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# The Content of Coli Bacteria In Shallow Well Water In Surabaya Small Type Housing Is Very High. Why?

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***Abstract*—This research is motivated by the fact that the quality of groundwater in small type housing in Surabaya is low, with a high content of E-Coli bacteria. By this fact, it is necessary to study what factors are causing the high content of E-Coli bacteria. Continuing the previous research as a target of the study, this study was conducted in Pondok Benowo Indah Housing (PBI) Pakal subdistrict West Surabaya. From the PIB housing area, four houses/ shallow wells were selected as the center of the study site. This study analyzed several variables such as water quality with several parameters, the distance between septictank and the wells, soil density, soil permeability, many quality of septictank construction of surrounding community activities, channels situation, and frequency of flood. Data were collected by means of measurements in the field, laboratory tests, news on social media, and interviews with local communities. Data processing was done descriptively. This study found that the main factor of the high content of e-Coli bacteria originated from the quality of septictank, there may be damaged, broken, leaking, and the wall is permeabel, so that by the times, it become absorbed and by the soil and run into the well.**

***Keywords—E-Coli bacteria, groundwater quality, septic tank.***

## I. INTRODUCTION

The quality of sanitation is closely related to the quality of health, education, tourism, economic growth to the national pride and admiration. Cleanliness of a country is measured by the quality of sanitation and toilets in general. The Singapore government spends a lot of money to improve the sanitation system because it has an impact on improving the quality of the health of its citizens. Investments in sanitation and toilets are seen as lower than spending money for sick people due to poor sanitation conditions. In Singapore's experience, improved sanitation can attract foreign investors. Investors who are accustomed with clean toilets in their country are usually reluctant to come and live in countries with poor sanitation conditions. Noted there are still 2.5 billion people in this world who do not have access to good sanitation (Jack Sim in the KOMPAS daily 9th December 2013) [1]. All this time, talking about toilets was avoided and even considered as disgusting thing.

Poor sanitation quality will have an impact on public health, especially related to the need for clean water. In developing countries, most drinking water needs cannot yet be met with clean water, due to the limited capacity of clean water and also the limited network. Domestic water needs are met with the nearest water source potluck, usually ground water taken by making wells (Victor M. Ehkers, and Ernest W. Steel, 1955) [2].

Research by Winanti, et al in 2013 [3] examined the conditions of sanitation and water supply in small type housing in East Java Province. From a sample of selected locations, there is one location in Surabaya city, where the quality of the well water is very poor, namely Real Estate Pondok Benowo Indah. Well water is not consumed for drinking and cooking but it is used for bathing, washing, and other purposes. The PDAM (Indonesian Regional Water Utility Company) water network already exists and is used as drinking water and cooking. In that location, every house has shallow well facilities, which are 8 m apart from septictank. The installed channels are made of PVC, the channels between the bathroom tube and the kitchen tube are connected, and rain water channel and dirty water channel are also combined. In the housing location of this study there is no management of rain water, ground water quality (well water) is very poor, the main indicator is the content of E-Coli bacteria ranged from 35,000 to 160,000 MPN /100 ml. Such condition of well water is very dangerous to human health if it enters the body through drink and foods. Therefore, this study looks for any factors that cause such a high content of E-Coli bacteria in well water. This study aims to find out the factors that cause the high content of Coli in well water.

## II. LITERATURE REVIEW

A house is a closed/separate residence from the direct influence of external situations, so the house must be able to keep its inhabitants away from health problems caused by epidemics of infectious diseases such as typhus, cholera, and dysentery. In addition, the house must also be able to provide protection against security disturbances due to crime or riots such as theft or robbery (APHA), 1960 [4].

