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A RELIABILITY STUDY: CISADANE RIVER AS A DOMESTIC WATER SOURCE OF TANGERANG CITY

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ABSTRACT

Tangerang City's rapid development requires infrastructure of drinking water with a target of 80% from the population, amounting to 4.665 l/s. This number is much larger than the existing condition of service which only reached 1.330 l/s in 2010. One potential source of raw water that can be optimized is Cisadane River; this river divides the city of Tangerang since it flows from south to north. The aim of the study is to assess the potential of increasing the usage of raw water from Cisadane River in terms of quantity and quality aspects. The study used a quantitative method of recording data AWLR, analyzing the contamination characteristic, and analyzing the topography from the city. The reliability analysis of raw water at 90% confidence level was 18.2 m^3/s. When the number was compared with 80% of drinking water target of the population, Tangerang city requires that 4.665 l/s have to be sufficient in number. However, there was a deficit in the dry season to meet the demand of both industry and irrigation. The water quality of Cisadane River was included in level standard 2 where processing can still produce quality drinking water to meet the standard. The levels of Iron and Manganese exceeded the quality standard significantly. The level of nitrite-nitrate fluctuated with the average of the normal standard level. Improving the reliability of the water source in the dry season can be supplied by making storage ponds in the West Panunggangan and Bojongjaya with additional discharge of 97 l/s and 85 l/s.

Keywords: Cisadane River; Potential Intake; Water reliability; Water quality

1. INTRODUCTION

Tangerang City's rapid development requires infrastructure for drinking water. Drinking water target of 80% of the total population in Tangerang requires 4.665 l/s, much larger than the existing condition of service which only reached 1.330 l / s in 2010 (Department of Public Works Tangerang City, 2010). Management and development of drinking water are generated by target in 2019 where the level of water service is expected to reach 100% in urban areas. Based on Government Regulation No. 16/2005 on the Development of Water Supply System, one of the efforts to achieve these targets is through raw water management and increasing service network. Raw water management is directed to fulfill the needs of drinking water continuously. Drinking water supply gets two major challenges like the availability of sustainable water and good quality of riverwater.

One potential source of raw water that could be improved is Cisadane River in Tangerang. The watershed of Cisadane River have a characteristic of diverse areas, including forests and fields in the upstream area of Mount Salak, settlements and fields

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in the Central part, and urban activities in downstream areas. The source of the upstream water is around Lido and the slope of Mount Salak. Cisadane river flows in the middle of the city of Tangerang along 15 km. The width of Cisadane River is about 40-100 m. Dam Mekarsari village of Neglasari Subdistrict controls the water flow into the downstream of Cisadane Tangerang. Some of the channels that serve as a technical irrigation network include Kali Mokervart, West and East Cisadane, and Siphoon Cisadane (Department of Public Works Tangerang City, 2010). The availability of the water level shows that in the dry season, Cisadane River discharge is not able to provide sufficient water to fulfill the needs of industry, irrigation and drinking water.

The second challenge is the problem about fluctuating water quality. Cisadane River discharge is from domestic wastewater that is large enough from urban activities (Hariyadia, et al., 2010). Domestic wastewater includes human fecal waste and wastewater from bathing, washing and kitchen containing a lot of organic materials that can be decomposed. Water pollution has caused 86 species of fish that once lived in the lake area of Cisadane riverflow to decrease to 24 species that can be found, meaning that the rate of the loss of species is around 72.1% (Hadiaty, 2009). Using of land in the watershed is dominated by Cisadane moor (53.8 % watershed area), forest (22.9% watershed area) and settlement (15.6% of watershed area) (Junaidi, 2013). The existing condition of urbanization in the swampy areas in Jabodetabek physically and ecologically shows that the swamp, salinity and water quality have degraded (Henny & Meutia, 2014). The pollutant sources influence water quality.

This research explaines the strategy to rise the utilization of the raw water of Cisadane River in terms of quantity and quality aspects. The results of this study are useful to be both a government input in the decision making of reparation as well as improvement strategies regarding the quality of Watershed and a recomendation on the amount and location of raw water tapping from Cisadane River.

