

Construction of Recharge Well Project as an Effort to Prevent Flooding on Balai Street, Rawabangun Subdistrict, Taman Sari District, Pangkal Pinang City

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Abstract: Flooding in urban areas has become a serious issue, including in Jalan Balai, Rawabangun Subdistrict, Pangkalpinang, which frequently experiences inundation due to insufficient water infiltration and inadequate drainage systems. This study aims to analyze the effectiveness of infiltration wells in mitigating floods, assess their impact on the community, and evaluate their financial feasibility. The research employs a descriptive quantitative approach, utilizing primary and secondary data analysis.

The study results indicate that the infiltration well construction project is feasible, with a positive NPV of Rp 142,743,495 (10%) and Rp 111,783,802 (15%), an IRR of 12.8%, a BCR of 2.06, and a payback period of 1.85 years. This construction is expected to reduce water inundation, enhance community mobility, and support environmental sustainability by preserving groundwater reserves. Additionally, the project provides a strategic solution to minimize flood risks and improve the quality of life for the local community. The study recommends regular maintenance of infiltration wells and public awareness campaigns to ensure their effectiveness.

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Introduction

Flooding has become a complex issue in various urban areas, especially in Indonesia, known as a tropical country with high rainfall intensity. In urban areas, floods are often caused by rapid urbanization, which reduces water-absorbing land. According to Bahunta & Wasposito (2019), urban floods can be classified into floods caused by heavy local rainfall, river overflow floods, and flash floods. Land that once absorbed water is now largely replaced by infrastructure such as concrete, asphalt, and buildings, preventing

natural water absorption. This situation is exacerbated by inadequate drainage systems and the habit of people littering, which eventually clogs water channels.

The impacts of flooding are not only economically damaging, such as infrastructure and property damage, but also affect public health and comfort. In the long term, recurring floods also threaten the balance of urban ecosystems, including declining environmental quality and groundwater availability.

The construction of infiltration wells has emerged as an innovative solution to address this problem. In general, infiltration wells are structures or pits designed to collect rainwater or surface runoff, allowing it to seep into the ground. This process can help maintain and even increase groundwater levels and reduce surface runoff because the water is directly absorbed (Silvia, 2020). These wells collect water from surfaces such as rooftops or roads and channel it deeper into the ground through infiltration systems. This simple technology not only reduces rainwater runoff that causes flooding but also plays a strategic role in replenishing aquifers or groundwater reserves. Thus, infiltration wells serve both as flood mitigation tools and as sustainable water conservation methods.

A plan to build infiltration wells is set for Jalan Balai, Rawabangun Subdistrict, Taman Sari District, in the city of Pangkalpinang. This road is a vital part of Pangkalpinang, serving as a crucial link for economic activities and transportation access frequently used by the community. Jalan Balai is notorious for flooding, particularly during the rainy season, due to its low-lying location and proximity to a river. Frequent flooding has made this road a point of special concern. The floods here are often caused by inadequate drainage and accumulated waste blocking the water channels. As a result, when rainfall increases, it can lead to flooding. This phenomenon is due to geographical factors, where infrastructure development often overlooks environmental considerations.

Consequently, flooding on this road disrupts many community activities, including transportation and access to public services. Therefore, addressing the flood problem on Jalan Balai must be a top priority to ensure the comfort and safety of local residents. To meet this need and contribute to the smooth flow of community activities in this area, building infiltration wells is seen as an effective solution to mitigate flooding. It is

hoped that these wells will benefit the community, allowing them to carry out their activities without worrying about floods during rainfall, as the water will be absorbed into these wells.

Literature Review

1. Previous research conducted by Nurwidyaningrum et al. (2023) in their study entitled "Application of Rain Water Harvesting in Infiltration Wells for Flood-Prone Areas" addresses the pressing issue of urban flooding in Beji Village, Depok City, Indonesia. As one of the densely populated areas in the region, Beji Village faces a significant challenge in managing rainwater due to the depletion of vacant land for water infiltration caused by widespread housing development. This has led to frequent flooding, particularly during periods of heavy rainfall. To combat this issue, the researchers proposed and implemented a rainwater harvesting system through the construction of infiltration wells. These wells channel rainwater into the ground, allowing it to infiltrate the soil and replenish groundwater reserves. This method not only mitigates flooding but also provides an additional water source for non-drinking purposes, such as plant irrigation and cleaning. The initiative, carried out under the community service program supported by the Jakarta State Polytechnic, included site surveys, detailed engineering design using Google SketchUp, and close collaboration with local residents, ensuring both technical effectiveness and community acceptance.

