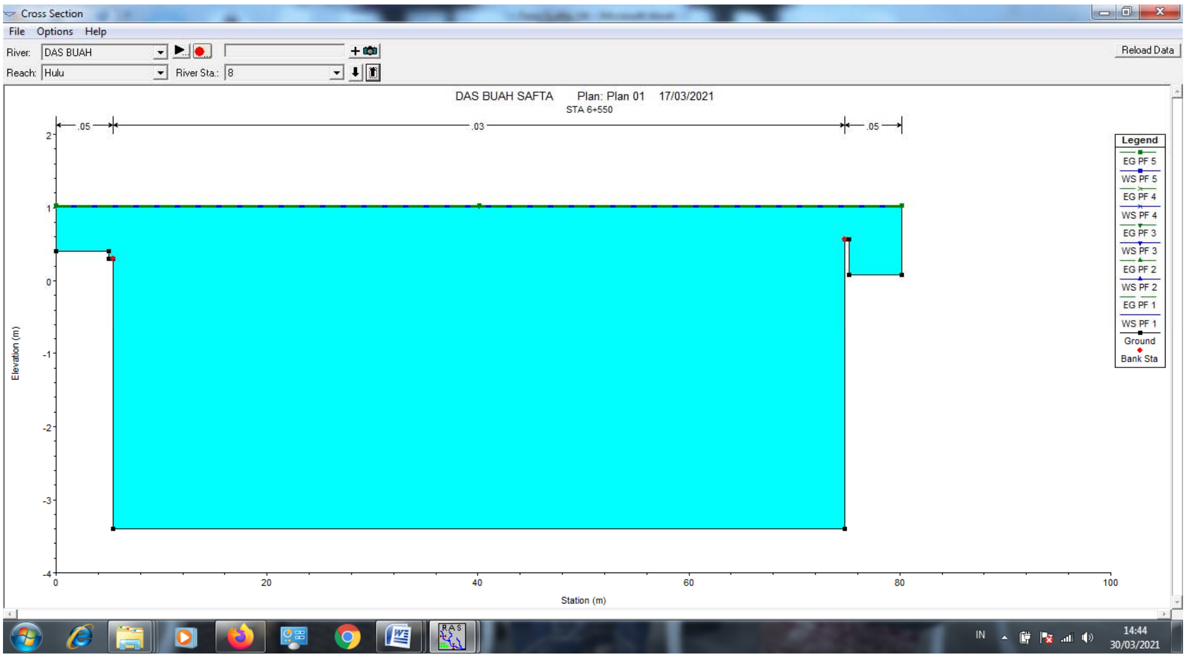

Fig. 9. The pattern of water flow movement in the Buah river Sta.6+550

In Figure 9. it can be seen that at Sta.6+550 there is an increase in the water level in the Buah River. This means that an overflow occurs at Sta 6+550 so that it will affect the water level elevation in the retention pond.

