CHAPTER III

THEORETICAL BASIS

Water needs in the provision of clean water categorized in two types, namely domestic and non domestic water requirements. Domestic water demand is the need for household water use for the purpose of drinking, cooking, bathing, washing clothes and other purposes. While the demand for non-domestic water is a necessity of water used for commercial activities such as industry, office, and social activities such as schools, hospitals, places of worship, and commerce. Water needs determine the magnitude of the system set based on usage. Water needs are the amount of water needed naturally for the basic human needs (domestic) and other activities that require water.

This water needs to consider the availability of water, both from natural water source and reservoir. Water sources that can be utilized for drinking water include rainwater, ground water, water in the soil and springs. The dencer the population and the higher the activity level will cause the greater the level of water needs. Variables that determine the size of the needs of clean water include:

a. Total population

b. Type of activity

c. Water consumption standards for individuals

d. Number of connections

In order to obtain the planning result of a good water supply system, i.e water supplies available at all times with adequate discharge and pressure, as well as qualified quality, then required planning criteria for the following system dimensions and the specifications of the system components have good performance. The planning criteria used are guided by the planning criteria and technical instruction in the field of clean water.

With the validity of the quality of water for water bodies, wastewater and clean water, the water quality assessment can be done for various needs. Provisions regarding clean water quality standards in Indonesia refer to Regulation of the Minister of Health based on government regulation number 416

year 1990 on the terms and supervision of clean water quality. Based on the Ministry of Health Regulation, the criteria determination of standard water quality standards are divided into three parts, namely water quality requirements for drinking water, water quality requirements for clean water and water quality requirements for liquid waste for Activities that have been in operation.

3.1 Clean Water Supply System

Clean water supply system is based on :

a. Sources of raw water in the form of springs, groundwater, surface water, and rainwater.
b. Water treatment, i.e. complete or incomplete processing, based on the results of raw water quality inspection.
c. Distribution system, which is gravity or pumping
d. Service system that is in the form of home/direct connection (drinking water service from the system that is streamed directly to the customer) and general hydrant (drinking water service system, in the form of a water reservoir equipped with water faucet)/general faucet (drinking water service systems with water supply directly from the piping system without going through the hydrant tank).

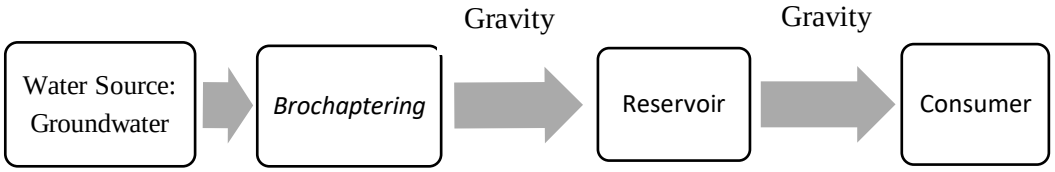

Figure 3.1 Water Supply From Springs with Gravitational System

Source: (Wulan, 2009)

Water supply system from the springs usually uses gravity system because it is seen from the location of the springs located in the mountain area. In the treatment of water sources of the springs, water is captured by brochapturing then the water is channeled into the reservoir using the gravity system. In the reservoir water is accommodated, and when the water source of the spring is already meet

the standard of clean water then there is no need of processing anymore and can be directly distributed to the consumer through the gravity system.

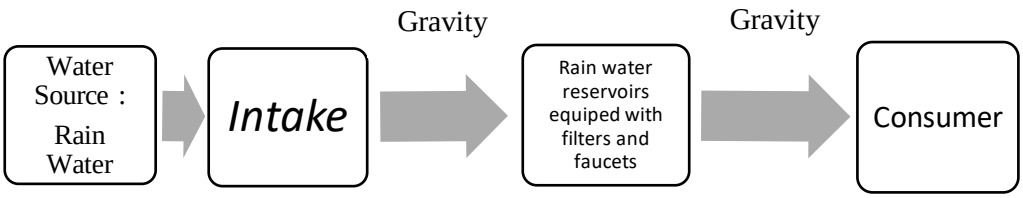

Figure 3.2 Clean Water from Groundwater with Pumping System and Gravity

Source: (Wulan, 2009)

Water supply system of rainwater, rainwater is accommodated through the intake of gravity system, then water is processed in the shelter. After water complies with clean water quality standards, water can be distributed to customers can use gravity system.