The results of this study highlight the effectiveness of rainwater harvesting as a sustainable solution for urban water management. The constructed infiltration wells demonstrated a twofold increase in water absorption rates, significantly reducing the time required for water runoff to dissipate. For instance, areas that previously experienced water pooling

for 30 minutes saw this reduced to 10–15 minutes after the wells were operational. The project also emphasized the importance of proper material selection, such as the use of concrete rings and PVC pipes for durability and functionality. Additionally, the inclusion of filtration systems ensured that the collected water was free from debris, enhancing the performance of the infiltration wells. The successful implementation of this project underscores the potential of integrating simple yet innovative engineering solutions with active community participation to address environmental challenges like flooding. It also sets a precedent for similar urban areas facing water management issues, demonstrating that localized interventions can yield significant environmental and social benefits.

2. Previous research conducted by Fachrul et al. (2020) in their study entitled "Counseling for Constructing Infiltration Wells as Conservation of Water Resources in Sukmajaya Sub-District, Cisalak, Depok, West Java" highlights efforts to mitigate flooding and conserve water resources through community education and the construction of infiltration wells. This study addresses environmental challenges caused by rapid urbanization, such as reduced open green spaces and altered water management systems in Cisalak Village. The counseling program aimed to raise awareness among residents about the benefits of infiltration wells, which help channel rainwater into the ground to replenish groundwater, mitigate flooding, and ensure water sustainability. The program involved lectures, discussions, and interactive sessions with local residents, focusing on water conservation practices and practical techniques for constructing infiltration wells. By fostering an environmentally friendly mindset, the project successfully

equipped the community with knowledge to address water-related issues effectively.

The implementation of this program underscored the importance of collaboration between academic institutions and local communities in tackling environmental problems. The study identified key issues in Cisalak, including inadequate water catchment areas due to dense settlements, frequent flooding, and the poor condition of Situ Pangarengan, a local water body affected by sedimentation and waste pollution. The outreach activities demonstrated the feasibility and benefits of infiltration wells in urban settings, as residents actively engaged in discussions and expressed interest in applying these solutions to their neighborhoods. This initiative not only improved the community's understanding of sustainable water management but also laid the groundwork for continuous efforts to promote water conservation through practical infrastructure and increased awareness.

3. Previous research conducted by Akhmad Azis et al. (2016) in a study entitled "Soil Water Conservation through the Construction of Rainwater Recharge Wells in Maradekaya Sub-district, Makassar City" addresses the critical issue of groundwater crises in urban areas. This study focuses on implementing artificial recharge methods to mitigate the adverse effects of overexploitation and urbanization, which have led to land subsidence, seawater intrusion, and declining groundwater quality in Makassar. The researchers aimed to educate the local community in RW 03 and RW 04 of Maradekaya Sub-district about the construction and benefits of rainwater recharge wells. By implementing recharge wells in five households per neighborhood, they

demonstrated significant improvements in water quality parameters. For example, turbidity decreased by 27.5%, sodium levels by 12.3%, and chloride by 11.1%, reflecting enhanced water quality and sustainability.

The study emphasized the long-term objective of promoting mandatory legislation for rainwater recharge wells in Makassar to ensure sustainable groundwater management. Additionally, the findings revealed community enthusiasm and highlighted the broader ecological benefits, such as reduced surface runoff, flood mitigation, and prevention of seawater intrusion. Overall, this research underlines the importance of integrating community-based water conservation strategies to address urban water crises.

4. Previous research conducted by Herlin Sukmarini et al. (2023) in a study entitled "Study of the Identification of RTH Potential and Development Directions of Recharge Well Areas in Pasar Rebo Subdistrict" highlights the strategic role of Green Open Space (RTH) and recharge wells in urban spatial planning and flood management. The research examines Pasar Rebo Subdistrict in East Jakarta, a lowland area facing challenges such as inadequate RTH—only 4.4% of the total area compared to the mandated 20%—and recurring flood incidents due to limited drainage capacity and reduced infiltration zones. The study aims to identify flood-prone areas, evaluate RTH utilization, and recommend potential recharge well locations to mitigate these issues.

