Designing Open Channel Dimension for Imkasu Area West Papua

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Abstract. Gag Nikel Ltd belongs to a Contract of Work located in Gag Island, West Waigeo Islands District, Raja Ampat Regency, West Papua Province. The open pit mining system employed at this company will enter the mining location and therefore, requires a design of open channel for diversing water coming from rainfall, run off, and ground. The rainfall intensity calculated by Mononobe formula obtained 5,994 mm/hour, whereas the catchment area got 0.59 km². The total discharge of run off calculated by Rational Formula gained 1867.956 m³/hour. Meanwhile, the design of open channel calculated by Manning Formula yielded wet section (A) = 0.668 m², base width (b) = 0.714 m, and depth (h) = 0.714 m, surface width (B) = 1.542 m. Box control having the volume 1 m³, length = 1 m, width = 1 m, and height 1 m must be made every 1 kilometer of open channel length. Around the area of open channel, the used tire must be given to reduce the erosion rate flowing into settling pond. All of these are necessary because the open channel is located near the natural channel and we must also consider several regulations such as Presidential Decree and IPPKH adjusted to the technical study that has been designed.

1. Introduction
Nickel mining activities are one of the activities that have a big impact, namely the surface of the damaged mining area and has a very steep slope of the excavation walls so that it is easier for erosion to occur, changes in landscape, sedimentation due to erosion rates, and decreased soil fertility due to cover crops poorly cared for.

In the research area, PT Gag Nikel applies an open pit system with the mining method used is open cast mining method and is a protected forest area that has a high enough rainfall. Considering that the Imkasu Area is the area with the lowest elevation in PT Gag Nikel and is very close to the Imkasu river and the coast, it is necessary to divert the water flow so that the water flow does not go directly to the compliance area to the sea / river which will pollute the environment. water is to make an open channel in the Imkasu area. The construction of this open channel aims to accommodate runoff water leading to the Imkasu area. Runoff water enters the channel, then flows into the settling pond using the force of gravity.

Therefore, the design of a good and safe open channel needs to assess rainfall, rain intensity, determination of the catchment area, the amount of runoff water that enters, and the dimensions of the open channel to channel runoff water from the open channel to the settling pond need to be adjusted. to prevent overflow when the channel is open to drain the maximum water flow

2. Case Study Description
2.1. Location and Accessibility
PT Gag Nikel's Contract of Work area is located in Gambir Village, West Weigo Islands District, Raja Ampat Regency, West Papua Province. To reach the research location, it can be reached by air from Surabaya to Sorong with a distance of ± 2,400.4 km with a travel time of ± 3 hours, while the operational location of the field is right at Gag Island, which is 160 km from Sorong City and can be reached by KMP Arar for ± 10 hours.

![Figure 1. Location of the project site](image)

2.2. Local Geology
In general, Gag Island is flanked by the Sorong Fault and the Halmahera Fault and forms a northwest-southeast direction. This straightness stretches to the northwest towards Gebe Island which is parallel to the shape of the Bay of Saulalkasu. The straightness is thought to be related to the faults that develop in the area. Gag Island is included in the geological map of the Waigeo sheet, in general its tectonic history is closely related to the regional tectonics of the area. At the End of Jurassic, there was the expansion of the Pacific Ocean [12].

This expansion was followed by the formation of a deep sea which accumulated marine sediment in the Tanjung Bomas Formation. As the process continues, many shear faults are formed which result in deterioration. Furthermore, more or less ending in the Early Tertiary, there was deposition of the Lamlam Formation.

The formation of the unit is thought to have surrounded the limestone area in the southwestern part of the archipelago. The uplift that occurs on the island is followed by erosion, which results in the formation of alluvium deposits and the growth of coral reefs in several places. In the field, indications of faults are indicated by the existence of a zone of destruction ± 50 m wide in the form of fault breccias located near Gambir Bay, precisely on the border between the morphological units of steep wavy hills and gently wavy hills, forming a southeast to northwest alignment. This fault field separates ultramafic rock units and volcanic rock member units and has lifted the ultramafic rock to the surface in a position parallel to the volcanic rock member.

Laterite nickel in the form of garnierite on Gag Island is found in the Jurassic ophiolite complex. The process of chemical weathering of ophiolite/ultramafic rocks forms laterite which consists of a limonite layer and a saprolite layer. Secondary nickel ore is present in both of these layers but economical concentrations are found in the saprolite ore layer.
3. Methodology
The methodology used to design the dimensions of the open channel, Imkasu area is a review of the actual field conditions, data collection, and data analysis [11]. The method used in detail is described below.

1) Observation of actual field conditions aims to obtain detailed information on the location of the open channel plan to be worked on. The total length of the open channel plan with a total length of 1450 meters.

2) Data collection aims to collect the data parameters needed to be analyzed. The data required for the design of the open channel dimensions, namely, rainfall data, rainfall intensity data, planned rainfall, material type, runoff coefficient, runoff water discharge, catchment area topographic map, and water flow direction map.

