International Journal of Progressive Sciences and Technologies (IJPSAT)
ISSN: 2509-0119.

Vol. 32 No. 1 April 2022, pp. 30-39

Numerical Hydraulic Model of Water Fluctuations in Section 4 Jakabaring Sport City (JSC) Main Channels, Palembang, Indonesia

Akhirudin[1] and Achmad Syarifudin[2]

[1,2] Civil and Environment Engineering Faculty,
Universitas Bina Darma
Indonesia

***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. , Sei Selincah, Keramasan, Kertapati, Kedukan Ulu, Aur, Sriguna, Jakabaring and Plaju.**

The study was conducted to see the changes in the water level in the main channel of Jakabaring Sport City (JSC) in section 4 using the HEC-RAS ver.4.1.0 program.

The results showed that the pattern of water flow movement in the main channel of Jakabaring Sport City (JSC) in section 4 has an overtopping area, namely at station 0 + 000, both the return period (R) 2, 5, 10, 20 and 50 years, which is 2.50 m both on the right and left of the cliff channel.

At stations 0 + 100 to 0 + 900 in the return period R_{20} (PF4) there is an increase in water level (over flow) between 0.50 m to 2.00 m. Meanwhile, at sta. 1 + 000 there is no water level rise in the channel.

Keywords—The JSC main channel; Flood discharge; IDF curve; HEC-RAS program; Water level fluctuation

I. Introduction

Floods are disasters that often hit especially urban areas so that they 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).

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 is the largest river with an average width of 504 meters and a maximum width of 1,350 meters around Kemaro Island. (Syarifudin, A, 2018)

Based on the division of river areas, 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, Weir, Lawang Kidul, Buah, Juaro, Batang, Sei Selincah, Keramasan, Kertapati, Kedukan Ulu, Aur, Sriguna, Jakabaring and Plaju. (Department of PUPR of Palembang city, 2018)

The drainage network system of the city of Palembang is divided into 19 sub-watersheds. Drainage system which includes: Gandus, Gasing, Lambidaro, Borang, Sekanak, Weir, Lawang Kidul, Buah, Juaro, Batang, Selincah, Nyiur, Sriguna, Aur, Kedukan, Jaka Baring, Kertapati and Cleanliness. (PUPR of Palembang city, 2018)

Due to the relatively flat condition of the Palembang city area, in certain locations it often experiences puddles (floods) caused by the flow of rainwater (run off) which the canal cannot accommodate. In addition, at certain locations, puddles (floods) are also caused by the runoff of the Musi River.

Floods that occurred in the city of Palembang caused problems for the Government to evaluate the existing drainage channels. The rainwater drainage channels have been built but need to be reviewed and evaluated to function properly. (Achmad Syarifudin, 2022)

One channel that has an important role in the city of Palembang is the Jakabaring Sport City (JSC) Main River which is located in a built area. In recent years, the Main river of Jakabaring Sport City (JSC) is no longer able to accommodate the capacity (discharge) of water flow during the rainy season, not to mention a lot of water hyacinth in the channel.

Various efforts have been made, but these efforts have not been optimal in overcoming the problem of puddles (floods). These efforts are in the form of maintaining city drainage channels, cleaning river channels that cross the city. Likewise, studies related to flood control in urban areas, construction of flood control facilities have been made and several policies and regulations have been issued for flood control. These efforts turned out to be outpaced by the development of the city. (Achmad Syarifudin, 2022)

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 (Achmad Syarifudin, 2018).

HEC-RAS is a program that can model unsteady flow with a one-dimensional view with more accurate geometry 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. (Istiarto, 2015)

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 collection of rainfall data as material for analyzing rainfall with a certain return period includes a return period of 2 years, 5 years, and 10 years, after which the intensity of rainfall is calculated for the first time calculating the concentration time. Then the rainfall intensity intensity (IDF) curve is made and calculate the planned discharge for each certain return period. Then the program HEC-RAS ver. 4.1.0 is used to predict the overflow (overflow) of water in the channel/river at each cross-section based on the results of the cross-sectional survey and the longitudinal profile of the river being reviewed.

2.2. Research methods

This research was conducted for the first time using empirical methods, 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 calculation results are simulated on the existing channel using HEC-RAS 4.1.0.

2.3. Stages, Process and Data Analysis

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

a) Rainfall analysis

Rainfall data analysis with frquency 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) Numerical modeling

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 Stages

In accordance with the research objectives, the following stages are required:

1. The first stage is to collect references from journals, books, and other secondary data sources such as the BBWSS-VIII office, PU Pengairan, South Sumatra Province and PUPR in Palembang.
2. The second stage is conducting a field orientation survey to obtain the current (existing) field conditions, taking photos of the field (site) so that it can be used as initial research data.
3. The third stage is to collect survey data and measure channel topography to become input data for model simulation with the help of the HEC-RAS ver 4.1.0 program.
4. The fourth stage, conducts flow simulation with the help of the HEC-RAS ver 4.1.0 program with input data of initial conditions and boundary conditions according to channel data from the field.
5. The fifth stage, to get the results of the program, namely the condition of the water level (flood) in each section with a distance of 100 m along the 1.5 km main channel.
6. The sixth stage, analyze the simulation results and conduct discussions
7. The seventh stage, making research conclusions and providing suggestions for further research by other studies.