The researchers emphasized the dual role of RTH as ecological stabilizers and social spaces, while recharge wells were identified as key tools for enhancing groundwater conservation, flood control, and erosion prevention. In 2021, 9,043 recharge wells were constructed across

five villages in Pasar Rebo, with an average capacity of 2.43 m³ per well, significantly contributing to flood mitigation efforts. The study recommends optimizing RTH usage, restoring riverbanks, and integrating recharge wells in residential zones, supported by regulations such as Jakarta Governor Regulation No. 31/2022. This comprehensive approach offers a sustainable framework for urban resilience in densely populated areas.

5. Previous research conducted by Edwin Permana et al. (2019) in a study entitled "Counseling on Biopore Infiltration Hole Making in RT 04 Mayang Mangurai Village, Jambi City" explores the implementation of biopore technology to address issues of flooding and water scarcity in urban areas. The study focuses on the application of biopore infiltration holes as a sustainable solution in Mayang Mangurai Village, where seasonal droughts and flooding are prevalent due to inadequate groundwater recharge and poor environmental practices. These infiltration holes, filled with organic waste, enhance water absorption into the soil while promoting composting.

The researchers conducted community outreach, emphasizing the benefits of biopores, including flood mitigation, organic waste management, soil fertility improvement, and groundwater quality enhancement. Practical training sessions equipped residents with tools and techniques to create biopores in their residential areas. The findings indicated high community enthusiasm, with many participants adopting the technology in their homes. This initiative highlighted biopores as an efficient, low-cost solution to urban environmental challenges, fostering collaboration between the community and academia for sustainable development.

Method

This research is descriptive and quantitative in nature. The descriptive research method is an approach that aims to describe in detail and systematically a phenomenon, situation, or characteristic being studied. This research focuses on "what is," where the researcher strives to present facts according to what is found without attempting to influence or change the situation (Hanyfah et al., 2022). Descriptive research is used when the researcher wants to understand or map a particular phenomenon, such as societal behavior, social conditions, or the physical characteristics of an object.

Meanwhile, the quantitative research method focuses more on measuring and analyzing data based on numbers. This approach is often used to test specific hypotheses or to find patterns, relationships, or generalizations based on numerical data. Quantitative research uses standard measurement tools and statistical techniques to collect and analyze data (Abuk & Rumbino, 2020).



720 m

Research Location

Jalan Balai is one of the streets located in the Rawabangun neighborhood, Taman Sari District, Pangkalpinang City, Bangka Belitung Province. It is situated in a vital area of Pangkalpinang city, serving as an important route that connects various economic activities and transportation access, frequently used by the public for various activities. However, Jalan Balai in

Pangkalpinang is also known as one of the areas prone to flooding, especially during the rainy season, due to its low-lying location and proximity to a river.

Stages of research

a. Data Collection Methods

The data used in this study consists of primary and secondary data. Primary data is collected through direct observations conducted in the field, while secondary data is obtained from relevant institutions if needed to support the research findings. Primary data for this study will be gathered through direct field observations. Secondary data serves as supporting data collected from literature studies, such as books and research journals, as well as data compilation (Silvia, 2020).

Observation

In observation, the research object is observed to determine the initial condition of the road location and the current drainage condition of the public road.

Documentation

Documentation is used to collect data, specifically the sections and length of the road, for the planning of the infiltration well construction points.

b. Data Processing and Collection Phase

According to (Hanyfah et al., 2022), data processing is the process of transforming raw data into usable and relevant information. This requires a sequence of actions to organize, analyze, and present the data in a way that can be evaluated and used for decision-making.

1. NPV (Net Present Value)

The Net Present Value (NPV) method compares the present value of net cash inflows (revenues) with the present value of investment costs (expenditures). To evaluate the feasibility of an investment using the NPV approach, data on initial cash outflows, future net cash inflows, and the target minimum

return rate are required. (Abuk & Rumbino, 2020)

$$NPV = \sum_t^n = 0 \frac{CF_t}{(1+r)^t} - C_0$$

CF_t: Cash flow in period *t*
r: Discount rate

n: Number of years (economic lifespan) of the project

C₀: Initial investment

If the NPV is positive, the project is considered feasible, as it is expected to generate profit. Conversely, if the NPV is negative, the project is not viable as it is likely to incur losses. Meanwhile, if the NPV equals zero, the planned investment is expected to neither generate profit nor incur loss.

