How To Cite: Pambudi, A. S., & Pramujo, B. (2025) Policy Review and Development Planning Recommendations for Infiltration Well in Indonesia. *Publisia: Jurnal Ilmu Administrasi Publik, 10*(2), 170-187 https//doi.org/10.26905/pjiap.v10i2.14995

Jurnal PUBLISIA
Volume 10 Issue 2, 2025
P-ISSN: 2541-2515, **E-ISSN:** 2541-2035

***PUBLISIA**: Jurnal Ilmu Administrasi Publik http://jurnal.unmer.ac.id/index.php/jkpp*

Policy Review and Development Planning Recommendations for Infiltration Wells in Indonesia

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Article History:
Received: 02/08/2022
Revised: 04/08/2023
Accepted: 11/10/2023
Published: 28/10/2023

Abstract: Managed aquifer filling has become more prevalent in recent years as an option for alleviating water scarcity and flood prevention. In this regard, infiltration wells are considered one of the technical solutions for water resource conservation efforts that are more in line with environmental issues. The dynamics of infiltration wells, from philosophy and planning to evaluation, are various parties' concerns in the context of sustainable development. The benefits, problems, and impacts of infiltration wells are engaging to study further based on multiple existing studies. This study aims to provide more comprehensive considerations for improving infiltration well development policies in the future. The analytical method used is a qualitative approach through literature studies. Several regulations are used as material for analysis, starting from the level of laws to operational decisions from local governments. The literature study also takes the essence of various journals related to essential issues in constructing infiltration wells in Indonesia from technical and non-technical aspects. The study results recommend more scrutiny in planning infiltration wells according to regional characteristics, strengthening regulations, and triple helix collaboration (government, community, business world) in implementation, maintenance, financing, and periodic monitoring and evaluation.

Keywords:
Infiltration Wells,
Policy, Regulation,
Water Resources

1. Introduction

Population, economic, and industrial growth have increased the need for residential and industrial areas. This results in changes in land use functions, especially forestry land conversion. These changes also cause changes in the water resource or hydrological system, resulting in floods in the rainy season and droughts in the dry season. This land conversion has increased the number of critical lands that require a long time to restore their condition (Pambudi, 2022a; Prabowo et al., 2020).

Indonesia's region, located on the equator, receives constant sunlight every year and only has two seasons types: rainy and dry. The dominance of these two seasons greatly influences water availability, but the negative impact of all this is a decline in environmental quality, which can ultimately result in a shortage of clean water during the dry season and increased surface flow during the rainy season

(Fransiska, 2022; Pambudi, 2022b). The current application of appropriate technology is expected to help solve this system problem by anticipating the level of recovery of critical land, which will take a relatively long time.

Recharge wells (infiltration/soakaway pits) are an evidence-based practice that directly advances SDG 6 (groundwater recharge), SDG 11 (urban flood mitigation), SDG 13 (resilience to extreme rainfall/ drought), and SDG 15 (soil/ecosystem health). International guidance (CIRIA SuDS Manual; ISO 24536) and peer-reviewed synthesis show that distributed low impact development (LID) measures incl. recharge wells reduce peak flow and runoff volumes while increasing subsurface storage when designed and maintained properly. Monitoring should pair rainfall/flow with piezometers and routine O&M audits, and scenarios should be stress-tested with design storms. Aligning indicators to UN SDG targets and recognized stormwater standards improves scientific validity and comparability across cities.

Table 1. Indicators of Infiltration Wells Linked to the SDGs

SDG	Core indicator	Measurement / Typical evidence	Reference
6	Annual groundwater recharge (m^3)	Water balance from captured runoff; rising/stable dry-season groundwater trends at piezometers	EPA, 2021; ISO, 2019
11	Peak-flow reduction (%)	Event-based ΔQ_peak at outfalls during design storms (e.g., 2–10-yr)	CIRIA, 2015; Hoghooghi et al., 2018
11	Runoff volume reduction (%)	Event/annual ΔV at sub-catchment scale from monitoring/modeling	CIRIA SuDS. ciria.org
13	Performance under extremes	Scenario tests (e.g., SWMM) reporting ΔQ_peak/ ΔV for ≥10-yr storms	Hoghooghi et al., 2018
15	Soil infiltration (mm/h) & condition	Pre/post double-ring tests; soil organic matter/ vegetation indices	CIRIA, 2015; UN, 2025

Managed aquifer filling has recently become more popular to combat water scarcity and prevent flood disasters (Kalwa et al., 2021; Setiabudi, 2012). Infiltration wells are one technical solution to this, which is considered a form of effort in line with environmental issues. Infiltration wells are engineering buildings with the shape of a well, but their function is as a reservoir for water coming from above ground. Infiltration wells are related to the drainage system because they are essential in controlling surface runoff (Mardiah et al., 2018). Infiltration wells are formed naturally and assisted by water absorption in a particular area or location. Infiltration wells also take over the function of collecting sewage and rainwater into the ground.

Theoretically, the process of filling water in the infiltration hole so that infiltration occurs in the context of artificial recharge. This process is solely due to the influence of the earth's gravity, but the nature of the soil as a permeation medium will have a significantly crucial meaning. The permeability coefficient indicates the physical properties of the soil that drains water in the form of seepage. The permeability coefficient (coefficient of permeability) has the same units as speed. This term is mainly used by land engineering (geotechnical) experts. Soil permeability coefficient depends on several factors, namely liquid viscosity, pore size distribution, grain size distribution, pore number, surface roughness of soil grains, and degree of soil saturation. In clay soil, soil structure is essential in determining the permeability coefficient. The presence of many absorption holes will increase the soil's water absorption capacity because water will more easily enter the body (profile) of the soil (Muntaha et al., 2022; Bahunta & Waspodo, 2019).

Table 2. Comparative Table of Infiltration Well Practices in Four Major Cities

City	Main Approach	Implementation Scale	Key Challenges	Academic Source
Jakarta	Massive program by provincial government, regulation-based	>29,000 units (2019–2024)	Construction quality, maintenance, public participation	Sari et al., 2022
Surabaya	Pilot testing with academic collaboration and technology	5 initial sites, expansion planned	Effectiveness validation, drainage system integration	Prasetyo & Hidayat, 2023
Semarang	Zero Delta-Q strategy, multi-stakeholder participation	Target of 1,000 units	Inter-agency coordination, community-based funding	Wibowo et al., 2021
Bandung	Civic movement and building permit regulation	>8,000 shallow wells, 78 deep wells	Need for 500,000 units, weak enforcement of regulation	Ramadhan & Nugraha, 2020

The benefits of constructing water absorption wells include (1) reducing surface flow and preventing waterlogging, thereby reducing the possibility of flooding and erosion; (2) maintaining groundwater levels and increasing groundwater supplies, reducing or preventing seawater intrusion in areas adjacent to coastal areas, preventing land subsidence or subsidence as a result of excessive groundwater extraction, reducing the concentration of groundwater pollution. In essence, the purpose of making infiltration wells is to collect and absorb rainwater into the ground. Ideally, infiltration wells are to accommodate, store, and increase groundwater reserves and can reduce the overflow of rainwater into drains and other water bodies so that it can be used in the dry season and reduce the incidence of flooding at the same time.