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.

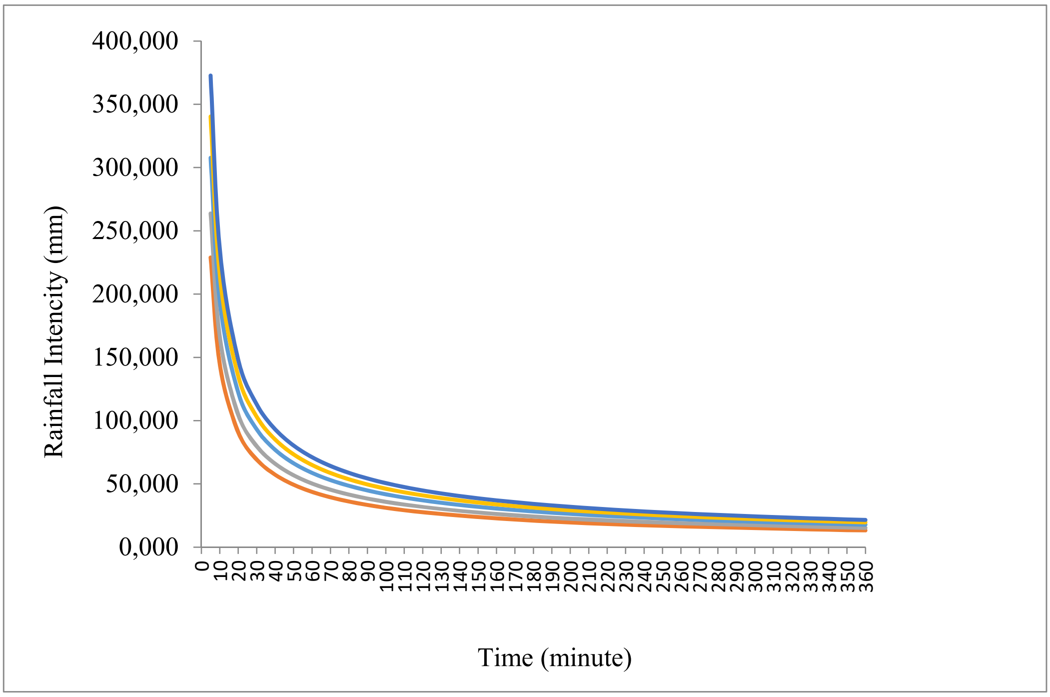

Fig 1. IDF curve graph (Intensity Duration Frequency)

3.1. Jakabaring Sport City channel flow debit

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

TABLE I. THE RESULTS OF THE CALUCULATION OF RUNOFF DISCHARGE

Return Period (Year)	C	I (mm/jam)	A (km^2)	Q (m^3/det)
2	0,8889	30,771	5,58	40,600
5	0,8889	40,247	5,58	55,497
10	0,8889	46,522	5,58	64,149
20	0,8889	54,449	5,58	75,080
50	0,8889	60,330	5,58	83,189

3.2. Simulation Results

After inputting data in the HEC-RAS program, then running a test, the simulation results are obtained in the form of a graph of fluctuations in water level changes in each cross section of the channel.

The pattern of water flow movement in the JSC section 4 main channel for the 5 year rain return period (PF2) can be seen as shown below:

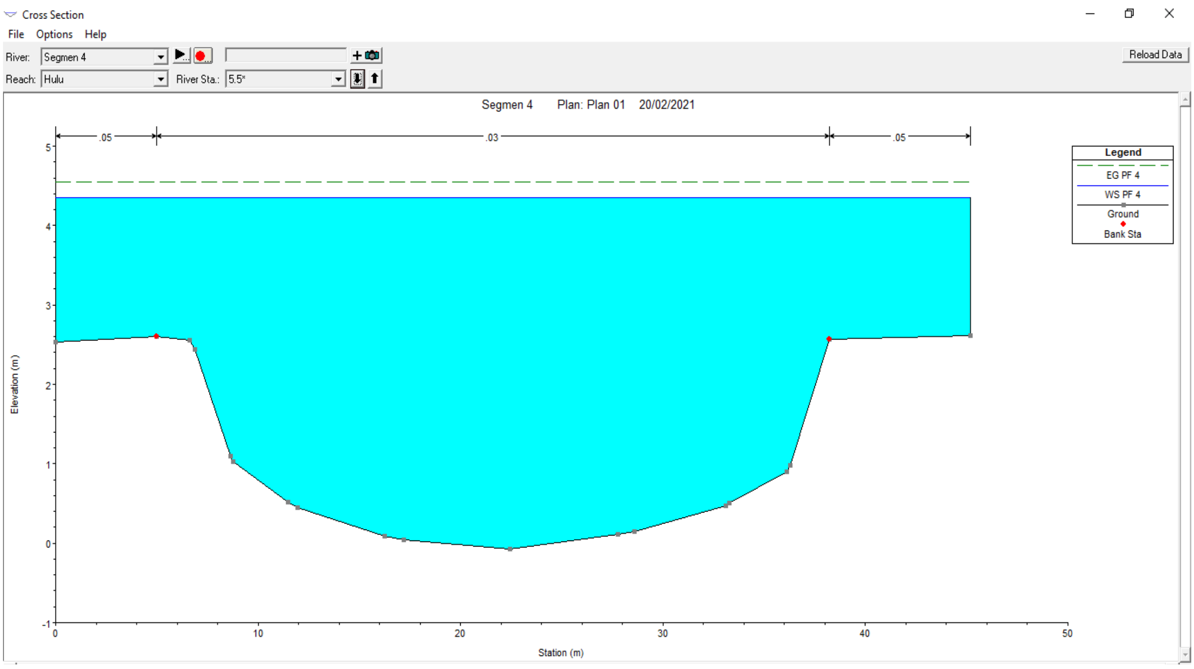

Fig 2. Pattern of water flow movement in the main channel of JSC Sta. 0+000 (P22)

In Figure 2. it can be seen that at Sta.0+000 (P22) with a return period of 20 years (R20), there was an increase in the water level as high as 1.00 m, so that at the Sta.0+000 (P22) channel there was an overflow.

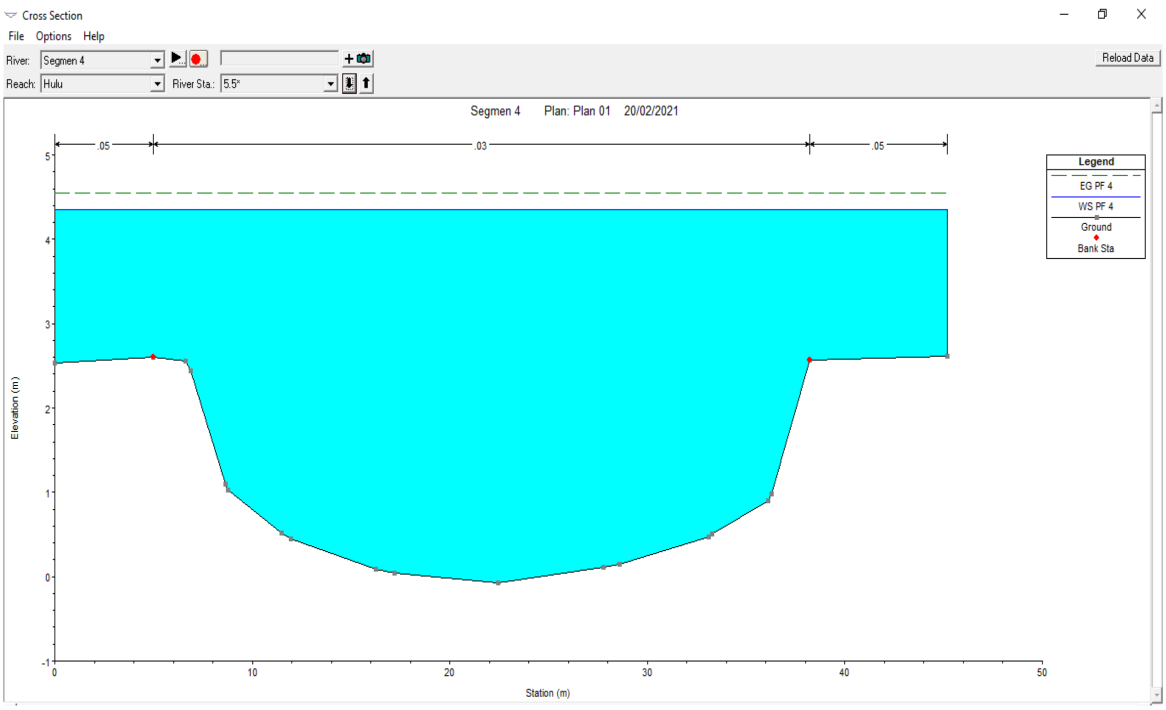

Fig 3. Pattern of water flow movement in the main channel of JSC Sta. 0+100 (P23)

In Figure 3. it can be seen that at Sta.0+100 (P23) with a return period of 20 years (R20), there was an overflow of the water level as high as almost 1.50 m, so that at the Sta.0+100 (P23) channel there was an overflow. .