It should be noted that a healthy home is not the same as a luxury home. A healthy home can adequately meet the basic needs (fundamental needs) of humans, but may not be able to meet the desires (demand) of a person. So there must be a separation between needs and desires. It is because the desires of each human are not the same and unlimited. A healthy house is a place where a family lives, is required to have a strong and durable construction, and also meet other important requirements, namely:

a. There is enough clean water to live (drinking, cooking, and other household needs) and life.

b. There are spaces for the management of rainwater, dirty water, garbage, and other impurities that meet health requirements.

c. Regular sanitation system that does not cause interference with other needs.

(Rudi Gunawan and Haryanto, 1981) [5]

Open space outside the house for residence including small type houses in urban areas are usually covered with grass, gravel, asphalt, concrete plaster, paving, shrubs (ornamental plants), fruit trees, or left open untreated.

Winanti's research (1995) [6] states that grass has the most role to absorb rainwater into the soil at residential locations in urban areas, while type of shrub or ornamental plant is the second, and the third is trees. The grass is able to inhibit surface runoff so as to provide greater opportunity for water to seep into the ground, while shrub is able to block rainfall to slow the process of rainwater to the ground surface, as well as trees.

Ground cover such as asphalt, paving, concrete plaster is impermeable so it is unable to absorb water into the soil. All rain water that falls at such closure will run out of the yard dumped into the public canal.

Household waste is the largest water pollutant in addition to industrial, agricultural, livestock, and other pollutants. Household liquid waste flows into gutters, wells, rivers, and will certainly pollute it. The greater human population will make the higher level of pollution (Pangarso, Harjoso Projo, 1991) [7]. Feces (E-Coli), washing water, and bathroom waste can contain germs that will follow the water flow.

Bacteria Escherichia coli are known as one of the bacteria that causes digestive disorders in humans. These bacteria are included in the group of bacteria in the form of short stems and grow ideally at temperatures of 20-40 degrees Celsius, normal human body temperature (36-37)º C. These bacteria have benefits for humans because they live in the walls of the large intestine and function as a decomposition of residual - leftover food that is not absorbed in the human digestive system. Escherichia coli are easier to find and also the development of these bacteria is fairly fast. Within 15 to 20 minutes can double its body. In the exponential geometric chart, it is recorded that in just 10 hours one bacterial cell can multiply its body and develops into more than 1 trillion cells (Victor M. Ehkers, and Ernest W. Steel, 1955) [2]. A small portion of Escherichia coli can stimulate diarrheal disease, advanced diarrheal syndrome, and uremic hemolytic. Government Regulation number 20 year 1990 [8], requires a maximum total content of coliform on group B water is 2000 MPN/100ml. For clean water, which is required in Regulation of the Minister of Health Number 416/Menkes/Per/ IX /1990 [9] total coliform of 10 MPN/100 ml.

Cities that do not have a closed sewerage system, in general, only waste water from the bathroom and washing is discharged to the municipal waste disposal center, while the sewage from the toilet will be disposed of to a special disposal site known as septic tank. Some provisions that must be obeyed in the construction of septictank are: the making of dug wells for domestic needs should be a minimum of 11 meters from the source of pollutants (septic tank), this distance is greatly influenced by the water flow below the surface of the land called soil permeability. This 11 meter requirement applies if the pollutant is bacterial, but if the pollutant is chemical then the distance from the dug well is at least 95 m (Rudy Gunawan, 1981) [5]. The septic tank construction must be sturdy, stable, not tilted, no sinking, no sliding, no breakage, no leakage, and no seepage.

Soil permeability is the ability of soil to drain water or air, expressed in units of cm/ hour (Handayanto, 2009) [10]. Texture greatly influences soil permeability. This is because permeability is the flow of liquid through the pore/cavity of the soil texture for example sandy soil will easily pass water in the soil. This is related to the effect of texture on the proportion of colloidal material, pore space, and adsorptive surface area (Hanafiah, 2007) [11]. The finer the texture of the soil or the more clay content, the slower the permeability of ground water.