2. METHODOLOGY/ EXPERIMENTAL

The study was conducted in March - August 2013 in Tangerang City. Walkthrough Cisadane carried from the upstream of the river in the town of Tangerang to the 10th dam. The equipment used was water quality sampling equipment including water sampler, sample bottles, labels, stationery, calculators, and computers. Taking samples of GPS coordinates was also done. The research used quantitative methods, corroborated by qualitative analysis. The steps of the research included, first, analyzing the quantity of the river conditions, second, analyzing the characteristics of the pollution, third, topographically analyzing the raw water system development tapper.

The calculation of the discharge used mathematical calculations from Automatic Water Level Records data in 10th dam over the last ten years with a confidence level of 80%. The river water quality time series data in January - October 2011 was conducted by BLH. The primary sample was made to compare the results of lab tests. Qualitative parameters that discussed included key parameters, namely DO, Nitrates, Nitrates, Chlorine, Manganese and Fe. The measurement results compared with PP No 82 of 2001 on Standard Class 1 was used as a reference class of water to the raw water. The needs for reservoirs / retention ponds were analyzed through the existing topography compared to the search field.

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3. RESULTS AND DISCUSSION

3.1 Quantity Analysis of Cisadane River

Based on the amount of water supply and compared to water demand, it can be determined that the amount of the balance between water availability and water needs. The data of Serpong Dam observation show that during rainy season in February, Cisadane River flow reaches a large excess of 1100 m^3/sec. In September to June, the river can supply the needs of irrigation, industry, and taps. However, in July-August, the deficit of water is large enough. An impact of the reduced water supply occurs in the irrigation sector where in rainy season, irrigation which gets more than 20 m^3/sec only gets 10 m^3/sec in September.

The use of water for industry and PDAM is relatively constant at 2.912 m^3/s and 4.512 m^3/sec. The extraction of drinking water and water for industry is relatively safe with the 10^{th} dam which raises the water level of the river. The presence of a dam cannot increase the amount of water, but increase the mainstay of the discharge; distribution of water that removed can be set so that the flow in the dry season will increase. The calculation of water availability using an analysis of Automatic Water Level Record data for ten years in Serpong South Tangerang obtained a reliability of raw water as shown in Figure 2 at 90% confidence level of 18.2 m^3/s.

Aother research mentions that Cisadane Base flow is generated by forest (19.9 m3 / s), settlement (1.71 m3 / s), garden mix (5.52 m3 / s), moor (4.72 m3 / dt), ricefield (0.55 m3 / s) and shrubs (0.12 m3 / s) (Junaidi, 2013). While the present research was based on (Sabar & Mukmin, 2006) the domestic source of raw water from Cisadane Intake obtained from the reliability analysis upstream Bogor Regency has a design discharge of dry s / d Dry maximum allowed discharge plan for 2998 L / sec and 5660 L / dt.