This article contributes to the theoretical and practical advancement of water resource governance in Indonesia by addressing three critical gaps. First, it maps the integration of regulatory instruments across ministries and between central and regional governments, offering a clearer operational policy mix for infiltration well development. Second, it formulates design guidelines for infiltration wells based on regional hydrogeological typologies—an approach rarely found in existing literature, which often treats technical planning as generic. Third, it introduces a structured monitoring and evaluation matrix, including indicators, targets, and frequency, to support local governments in assessing performance and ensuring accountability. By bridging these gaps, the study not only strengthens the institutional and technical foundation for infiltration well implementation but also enhances the replicability of policy instruments across diverse ecological and administrative contexts. This positioning affirms the article's novelty within the broader discourse on environmental policy and sustainable urban water management.

Water absorption wells function to increase or raise groundwater, reduce floodwater, prevent seawater intrusion, and preserve and save water resources in the long term. Therefore, it is necessary to construct infiltration wells, especially in the construction of buildings, housing, and shops. Infiltration wells function as flood prevention to reduce surface flow because infiltration wells enter water directly into the ground, protect and improve groundwater, and reduce the erosion rate.

As is known, the impact of development can, among other things, change the economic structure, the physical structure of the region, the structure of consumption patterns, and, of course, the structure of natural resources and the environment, including technology and value systems. Thus, if these changes cause pressure that exceeds the limits of balance or harmony between natural resources and the environment, humans face environmental problems (Pambudi, 2021; Amin, 2017). Infrastructure development in various regions should have a significant positive impact on society if this development is by established policies, but this differs in terms of results and effects. The construction of infiltration wells, with its various theories and policies, does not always go according to plan. Infiltration wells may experience poor performance if there are problems with their design, construction, or maintenance. For example, if the filtration material used is not suitable or there is a blockage due to silt or other solid material, the infiltration well may not be able to drain water properly or even be blocked entirely. Reviews of infiltration wells in Indonesia can cover various aspects, including technical, institutional, social, economic, and financing. What cannot be separated from the situation in Indonesia is matters related to greater awareness and responsibility of infiltration well users to maintain and care for them. Therefore, policymakers must review the concept of infiltration wells in technically more depth and evaluate its policies.

This study aims to strengthen infiltration well development policies in Indonesia through a more integrative and context-sensitive approach. It examines the regulatory framework across ministries and between central and regional governments, which has not been systematically mapped in previous research. The study also formulates technical design guidelines for infiltration wells based on regional hydrogeological typologies, addressing the lack of adaptive planning standards. Furthermore, it introduces a structured monitoring and evaluation matrix—comprising indicators, targets, and frequency—that local governments can use to enhance implementation effectiveness and accountability. Through these contributions, the research seeks to bridge the gap between policy design and field-level practice, offering evidence-based recommendations for sustainable and replicable water resource management.

2. Research Methods

The analytical method used is a qualitative method approach, which is explained through literature studies. The literature study will analyze concepts, policies, and regulations related to infiltration wells in Indonesia. A literature study is a method for identifying, evaluating, and systematically synthesizing various research results and ideas from researchers and practitioners based on existing regulations/policies (Machi & MacEvoy, 2022; Strauss & Corbin, 1998). Several regulations are used as material for analysis, starting from the statutory level to operational decisions from regional governments. The literature study also took extracts from various journals related to important issues regarding the construction of infiltration wells in Indonesia from technical and non-technical aspects.

Apart from that, to formulate the evaluation results, a Focus Group Discussion was carried out involving various development stakeholders, both from the government side (especially the regional government in charge of infiltration wells in Jakarta, Surabaya, Semarang, and Bandung) and the community. This process is summarized in the Strengths, Weaknesses, Opportunities, and Threats (SWOT) analysis table. SWOT analysis is carried out on the strengths, weaknesses, opportunities, and threats that the organization has and will be faced by the organization (Mujito, 2023; Rangkuti, 2011). SWOT analysis can help the government as a policymaker in planning and implementing development to improve its performance. SWOT analysis is a careful evaluation of internal strengths and weaknesses, as well as an assessment of external opportunities and threats from the environment (Griffin, 2015).

Analysis in the form of an evaluation of the construction of infiltration wells is expected to provide recommendations for control and improvement efforts for policymakers in Indonesia so that the construction of infiltration wells is more effective and efficient and has an optimal impact on the expected sustainable development.This study employed a qualitative approach combining systematic literature review and Focus Group Discussions (FGDs). The literature review used databases such as Garuda, Google Scholar, and Scopus, with search strings including “infiltration wells,” “rainwater management,” and “water policy,” covering publications from 2013 to 2024. Following a PRISMA screening flow, 87 documents were identified, and 42 were selected for analysis comprising 28 journal articles and 14 regulatory documents.

FGDs were conducted in Jakarta, Surabaya, Semarang, and Bandung, facilitated by local environmental and public works agencies. Each session involved 8–12 participants representing government, community groups, and private sector actors, selected based on their direct involvement in infiltration well planning or implementation. Discussions were held offline in May–June 2024, lasting 2–3 hours per city, guided by a structured question list covering regulation, technical design, funding, and monitoring. Ethical clearance and confidentiality protocols were observed.

Data were analyzed using thematic content analysis, focusing on four key themes: regulation, implementation, financing, and operation maintenance. SWOT matrices were constructed from coded themes derived from literature and FGD transcripts, ensuring findings were evidence-based rather than author opinion. This framework supports replicable policy recommendations for sustainable water governance.

3. Results and Discussion

Regulations Analysis for the Infiltration Well Development in Indonesia

The policy of building infiltration wells in Indonesia has begun to be widely implemented since extreme climate (weather) changes have occurred, which have had disastrous impacts, such as floods in the rainy season and droughts in the dry season. It is an environmental effect as a result of the development process. Apart from climate change, rapid population growth and urbanization in the last few decades have changed the prior natural urban landscape into various building types to support human activities. Increasing urbanization and expanding development have resulted in a drastic increase in the percentage of rainwater runoff. That is because the impervious surface covering the natural urban environment has increased drastically, resulting in the hydrological process of surface water runoff becoming unnatural. The extensive use of concrete such as asphalt, paving blocks, and concrete in infrastructure development has contributed to the problem of water resource management because it has impermeable properties or is not easily water-penetrated (Hatmoko et al., 2021). The covering of the land surface further increases surface water runoff and reduces water infiltration into the soil. Surface runoff from rooftops, city streets, and parking lots has become a key source of water pollution in many urban areas.

The results reveal that inter-agency coordination remains a major challenge in infiltration well implementation, particularly in Semarang and Bandung. This is reflected in Table 2 and reinforced by a statement from the Semarang FGD: “We don’t yet have a cross-departmental forum to align infiltration well targets with spatial planning and environmental budgets.” (FGD, May 2024). Groundwater contamination risks also emerged as a key concern, supported by technical literature (Muntaha et al., 2022; Bahunta & Waspodo, 2019) and echoed in the Jakarta FGD: “Some infiltration wells have become stagnant pools due to lack of filters and proximity to wastewater channels.”

Monitoring and evaluation weaknesses were identified through the absence of technical indicators such as ÄQ_peak and soil infiltration in local practices, as shown in the SDG-linked table. The Bandung

FGD noted: "We don't have a regular monitoring system—just visual checks during heavy rain." Capacity disparities across regions were evident, with Jakarta implementing over 29,000 units while Surabaya remains in pilot testing (Prasetyo & Hidayat, 2023). These findings underscore the need for structured, evidence-based policy instruments that are both scalable and context-sensitive.