The density of soil solids is the ratio between the mass density and the volume of the solid itself. Measurements were made for 24 hours with an absolute temperature of 105oC or between 100 -110oC. The requirements of temperature, time, and groundwater content are zero and absolutely will not change. Bulk density in layer A, the mineral soils generally ranges between 1.2-1.6 gram / cm3. Mass density at various horizons in clay soil shows that horizon C (parent material) is the densest layer with a mass density of 1.7 gram / $cm^3$. Structural formation during soil development causes the horizons at the top to have a lower mass density than the original parent material.

Table 1. Class of soil permeability according to darcy's law

| No. | Class | Permeability (cm/hour) |
|---|---|---|
| 1 | Very slow | <0.125 |
| 2 | Rather Slow | 0.125-0.500 |
| 3 | Slow | 0.500-2.000 |
| 4 | Medium | 2.000-6.250 |
| 5 | Rather fast | 6.250-12.500 |
| 6 | Fast | 12.500-25.000 |
| 7 | Very fast | >25.000 |

Source: Josephe Bowles, 1993 [12]

## III. METHOD

This research was conducted in Surabaya City area, which is located in East Java Province. Surabaya is located at 111 ° -114 ° 4' East Longitude and 7 ° 12' - 8 ° 48' South Latitude (Surabaya in numbers, 2014) [13]. Regional boundary of Surabaya is bordered by Sidoarjo in the south, in the east there is Madura Island. While in the west it is bordered by Gresik Regency. The total area of Surabaya is ± 300 km2 which is completely divided into 31 districts. Topographically the surface of the earth in Surabaya is a lowland area (4-20) meters above sea level. Most are low, only a small fraction of 20% corrugates as high (20 m)

The target of the research is a small type of house, which is a settlement with a maximum size of 100 m2 and a maximum building area of 40 m2. Development of small type settlements in Surabaya is carried out by several parties, namely the community in private, the government which is carried out by Perum Perumnas, and by the private sector which is in this case the developer under the auspices of the housing organization Real Estate Indonesia (REI). Due to the target of this research is to obtained information

about the factors causing the low quality of ground water in the study area, thus data with clear measurements are needed. Therefore, the research target was focused on settlements built by the Public Housing and Developer (Minister of Public Works Decree No. 20/KPTS/1986) [14]. In other words, housing built by the community was not included in the objectives of this study

A study by Winanti in 2013 [3] found a location where ground water quality is low. Based on various considerations, the target of this study is the location of Pondok Benowo Indah housing area with ± 150 units of small type houses. The exact location is on the Babat Jerawat subdistrict, Pakal subdistrict Surabaya city. To determine the houses studied, samples were taken purposively, namely choosing four houses that are inhabited and have shallow wells/dug wells with the lowest water quality (Todd, David Keith, 1980) [15].

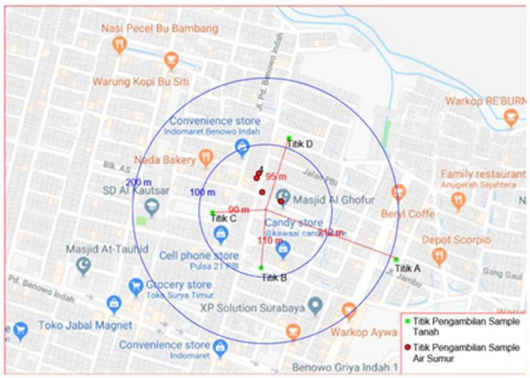


Figure 1. of Location Determination of Research Points
in the Pondok Benowo Indah (PBI) Area, West Surabaya

Variable

1. Form of community activities that are suspected influencing the content of Coliform, for example various types of home industries (food, livestock, textiles, repair shop, and the other) are observed up to a radius of 200 m.
2. The distance of the septic tank (nearest and neighboring) to the shallow well under study,
3. Frequency of flood inundation every rainy season
4. Condition of the channel at a residential location (flowing smoothly, slowly, or stopping).
5. Chemical content in water in the form of pH, DHL, TDS, Cl-, nitrate, cadmium, copper, and total of coliform (Manahan, SN, 1977, Sudarmadji, 1991) [16]. [17]
6. Soil permeability and soil density (Das, Bradja M., et al) [18]
7. Quality of septictank construction