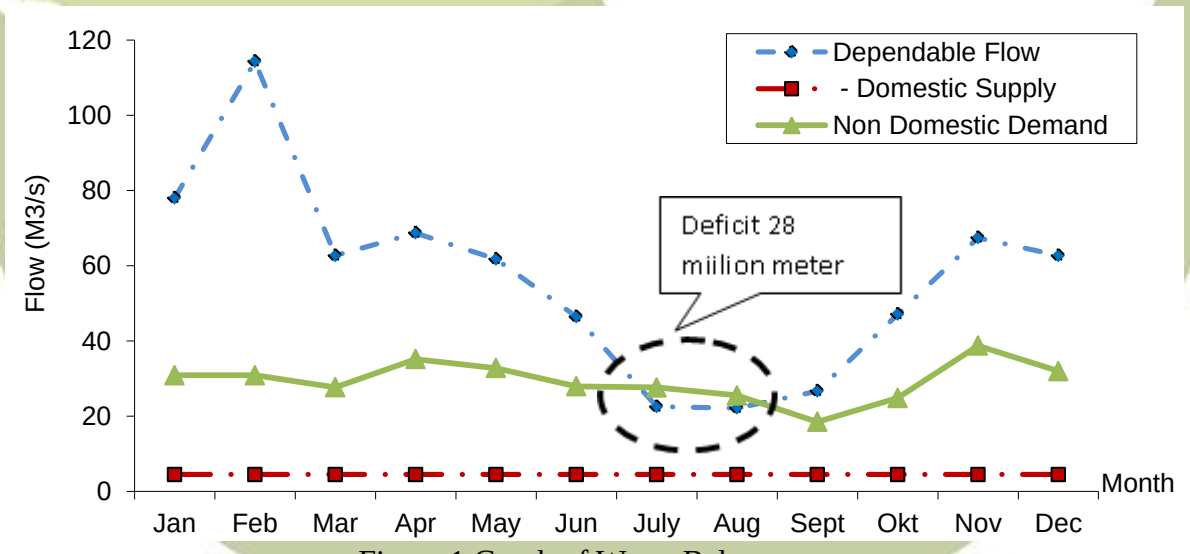

Figure 1 Graph of Water Balance
Source: BBWS Citarum Cisadane, 2013

The limited amount water compared to the large needs requires solutions comprehensively. The first alternative through a review of the needs of the water usage of Cisadane River is based on Government Regulation No. 42 Year 2008 on the Management of Water Resources. "The main priority of supplying water resources is intended to fulfill the daily basic needs and to fulfill the irrigation needs for the agricultural community in the irrigation system that already exists" in 70 indicates that

the use of raw water should be a priority of water use in addition to other uses such as irrigation and industry.

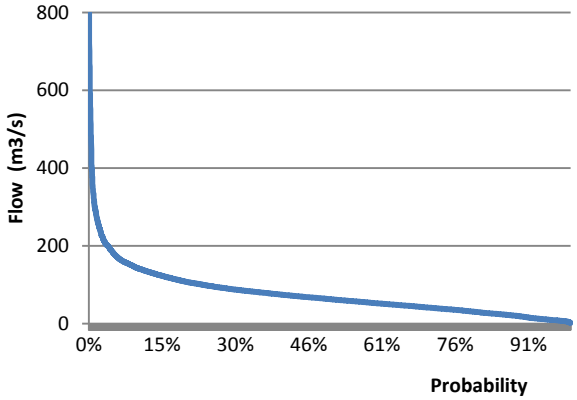

Figure 2 Flow Duration Curve of Cisadane at 90% Confidence Level

The reliability of the availability of the raw water at a minimum level on the river is calculated at 90%, which means in ten years, there is one possibility of drought. While the irrigation level is at a confidence of 80%, when drought occurs, taking water from the raw water is preferred. Seen at 90% of confidence level, the mainstay of the discharge that can be used is 18.2 m^3/sec, which is perfectly enough to fulfill the needs of Tangerang.

The second alternative, making a reservoir to store water during the dry season, is one of the good water control solutions in the future. Seeing the growing Tangerang City and diverse array of water needs requires a comprehensive decision. The principle is to save water in the rainy season to spend during the dry season. Its volume bin is based on the deficit volume from the result of projection in July and Agust. The result of the calculation shows that the volume required is 28 million $m^{3.}$

3.2 Cisadane Water Quality Analysis

Based on Government Regulation Number 82 of 2001 on Water Quality Management and Water Pollution Control, drinking raw water sources requires first-class quality as a source of raw water. Tests were conducted twice a week by the Internal Laboratory PDAM pursuant to Government Regulation of Republic of Indonesia No. 82 of 2001. The results of the measurements conducted by PDAM Tangerang on Cisadane water quality on taking raw water inlet taps show that some parameters have exceeded standard class 1. The parameters that exceed the quality standard include Iron, Manganese, Ammonia, Nitrite, Nitrate and Chlorine. From the results of the laboratory measurements, Cisadane River is classified as second-class raw water. In the second class quality standard, raw water can still be treated well as drinking water with technology owned by PDAM.

