Mine Drainage System Planning At PT Putra Coal in The North Kalimantan Region

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Abstract

Coal is a deposit of plant fossils that has undergone a peat process over a long period of time. A company in Malinau Regency, North Kalimantan Province, requires replanning for the existing drainage system because its holding pond or sump, which is a former pit, will be re-mined. Therefore, this research re-plans the drainage system to overcome this problem. The methods for data processing comprised the Gumbel method, the Monobe equation, the Seyhan equation, and the calculations of open channels and holding pond dimensions, as well as pump capacity. The mine drainage system creates channels or ditches that function to prevent runoff water from entering the mining area. The channel capacity was 0.6 m3 /second, or 2,261 m3 /hour, with a large runoff of 0.146 m3 /second, or 63 m3 /hour. The channel would be made in a trapezoid shape. Meanwhile, the mine dewatering method used a pumping system to release water into the sump. Using 1 pump of MF-420EX, the total flow of water that could be pumped reached 50,537 m3 /hour with working hours of 20 hours. The sump capacity was 28,825 m3 in a trapezoid shape with dimensions of 95 m surface length, 70 m surface width, 85 m base length, 60 m base width, and 5 m depth

Keywords: *Mine Dewatering; Mine Drainage; Open Channel; Pump; Sump*

1. Introduction

Coal is a deposit of plant fossils that has undergone a peat process over a long period of time. Mining in Kalimantan is mostly coal commodities. Especially for companies located in Malinau Regency, North Kalimantan Province. This company focuses primarily on the coal mining sector [1].

The mining method used is open pit mining, which means that all activities are related and directly related to outside air such as heat, rain and so on [2]. This method will definitely form a basin where when it rains, the rainwater that falls as runoff from higher areas will fall and enter the mining area and become a puddle. The emergence of these puddles has a big impact on the mining process so this should not be allowed because it will have fatal consequences if not treated immediately [3]-[4]. The impact if this puddle is left untreated is a wet and slippery road which will hinder mining, threaten worker safety and will disrupt productivity and have detrimental effects on the company[5].

The emergence of this group has a big influence on the mining process so this cannot be ignored because it will have fatal consequences if not treated immediately [6]. At PT. Putra Coal does not have a holding pond or sump, but the company uses a former pit as a holding pond. Because the pit can still be mined, the company wants to plan a drainage system from open channels, sumps to pumps that will be used later in the new storage pond. Based on this background, the author is interested in conducting research.

2. Method

The research method used is a quantitative method and results will then be obtained in the form of numbers, graphs or tables from which conclusions will then be drawn to obtain results that answer the background of the problem. This research includes calculating rainfall intensity, water discharge entering the research location, open channel dimensions, sump capacity and pump capacity. The research began by conducting a literature study as reference material related to the title.

2.1. Raifall

Rainfall is the amount of water that falls to the ground surface during a certain period of time, which is measured in millimeters [7]. In calculating rainfall, the Gumbel method can be used, with the following Equation 1 [8].

$$Xt = Xr + \frac{S}{Sn} (Yt - Yn) \quad (1)$$

with the following Information :

Xt	=	Calculated results of planned rainfall values (mm/day)
ΣCH	=	Max rainfall amount (mm/day)
n	=	Amount of data
Xt	=	Average maximum rainfall (mm/day)
Sn	=	*reduced variate,* nilai tergantung n
S	=	*standart deviation*
Yt	=	*Mark Reduced variate* of a variable at a certain return period
Yn	=	*reduce mean*

2.2. Rainfall Intensity

Rainfall intensity is how much rain falls in a short time, expressed in units of mm/hour. To measure rainfall intensity, the monobe Equation is used [9] . The monobe Equation 2 can be seen below:

$$I = \frac{R24}{24} \left(\frac{24}{t}\right)^{2/3} \quad (2)$$

With the following information :

I	=	Rainfall Intensity (mm/hour)
R_{24}	=	Max daily rainfall (mm/day)
t	=	Time

2.3. Rain Catcment Area

A rain catchment area or abbreviated as catchment area is a place where rainwater flows to lower areas. The basis for determining rain catchment areas is seen from the height, direction of water flow and position of the river. What defines rain catchment areas are high to low areas so that when determining rain catchment areas, we look at the tendency of the water to flow towards lower areas and the location of the river is usually at the lowest point. The rain catchment area is divided into two, namely the outer catchment area to handle water from outside the pit and the inner catchment area to handle water inside the pit.

