ANALYSIS OF LEAD CONTENT IN REFILLABLE DRINKING WATER IN LHOKSEUMAWE CITY

Rizka Sofia, Khairunnisa Z and Aditya Fajar Perkasa

Faculty of Medicine, Malikussaleh Lhokseumawe University, North Aceh

rizka.sofia@unimal.ac.id

ABSTRACT

Water is an important element needed by living things, especially humans. There are many ways to get water for human consumption, including bottled drinking water (AMDK) and refill drinking water (AMIU). The number of AMIUs in each district/city is assumed to have not met the specified standards. To explore this, a study was conducted at the AMIU depot with the aim of knowing the lead content. To achieve this goal, research was conducted at the AMIU depot in Lhokseumawe City. In this study, a sample of 66 depots was used from a total of 204 AMIUs. By using random sampling technique, the distribution of depots in each sub-district was obtained. Banda Sakti District has 29 depots, Muara Dua has 19 depots, Muara Satu has 10 depots, Blang Mangat has 8 depots. To examine the lead content in each depot, a 100 mL volumetric flask, volumetric pipette, micro pipette, and Atomic Absorption Spectrophotometry (AAS) were used. The lead content was measured by spectrophotometry using the SSA-Flame method which refers to the Minister of Health Regulation No.492/Minister of Health/Per/IV/2010 (≤ 0.01 mg/L). The results showed that there were 96.97% of AMIU that met the requirements of the Minister of Health of the Republic of Indonesia with an average lead level of 0.003 ± 0.004 mg/L. However, there were still 2 (two) AMIUs exceeding the lead levels, namely 0.012 mg/L and 0.011 mg/L. Based on the results of the analysis, it was concluded that there were still AIMU depots in Lhokseumawe City that contained lead levels. Heavy metals, heavy lead can cause harmful effects on health, if accumulated in the human body cause anemia and damage to brain function and kidney function failure.

Keywords: *Refill drinking water, SSA-flame method, spectrophotometry, lead*

DOI Number: 10.14704/nq.2022.20.9.NQ440028 **Neuro Quantology 2022; 20(9):265-272**

INTRODUCTION

Water is an important element that is needed for living things, especially humans. Without water humans will become dehydrated and die faster than without food. The function of water as a transport of nutrients throughout the body as a lubricant for body tissues as well as cushioning bone and muscle joints (Rahayu et al., 2013). There are many ways to get water for human consumption, including Bottled Drinking Water (AMDK) and Refill Drinking Water (AMIU). Price comparison between AMDK and AMIU, the price of this AMDK is still relatively expensive, especially if you buy it continuously, which makes people more inclined to choose AMIU. The price of AMIU is more affordable and easy to get, allowing people to come to the refill drinking water depot by bringing used gallons of any brand for refills. Another convenience, can take advantage of the shuttle service offered by the refill drinking water depot (Khaira, 2014).

The need for drinking water is not only seen from the quantity but also from the quality of drinking water. According to Indonesia's Health Profile in 2019, nationally, the percentage of households with access to adequate drinking water is 73.65%. The provinces with the highest percentage of households with access to adequate drinking water are East Kalimantan (93.77%), Riau Islands (91.53%) and Bali (88.67%). Aceh ranked 22nd with a value (70.70%), while the provinces with the lowest percentage of households were West Kalimantan (37.37%), Papua (39.05%) and Bengkulu (49.52%) (Khaira, 2014; Prabhakara, 2010). One of the qualitative criteria for drinking water is that the heavy metal content must comply with the standards of the Minister of Health Regulation Number 736 / MENKES / PER / VI / 2010, it turns out that not all AMIUs meet the specified standards. The results of a study conducted by the Surabaya Consumer Protection

Agency (LPKS) on 23 refill drinking water depots found that the amount of metal exceeded the normal threshold. Metal levels that exceed this normal threshold can be harmful to public health (Pulungan & Wahyuni, 2021). Another study conducted in Malang City showed that in 5 AMIU, lead levels exceeded normal limits in all samples studied (Margareta, 2019).