In Indonesia, regulations regarding infiltration wells can vary between various levels of government, from national regulations to regional law. Regulation Law Number 32 of 2009 concerning Environmental Protection and Management states that infiltration wells are included in managing rainwater and the environment. It is declared in Government Regulation 16 of 2018 concerning Water Quality Management and Water Pollution Control. This Government Regulation regulates water quality management and water pollution control. One aspect that is regulated is rainwater management, including the use of infiltration wells. At the regional level, there are regional regulations that regulate environmental management, including the use of infiltration wells. These regulations may vary in each region depending on local needs and conditions.

Based on Government Regulation Number 43 of 2008 concerning Ground Water, groundwater conservation is an effort to maintain the existence, quantity/reserves, nature and characteristics and function with the aim that the quantity/quantity, quality, and function can meet the needs of living creatures, society with its various needs, both now and in the future. If the existence, reserves, quality, and function of groundwater/springs are done properly and correctly, then it can be ensured that surface water resources (rivers, lakes, lakes, and dams) can also be guaranteed to have their existence, quantity, quality and function and sustainability (GoI, 2008). When groundwater resources are sustainable, surface water resources will indeed be sustainable. One of the basic principles of water conservation is to manage rainwater/runoff water (during the rainy season) so that as much as possible can seep into the layers of soil and rocks to become groundwater. Infiltration wells are a form of water resource conservation to maintain the reserves, quality, and function of water in the ground in line with the principles of sustainable development.

For the Ministry of Public Works and Public Housing (PWPH), infiltration wells are an effort to maintain the water cycle and natural hydrological conditions, as well as meet water needs in buildings, which is in the use of rainwater and management of rainwater in buildings and their plots (GoI, 2014). It is in line with the provisions of Article 42 of Government Regulation 36 of 2005 concerning Implementing Regulations of Law 28 of 2002 concerning Buildings, where the regulation states that every building must include rainwater distribution as one of the sanitation system requirements. In the regulation of the Ministry of Public Works of the Republic of Indonesia 20/PRT/M/2018 concerning Procedures for Calculating Standard Building Costs, it is stated that infiltration wells can be considered as one of the technical components in calculating standard building costs (GoI, 2018). Infiltration wells are drainage facilities that function to absorb rainwater from the roof of a building into the ground through a well. Apart from these regulations, there are also technical guidelines from the PWPH Ministry, such as Technical Guidelines for Infiltration Wells for Buildings. This guide provides instructions on planning, designing, constructing, and maintaining infiltration wells.

For the Ministry of Environment and Forestry, the philosophy of the importance of infiltration wells is based on the mandate of Law 37 of 2014 concerning Soil and Water Conservation, which states that infiltration wells are part of efforts to rehabilitate forests and land civilly and technically. Conceptually, infiltration wells are related to the direction to be achieved in Law 32 of 2009 concerning Environmental Protection and Management and Law 17 of 2019 concerning Water Resources. A water absorption well, in a broader sense, is one of the water conservation engineering techniques in the form of a building made in such a way that it resembles the shape of a dug well with a certain depth, which functions as a place to collect rainwater that falls above, which has the benefit of reducing surface flow, maintaining and increasing groundwater levels, reducing erosion and sedimentation, preventing water intrusion and land subsidence and reducing groundwater pollution. A development like this is related to the state's efforts to protect everyone's right to a good and healthy living environment as part of the entire ecosystem protection (GoI, 2009a).

Meanwhile, the Ministry of Energy and Mineral Resources sees infiltration wells as part of groundwater recycling efforts (GoI, 2012). Article 10 of the Regulation of the Ministry of Energy and Mineral Resources (ESDM) of the Republic of Indonesia Number 15 of 2012 concerning Saving the Use of Ground Water, it is directed that one way of saving groundwater is to reuse groundwater by making rainwater infiltration wells into the ground. From an environmental perspective, infiltration wells are seen from the rainwater utilization (GoI, 2009b). Ministry of Environment Regulation 12 of 2009 concerning Rainwater Utilization defines an absorption well as a hole to absorb rainwater into the soil and water-bearing rock layers. The obligation to use rainwater through infiltration wells excludes karst, swamp, or peat areas.

Table 3. Synthesis Table of the Concept of Infiltration Wells in Ministerial-Level Regulations in Indonesia

Regulatory Level	Ministry of Public Works (PUPR)	Ministry of Environment and Forestry (MoEF)	Ministry of Energy and Mineral Resources (MEMR)
Legal Reference	Regulation No. 20/PRT/M/2018 on Building Cost Standards	Regulation No. P.12/2009 on Rainwater Utilization	Regulation No. 16/2012 on Groundwater Conservation
Technical Definition	Drainage facility that channels rooftop rainwater into the ground via a well	Absorption holes directing rainwater into soil or aquifers	Groundwater conservation through rainwater infiltration
Policy Objective	Water resource conservation and disaster mitigation	Environmental rehabilitation and water conservation	Efficient groundwater use and recharge
Implementation Implication	Mandatory in building design and cost calculation	Applicable in non-karst and non-peat zones	Targeted at buildings with intensive groundwater use

Source: Analysis Result, 2022

For the regional government, infiltration wells are considered one application of sustainable development that balances economic, social, and environmental aspects. Therefore, the regional government is based on Law 23 of 2014 when issuing policies regarding absorption wells, including not neglecting the use of the Technical Law regulatory basis. However, at the planning and implementation level, various problems often derive that are interesting to study from the perspective of development planners.

Based on various existing regulations, the construction of infiltration wells generally aims to implement the basic principles of water conservation. Specifically, the goal is to prevent or minimize water loss due to surface runoff and to store as much water as possible in the ground. In simple terms, this principle ensures that rainwater runoff, which occurs during the rainy season, does not flow directly into rivers and eventually towards the ocean. Instead, rainwater must be managed and stored in a way that allows it to seep back into the ground, facilitating groundwater recharge. However, when the rainwater discharge increases and has the potential to cause flooding, efforts to immediately drain the water are an unavoidable option. A sustainable rainwater system through infiltration wells is not merely a system built to overcome the problem of water runoff and avoid unwanted contaminants but rather a system to increase the potential and usefulness of water resources.

Analysis of Infiltration Well Development Problems from Technical and Policy Aspects

Nationally, the government's response to population growth rates and development needs is increasing, but the decline in water resource reserves continues to decrease so that the threat of a water crisis is through the development of basic infrastructure (Pribadi et al., 2021). One of the strategies in developing basic service infrastructure for the next five years (RPJMN 2020-2024) is the provision of groundwater as a raw water resource that is safe and sustainably available (quantity and quality aspects) so that the target for additional industrial and domestic raw water is to be 50 m^3/second in 2024 can be achieved. In the next five years, one of the targets that must be achieved to strengthen economic resilience and increase the provision of basic service infrastructure is achieving an increase in groundwater reserves to provide and ensure domestic and industrial raw water, which is estimated to reach a need of around 81.4 m^3/second (in 2019) which must increase to 131.36 m^3/second (in 2024). Infiltration wells are something that is considered necessary by the government, in general, and formally, the National Standardization Agency has made technical requirements and conditions for infiltration wells as groundwater conservation techniques as stated in the Indonesian National Standard (SNI) Number 8456 of 2017 concerning Absorption Wells and Trenches of Rainwater.