2. IRR (Internal Rate Of Return)

The Internal Rate of Return (IRR) is the interest rate used to evaluate the feasibility of a project over a specific period. The IRR method measures investment feasibility by calculating the interest rate that makes the present value of expected returns equal to the present value of capital costs, resulting in (NPV = 0). In this method, the time value of money is considered, so the cash flows received are discounted based on the cost of capital or the applied interest rate. If the internal rate of return exceeds the set discount rate or the company's financial policy, the project is considered profitable. In other words, a project with an IRR greater than the discount rate indicates potential for significant profit.

$$IRR = i_t + \frac{NPV_1}{NPV_1 + NPV_2} \times (i_2 - i_1)$$

Where:

NPV₁: NPV at the discount rate *i*₁

NPV₂: NPV at the discount rate *i*₂

*i*₁: Discount rate that results in NPV₁

*i*₂: Discount rate that results in NPV₂

3. BCR (Benefit cost Ratio)

The Benefit-Cost Ratio (BCR) method is an alternative comparison approach using the Benefit-Cost Ratio. Similar to IRR, the highest benefit-cost ratio does not necessarily imply the best choice. This criterion is based on the calculation of the ratio between the

total present value of positive benefit flows minus costs and the total present value of negative benefit flows minus costs (Sabrina et al., 2012).

$$BCR = \frac{\text{Total benefit}}{\text{Total cost}}$$

Total benefit: The value of benefits generated by the project

Total cost: The total cost incurred to implement the project

- If (BCR > 1), the benefits exceed the costs, indicating the project is feasible or economically profitable.

- If (BCR < 1), the benefits are less than the costs, indicating the project is economically unfeasible or unprofitable.

- If (BCR = 1), the benefits equal the costs, meaning the project is "break-even" in economic terms.

4. PP (Payback Period)

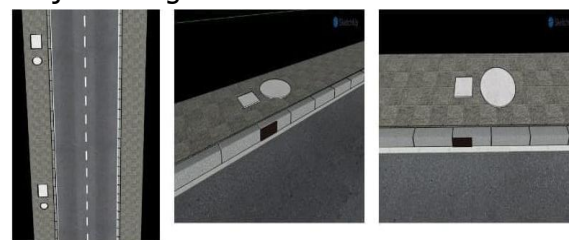
The Payback Period is a method to determine how long it will take for an investment to be recovered or the duration required to cover the investment expenditure (initial cash investment) using cash flows. In other words, the payback period is the ratio of the initial cash investment to the cash flows, resulting in a time unit. An investment proposal will be approved if the payback period is faster or shorter than the company's requirements. The formula for the payback period applies if the cash flows of the investment/project plan are equal each year.

$$PP = \frac{\text{Nilai investasi}}{\text{Pendapatan}} \times 1 \text{ tahun}$$

To calculate the analysis of this financial aspect, use the current interest rate of 5% per tahun.

Results and Discussion

Project Design



The plan for the construction of infiltration wells on Balai Street, Rawa Bangun Village, Pangkal Pinang City, with a road length of approximately 720 meters, involves the construction of infiltration wells utilizing around 25 units, which will be built on the sidewalks and distributed across several strategic locations.

A. Financial Analysis

1. Net Present Value (NPV)

Table 4.2 Net Present Value (NPV) 10%

Year	Cash Flow	Present Value
Year 0	IDR 133.860.000	IDR 133.860.000
Year 1	IDR 80.316.000	IDR 69.840.000
Year 2	IDR 72.284.400	IDR 54.657.391
Year 3	IDR 76.300.200	IDR 50.168.620
Year 4	IDR 68.268.600	IDR 39.032.794
Year 5	IDR 64.252.800	IDR 31.944.997
	Total PV	IDR 245.643.802
	NPV 15%	IDR 111.783.802

Source: Data Diolah (2024)

Tabel 4.3 Net Present Value (NPV)15%

Year	Cash Flow	Present Value
Year 0	IDR 133.860.000	IDR 133.860.000
Year 1	IDR 80.316.000	IDR 69.840.000
Year 2	IDR 72.284.400	IDR 54.657.391
Year 3	IDR 76.300.200	IDR 50.168.620
Year 4	IDR 68.268.600	IDR 39.032.794
Year 5	IDR 64.252.800	IDR 31.944.997
	Total PV	IDR 245.643.802

	NPV 15%	IDR
		111.783.802

Source: Data Diolah (2024)