## IV. RESULTS AND DISCUSSION

Based on the results of data analysis, it is stated that compared with well water in other cities in East Java, the pH value in Surabaya is the lowest, from 6.6 to 7. This means that water quality is not good for health, reinforced by the condition that the color is yellowish and the taste is a bit salty and smell bad, so this water does not qualify as clean water, even less drinking water.

Electrical conductivity (DHL) as an indicator of total ion content in the study area of between (938-1006) µmhos / cm gives a signal that there is a content of particles in it even though it is not concentrated. As a comparison, the DHL water value of PDAM Surabaya is 400 µmhos / cm. The content of organic substances, namely oxygen demand for oxidation, which is indicated by the content of permanganate (KMnO4), at the location of this study ranged from (7.58-37.92) mg/l, it is not safe as drinking water because the permitted level of permanganate is 10 mg/l. When it compared with permanganate concentrations in other cities ranging from 0.89-21.46 mg / l, the permanganate content in Surabaya is quite high.

The chloride content in ground water in the location of this study ranged from (112-150) mg/l, this value can be declared safe. Waters of group A and group B are permitted up to 600 mg/l. Nitrate (NO3-N) is the final product of oxidizing substances that are nitrogen, the amount of nitrate shows the speed of oxygen need if the atmosphere is to be improved. In this study, nitrate values ranged from (0-1.23) mg/l, this condition is very safe because it is less than 5 mg/l, as a water requirement for group A (PP no 20 of 1990) [8].

The total coli value in the study area (110,000-12,105) MPN/100 ml is very surprising. The maximum coliform is found in house number 3, whereas all houses have equal both distance and position of septic tank and shallow wells. Among the four houses studied there are three houses with total coliform values (110,000, 170,000, and 220,000) MPN/100ml, respectively. This value is unacceptable based on Government Regulation No. 20 of 1990 [8], because in the government regulation requires a maximum group B water content of 2000 MPN/100ml. Many possible causes of this condition are estimated: a. distance between nearest septic tank and surrounding neighbor to the shallow well under study, b. frequency of flood inundation every rainy season, c. the condition of the surrounding channel: flow smoothly, slowly, or stop), d. Distance of wells to home industry activities (food, livestock, textiles, repair shop, and the other). Among the variables above, septic tank leak is the most suspected variable.

Table 2. Test Results of Soil Density and Soil Permeability

| No | Soil Sample Point | Distance to the research well | specific gravity =γt (gr/cc) | γd=soil density (gr/cc) | Water Content (%) | Permea-bility cm/hour |
|---|---|---|---|---|---|---|
| 1 | A | 200 m | 1.325 | 1.243 | 6.593 | 1.044 |
| 2 | B | 110 m | 2.061 | 1.687 | 37.694 | 0.02 |
| 3 | C | 90 m | 1.739 | 1.57 | 10.725 | 0.238 |
| 4 | D | 95 m | 1.878 | 1.365 | 49.589 | 0.000042 |

Source: Primary data

The distance of the septictank to the well under study ranged from 8-10 meters, the condition of the channel in this

housing area is good, the flow run continuously and nothing is stopped, the pipeline was made of parallon and nothing leaked. Community activities are measured from the central point at the study site, cross section north to south with a radius of 200 m; no home industry activities are found. Likewise in the survey on the cross section west to east with a radius of 200 m also there is no home industry activity.