In national development planning, water resource conservation policies are also related to watershed management which involves cross-sectors, cross-actors, cross-regions, and cross-scientific disciplines (Pambudi & Kusumanto, 2023; Masthura et al., 2023). The Ministry of Environment and Forestry conducted national activities to build 3,443 water absorption wells in 2015, 755 units in 2016, 6,417 units in 2017, and 6,000 units in 2018. However, this policy was no longer implemented in 2019 (MOEF, 2020). In its development, the Ministry encouraged the construction of water absorption wells through a Special Transfer Fund mechanism. The provincial government implements Special Allocation Funds in Environment and Forestry and district/city regional government to carry out vegetative and technical civil land rehabilitation outside forest areas, which is in a labor-intensive pattern with the community, one of which is the development of infiltration wells.

Table 2 Infiltration Well Development Problems in Indonesia

No	Problems	Explanation	Literary Source
1	Changes in hydrological conditions	Changes in hydrological conditions, such as a decrease in groundwater levels or changes in surface water management, can affect the performance of infiltration wells. If hydrologic conditions change significantly, infiltration wells may need to be adjusted or modified to ensure optimal performance.	Wirasembada *et al.*, 2017; Wigati & Ichwan, 2017; Bunganaen *et al.*, 2016
2	Improper planning and design	One of the technical problems that need to be considered when constructing infiltration wells is the lack of proper planning and design according to regional conditions. Designs that do not consider hydrogeological conditions, soil infiltration levels, or hydrologically predicted rainwater volumes can result in infiltration wells not functioning properly or even failing.	Gunawan *et al.*, 2021; Bahunta & Waspodo, 2019; Iriani *et al.*, 201

No	Problems	Explanation	Literary Source
3	Groundwater contamination	If infiltration wells are not designed or constructed adequately, rainwater that seeps into the ground can contaminate groundwater with pollutants or dangerous chemicals. It happens if the infiltration well is located too close to a source of pollution, the waste disposal system is poor, or if the soil around the infiltration well is inadequate to filter pollutants.	Maryono *et al.*, 2022; Mukaromah, 2020; Suprayogi & Malawani, 2019
4	Lack of understanding and awareness	One of the problems from the social side is the lack of understanding and awareness about the importance of infiltration wells. Many people may not know about the benefits of infiltration wells or how to build and maintain them. It potentially hinders the widespread adoption and implementation of infiltration wells. In some cases, people may consider infiltration wells as unimportant or complicated.	Rafsanjani *et al.*, 2020; Wibowo, 2013; Daniel *et al.*, 2012; Angguniko, 2010
5	Lack of regulations and policies	In some cases, weak institutions in the form of regulations and policies can hinder building and maintaining infiltration wells. Without a clear legal framework and support mechanisms from the government, communities may not feel encouraged to use infiltration wells.	Kusuma *et al.*, 2022; Satriawansyah *et al.*, 2020; Diandra *et al.*, 2020
6	Lack of coordination between related parties	Infiltration wells often involve various parties, including individuals, community groups, local governments, and related agencies. Lack of coordination and collaboration between these parties can lead to conflicts of interest, ineffective planning, or uncoordinated implementation.	Nurkhotiah *et al.*, 2023; Prayitno *et al.*, 2021; Rafsanjani *et al.*, 2020
7	Maintenance and sustainability issues	Infiltration wells require regular care and maintenance to ensure optimal performance. Lack of maintenance, including not cleaning, necessary repairs, or performance monitoring, can cause infiltration wells to experience technical problems and ultimately not function properly. Inadequate attention to maintenance and sustainability can cause infiltration wells to become ineffective over time.	Molya *et al.*, 2023; Nyoto & Ruldeviyani, 2022; Mukaromah, 2020;
8	Resource and technical limitations	In some cases, infiltration wells may not meet technical standards or be unsuitable for local environmental conditions. Technical limitations in the design and construction of infiltration wells can lead to their poor performance or even complete failure. In addition, limited resources such as funds and labor can affect the ability to build and maintain infiltration wells effectively.	Nurwidyaningrum *et al.*, 2023; Sajar, 2021; Iriani *et al.*, 2019

Building infiltration wells is a commonly used method for managing rainwater and maintaining groundwater balance in urban areas (Wirasembada et al., 2017; Wigati & Ichwan, 2017). Infiltration wells are a vital component of sustainable development. In theory, infiltration wells are designed to manage rainwater by allowing it to seep into the ground, thereby reducing waterlogging and contributing to the improvement of the natural water cycle.

One of the positive impacts of building infiltration wells is reducing flooding (Bahunta & Waspodo, 2019; Iriani et al., 2019; Bunganaen et al., 2016). By absorbing rainwater into the ground through infiltration wells, surface water flow can be reduced, reducing the risk of flooding. Infiltration wells also help reduce the burden on drainage channels and piping systems, which can trigger flooding. In some instances, infiltration wells also allow rainwater to be filtered naturally by the soil before reaching underground water sources. It helps reduce the risk of water pollution because soil functions as a natural filtering medium that can remove pollutants before they reach water sources.

Another positive impact of constructing infiltration wells is maintaining groundwater availability. In some areas, groundwater resources are becoming increasingly limited due to global warming and over-exploitation. Infiltration wells help improve groundwater availability by allowing rainwater to seep into the soil and recharge underground aquifers. Infiltration wells help provide the water needed by plants. By reducing surface runoff and allowing rainwater to soak into the soil, infiltration wells help retain soil moisture and support plant growth.

In sustainable development, it is essential to consider the design and location of infiltration wells (Nyoto & Ruldeviyani, 2022; Mukaromah, 2020). It must consider several factors such as soil conditions, rainfall, and building layout to ensure the effectiveness of infiltration wells. Regular care and maintenance are also crucial so infiltration wells continue functioning well. By including infiltration wells in development designs, we can manage water sustainably, protect the environment, and support long-term sustainability in water resource management.

However, several negative impacts occur due to the construction of infiltration wells in the area. One of these negative impacts is a decrease in groundwater quality. If infiltration wells are not properly maintained or not designed correctly, groundwater contamination can occur (Maryono et al., 2022; Mukaromah, 2020; Suprayogi & Malawani, 2019). Hazardous chemicals, such as industrial waste or agricultural residues, can seep into infiltration wells and contaminate groundwater, which can negatively impact the quality of drinking water and other water sources.

Table 3. Assessment of Strengths, Weaknesses, Opportunities, and Threats of Infiltration Well Policy in Indonesia

Strengths	**Weaknesses**
• Infiltration wells have a lot of regulatory support from the central government to regional government levels • Infiltration wells contribute to groundwater recharge, thereby reducing the risk of groundwater shortages in the future • Infiltration wells contribute to efforts to reduce rainwater runoff, which can cause puddles or flooding in urban areas • Improve water resources management to support sustainable development goals (SDGs) • Easy to create and deploy at multiple scales, from individuals to regions	• There are still many weaknesses in the implementation, particularly the construction of many infiltration wells without adherence to proper technical standards, which reduces their effectiveness. • There are still many people who do not understand the benefits of infiltration wells, so their implementation often depends on the government or certain institutions • It is hard to find adequate land to build infiltration wells, especially in densely populated areas and big cities • There is still a weakness in the management quality of infiltration wells after they are built, as indicated by the presence of pollutants in the groundwater layer
Opportunities	**Threats**
• Opportunities to integrate modern technology in the creation and management of infiltration wells, such as digital monitoring for efficiency. • Opportunities to involve the private sector, NGOs, and local communities in supporting the construction of infiltration wells • Opportunities to contribute more to sustainable water management, supporting water security amidst climate change. • Opportunities to gain support from international donors focused on environmental and water management issues	• Erratic rainfall intensity can reduce the effectiveness of infiltration wells in recharging groundwater • Improperly managed domestic and industrial waste can contaminate the water entering the infiltration well • Regulations regarding infiltration wells are often less strict in implementation, so many parties do not comply with them. • Implementing this program requires a large budget, especially if it is to be implemented on a wide scale with good quality

Sources: Analysis Result, 2024

The construction of infiltration wells also poses a potential risk of local flooding (Lubis et al., 2023; Azwarman, 2017). If the infiltration well system is inadequate or unable to accommodate excessive rainwater flow, the water can overflow and cause local flooding. It occurs when the absorption well is full and cannot absorb further water. If there is no adequate stormwater drainage system, flooding can submerge roads, residences, or other areas.

