UNIVERSITAS
GADJAH MADA
**EFEKTIVITAS SUMUR PERESAPAN AIR HUJAN (SPAH) DALAM MENGURANGI VOLUME LIMPASAN PADA SALURAN AIR HUJAN
JALAN SOEPOMO MENGGUNAKAN EPA SWMM 5.2**
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INTISARI

Pertumbuhan kawasan permukiman padat di perkotaan menyebabkan peningkatan luas area kedap air yang berdampak pada meningkatnya volume dan debit puncak limpasan permukaan. Drainase Jalan Soepomo, Kota Yogyakarta baru selesai dibangun pada Desember 2025 untuk menggantikan saluran lama yang kapasitasnya tidak mencukupi. Penelitian ini bertujuan mengevaluasi kinerja drainase baru tersebut secara proyektif pada kondisi seluruh area pelayanan telah terhubung, serta mengkaji efektivitas Sumur Peresapan Air Hujan (SPAH) sebagai implementasi *Low Impact Development* (LID) dalam mengurangi limpasan permukaan.

Simulasi hidrologi-hidraulika dilakukan menggunakan EPA SWMM 5.2 dengan model terdiri dari 21 *subcatchment* (29,56 ha), 50 *junction*, 75 *conduit*, 25 unit SPAH sebagai *storage unit*, dan 1 *outfall*. Hujan rencana menggunakan distribusi Log-Pearson III kala ulang 5 tahun (R24 = 122,62 mm, durasi 2 jam) berdasarkan data ARR Stasiun Gemawang 2001-2023, dengan persentase area kedap air 80%. LID SPAH dimodelkan sebagai *Infiltration Trench* berdensitas 1 unit/60 m². Analisis sensitivitas dilakukan terhadap densitas SPAH (1/40, 1/60, 1/80 m²), kala ulang hujan (2, 5, 10 tahun), serta parameter %*Impervious* dan %*Pervious Area Treated* pada LID *Usage*.

Hasil simulasi menunjukkan sistem drainase eksisting valid dengan *continuity error* di bawah 10%. Terdapat 3 *node flooding* dengan total volume 449 m^3 dan durasi kurang dari 1 jam, serta lebih dari 40 *conduit surcharge*. Penerapan LID SPAH mengurangi volume limpasan total 14,14% dan volume *outfall* 13,96%. Total volume *flooding* berkurang 44,76%, dengan reduksi terbesar pada *node* J-30 sebesar 66,67%. Ketiga *node flooding* tetap berdurasi dibawah 1 jam pasca penerapan LID. Durasi *node flooding* termasuk kategori prioritas terendah berdasarkan Permen PU No.12/2014. Perubahan densitas SPAH dari densitas rendah (1/80 m²), sedang (1/60 m^2) hingga tinggi (1/40 m²): limpasan 11,17%, 14,14, dan 21,12%, *outfall* 11,08%, 13,96%, dan 20,51%, dan *flooding* 30,29%, 44,77%, 80,62%. menunjukkan bahwa semakin banyak jumlah unit SPAH maka efektivitas reduksi volume limpasan, *outfall*, dan *flooding* akan semakin tinggi. Analisis sensitivitas kala ulang hujan menunjukkan bahwa efektivitas LID SPAH dalam mereduksi volume limpasan dan *outfall* cenderung menurun seiring meningkatnya kala ulang, yaitu dari 21,58% dan 21,65%, pada kala ulang 2 tahun menjadi 11,44% dan 9,63% pada kala ulang 10 tahun. Pola reduksi volume *flooding* bersifat non-monoton: tidak terjadi *flooding* pada kondisi eksisting kala ulang 2 tahun, reduksi tertinggi sebesar 44,76% terjadi pada kala ulang 5 tahun, kemudian menurun menjadi 30,35% pada kala ulang 10 tahun seiring meningkatnya volume banjir eksisting yang melampaui kapasitas LID. Pada analisis %*Area Treated*, %*Pervious Area Treated* tidak berpengaruh karena limpasan *pervious* eksisting bernilai nol, sedangkan %*Impervious Area Treated* 100% sedikit menambah reduksi limpasan dan *outfall* namun memperbesar volume *flooding* pada seluruh *node*, karena unit LID lebih cepat jenuh dan melepaskan debit secara tiba-tiba. Hasil analisis sensitivitas menunjukkan bahwa densitas 1 unit per 60 m^2 merupakan pilihan yang seimbang antara efektivitas dan kemudahan penerapan di lapangan, sementara densitas 1 unit per 40 m^2 dapat direkomendasikan jika ketersediaan lahan memungkinkan. SPAH lebih efektif berperan sebagai pelengkap sistem drainase konvensional dan perlu dikombinasikan dengan infrastruktur lain untuk menghadapi kejadian hujan dengan kala ulang yang lebih tinggi.