2.3. Run Off

According to [10] runoff water is water that comes from rainwater that spreads to the ground surface. In calculating runoff water discharge (Q), the Equation 3 used according to is as follows:

$$Q = 0{,}278 \times C \times I \times A \quad (3)$$

with the following Information :

Q	=	Maximum runoff discharge (m^3/s)
C	=	Runoff coefficient
I	=	Maximum Rain Intensity (m/hour)
A	=	*catchment area* (m^2)

2.4. Open Channel

Open channels are useful as a place to channel water to a pond or other location. When making an open channel, it is necessary to select the type of cross-section, factors including water discharge, type of material and simplicity. However, it generally has a trapezoidal shape. Because the water

discharge that is stored is greater. Meanwhile, square and triangular shapes are designed for small water discharge. See Equation 4[11].

$$Q = \frac{1}{n}\ x\ R\frac{2}{3}\ \text{x}\ S\frac{1}{2}\ x\ A \quad (4)$$

with the following Information :
Q = Runoff water discharge (m³/sec)
n = Manning coefficient
R = Hydraulic Radius (m)
S = Base Slope Channels (%)
A = Channel wet cross-sectional area (m^2)

2.5. Sump

A sump is a place for temporary storage of runoff water in the form of a pond before the water is pumped out of the mining area. The size and diameter of the holding pond are adjusted to the incoming and outgoing water discharge. In making sump, it is always adjusted to the progress of the drum. Things that influence the volume of incoming water [12].
in the sump, namely the total volume of water entering through the channel. To calculate the sump volume, use the following Equation 5*:*

$$Q\ sump = (QRunoff - Qp)\ x\ t \quad (5)$$

with the following information :
QRunoff = Runoff water discharge (m³/hour)
t = Length of working hours (hours)
Qp = Pumping flow rate (m³/hour)

2.6. Pump and Pipes

The purpose of the pump is as a medium for moving fluid to a certain place. The main function of the pump is to help empty the water in the mine. Apart from moving fluids, pumps can also be used to increase the speed, pressure and height of the pump [13]. The energy used to flow a certain volume of water under certain conditions. Head can be searched using the following Equation 6:

$$H = Hs + Hv + Hf\ out + Hf\ in + Hf\ suction\ valve \quad (6)$$

with the following information *:*

H	=	Head total (m)
Hs	=	Head Statis (m)
Hv	=	Head Velocity
$H_{f\ in}$	=	Head Friction
Hf out	=	Head Friction Out
Hfsuctiovalve	=	Head Friction

Can see Equation 7-13 [14][15].
Head Statis :

$$h_s = h_2 - h_1 \quad (7)$$

Speed in the Pipe:

$$V = \frac{(Q)}{A} \quad (8)$$

head Velocity :

$$H_v = \frac{V^2}{2g} \quad (9)$$

Lamda :

$$\lambda = 0{,}2 + \frac{0{,}005}{\text{Outlet Pipe Diameter}} \quad (10)$$

Head Friction :

$$\text{Hf out} = ג \frac{\text{Q Length of exit pipe) x } (V^2))}{(2 \text{ x outlet Pipe Diameter x g})} \quad (11)$$

$$\text{Hf in} = ג \frac{\text{Q (Suction pipe length) x } (V^2))}{(2 \text{ x suction Pipe Diameter x g})} \quad (12)$$

Head Friction suction valve :

$$\text{Hf} = f\frac{V^2}{2.g} \quad (13)$$

A pipe is a tool shaped like a closed channel which functions to convey fluids with the help of a pump. In calculating the flow speed of a pipe, it is known by using the water discharge released per unit time and the cross-sectional area of the pipe. The following is the pipe speed Equation 14:

$$Q = V \text{ x } A \quad (14)$$

With the following information :

Q = Water discharge (m^3/s)
V = Flow speed (m/s)
A = Pipe cross-sectional area (m^2)

3. Results

3.1. Condition of Land Surface and Vegetation

Based on measurements of the topographic slope and direct observations at the research location, the topographic conditions in the rain catchment area around the research location were searched using the slope percentage Equation , resulting in a classification that was included in the moderate slope with a slope percentage of 4%. with types of forest and plantation land

3.2. Catchment Area

To determine the rain catchment area, you can use the differences in height on the topographic map, from the highest elevation to the lowest elevation [4]. Based on topographic studies, the research location has 3 rain catchment areas. This rain catchment area is at the highest elevation in the area around the research location which causes water to flow towards the mining location. The area of rain catchment area I is 26.5 m², the area of rain catchment area 2 is 4.7 m² and the area of rain catchment area 3 is 4.2 m².

