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The Role of Sustainable Drainage Systems in the Stormwater Management: Issues in the Design of Infiltration Wells*

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Abstract

The article presents the characteristics of selected measures classified as sustainable urban drainage systems (SUDS). The research primarily focuses on infiltration wells. Proper design of these measures requires an analysis of several variables, including the number and diameters of wells, as well as the thickness and saturated hydraulic conductivity of the sand filters. These parameters affect the depth of water in the well (distance from the water table in the well to the bottom) (h_s) and the thickness of the water layer above the sand filter (h_w). There is a lack of publications analyzing the impact of the above parameters on the well infiltration capacity. The research presented in this paper aims to analyze the impact of various selected parameters on the depth of the water in the well, which, in turn, directly affects the infiltration rate. Results show that the saturated hydraulic conductivity of the soil (k_s), design rainfall intensity, and well diameter have an impact on the required water depth (h_s). This influence increases significantly in the range of lower k_s values. Results also indicate that the thickness and the hydraulic conductivity of the upper sand filtration layer (h_{f1} and k_{f1}, respectively) have a significant impact on the required water layer thickness above the filter (h_w). The results show that the thickness and hydraulic conductivity of the lower, coarser-grained filtration layer (h_{f2} and k_{f2}, respectively) have a lower impact on the h_w value and, consequently, on the infiltration rate. Results may be helpful for decision-makers and engineers designing the infiltration wells for stormwater management.

Keywords: stormwater management, sustainable urban drainage systems (SUDS), infiltration well, dry well, hydraulic conductivity, climate change.

Introduction

The way urban areas are developed has undergone significant changes over the last few decades. These changes have continued and accelerated significantly in recent years (Taubenböck et al., 2024). Progressive urbanization and increasing building density have caused, and continue to cause, a steady increase in the degree of soil sealing. Former green areas, such as forests and meadows, are being developed, and more and more impervious areas, including buildings, roads, sidewalks, and parking lots, are appearing on them (Vieillard et al., 2024). Natural river floodplains are often developed contrary to their intended purpose, and concrete surfaces are gradually replacing natural areas (Hanna et al., 2024).

This steady increase in the percentage of impervious surfaces has led to a disruption of the natural water cycle, especially in urbanized areas (Navarro-Leblond et al., 2021). This situation leads to changes in the hydrological cycle, which in turn hinders infiltration, i.e., the absorption of rainwater into the ground. These changes, in turn, lead to an increase in surface runoff (rainwater runoff on the surface of the land) (Jato-Espino et al., 2016; Lepeška, 2016).. In addition, global warming and the associated occurrence of extreme weather events, such as heavy rains or prolonged droughts, also affect the hydrological cycle (Pizzorni et al., 2024).

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The ongoing global warming is caused by excessive greenhouse gas (GHG) emissions (mainly CO_2). According to Tollefson (2025), GHG emissions are increasing every year and are projected to rise by as much as 1.1% by the end of 2025. According to Condon et al. (2020), the temperature of the Earth and its surrounding atmosphere is constantly rising, leading to faster evaporation of water and, consequently, to water loss from the Earth's surface, which in turn contributes to local droughts. However, it should be emphasized that the higher the atmospheric air temperature, the greater the amount of water evaporates from the ground surface and the greater the amount of water vapor that can be contained in the atmosphere, which promotes the formation of strongly elevated cumulonimbus clouds and the formation of storm supercells (Ehtasham et al., 2024). Precipitation associated with this type of atmospheric front can be highly intense, and in extreme cases, can even lead to local flooding or flash floods, which are among the most extreme natural disasters (Pham and Kieu, 2025; Li et al., 2024). It should therefore be emphasized that the combined impact of adverse climate change and significant sealing of land surfaces associated with progressive urbanization leads to the simultaneous intensification of two fundamental problems (Fathy et al., 2021):

- increased flood risk,
- depletion of groundwater resources leading to agricultural drought, hydrological drought, and, in extreme cases, also hydrogeological drought.

