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RESEARCH ARTICLE OPEN ACCESS

Analysis of Water Level Fluctuation in The Buah River With HEC-RAS Program

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ABSTRACT
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 - Flood discharge, IDF curve, HEC-RAS program, water level fluctuation

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I. INTRODUCTION

Palembang City itself has 108 tributaries. There are 4 major rivers that cross the city of Palembang, namely the Musi River, Komering River, Ogan River, and Keramasan River. Of the 4 (four) large rivers above the Musi River, it is the largest river with an average width of 504 meters and a maximum width of 1,350 meters, which are around Kemaro Island [1]

Based on the division of the river area there are 21 sub-watersheds, but only 18 sub-watersheds in the city of Palembang which empties directly into the Musi river in the city of Palembang, namely the Rengas Lacak, Gandus, Lambidaro, Boang, Sekanak, Bendung, Lawang Kidul, Buah, Juaro sub-watersheds. Batang, Sei Lively, Keramasan, Kertapati, Kedukan Ulu, Aur, Sriguna, Jakabaring and Plaju [2]

Water resource problems such as drought, floods, 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 watercourses as well as under and reservoirs experience a sharp reduction in water volume. On the other hand, during the rainy season, some parts of the Buah Watershed experience flood problems as a result of scouring and sedimentation from the Buah River, as well as the changing land use factors which prevent water from penetrating the ground.

In hydrology, rain is an important input component in the hydrological process. Rain data analysis 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 relevant watershed is not equipped with an Automatic Water Level Recorder (AWLR) gauge. To obtain the amount of rain that can be considered as the depth of rain that actually occurs throughout the watershed, a number of rain stations are needed that can represent the amount of rain in the watershed. [3]

In addition to rainfall data, surface runoff is an important factor in the transport system for various materials that will be brought into river flow. If this rainfall intensity exceeds the infiltration rate, excess water begins to accumulate as a surface reserve. When the surface reserve capacity is exceeded the surface runoff begins as a thin film flow. Surface runoff is the portion of runoff that passes above the ground level into a river channel [4]

Another term for surface runoff that is often used by some experts is overland runoff or runoff water. Duration of rain, intensity and distribution of rain affect the rate and volume of surface runoff. The total surface runoff for a rainfall is directly related to the length of time of rain for a particular rainfall intensity. Rain with the same intensity and with a longer time will result in greater 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. Topographic forms such as the slope of the land will affect surface runoff. Watersheds with high slopes will produce greater surface runoff. The presence of vegetation can increase the amount of water held above the surface, thereby reducing the rate of surface runoff.

Estimation of spatial water balance is carried out by considering factors of rainfall, land cover, soil texture and geology as a result of these factors in playing a very important role in groundwater recharge.

II. MATERIALS AND METHODS

HEC-RAS is a program that can model unstable flow with a one-dimensional view with a more accurate geometric modeling because the approach points for modeling river cross sections can be made more than some other one-dimensional unstable 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. [8]

Simulation with HEC-RAS aims to determine the longitudinal profile of the river, maximum water level, and flow velocity. In addition, this model can also modify the channel view to get a channel view that can anticipate the planned flood discharge. Modeling that will be discussed consists of 3 studies, namely the existing model, sluice gates and pumping systems [8].

Flood is a disaster that often hits, especially urban areas, so that it can harm human activities and other living things. The first step in predicting flooding is hydrological modeling. The hydrological model is a simple watershed (DAS) description of a complex hydrological system to predict future hydrological events such as floods[6].

Palembang City itself has 108 tributaries. There are 4 major rivers that cross the city of Palembang, namely the Musi River, Komering River, Ogan River, and Keramasan River. Of the 4 major rivers above the Musi River, the largest river with an average width of 504 meters and a maximum width of 1,350 meters is located around Kemaro Island. [2]

Based on the division of the river area there are 21 sub-watersheds, but only 18 sub-watersheds in the city of Palembang which empties directly into the Musi river in the city of Palembang, namely the Rengas Lacak, Gandus, Lambidaro, Boang, Sekanak, Bendung, Lawang Kidul, Buah, Juaro sub-watersheds. Batang, Sei Lively, Keramasan, Kertapati, Kedukan Ulu, Aur, Sriguna, Jakabaring and Plaju. (PUPR Office of Palembang city, 2018).

The city drainage system which always experiences flooding in Palembang every year, among others, is the Buah river basin. The Buah River, with the main river being 7.93 km long, has many meanders and a river wall reinforcement has been built. The sub-watershed of Buah, with an area of 10.79 km2, is generally a residential, industrial and swampy area. (PUPR Office of Palembang city, in Ayu Marlina and Reni Andayani, 2020). [7]

The sub-watershed of Buah is one of the 33 prone areas for floods in the city of Palembang. This is because, until now the Buah Watershed (DAS) does not yet have pumping facilities. As a result, the Sapta Marga, Sekojo, and Urip Sumoharjo areas, which flow into the Sungai Buah watershed, are also regularly subject to flooding. (Sripo, 24 November 2020)

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

The HEC-RAS 4.1.0 program is carried out to predict water overflow in a channel / river in each cross-section based on the results of a survey of the cross-sectional and longitudinal profiles of the river. [8]