3) The mining system that is applied is an open pit system using open cast mining method. For the drainage system, the trapezoid-shaped puritan method is applied, which is the easiest method to make a channel at the mine site and use it globally in open pit areas. Water sources which will enter the channel, namely rainwater and runoff water.
4) After all data parameters are obtained, data analysis is carried out using the Rational method to obtain the total runoff discharge that will enter the channel and the method Manning used to get an open dimensional plan.

| Table 1. Physical and mechanical properties of rock strata |
|----------------------------------------------------------|
| Tilt | Land cover / type                        | Runoff coefficient (C) |
|------|------------------------------------------|------------------------|
| <3% (Flat) | Rice fields, forests, swamps | 0.2                    |
|       | Plantation                               | 0.3                    |
| 3%-15% (Moderate) | Housing,                              | 0.4                    |
|       | Forests, plantations                     | 0.4                    |
| > 15% (Steep) | The bush is a bit sparse,               | 0.8                    |
|       | Housing,                                 | 0.7                    |
|       | Open land in the mine area               | 0.9                    |

4. Results analysis and discussion

4.1. Result Analysis
Based on calculations carried out using the method Gumbell for the 2010-2017 rainfall data, the results of the planned rainfall data for 8 years are 128 mm / day. The calculation of rainfall intensity is calculated by the method Mononobe which will be used as the basis for calculating the runoff water of Gag Nikel Ltd. To obtain the results of rainfall intensity, it is necessary to plan rainfall data and the length of time of concentration. From the calculation of rainfall intensity based on the method Mononobe at Gag Nikel Ltd it is 5,994 mm / hour with a concentration time of 13.297 hours/day.

| Table 2. Calculation of rainfall intensity |
|--------------------------------------------|
| Channel length (meter) | Different height (degree) | S | Time concentration (meter) | Intensity Rainfall (I) |
|------------------------|---------------------------|---|---------------------------|-----------------------|
| 71                     | 15                        | 56 | -15                       | 1,436                 |

Determination catchment area carried out based on the processing of actual topographic maps at the research location. Topographic map processing at the research location aims to determine the distribution of runoff water flow and determine the area catchment area as well as knowing the highest elevation and lowest elevation. Based on the runoff coefficient (C) of land use the value is 0.9 with a slope of > 15°. Based on the analysis of the actual topographic map, it is known that there is already an entrance to the Imkasu area which is limited by the slope levels that have been made in the Imkasu area. From this data, it can be determined the boundaries of the rain catchment area using software mine. As for Catchment Area obtained is divided into two (2), namely with the symbol A era area of 0.23 km² and symbol B an area of 0.36 km², so that the total area catchment area amounting to 0.59 km².

4.2. Open channel dimensions
The source of water in the Imkasu Area comes from surface runoff discharge, water discharge into the open channel comes from rainfall and, groundwater discharge. Runoff is the total running water that
occurs as a result of rain moving from a higher place to a place that tends to be lower regardless of the origin or the path taken before reaching an open channel.

The next source of water is rainfall. Rainfall is the amount or volume of rain water that falls in a certain unit of area expressed in units of millimeters (mm), so that 1 mm means that in an area of 1 m² the amount of rain water that falls is 1 liter. Rainfall is a factor that is very much considered for planning the drainage system, because large or small rainfall in a mining area will affect the amount of water that enters the Imkasu area so it must be addressed.

Groundwater in the study area was neglected because groundwater was not found in all areas of Gag Nikel Ltd. This was evidenced by exploration activities carried out using test pit (test wells). Exploration by method test pit done because of the shallow mineral deposit conditions. In this case it is said that the area that is mined does not cut the groundwater table so that it becomes the basis that groundwater is neglected.

After examining the water sources entering the Imkasu area, knowing the runoff coefficient value, rain intensity, and determining the area catchment area, then it can calculate the total discharge of water that enters the Imkasu area.

The total flow of water entering the Imkasu Area is the discharge of runoff water channeled by catchment area will be added with the discharge of water entering the open channel from rainfall and groundwater discharge. So that the total discharge of water entering the Imkasu area is 2559.099 m³/day.

The location of the open channel is placed around the Imkasu entrance area to the silt deposition pond (KPL) where the open channel surrounds the Imkasu area so that water will not go directly to the Imkasu coast and river. The water will flow around the Imkasu area following the contour and utilizing gravity as a water propulsion medium. This open channel design will culminate in a silt settling pond where a ditch will be made along the entrance to the Imkasu area.

Based on catchment area that has been made and has calculated the runoff discharge, then the plan for the dimensions of the open channel DTH A and DTH B is as shown in Figure 4 and Figure 5. Planning for making an open channel needs to be considered in determining the shape of the open channel. The open channel to be made is in the shape of a trapezoid, because it is relatively easy to manufacture and maintain compared to other channels, as well as the ease of making an open channel according to field conditions.

![Figure 4. Catchmen area open channel dimension A](image)

![Figure 5. Catchmen area open channel dimension B](image)
5. Conclusion

The source of water that enters the Imkasu area comes from surface runoff of 884,821 m³/3 hours, the rainfall rate is 983,135 m³/3 hours, and groundwater is considered zero. The total flow of water entering the area is 1867,956 m³/second, where this amount of discharge can be accommodated by an open channel and there is no overflow.

The dimensions of the open channel DTH A, the wet cross-sectional area of the channel (A) = 1.139 m², flow section depth (d) = 0.811 meters, open channel depth (h) = 0.933 meters, channel bottom width (b) = 0.933 meters, bottom-to-surface side section (a) = 1.077 meters, channel surface width (B) = 1.90 meters, and the slope of the channel wall (m) = 0.58. While the dimensions of the open channel DTH B, the wet cross-sectional area of the channel (A) = 0.668 m², flow cross-sectional depth (d) = 0.621 meters, open channel depth (h) = 0.714 meters, channel bottom width (b) = 0.714 meters, side section of the bottom channel to the surface (a) = 1.082 meters, the channel surface width (B) = 1.54 meters, and the slope of the channel walls (m) = 0.58.

Every 1 kilometer of open channel length, a control box is made with a volume of 1 cubic meter, where length = 1 meter, width = 1 meter, and a height of 1 meter, and in the area around the open channel it is better to provide used tires to reduce the rate of erosion that will go directly to settling pond and the point of compliance before being flowed into the river, considering that the research area is close to the coast and the Imkasu river and is limited by IPPKH.

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