Lead is an element that tends to be metallic, glossy bluish-white, mushy, malleable, poor conductor of heat and electricity, stainless, acid-resistant, radiation-resistant, and radioactive rays can react with strong bases. Lead is considered responsible for damage to environmental health, such as contamination in the sea, lead concentrations of 0.05 mg/L can pose a danger to the marine environment, namely killing marine organisms. Another study with marine organism test materials showed that the content of lead metal in water at a concentration of 2.75-49 mg / L will cause the death of crustaceans after 245 hours, while insects experience death in a short time of 168 hours (Dian Yuni Pratiwi, 2020). Heavy metals that have the potential to pollute the environment in the case of industrial companies, one of which is lead, which can be found in chemical, paint, and fertilizer industry waste (Ezraneti & Khalil, 2017). Lead is also derived from human (anthropogenic) activities, usually found in printing houses that use lead, in ceramic factories, in painting work, on lead painting materials, in glass glazing work, and soldering. The use of lead in fuel also makes an artificial lead cycle formed, that is, the lead in the vehicle engine is burned so that lead salts (chlorine, bromine, and oxides) will be formed. These lead salts enter the environment through vehicle gas discharges. Larger particles will immediately fall to the ground and then pollute the soil or water surface. Particles that are smaller in size will move over long distances through the air and settle in the atmosphere. The lead cycle due to human activity is much wider than the natural lead cycle, it causes lead pollution to become a world problem (Pulungan & Wahyuni, 2021).

The Minister of Health of the Republic of Indonesia has issued 4 parameters of drinking water quality in Number 492 / MENKES / PER / IV / 2010 concerning drinking water quality requirements, namely physical, chemical, bacteriological and radioactive parameters. The chemical parameters of drinking water should not contain organic and inorganic substances exceeding the established standards, the pH is between 6.5–8.5, and does not contain toxic chemical substances that can cause health problems. The limits of the content of inorganic substances in drinking water are distinguished into mandatory parameters and additional parameters. Mandatory parameters include ferrous metals, copper, aluminum, chloride, manganese, zinc, sulfates and ammonia. Additional parameters include lead, mercury, antimony, barium, boron, molybdenum, nickel, sodium, and uranium (Prabhakara, 2010).

The use of lead in drinking water jetting pipes and pipe splicing soldering is one of the causes of the discovery of lead in the water. It is possible to have lead contamination in the water of regional drinking water companies (PDAMs) (Margareta, 2019). Lead can cause harmful effects on health, if lead accumulates in the human body, in particular in children, it can cause disturbances in the early phases of physical and mental growth that then result in the functioning of intelligence and academic ability. Long-term exposure to lead will accumulate in the teeth, gums, and bones. This element strongly binds a number of amino acid molecules, hemoglobin, enzymes, RNA, and DNA, it will disrupt metabolic channels in the body. Lead poisoning can also result in impaired blood synthesis, hypertension, hyperactivity, and brain damage (Dewa et al., 2015). Increased lead concentrations will lead to anemia and damage to brain function as well as kidney malfunction. Adults with lead poisoning are characterized by symptoms such as pallor, pain, and paralysis (Nuraini et al., 2015). To explore this, an analysis of the lead content in refillable drinking water was carried out in Lhokseumawe City.

METHOD

This study used a cross-sectional descriptive research method to determine lead levels in refillable drinking water using laboratory tests. In analyzing the lead content of refillable drinking water in Lhokseumawe, the following materials are needed: Metal-free distilled water, Nitric acid (HNO3), Water samples, 100 mL measuring flasks , *volumetric* pipettes , micro pipettes, and Atomic Absorption Spectrophotometry (SSA).

The population of this stud-y is all refill drinking water depots in Lhokseumawe City which amount to 204 depots and are divided into 89 depots in Banda Sakti District, 58 depots in Muara Dua District, 32 depots in Muara Satu District, and 25 depots in Blang Mangat District. With the population and distribution of the depot, 6 was used and all populations that met the inclusion and exclusion criteria as samples were used. The number of samples was 66 depots spread across four sub-districts. Banda Sakti District has 29 depots, Muara Dua has 19 depots, Muara Satu has 10 depots, Blang Mangat has 8 depots. The examination of lead levels in AMIU was carried out at the UPT Regional Health Laboratory of the North Sumatra Provincial Health Office.

FINDINGS AND DISCUSSION

Laboratory examinations are carried out using the SSA method to determine the results of lead levels and lead threshold values. Examination to determine lead levels with SSA is produced in the form of mg/L units. Examination to determine the threshold value of lead based on Minister of Health Regulations No.492 of 2010 with a value not exceeding the threshold (≤0.01 mg/L) or passing the threshold (>0.01 mg/L).