III. RESULTS AND DISCUSSION

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

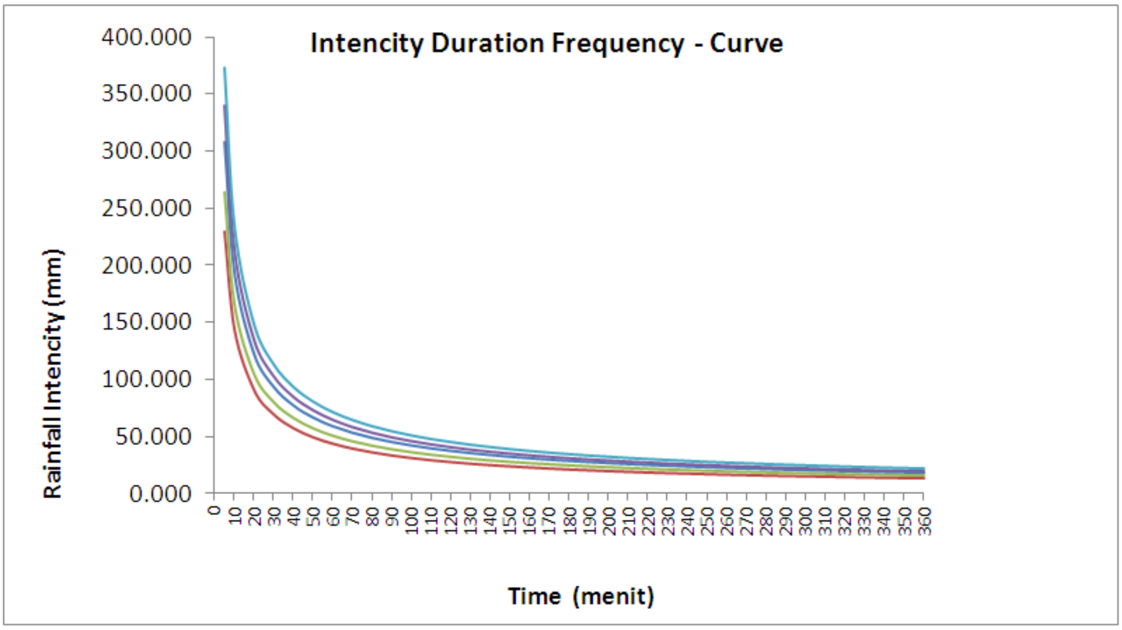

Figure 1. IDF (Intensity Duration Frequency) Curve

3.1. The discharge of the Buah river

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

Table 1. The results of the calculation of runoff discharge

Return Period (year)	C	I (mm/hours)	A (km^2)	Q (m^3/sec)
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 running and the results of the data are seen. Each return period discharge is seen in each cross section.

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

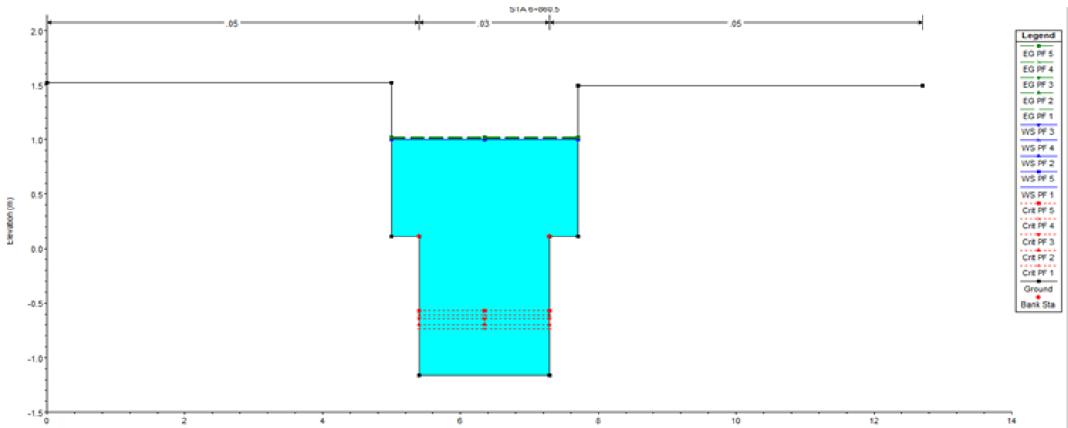

Figure 2. The pattern of water flow movement in the Buah river Sta.6 + 860.5 river

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.

