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Reuse of Treated Water From Bojongsoang Domestic Wastewater Treatment Installation as Water for Industrial Puproses

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Abstract: Subdistrict Bojongsoang and its surroundings are based on the 2016-2036 Bandung Regency Spatial Planning, the designated area where the industry is. Currently, there are 125 existing industries operating. The area is also included in groundwater withdrawal through well artesian on a massive scale, including into the national protected area (CAT: Groundwater Basin) Bandung - Soreang Area. Excessive groundwater extraction poses challenges coupled with the significant water demand from society and industry. This will result in deteriorated groundwater conditions that require prompt restoration, having already suffered damage. On the other hand, there is the Bojongsoang WWTP, which can treat wastewater at 2800 l/s; meanwhile, at the moment, this capacity processing is utilized about 37-40% or about 1000m^3/day. This research uses a descriptive method. The research results prove that reusing water from Bojongsoang WWTP could produce raw water for the necessity industry of 300 l/s.

Keywords: *domestic wastewater; industrial purpose; reuse; water treatment.*

1. Introduction

Bojongsoang is a district in Bandung Regency West Java Province, Indonesia. Based on the Bandung Regency spatial plan for 2016 – 2036, Bojongsoang District is directed to be an industrial area. Based on the survey results conducted by the authors, there are at least 35 operating industries, which consist of big, medium, and small industries. If combined with the existing industries in neighboring sub-districts such as Dayeuhkolot and Bojongsoang sub-districts, there are 125 industries. Industries that develop in the Bojongsoang District and its surroundings need massive amounts of groundwater. Currently, the easiest and most efficient way to get water is to take groundwater through the artesian well. The amount of artesian wells built in the industrial area results in a bad situation where groundwater continuously decreases. Even though the recharge wells have been implemented, an intensive decrease in the groundwater level has occurred in Cimahi, Dayeuhkolot, and Rancaekek areas. An intensive groundwater extraction in this area has caused a depletion in the groundwater table (Purwoarminta, Lubis, & Maria, 2019).

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The Bojongsoang District area is included in the Bandung-Soreang Water Basin Area (CAT: Cekungan Air Tanah). The current Bandung-Soreang Basin has become an area that continues to develop into an urban area full of industrial activity. Large-scale groundwater intake is carried out in line with the significant demand for water by both the community and industry; this has resulted in a damaged groundwater condition at the Bandung-Soreang Water Basin Area and must be restored immediately (Harnandi & Herawan, 2009). To reduce its impacts, it is necessary to take preventive measures, such as reducing water discharge and recharging it. One of the most significant ways to reduce water discharge is to prevent water intake for industries (Waluya, 2016). If this condition is chosen to be one of the alternatives, then other water sources should be utilized for non-drinking water needs, including for industrial necessity. A wastewater treatment plant works as an infrastructure to treat domestic wastewater in an area so that it can be disposed of safely in an environment following the established quality standards. Research conducted by Sulistia and Septisya (2020) on office complex WWTP in Serpong resulted in several parameters that exceeded the established quality standards: COD, ammonia, oil, and grease. In contrast, pH, BOD, TSS, and total coliform are still under the quality standards. In terms of quality, reuse water from WWTP still needs to be improved, but in terms of its quantity, reuse water from WWTP can be utilized as an alternative.

In the South Bandung area, specifically in Bojongsoang District, there is the Bojongsoang WWTP, which has a maximum capacity of 243,000 m3/day, although currently only 37-40% is utilized or around 90,000 m3/day. It could become an opportunity for utilization to return the resulting water-processed WWTP to fulfill the needs of the existing industry around it. Water efficiency and wastewater reuse are frequently complementary as part of a program that reduces the environmental impact and total cost of water service provision. (White, Bruce 1998) & Purwanto et al. (2017).

