Technical Design of Wells (Sump) and Pump Requirements in Open Pit Mine Drainage at PT. Mulia Baratama Plan, Long Beleh, Kembang Jagut, Kutai Kartanegara, East Kalimantan

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Received: 2023-09-04 Received in revised from 2023-09-22 Accepted: 2023-09-30

Abstract

PT. Rencana Mulia Baratama is one of the companies engaged in coal mining in Long Beleh Village. The area of WIUP OP owned is 3,993 ha with a Production Forest Area of 2,630.4. The drainage system applied at PT. Mulia Baratama's plan is Mine Dewatering, which is by flowing all runoff water into a well *(sump)* to be pumped out of the mining area which flows into the *settling pond*. The well is a place that serves to hold a temporary amount of water before being pumped out The actual volume of the well in pit 1 is 58,000 m^3. The planned rainfall period based on the 5-year rain reset period is 179.473 mm/day and the duration of rain is 2.4 hours per day. So that the amount of rain intensity calculated by the monobe equation is 37.39 mm/hour. The total water discharge entering the mining site is 58,817,254 m^3/day which comes from runoff water discharge of 13,260,552 m^3/day and rainwater discharge of 45,556,704 m^3/day. The pumping discharge carried out is 462.4 m^3/hour using one type of centrifugal pump 200x150 using Rpm 150 so that the total water discharge that can be drained in a day is 7,398.4 m^3/day.

Keywords: Sump; runoff water; Debit; Pumping

1. Introduction

Coal is an example of potential resources that exist in Indonesia to be managed, because coal is also widely used in everyday life, for example used for fuel in power plants. One of the regions or coal producing areas in Indonesia is Kalimantan, especially in the East Kalimantan area. This mining activity is carried out in an open area or the activity is directly related to the outside air, so that when there is rain water will directly enter the mining site or pit. Field observations obtained conditions from wells that are not in maximum condition because there are also many other materials collected in the sump.

The sump is used to temporarily hold the water entering the mining site will then be pumped out of the well to the settling pond. Pump is a tool or machine used to move water from a well to a settling pond in a pumping system used one type of HPDE pipe with a pipe length of 50 meters.

The research conducted is a research that focuses on sump and pumping studies. The purpose of this study is to determine the dimensions of the well and the number of pumps that will be used to remove water from the sump to the settling pond.

2. Method

The method used in this study is a quantitative research method where this research is related to applied science. Data collected in this study is in the form of rainfall data for the last ten years, *sump* dimension data and pumping discharge and pump specifications used.After the data is collected, the next stage is to process the data to find out the average amount of rainfall, calculate the number of sump dimensions, and find out the amount of pumping discharge can use the formula below.

2.1. Rainfall

In the calculation of rainfall plans can be done using 4 methods of disitbfusion, namely Normal, Log Normal, Gumbel, and Log Pearson Type III. The distribution used in the calculation of rain plans is to use the *Pearson Type III Log distribution* due to Value.

Pearson III Log Distribution

Log XT = Log X + KT x S Log X.. (1)

To find the standard deviation value can be done using the following formula:

$$\overline{\mathrm{S}\log X} = \sqrt{\frac{\sum_{i=1}^{n}(log\,X_i-\overline{log}X)^2}{n-1}} \quad \text{.......... (2)}$$

The skewness factor (Cs) is calculated by the following formula.

$$Cs = \frac{n\,\sum_{i=1}^{n}(log\,X_i-\overline{\log\,X})^2}{(n-1)(n-2)(S\log X\,)} \quad \text{.......... (3)}$$

Information:

Log XT = Logarithmatic value of rain plan with re-period T(mm)

Log X = Average rainfall (mm)

S log X = Standard Deviation

K = Frequency factor

Ktr = Frequency factor, the value depends on the coefficient of astonishment (Cs or Cg)

2.2. Rainy Reset Period

Precipitation occurs in a certain pattern. Rainfall will often repeat over a certain period of time known as the return of rain. To calculate the rain re-period can be calculated using the following E.J Gumberl formula.

$$\mathrm{Pr} = \left[1-\left\{\frac{1}{\mathrm{Tr}}\right\}\right]^{\mathrm{TL}} x\ 100\% \quad \text{.......... (4)}$$

Information:

Pr = Hydrological Risk

Tr = Rain reset period

TL = length of time the drainage system will work (years)