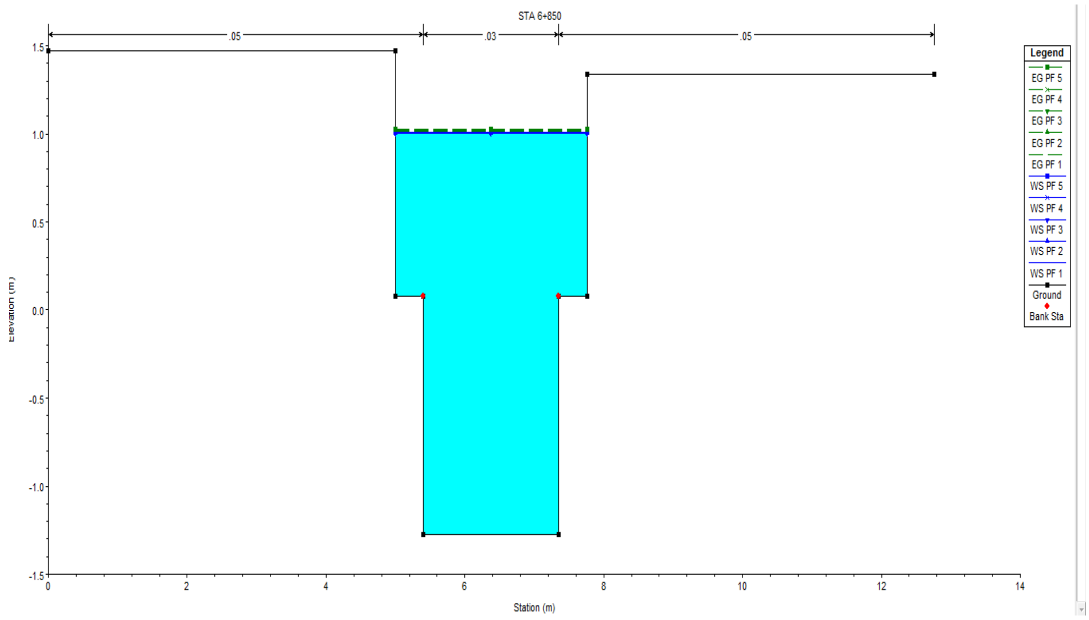

Figure 3. The pattern of water flow movement in the Buah Sta.6 + 850 river

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

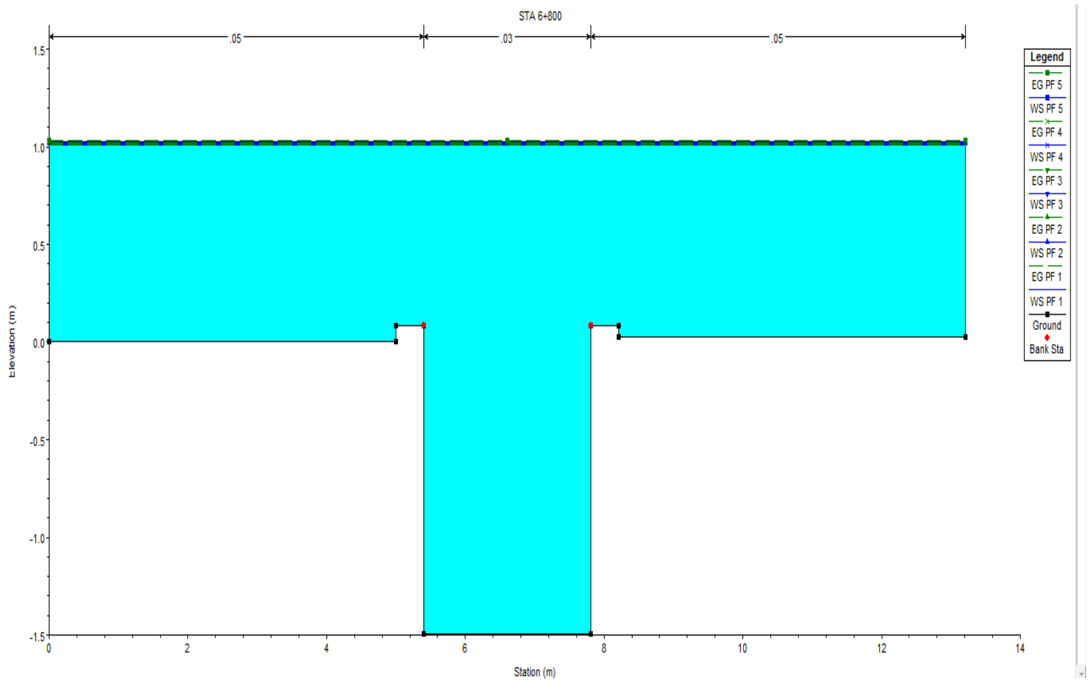

Figure 4.The pattern of water flow movement in the Buah Sta.6 + 800 river

In Figure 4, it can be seen at Sta.6 + 800 that there is an increase in the water level in the Buah river. This means that there is an overflow at Sta 6 + 800 due to the influence of the existing retention pool.