Stormwater drainage systems play a significant role in draining precipitation to receiving waters (Roozbahani et al., 2025). With a properly designed drainage system, in the case of a semi-separate drainage system, water falling on the surface of the area in the initial phase of precipitation can partially end up in a sewage treatment plant, which protects the receiving water body from pollution. Torrential rainfall and the flash floods it causes are particularly dangerous in mountainous and hilly areas. In such regions, a small stream can often turn into a large, rushing river within a few minutes. Local flooding and floods, as well as flash floods, can also occur in low-lying areas, especially in densely built-up cities with a high degree of surface sealing (Geris et al., 2022; Sousa et al., 2024). Unfortunately, it often happens that older stormwater drainage systems, designed and built several decades ago, become inefficient in relation to rainfall caused by climate change. Therefore, in many places, especially in urban catchment areas, there is a need to optimize and support sewage systems by creating sustainable drainage systems (SUDS), which are facilities and devices that allow for the management of rainwater at the point of precipitation (Roozbahani et al., 2025; Fletcher et al., 2014). The enhancement of drainage systems with the use of SUDS helps to reduce surface runoff and has a positive impact on the quality of rainwater discharged into receiving waters. According to Monachese et al. (2025), by integrating SUDS into urban catchments, residential areas can promote sustainability while enhancing stormwater management and hydrological resilience. SUDS include, among others, infiltration wells (also known as dry wells), galleries, infiltration boxes, drainage chambers, retention basins and troughs, retention and infiltration reservoirs, rain gardens, and green roofs (Fletcher et al., 2014).

Stormwater management with use of sustainable urban drainage systems

In 2017, the Polish Water Law Act was amended (Ustawa Prawo Wodne, 2017). According to this amendment, as of January 1, 2018, rainwater and meltwater are no longer classified as sewage, but are instead classified as polluted water. According to Priestley et al. (2025), rainwater should be treated as a valuable natural resource and, wherever possible, used to recharge aquifers, thereby enriching groundwater resources while minimizing the risk of flooding. Three different strategies and measures for sustainable stormwater management (e.g., porous (permeable) pavements, infiltration trenches, and infiltration wells) are described in this section.

Permeable surfaces are a simple and inexpensive way to manage rainwater at the point of precipitation. These surfaces can be lawns, green areas, gravel-covered surfaces, or surfaces reinforced with openwork slabs. The pervious asphalt or concrete pavements, which are partially permeable to rainwater, are also commonly used (Sousa et al. 2024). The use of permeable asphalt pavements reduces surface runoff and mitigates the risk of flooding. They also enable the filtration of pollutants, thereby enhancing water quality (Antunes et al. 2018). Pervious asphalt pavements' permeability is 6–10 times higher than that of the conventional impermeable asphalt surfaces. Air voids in permeable asphalt pavements typically occupy 15 to 20% of the volume, whereas in impermeable pavements, they occupy only 3 to 6% of the volume (Sousa et al., 2024). Rainwater management using permeable asphalt surfaces is an environmentally friendly and cost-effective approach compared to traditional rainwater drainage systems (Antunes et al. 2018). Although they offer advantages, a significant challenge with permeable surfaces is their clogging (Sousa et al., 2024).

Infiltration trenches and infiltration basins are another example of structures used for rainwater infiltration. Infiltration trenches are linear ditches with a permeable bottom that enables the collection and infiltration of rainwater from adjacent areas, such as roads, pavements, and carparks (Figure 1).

The bottom of these trenches is highly permeable and can be filled with coarse aggregates (Lopes Bezerra et al., 2022). Water percolates through the bottom or accumulates above them. In the case of ditches, the depth of accumulated water should not exceed 0.3 m (Edel, 2017). Infiltration trenches integrated with elements of landscape architecture in cities can retain considerable volumes of surface runoff while also enabling effective irrigation of trees (Hanley et al., 2024). The infiltration trench shown in Figure 1 is coupled with the traditional drainage system. This measure enables both the rainwater infiltration and the outflow of the excess runoff to the traditional drainage channel. The slopes of this ditch are reinforced with openwork slabs.

Fig 1. A part of an infiltration-drainage ditch located along a multi-family building in Częstochowa (Poland). Photo taken by the author

Infiltration ditches play a crucial role in preventing soil erosion and protecting both surface and groundwater from pollution (Pizarro et al., 2024). If rainwater fed into the infiltration trench is not pre-treated, it may become silted up. The clogging of both the trench bottom and the aeration zone located directly below the bottom may also occur, resulting in a decrease in infiltration efficiency (Mueller et al., 2022).

Another examples of structures classified as sustainable drainage systems are infiltration wells (also called dry wells), which can vary in design and characteristics. The cross-section of the infiltration well is presented in Figure 2.

