

RAW WATER RELIABILITY ANALYSIS FOR CONTINUITY OF TEMBUDAN SPAM INTAKE (RAW WATER RELIABILITY ANALYSIS FOR THE SUSTAINABLE ENTERANCE OF THE SPAM BREAK)

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Abstract

The Tembudan Drinking Water Supply System (SPAM) in Berau Regency, East Kalimantan, relies on Lake Telaga Biru as its primary raw water source with an intake capacity of 10 liters/second, currently serving 224 household connections and planned to expand to two additional villages. This study aims to evaluate the lake's reliability in meeting long-term clean water demands while considering increasing consumption and environmental risks from land clearing activities around the catchment area. A hydrological assessment was conducted using the FJ Mock method and Current Flow Meter measurements, combined with discharge analysis, storage capacity evaluation, and demand projections up to 2045. The results show that the lake's daily storage capacity reaches 16,816.85 m³, far exceeding the.

Keywords: *Tembudan SPAM, Blue Lake, Water discharge, Lake intake*

INTRODUCTION

The provision of drinking water is a basic need that significantly determines the quality of life of the community. In Batu Putih District, Berau Regency, East Kalimantan, the fulfillment of clean water needs still relies on the Tembudan Drinking Water Supply System (SPAM), which sources its raw water from Lake Telaga Biru (Tulung Ni' Lenggo). This system has an intake capacity of 10 liters/second and currently serves only 224 household connections in Tembudan Village, with plans to expand to Kayu Indah Village and Sumber Agung Village. Population growth, expanding service coverage, and human activities around the water catchment area have created an urgency to reassess the reliability and sustainability of raw water sources. The main research problem is: Is Telaga Biru Lake capable of meeting the long-term raw water needs of Tembudan SPAM, given the increasing demand and potential environmental pressures? This question is important considering that the need for clean water tends to increase from year to year, while the availability of water resources often fluctuates due to climate change, environmental degradation, and anthropogenic pressures.

The purpose of this study is to evaluate the reliability of Telaga Biru Lake as a raw water source, through an analysis of its discharge capacity, storage capacity, and aquifer potential, and to compare them with projected needs until 2045. This study also highlights environmental factors that have the potential to reduce the lake's carrying capacity, particularly land clearing activities around the catchment area. Scientifically, this research is relevant because it enhances understanding of water resource management at the local scale, using a quantitative approach based on hydrological analysis. This research fills a research gap in the lack of integrative studies on the sustainability of lake-based drinking water systems (SPAM) in rural areas of East Kalimantan. The findings are expected to provide practical contributions to local governments and SPAM managers in formulating conservation strategies and planning sustainable drinking water infrastructure.

II. DATA COLLECTION METHODS

Time and Location of Research

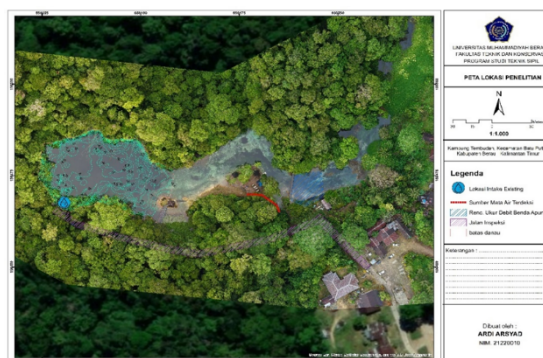
Observations and data collection were conducted on January 30 and May 31, 2025, during a research period estimated to last six months. The research location is at Telaga Biru Lake (Tulung Ni' Lenggo), Tembudan Village, Batu Putih District, Berau Regency, East Kalimantan.

Figure 2.1 Map of Existing Raw Water Source Locations



Source: Topographic Map of Indonesia (RBI) (2019)

Figure 2.2 Map of Alternative Raw Water Source Locations



Source: Topographic Map of Indonesia (RBI) (2019)

Tools and materials

The following are some of the tools and materials used in this research to help conduct surveys in the field:

Table 2.1 Research Tools

No.	Jenis Bahan	Kegunaan
1.	Baterai A3	Sumber daya untuk menghidupkan GPS Handheld dan Stopwatch
2.	Tali / Pita Penanda	Sebagai penanda / acuan

Source: Analysis Results (2025)