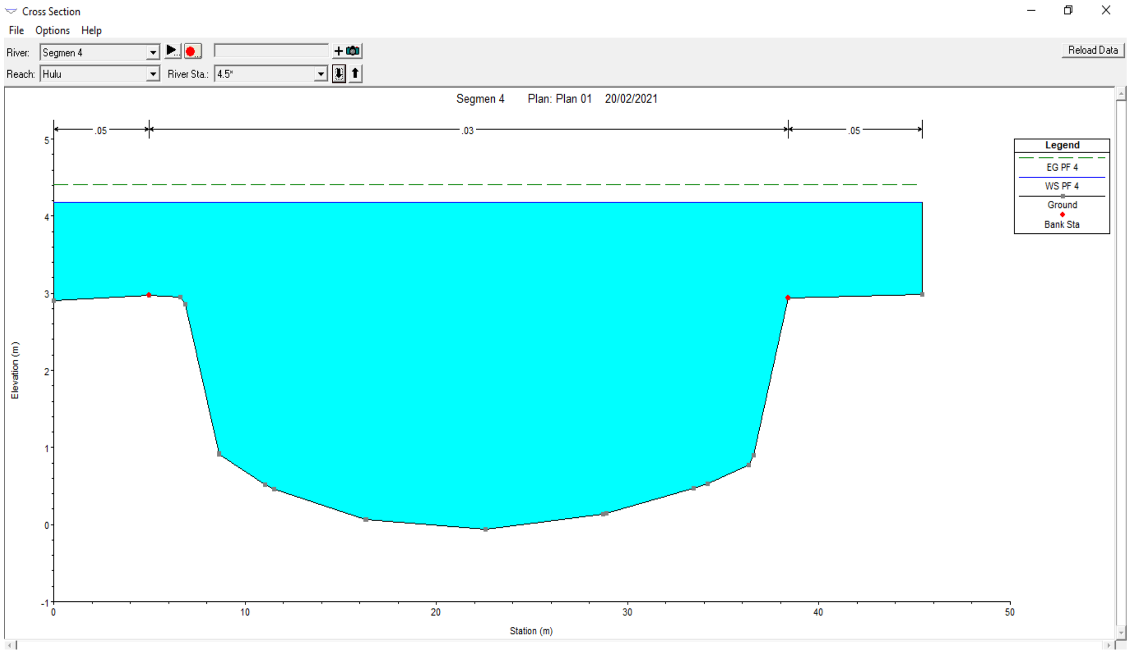

Fig 4. Pattern of water flow movement in the main channel of JSC Sta. 0+300 (P25)

In Figure 4. it can be seen at Sta.0+300 (P25) with a return period of 20 years (R20), there was an overflow of the water level as high as almost 1.00 m, so that at the Sta.0+300 (P25) channel an overflow occurred.

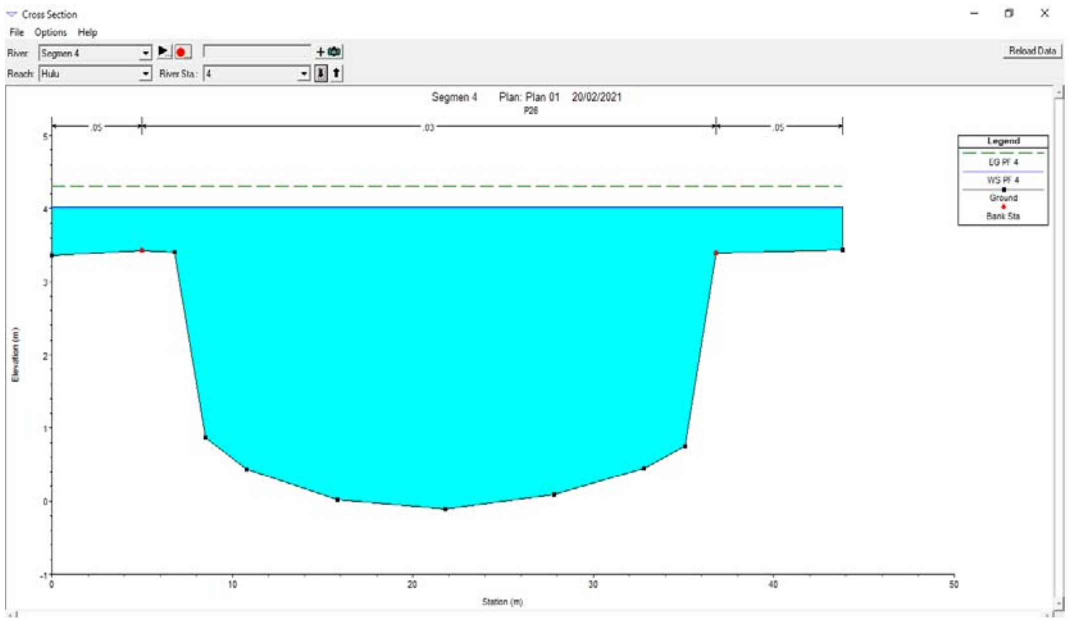

Fig 5. Pattern of water flow movement in the main channel of JSC Sta. 0+400 (P26)

In Figure 5. it can be seen that at Sta.0+400 (P26) with a return period of 20 years (R20), there was a decrease in the overflow of the water level as high as almost 0.50 m, so that at the Sta.0+400 (P26) channel there was an overflow (overflow).