Based on Minister of Health Regulations No. 492 of 2010, 64 AMIU did not cross the threshold and there were 2 AMIU crossing the threshold. Samples of refillable drinking water containing the highest lead were found in Muara Dua District with lead levels of 0.012 mg/L and raw water sourced from borehole water. Lead levels that exceed the threshold allowed by the Regulation of the Minister of Health of the Republic of Indonesia No.492 of 2010 indicate that the water is not safe for consumption. The results of the lead level examination test in Muara Dua District are presented at Table 1 below.

Table 1 Lead level test results at AMIU Estuary Two

Code	Lead Analysis Results (mg/L)	Minister of Health regulations Description	Median	Standard Deviation	Maximum	Minimum
A1	<0,000	Qualify	0,003	0,004	0,012	0,000
A2	<0,000	Qualify				
A3	<0,000	Qualify				
A4	<0,000	Qualify				
A5	<0,000	Qualify				
A6	<0,000	Qualify				
A7	0,002	Qualify				
A8	0,006	Qualify				
A9	0,01	Qualify				
A10	0,003	Qualify				
A11	0,002	Qualify				
A12	0,009	Qualify				
A13	0,003	Qualify				
A14	0,006	Qualify				
A15	0,009	Qualify				
A16	0,005	Qualify				
A17	0,004	Qualify				
A18	0,12	Ineligible				
A19	0,012	Qualify				
Average	**0,004**					

Table 1 shows that of the 19 samples tested using SSA, there was 1 sample that was ineligible and 18 samples met the requirements prescribed by Health Minister Rule No. 492 of 2010. The highest levels were obtained in the A18 sample (0.012 mg/L). The results of the lead level examination test in Muara Satu District are presented in the following Table 2.

Table 2 Lead level test results at AMIU Estuary One

Code	Lead Analysis Results (mg/L)	Minister of Health regulations Description	Median	Standard Deviation	Maximum	Minimum
B1	0,011	Ineligible	0,005	0,004	0,011	0
B2	0,005	Qualify				
B3	0,003	Qualify				
B4	0,004	Qualify				
B5	0,009	Qualify				
B6	0,002	Qualify				
B7	0,004	Qualify				
B8	0,01	Qualify				
B9	0,007	Qualify				
B10	<0,000	Qualify				
Average	**0,005**					

Table 2 shows that out of 10 samples tested usingSSA (Atomic Absorption Spectrophotometry) there was 1 unqualified sample and 9 samples qualified as determined by Minister of Health Regulations No.492 of 2010. The highest levels were obtained in the B1 sample (0.011 mg / L). The results of the lead level examination test in Blang Mangat District are presented in Table 3 below.

Table 3 Lead level test results at AMIU Blang Mangat

Code	Lead Analysis Results (mg/L)	Minister of Health regulations Description	Median	Standard Deviation	Maximum	Minimum
C1	0,000	Qualify	0,000	0,000	0,000	0,000
C2	<0,000	Qualify				
C3	<0,000	Qualify				
C4	<0,000	Qualify				
C5	<0,000	Qualify				
C6	<0,000	Qualify				
C7	<0,000	Qualify				
C8	<0,000	Qualify				
Average	**0,000**					

Table 3 shows that out of 8 samples tested using SSA (Atomic Absorption Spectrophotometry) all samples were qualified. The highest levels were obtained in the C1 sample (0.0001 mg/L). The results of the lead level examination test in Banda Sakti District are presented in Table 4 below.

Table 4 Results of lead level test at AMIU Banda Sakti

Code	Lead Analysis Results (mg/L)	Minister of Health regulations Description	Median	Standard Deviation	Maximum	Minimum
D1	<0,000	Qualify	0,000	0,003	0,010	0,018
D2	<0,000	Qualify				
D3	<0,000	Qualify				
D4	<0,000	Qualify				
D5	<0,000	Qualify				
D6	<0,000	Qualify				
D7	<0,000	Qualify				
D8	<0,000	Qualify				
D9	<0,000	Qualify				
D10	<0,000	Qualify				
D11	0,001	Qualify				
D12	<0,000	Qualify				
D13	0,007	Qualify				
D14	<0,000	Qualify				
D15	0,000	Qualify				
D16	0,008	Qualify				
D17	0,002	Qualify				
D18	<0,000	Qualify				
D19	0,010	Qualify				
D20	0,003	Qualify				
D21	<0,000	Qualify				
D22	<0,000	Qualify				
D23	<0,000	Qualify				
D24	<0,000	Qualify				
D25	0,005	Qualify				
D26	0,003	Qualify				
D27	<0,000	Qualify				
D28	<0,000	Qualify				
D29	<0,000	Qualify				
Average	**0,001**					