Some research shows that Cisadane River quality has decreased. The estuary of Cisadane River along 12 km, in estuary has suffered pollution caused by various activities, especially organic pollution from urban activity in the upstream (Hariyadia, et al., 2010). The changes do not construct land into smaller plots in Bogor for 65.75% of land use residential, industrial and other public facilities were above statutes agricultural areas wetlands exacerbate water quality and quantity Cisadane (Krisnaningtyas & Trimarmanti, 2014).

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The function of the river seems to turn into landfills and sewer systems. The river is dynamically affected by changes in the nature of the discharge and the local geomorphology. The discharge of the river always changes, affected by rainfall, land conditions and changes in the river flow. The character of the river is determined by the geohydrobiological condition of the region and local culture. Considering the relationship trend between community and river, as mentioned above, the space around the river should be protected from being compelled by the interests of other uses (Subyandono, 2009).

The iron and manganese level excess of the first-class quality standards fluctuates each month. Iron and Manganese have a similar characteristic i.e. dissolved in water. The high level of Iron and Manganese is caused due to a high content of iron and manganese in the soil around the river which is beyond the normal limits. Iron and manganese will be dissolved in water when the dissolved oxygen is low, and can settle itself at normal pH and enough oxygen that form Fe_2O_3. In general, the excessive iron and manganese are easily overcome with the processing of aeration and pH disposition. The content will precipitate together with discrete particles or trapped in the sand filtration.

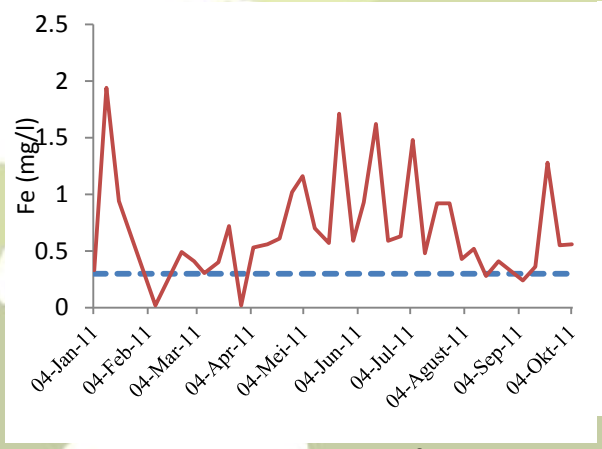

Figure 3 Concentration of Iron

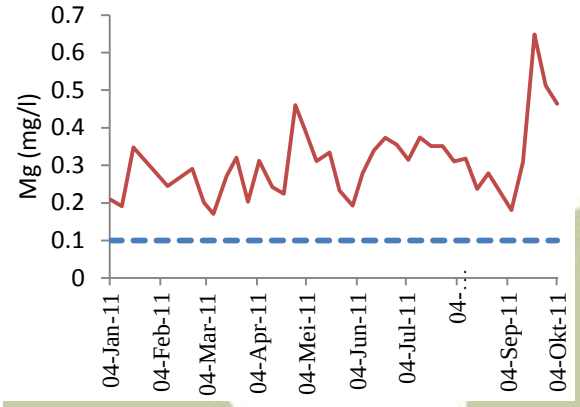

Figure 4 Concentration of Manganese

The measurement results show that the levels of Nitrogen in the form of nitrite and nitrate exceeded the quality standard class one. Nitrate (NO_3) and nitrite (NO_2) are natural inorganic ions, which is a part of nitrogen cycle. Nitrite can be easily oxidized to nitrate; nitrate is the compound most commonly found in underground water and water contained in the surface. Agricultural activities in the upstream areas are a major factor of the increased levels of nitrate in water through the use of fertilizers. In the dry season, the river water will appear in green, which indicates the growth of algae in large quantities. Nitrite and nitrate treatment is difficult if done through conventional technologies due to the form of ions dissolved. Therefore, ions can go through the process of sedimentation and filtration. Nitrogen in the form of nitrates is generally still below the quality standard.