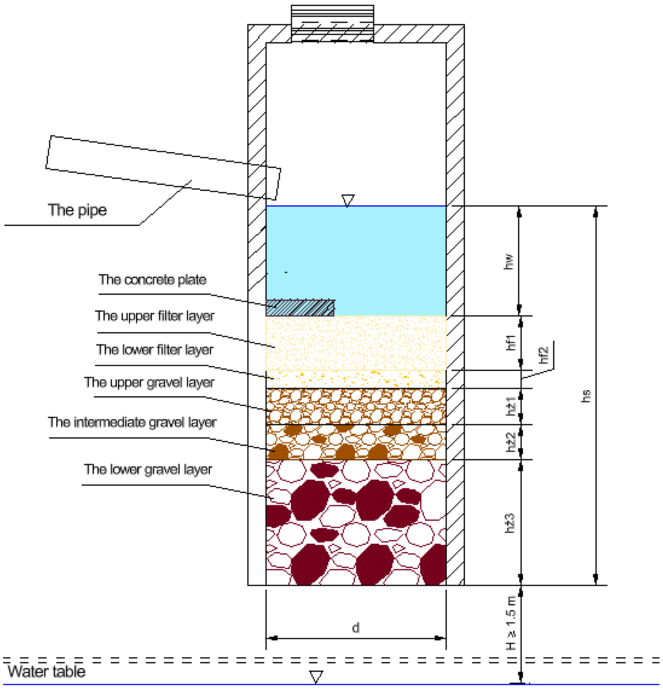

Fig 2. The dry well with the permeable bottom, designed using the Maag method

The infiltration well can be constructed in the form of prefabricated plastic elements or as a structure consisting of concrete rings. The dry well systems typically consist of (Li et al., 2025; Edel, 2017): a swale (which can be vegetated), a primary chamber serving as a settling tank, and one or more infiltration wells with open bottoms and/or holes along the walls. The interior of the dry well is filled with layers of both sand and gravel filters, as well as a support layer consisting of aggregates with appropriate grain sizes. Rainwater fed into the infiltration well is dispersed from it to the vadose zone through a permeable bottom or perforated side walls. Then, as a result, water percolates to the groundwater table. It is recommended that the distance between the bottom of the dry well and the groundwater table be at least 1.5 m (Edel, 2017). If the surface runoff water is contaminated, pre-treatment devices should be used to protect the soil and water environment before the water is discharged into the infiltration well (Li et al., 2025). Numerous studies have found that the groundwater contamination from dry wells can be avoided provided they are located in appropriate points and their operation is correct (Edwards et al., 2016).

If the infiltration of the rainwater from the dry well into the aquifer occurs only through the bottom (see Figure 2), such a well is designed using the so-called Maag method (Edel, 2017). Hydraulic calculations for a dry well using this method involve calculating the depth of the water column in the well, h_s (from the water table in the well to the bottom of the well). A significant parameter is also the thickness of the water column in the well, h_w (above the upper part of the filter layer), which guarantees a sufficient infiltration rate to absorb the required discharge of rainwater, Q_r. This volume is determined based on the design rainfall intensity q and the horizontal projection of the reduced catchment area A (equation 1) (DWA-A138, 2005; Edel, 2017).

$$Q_r = q \cdot A \tag{1}$$

where: Q_r – the discharge of rainwater to the dry well [m^3], A – horizontal projection of the reduced catchment area [ha], q – design rainfall intensity [$dm^3/(s \cdot ha)$], calculated from the appropriate precipitation model based on rainfall duration and the assumed return period.

The infiltration capacity of the dry well, whose bottom is located above the water table, according to the Maag method, is calculated from the formula (DWA-A138, 2005; Edel, 2017):

$$Q_w = 4 \cdot \pi \cdot (h_s - H_0) \cdot k_s \cdot r_w \tag{2}$$

where: Q_w – the infiltration capacity of dry well [m^3], h_s – the depth of the water in the dry well (distance between water table in the well and the bottom of the well (see Figure 2) [m], k_s – the saturated hydraulic conductivity of the porous medium (the vadose zone between well bottom and the groundwater table) [m/s], r_w – the internal radius of the well [m], H_0 – the distance between the water table in the aquifer and the bottom of the dry well, only if this bottom is located below the water table [m] (if the well bottom is placed over the water table assumed value of H_0 is 0 m (see Figure 2).