The relationship of the repeat period with the variance reduction of the variable Y is shown

2.3. Rain Intensity

The intensity of rain is a relatively short number of units of time, expressed in mm/hour, mm/second. The intensity of rain is usually denoted by the letter I in units of mm/hour. The calculation of rain intensity can be done with the following monobe formula:

$$I=\frac{\mathrm{R}_{24}}{24}\left(\frac{24}{\mathrm{t}}\right)^{2/3} \quad \text{.......... (5)}$$

Information:

I = Rain intensity (mm/hour)

R24 = Precipitation plan in 24 hours (mm3)

T = Duration of precipitation (hours) =

L = Flow Length (km)

V = Flow propagation speed (km/h)

= 0.6

H = Height difference between upstream and downstream (m)

2.4. Water Runoff

Runoff water is one part of rainfall that flows over the land to rivers and seas. For the calculation of maximum runoff water discharge, the following rational formula is used:

Q = 0.275 x C x I x A.. (6)
Information:
Q = Runoff discharge (m3/h)
C = Runoff coefficient
I = Rain intensity (mm/hour)
A = Area of rain catchment (km2), if in km2 correction factor (fk).

2.5. Rain Discharge

Rainwater discharge is the discharge of water from heavy rain that occurs in an area where rainwater falls directly into the *lowest lower pit area during* rain. Rainwater discharge is very influential for the design of the sump and the calculation of water entering the *sump*. The formula for determining rainwater discharge is as follows:
$Q = Xr \ x \ A$... (7)
Information:
Q = Rainwater discharge
Xr = Precipitation
A = *Bottom Pit* Area

2.6. Total Debit

From the calculation of runoff water discharge, rainwater, and groundwater, the total discharge can be known by the following formula:
Total Q = Q1 + Q2 + Q3.. (8)
Description:
Q1 = Runoff water discharge
Q2 = Rainwater discharge
Q3 = Groundwater discharge

2.7. Sump

The sump has the function of storing surface water that flows into the hole or enters the pit. The location of the sump should be lower than the surrounding area so that water easily flows into the *sump.* The water that enters the *sump* is a certain amount of water flowing on the surface. When carrying out mining operations, temporary sumps are usually made, which are in accordance with the progress of the mine called *traveling sumps.* For the calculation of well demension can be done with the following formula:
Vsump : Runoff Volume (Q) + (sediment material (25%)).. (9)
Where:
Runoff volume = Q x tc
Sediment material: mud particles undermined by runoff water (estimated at about 20%)
Sump Dimensions
To get the dimensions of the sump we first determine the volume of the sump with the equation:
Volume :(Sump surface area + sump base area) $\frac{(x1)x}{2}$ tall... (10)

2.8. Pump

The pump can be used to remove water from the well to the *setling pond* to be neutralized before being discharged into the river or the nearest effective place. *The total pump head* to drain a certain amount of water from as planned can be determined from the installation conditions that will be served by the pump, so that the total pump rate can be written as follows:

$H = H_s + H_v + H_f + \left(\frac{V^2}{2g}\right)$..(11)

Information:

H = Total *pump head* (m)

Hs = *Pump static head* (m)

Hv = *Head velocity* (m)

Hf = *Head* to overcome various obstacles in pumps and pipes (m), covering pipe friction heads and pipe turn *heads* etc.

$(V^2/2g)$ = *Head* velocity (m)

Calculation of sharing julang on the pump

a. *Static Head* is the loss of energy due to the height difference between the inlet pipe and the outlet pipe. In simple terms, static load is calculated as follows:

$hs = h_2 - h_1$.. (12)

Information:

h_1 = Suction side elevation (m)

h_2 = Exit side elevation (m)

b. *Head Velocity* is a loss caused by the speed of water through the pump

$hp = h_{p2} - h_{p1}$ .... (13)

Information:

h_{p1} = pressure beam on the suction side *(input)*

H_{P2} = Pressure Interval on Output Side

c. Friction Head

$H_{F1} = \left(\frac{LV^2}{2Dg}\right)$.. (14)

Information:

f = Coefficient of friction (no units)

V = Flow velocity in pipe (m/sec)

L = Pipe Length (m)

D = Pipe diameter (m)

g = Earth's gravitational velocity (m/sec^2)

d. The value of the Coefficient *of Friction f* is found using the equation:

$\frac{1}{\sqrt{f}} = 2 \log \frac{3{,}7\ D}{K}$..(15)

Information:

K = Coefficient of hardness of the pipe

D = Inner diameter of pipe

3. Results and Discussion

a. Rainfall

From the results of the study, rainfall data was used to calculate planned rainfall, the data used is rainfall data for the last 10 years starting from 2012-2021. The following are the highest rainfall and rainfall data during the period 2012-2021 as Table 1:

Table 1. Maximum rainfall 2012-2021

Year	***Max CH***
2012	260,00
2013	279,00
2014	250,20
2015	247,80
2016	255,00

2017	184,40
2018	205,50
2019	214,50
2020	189,50
2021	281,00

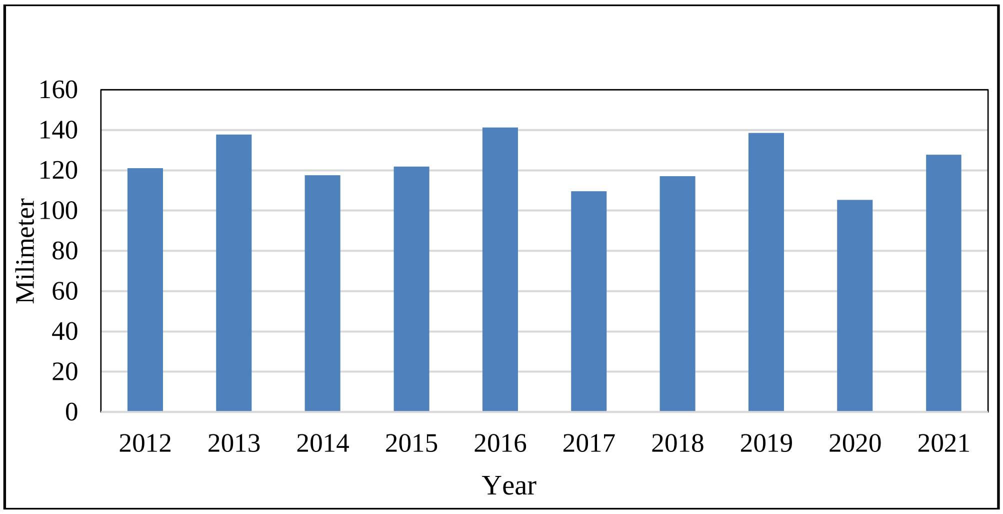

Figure 1. Average Monthly Rainfall 2012-2021

b. Sump

From the results of the study, it was found that the condition of the sump in pit 1 at the research location was not in maximum condition because of the presence of other materials that had been deposited in the *sump*. For *sump* state can be seen in Figure 2.

Figure 2: Sump Condition 1, (2022)

c. Pump

From data collection at the research site, it was found that the pumping system used in *sump pit* 1 used a single pumping system. The pump specifications used are 200 x150 ebara centrifugal pumps assisted with HDPE type pipes with a diameter of 315 mm with a pipe length of 50 meters from the *inlet* side to the *outlet*. Pump can see at Figure 3.

Figure 3: Pump condition in sump pit area 1,(2022)

3.1. Discussion

a. Drainage System

From the results of the study, it can be seen that the water entering sump pit 1 comes from runoff water discharge of 13,260.55 m^3 and rainwater discharge of 45,556,704 m^3 so that it can be known the total water discharge entering the well of 58,817,254 m^3/day. The drainage system applied in pit 1 uses a *mine dewatering* drainage system, where the water in the well is pumped out into the *setling pond* by using one type of *centrifugal* pump.

b. Sump

From the results of the study, it was found that the condition of the sump in *pit 1* was not in ideal condition because the adaya ari exceeded the capacity of the *sump.* Volume sumuran *(sump)* in *pit* 1 amounting to 58,000 m^3 which is at an elevation of 20 masl. By considering the results of data processing, it can beassumed that this condition shows that the *sump* capacity is not able to accommodate the discharge of water entering the well of 58,817.25 m^3/day with the actual well capacity obtained of 58,000 m^3. This will cause an overcapacity of 817.25 m^3 this overflow occurs in the surface area of the well.

c. Pumping

The pump used in sump pit 1 is a type of Ebara Centrifugal pump 200x150 with a pumping capacity of 7,398.4 m^3/day, the amount of *operting speed* used is 1500 rpm. In pumping, one type of HDPE pipe is also used with a pipe length of 50 and has a diameter of 313 mm, the pump operated is included with pumps that are old or very old so that they often also experience problems with the engine that cause hampering pumping activities in the sump.