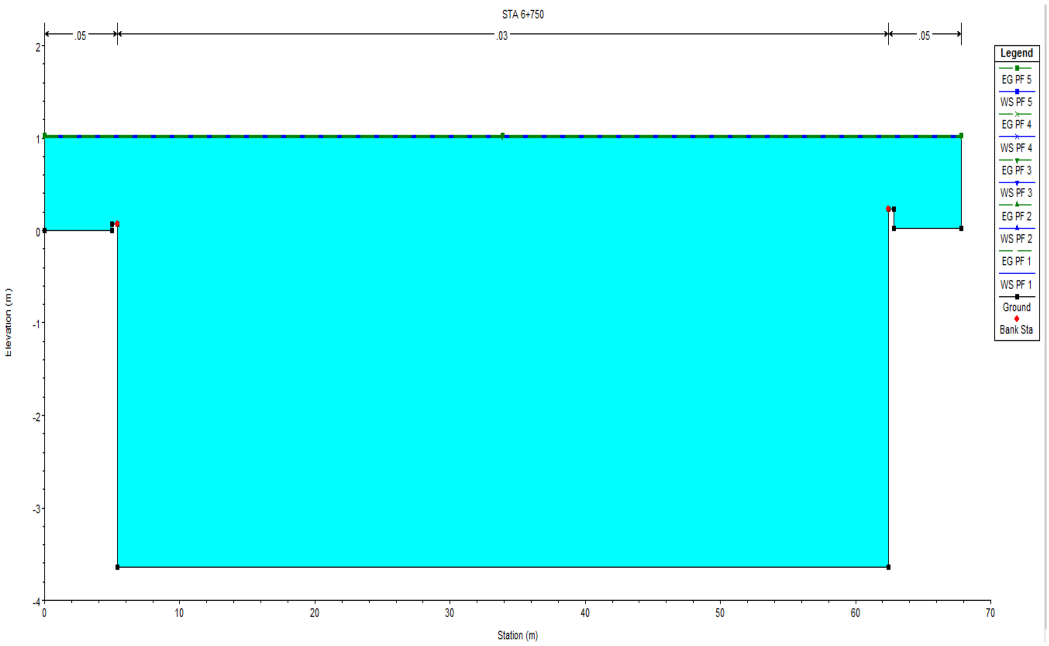

Figure 5. The pattern of water flow movement in the Buah Sta.6 + 750 river

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

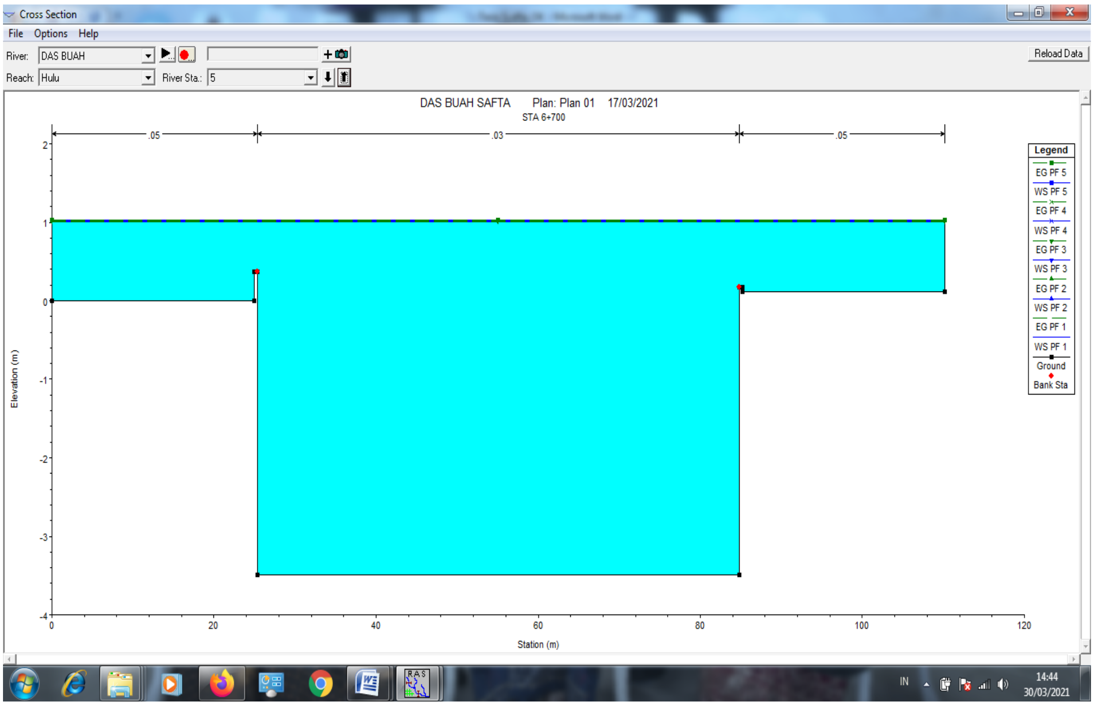

Figure 6. The pattern of water flow movement in the Buah Sta.6 + 700 river

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

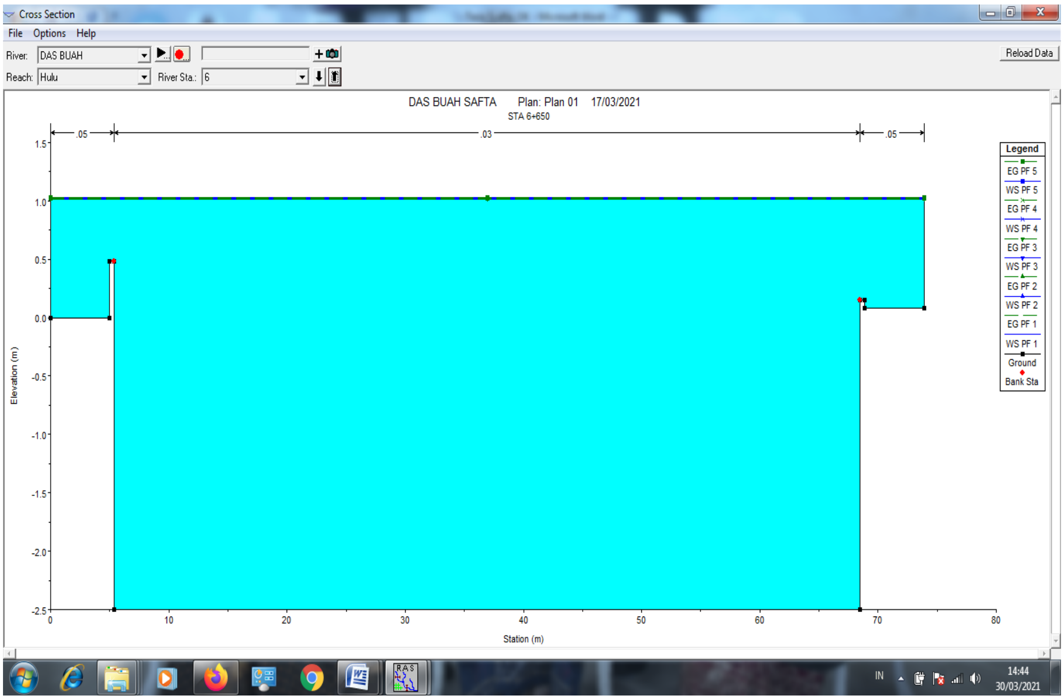

Figure 8. The pattern of water flow movement in the Buah Sta.6 + 650 river

In Figure 8, it can be seen that at Sta.6 + 650 there is an increase in the water level 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.