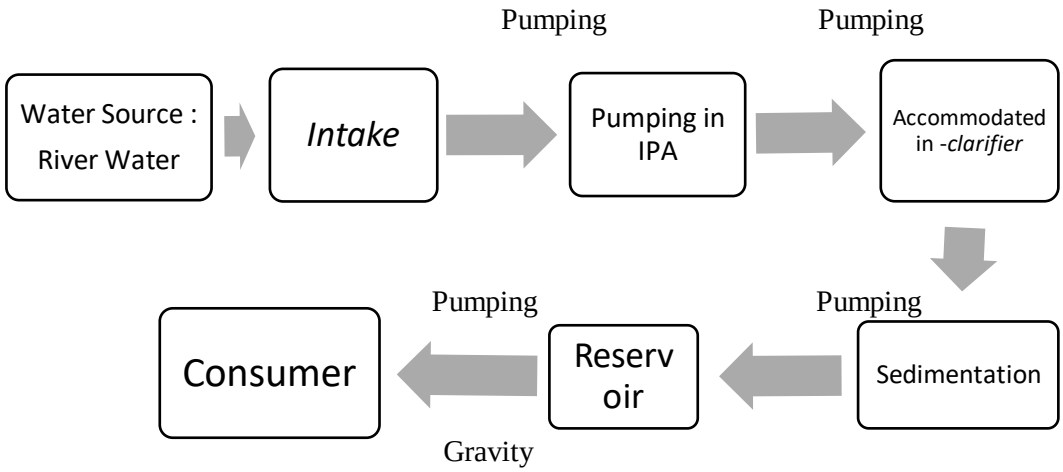

Figure 3.3 Water Distribution System from Reservoir to Customer

Source: PDAM GiriTirta Gresik

Water supply system of the river water is accommodated through the intake. Then water is pumped in the water treatment plant. Raw water is accommodated in the clarifier to separate the clear water and sediment sludge previously added liquid alum. The deposition process is also called sedimentation. Once the water is filtered with silica sand as a filter and added chlorine to remove

the bacteria. Then the water is accommodated into the reservoir measuring 1100 liters. Then the water is tested in the laboratory of the water treatment and diompa through the city of Gresik as far as 41 Km and then water distributed through the pump and gravity

3.2 Types of Clean Water Needs

Water needs for people always increase over time, not only because of the increasing number of people who need the water, but also because of the increasing intensity and variety of the need for water (M.D. Silalahi in Kusumo, 2016). According to Winarno in Ekawati (2017) the amount of clean water needs/drinking water that must be met in order to achieve health requirements is 86.4 lt/person/day. Winarno also explained that the amount of clean water needs/drinking water for the city is very related to the number of urban population. The needs of clean water in urban areas can be noted in the following table 3.1:

Table 3.1 Standard for Clean Water Needs by City Type

Category	City Size	Population	Water Needs (lt/person/day)
I	Metropolitan City	> 1.000.000	190
II	Big City	500.000 - 1.000.000	170
III	Medium City	100.000 - 500.000	150
IV	Small City	20.000 - 100.000	130
V	District City	< 100.000	100

Source: Department of Settlement and Regional Infrastructure 2002 in Winarni (2011)

Customer units of GiriTirta Gresik Water Supply Company are divided into various groups in each home connection (*SambunganRumah* / SR), among them can be noted in table 3.2:

Table 3.2 Classification of Group Customers of GiriTirta Water Supply Company, Gresik Regency