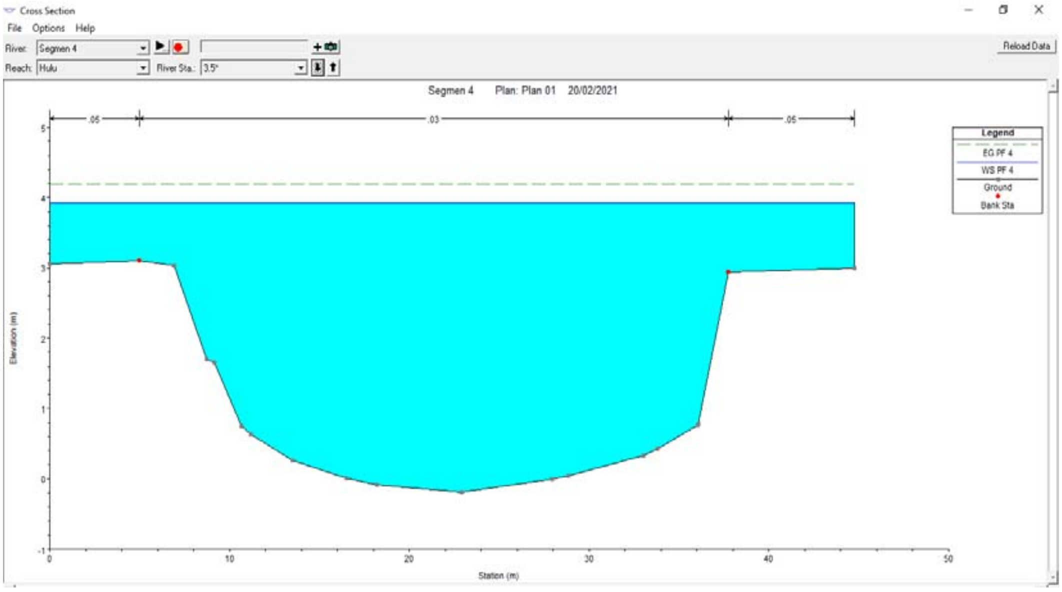

Fig 6. Pattern of water flow movement in the main channel JSC Sta.0+500 (P27)

In Figure 6. it can be seen that at Sta.0+500 (P27) with a return period of 20 years (R20), there was a decrease in the overflow of the water level as high as almost 0.60 m, so that at the Sta.0+500 (P27) channel there was an overflow (overflow).

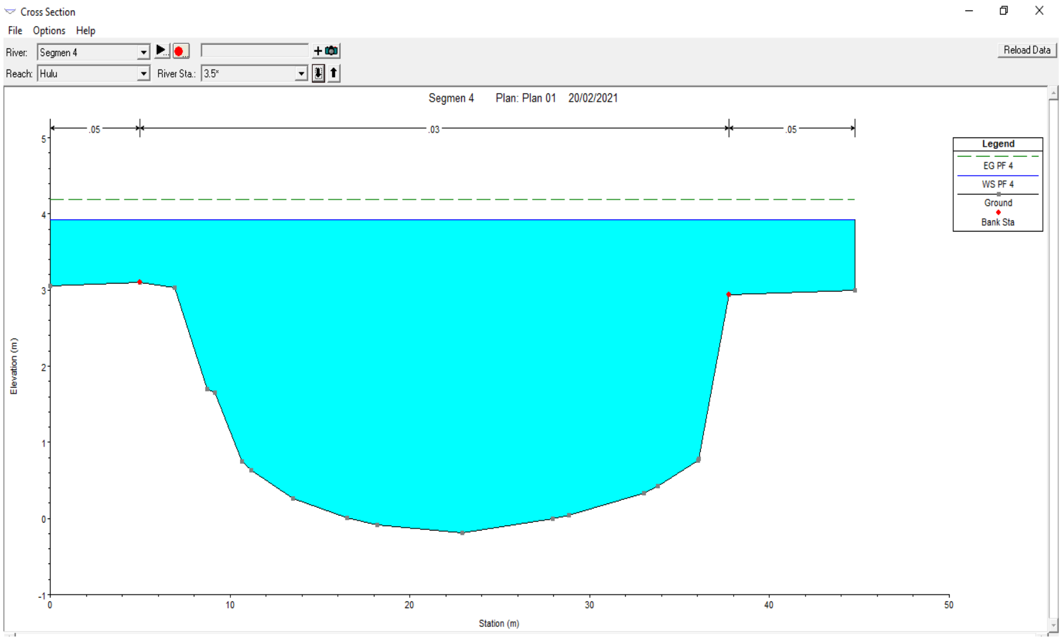

Fig 7. Pattern of water flow movement in the main channel of JSC Sta. 0+600 (P28)

In Figure 7. it can be seen that at Sta.0+600 (P28) with a return period of 20 years (R20), there was a decrease in the overflow of the water level as high as almost 0.50 m, so that at the Sta.0+600 (P28) channel there was an overflow (overflow).