Soil samples are taken from 4 circular points with the distances of 90 m, 95 m, 110 m, and 200 m from the center point of four wells. The permeability of four samples rates ranging from 0.0000417-1.004 cm/hour. The soil at point A is 200 m from the well which its permeability is slow (1,044 cm/hour), point B is 110 m from the well with its permeability is very slow (0.02 cm/hour), point C is 90 m from the well with its permeability value is rather slow (0.238 cm/hour). Point D is 95 m from the well with its permeability value is very slow (0.000417 cm/hour). The average is 0.326 cm/hour.

The density of soil solids is the ratio between the mass density and the volume of the solid itself. Measurements were made for 24 hours with an absolute temperature of 105oC or between 100 -110oC. The requirements of temperature, time, and groundwater content are zero and absolutely will not change. Bulk density in layer A, the mineral soils generally ranges between 1.2-1.6 gram / cm3. Mass density at various horizons in clay soil shows that horizon C (parent material) is the densest layer with a mass density of 1.7 gram / cm3. Structural formation during soil development causes the horizons at the top to have a lower mass density than the original parent material.

The study area is inundated when it rained but it is not long and not high, nor is always every rainy season. Soil density (γd) in the study area ranged from 1,243-1,687 gram/cc, top soil typically ranged from 1.2-1.6 gram/cc if clay soils had a value of ± 1.7 g / cc.

Septic tank construction cannot be assessed or observed because it is buried underground. Poor septic tank construction will also have a bad effect on the quality of well water, because well water will always get a continuous flow of septic tank that leaks or seeps over a long period of time. Proper septic tank construction must be stable and sturdy, not leaking and not impermeable.

Table 3. Recapitulation of Variable Values

| No | Variable | Status |
|---|---|---|
| 1 | Community activities | Not Found |
| 2 | The distance of the septic tank to the shallow well | Barely qualified |
| 3 | Frequency of inundation | Low |
| 4 | Condition of the channel | Good |
| 5 | The quality of well water | Bad |
| 6 | Soil permeability | Rather slow |
| 7 | Soil Density | Normal |
| 8 | Quality of septictank construction | Not detected |

Based on the Table 3. of variable status above, it can be stated that there are no community activities that have the potential to trigger high levels of Coli bacteria. Flood inundation that is not high and only occasionally occurs with a fast duration will not be able to infill into the ground, considering the permeability value is also low with an average of 0.326 cm/hour. Thus to reach the 1.5 meter ground water level takes 150: 0.326 = 460 hours or 19 days. The flow of channels in the research area runs smoothly does not stagnate or stop, so that it does not potentially seep into the ground. The nearest river is approximately 500 meters away, so it is not considered the potential influence in supplying Coli bacteria.

The main variable that deserves to be suspected of supplying Coli bacteria into the well is the septictank. If viewed from the distance of the septic tank to the well it actually does not matter, it is (8-10) m <11 meters from the requirement, almost fulfilling the requirements. Strong suspicion is the occurrence of septictank leak or connecting channel from septictank to the absorbing well. Leaks can occur because the construction of the septic tank is not sturdy and is not waterproof or damaged, meaning that there is a septictank such as the wall or base that is broken or cracked. Construction of septictank must be made of reinforced concrete with a mixture of 1 Pc: 2 Sand: 3 gravel, and given reinforcement. However, this research cannot be observed because the construction is buried underground. After these findings, then there is a crosschecked to the research location to ascertain whether there are residents who dismantle and/or move septictanks or wells, the answer is none. This answer can be trusted because there is no more space to move the septic tank or well. Thus it can be stated that the construction was made by the developer who built Pondok Benowo Indah. The second variable is a flood inundation, this happens if the rain is very heavy, the water overflows to pool several centimeters and a bit longer as happened in February 2019 [19].

## V. CONCLUSION

The high amount of Coli bacteria that appears in well water on Pondok Benowo Indah housing Babat Jerawat, Pakal sub-district, Surabaya, caused originating from septic tank leakage or seepage that lasts continuously for a long period of time. The second trigger is a flood inundation if the rain is very heavily.

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