This research state-of-the-art explains that reusing water from centralized municipal wastewater treatment plants can be used as a substitute for groundwater use in industrial areas that have already experienced a groundwater crisis. Various studies that have addressed this subject include the use of reused water from domestic wastewater as an alternative to clean water and efforts to increase environmental sanitation in supporting SDGs (Tortajada, 2020), the use of reuse water in aquaculture (Fedorova, 2022), research on perceptions and social acceptance of the use of reuse water for individuals with a high level of education (Costa Faria, 2022), the use of reuse water from industrial effluent in the industrial area itself (Kaveh Ostad, Ali Askari, 2021), public perceptions and attitudes towards the reuse of wastewater throughout the world (Peter R Nkhoma, 2021), and the reuse of water in the business sector in Jakarta for flushing and gardening purposes (Priadi, Cindi et al., 2017).

Based on the description above, this study aims to evaluate the potential of reusing treated water from Bojongsoang WWTP for industrial purposes. The government can utilize this study as a reference and source of information in formulating policies regarding groundwater use in the industrial sector, which is currently in critical condition, by substituting groundwater with water treated from the Bojongsoang WWTP and enriching the repertoire in the field of regional and urban planning, especially in sustainable infrastructure studies.

2. Research Methods

a. Research location and time

The research is conducted in the Bojongsoang District. The Bojongsoang District is located east of the Central Bandung Regency Governance. It is one of the 31 districts under the Bandung Regency Governance. This location is 630 meters above sea level with maximum temperatures of 26°C and a minimum of 18°C. It is topographically flat to rough

and has an average yearly rainfall of 2000 - 4000 m3. The research began in August 2020 and finished in May 2021.

b. Research methods

This study uses a qualitative method with field observation and interviews. The procedures carried out are related, starting with data collection, analysis, and recommendation formulation. The following are the research procedures conducted:

1. Data collection step:
   a. Primary data collection with direct observation of the river water quality based on PP (Government Regulation) Number 82 of 2001, and interviews with parties related to WWTP management, Bandung Regency PDAM, Department of Energy and Mineral Resources, and Bandung Regency Industry and Trade Office.
   b. Secondary data collection from related technical offices in Bandung Regency.

2. Analysis step:
   a. Statistical approach on water demand analysis for various industrial activities based on its scale (large-scale, medium-scale, and small-scale industries)
   b. Identification of the source water availability:
      - Identification of the current amount of wastewater at Bojongsoang WWTP based on the average discharge generated by the Bojongsoang WWTP.
      - Identification of the treated water quality from Bojongsoang WWTP.
      - Identification of the treated water continuity from Bojongsoang WWTP related to the sustainability of the minimum water discharge that can be used for industrial activities.
3. Formulation recommendation step:
   Formulate instructions for utilizing Bojongsoang WWTP water reuse for industrial activities in Bojongsoang District and its surroundings.

3. Results and Discussion

A. Water demand in industrial activities

Several methods can be used to estimate the amount of water needed for industrial activities, including the industrial land area approach and the classification of industrial scale types. Calculation of water requirement for industrial activity in Bojongsoang District and its surroundings refers to two references:

1. Jabotabek Water Resources Management Study (JWRMS) in 1994 uses a statistics approach by looking for the relationship between the number of employees and water use in the industry. The JWRMS study was conducted with a sample of 6.000 industries consisting of small, medium, and large industries in Jakarta, Bogor, Tangerang, and Bekasi. The result concludes that the industrial water needs consist of water for sanitation and for industrial processes, which are 500 liters per day per employee. **Where industry A's water requirements (liters/day) = 500 liters x number of workers**.
2. Industrial classification approach (large, medium, small) carried out by Purwanto, 1995 (Purwanto, MYJ (1995). *Water demand for industry, village,*

and city. Seminar on Water Demand and Developing Country. Tokyo. Japan) divides water needs based on industrial scale as follows:

- Big-scale industry ranging 151 - 350 m^3/day,
- Medium-scale scale ranging from 51 – 150 m^3/day, and
- Small-scale industry ranging from 5 - 50m^3/day.

The following table calculates the domestic water needs for industrial activity based on both approaches. The result estimated water requirements for the industrial activity in Bojongsoang District and the surrounding districts for the industrial sector, which is 265.88 liters/sec – 306 liters/second (see Table 1 and Table 2).