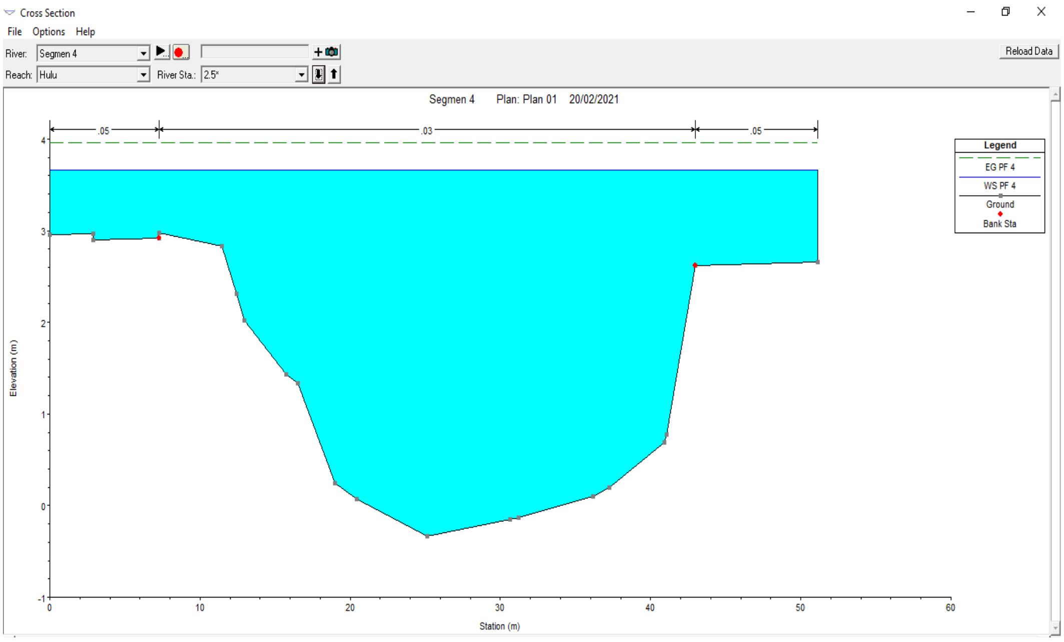

Fig 8. Pattern of water flow movement in the main channel of JSC Sta. 0+700 (P29)

In Figure 8. it can be seen that at Sta.0+700 (P29) with a return period of 20 years (R20), there was a decrease in water level overflow of approximately 0.50 m, so that at the Sta.0+700 (P29) channel it still occurred overflow.

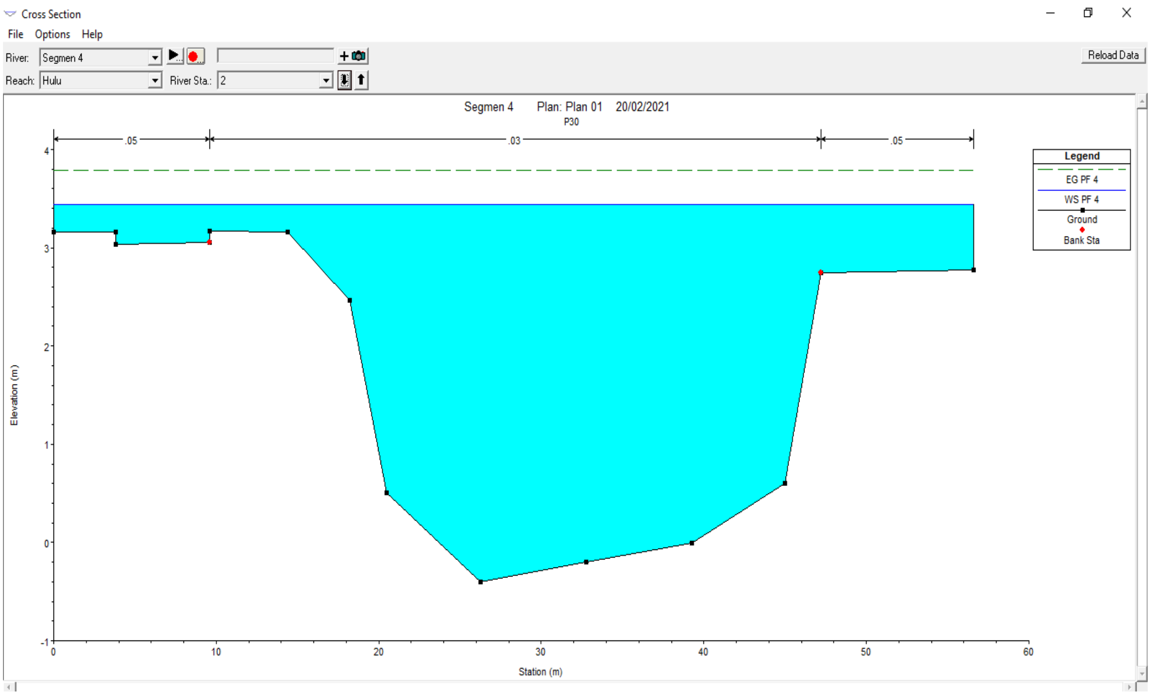

Fig 9. Pattern of water flow movement in the main channel of JSC Sta. 0+800 (P30)

In Figure 9. it can be seen that at Sta.0+800 (P30) with a return period of 20 years (R20), there was a decrease in water level overflow of approximately 0.40 m, so that at the Sta.0+800 (P30) channel it still occurred overflow.

