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Original Article

Non-Metalic Material Sand, Gravel and Stone on Ongkag River : Method of Mining

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Abstract *- Mining nonmetallic sand, gravel, and river stones in a river channel has previously caused damage to the river channel itself and the surrounding environment. Technical studies are needed to minimize the damage in mining in the river channel. Ongkag Dumoga River channel is planned to be the location of mining non-metal material for sand, gravel and river stone. The research method was carried out by geodesic mapping to determine the profile of the river cross-section, hydrological analysis with a return period of 25, 50, and 100 years and hydraulic analysis on the river flow along the 600 m. The design of the post-mining river technical profile is carried out to improve the capacity of the existing river cross-section. Changes in river profile are the potential volume of nonmetallic material in the form of sand, gravel and river stones that become river sediment. The results of the analysis of flood discharge HSS-Snyder method get a discharge of 1249.1692 m³ / s at the 100-year return, 1178.8064 m³ / s at the 50-year return period, 1104.2372 m³ / s at the 25-year return period. The simulated flood discharge shows a flood overflow in the existing river during the 25, 50 and 100-year floods. The new technical river cross-section will use the economic cross-section of the trapezium cross-section. Changes in river profiles are calculated to get a potential excavation volume of 88,347.42 m³.*

Keywords *- Nonmetallic material mining, Plan flood discharge, Economic latitude view, Dumoga cost.*

1. Introduction

Before 2014 the mining of nonmetallic material in the river channel or commonly called Galian C mining permit was granted by the Level II Regional Government, namely the Regent or Mayor; without going through studies on the impacts that could occur, therefore, there was heavy damage to the rivers primarily occurred on the river Dumoga Ongkag whose material was mined before 2014.

Based on the damages, the central government issued a moratorium through Law No. 23 of 2014, which explains that non-metal mining or Galian C in rivers permits are granted by the Level I Regional Government, namely the Governor. However, a technical study of water flow, transport sediment, and river morphology matters must be conducted.

This study is expected to be able to control the damage that might occur in the Ongkag Dumoga river, which is one of the locations for mining sand, gravel and river stone material to a predetermined limit and can find out the material potential contained in the Dumoga Ongkag river.

2. Area of Research

Administratively the research location is located in Totabuan village, Lolak sub-district, Bolaang Mongondow district and geographically, it is located at 0 ° 46 '48.33683 "LU and 124 ° 6" 25.0785 "East.

This study aims to meet the standards of the technical rules of river channel mining, river border management, cross-sectional capacity, and river discharge by the mining laws of a non-metal material, sand, gravel and river stone which can then be referred to miners.

3. Method of Data Collection

3.1. Secondary Data

This data can be obtained from agencies and parties deemed related to the Dumoga River and from literature, reports or notes from parties related to research. The data include:
- Watershed Map, Land Use Map, and Map of Station. Station for Ongkag Dumoga Watershed
- Rainfall data obtained from the Sulawesi River Region I (BWSS I)
- Results of previous topographic mapping.

3.2. Primary Data

The primary data collection is carried out by field surveying to acquire data accurately. Identifying and listing are the initial primary data collection process to get the research location's big picture. Visual observation and interview with the community location survey to obtain data on Dumoga River conditions in Dumoga through interviews with communities around the river and the local government.

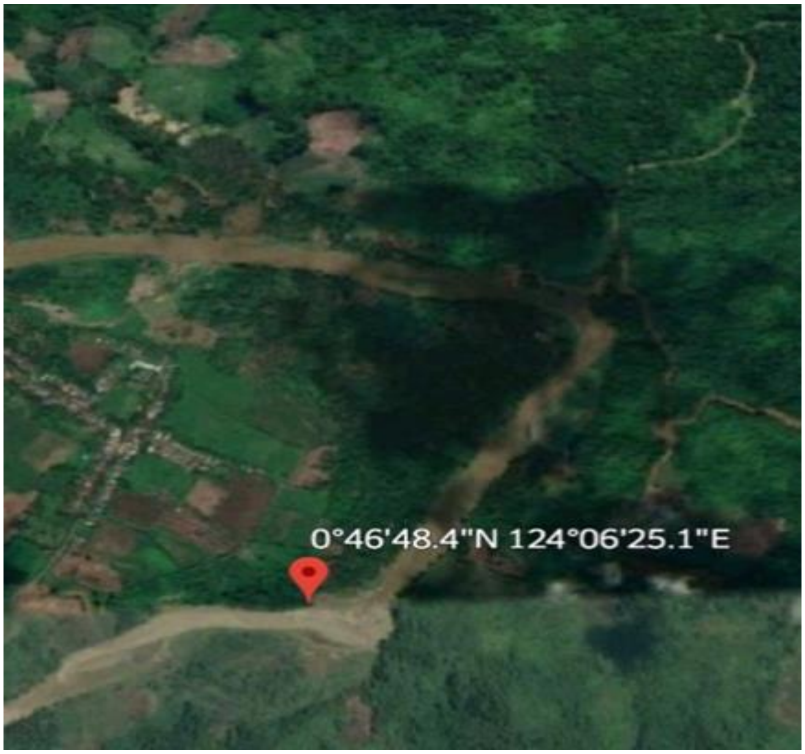

Fig. 1 Map of Ongkag River

4. Method of Data Analysis

Analysis of the data in question is to analyse the Frequency and Distribution of hourly rain from rainfall data obtained based on the Probability Distribution and calculate the rainfall intensity. Flood discharge analysis was carried out using various methods; the results of the flood discharge based on the recycling will be carried out through hydraulic analysis using the HEC-RAS software so that the flood water profile can be identified. The hydraulic profile of the excavated river profile is calculated to obtain the volume excavation plan.

4.1. Rainfall Data

Rainfall data is obtained from the maximum daily rainfall data of the four closest Rain Observation Stations: Toraut Rain, Konarom, Matayangan and Pusian Observation Stations. The data was obtained from BWSS I (Balai Sungai Sulawesi I) of North Sulawesi Province. The observation was carried out for ten years (2008 - 2017).

4.2. Data Quality Analysis

An Outlier data test is performed before analyzing rainfall data to determine whether extreme rainfall data is due to negligence in recording or extreme conditions occur. This outlier data test is performed for high and low outlier data with the test requirements based on the skewness coefficient (CsLog). Outlier test results get no outlier data in every rainfall data available.

4.3. Thiessen Polygon Method Average Rainfall Analysis

Average Rainfall Analysis is performed to get the average rainfall value by calculating the area of influence based on the Thiessen Polygon.

4.4. Rainfall Probability Data Analysis

Determination of the type of distribution per the data is done by testing the rainfall data using statistical parameters. This analysis is calculated using rainfall data that has been corrected from the results of the outlier data analysis. Some probability distribution methods that can be used are Gumbel, Normal, Normal Log, and Type Person Log III. The Calculation of statistical parameters for the observation data is as follows:

Central tendency

$$\bar{X} = \frac{\sum xi}{n} = \frac{956,90}{10} = 95,69\ mm$$

$$\log\bar{X} = \frac{\sum \log xi}{n} = \frac{19,76}{10} = 1,975\ \text{mm}$$

Standard deviation source data

$$S = \sqrt{\frac{1}{n-1}\sum_{i=1}^{n}(xi - \bar{x})^2}$$

$$= \sqrt{\frac{1}{10-1}.3566{,}78} = 19{,}90$$

$$\text{Slog} = \sqrt{\frac{1}{n-1}\sum_{\text{i}=1}^{\text{n}} \log\,(\text{xi} - \bar{\text{x}})^2}$$

$$= \sqrt{\frac{1}{10-1}.0{,}0760} = 0{,}0919$$

Variation Coefficient

$$CV = \frac{S}{\bar{X}} = \frac{19{,}9075}{96{,}4981} = 0{,}206$$

$$CVlog = \frac{Slog}{log\bar{X}} = \frac{0{,}0919}{1{,}976} = 0{,}047$$

Skewness coefficient source data

$$\text{Cs} = \frac{n\sum(\text{xi}-\bar{\text{x}})^3}{(n-1)(\text{n}-2)\text{S}^3} = \frac{107315{,}3223}{568044{,}6431} = 0{,}19$$

$$\text{Cslog} = \frac{n\sum\log\,(\text{xi}-\text{log}\bar{\text{x}})^3}{(n-1)(n-2)\text{Slog}^3} = \frac{-0{,}021592093}{0{,}055945976} = -0{,}39$$

Kurtosis coefficient source data'

$$\text{Ck} = \frac{n^2}{(n-1)(n-2)(n-3)\text{S}^4}\sum_{\text{i}=1}^{\text{n}}(\text{x}_{\text{i.}} - \bar{\text{x}})^4$$

Ck = 3.883

4.5. Analysis of Design Rainfall

Design rainfall analysis is calculated using the Log Pearson type III method with the following equation.

$$\log Xtr = \log \bar{X} + Kt\ \times Slog$$

$$Xtr \quad = 10^{\log Xtr}$$

Analysis of the design rainfall for the 25th, 50th and 100th birthdays was done by calculating in tabular form as follows.