Kata kunci: drainase perkotaan, EPA SWMM, Low Impact Development, sumur resapan, limpasan permukaan, Yogyakarta.

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ABSTRACT

The growth of dense urban settlements increases impervious surface area, thereby raising both the volume and peak discharge of surface runoff. The drainage system on Soepomo Street, Yogyakarta City, was completed in December 2025 to replace the old channel whose capacity was no longer adequate. This study evaluates the performance of the new drainage system under a projected condition in which the entire service area is fully connected, and examines the effectiveness of Rainwater Infiltration Wells (Sumur Peresapan Air Hujan/SPAH) as an implementation of Low Impact Development (LID) in reducing surface runoff.

Hydrologic-hydraulic simulation was performed using EPA SWMM 5.2, with a model consisting of 21 subcatchments (29.56 ha), 50 junctions, 75 conduits, 25 SPAH units modeled as storage units, and 1 outfall. The design storm was derived from a Log-Pearson Type III distribution with a 5-year return period (R24 = 122.62 mm, 2-hour duration) based on ARR rainfall data from Gemawang Station for 2001-2023, with an impervious area percentage of 80%. LID SPAH units were modeled as Infiltration Trenches at a density of 1 unit per 60 m². Sensitivity analyses were conducted on SPAH density (1/40, 1/60, and 1/80 m²), rainfall return period (2, 5, and 10 years), and the %Impervious and %Pervious Area Treated parameters within the LID Usage settings.

Simulation results show that the existing drainage system is valid, with a continuity error below 10%. Three nodes experienced flooding with a total volume of 449 m³ and a duration of less than 1 hour, along with more than 40 surcharged conduits. The application of LID SPAH reduced total runoff volume by 14.14%, outfall volume by 13.96%, and flooding volume by 44.76% (with the largest reduction occurring at node J-30, at 66.67%), while flooding duration at all three nodes remained under 1 hour, placing it in the lowest priority category according to Ministerial Regulation of Public Works (Permen PU) No. 12/2014. Increasing SPAH density from low (1/80 m²) to high (1/40 m²) raised runoff reduction from 11.17% to 21.12%, outfall reduction from 11.08% to 20.51%, and flooding reduction from 30.29% to 80.62%, indicating that a greater number of SPAH units yields higher LID effectiveness across all three indicators. The rainfall return period sensitivity analysis showed that LID SPAH effectiveness in reducing runoff and outfall volume tends to decline as the return period increases, from 21.58% and 21.65% at a 2-year return period to 11.44% and 9.63% at a 10-year return period. The flooding reduction pattern, however, was non-monotonic: no flooding occurred under existing conditions at a 2-year return period, the highest reduction (44.76%) occurred at a 5-year return period, and this then declined to 30.35% at a 10-year return period as the existing flood volume increasingly exceeded LID capacity. In the %Area Treated analysis, increasing %Pervious Area Treated had no effect, since pervious-area runoff under existing conditions was zero, whereas increasing %Impervious Area Treated to 100% slightly improved runoff and outfall reduction but instead increased flooding volume at all nodes, because the LID units—forced to accommodate the entire impervious runoff—became saturated more quickly and released discharge abruptly. The sensitivity analysis results indicate that a density of 1 unit per 60 m² offers a balanced choice between effectiveness and ease of field implementation, while a density of 1 unit per 40 m² can be recommended where land availability permits; similarly, a 50% Impervious Area Treated setting provides a more balanced outcome than 100%. SPAH is more effective when serving as a complement to conventional drainage infrastructure and should be combined with other infrastructure to address rainfall events with higher return periods.

Keywords: *urban drainage, EPA SWMM, Low Impact Development, infiltration well, surface runoff, Yogyakarta*