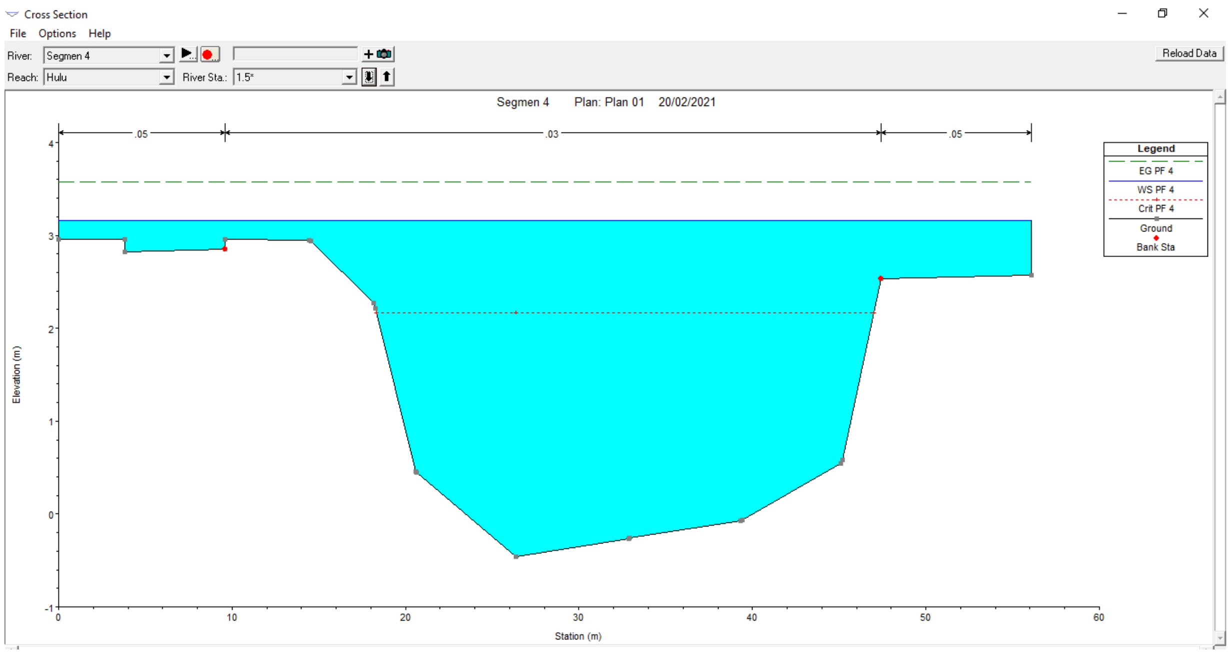

Fig 10. Pattern of water flow movement in the main channel of JSC Sta. 0+900 (P31)

In Figure 10. seen in Sta. 0+900 (P31) with a return period of 20 years (R20), there was a decrease in the water level of about 0.30 m, so that the Sta. 0+900 (P31) there is still an overflow, even though it is small.