3.3. Rainfall data processing

Table 1 Rainfall data processing.

No	Month	Rainfall (X)	(Standart Deviation)	Reduce Standart Deviation	Maks Reduce Variate	Reduce Mean Variate	Rave (mm/hours)	Rave(m/s)
1	January	300,85	54,43	0,95	2,25	0,50	401,45	0,001115
2	February	173,46	45,06	0,95	2,25	0,50	256,75	0,000713
3	March	230,05	60,69	0,95	2,25	0,50	342,23	0,000951
4	April	276,16	51,17	0,95	2,25	0,50	370,74	0,001030
5	Mey	324,60	79,81	0,95	2,25	0,50	472,11	0,001311
6	Juny	303,21	92,58	0,95	2,25	0,50	474,33	0,001318
7	July	307,08	136,90	0,95	2,25	0,50	560,11	0,001556
8	Agust	277,75	76,60	0,95	2,25	0,50	419,33	0,001165
9	September	330,52	74,14	0,95	2,25	0,50	467,56	0,001299
10	Oktober	299,79	70,58	0,95	2,25	0,50	430,24	0,001195
11	November	279,07	61,95	0,95	2,25	0,50	393,57	0,001093
12	December	364,37	66,60	0,95	2,25	0,50	487,47	0,001354

3.4. Rainfall Intensity

Table 2 Rainfall Intensity Data Processing

Month	Rainfall Max	Time (Hour)	Rainfall Intensity (mm/s)
January	401,45		106,2
February	256,75		67,9
March	342,23		90,5
April	370,74	1,5	98,1
Mey	472,11		124,9
Juny	474,33		125,5
July	560,11		148,2
Agust	419,33		110,9
September	467,56		123,7
Oktober	430,24	1,5	113,8
November	393,57		104,1
December	487,47		129,0
Max (mm/hour)			148,2
Average Rainfall Intensity (mm/hour)			111,9
Rainfall Intesity (m/s)			**0,14833**

3.5. Runoff water Discherge

Runoff water discharge is the amount of water that falls and falls into the mining location. After carrying out calculations, it was found that the runoff water discharge at catchment area 1 was 3,547 m3/hour, at catchment area 2 was 279 m3/hour, and at catchment area 3 was 247 m3/hour.

Table 3 Runoff water Discharge Data Processing

No	Location	Runoff Coefisien	Catchment area (m^2)	Maks Rain Intensity (m/hours)	Water Discharge			
					(m^3/s)	(m^3/minute)	(m^3/hour)	(m^3/day)
1	Catchment area 1	0,9	26,5	0,1483	0,985	59	**3.547**	85.097
2	Catchment area 2	0,4	4,7	0,1483	0,077	4,64	**279**	6.686
3	Catchment area 3	0,4	4,2	0,1483	0,68	4,11	**247**	5.916
Overall catchment area 1 which enters the Sump					0,985	59	3.547	85.097
Overall catchment area 2&3 entering the channel is blocked					0,146	63	525	12.602

3.6. Open Channel

The open channel design plan at the research location will be trapezoidal in shape. This channel will function as a reservoir for runoff water and channel runoff water to the surrounding river area.

The dimensions of the planned open channel are as follows:

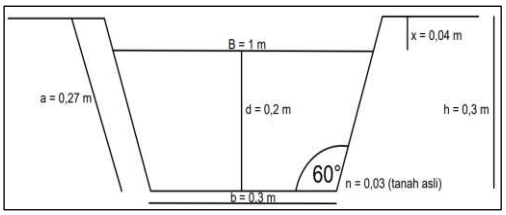

Figure 1 The Dimention Of Open Channel [7]

3.7. Sump

Sump functions as a water controller which will disrupt productivity at the mining site. With a top side length of 95 meters, top width of 70 m, bottom length of 85 meters, bottom width of 60 meters and depth of 5 meters and a sump capacity capable of holding a water volume of 28,825 m³. Below is the shape and dimensions of the sump