Tr	1/Tr (%)	Kt	Log Xtr	Xtr
25	4	1,699	2,088476	122,596
50	2	1,974	2,118503	131,372
100	1	2,217	2,145038	139,649

4.6. Analysis of Flood Discharge HSS-Snyder Method

Flood discharge analysis using the HSS-Snyder method was carried out at the 25, 50 and 100-year return period. The results of the flood discharge obtained are as follows.

Parameter:
Taken Ct = 2.1 and Cp = 0.9
Determine the time from the point of heavy rain to the peak discharge (tp).

$$tp = Ct \times (Lc \times L)^3$$

$$tp = 2{,}1 \times (48{,}95 \times 145{,}22)^3 = 30{,}044\ jam$$

Duration of effective rain (tr ')

$$tr' = \frac{tp}{5{,}5} = \frac{30{,}044}{5{,}5} = 5{,}462$$

Because tr '<tr assumption then:

$$Tp = tp + \frac{tr}{2} = 30{,}044 + \frac{7}{2} = 33{,}544\ jam$$

Determine peak hydrograph peak units (qp)

$$qp = Cp \times \frac{275}{Tp} = 0.9 \times \frac{275}{33{,}544} = 7{,}378\ m^3/detik/km^2$$

Determine peak discharge (Qp)

$$Qp = \frac{qp \times A}{1000} = \frac{7{,}378 \times 1158{,}0164}{1000} = 8{,}544\ m^3/detik$$

$$Qb = 0{,}4751 \times A^{0{,}6444} \times D^{0{,}9430}$$

$$Qb = 0{,}4751 \times 1158{,}016^{0{,}6444} \times 1{,}42571^{0{,}9430} = 62{,}55\ m^3/detik$$

Flood discharge analysis using the HSS-Snyder method was carried out at the 25, 50 and 100 year return period. The results of the flood discharge obtained are as follows.

Return Period	Flood discharge
25 Year	1104,2372 m³/s
50 Year	1178,8064 m³/s
100 Year	1249,1336 m³/s

4.7. Measured Discharge Calibration

Calibration is done to determine if the parameters used in the flood discharge analysis are correct.

4.7.1. Regional Debit Analysis

Calibration is carried out using measured discharge data in the field because measured discharge data is not available, so regional discharge analysis is used to find the measured discharge from the nearest river. The river for which the debit data was collected is the Ongkag Lombagin River in 2011 carried out by:

$$Q_2 = \frac{Q_1}{A_1} \times A_2$$

with:
Q_2 = discharge of Ongkag Dumoga
A_2 = catchment area of Ongkag Dumoga
A_1 = catchment area of Ongkag Komangaan
Q_1 = measured discharge of Ongkag Komangaan

4.7.2. Calibration of HSS-Snyder Parameters

Calibration is done through the coefficient of determination test to determine the level of similarity of the model from the results of the calculated discharge and measured discharge. The test value of the coefficient of determination > 0.6 is considered to be able to meet the provisions for the level of similarity.

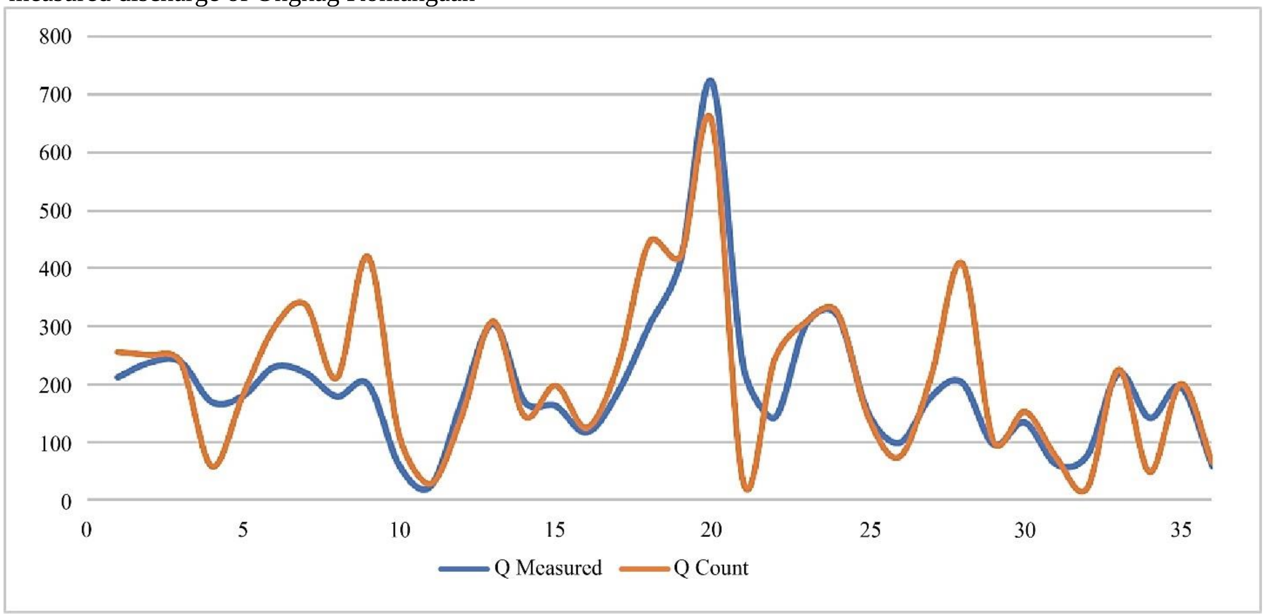

Fig. 2 Discharge rating curve

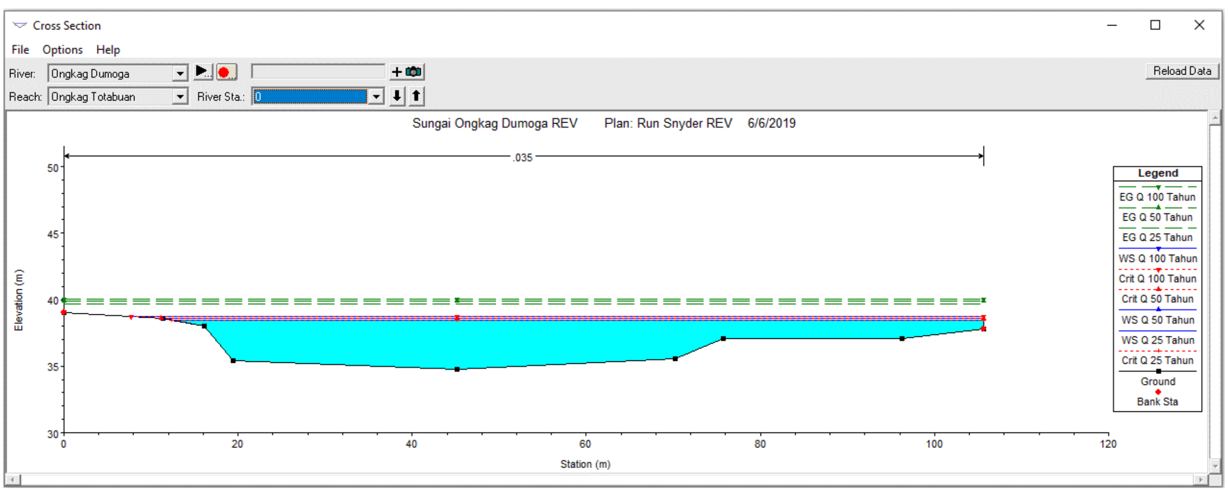

Fig. 3 Water level high at STA 0

The coefficient of determination test value (r2) getting a result of 0.86 is considered to have met the similarity value of the measured discharge data. Then the HSS-Snyder parameter can be used to calculate the planned flood discharge.

4.8. Analysis of Existing River Cross Section Hydraulics

An analysis is carried out on the existing river conditions to obtain information on water level, water surface width, channel base slope and other information on flood conditions with a specified return.

The river is modelled to be crossed by the Snyder HSS flood discharge method in 25, 50, and 100 years return times using the HEC-RAS software. Simulation results can be seen in the following image.