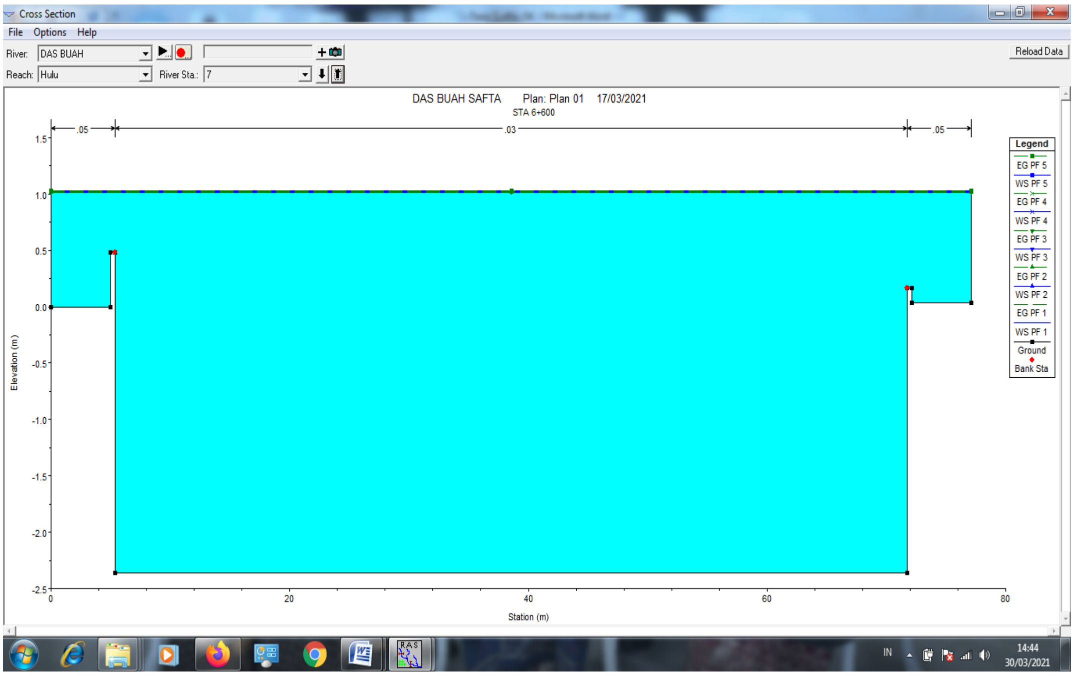

Figure 9. The pattern of water flow movement in the Buah river at Sta.6 + 600

In Figure 9, it can be seen that at Sta.6 + 600 there is an increase in the water level in the Buah river. This means that there is an overflow at Sta 6 + 600 so that it will affect the water level in the retention pond.

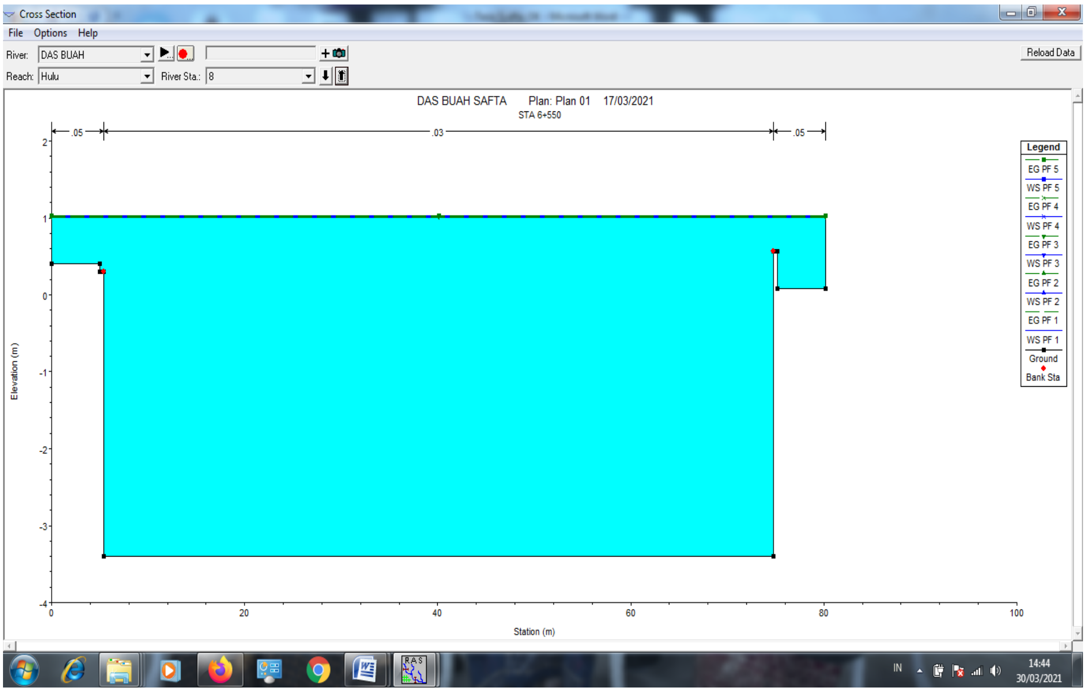

Figure 10. The pattern of water flow movement in the Buah river at Sta.6 + 550

In Figure 10., it can be seen that at Sta.6 + 550, there is an increase in the water level in the Buah river. This means that there is an overflow at Sta 6 + 550 so that it will affect the water level in the retention pond.