Num.	Customers Group	Code	Descriptions
Group I			

1	a. General Social *(SosialUmum)*	S-U	Public Hydrant, Public Faucet / Public Terminal
2	b. Social Specific 1 *(SosialKhusus 1)*	S-1	Worship Place
3	b.2 Social Specific 2 *(SosialKhusus 2)*	S-2	Social Foundation, Orphanage, Public Schools, Islamic Boarding Schools, public bathrooms
Group II			
4	a.1 Household 1 *(RumahTangga 1)*	R-1	Building Size< 36 m^2, Flats, *Balai RT / RW* and its kind
5	a.2 Household 2 *(RumahTangga 2)*	R-2	Building Size 36 m^2located in residential and public housing R-1 which has business activities and its kind
6	a.3 Household 3 *(RumahTangga 3)*	R-3	Building size>36 m^2located in the R-2 residential and public housing that has business activities
7	a. Government Agencies*(InstansiPemerintah)*	IP	Government Agencies, TNI/POLRI, Non-Commercial Institutions, Government Dorms, TNI/POLRI and its kind
Group III A			
8	a. Small Trade *(Niaga Kecil)*	NK	Small Machine Shop, Grocery Store, Internet Cafe, Boarding House, Polyclinic, Midwife / Doctor's Practice, Pharmacy, Office, Service Bureau, Notary, Mess, and its kind

9	b. Small Industry *(Industri Kecil)*	IK	Home Industry, Small Industrial Business, and similar Small Business Industries
Group III B			
10	a. Big Trade *(NiagaBesar)*	N-B	Restaurants, Supermarkets, Gas Stations, Large Showrooms, Wholesale Distributors, Swimming Pools, Hotels, Hospitals, Warehouses, Service Bureaus, and the kind
11	b. Big Industry *(IndustriBesar)*	I-B	Textile Manufacturing, Garments, Car Body Manufacturing, Timber, Steel / Concrete Construction Fabrication, Ceramic Manufacturing, and Similar Industries
Group III C			
12	Port *(Pelabuhan)*	KH-1	-
Special Group			
13	Special Area *(Khusus (Kawasan))*	KH-2	-

Source: GiriTirta Gresik Water Supply Company (2019)

3.3 Estimated Population

Population projection is determining the approximate number of people in the next few years, according to the desired planning period. The usual formula of population projections are geometric methods, as described by Rusli in the following Sutikno (2017):

:

$$Pn = Po\ (1 + r)^n \quad \text{..... 3.1}$$

$$r = \frac{Amount\ of\ \%\ Increase}{Year_n - Year_o} \quad \text{..... 3.2}$$

Description

Pn : Total population in projection year n,

Po : Total population at the beginning of the year

r : Average annual population growth

3.4 Estimated Water Demand

Eight specific and measurable global development objectives called the Millennium Development Goals (MDGs) were agreed upon by world leaders in 2000 (Wahyuningsih, 2017). The MDGs is a global development paradigm declared to address settlements relating to issues of national development, such as, tackling poverty and hunger, and ensuring environmental sustainability. In fulfilling these objectives, one of the roads that must be pursued is through preserving the natural resources of water. In meeting the needs of the water authorities need to know the expected future water demand. So in accordance with the MDGs guidelines that need to be known in addition to the projection of population to predict the amount of water needs, are:

a. Level of community service

The coverage of clean water services to the national average community is 80% of the population.

$$Cp = 80\% \times Pn \quad \text{..... 3.3}$$

Description:

Cp : Water service coverage

Pn : Population in the n year projection

b. Direct connection service/home

The number of people who got clean water through a home connection is:

$$Sl = 80\% \times Cp \quad \text{..... 3.4}$$

Description:

Sl : Water consumer with direct connection

Cp : Water service coverage

c. Indirect connection or public bath connection

An indirect connection or general body connection is a connection to serve the incapacitated population where a public bath can serve approximately 100 people or about 20 families. The number of inhabitants who get clean water through an indirect connection or a public bath is calculated by the formula:

$Sb = 20\% \times Cp$ 3.5

Description

Sb : Public tub water Consumption

Cp : Water service coverage

d. Clean Water Consumption

The consumption of clean water in accordance with the Department of Regional Conservation and infrastructure year 2002 is assumed to be as follows:

a. Consumption of water Medina for home connection/direct connection as much as 100 lt/person/day

b. Consumption of water for indirect connections/public bath for the underprivileged community as much as 30 lt/person/day

c. Consumption of non-household clean water (offices, schools, places of worship, industry, fire brigade, etc.) is determined by 15% of the amount of water consumption for the joint home and tub with the following formula:

$Kn = 15\% (Sl + Sb)$ 3.6

Description:

Kn : Water Consumption for non-household

Sl : Direct Water Consumption

Sb : Public Tub Water Consumption

e. Water Loss (Lo)

Water loss is assumed to be 20% of total clean water needs. Approximate loss of this amount of water due to the connection of the leaking pipe, the pipe is cracked DN less perfumed installation time, pipe washing, water meter damage, water in the tower water, and others.