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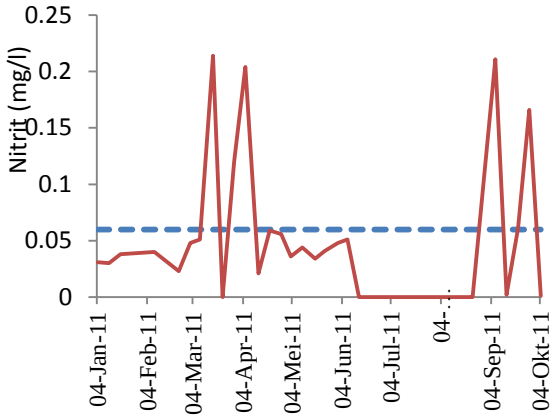

Figure 5 Concentration of Nitrite

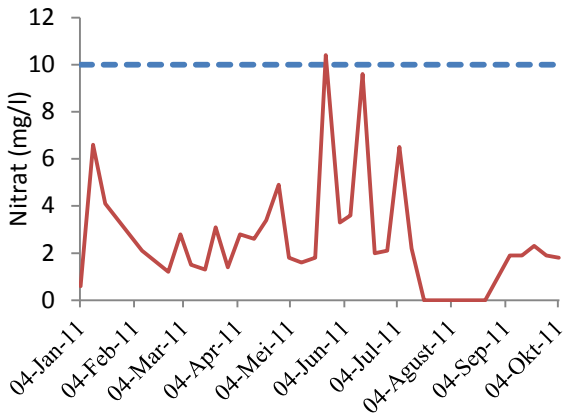

Figure 6 Concentration of Nitrate

The level of chlorine that is excessive in the river comes from septic tanks or water disposal of household waste. When using cleaning or washing agents containing chlorine, it could make the water disposal infiltrate into the soil and contaminate wells that are the source of household water. Pool facilities also generally use chlorine as a "purifier" of microorganisms present in water. The utilization of disinfectant in industry also contributes to the increased levels of chlorine.

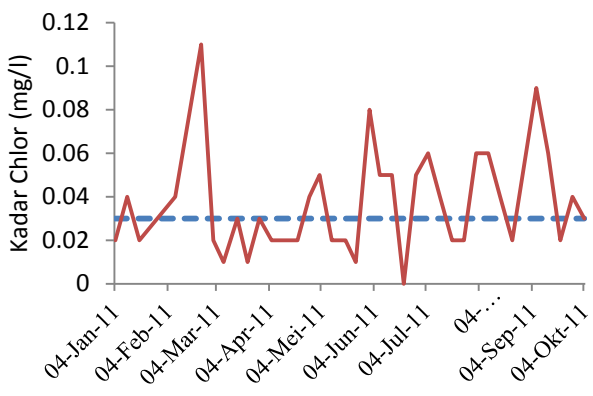

Figure 7 Concentration of Chlorine

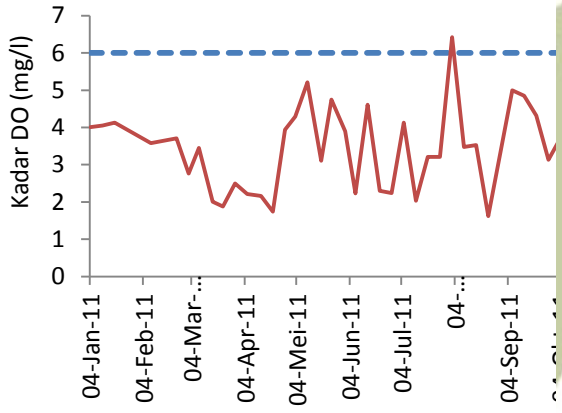

Figure 8 Concentration of Dissolved Oxygen

The levels of the dissolved oxygen in the water is very low, i.e. up to 2 mg / l, indicating a process of biological and chemical degradation of the pollutants found in the water of the river. This leads to the value of Chemical Oxygen Demand Levels (COD) and Biological Oxygen Demand (BOD) to be in a high level. Low DO and acid pH will increase the solubility of iron and manganese in the water. A low brightness level is only as deep as 12 -18 cm compared to the depth of water compared with an average of 5.3 m to set the limits of primary productivity rates as a whole, so it is not enough to supply oxygen for the purposes of water metabolism (Hariyadia, et al., 2010)