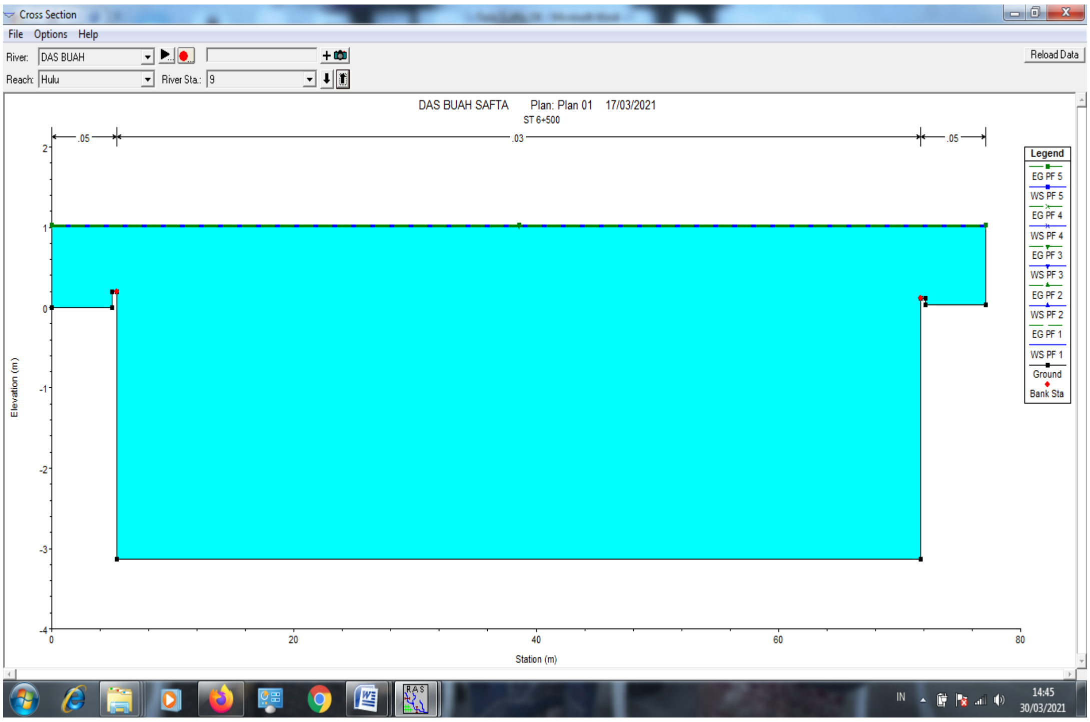

Figure 11. The pattern of water flow movement in the Buah river at Sta.6 + 500

In Figure 11. 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 in the existing retention pond.

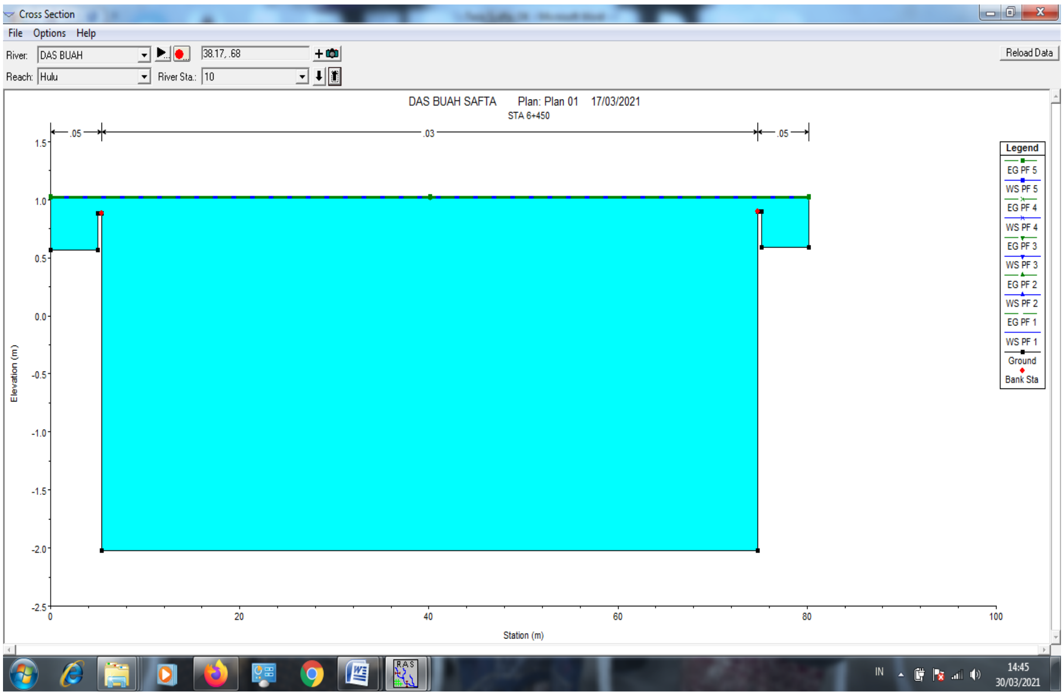

Figure 12. The pattern of water flow movement in the Buah river at Sta.6 + 450

In Figure 12. 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 positioned at station 6 + 450.