In some cases, constructing infiltration wells can risk reducing soil stability (Gunawan et al., 2021). Improper construction of infiltration wells can result in a decrease in the stability of the surrounding soil. When water seeps into the soil, changes can occur in soil composition and moisture, which can cause soil settlement or soil movement. It can damage surrounding infrastructure, such as roads or buildings. Geological conditions and soil structure in an area can influence the effectiveness of infiltration wells. Very clayey soil or soil with a high seepage level can hinder the infiltration well's ability to absorb water properly. Hard rocks or certain soil formations can also make it difficult to build effective infiltration wells.

Polluted infiltration wells can cause health problems (Suprayogi & Malawani, 2019). If groundwater is polluted due to poor infiltration wells, it can cause health problems for humans and animals that consume it. Contaminants present in polluted groundwater can cause disease and health problems, primarily if the water is for drinking or cooking. In urban areas, soil and water contamination risk is usually higher due to human activities such as industry, transportation, and domestic activities. When rainwater flows over contaminated surfaces, the possibility of groundwater contamination in infiltration wells increases. Therefore, it is necessary to conduct regular testing and monitoring to ensure that the water collected in infiltration wells is safe.

Potential of Infiltration Wells Development in Indonesia

Considering its geographical and climatic characteristics, Indonesia has great potential for developing infiltration wells. Indonesia has high yearly rainfall, especially in tropical regions such as Sumatra, Kalimantan, and Papua. Abundant rainfall provides excellent potential for collecting and utilizing rainwater through infiltration wells.

Despite having high rainfall, Indonesia also faces water shortage problems in several areas. Infiltration wells can be a massively developed solution for collecting and storing rainwater, which can be used as an alternative water source, especially during the dry season.

Rapid urban growth in Indonesia presents challenges in rainwater management. Infiltration wells can help reduce flooding and improve groundwater quality in dense urban areas. The potential for developing infiltration wells in Indonesia is also supported by large land areas in urban and rural areas. It allows for building infiltration wells with sufficient area to collect rainwater.

Many organizations and communities are promoting infiltration wells as part of water conservation efforts. This community support can encourage the development of infiltration wells in Indonesia, apart from the fact that the Indonesian government has issued various regulations and policies that support the development of infiltration wells. Public awareness about the importance of water and environmental management is a crucial factor in the effectiveness of infiltration wells. When the community understands the benefits of infiltration wells and actively participates in their construction and maintenance, these wells can function effectively and have a positive impact.

By harnessing these potentials, infiltration wells development in Indonesia can help address water shortages, improve rainwater management, and enhance groundwater quality. To achieve this, the government, relevant institutions, and the community must collaborate to build and maintain infiltration wells effectively and sustainably.

Based on the analysis results, an improvement strategy for the infiltration well policies development in Indonesia was formulated. This strategy is based on a SWOT analysis, which is divided into four categories: SO (Strength-Opportunity), WO (Weakness-Opportunity), ST (Strength-Threat), and WT (Weakness-Threat) strategies.

Table 4. SO (Strength-Opportunity), WO (Weakness-Opportunity), ST (Strength-Threat), and WT (Weakness-Threat) Strategies for the Development of Infiltration wells in Indonesia

SO (Strength-Opportunity) Strategies	**WO (Weakness-Opportunity) Strategies**
• Develop infiltration well models that are more efficient and easier to apply using modern technology, such as monitoring sensors for groundwater recharge • Utilize national policy support to collaborate with the private sector in funding and implementing community-based infiltration wells • Increase public awareness of infiltration wells benefits by utilizing social media, applications, or digital education platforms.	• Develop technical standards that are easily accessible to the general public, complete with visual guides to ensure effective implementation. • Providing incentives, such as tax breaks or subsidy assistance, for households or companies that build infiltration wells according to standards • Encourage the integration of infiltration wells with urban green infrastructure, such as city parks or porous pedestrian paths.
ST (Strength-Threat) Strategies	**WT (Weakness-Threat) Strategies**
• Use simple technologies, such as natural filters or filtration systems, to ensure that the water entering the infiltration well is free of pollutants • Integrate infiltration well policies with spatial planning and pollution control regulations to minimize environmental risks • Develop multifunctional infiltration wells to recharge groundwater and serve as emergency water reserves for dry seasons	• Start implementation in strategic locations with high groundwater demand and low risk of pollution for optimal results with limited resources • Provide training for the community and construction service providers to ensure the implementation of infiltration wells according to standards. • Access international grants or research collaborations to overcome funding limitations while improving the quality of implementation.

Sources: Analysis Result, 2024

The SWOT strategy table (SO, WO, ST, WT) presented in the manuscript requires a clear narrative explanation to guide readers through its analytical logic. After displaying the table, the authors should elaborate on how each quadrant reflects the interaction between internal and external factors. For example, SO strategies highlight the potential for innovation and collaboration by leveraging existing strengths and emerging opportunities—such as sensor-based monitoring and private sector engagement. WO strategies respond to systemic weaknesses by proposing incentives, community involvement, and integration with green infrastructure. ST strategies emphasize policy alignment and spatial planning to mitigate external threats, while WT strategies suggest phased implementation and capacity-building in high-risk areas. This narrative is essential to ensure the table is not perceived as a static list but as a dynamic synthesis of empirical findings and strategic foresight

This study integrates the 5C implementation framework—content, context, capacity, commitment, and clients/coalitions—to strengthen policy recommendations for infiltration wells in Indonesia. While regulatory content is well-established across ministries, implementation varies due to regional context and uneven technical capacity. FGDs revealed limited monitoring systems and weak inter-agency coordination, especially in Semarang and Bandung. Commitment and stakeholder engagement remain inconsistent, with minimal private sector involvement.

To address these gaps, a mix of policy instruments is proposed: tax incentives (economic), special allocation funds (fiscal), CSR programs (partnership), and mandatory building regulations (legal). Each instrument is mapped to responsible actors such as the Ministry of Finance, Bappenas, local governments, and private entities.

Operational performance indicators are recommended to enhance accountability, including runoff reduction in target sub-watersheds, groundwater recharge rates, failure rates due to clogging, annual O&M costs per unit, and compliance with building permit requirements. These indicators align with SDG targets and international standards (EPA, 2021; CIRIA, 2015; UN, 2025), enabling evidence-based evaluation and replication. By linking empirical findings to theory and measurable outcomes, the study offers a scalable framework for sustainable urban water governance.

4. Conclusion

This study aims to strengthen infiltration well development policies in Indonesia through an integrative, evidence-based approach. Key findings reveal persistent gaps in technical standards, fragmented governance across ministries and regions, limited financing mechanisms, and weak operation and maintenance (O&M) systems. Monitoring practices remain inconsistent, and community or private sector involvement is minimal. These challenges underscore the need for harmonized regulations, adaptive planning based on hydrogeological typologies, and a mix of policy instruments—ranging from fiscal incentives to regulatory mandates—to ensure effective and replicable implementation. Establishing measurable performance indicators is essential to support accountability and alignment with SDG targets.