Table 1. Analysis of Water Needs for Industrial Activity Based on Statistical Approach in Bojongsoang District and Area in 2020

Subdistrict	Number of Industries	Number of employees	Water needs projection	
			liter/day	liter/second
Dayeuhkolot	70	36,030	18,015,000	208.51
Bojongsoang	35	3,867	1,933,500	22.38
Baleendah	20	6,047	3,023,500	34.99
Total	**125**	**45,944**	**22,972,000**	**265.88**

Table 2. Analysis of Water Needs for Industrial Activity Based on Industry Classification in Bojongsoang District and Area in 2020

Subdistrict	Number of Industries	Number of employees	Water needs projection	
			liter/day	liter/second
Dayeuhkolot	70	36,030	15,702,000	181.73
Bojongsoang	35	3,867	6,143,000	71.10
Baleendah	20	6,047	4,602,000	53.27
Total	**125**	**45,944**	**22,972,000**	**306.10**

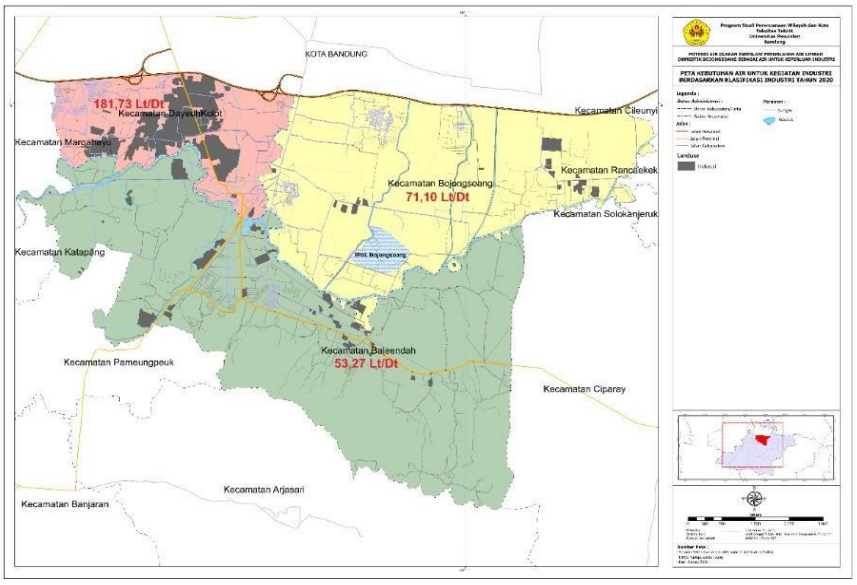

Figure 1. Water Needs for Indsutrial Actiivities Based on Industrial Classification in Bojongsoang District and Surrounding Areas in 2020

Through West Java Government Regulation (Perda) Number 1 of 2017 on Groundwater Management and Bandung Regency Regional Regulation Number 10 of 2013 on Amendments to Regional Regulation Number 8 of 2011 on Groundwater Management, it rules policy related to groundwater management based on groundwater basins. The Bandung Basin consists of three main aquifers, which are shallow aquifers (<35m), middle aquifers (45-90m), and deep aquifers (90-100m). Based on the simulation results of groundwater extraction zoning maps in the Bandung Basin by the Directorate of Geological Environment Management (Irawan, 2009), the Bojongsoang area and its surroundings are categorized as a critical zone. Based on Gumilar's (2014) research, the Bandung Basin has a high level of danger of land subsidence, as well as the Bandung - Soreang Water Basin Area (Harnandi & Herawan, 2009) This shows that there is a strong correlation between the rate of decline in groundwater levels and the rate of land subsidence—derived from GPS at several locations in the Bandung Basin, with correlation coefficients up to about 0.92. There is a significant decrease in the textile industry area, where vast volumes of groundwater are usually extracted. Based on these conditions, the dependence of groundwater needs on the industrial sector has become a concern and must be restored immediately.

