Evaluation of Design Planning Water Distribution System with Watercad v.7.0 Simulation Program for Townsite Basecamp Settlement Relocation in Tanjung Enim, South Sumatra

by Eka Septiawati Edy Sutriyono

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Eka Septiawati, Edy Sutriyono, Ika Juliantina, Ari Siswanto

Civil Engineering Department Sriwijaya University Indonesia

Corresponding author: ikawig@yahoo.com

Abstract. Settlement infrastructure is one important factor for support our social life, especially in mining society. One of mining settlement is named by Townsite Basecamp settlement where is placed in Tanjung Enim, South Sumatra. This settlement location is 500 meters far away from the mining area and needs to be relocated to Township settlement as the new location which has 50 km far away from the old one. This relocation is caused by the mining company has to get the coal which is under the settlement location. Of course, this effort needs new design project for the infrastructure especially for water distribution system in new location. This research purpose is to evaluate the design planning of the water distribution system in a new location based on the main problem of water distribution system in old location. The methodology which used for this research is watercad v.7.0 simulation program and descriptive quantitative analysis. From the data analysis and survey result to the 35 respondents of 336 people who live in Townsite Basecamp settlement, there are 3 of 10 locations still have the continuity of fewer than 24 hours, 4.2 for minimum number of pH water while the normally is 7.0 for number of pH water, average number of 102.496 m3 water productivity in a month, average number of 42.140 m3 water consumption in a month while the standard is 13.095 m3 in a month. From the analysis result of water distribution system design with watercad v.7.0 simulation program, the number of water demand is 4.67 l/sec or 403.200 l/day while the minimum requirement is 1.82 l/sec or 157.248 l/day. The new design needs 61 nodes for each junction and 6.938, 75 m length of pipe, 5.31 atm for maximum pressure and 0.48 atm for minimum pressure. Keywords: Water distribution system, watercad v.7.0, descriptive quantitative analysis

a. Introduction

Settlement infrastructure as the important aspect for a district to develop its area which supports the social activity. Infrastructure consists of the physical or structure facilities which are needed in human life and social economy community. One mining settlement is named by Townsite Basecamp settlement where is placed in Tanjung Enim, South Sumatra. This settlement location is 500 meters

far away from the mining area and needs to be relocated to Township settlement as the new location which has 50 km far away from the old one.

The old settlement is called by Townsite Basecamp settlement and the new settlement is called by Township settlement. This relocation needs new project infrastructure especially water infrastructure in a new location. This research purpose is to evaluate the design planning of the water distribution system in a new location based on the main problem of water distribution system in old location. Based on the observation, the continuity factor is less than 24 hours in a day with low pressure in some locations in the Townsite Basecamp settlement. Of course, things to note that in the Township settlement has to fulfill all the minimum requirements of water distribution system and fix the problem in Townsite Basecamp settlement.

b. Literature

Some of the literature which is used in this research is commonly from the research before and from other literature. The literature consists of the explanation about infrastructure, water infrastructure, the theory of hydraulic analysis, and watercad v.7.0 simulation program.

b.1. Infrastructure

Infrastructure is main supporting for the social function and economy system in daily humanity [1]. Infrastructure is clearly defined as facilities and physical structure which is built to make sure the continuity of social activity that the infrastructure provider of it.

b.1.1. Water Infrastructure. The water demand consists of 2 groups, both of them are domestic water and non-domestic water [1]. Domestic water demand is the water supply for house domestic, and the non-domestic water demand is the water supply for social facilities. The requirements of water distribution system consist of 4 aspects, they are the quality aspect, quantity aspect, continuously aspect and pressure aspect. Quality aspect has to be suitable for the regulation of Healthy Ministry Department No 3 in the year of 2017 [2] about the parameter of water distribution that consists of physical, biology and chemistry. The requirement's quantity is defined as the ability to supply water demand as the main water supply [3]. The requirements of planning water distribution system according to Ministry of Public Services, Directorate General of Human Settlements Regulation [4] as table 1 below.

Table 1. Standard of Water Distribution System Planning

No	Parameter	Number
1	Connectivity of pipe for each house (SR)	80 liter per man/day
2	People per HU	100 people/ unit
3	People per SR	5 people/ unit
4	Water Losses	20%
5	The factorof Maximum Peak Days	1.75 SR
6	Operational Hours	24 Hours
7	Volume of Reservoir	25%
8	Distribution Area Services	90%
9	Water Demand for IPAM	10%

Continuity aspect is the ability of water supply to services water demand in 24 hours in a day both in rainy or dry season. The standard water continuously minimum is 8-12 hours in a day while the ideal in 24 hours continuously [5]. The important factor which is needed to keep 24 hours continuously is providing the reservoir facility and energy for keeping the water distribution. The standard which is used in pressure aspect is minimal 1 atm according to Ministry of public services Regulation [4].

b.1.2. Water Distribution System. Water distribution system is the system to supply water from the resources to the consumer society. Water distribution system consists of 4 parts of the activity. They are water resources, water treatment process, transmission part and distribution part. The explanation about the water distribution system as figure 1 below.