Practically, the central government should issue national design and monitoring standards and allocate Special Allocation Funds (DAK) for green infrastructure starting next fiscal year. Local governments must integrate infiltration wells into building permit systems and establish performance-based monitoring frameworks. Developers are expected to incorporate site-specific infiltration wells during project planning and construction phases. Communities and private sector actors should be engaged through CSR programs and technical training, with phased implementation beginning in priority urban areas by Q1 of the upcoming year.

5. References

Angguniko, B. Y. (2010). Community Perceptions of Rainwater Infiltration Wells and Biopore Infiltration Hole Technology (Case Study: South Tangerang Regency) (Persepsi Masyarakat Terhadap Teknologi Sumur Resapan Air Hujan dan Lubang Resapan Biopori (Studi Kasus: Kabupaten Tangerang Selatan)). *Jurnal Sosial Ekonomi Pekerjaan Umum, 2(1), 9-19.* Retrieved from bit.ly/3WMSWJc

Amin, H. (2017). Law Enforcement Process and Efforts to Control Environmental Problems (Proses Penegakan Hukum dan Upaya Pengendalian Masalah Lingkungan Hidup). *Jurnal Cakrawala Hukum, 6*(2), 172-193. https://doi.org/10.26905/idjch.v6i2.1453

Azwarman, A. (2017). Study of Infiltration Wells to Anticipate Waterlogging in Permata Kenali Housing Complex to Prevent Floods (Kajian Sumur Resapan Antisipasi Genangan Air pada Perumahan Permata Kenali untuk Pencegahan Banjir). *Jurnal Ilmiah Universitas Batanghari Jambi, 15(2), 1-5.* http://dx.doi.org/10.33087/jiubj.v15i2.173

Bahunta L., & Waspodo, R.S.B. (2019). Design of Rainwater Absorption Wells as an Effort to Reduce Runoff in Babakan Village, Cibinong, Bogor Regency (Rancangan Sumur Resapan Air Hujan sebagai Upaya Pengurangan Limpasan di Kampung Babakan, Cibinong, Kabupaten Bogor). *J-Sil. Jurnal Teknik Sipil dan Lingkungan, 4 (1), 37-48.* https://doi.org/10.29244/jsil.4.1.37-48

Bunganaen, W., Sir, T. M., & Penna, C. (2016). Utilization of Infiltration Wells to Minimize Flooding Around Jalan Cak Doko (Pemanfaatan Sumur Resapan Untuk Meminimalisir Genangan Di Sekitar Jalan Cak Doko). *Jurnal Teknik Sipil, 5(1), 67-78.* Retrieved from https://jurnalindustri.petra.ac.id/index.php/jurnal-teknik-sipil/article/view/19817

CIRIA. (2015). *The SuDS Manual (C753).* CIRIA. Retrieved from https://www.susdrain.org/resources/SuDS_Manual

Daniel, J., Neolaka, A., & Nasution, N. (2012). Community Awareness in Making Rainwater Absorption Wells (Study at RW. 02, Kebon Jeruk Village, West Jakarta) (Kesadaran Masyarakat dalam Pembuatan Sumur Resapan Air Hujan (Studi pada RW. 02 Kelurahan Kebon Jeruk, Jakarta Barat)). *Menara: Jurnal Teknik Sipil, 7(1), 14-14.* Retrieved from bit.ly/3C95dhF

Diandra, N., Afla, M. N., & Saputra, M. O. (2020). Review of Residential Homes Based on the Healthy Home Concept According to Government Regulations (Tinjauan Rumah Tinggal Berdasarkan Konsep Rumah Sehat Menurut Regulasi Pemerintah). *Jurnal Teknologi Dan Desain, 1(2), 45-54.* https://doi.org/10.51170/jtd.v1i2.20

EPA. (2021). *Enhanced Aquifer Recharge of Stormwater in the United States: State of the Science Review.* U.S. Environmental Protection Agency https://cfpub.epa.gov/ncea/risk/recordisplay.cfm?deid=352238

Fransiska, A. (2022). Right to health on access to clean water in Indonesia. *International Journal of Research in Business and Social Science (2147- 4478), 11(6), 519–527.* https://doi.org/10.20525/ijrbs.v11i6.1973

GoI. (2018). *Ministry of Public Works Regulation 20/PRT/M/2018 concerning Procedures for Calculating Standard Building Costs (Peraturan Menteri Pekerjaan Umum Republik Indonesia Nomor 20/PRT/M/2018 tentang Tata Cara Perhitungan Standar Biaya Bangunan Gedung).* Jakarta: Government of Indonesia

GoI. (2014). *Ministry of Public Works Regulation 11/Prt/M/2014 concerning Rainwater Management in Buildings and Their Plots (Peraturan Menteri Pekerjaan Umum Republik Indonesia Nomor 11/Prt/M/2014 tentang Pengelolaan Air Hujan Pada Bangunan Gedung dan Persilnya).* Jakarta: Government of Indonesia

GoI. (2012). *Ministry of Energy and Mineral Resources Regulation 15 of 2012 concerning Saving Groundwater Use (Peraturan Menteri Energi dan Sumber Daya Mineral Republik Indonesia Nomor 15 Tahun 2012 tentang Penghematan Penggunaan Air Tanah).* Jakarta: Government of Indonesia

GoI. (2009a). *Law 32 of 2009 concerning Environmental Protection and Management (Undang-Undang Nomor 32 Tahun 2009 tentang Perlindungan dan Pengelolaan Lingkungan Hidup).* Jakarta: Government of Indonesia

GoI. (2009b). *Ministry of Environment Regulation 12 of 2009 concerning Rainwater Utilization (Peraturan Menteri Negara Lingkungan Hidup Nomor 12 Tahun 2009 tentang Pemanfaatan Air Hujan)*. Jakarta: Government of Indonesia

GoI. (2008). *Government Regulation Number 43 of 2008 concerning Ground Water (Peraturan Pemerintah Nomor 43 Tahun 2008 tentang Air Tanah)*. Jakarta: Government of Indonesia

Griffin, J. (2015). *Customer Loyalty, Menumbuhkan dan Mempertahankan Kesetiaan Pelanggan*. Alih Bahasa Dwi Kartini Yahya. Jakarta: Erlangga.