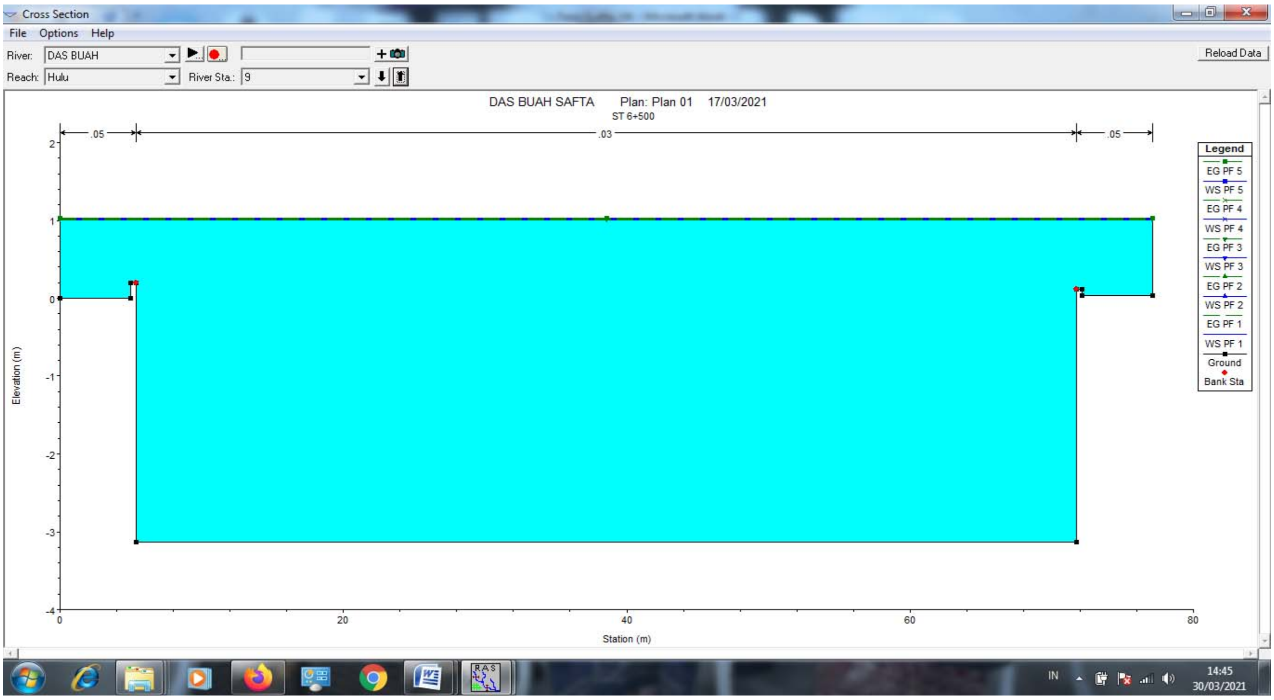

Fig. 10. The pattern of water flow movement in the Buah river Sta.6+500

In Figure 10, it can be seen that at Sta.6+500 there is an increase in the water level in the Buah River. This means that there is an overflow at Sta 6+500 so that it will affect the water level elevation in the existing retention pond.

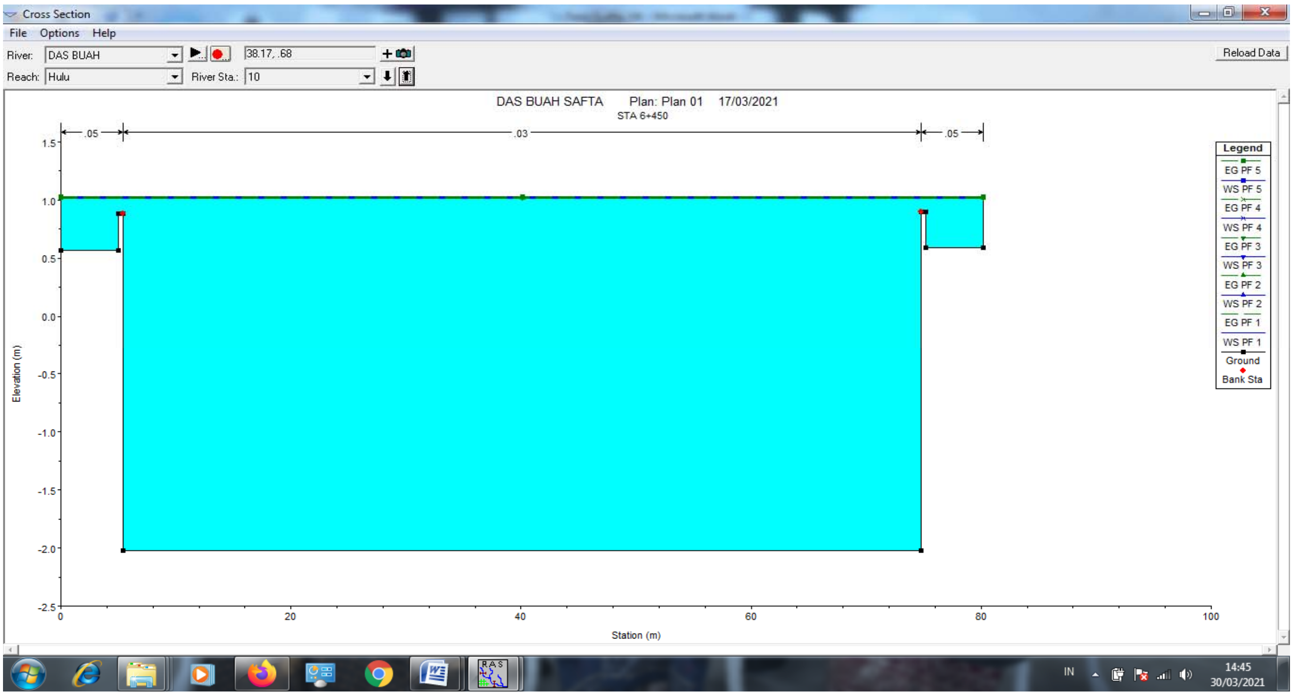

Fig. 11. The pattern of water flow movement in the Buah river Sta.6+450

In Figure 11. it can be seen that at Sta.6+450 there is an increase in the water level in the Buah river. This is due to the presence of the Kiwal retention pond which is not in a position at station 6+450.