B. Identification of the Availability of Water Sources for Utilizing Reused Water from the Bojongsoang WWTP for Industrial Use

If implemented correctly, the reuse of treated wastewater is considered an example of the application of ESTs (Environmentally Sound Technologies) in Agenda 21. By reusing treated wastewater for industrial sector needs, more freshwater reserves can be allocated for uses that require higher water quality (UNEP, 2004). Wastewater recycling is a profitable and stable approach over a long period of time. Initially, treating wastewater for reuse, installation, and utilization of this type of system can be more expensive than other water-saving options. However, this activity has been successful in many countries (Ostad-Ali-Askari & Eslamian, 2021). The potential for wastewater in this research is to determine the condition of quality, quantity, and continuity of treated water from the Bojongsoang WWTP.

- *Waste Water Quantity*

  The average wastewater processed from 2015 to 2019 was 81,997 m3/day. The treated water produced on average is 57,985 m3/day or 671.12 liters/second, with an average loss difference of 24,012 m3/day or 29%. This figure is then used as input/potential for water reuse.

Table 3. Average Wastewater Discharge Data for 2015-2019

No.	Year	Unit	Inlet Average	Average Outlets
1	2015	m^3/day	70.152	49.987
2	2016	m^3/day	82.985	57.983
3	2017	m^3/day	78.667	55.058
4	2018	m^3/day	76.881	49.320
5	2019	m^3/day	101.303	77.578
Amount		**m^3/day**	**409.998**	**289.926**
Average		**m^3/day**	**81.997**	**57.985**

Source : Tirtawening Regional Public Company , 2019

- *Wastewater Quality*

  The quality of treated water from the Bojongsoang WWTP comes from samples taken from the outlet channel of the Bojongsoang WWTP in 2020. These were then analyzed, tested for quality, and compared with water quality standards according to the River Water Quality Standards in PP No. 82 of 2001 concerning water quality management and control of class II river water pollution.

Table 4. Test Results of Bojongsoang WWTP Treated Water Quality Based on 2020 River Water Quality Standards

No.	Parameter	Unit	Test results	Quality Standard	Information
Physics Parameters					
1	temperature	^{0}C	30.4	deviation 3	appropriate
2	TDS (Residual dissolved)	mg/L	227	1000	appropriate
3	TSS (residue suspended)	mg/L	195	50	not appropriate
Chemical Parameters					
1	pH	-	7.84	6 (-) 9	appropriate
2	BOD $_5$	mg/L	53	50-150	appropriate
3	COD	mg/L	71	100-300	appropriate
4	DO	mg/L	2.8	>4	not appropriate
5	Phosphat (PO4 $_3$ -P$^{)}$	mg/L	<0.053	0.2	appropriate
6	Nitrate (NO3 $_-$ N)	mg/L	<2	10	appropriate
7	Dissolved Cadmium (Cd).	mg/L	<0.0078	0.01	appropriate
8	chrome Hexavalent (Cr $^{+6}$)	mg/L	<0.025	0.05	appropriate
9	Dissolved Copper (Cu).	mg/L	<0.0071	0.02	appropriate
10	Dissolved Lead (Pb).	mg/L	<0.021	0.03	appropriate
11	Dissolved Zinc (Zn).	mg/L	0.06	0.05	not appropriate
12	Cyanide (CN ^{0})	mg/L	<0.008	0.02	appropriate
13	Florida (F ^{0})	mg/L	0.22	1.5	appropriate
14	Nitrite (NO $_2$ -N)	mg/L	0.03	0.06	appropriate
15	Chlorine Free (Cl $_2$)	mg/L	0.04	0.03	not appropriate
16	Ammonium (NH $_3$ -N)	mg/L	1.14	1-5	appropriate
Microbiological Parameters					
1	Fecal Coliform	MPN/O,1L	43,200	1000	not appropriate
2	Total Coliforms	Colony /0.1L	300,000	5000	not appropriate
Organic Chemistry					
1	detergent	mg/L	<0.02	0.2	appropriate
2	Phenol	mg/L	0.066	0.001	not appropriate
3	Oil and Fat	mg/L	<1.27	1	not appropriate

Description :
Value above is limit maximum, except for pH and DO (For pH is mark range that is not can minus or more from listed value . Pure DO value mark minimum limit)

Based on the water quality analysis results, almost all parameters meet the existing or water quality standards, whereas 8 of the 24 parameters do not meet the water quality standards. Meanwhile, the treated water that will be utilized for reuse water must meet the existing quality standards.