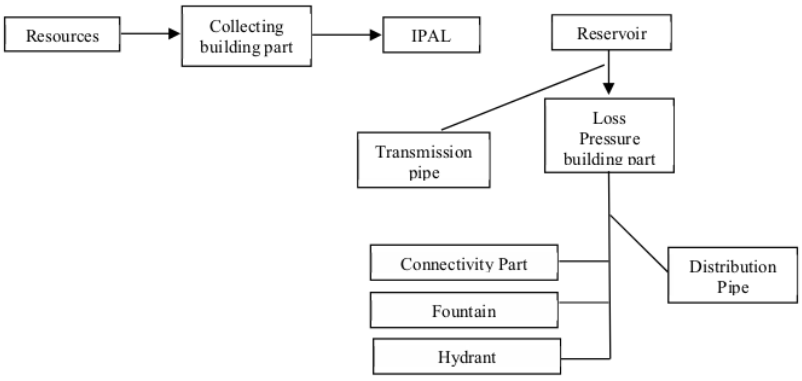

Figure 1. Water Distribution System

b.1.3. Analysis of water demand.

The water demand will increase annually along with the population growth and services. Total water demand is calculated by projecting the population about 5 to 15 years in future and losses factor at 20% to 30 % [6]. The steps to calculate the total water demand are explained below.

Analysis of water demand. Daily Water Demand (Q_{rh}) is the total number of water demand which is needed in a day. The formula is :

$$Q_{rh} = pxq \quad (1)$$

Maximum Water Demand (Q_{hm}) is the maximum number of water demand which is needed in a day. The formula is :

$$Q_{hm} = f_{hm}xQ_{rh} \quad (2)$$

Peak Water Demand (Q_{jp}) is the peak number of water demand which is needed in a day. The formula is :

$$Q_{jp} = f_{jp}xQ_{hm} \quad (3)$$

b.1.4. Hydraulic Analysis.

The hydraulic analysis is needed to plan and calculate the plumbing system and water facility. There are 4 theories will be needed to plan the plumbing system, they are.

a. Hydrodynamic Theory is the theory that explains water distribution in the plumbing system. It consists of debt equation, continuity equation, and Bernoulli's equation. Water flow in the plumbing system is a closed flow that the water has contact with the flow itself [7]. The formula to calculate debit of water flow is [8] :

$$Q = Axv \quad (4)$$

The formula to calculate debit of water flow in the same section of pipe is :

$$A_1xV_1 = A_2xV_2 \quad (5)$$

The formula to calculate debit of water flow for branched pipa is :

$$A_1xV_1 = A_2xV_2 + A_3xV_3 \quad (6)$$

b. Energy Losses. The energy losses will influence the water pressure, water velocity, and water debt. Higher the number of energy losses, so the number of water pressure, water velocity, and water debit will be decreased. The equation is explained below :

$$h_l = h_f + h_m \quad (7)$$

c. Water Losses is total water volume which losses because of technical aspect and non-technical aspect. The minimum requirements of water losses are 15% to 17% according to Ministry of public services Regulation [4].

c.1.1. Watercad v.7.0. Program Watercad v.7.0is a product that distributed by Bentley system as mobile information through the integrated project for the infrastructure. Bentley watercad is a product to make water model and simulation the hydraulic of the pipe [9]. To analysis water distribution system can use watercad simulation program with 6 (six) steps [10]. The steps to planning and calculate water distribution system with watercad v.7.0 simulation program are explained as diagram 2 below :

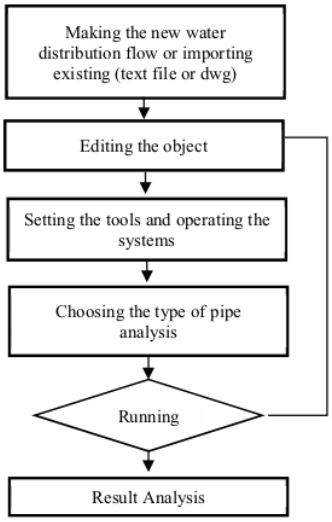

Figure 2. Flowchart of Watercad v.7.0

d. Methodology

Some of the methodology consist of location and the requirements of data. They are explained below :

d.1. Location

The research location is placed at mining area settlement in Tanjung Enim, South Sumatra. The old settlement is called by Townsite Basecamp settlement (in Figure 3) and the new settlement is called by Township settlement (in Figure 4).