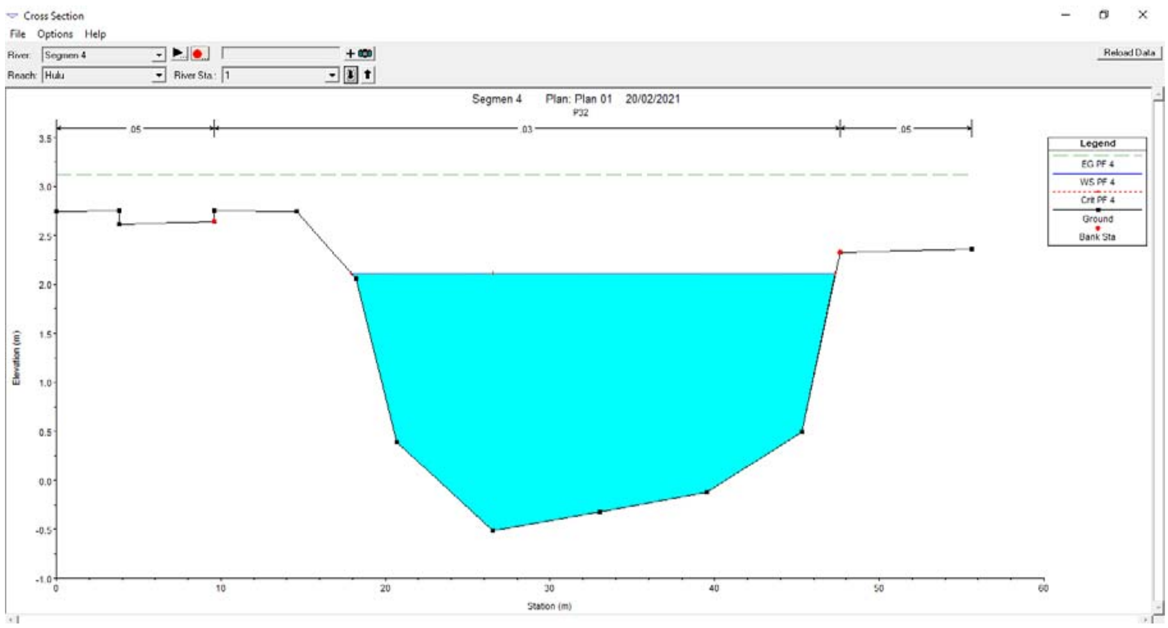

Fig 11. Pattern of water flow movement in the main channel of JSC Sta. 1+000 (P32)

In figure 11. seen in Sta. 1+000 (P32) with a return period of 20 years (R20), no overflow in the channel means that it is safe against flooding in the channel.

IV. Conclusion

The main channel Jakabaring Sport City (JSC) in segment 4 has an area where the water runs over, namely at station 0+000 for the return period (R) 2, 5, 10, 20 and 50 years, which is 2.50 m both on the right and left of the cliff. Channel where at the stations 0+100 to 0+900 in the return period 20 years (PF4) there is an increase in water level (overflow) between 0.50 m to 2.00 m. Meanwhile at station 1+000 there is no water level rise in the channel.

REFERENCES

[1] Achmad Syarifudin, 2022, "Sheet-Pile Foundation for Flood Control of Musi river Basin", International Journal of Innovative Science and Research Technology (IJISRT), Vol. 7, number 1, pp. 327-333

[2] Achmad Syarifudin, 2022, "Erosion and Sedimentation Analysis of Rural Channels (RC) and Main Drainage Channels (MDC) on Tidal Lowland in Indonesia", International Journal of Innovative Science and Research Technology (IJISRT), Vol. 7, Number 1, pp. 419-426

[3] Achmad Syarifudin, 2022, "Prediction of The Depth Erosion in Rivers with Scale Models", International Journal of Progressive Sciences and Technologies (IJPSAT), Vol. 30, Number 2, pp. 123-130.

[4] Baitullah Al Amin, M., 2016, HEC-CRAS Short Tutorial for Beginners. Palembang: Faculty of Civil Engineering, Sriwijaya University

[5] Cahyono Ikhsan., 2017, "The effect of variations in flow rate on the bottom of an open channel with uniform flow", Civil Engineering Media.

[6] Chandra Sucipta et al, 2019, "Analysis of river geometry on flow discharge in alluvial channels", JeLAST, Vol. 6 No. 3

[7] Iin Karnisah, 2010, Hidrolika Terapan, Jurusan Teknik Sipil, Politeknik Bandung

[8] Istiarto, 2015, Genangan Banjir HEC-GeoRAS), Bimbingan Teknik, Universitas Gadjahmada, Yogyakarta

[9] Robert. J. Kodoatie, Sugiyanto., 2002, Flood causes and methods of control in an environmental perspective, Yogyakarta

[10] Syarifudin. A, 2017, "The influence of Musi River Sedimentation to The Aquatic Environment", DOI: 10.1051/matecconf/201710104026, MATEC Web Conf, 101, 04026, , [published online 09 March 2017]

[11] Syarifudin A and Dewi Sartika, 2019, "A Scouring Patterns Around Pillars of Sekanak River Bridge", Journal of Physics: IOP Conference Series, volume 1167, 2019, IOP Publishing

[12] Syarifudin. A, 2018, Hidrologi Terapan, Andi Publishers, Yogyakarta, p. 45-48

[13] Syarifudin. A, 2018, Drainase Perkotaan Berwawasan Lingkungan, Andi Publisher, Yogyakarta, p. 38-42

[14] Suripin., 2004, Sustainable Urban Drainage Systems, Andi Publishers, p. 176-179.\

[15] Syarifudin A, HR Destania., "IDF Curve Patterns for Flood Control of Air Lakitan river of Musi Rawas Regency", IOP Conference Series: Earth and Environmental ScienceVolume 448, 2020, The 1st International Conference on Environment, Sustainability Issues and Community Development 23 - 24 October 2019, Central Java Province, Indonesia

[16] Syarifudin A., 2014, "The 2nd International Conference on Informatics, Environment, Energy, and Applications *(IEEA 2013"),* Bali, Indonesia, March 16-17, 2013, JOCET (Journal of Clean Energy and Technology) Journal ISSN: 1793-821X Vol. 2, No. 1, January 2014

[17] Yosi Marizan and Achmad Syarifudin, 2022, Analysis of Flood Discharge due to Land Used Changes in Keramasan Watershed Palembang, Indonesia, International Journal of Progressive Sciences and Technologies (IJPSAT), Vol. 30, Number 2, pp. 147-159