- *Wastewater Continuity*

  Wastewater continuity can be seen from the wastewater discharge produced each year. Based on the average discharge and the continuity of wastewater, we can see that the amount of available potential wastewater is 49,320 m3/day or 570.83 liters/second. This amount of wastewater can be processed and taken as input for reuse water to meet sustainable water needs to support industrial activities in Bojongsoang District and its surroundings.

Table 5. Average wastewater discharge data for 2015-2019

No.	Year	Unit	Inlet Average	Average Outlets
1	2015	m^3/day	70.152	49.987
2	2016	m^3/day	82.985	57.983
3	2017	m^3/day	78.667	55.058

4	2018	m^3/day	76.881	49.320
5	2019	m^3/day	101.303	77.578
Amount		**m^3/day**	**409.998**	**289.926**
Average		**m^3/day**	**81.997**	**57.985**

Source : Tirtawening Company Regional Public Company, 2019

C. Instructions for Utilizing Reused Water Results as an Alternative Water Source for industrial activities

Groundwater resource will reach its critical level caused by the unlimited demand capacity, causing a decline in water resources. Nowadays, water reuse is seen as a vital tool of supplying water supply needs (Ostad-Ali-Askari & Eslamian, 2021). The design procedure for water reuse must be based on a strict examination of needs, availability, and quality requirements. Still, the basic idea is to make water reuse a strategic step that needs to be considered to meet current and future water needs (Elboughdiri, Al Arni, Ghernaout, & Al Arni, 2019).

Based on the Bojongsoang IPAL outlet water quality analysis results, 8 out of 24 parameters do not meet water quality standards. Thus, further processing is needed to reduce parameters that exceeded the quality standards. The following is a scheme for further processing of treated water from the Bojongsoang WWTP for industrial purposes.