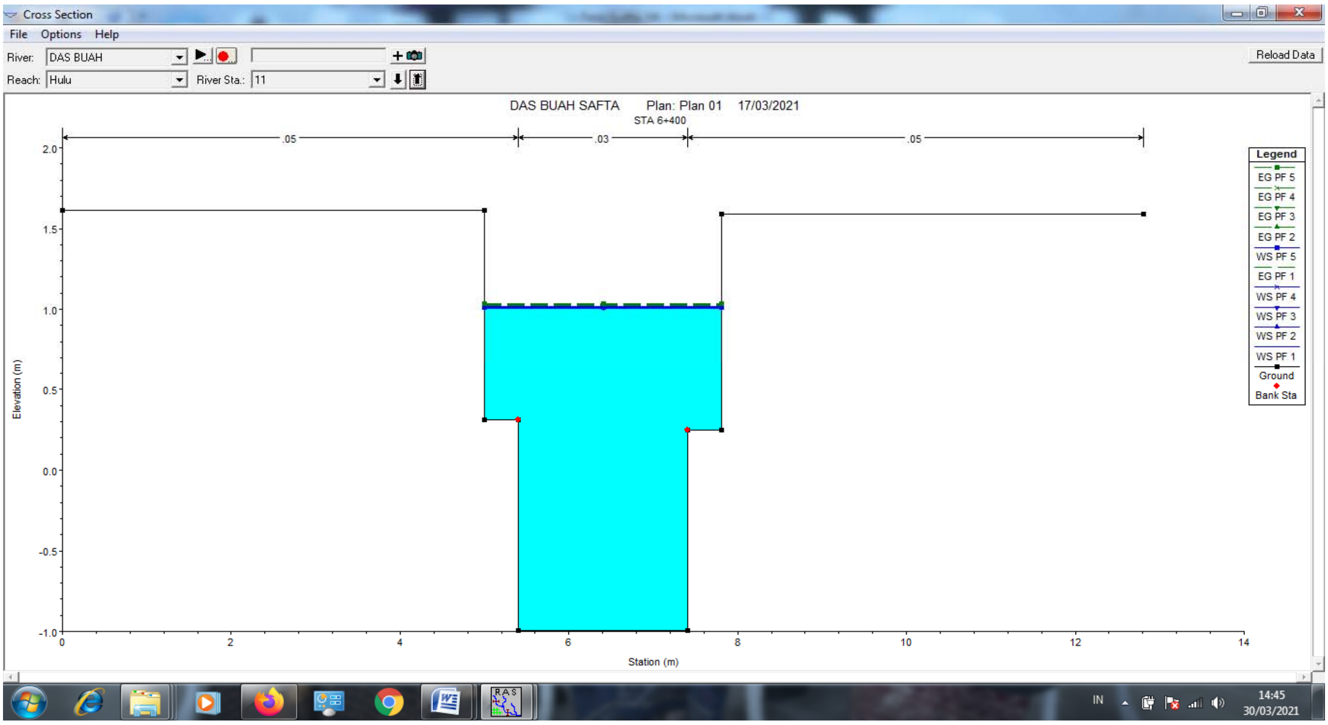

Fig. 12. The pattern of water flow movement in the Buah river Sta.6+400

In Figure 12, it can be seen that at Sta.6+400 there is no runoff in the Buah river so it is safe against inundation at the station and this is because it is affected by the Kiwal retention pond.