Figure 3. Townsite Basecamp Settlement

Figure 4. Township Settlement

d.2. *Data.*

The data research is taken from the observation and the company references. The primary data consists of questionnaire and observation. Secondary data consists of debit water supply, topography, water quality, plan design of pipe distribution, and reference standard guidance from SNI 03-1733-2004 [11] and Ministry of public services regulation, 1996 [4].

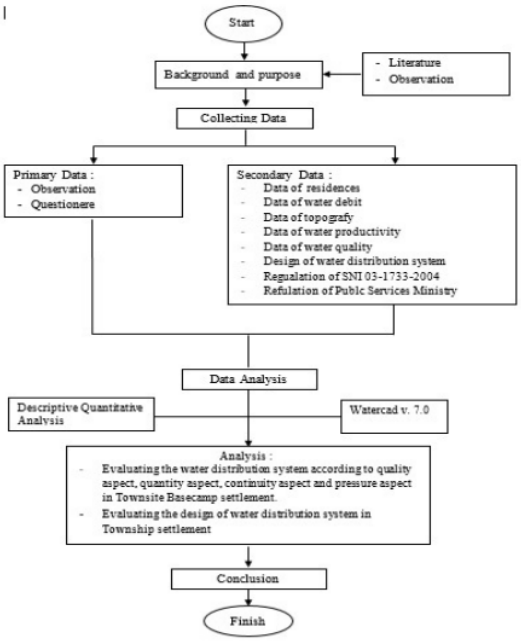

Figure 5. Flowchart of Watercad v.7.0

The steps for this research are :

a. Analyzing the problem in the location
b. Collecting the primary data and secondary data

c. Doing survey and questionnaire
d. Analyzing the questionnaire result
e. Analyzing water distribution design with watercad v 7.0
f. Making the conclusion

e. Result and Analysis

Some of the analysis using the survey and watercad v.7.0 simulation program. The analysis result consist of two part discussion, they are explained below.

e.1. *Water Condition in Townsite Basecamp settlement*

The analysis of water condition in Townsite Basecamp settlement consist of quality aspect, quantity aspect, continuosuly aspect and pressure aspect.

e.1.1. Quality Aspect.

From the survey result, for the smelly parameter, there is 0 respondent said the water is not smelly at all, 31 respondents said the water is not smelly and 4 respondents said the water is rather smelly. For the taste parameter, there is 1 respondent said the water does not taste at all, 27 respondents said the water is not taste and 7 respondents said the water is taste. From the color parameter, there is 0 respondent said the water is not colored at all, 18 respondents said the water is not colored and 18 respondents said the water is color. From the data of biology and chemistry parameter, the water content shows 4.2 at pH minimum in the year 2017*:*

e.1.2. Quantity Aspect.

From the data analysis, the total water productivity in the year 2017 is 1.229.948 m3 or with the average of 102.496 m3 in a month. The realization of water consumption in the year 2017 is 42.140 m3 while the standard of water consumption is 13.095 m3. The summary of water productivity at Townsite Basecamp Relocation in the year 2017 is explained as the table below*:*

Table 2. Summary of Water Productivity in the year 2017

Year Periodeof 2017	Townsite Settlement (m3)	House of Director, Club House (m3)	Basecamp Settlement (m3)	Total of Water Productivity (m3)
January	61.609	6.151	20.040	87.800
February	57.685	5.397	18.584	81.666
March	58.994	3.342	20.910	83.246
April	52.616	2.399	19.595	74.610
May	27.284	6.350	20.300	53.934
June	88.007	6.382	20.546	114.935
July	90.701	7.417	23.406	121.524
August	90.579	7.783	24.602	122.964
September	89.793	9.753	25.020	124.566
October	88.485	7.669	23.530	119.684
November	93.121	7.029	23.273	123.423
December	86.351	8.306	26.939	121.596
Total	885.225	77.978	266.745	1.229.948

e.1.3. Continuously Aspect. From the survey result, there are 3 locations which have water distribution at less than 24 hours continuously, they are Damar St, Cemara St and Jati St. There are 13 respondents said that the water is distributed continuously 24 hours in a day, 11 respondents said that the water is distributed 12 to 24 hours in a day and 11 respondents said that the water distributed 4 to 10 hours in a day. The summary of the survey result is explained in the table below*:*