Table 4 shows that of the 29 samples tested using SSA (Atomic Absorption Spectrophotometry) all samples were qualified. The highest levels were obtained in the D19 sample (0.010 mg / L). The results of the descriptive test of lead levels in Lhokseumawe City are presented in Table 5 while the results of the descriptive analysis of lead levels are presented in Table 6.

Table 5 Lead grade descriptive test results

	Average	Median	Standard Deviation	Maximum	Minimum
Concentration Power Lead (mg/L)	0,003	0,000	0,004	0,012	0,000

Table 6 Results of AMIU lead level test in Lhokseumawe City

	Sum	Percentage (%)
Eligible (≤ 0.01 mg/L)	64	96,97%
Ineligible (> 0.01 mg/L)	2	3,03%

Table 6 shows that 2 of the 66 AMIU samples in Lhokseumawe City did not meet the threshold requirements allowed by Minister of Health Regulations No.492 of 2010.

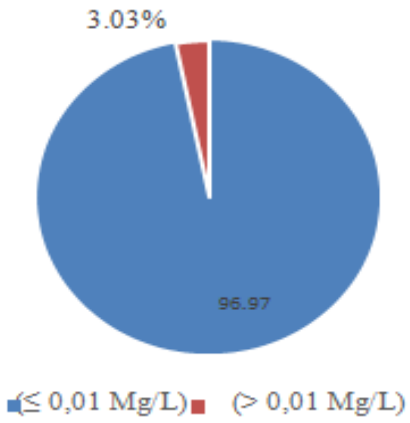

Figure 1. AMIU lead level test results in Lhokseumawe City

Lead inspection using spectrophotometry showed varying levels of lead. The average value of lead content in the sample tested was 0.003 mg/L with a standard deviation of 0.004 mg/L. The highestlead content was found in Muara Dua District with a level of 0.012 mg / L and had passed the maximum threshold of lead according to Health Minister Regulation No. 492 of 2010, which was ≤ 0.01 mg/L, then there were 64 depots with lead levels not crossing the threshold.

This increase in lead levels can be influenced by several factors, such as the environment and the water filtration process. The environmental factor is the air temperature.Temperature can affect the concentration of heavy metals in the water column and sediment, a rise in the temperature of colder water will make it easier for heavy metals to settle into the sediment. Based on the standard of the Minister of Health of the Republic of Indonesia No. 416 MENKES/PER/IX/1990, the maximum limit of temperature parameters for clean water is 28 ° C with a range of ±3ºC. Low air temperature has the potential to become lead deposition. The results obtained by the minimum temperature of Lhokseumawe City range from 21ºC and the maximum temperature of 33ºC with an average temperature of 27.1ºC.

The water filtration process affects the level of heavy metals. Based on the results of research by Saifuddin et al., (2018), it is said that the influence of the composition of silica sand on the manufacture of ceramic membranes as a filter medium for PDAM water filtration is very effective in removing particles in the water. The more and smaller the size of the silica sand used, the clearer the water produced will be and does not contain heavy metals. Fromthe results of this study, it was found that most drinking water depots use PDAM as their water source (45%).

The source of raw water for PDAM Lhokseumawe City is managed by the Regional Water Company Tirta Mon Pase which is jointly managed with North Aceh Regency. The source

of water comes from rivers or surface water and ground water. The area is an area surrounded by several factories, including fertilizers that are currently and have been operating. Other raw sources used are raw water sources from wells that are used as samples, because well water is very potential, especially in most areas of Aceh (Febrina & Astrid, 2014; Masthura & Jumiati, 2017).

The data from this study stated that 2 (two) AMIUs that crossed the threshold, namely 0.012 mg/L from Muara Dua District, came from bore wells and 0.011 mg/L from Muara Satu District, came from PDAM. Based on research conducted by Sartika et al., (2020) it is said that bore well water in the Aceh Province has low quality because it is yellowish in color, smells, and has a taste due to the heavy metal content in it. Bore well water cannot be used directly. Acehnese people living in rural areas use borehole water as a source of raw water. The presence of heavy metals in the well water can be caused by the occurrence of intrusion from sea water (Dewi et al., 2018). According to research conducted by Komarawidjaja et al., (2017) sea water in the coastal areas of Lhokseumawe City and North Aceh Regency is not in good condition. This is because the lead content exceeds the applicable sea water quality standard based on the Decree of the Minister of Environment no. 51 of 2004 (Komarawidjaja et al., 2017).