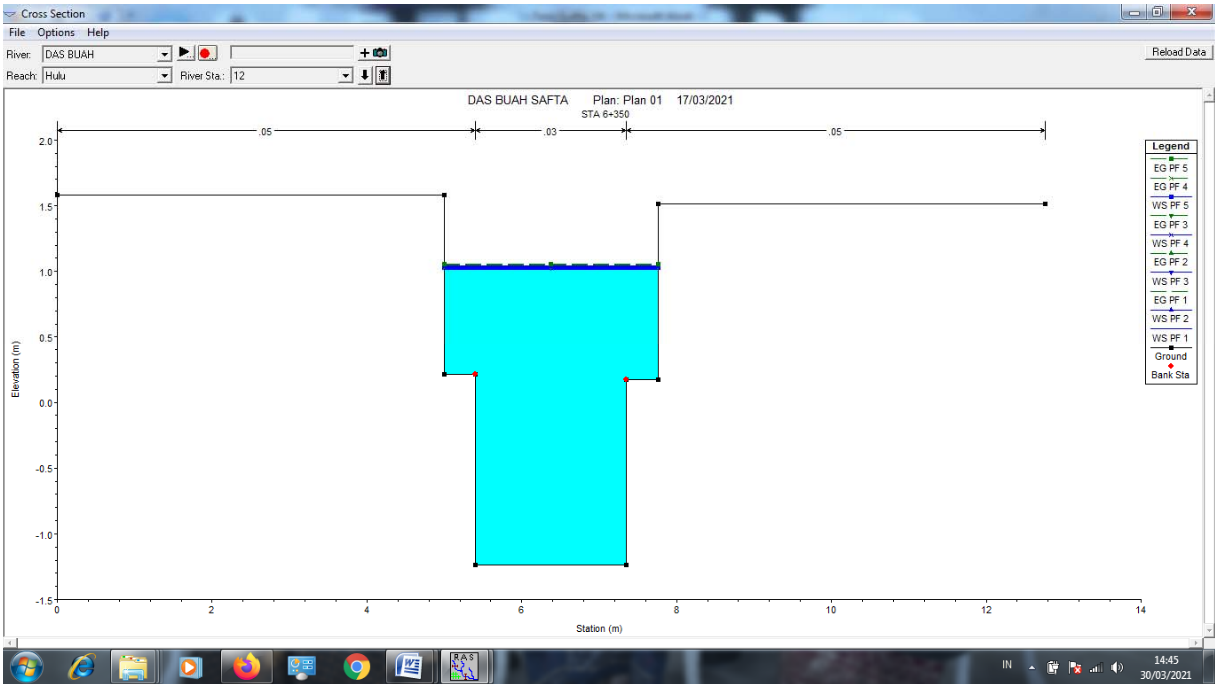

Fig. 13. The pattern of water flow movement in the Buah river Sta.6+350

Figure 13. also shows no overflow at Sta.6+350. This is because it is still affected by the Kiwal retention pond.