Table 2.2 Research Materials

No.	Jenis Peralatan	Fungsi
1.	Meteran Roll 50 Meter	Untuk mengukur Panjang dan lebar penampang danau.
2.	Meteran Pendek 7,5 Meter	Untuk mengukur kedalaman muka air ke dasar penampang danau.
3.	Current Meter Flowatch	Untuk mengukur kecepatan Arus air pada danau.
4.	GPS Handheld	Untuk mengukur titik kordinat lokasi penelitian.
5	Drone	Untuk pengambilan foto udara rupa bumi terkini pada danau.
6	Stopwatch	Untuk mengukur waktu benda apung selama dilintasan aliran air.
7	Laptop	Untuk melakukan pengolahan data dan pembuatan laporan.
8	Alat Tulis	Untuk mencatat seluruh data observasi.
9	Kamera / Handphone	Untuk melakukan pengambilan dokumentasi kegiatan di lapangan.

Source: Analysis Results (2025)

Method of collecting data

This study uses a quantitative approach with a focus on hydrological analysis to assess the reliability of the Tembudan SPAM raw water source. The research object is Lake Telaga Biru (Tulung Ni' Lenggo) in Tembudan Village, Batu Putih District, Berau Regency, East Kalimantan, which is currently the main source of SPAM raw water. The location was chosen because the lake is the only water source serving 224 household connections and is planned to expand coverage to two other villages. The research data consists of primary and secondary data. Primary data were collected through field surveys, including measuring flow discharge using a Current Flow Meter, measuring the dimensions of the lake's cross-section and depth, observing the water level against the tides, and spatial documentation using GPS and drones. Secondary data were obtained from relevant agencies, including rainfall data from the Meteorology, Climatology, and Geophysics Agency (BMKG), population data from the Directorate General of Civil Registration (Dukcapil), water quality test results from the Batiwakkal Regional Water Company (PDAM), and geoelectric and bathymetric data from technical consultants.

Data Analysis Methods

Data analysis was conducted in stages, calculating population growth projections until 2045, estimating domestic and non-domestic drinking water needs, and calculating raw water availability. The mainstay discharge was calculated using the FJ Mock method based on rainfall data, while groundwater potential was analyzed using geoelectric data. Lake outflow was calculated using the Current Meter and Six-Tenths Methods. The analysis results were compared with projected needs to assess the reliability of the raw water source.

III. Results and Discussion

Population Projection

Table 3.1 Projected Population Growth Rate
Source: Calculation Analysis (2025)

No.	Desa/Kelurahan	Jumlah Penduduk Setiap Tahunnya					Laju Pertumbuhan Penduduk Rata - Rata
		2020	2021	2022	2023	2024	
1	Tembudan	2.133	2.166	2.201	2.237	2.265	1,20%
2	Kayu Indah	863	882	888	900	914	1,15%
3	Sumber Agung	772	789	802	811	823	1,28%
Jumlah		3.768	3.837	3.891	3.948	4.002	

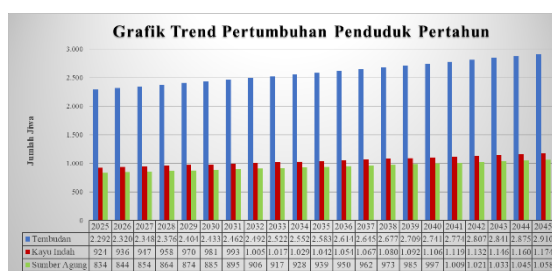


Figure 3.1 Graph of Annual Population Growth Trends in Tembudan, Kayu Indah, and Sumber Agung Villages

Based on population projections for three villages (Tembudan, Kayu Indah, and Sumber Agung) by 2045, water demand is estimated to reach 14.74 liters/second. The distribution of demand indicates Tembudan Village's dominance at 57%, followed by Kayu Indah at 23%, and Sumber Agung at 20%. This data confirms that the Tembudan SPAM service burden will increase in line with population growth and service coverage.

Population Projection

The process of estimating the amount of water needed by a region over a specific period of time, based on population growth, consumption patterns, and the level of clean water services. This analysis is crucial for planning drinking water supply systems (SPAM), water resource management, and the development of sanitation and housing infrastructure.