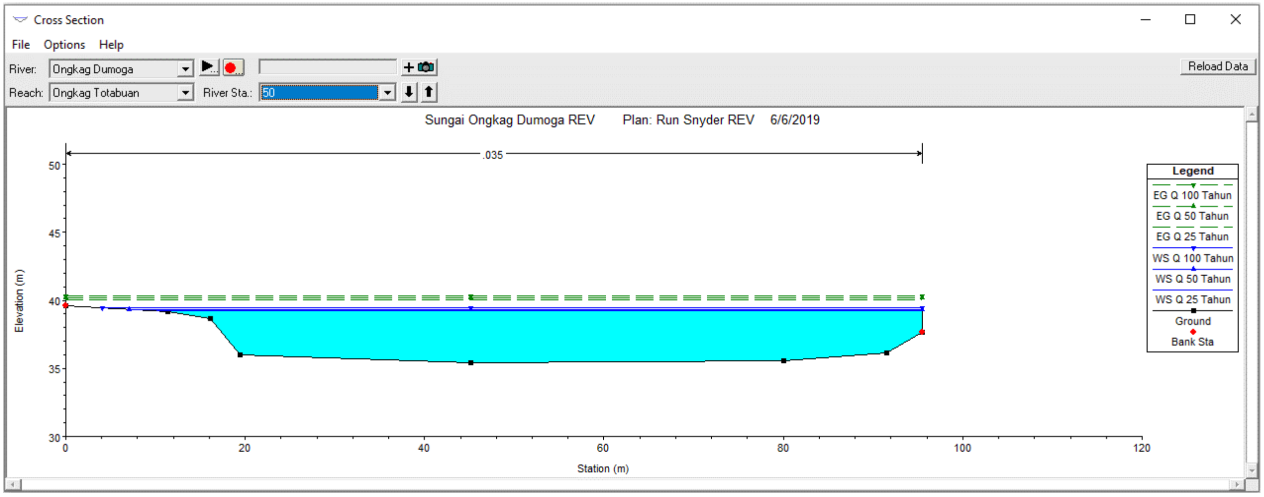

Fig. 4 Water level high at STA 50

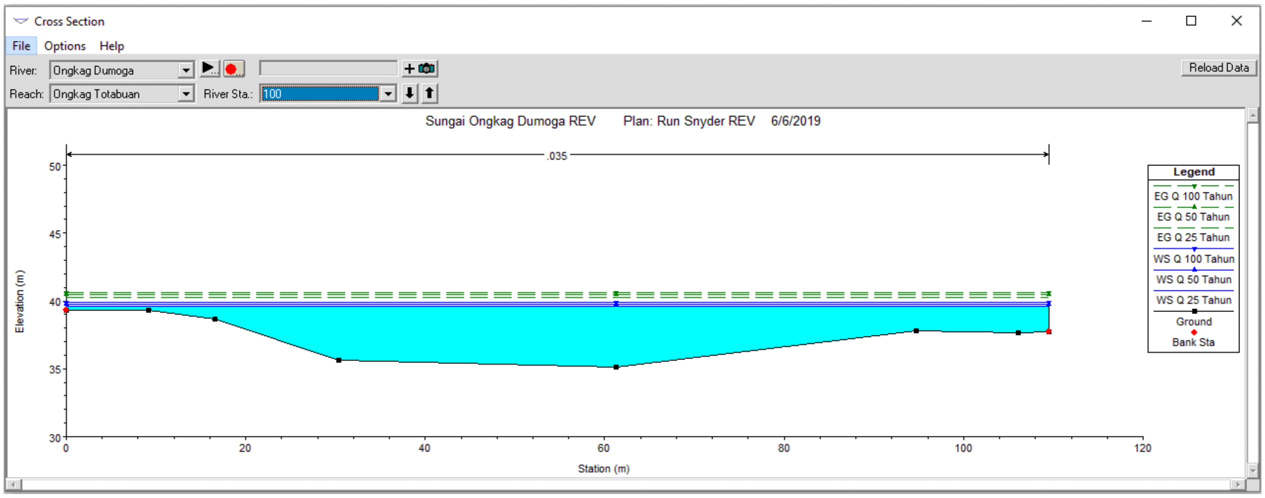

Fig. 5 Water level high at STA 100

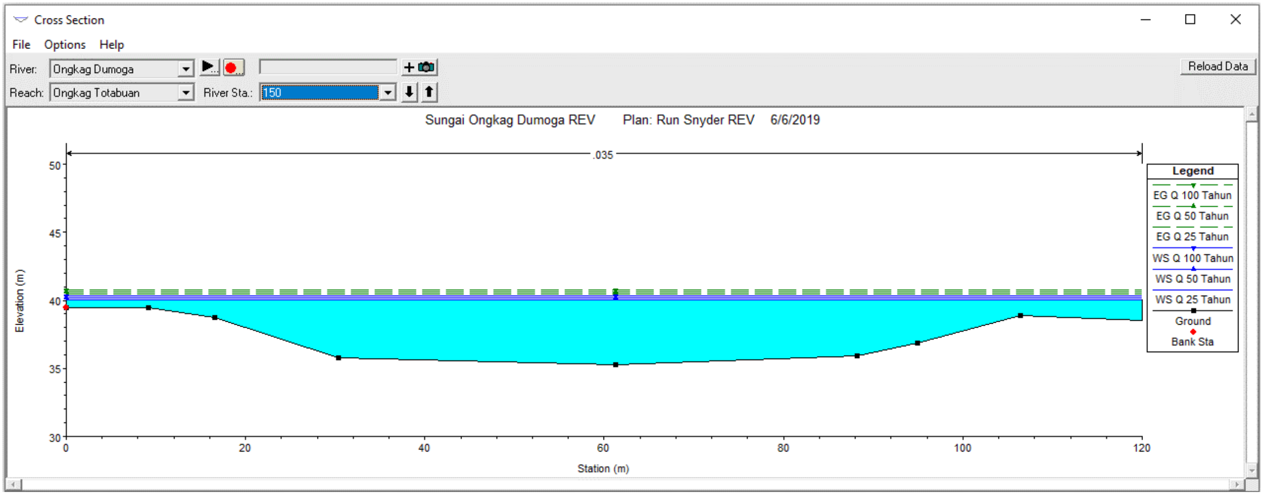

Fig. 6 Water level high at STA 150

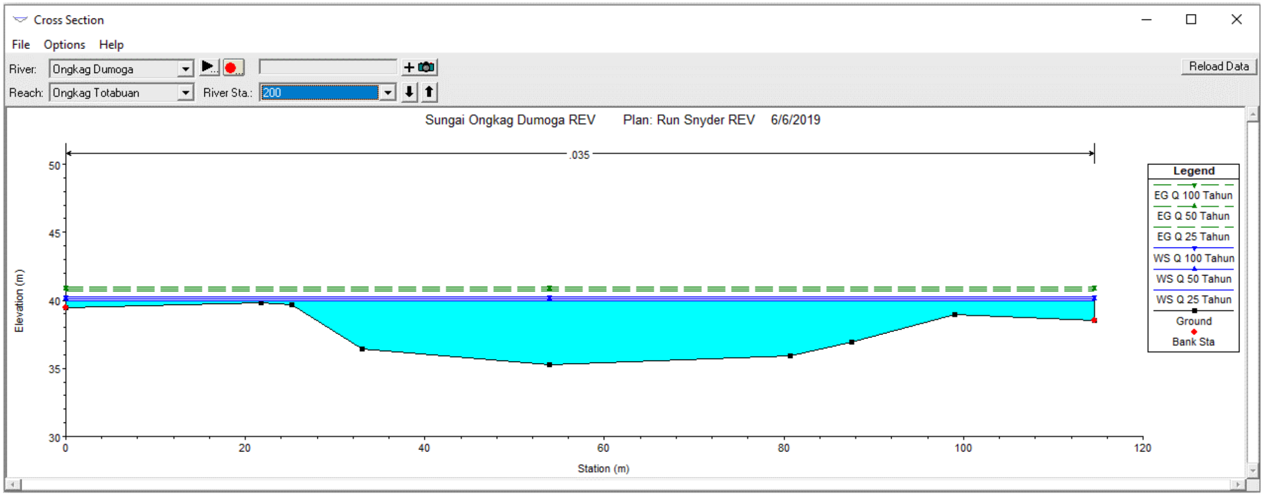

Fig. 7 Water level high at STA 200

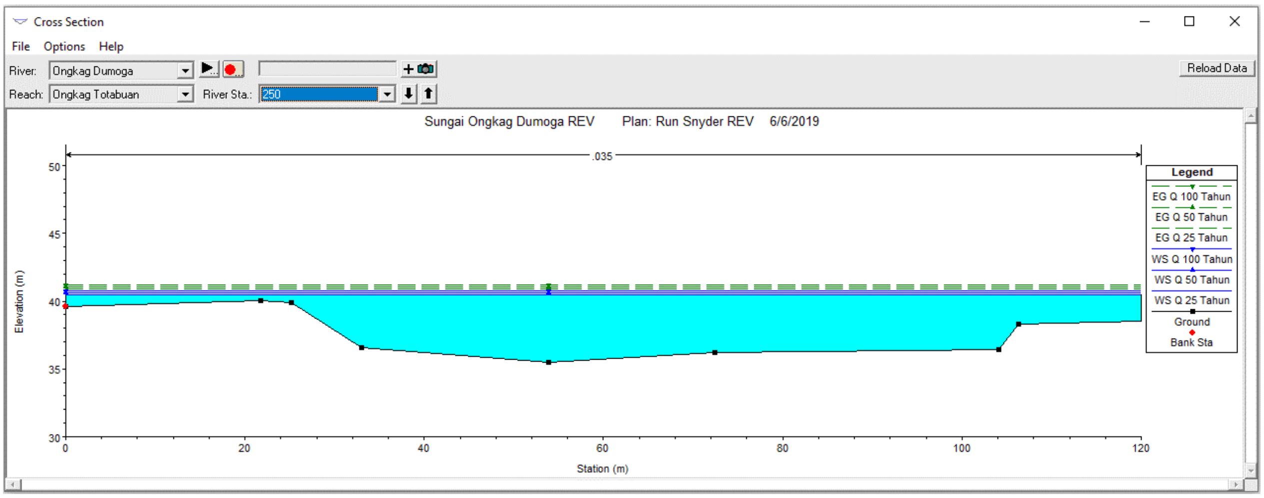

Fig. 8 Water level high at STA 250

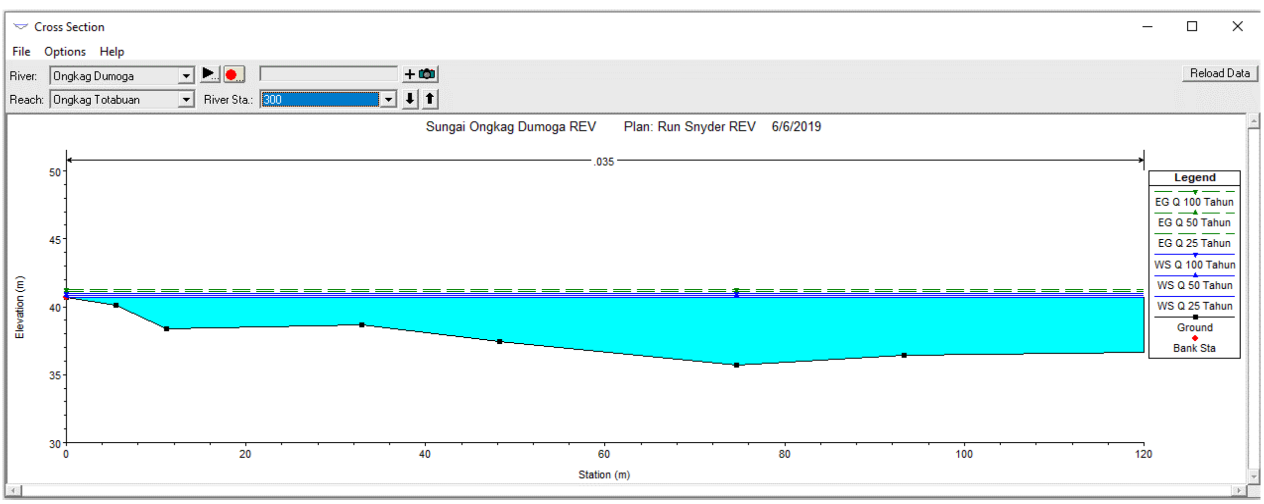

Fig. 9 Water level high at STA 300

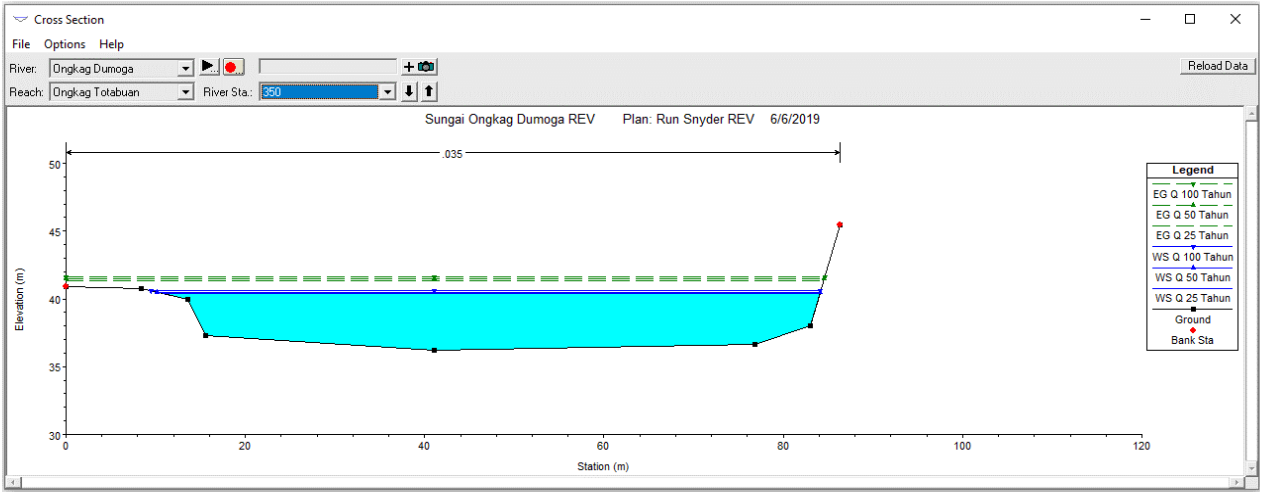

Fig. 10 Water level high at STA 350

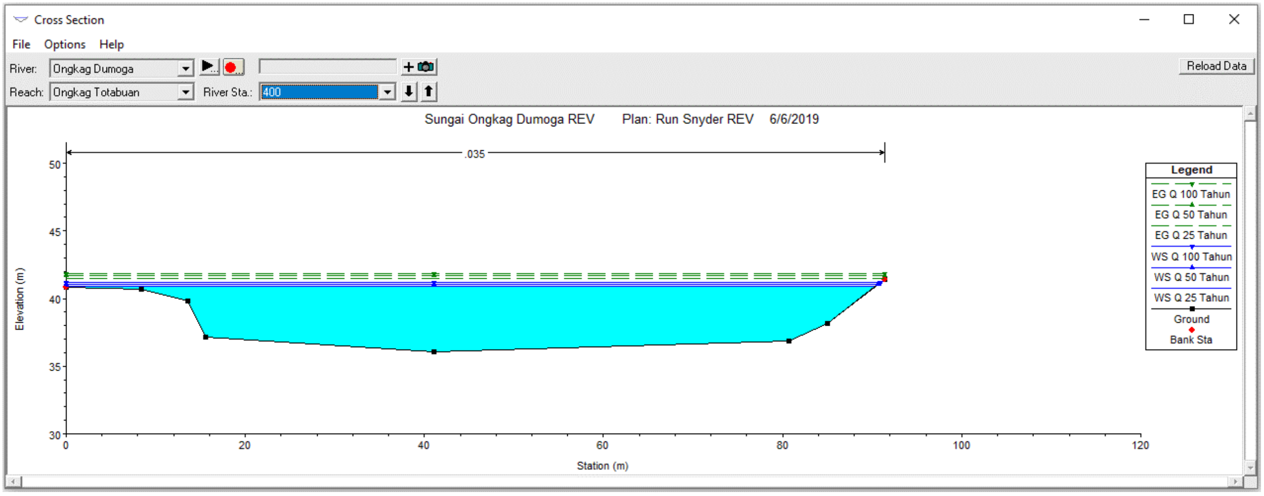

Fig. 11 Water level high at STA 400

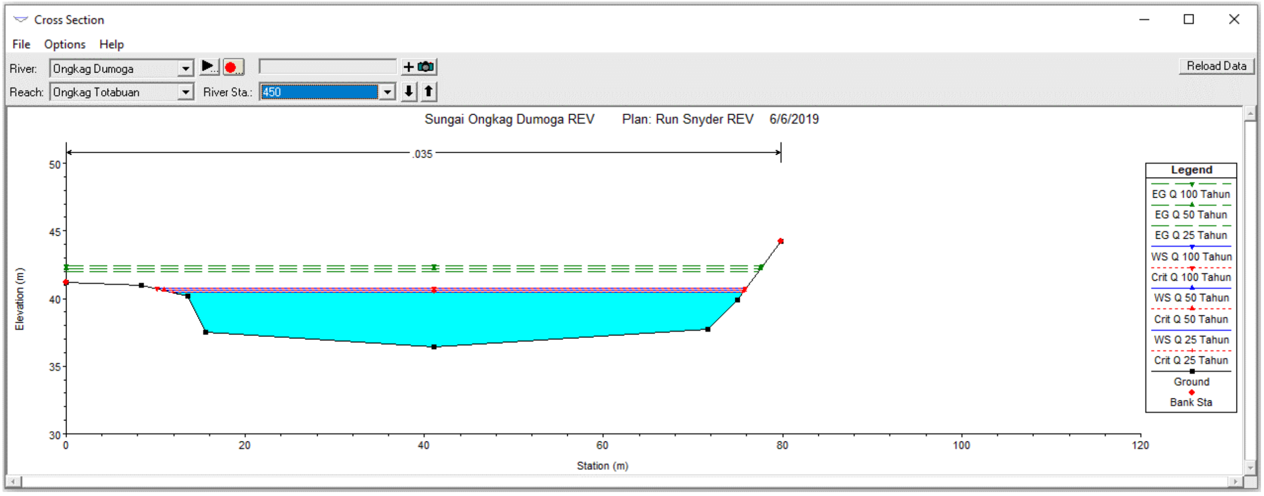