2. Internal Rate of Return (IRR)

Known:

$$i_1 = 10\% \quad NPV_1 = \text{Rp } 142.743.495$$

$$i_2 = 15\% \quad NPV_2 = \text{Rp } 111.783.802$$

$$IRR = i_t + \frac{NPV_1}{NPV_1 + NPV_2} \times (i_2 - i_1)$$

$$IRR = 10\% + \frac{\text{Rp } 142.743.495}{\text{Rp } 142.743.495 + \text{Rp } 111.783.802} \times$$

(15% - 10%)

$$IRR = 10\% + \frac{\text{Rp } 142.743.495}{\text{Rp } 254.527.297} \times 5\%$$

$$IRR = 10\% + 0,56 \times 5\%$$

$$IRR = 10\% + 2,8\%$$

$$IRR = 12,8 \%$$

3. Benefit Cost Ratio (BCR)

$$\text{Benefit} = \sum PV \text{ manfaat } (1 - 5)$$

$$= \text{Rp } 276.603.495$$

$$\text{Cost} = \text{Rp } 133.860.000$$

$$B/C = \frac{\text{Benefit}}{\text{Cost}}$$

$$B/C = \frac{\text{Rp } 276.603.495}{\text{Rp } 133.860.000} = 2.06$$

4. Payback Peroid (PP)

Known:

$$\text{Investment value} = \text{Rp } 133.860.000$$

$$\text{Income} = \frac{\text{Rp } 361.422.000}{5}$$

$$= \text{IDR } 72.284.400$$

$$PP = \frac{\text{Nilai Investasi}}{\text{Pendapatan}} \times 1 \text{ tahun}$$

$$PP = \frac{\text{Rp } 133.860.000}{\text{Rp } 72.284.400} \times 1 \text{ tahun}$$

$$PP = 1,85 \text{ tahun}$$

The Bill of Quantities (RAB) is one of the main stages in a project, as it serves as the foundation for preparing the financing proposal and establishing the budget framework that will be spent (Juansyah et al., 2017). The RAB includes various important aspects, such as the following cost planning:

- a. Preparation Costs are the expenses incurred before the construction begins. The required preparation costs amount to Rp 1,450,000.
- b. Operational Costs are the expenses incurred for paying labor, electricity, water, telecommunications, cleaning services, and consumable materials. The operational costs for this construction project amount to Rp 124,276,000.
- c. Investment Costs are the expenses incurred for making investments, such as purchasing assets. The required investment costs amount to Rp 8,134,000.

Based on the financial feasibility analysis of the recharge well construction project on Balai Street, Rawabangun Subdistrict, Pangkalpinang City, the project is considered financially viable using several key indicators. First, the Net Present Value (NPV) calculation shows a positive result of Rp 142,743,495 at an interest rate of 10% and Rp 111,783,802 at an interest rate of 15%. This positive NPV indicates that the project is expected to generate profits greater than its investment costs, making it feasible to implement. Additionally, the Internal Rate of Return (IRR) for the project is 12.8%, which means the return rate is higher than the interest rate used in the analysis, showing significant profit potential. In terms of the benefit-cost ratio, the project has a Benefit-Cost Ratio (BCR) of 2.06, meaning every rupiah invested will generate more than twice the benefits of the costs incurred.

A BCR greater than 1 indicates that the project is not only economically beneficial but also provides a greater positive impact than its expenses. Finally, the Payback Period (PP) calculation shows that the capital invested in this project can be recovered in 1.85 years, which is a relatively short payback period, confirming the project's feasibility in terms of investment recovery. With the financial analysis showing clear profits, the recharge well construction project is deemed feasible to implement both economically and in terms of investment recovery time.

Conclusion

The construction of recharge wells on Balai Street, Rawabangun Subdistrict, is an effective solution to address the frequent flooding issues that disrupt community activities. Based on the financial feasibility analysis, this project is considered viable with positive NPV, IRR, and BCR values, as well as a short payback period. Additionally, the positive impact of the recharge well construction not only reduces water pooling but also enhances comfort, safety, and the smoothness of community activities in the area. This project also contributes to environmental sustainability by maintaining groundwater availability and minimizing infrastructure damage caused by flooding.

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Conflict of Interest

The author is conducting research as a community who needs a solution to overcome the problem of flooding, in this case the author as a designer provides an overview of the feasibility of the infiltration well project

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