Table 3.2 Input data parameters for calculating water requirement projections

Komponen	Simbol	Nilai	Sumber
Proyeksi jumlah penduduk 2045	Pn	5.128 jiwa	Analisis Data Hasil proyeksi penduduk
Kebutuhan air per kapita perhari	q	100 liter/orang/hari	Standar Direktorat Jenderal Cipta Karya, Kementerian PU
Koefisien faktor non-domestik	fnd	15%	Wilayah semi-urban/pedesaan[29]
Koefisien kehilangan air	fk	20%	Standar Kementerian PUPR dan RPJMN[30]
Koefisien hari maksimum	fm	1,2	Pedoman Dirjen Cipta Karya – Kementerian PUPR[31]
Koefisien jam puncak	fjp	1,5	Pedoman Dirjen Cipta Karya – Kementerian PUPR[31]

Source: Data Analysis (2025)

Hydrological calculations show that Telaga Biru Lake has a storage capacity of 16,816.85 m³/day, far exceeding the current daily requirement of 794.44 m³/day (4.72%). The spring water discharge reaches 3.29 m³/second, with a surplus of more than 3.27 m³/second compared to the requirement of 0.01474 m³/second. In addition, the potential flow from the aquifer of 0.002625 m³/second also strengthens the reliability of supply. The

minimum discharge from rainfall (1,304 m³/second) remains far above demand, indicating supply resilience under extreme conditions.

Water Quality and Environmental Factors

Laboratory test results showed that the physical, chemical, and microbiological parameters still met drinking water quality standards, although the iron (Fe) content was slightly close to the threshold. Environmental factors, particularly land clearing activities around the catchment area, have the potential to degrade the quality and quantity of raw water if not managed properly.

IV. Conclusions and Suggestions

1. Water Discharge Conditions for Water Sources
 - a. Telaga Biru Lake has a water storage capacity of 16,816.85 m³/day, which shows that the water storage volume is large enough for the raw water needs of the Tembudan SPAM.
 - b. The raw water demand is much smaller than the capacity of Telaga Biru Lake. At 1,274.89 m³/day, it represents only 3.37% of the lake's total daily capacity.
 - c. The Minimum Rainwater Discharge occurred in June at 1,304 m³/second and the Maximum Discharge occurred in September 2,102 m³/second with a Monthly Average for the 2014-2024 Period of 1,733 m³/second from the Clean Water requirement of 0.01474 m³/second. The Average Discharge of Rainfall with a reservoir area in the Blue Lake is very reliable as a source of raw water for the Tembudan SPAM.
 - d. The water source discharge is capable of producing 3,287 m³/second, while the drinking water discharge requirement is smaller, namely 0.01474 m³/second, resulting in a water discharge surplus of 3,272 m³/second in Blue Lake (Tembudan).
 - e. The projected need for clean water in Tembudan, Kayu Indah and Sumber Agung Villages from 2025 to 2045 is 14.74 liters/second.
 - f. Alternative water level control measures for Telaga Biru Lake require structural engineering and environmental engineering around the lake. Tidal measurements indicate that the tidal pattern in Telaga Biru Lake is more dependent on rainfall intensity than tidal influence. This phenomenon is temporary and unrelated to ocean tides, but rather a result of local rainfall and local hydrological conditions.

Suggestion

After completing all the discussions in this thesis, the author presents several recommendations in the closing section. These recommendations are formulated based on the findings and analysis obtained during the research process. The goal is to provide both practical and academic contributions to the issues studied. The following are several suggestions put forward by the author as a follow-up to the research conducted:

1. There needs to be legal regulations governing the protection of the vegetation environment around the Blue Lake area.
2. There is a need for a strict protection zone around Lake Tembudan to reduce the impact of human activities.
3. Strict policies need to be implemented to ensure that there is no dumping of household, agricultural, or industrial waste into the lake area, in order to maintain water quality and the sustainability of the aquatic ecosystem.
4. It is necessary to build an adequate reservoir at the Tembudan SPAM to ensure continuity and reliability of raw water distribution.
5. Install water discharge and quality monitoring equipment regularly to ensure long-term raw water availability.
6. Optimize the raw water intake schedule consistently so as not to exceed the planned capacity.
7. Optimize intake design to efficiently capture the mainstay discharge while minimizing environmental impact.
8. To maintain the water level, environmentally friendly construction engineering is needed in the form of building embankments/dams around the lake overflow area.
9. There needs to be a limit on the area of lake utilization considering that there is natural tourism, so that the potential for waste pollution to the raw water sources in the area around the intake is not disturbed.
10. Making monitoring wells for aquifer conditions to periodically monitor underground flow.
11. There needs to be security in areas where water sources originate from rock crevice flows (aquifers) to maintain the cleanliness and clarity of the water so that the source remains protected.

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