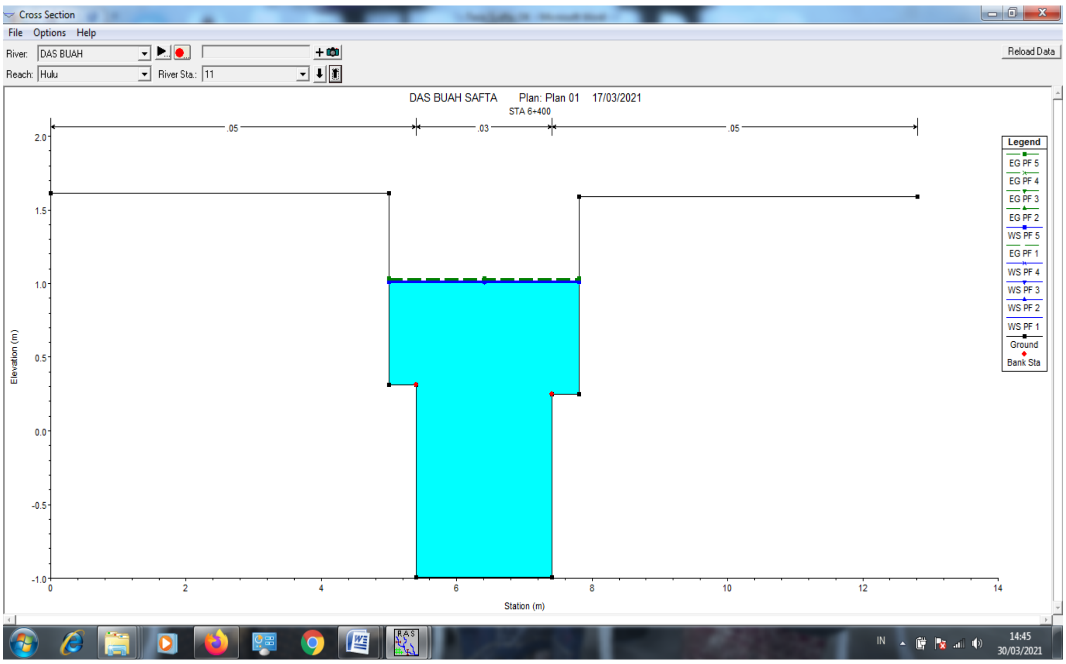

Figure 13. The pattern of water flow movement in the Buah river at Sta.6 + 400

In Figure 13. 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.

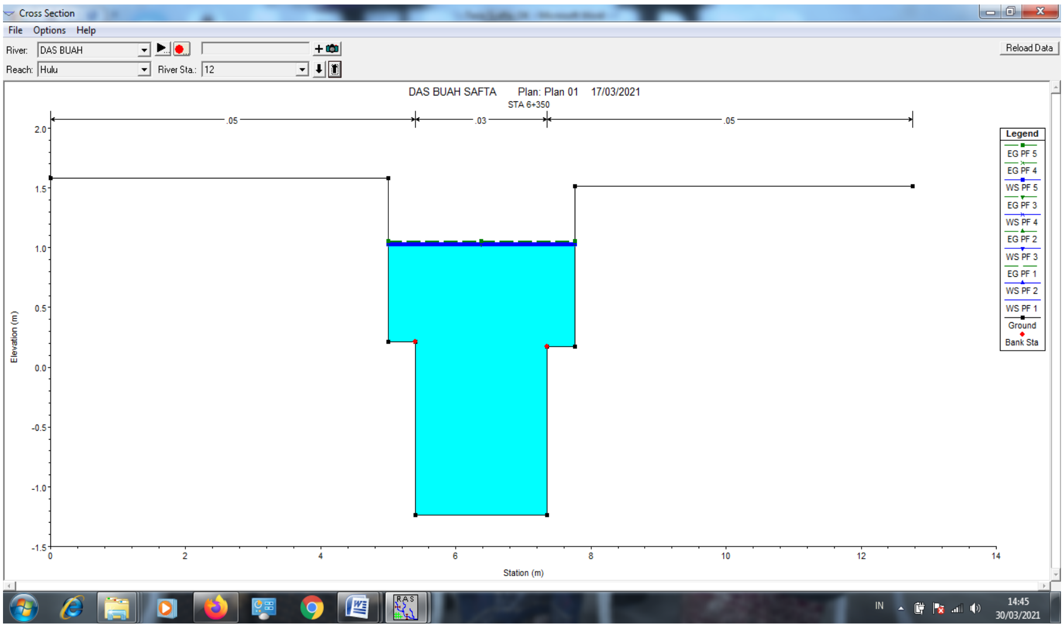

Figure 14. The pattern of water flow movement in the Buah river at Sta.6 + 350

In Figure 14. it is also seen that there is no runoff at Sta.6 + 350. This is because it is still affected by the Kiwal retention pool.