3.2. Sump Design

From the results of the research conducted, it was found that the water discharge in the well was excess capacity. Based on this, a new design of *sump* was carried out. To plan a new well, it can be done by first conducting a study on the well by examining the total discharge of water entering the well in reducing the pumping discharge. The total water discharge entering the well is 58,817.25 m^3/day, the water discharge that can be pumped is 7,398.4 m^3/day. The total water discharge that enters and is reduced by pumping discharge so that the sump capacity is designed to be able to accommodate the incoming water discharge of 58,817.25 m^3. The author designed the *sump* to be able to accommodate the incoming water discharge, so the following design was made.

Actual sump		Design *Sump*	
Length	: 200 meters	*Sump length*	: 225 meters
Width	: 58 meters	Width	: 58
Dept	: 5 meters	Dept	: 5 meters

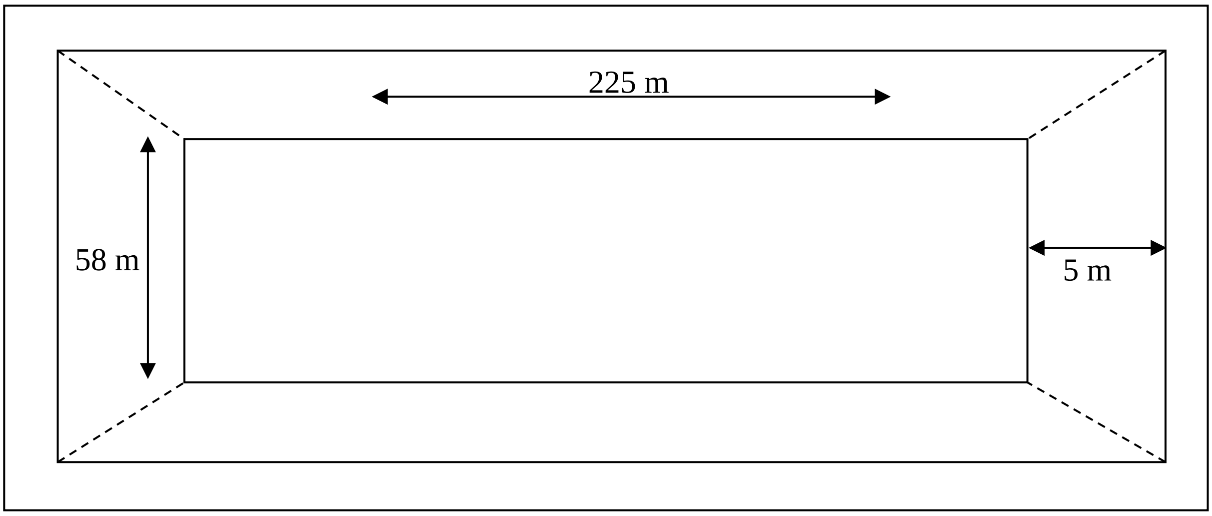

Figure 4: New sump design, 2022

The result of this sump design is obtained sump capacity of 65,250 m^3 while the water discharge that must be accommodated in one day is 58,817.25 m^3. The additional capacity of the recommended sump will be able to accommodate the incoming water discharge so that there will be no more excess capacity in the well area

4. Conclussion

In this study, it was concluded that the rainfall that occurred at PT. The noble plan of baratama is based on a 5-year anniversary period of 179.473 mm/day. with a maximum rain duration of 2,4 hours/day. The catchment area in the pit of 1 RMB amounted to 518, 025 m^2. So the amount of rain intensity in count with the monobe formula is 37.39 mm/hour. The total discharge of water entering the well amounted to 58,817,254 m^3/day this value was obtained from the sum of runoff water discharge of 13,260,552 m^3/day and rainwater discharge of 45,556,704 m^3/day. While the capacity of the well in pit 1 RMB is 58,000 m^3, this shows that the condition of the well reservoir in pit 1 RMB has not been able to accommodate the incoming water discharge so that there is overflow in the semant area (Sump). The wells in pit I RMB with actual dimensions, 200 meters long, 58 meters wide and 5 meters deep wells, with a total well capacity of 58,000m^3.

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