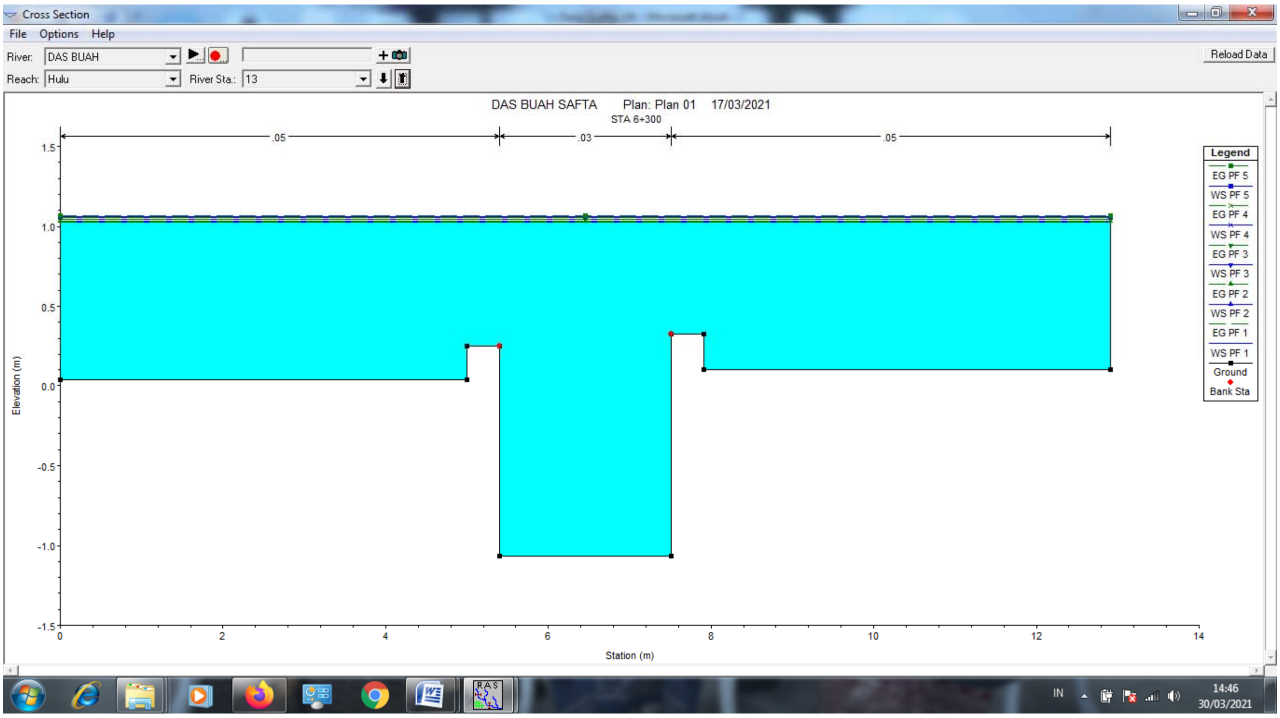

Fig. 14. The pattern of water flow movement in the Buah river Sta.6+350

In Figure 14, it can be seen that there was a rise in the water level in the Buah River at Sta. 6+300. This is because the existing retention pond does not affect the Buah river and causes overflow.

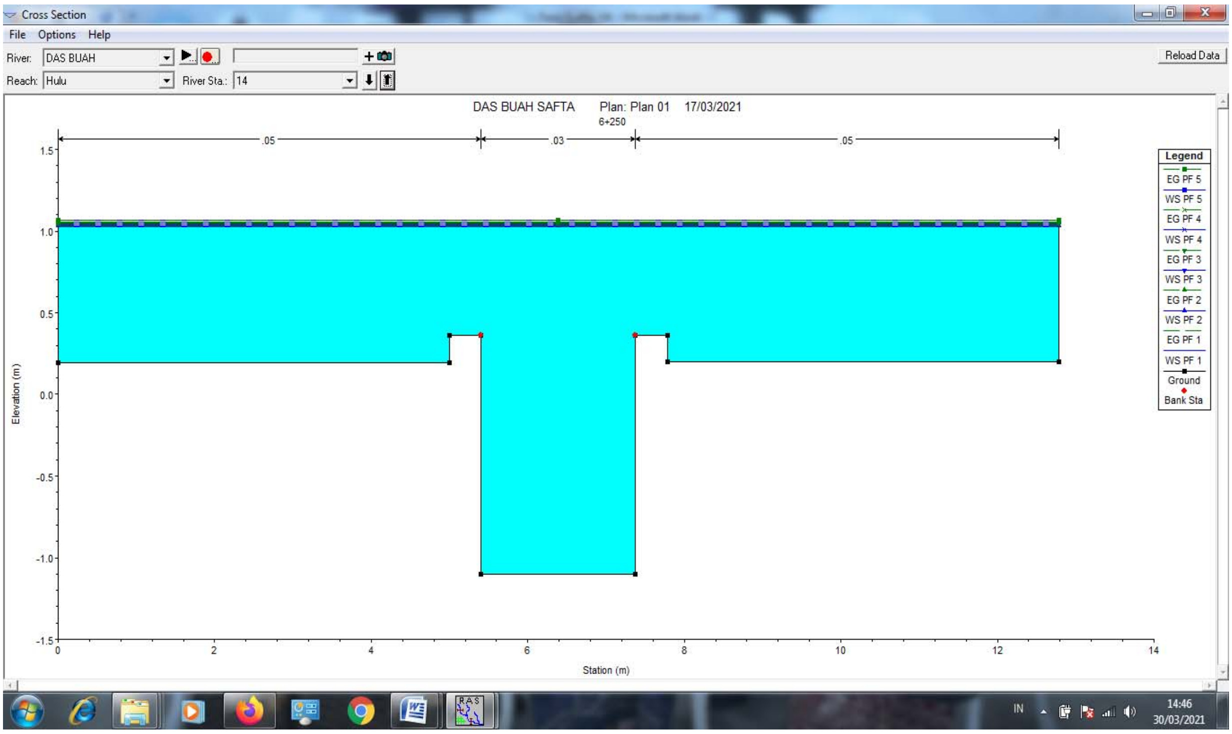

Fig. 15. The pattern of water flow movement in the Buah river Sta.6+350

In Figure 15, it can also be seen that there is an increase in the water level in the river at Sta.6+250, so that at the station on the Buah river there will be overflow or a rise in water level.

IV. Conclusion

At Sta. 6+860.5ta. 6+850 there is no water level rise in the Buah river. This condition is due to the influence of the Kiwal retention pond to lower the water level in the Buah River. But at Sta. 6+800 up to Sta. 6+450 water level fluctuations occurred with a significant increase in the river, after that there was a decrease in the water level in the river, namely at Sta. 6+400 up to Sta. 6+350. This is a condition where the river does not affect the Kiwal retention pond.

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