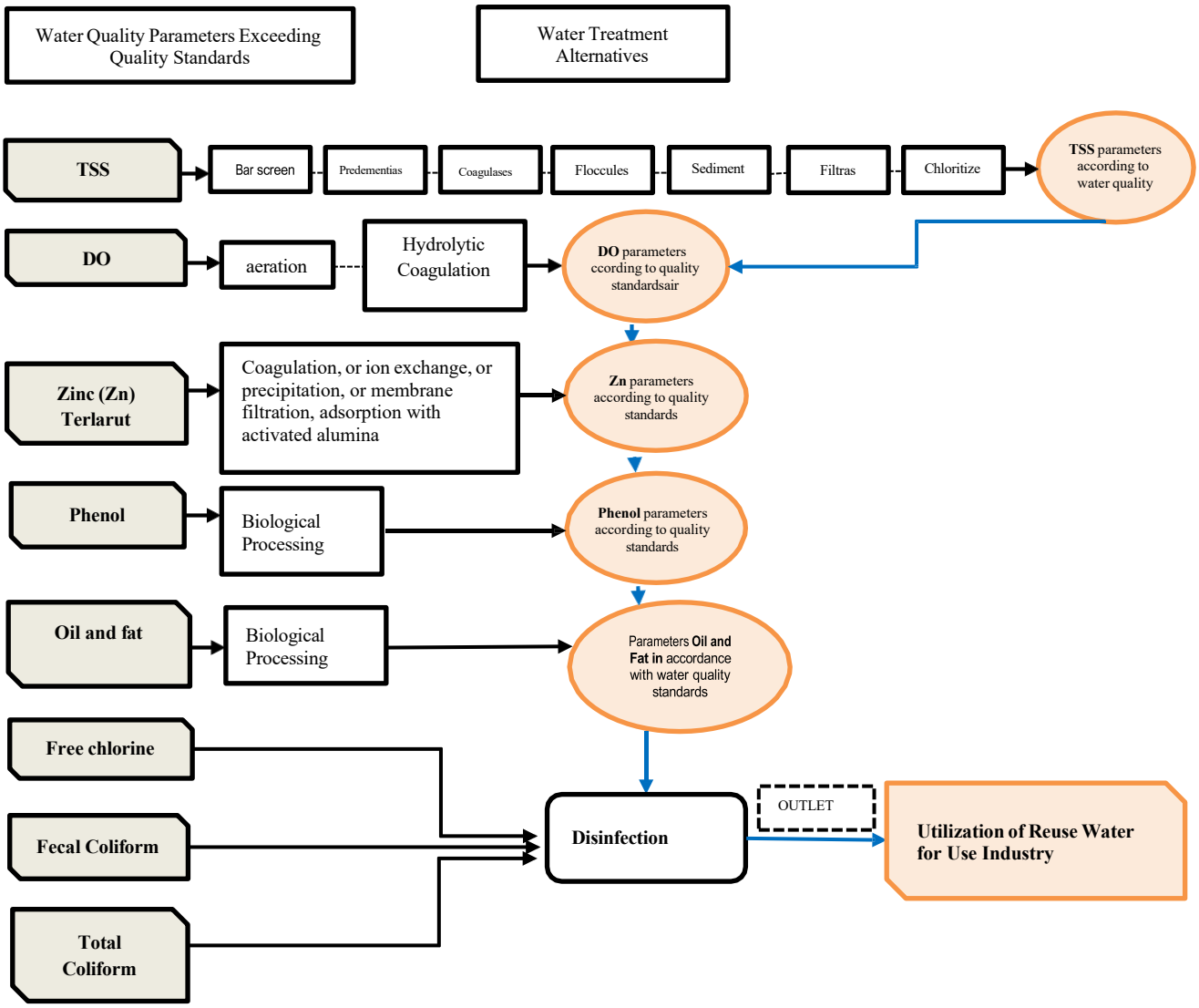

Figure 2. Advanced Treatment Scheme for Bojongsoang WWTP treated water for use in industrial activities

4. Conclusion

Treated water from Bojongsoang WWTP has the potential to replace groundwater used by current industries. With an average of 670 liters/second of reuse water from Bojongsoang WWTP, it will be able to meet the water needs for industrial activities in Bojongsoang District and its surroundings by around 300 liters/second. Further physical, chemical, and biological processing is required to utilize treated water from Bojongsoang WWTP for industrial purposes and to improve the quality of the treated WWTP water.

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References

Asolekar, S. R., & Gopichandran, R. (2012). Recycle and reuse of wastewater. *Preventive Environmental Management*, 367–391.

Cecilia Tortajada, (2020) *Contributions of recycled wastewater to clean water and sanitation sustainable development goals*, npj clean water 3: 22; https://doi.org/10.1038/s41545-020-0069-3

Cherchi, C., Kesaano, M., Badruzzaman, M., Schwab, K., & Jacangelo, J. G. (2019). Municipal reclaimed water for multi-purpose applications in the power sector: A review. *Journal of Environmental Management*, *236*, 561–570.

Cindy R. Priadi1, Evelyn Suleeman2, Linda Darmajanti2, Shanty Novriaty2, Nyoman Suwartha1, Rina Resnawati1, Rahayu Handayani3, Gita L. Putri1, Elzavira Felaza1, Tri Tjahjono, (2017) *Water recycling opportunity in the business sectors of greater Jakarta, Indonesia*, International Journal of Technology 6: 1031-1039 ISSN 2086-9614.

Daniella Costa Faria,Liliana Pena Naval (2022) *Wastewater reuse: perception and social acceptance*, water and environmental Journal Promoting Sustainable Development, First published: 14 February 2022.