Accumulation of heavy metals in water, either directly or indirectly, will chemically degrade water quality. Water actually has the carrying capacity to purify itself, especially groundwater that utilizes filtration from soil pores and plant roots, but if the heavy metal content has a high dose it will exceed the carrying capacity of the water. The risk of lead pollution also exists in PDAM water. The causes of the pollution are fuel emissions and the use of lead-coated pipes. Lead can reach the ground due to gasoline spills or is released into the air after the combustion process of vehicle fuel which will then fall to the ground and pollute the waters. Another way for lead pollution is the use of lead in pipe structures to convey water. Lead is used to coat the inside of iron pipes so as not to rust, but the lead will be released and pollute the water in the pipes due to many factors, such as the age of the pipe, the thickness of the pipe, the pressure factor, the corrosive process, and other environmental factors (Artati, 2018).

There are 64 DAMIU refill drinking water depots in Lhokseumawe City that do not exceed the lead threshold value, this shows that the water treatment in the refill drinking water treatment process is good and meets the drinking water standards set by the Minister of Health Regulation No. 492 of 2010. The Food and Agricultural Organization/World Health Organization (FAO/WHO) states that the provisional tolerable weekly intake (PTWI) for lead metal in the human body is 25 g/kg body weight. Equivalent to 1500 mg/g lead/week for a body weight of 60 kg (44). Based on the value of Biological Exposure Indices (BEIs), lead in blood is 30 L/100µL of blood according to WHO. Lead can come from the act of consuming food, drink or through inhalation from the air, dust contaminated with lead, skin contact, eye contact, and parenteral (Hananingtyas, 2017).

Prevention that can be done to avoid poisoning from lead is to avoid using water contaminated with heavy metals. Prevention of heavy metal accumulation in the body can be done by consuming lots of fiber-rich foods, such as fruits, vegetables, onions, and nuts. These foods, besides being rich in fiber, also contain pectin, lignin, vitamin C, and bioflavonoids, as well as several hemicelluloses from other polysaccharides. The substance is soluble in water and can neutralize and reduce the absorption of lead metal through the digestive system.

Based on the analysis of 66 refill depots in Lhokseumawe City, it was concluded that: the average lead level in DAMIU in Lhokseumawe City was 0.003. A total of 96.97% of DAMIU in Lhokseumawe City does not contain lead. Most of the DAMIU containing lead did not exceed the threshold determined by the Minister of Health of the Republic of Indonesia.

CONCLUSION

Based on the analysis of 66 refill depots in Lhokseumawe City, it was concluded that: the average lead level in DAMIU in Lhokseumawe City was 0.003. A total of 96.97% of DAMIU in Lhokseumawe City does not contain lead. Most of the DAMIU containing lead did not exceed the threshold determined by the Minister of Health of the Republic of Indonesia.

REFERENCES

Artati, A. (2018). Analisis Kadar Timbal (Pb) pada Air yang melalui Saluran Pipa Penyalur Perusahaan Daerah Air Minum (PDAM) Makasar. Jurnal Media Analis Kesehatan, 1(1), 47–55. https://doi.org/10.32382/mak.v1i1.152

Dewa, R. P., Hadinoto, S., & Torry, F. R. (2015). Analisa Kandungan Timbal (Pb) dan Kadmium (Cd) Pada Air Minum Dalam Kemasan Di Kota Ambon. Jurnal Majalah Biam, 11(2), 76–82.

Dewi, R., Sari, R., & Hakim, L. (2018). Penerapan Teknologi (Prototipe) Pengolahan Air Payau menggunakan Multi Filter berbahan Alami bagi Masyarakat Nelayan Desa Pusong Baru Kecamatan Banda Sakti Kota Lholseumawe. Jurnal Vokasi - Politeknik Negeri Lhokseumawe, 2(2). https://doi.org/10.30811/vokasi.v2i2.725

Dian Yuni Pratiwi. (2020). Dampak Pencemaran Logam Berat (Timbal, Tembaga, Merkuri, Kadmium, Krom) terhadap Organisme Perairan dan Kesehatan Manusia. Jurnal Akuatek, 1(1), 59–65.