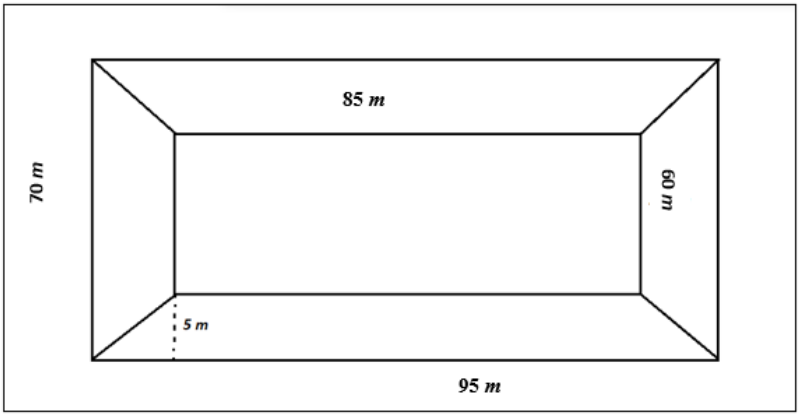

Figure 2 Dimention of *sump*

Pump Management Calculations

In pumping system management, researchers designed 1 pump unit. The pump used is the Multiflow 420 EX with an operating speed of 1400 which is capable of producing a discharge of 710 liters/second or 2,574 m3/hour. The following are the results of pump management calculations

Table 4 Pump Management Calculations

Information	Result
Head statis (hs)	75 *m*
Head Velocity (hv)	0,00014 *m*
(v)	0,05 *m*
(hf)	0 *m*
head (htot)	75,282 *m*
(Qpompa)	50.537 m^3/*hours*

Mine Drainege System Planning

The drainage system planning at PT. Putra Coal The use of the mine dewatering method is used to control the water in the mining area that has entered and is stored in the sump which will then be pumped out. Meanwhile, the mine drainage method is used to carry out control through a ditch system or open channel, which is useful for diverting runoff water from areas outside the mining location, towards the surrounding river

Open Channel

The open channel planning at PT.Putra Coal The planned channel will be trapezoidal in shape with dimensions suitable for channeling runoff water. The open channel is planned with the following data required: The value of the Manning coefficient with the condition of the channel being a uniform natural open channel, with a value (n) = 0.03. And the slope of the channel bottom (S) is 0.05 or 5% to avoid mud deposition in the channel. The debt that can be channeled by this channel is around 2,261 m3/hour.

Sump

The water in the holding pond is discharged runoff water. In calculating sump discharge, it does not take into account rainwater and groundwater, this is because at the research location, groundwater does not pass through the lowest mining area or blottom pit, so that in calculating the discharge of water entering the holding pond, groundwater is not affected. Where the sump is planned to be the main sump which can accommodate runoff water from catchment area with a pool capacity as large as 28.825 m^3.

Pump

To help handle water in the sump, a pumping system is needed. In planning the pump, researchers used 1 unit of the MF-420EX water pump. The pump's working time is 10 hours/day. The pipe used is 12 inch diameter with an exit pipe length of 150 m and a suction pipe length of 15 m. From the results of the calculations carried out, the water discharge that can be released by 1 pump unit at a main sump with a capacity of 28,850 m3 is 2,526 m3/hour. So the debt released by 1 pump unit for 20 hours (for 2 shifts) is 50,537 m3/day

4. Conclussion

The total discharge of runoff water is increased to 2. In catchment area I, it is 3,546 m^3/hour, which will overflow into the research location. Meanwhile for catchment area 2 & 3 it is as large as 525 m^3/hour which will overflow into the open channel.

The open channel planned by the researchers is trapezoidal in shape, without hardening (regular) with a capacity of ether, has a water flow height (x) of 0.04 meters, a surface width (BL) of 1 meter, a channel depth (h) of 0.3 meters, and channel wall coefficient (n) 0.03.

In planning the water flow system at PT. Putra Coal Where the water flow from the Hujlan I catchment area will enter the main sump and the planned main sump capacity will be able to accommodate 28,825 m^3 of water. The dimensions of the holding pond are as follows: length of the upper side of 95 meters, length of the side of the blawah 85 meters, width of the upper side of 70 meters, width of the side of the under 60 meters and depth of 5 meters. By using a 60° tilt angle to make maintenance easier.

The use of the pump planned by the researcher is 1 unit with an MF-420EX type pump which operates for 20 hours per day (for 2 shifts) with a max operating speed of 1700 rpm. Where the use of pumps will be installed in series, and the pump is used to remove water from the sump. Where the pumping debt is 50,537 m^3/day for 1 pump unit. When using the pump, it moves with an operating speed of 1400 which is capable of releasing a discharge of 2,474 m^3/hour so that in 20 hours the discharge that can be released is 51,480 m^3/day. So it can be concluded that the pump can release water into the sump. This shows that the pump can release water discharge in the sump.

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