Fig. 12 Water level high at STA 450

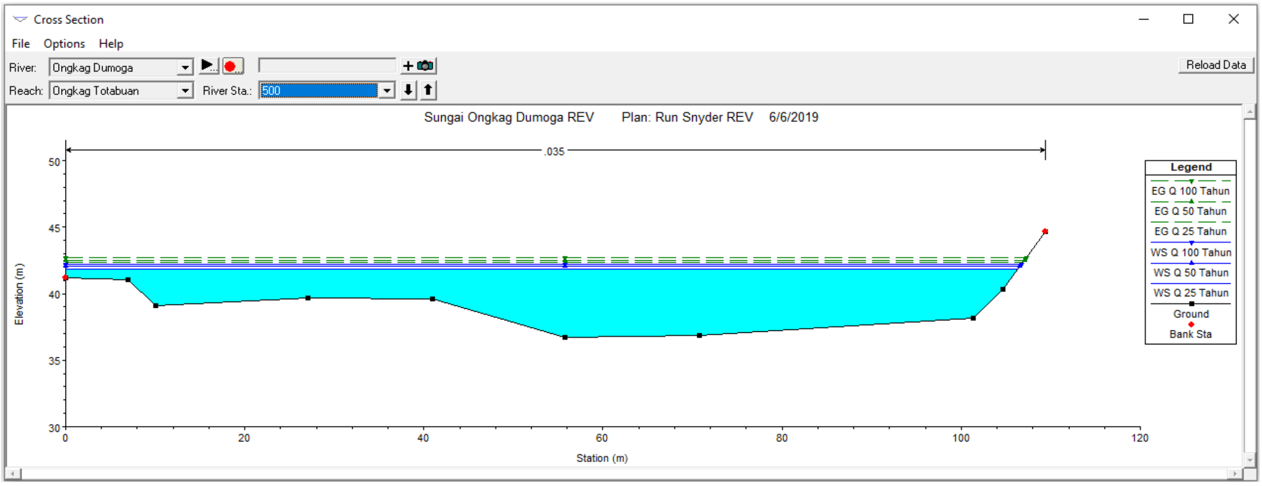

Fig. 13 Water level high at STA 500

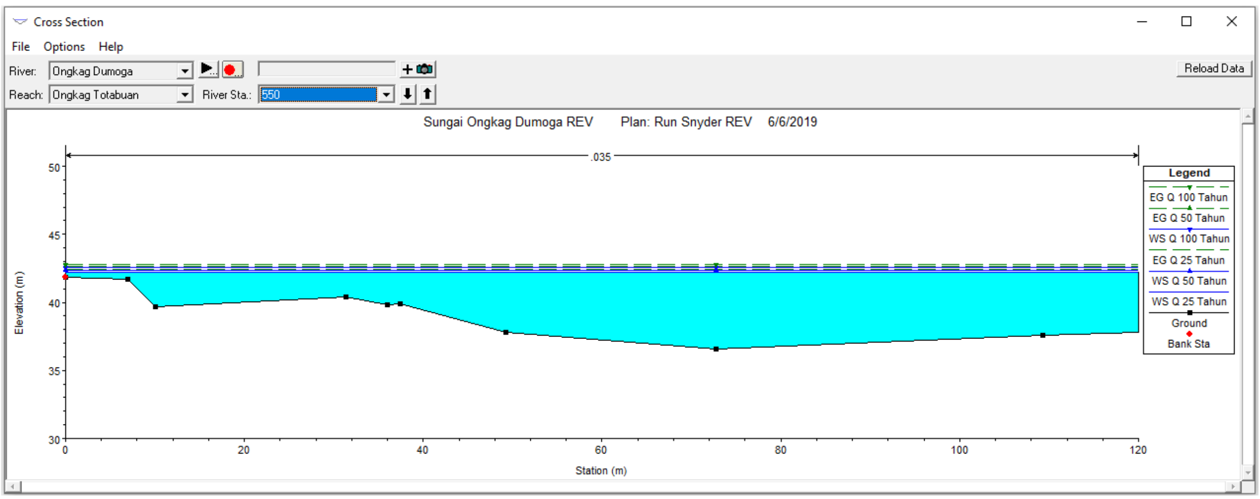

Fig. 14 Water level high at STA 550

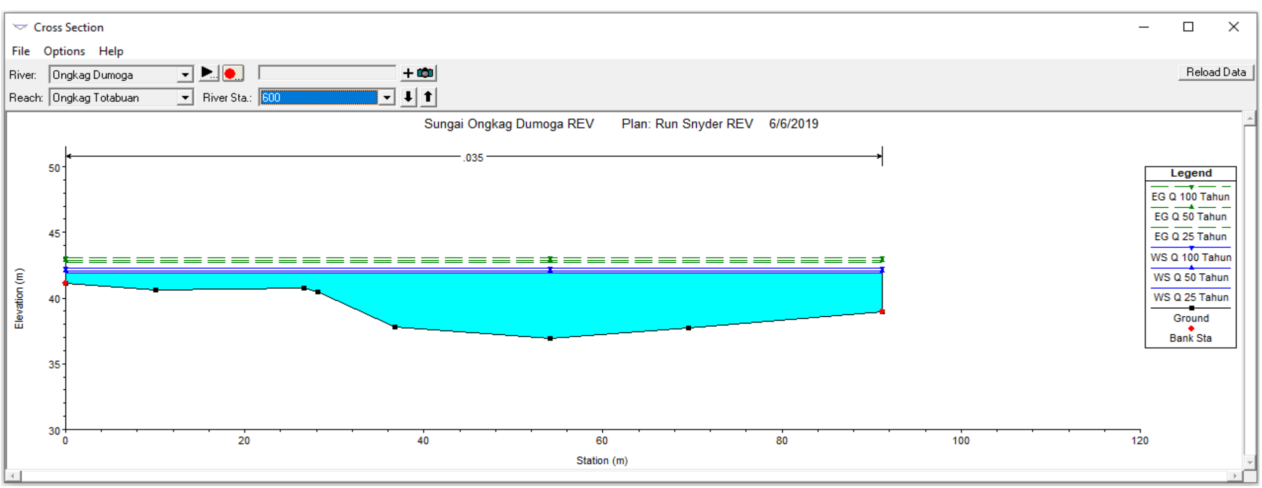

Fig. 15 Water level high at STA 600

4.9. Technical Analysis of Post-Mining River Cross-Section Hydraulic

Post-mining river cross-section analysis is carried out to obtain a new cross-section based on the economic cross-section method by maintaining the slope of the original river bed. River cross sections will be analyzed to pass the HSS-Snyder flood discharge with a 100-year return period. The design of the new river's technical appearance requires information on the average width of the existing riverbed, the slope of the riverbed, the coefficient of velocity based on river wall conditions, the depth of the potential for sand, gravel and river stone excavations and other information. This information will be included in the economical cross-section method of the river trapezoidal cross-section.

Analysis of Height and Width of Surface Water of the Technical Cross Section of the Post Mining River. The Post-Mining River Technical Cross section will then be analyzed using the HEC-RAS program to determine whether the new river cross-sectional capacity has accommodated flood discharges for 100 years.