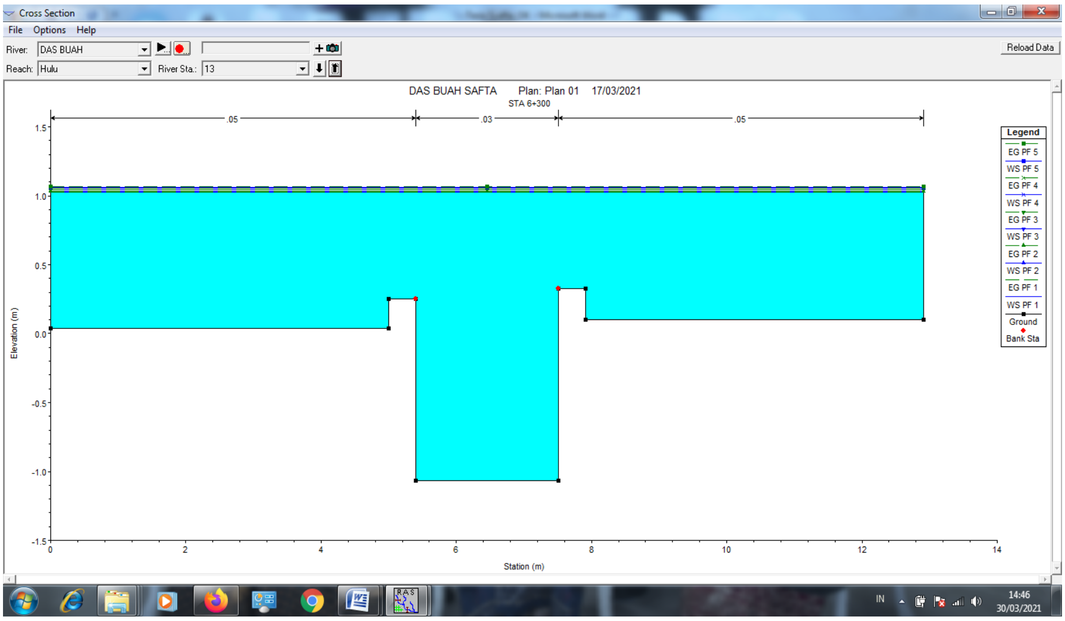

Figure 15. The pattern of water flow movement in the Buah river at Sta. 6 + 300

In Figure 15. it can be seen that there is an increase in the water level in the Buah river at Sta. 6 + 300. This is because the existing retention ponds do not affect the Buah river and result in runoff.

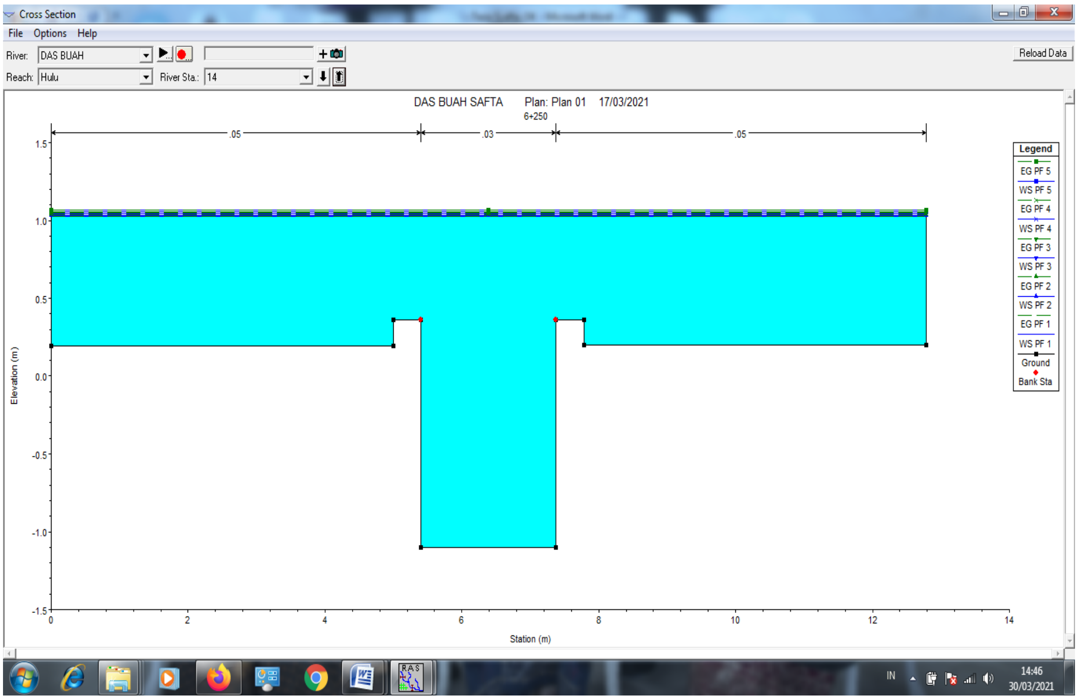

Figure 16. The pattern of water flow movement in the Buah river at Sta.6 + 250

In Figure 16, it is also seen that there is an increase in the water level in the river at Sta.6 + 250, so that at the station in the Buah river there will be runoff or an increase in the water level.

IV. CONCLUSION

At Sta. 6 + 860.5 to Sta. 6 + 850 there is no rise in the water level 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 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.

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