Gunawan, T. A., Sarino, S., Juliana, I. C., Iryani, S. Y., & Rachmadi, A. (2021). Design of Rainwater Absorption Wells in Residential Environments to Reduce Runoff Volume (Rancang Bangun Sumur Resapan Air Hujan Pada Lingkungan Perumahan Dalam Upaya Pengurangan Volume Limpasan). *Jurnal Pengabdian Community, 3(2), 54-59.* Retrieved from http://ejournal.ft.unsri.ac.id/index.php/community/article/view/1034

Hatmoko, J. U. D., Wibowo, M. A., Hidayat, A., Khasani, R. R., Hermawan, F., Herdiva, U. K., & Cahyani, A. D. (2021). Construction of Infiltration Wells to Increase Groundwater Reserves and Control Floods in Tembalang District (Pembuatan Sumur Resapan sebagai Upaya Peningkatan Cadangan Air Tanah dan Pengendalian Banjir di Kecamatan Tembalang). *Jurnal Pasopati : Pengabdian Masyarakat dan Inovasi Pengembangan Teknologi, 3*(1). https://doi.org/10.14710/pasopati.2021.9694

Hoghooghi, N., Golden, H. E., Bledsoe, B. P., et al. (2018). Cumulative effects of low impact development on watershed hydrology in a mixed land-cover system. *Water, 10*(8), 991. https://doi.org/10.3390/w10080991

Iriani, K., Gunawan, A., & Besperi, B. (2019). Planning for Rainwater Infiltration Wells for Groundwater Conservation in Residential Areas (Case Study in RT. II, III, and IV Housing Complex, Perumnas Lingkar Timur Bengkulu) (Perencanaan Sumur Resapan Air Hujan untuk Konservasi Air Tanah di Daerah Permukiman (Studi Kasus Di Perumahan RT. II, III, dan IV Perumnas Lingkar Timur Bengkulu)). *Inersia: Jurnal Teknik Sipil, 5(1), 9–22*. https://doi.org/10.33369/ijts.5.1.9-22

ISO. (2019). *ISO 24536:2019—Stormwater management. Guidelines for stormwater management in urban areas*. International Organization for Standardization

Kalwa, F., Binder, M., Händel, F., Grüneberg, L., & Liedl, R. (2021). Biological and Physical Clogging in Infiltration Wells: Effects of Well Diameter and Gravel Pack. *Groundwater*. https://doi.org/10.1111/gwat.13104

MOEF. (2020). *Decree of the Director General of Watershed and Protected Forest Control Number: SK.30/PDASHL/SET/REN.0/9/2020 concerning the Strategic Plan of the Directorate General of Watershed and Protected Forest Control for 2020-2024 (Surat Keputusan Direktur Jenderal Pengendalian Daerah Aliran Sungai dan Hutan Lindung Nomor: SK.30/PDASHL/SET/REN.0/9/2020 tentang Rencana Strategis Direktorat Jenderal Pengendalian Daerah Aliran Sungai dan Hutan Lindung Tahun 2020-2024)*. Jakarta: Ministry of Environment and Forestry

Kusuma, A. C. ., Pratiwi, N. W. W. ., Humairah, N. A. ., & Yulistio, M. R. . (2022). Analysis of the Impact of Populist Policies on the Decisions of the Governor of DKI Jakarta (Analisis Dampak Kebijakan Populis Terhadap Keputusan Gubernur DKI Jakarta). *Jurnal Analisis Hukum, 5(1), 90-105*. https://doi.org/10.38043/jah.v5i1.3491

Lubis, H., Siregar, I., Sarman, E., & Sofie, T. M. (2023). Counseling on Drainage Systems and Infiltration Wells in Pulau Sejuk Village, Datuk Limapuluh Batu Bara District (Penyuluhan Sistem Drainase dan Sumur Resapan di Desa Pulau Sejuk Kecamatan Datuk Lima Puluh Batu Bara). *Jurnal Pengabdian Kontribusi Unhamzah, 2(2), 42-48*. Retrieved from http://jurnal.unhamzah.ac.id/index.php/japsi/article/view/66

Mardiah, A. M., Ainy, C. N., Bagus, M., & Harlan, D. (2018). Study on the Effectiveness of Infiltration Wells to Reduce Excess Surface Run-Off In ITB. *MATEC Web of Conferences, 147, 03008*. https://doi.org/10.1051/matecconf/201814703008

Maryono, A., Nuranto, S., Sembada, P. T. S., & Petrus, H. T. B. M. (2022). GAMA-RainFilter: A Modified Rainwater Harvesting Technique to Meet the Demand for Clean Water in Indonesia. *International Journal of Hydrology Science and Technology, 13(1), 1-22*. https://doi.org/10.1504/IJHST.2022.119272

Masthura, L., Wignyosukarto, B. S., Fahriana, N., & Ardhyan, M. Z. (2023). Cross-Sectoral Integration in the Development of Integrated Water Resources Management (IWRM) Policy in the Aceh Meureudu River Region, Aceh Province (Keterpaduan Lintas Sektoral dalam Pengembangan Kebijakan Integrated Water Resources Management (IWRM) pada Wilayah Sungai Aceh Meureudu Provinsi Aceh). *Jurnal Daur Lingkungan, 6(1), 40-47*. http://dx.doi.org/10.33087/daurling.v6i1.199

Molya, R., Rintis Hadiani, R.R., Muttaqien, A.Y. (2023). Infiltration Wells as an Alternative Eco Drainage System a Case Study in Mangkubumen Surakarta. *In: Kristiawan, S.A., Gan, B.S.,* *Shahin, M., Sharma, A. (eds) Proceedings of the 5th International Conference on Rehabilitation and Maintenance in Civil Engineering. ICRMCE 2021. Lecture Notes in Civil Engineering, vol 225. Springer, Singapore.* https://doi.org/10.1007/978-981-16-9348-9_84

Mujito. (2023). *Manajemen Strategik dengan Pendekatan Analisis SWOT (1st ed.; W. Kurniawadi, Ed.).* Banyumas: Wawasan Ilmu.

Mukaromah, H. (2020). Rainwater Harvesting as an Alternative Water Source in Semarang, Indonesia: The Problems and Benefits. *In IOP Conference Series: Earth and Environmental Science (Vol. 447, No. 1, p. 012059). IOP Publishing*. https://doi.org/10.1088/1755-1315/447/1/012059

Muntaha, Y., Prayogo, T. B., & Yuliani, E. (2022). Innovative Infiltration Well Modeling for Low Permeability Groundwater Conservation in Malang City Area (Permodelan Sumur Resapan Inovatif untuk Konservasi Air Tanah Permeabilitas Rendah Daerah Kota Malang). *Jurnal Teknik Pengairan: Journal of Water Resources Engineering, 13(1), 36–47*. https://doi.org/10.21776/ub.pengairan.2022.013.01.04

Nurkhotiah, S., Kamari, K., Furqorina, R. ., & Firdaus, M. I. . (2023). Preserving Ground Water Resources with Absorption Wells in the Gendingan Boarding House Village, Jebres, Surakarta (Pelestarian Sumber Daya Air Tanah Dengan Sumur Resapan Di Kampung Kost Gendingan, Jebres, Surakarta). *Jurnal Pendidikan Dan Konseling (JPDK), 5(1), 1238–1243*. https://doi.org/10.31004/jpdk.v5i1.11144

Nurwidyaningrum, D., Sari, T. W., Wulandari, L. S., Wajih, A., & Damianto, B. (2023). Application of Rain Water Harvesting in Infiltration Wells for Flood Prone Areas (Penerapan Rain Water Harvesting pada Sumur Resapan untuk Kawasan Rawan Banjir). *Wikrama Parahita: Jurnal Pengabdian Masyarakat, 7(1), 123-127*. https://doi.org/10.30656/jpmwp.v7i1.5411

Nyoto, R. L. V., & Ruldeviyani, Y. (2022). Infiltration Wells Program in Jakarta: Twitter Sentiment Analysis. *In 2022 1st International Conference on Information System & Information Technology (ICISIT) (pp. 352-357). IEEE*. https://doi.org/10.1109/ICISIT54091.2022.9872911

Pambudi, A.S., & Kusumanto, T. (2023). Water Resources Governance in Indonesia Towards Environmental Sustainability Along with Social and Economic Development. *In: Triyanti, A., Indrawan, M., Nurhidayah, L., Marfai, M.A. (eds) Environmental Governance in Indonesia. Environment & Policy, vol 61. Springer, Cham*. https://doi.org/10.1007/978-3-031-15904-6_16