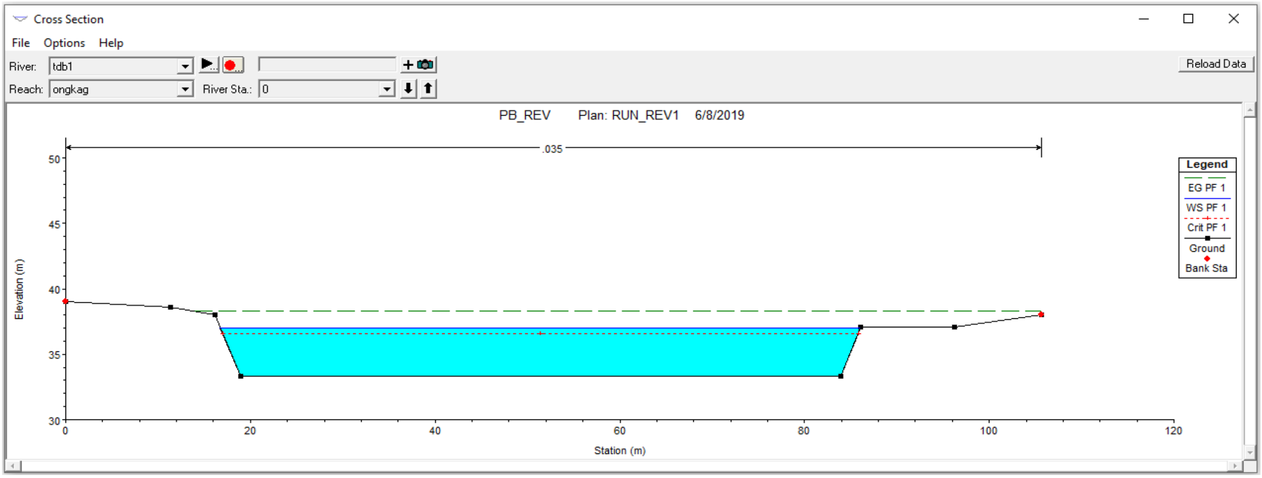

Fig. 16 Water level high at STA 0

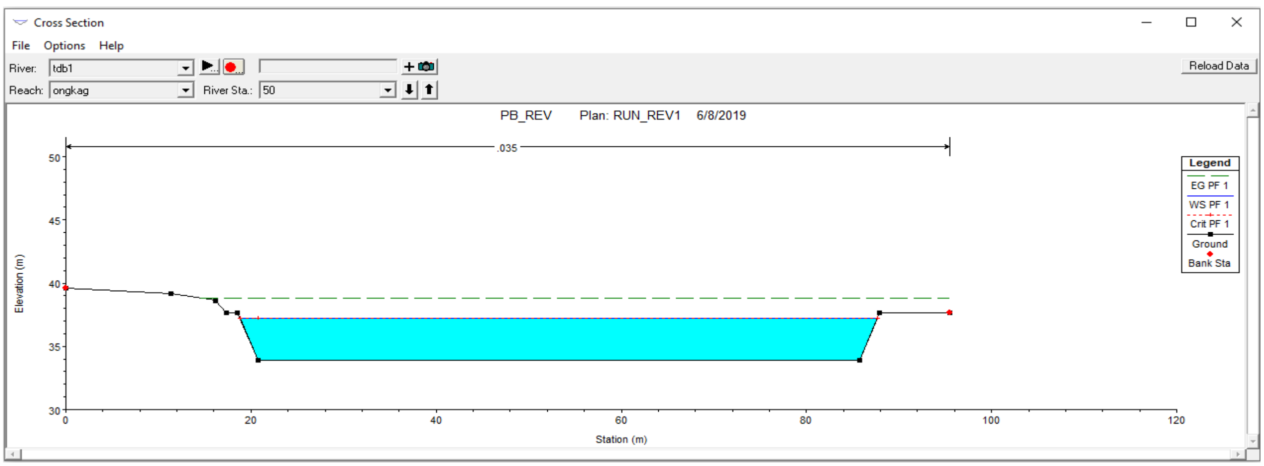

Fig. 17 Water level high at STA 50

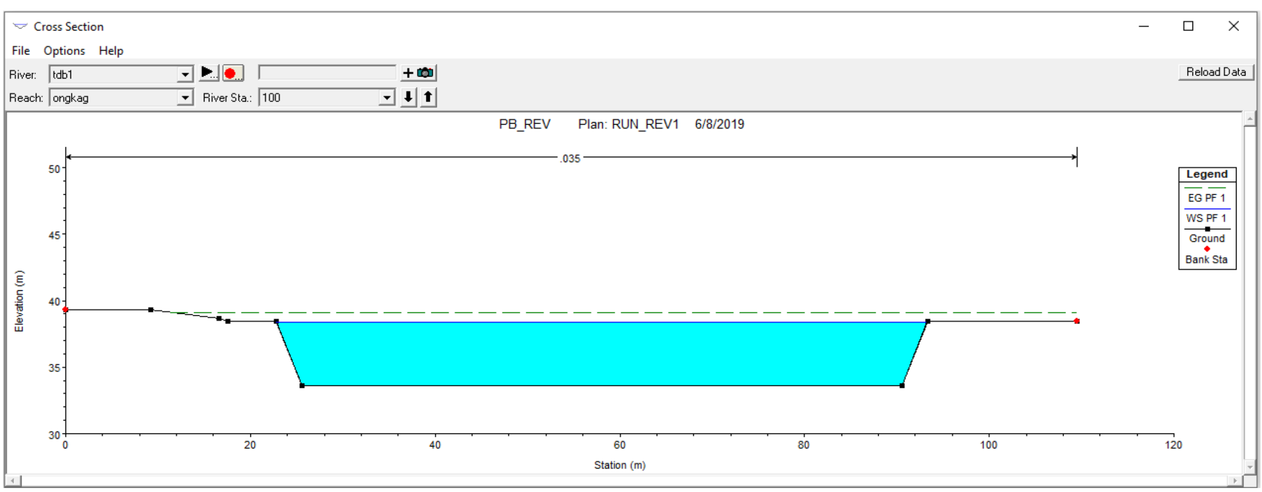

Fig. 18 Water level high at STA 100

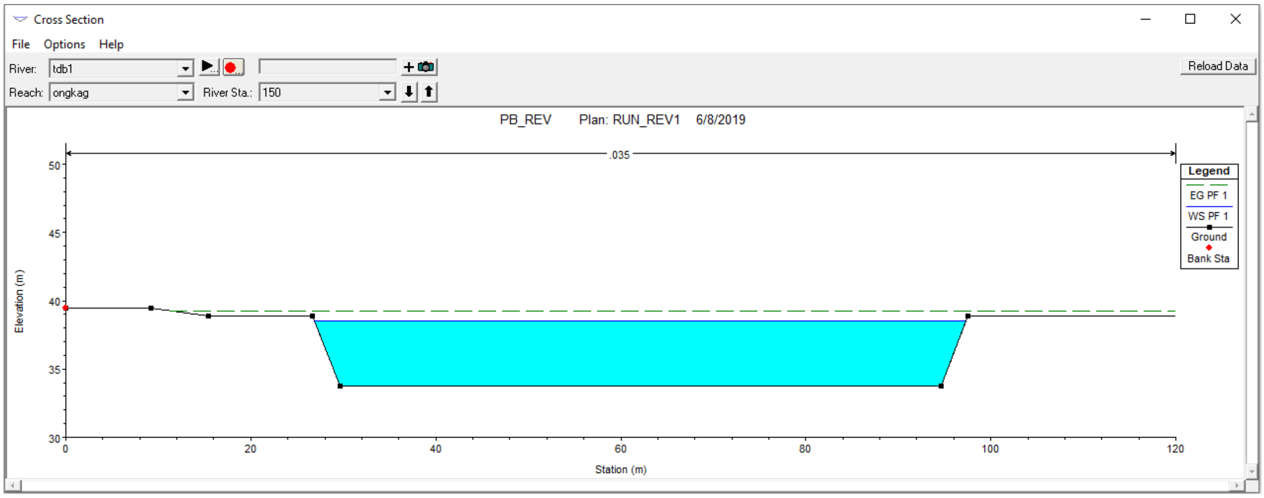

Fig. 19 Water level high at STA 150

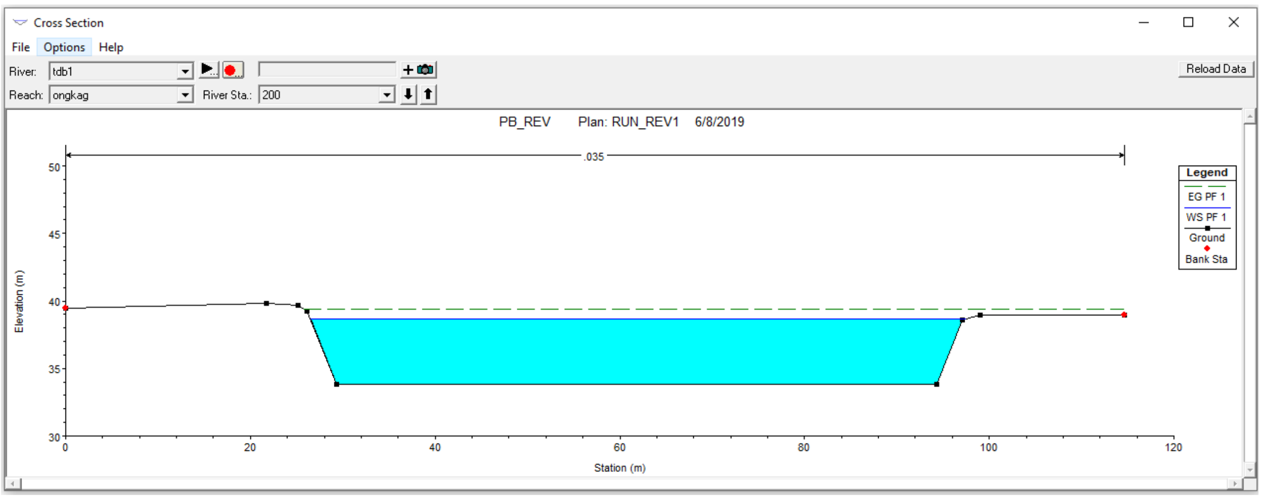

Fig. 20 Water level high at STA 200

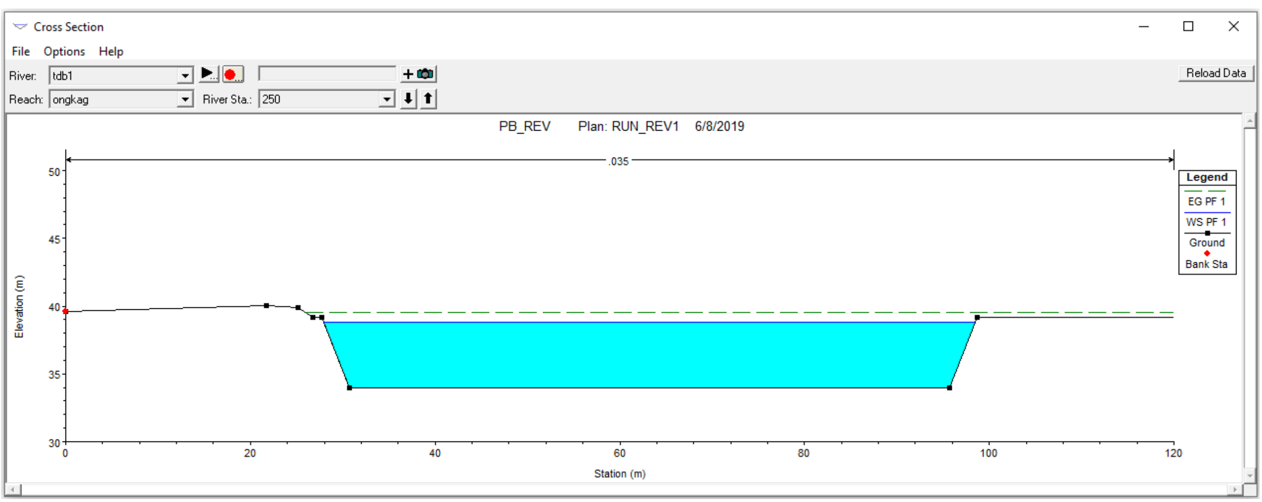

Fig. 21 Water level high at STA 250

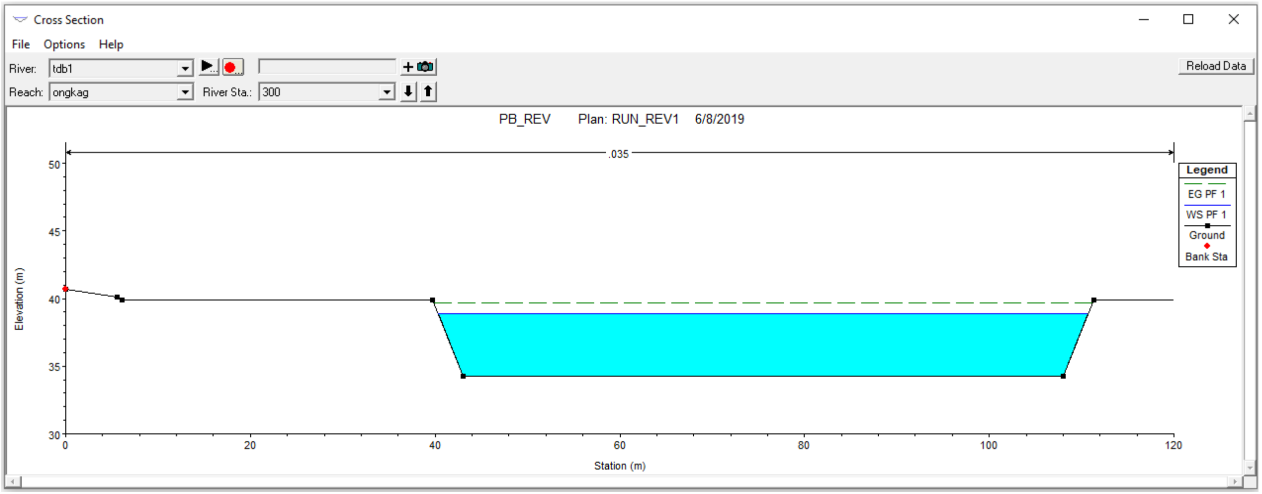

Fig. 22 Water level high at STA 300

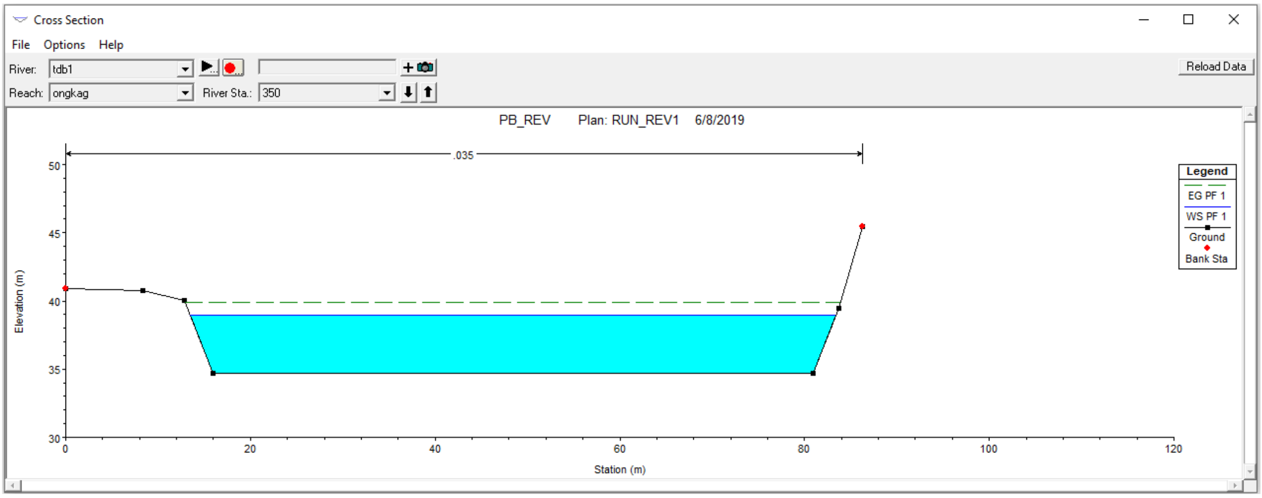

Fig. 23 Water level high at STA 350

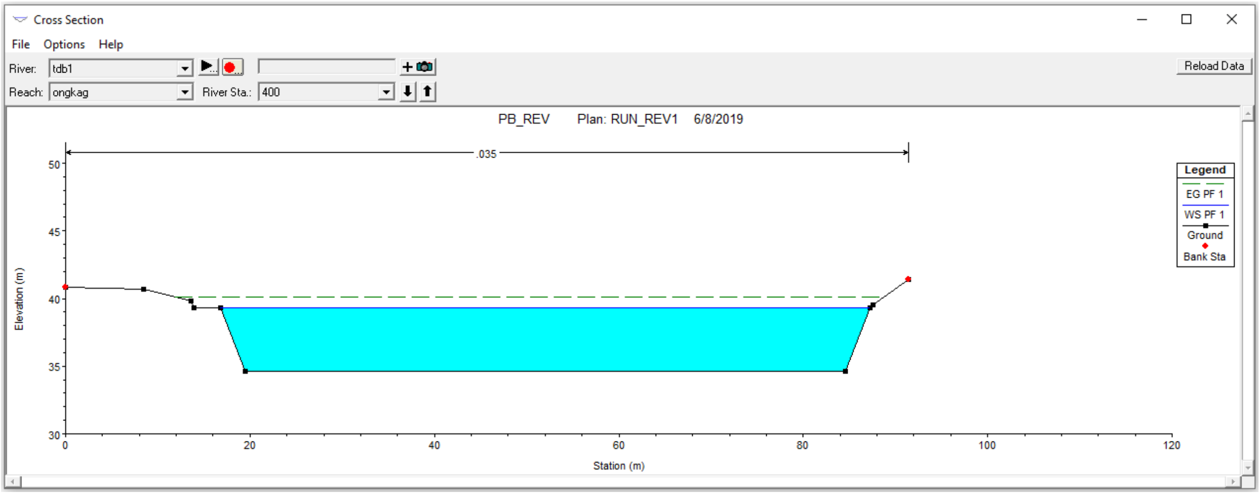

Fig. 24 Water level high at STA 400

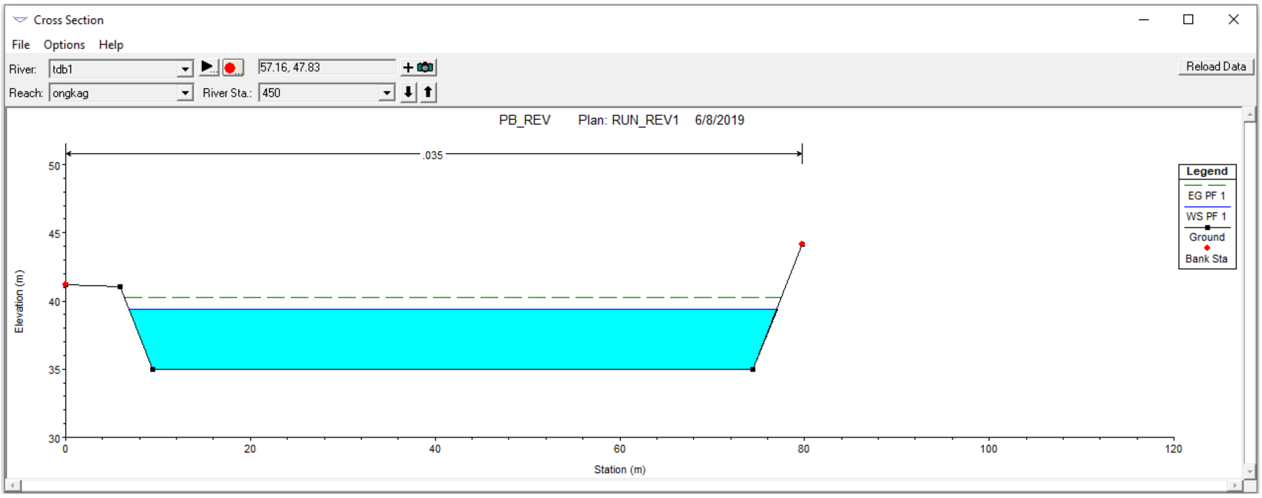

Fig. 25 Water level high at STA 450

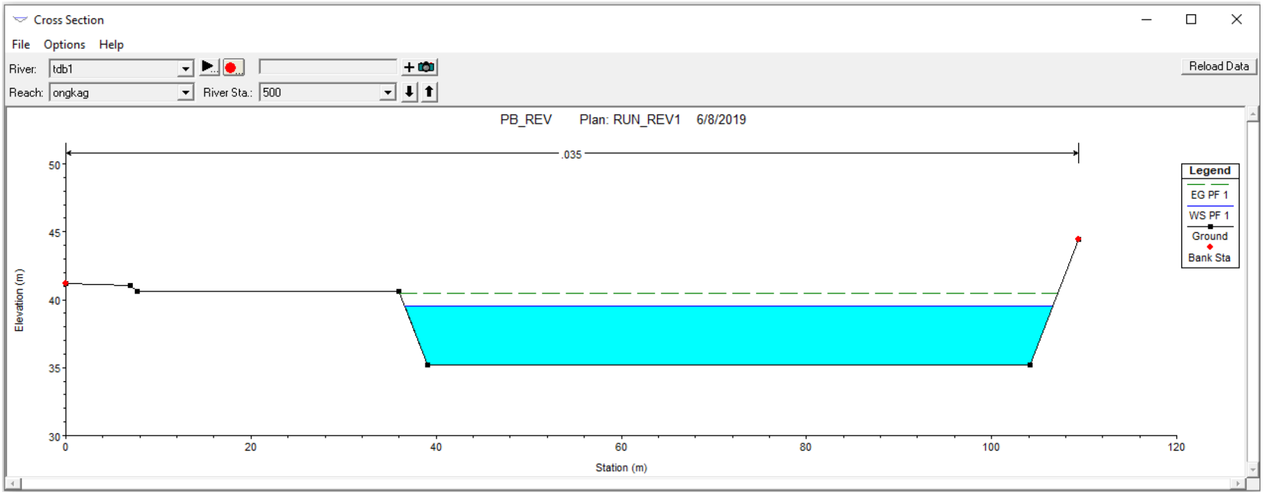

Fig. 26 Water level high at STA 500

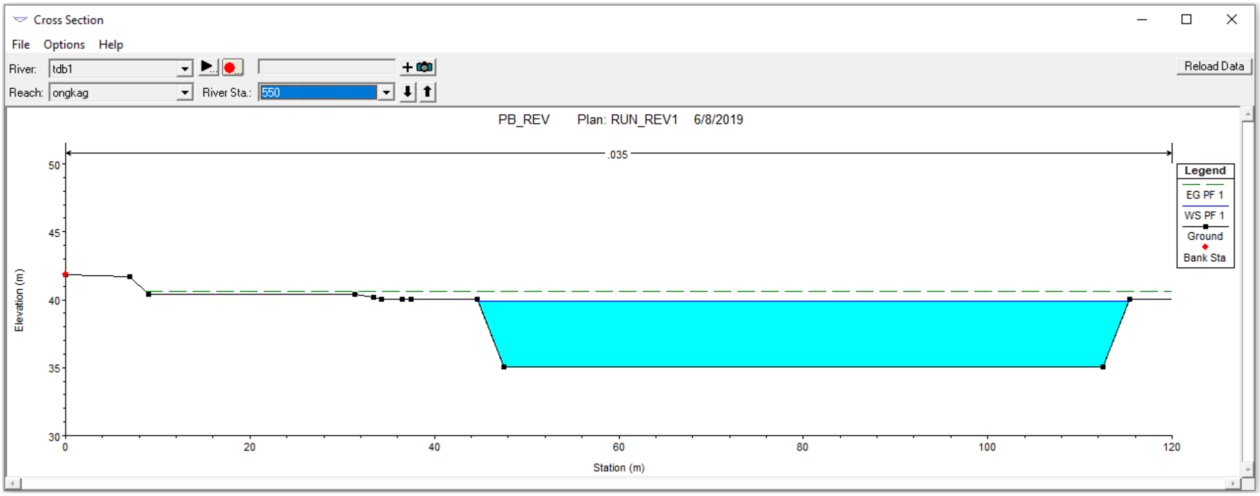

Fig. 27 Water level high at STA 550

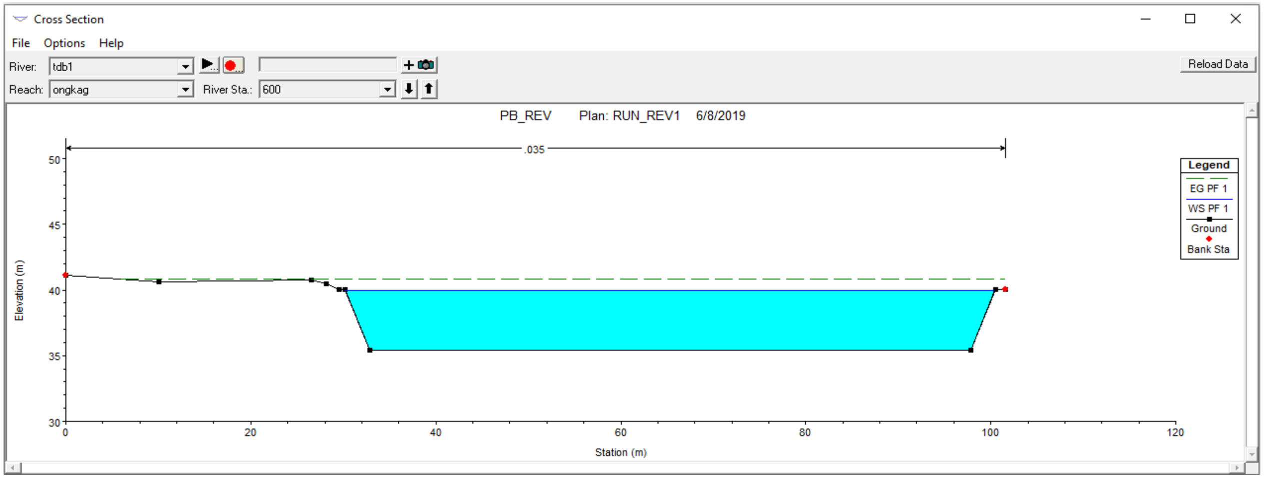

Fig. 28 Water level high at STA 600

5. Result and Discussion

The height and width of the flood water level are obtained from the results of hydraulic analysis on the existing river cross-section. Hydraulic analysis results show that from the simulated discharge, flooding occurred in the cross-section of STA 0, STA 50, STA 100, STA 150, STA 200, STA 250, STA 300, STA 400, STA 500, STA 550 and STA 600, while the overflow it does not occur only in the cross-section of STA 350 and STA 450. Planning a new river profile is needed to improve the capacity of the existing river cross-section.