Eko W Purwanto, Candra Samekto, Nur Aisyah, Ardhiantie, Frida Hazet, Amos Gracianto, and Kariza Wiryant. (2017) *Study of domestic water mix*, Journal Development Planning The Indonesian Journal of Dev. Planning, Vol. 1 No. 1 Apr 2017.

Elboughdiri, N., Al Arni, S., Ghernaout, D., & Al Arni, S. (2019). Water reuse (WR): Dares, restrictions, and trends. *Salah Al Arni. Water Reuse (WR): Dares, Restrictions, and Trends. Applied Engineering*, *3*, 159–170.

Fito, J., & Van Hulle, S. W. H. (2021). Wastewater reclamation and reuse potentials in agriculture: towards environmental sustainability. *Environment, Development and Sustainability*, *23*, 2949–2972.

Galkina, E., & Vasyutina, O. (2018). Reuse of treated wastewater. *IOP Conference Series: Materials Science and Engineering*, *365*. https://doi.org/10.1088/1757-899X/365/2/022047

Ganna Fedorovaa, RomanGrabica, Kateřina Grabicováa, JanTureka, TuyenVan , TomasRandaka, Bryan W.Brooksb, Vladimir Zlabeka (2022) *Water reuse for aquaculture: Comparative removal efficacy and aquatic hazard reduction of pharmaceuticals by a pond treatment system during a one year study*, Journal of Hazardous Materials, Volume 421, 5 January 2022, 126712.

Gumilar, I., Abidin, H. Z., Andreas, H., Sidiq, T. P., Gamal, M., & Fukuda, Y. (2014). Land subsidence, groundwater extraction, and flooding in Bandung Basin (Indonesia). *International Association of Geodesy Symposia*, *139*, 167–173.

Harnandi, D., & Herawan, W. (2009). Groundwater recovery based on hydrogeological studies in the Bandung-Soreang Groundwater Basin. *Journal of Water Resources*, *5*, 43–52.

Irawan, DE (2009). Bandung Basin hydrogeology. In *Bandung Basin Geology* (pp. 1–20).

Kaveh Ostad - Ali-Askari and Saeed Eslamian, (2021) Water *Reuse in Industry: Necessities and Possibilities*, American Journal of Engineering and Applied Science, DOI: 10.3844/ageassp.2021.94.102

Ostad-Ali-Askari, K., & Eslamian, S. (2021). Water Reuse in Industry: Necessities and Possibilities. *American Journal of Engineering and Applied Sciences*, *14*, 94–102.

Peter R Nkhoma, Kamal Alsharif, Erick Ananga, Michael Eduful and Michael Acheampong, (2021) *Recycled water reuse: what factors affect public acceptance?*, Environmental Conservation Journal, https://doi.org/10.1017/S037689292100031X Published online by Cambridge University Press.

Purwoar Minta, A., Lubis, RF, & Maria, R. (2019). Artificial Groundwater Recharge for Bandung-Soreang Groundwater Basin Conservation. *Geology and Mining RESEARCH*, *29*, 65.

Sari, YS, & Bari, NA (2018). Clean Water Efficiency By Reusing Water Processed by WWTP Bio-Oxidation Systems in the Hospitality Sector. *ENVIROSAN: Journal of Environmental Engineering*, *1*, 1–5.

Sulistia, S., & Septisya, AC (2020). Analysis of Domestic Wastewater Quality in Office Space. *Journal of Environmental Engineering*, *12*, 41–57.

Stuart Bruce. White, C. Howe, (1998) Water efficiency and reuse: *a least cost planning approach'*, Proceedings of the 6th NSW Recycled Water Seminar, November, 1998.

Tirtawening Regional Public Company. (2019). Permit Review Bojongsoang WWTP Wastewater Disposal. Bandung

UNEP. (2004). *WATER AND WASTEWATER REUSE An Environmentally Sound Approach for Sustainable Urban Water Management An Environmentally Sound Approach for Sustainable Urban Water Management*.

Waluya, B. (2016). Industrial Relocation In Bandung Regency. *Journal of Geography Gea*, *7*, 1–11.