Other parameters such as heavy metals in Cisadane River according to a research (Rochyatun, et al., 2006) show that the levels of the heavy metal are still in accordance with the threshold value for marine water quality standards set by the government for

biota. However, based on a research (van der Meij, et al., 2010), Cisadane River contributes to the degradation of the water quality in the Bay of Jakarta, which comes from domestic pollution. An increased level of hydrocarbons, heavy metals such as Pb, Cd, Hg, Cu, and Zn has exceeded the quality standards. This value is different possibly becaue using different methods of sampling in different locations.

3.3 Proposed Water Retention

Pond Location and intake PDAM require a large land. In addition to the treatment unit, it initially needs sedimentation for water storage and initial deposition. The results of topographic modeling of the pond area lead to two alternative sites which are suitable for the use as a retention location of Cisadane River. The priority alternative selection sequence number in the table that the aspect of the quality and availability of land. For quantity aspect assessed same at every alternative cause withdrawal do in Cisadane river. Advanced analysis covers a land area that can be utilized for the construction of treatment plan units with its sedimentation unit, thus obtaining intake optimization that can be done from the same alternative, i.e. availability of the existing water and land.

The results of the analysis show that Tangerang City has a sloping topography from the south to the north. The southern area has an average altitude of 20 meters downhill to the north up to nine meters. The result of the calculation of the storage volume that is needed is 28 million m^3 and it would be difficult to obtain in Tangerang. The flat contour makes the planning for excavation reservoirs require large volumes and huge areas of land. If it is assumed that it can be dug up to a height of 6 m, the area required is 4.7 $km^{2,}$ or equal to two-thirds of Tangerang City. The construction of downstream dam will lead to the problem of garbage, quality and social. Then the alternative is very difficult to occur. The alternative to build dam in separate building is analyzed by the criteria of topography, location awoke, water quality.