The new river cross-section design is made in a more technical river cross-sectional condition using the trapezoidal economic cross-section method (Bambang Triatmodjo, 1996).

The analysis of the height and width of the flood water level results in the capacity of all technical cross sections of the new river to accommodate the magnitude of the simulated flood discharge. The volume of potential post-river quarrying considers the change in profile from the existing river to the post-mining river technical cross-section. Changes in river bed elevation and water level between existing river miners and the post-mining river technical cross-section can be seen.

5.1. Post Mining Material Volume Calculation, Sand and Gravel

The potential volume of sand, gravel and river stone excavation in the Dumoga Ongkag river section is calculated post-mining. The excavation area of each segment will be calculated, and then the excavation volume between two segments will be obtained by comparing the excavation area of the two segments multiplied by the length of the interval between segments.

The potential volume of sand, gravel and river stone excavation in the Dumoga Ongkag river section is calculated post-mining. The excavation area of each segment will be calculated, and then the excavation volume between two segments will be obtained by comparing the excavation area of the two segments multiplied by the length of the interval between segments.

6. Conclusion

Analysis of flood discharge obtains Snyder HSS flood discharge which is used as a planned flood discharge.

The analysis results of the height and width of the flood water surface show the state of the overflowing water in several segments of the existing river at the time of return 25, 50 and 100 years.

Technical research is carried out to obtain a profile of a new river profile post-mining, analysis of the height and width of the flood water level is carried out on the condition of the flood discharge 100 years of a new river profile, and the results of the analysis found that the water condition has not overflowed in each new river cross section segment.

The area of the new river profile changes with existing river conditions is calculated to be the potential for excavation of sand, gravel and river stone material; the quarry volume obtained in the river along the 600 m is 88,347.42 m³ while the embankment volume used to improve river cross-section capacity is 13,893.85 m³.

As the suggestion, mining sand, gravel, and river stone excavation materials are to pay attention to existing technical studies to minimize river damage that might occur to a predetermined limit.

The embankment volume needed to improve the river cross-section should use the excavated volume in the river channel.

Material scrap that can be obtained from the Dumoga Ongkag mining must be sediment not native to the river.

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