Ezraneti, R., & Khalil, M. (2017). Kandungan Logam Berat Timbal (Pb) Pada Beberapa Tambak Di Sekitar Kawasan Industri Kabupaten Aceh Utara dan Kota Lhokseumawe Keong Bakau (Telescopium Telescopium) Sebagai Bioindikator. Temu Ilmiah Ikatan Peneliti Lingkungan Binaan Indonesia 6, A047–A052. https://doi.org/10.32315/ti.6.a047

Febrina, A., & Astrid, A. (2014). Studi Penurunan Kadar Besi (Fe) Dan Mangan (Mn) Dalam Air Tanah Menggunakan Saringan Keramik. Jurnal Teknologi, 7(1), 36–44. https://jurnal.umj.ac.id/index.php/jurtek/article/download/369/341

Hananingtyas, I. (2017). Studi Pencemaran Kandungan Logam Berat Timbal (Pb) dan Kadmium (Cd) pada Ikan Tongkol (Euthynnus sp.) di Pantai Utara Jawa. Biotropic : The Journal of Tropical Biology, 1(2), 41–50. https://doi.org/10.29080/biotropic.2017.1.2.41-50

Khaira, K. (2014). Analisis Kadar Tembaga (Cu) Dan Seng (Zn) Dalam Air Minum Isi Ulang Kemasan Galon di Kecamatan Lima Kaum Kabupaten Tanah Datar. Sainstek : Jurnal Sains Dan Teknologi, 6(2), 116–123. http://ecampus.iainbatusangkar.ac.id/ojs/index.php/sainstek/article/view/111

Komarawidjaja, W., Riyadi, A., & Garno, Y. S. (2017). Status Kandungan Logam Berat Perairan Pesisir Kabupaten Aceh Utara dan Kota Lhokseumawe. Jurnal Teknologi Lingkungan, 18(2), 251. https://doi.org/10.29122/jtl.v18i2.2040

Margareta, S. N. (2019). Analisis Kandungan Logam Berat (Pb, Cu, Cd, dan Hg) Pada Air Minum Isi Ulang di Kota Malang Berbasis Spekteroskopi Serapan Atom Menggunakan Metode PCA. 1–99.

Masthura, & Jumiati, E. (2017). Peningkatan Kualitas Air Menggunakan Metode Quality Improvement of Water Using. FISITEK: Jurnal Ilmu Fisika Dan Teknologi, 1(2), 1–6.

Nuraini, Iqbal, & Sabhan. (2015). Analisis Logam Berat dalam Air Minum Isi Ulang (AMIU) dengan Menggunakan Spektrofotometri Serapan Atom (SSA). Gravitasi, 14(1), 36–43.

Prabhakara, G. (2010). Health Statistics (Health Information System). In Short Textbook of Preventive and Social Medicine. https://doi.org/10.5005/jp/books/11257_5

Pulungan, A. F., & Wahyuni, S. (2021). Analisis Kandungan Logam Kadmium (Cd) dalam Air Minum Isi Ulang (AMIU) dI Kota Lhokseumawe, Aceh. AVERROUS: Jurnal Kedokteran Dan Kesehatan Malikussaleh, 7(1), 75. https://doi.org/10.29103/averrous.v7i1.3666

Rahayu, C. S., Setiani, O., & Nurjazuli, N. (2013). Microbiological Contamination Risk Factor of Drinking Water Refilling in Tegal Regency (Faktor Risiko Pencemaran Mikrobiologi pada Air Minum Isi Ulang di Kabupaten Tegal). Jurnal Kesehatan Lingkungan Indonesia, 12(1), 1–9. http://ejournal.undip.ac.id/index.php/jkli/article/view/5954

Saifuddin, S., Khairina, K., & Fuadi, A. (2018). Pembuatan Membran Keramik Sebagai Media Filter Untuk Penyaringan Air PDAM. 2(1), 195–199.

Sartika, D., Muhni, A., Rifqan, R., & Putra, H. S. (2020). Groundwater Vulnerability to Pollution Using the GOD Method in Banda Aceh City, Aceh Province. Journal of Aceh Physics Society, 9(3), 84–90. https://doi.org/10.24815/jacps.v9i3.17332