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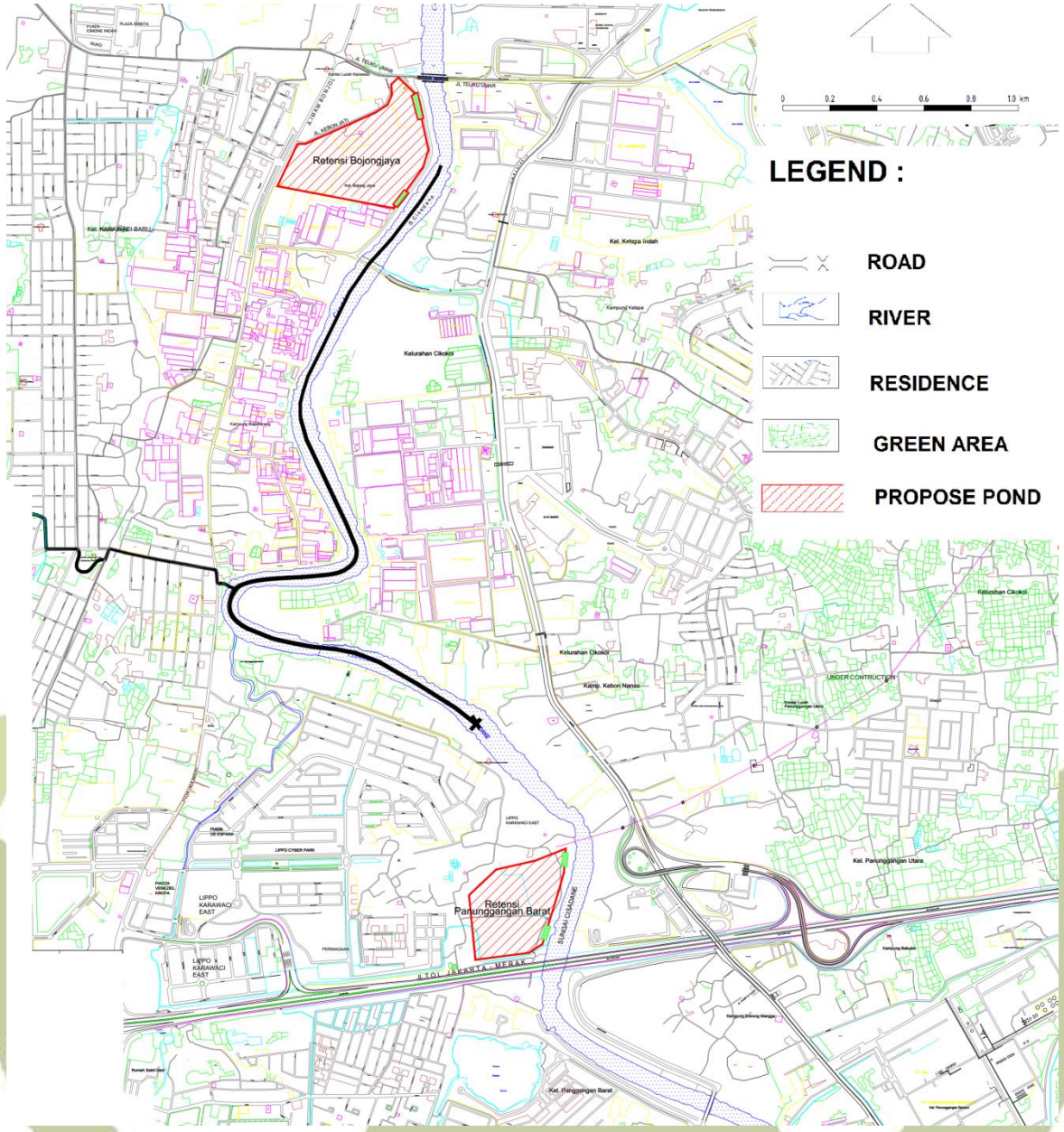

Figure 9 Alternative Location of Tapping Raw Water at Cisadane Tangerang City

Two alternative retention ponds are proposed. The retention pond in West Panunggangan with a volume of 753,380 m^3 potential as a source of raw water with a discharge of 97 to 194 l/sec while the retention pond discharge of Bojong Jaya is 85 to 170 l/sec. The retention model is better designed by off-site in addition to water bodies. This will make the inflow and outflow as well as pool sedimentation easily arranged.

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Table 1 Size of reservoir storage in facing drought conditions

No.	Locations	District	Reservoir Size			Retention (days)	Potential raw water (m3/s)	Potential raw water (L/s)
			Area (m2)	Height (m)	Volume (m3)			
1	S 6 ° 13'11.56 E 106 ° 37'43.88	West Panunggangan	75 338	5	376 690	45	0097	97
				10	753 380	45	0194	194
2	S 6 ° 11'57.62 E 106 ° 37'28.43	Bojongjaya	66 035	5	330 175	45	0085	85
				10	660 350	45	0170	170

4. CONCLUSION

The analysis of ten-year data AWLR Serpong obtains a reliability of raw water at 90% with a confidence level of 18.2 m3 / s. When compared with the drinking water target of 80% of the population in Tangerang, it requires that 4.665 l/s have to be sufficient in number. However, there is a deficit during the dry season due to the joint utilization by industry and irrigation. The number of water users is agriculture where in the dry season, the water supplies will reduce. Meanwhile, the supply of drinking water for industry is relatively safe at the 10^{th} dam. The water quality of Cisadane River is categorized in standard class no. 2 where a treatment can still produce drinking water with quality standard. The levels of Iron and Manganese exceed the quality standard significantly. The nitrite nitrate levels fluctuate with an average which is still within the quality Standard. To reduce the water deficit in July and August can be done by making storage ponds / situ in the Village of West Panunggangan and Bojongjaya with additional discharge of 97 l/s and 85 l/sec. A reservoir system is made using the river system off site.

5. ACKNOWLEDGEMENT

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