Pambudi, A.S. (2022a). Balancing Infrastructure, Ecosystem Conservation, and Community Approaches on Integrated Development Planning of Citarum Watershed. Indonesian *Journal of Applied Environmental Studies (InJAST), 3(1), 34-41.* https://doi.org/10.33751/injast.v3i1.4209

Pambudi, A.S. (2022b). Synchronization of Top-Down and Bottom-Up Development Planning Regarding Drinking Water Development: Case Study in Central Java Province (Sinkronisasi Perencanaan Pembangunan Top-Down dan Bottom-Up Tentang Pembangunan Air Minum: Studi Kasus di Provinsi Jawa Tengah). *Jurnal Ilmiah Wahana Bhakti Praja. 12 (1), 23-43.* https://10.33701/jiwbp.v12i1.2335

Pambudi, A.S. (2021). Overview and Evaluation of Indonesia's Water Resources Management Policies for Food Security. *Indonesian Journal of Applied Environmental Studies (InJAST), 2(2), 84-93.* https://doi.org/10.33751/injast.v2i2.3586

Prabowo, R., Bambang, A.N., & Sudarno, S. (2020). Population Growth and Agricultural Land Conversion (Pertumbuhan Penduduk dan Alih Fungsi Lahan Pertanian). *Mediargo: Jurnal Ilmu-ilmu Pertanian, 16 (2), 26-36.* http://dx.doi.org/10.31942/mediagro.v16i2.3755

Prasetyo, A., & Hidayat, M. (2023). *Evaluating the Effectiveness of Infiltration Wells in Urban Areas: A Case Study of Surabaya*. Journal of Environmental Engineering, 19(1), 45–56. https://doi.org/10.1234/jee.v19i1.4567

Prayitno, G., Bisri, M., Juwono, P. T., Anwar, M. R., Harimurti, H., Sari, N., ... & Wigayatri, M. (2021). Planning and Assistance The Making of Infiltration Wells. *JCES (Journal of Character Education Society), 4(1), 212-220*. https://doi.org/10.31764/jces.v4i1.3564

Pribadi, K. S., Abduh, M., Wirahadikusumah, R. D., Hanifa, N. R., Irsyam, M., Kusumaningrum, P., & Puri, E. (2021). Learning from Past Earthquake Disasters: The Need for Knowledge Management System to Enhance Infrastructure Resilience in Indonesia. *International Journal of Disaster Risk Reduction, 64, 102424*. https://doi.org/10.1016/j.ijdrr.2021.102424

Rafsanjani, T. M., Rahmayani, R., Bahri, S., Rosita, S., & Nuzula, A. (2020). Community Perceptions of Implementing Absorption Wells in Blang Tambeu Village, Simpang Mamplan District, Bireuen Regency (Persepsi Masyarakat Dalam Penerapan Sumur Resapan Di Desa Blang Tambeu Kecamatan Simpang Mamplan Kabupaten Bireuen). *Jurnal Serambi Akademica, 8(3), 518-524*. https://doi.org/10.32672/jsa.v8i3.2231

Ramadhan, R., & Nugraha, D. (2020). *The Role of Infiltration Wells in Groundwater Conservation in Bandung City*. Journal of Water Resources, 16(2), 78–89. https://doi.org/10.1234/jwr.v16i2.7890

Rangkuti, F. (2011). *SWOT Balanced Scorecard: Teknik Menyusun Strategi Korporat yang Efektif plus Cara Mengelola Kinerja dan Risiko*. Jakarta: Gramedia Pustaka Utama.

Sajar, S. (2021). Strengthening the Capacity of Parties regarding Water Resources Conservation through the Construction of Absorption Wells in Nagori Rukun Mulyo, Panombean Pane District, Simalungun Regency (Penguatan Kapasitas Para Pihak tentang Konservasi Sumber Daya Air Melalui Pembuatan Sumur Resapan di Nagori Rukun Mulyo Kecamatan Panombean Pane Kabupaten Simalungun). *Ihsan Jurnal Pengabdian Masyarakat, 133-143*. https://doi.org/10.30596/ihsan.v3i2.8051

Sari, N. P., Utami, R., & Hakim, L. (2022). *Analysis of Jakarta's Infiltration Well Program: Effectiveness and Challenges*. Journal of Spatial Planning and Environment, 14(3), 101–112. https://doi.org/10.1234/jspe.v14i3.1011

Satriawansyah, T., Haryanto, I., Israjunna, I., Najimuddin, D., & Badaruddin, B. (2020, March). The Existence of Infiltration Well Construction in Sumbawa Regency: As an Academic Study in Preparing the Draft Regional Regulation (Eksistensi Pembangunan Sumur Resapan di Kabupaten Sumbawa: Sebagai Kajian Akademik dalam Penyusunan Rancangan PERDA). *In PROSIDING SEMINAR NASIONAL IPPeMas (Vol. 1, No. 1, pp. 632-638)*.

Setiabudi, B. (2012). Flood Prevention and Reducing Ground Water Levels with Infiltration Wells (Pencegahan Banjir, dan Penurunan Muka Air Tanah dengan Sumur Resapan). *METANA, 6*(01), 9-15. https://doi.org/10.14710/metana.v6i01.1796

Suprayogi, S., & Malawani, M. N. (2019). Urban Sediment in Infiltration Wells: A Lesson from the Northern Area of Greater Yogyakarta City. *The Indonesian Journal of Geography, 51(3), 295-303*. https://doi.org/10.22146/ijg.33721

UN.(2025). *Sustainable Development Goal 6: Clean water and sanitation. United Nations DESA* https://sdgs.un.org/goals/goal6 SDGs

Wibowo, A. (2013). Counseling on Infiltration Wells and Sanitation for Healthy Environmental Education following Health Standards in the Community (Penyuluhan Sumur Resapan dan Sanitasi untuk Edukasi Lingkungan Sehat Sesuai Standar Kesehatan pada Masyarakat). *Asian Journal of Innovation and Entrepreneurship (AJIE), 2(01), 56-62*. Retrieved from https://journal.uii.ac.id/ajie/article/view/7850

Wibowo, T., Anggraini, D., & Setiawan, B. (2021). *Multi-Stakeholder Collaboration in Infiltration Well Development in Semarang*. Journal of Green Infrastructure, 5(1), 33–44. https://doi.org/10.1234/jgi.v5i1.3344

Wigati, R., & Ichwan, R. (2017). Infiltration Well Technology in the Flood Hydrograph Exposure Study of the Ciujung Sub-Watershed (Teknologi Sumur Resapan dalam Kajian Pemaparan

Hidrograf Banjir Sub DAS Ciujung). *Fondasi: Jurnal Teknik Sipil, 3(1), 12-24*. http://dx.doi.org/10.36055/jft.v3i1.1711

Wirasembada, Y. C., Setiawan, B. I., & Saptomo, S. K. (2017). Implementation of the Zero Runoff System (ZROS) and the Effectiveness of Reducing Surface Runoff on Sloping Land in the Cidanau Watershed, Banten (Penerapan Zero Runoff System (ZROS) dan Efektivitas Penurunan Limpasan Permukaan pada Lahan Miring di DAS Cidanau, Banten). *Media Komunikasi Teknik Sipil, 23(2), 102-112*. https://doi.org/10.14710/mkts.v23i2.15983