Table 3. Summary of Continuously Aspect for Townsite Basecamp Settlement

No	Location of Observation	Continuity		
		Continuously 24 hours	Very Often Continuously (12-24 hours)	Rarely Continuously (4-10 hours)
1	Mahoni Street	1	1	0
2	Angsana Street	3	0	0
3	Rasamala Street	3	2	0
4	Damar Street	0	0	3
5	Cemara Street	0	2	3
6	Kenari Street	4	0	0
7	Palm Street	2	3	0
8	Jati Street	0	3	2
9	Waru Street	0	0	1
10	Merbau Street	0	0	2
	Total	**13**	**11**	**11**

e.1.4. Pressure Aspect. From the survey result, there are 21 respondents said that the water has high pressure, 13 respondents said that the water has normally pressure and 0 respondents said that the water has low pressure. The summary of the survey result is explained in the table below*:*

Table 4. Summary of Pressure Aspect for Townsite Basecamp Settlement

Location of Observation	Pressure		
	High	Normal	Low
Mahoni Street	1	1	0
Angsana Street	3	0	0
Rasamala Street	4	1	0
Damar Street	2	3	0
Cemara Street	0	2	0
Kenari Street	3	1	0
Palm Street	5	0	0
Jati Street	3	2	0
Waru Street	0	1	0
Merbau Street	0	2	0
Total	**21**	**13**	**0**

e.2. *Analyzing the plumbing system*

From the analysis result of plumbing system in Township settlement with watercad v. 7.0 simulation program, the design needs 61 nodes of the junction with 0.08 lt/sec/nodes and 6938.75 m length of pipe for 4.67 lt/sec or 403.200 l/day water demand. The maximum water pressure is 5.31 atm at 65 m high elevation and the minimum pressure is 0.4813 atm at 115 m high elevation. While, from the standard or minimum requirements analysis according to public services regulation (1996), the design just needs 1.86 l/sec or 161.280 l/day water demand. The layout of water distribution system is explained as the figure below.

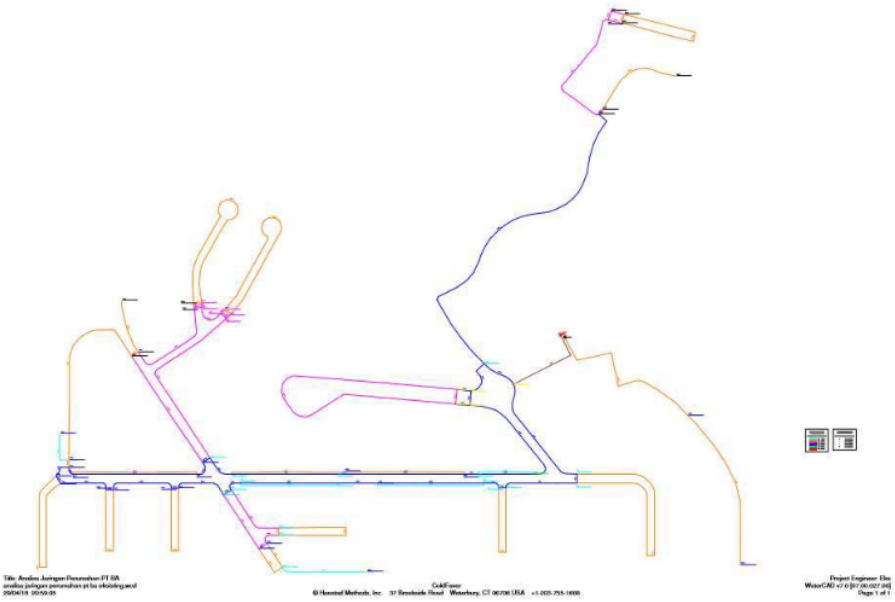

Figure 6. The Result of Distribution Water System in Township Settlement with Watercad v.7.0

f. Conclusion

The conclusion of this research are:

a. The service of water distribution system in Townsite Basecamp settlement has fulfilled the minimum requirements for the quality aspect, quantity aspect, continuously aspect and pressure aspect. Only minor rejection is founded on observation and survey. Things to note are the efficiency of the water consumption in Townsite Basecamp settlement. Although the water productivity still requires the water demand in the settlement, the water consumption is higher than the standard water consumption should be.

b. From the plumbing system analysis result in Township settlement with watercad v.7.0 program simulation, the new design has 403.200 l/day water demand while the minimum or standard requirement is 161.280 l/day and the water productivity is 3.417 m3/day of water demand.

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