$Lo = 20\% \times Pr$ 3.7

Description:

Lo : Water Loss,

Pr : Total Needs of Water

f. Analysis of Water Supply Company Water Needs

Total analysis of water demand made by PDAM is the amount of direct water consumption coupled with the consumption of water from the public bath and water consumption for non households, then combined with the loss of water due to pipe leaks or flushing Water.

$Pr = Sl + Sb = Kn + Lo$ 3.8

Description:

Pr : Total Needs of Water

Sl :Water consumption by direct connection,

Sb : Consumption of water from public tubs,

Kn : Water consumption for non households,

Lo : Water Loss

g. Analysis of Maximum Daily Needs

The maximum daily requirement is the largest amount of water needed in one year. The water requirement on the maximum daily is used to determine the processing capacity and calculated based on the average water requirement as follows:

$Ss = f_1 \times Sr$ 3.9

Description

Ss : Maximum Daily Needs,

Sr :Total amount of domestic and non domestic water needs,

f_1 : 1,15 (The dtandard used by GiriTirtaWater Supply Company Driyorejo Gresik)

h. Analysis of Water Use at Peak Hour Time

The use of water during peak hours is the highest water consumption at certain hours of the day. The water requirement in peak hours is used to determine distribution capacity, pipe diameter and calculated based on average water needs as follows:

$Peak\ time\ discharge\ Debit\ waktu\ puncak = f_2 \times Sr$ 3.10

Description:

Sr : Total amount of domestic and non domestic water needs,

f_2 : 1,5 (The standard used by GiriTirta Water Supply Company Driyorejo Gresik)

3.5 Reservoir

Reservoir is a clean water shelter, on a clean water system. Generallyreservoirs are required for a clean water supply that serves a city. The reservoir location depends on source and topoFigurey. Reservoir placement affects the distribution of streaming systems, namely by gravity, pumping or a combination of gravity pumping.

The main function of the reservoir is to balance between discharge production and discharge of water. Often for the same time, the discharge of clean water productioncan not always be as large as discharge water usage. For water shelter when the amount of clean water production is greater than the amount of water consumption, then the excess water is temporarily stored in the reservoir.

Reservoir volume is calculated at 40% of daily water needs
Source: Research and Development PDAM Giri Tirta Gresik

3.5.1 Based on Number of Connections

a. Water Loss (m^3/month/SR) : 0,2 x the average community Water consumption

b. Average water demand (lt/sec/SR) : average community water Consumption + water loss

c. Daily water needs (m^3) : Total SR x average water needs

d. Reservoir Capacity : 40% x Daily water needs

3.5.2 Baseon Population

a. Water loss (m^3/month/person) : 0,2 % x community average water

b. Average water demand (lt/sec/person) : community average water consumption + water loss

c. Daily water needs (m^3) : Total population x average water needs

d. Reservoir Capacity : 40% x daily water needs

3.6 Prediction of Operating Budget

$$Pn = Po\ (1+i)^{\mathrm{n}} \quad \text{..... 3.11}$$

$$i = \frac{Amount\ of\ \%\,\mathrm{increase}}{year_n - \mathrm{year}_o} \quad \text{..... 3.12}$$

$$Interpolasi = H1 - \frac{B1}{B2}\mathrm{x}(\mathrm{H1} - \mathrm{H2}) \quad \text{..... 3.13}$$

$$F = \mathrm{P}(\mathrm{f/p.i\%.n}) \quad \text{..... 3.14}$$

Explanation:

Pn : Total costs in the n projected year

Po : Total cost at the beginning of the year

i : Interest

P : CCapital/Value

F : Future Value

H1/H2 : Score Economi Engineering

B1 : Total %

B2 : Calculation results