Taking into account that $Q_w \geq Q_r$, based on equation 2, the minimum depth of the water in the dry well can be calculated from equation 3 (DWA-A138, 2005; Edel, 2017):

$$h_s = \frac{Q_r}{4 \cdot \pi \cdot k_s \cdot r_w} + H_0 \tag{3}$$

For H_0 = 0 m, the calculation of h_s can be simplified, as shown in equation 4:

$$h_s = \frac{Q_r}{4 \cdot \pi \cdot k_s \cdot r_w} \tag{4}$$

The calculation of the water depth in the well h_s requires the selection of both the appropriate diameter (radius) and the number of wells. It is often necessary to design several or a dozen wells to avoid excessively deep wells (it is usually recommended that the depth should not exceed 3 m). The calculation of h_s also requires the prior selection of the thickness of two sand filter layers (h_{f1} and h_{f2}, respectively) and their respective permeabilities (k_{f1} and k_{f2}). Based on the selected values, the average water permeability (hydraulic conductivity) of the filter should be calculated (equation 5) (DWA-A138, 2005; Edel, 2017):

$$k_f{}' = \frac{h_{f1} + h_{f2}}{\frac{h_{f1}}{k_{f1}} + \frac{h_{f2}}{k_{f2}}} \tag{5}$$

where: k_f'– the medium hydraulic conductivity of the sand filter [m/s], k_{f1}– the hydraulic conductivity of the upper filter layer [m/s], k_{f2}– the hydraulic conductivity of the lower filter layer [m/s], h_{f1}– the thickness of the upper filter layer [m/s], h_{f2}– the thickness of the lower filter layer [m/s].

If there is a need to design more than one identical well, the discharge of rainwater to the single well can be divided according to the expected number of wells (if wells will have different parameters, the discharge should be divided proportionally:

$$Q_r{}' = \frac{Q_r}{n} \tag{6}$$

where: Q_r'– the rainwater discharge to the single well [m^3/s], n – number of dry wells.

Therefore, the height of a water column in the well is calculated using the following formula:

$$h_s = \frac{Q_r{}'}{4 \cdot \pi \cdot k_s \cdot r_w} \tag{7}$$

An important parameter determining the infiltration of water through a sand filter is the appropriate thickness of the water layer accumulated in the well above the filter surface, h_w. This thickness is calculated for the most unfavorable conditions corresponding to the maximum water flow to the well. In order to calculate this parameter, the velocity of water filtration through the filter must be calculated (DWA-A138, 2005; Edel, 2017):

$$v_1 = \frac{Q_r{}'}{F_w} \tag{8}$$

where: v_r – the filtration velocity [m/s], F_w – the area of the cross-section of the well [m^2].

The thickness of the water layer over the sand filter can be calculated from equation 9, based on the loss of pressure during the water flow through the filter ($h_f = h_{f1} + h_{f2}$) (DWA-A138, 2005; Edel, 2017):

$$h_w = \frac{v_1 \cdot h_f}{k_f{}'} - h_f \tag{9}$$

where: h_w – the thickness of water layer over the filter [m], h_f – the total thickness of the sand filter, calculated as: $h_f = h_{f1} + h_{f2}$ [m].

Based on design calculations, the thickness of the lower gravel layer is selected in such a way that the distance between the bottom and the water table in the well is at least h_s:

$$h_{g3} \geq h_s - (h_w + h_f + h_{g1} + h_{g2}) \tag{10}$$

where: h_{g3} – the thickness of the lower gravel layer [m], h_{g1} and h_{g2} – the thicknesses of upper and intermediate gravel layers, respectively [m].

The final step in the design process is to calculate the absorption capacity of a single well, Q_w. Then the sum of absorption of all dry wells should be calculated. This sum should be compared with the discharge of rainwater into the wells. The total absorption capacity of all wells should be equal to or greater than the inflow rate to the wells:

$$\sum_{i=1}^{n} Q_{wi} \geq Q_r \tag{11}$$

where: Q_{wi} – the absorption capacity of ith dry well [m^3/s].

Since the proper design of the dry well requires the consideration of many variables, it is often necessary to consider multiple options. However, changing a single parameter can have a significant impact on the final solution, including the number of wells, their diameters, the depth of the water column, or the thickness and permeability of the filter layers.

Therefore, the article aims to analyze the impact of various variable parameters on the calculated depth of water in the dry well (h_s). The investigation yielded several curves illustrating the impact of soil saturated hydraulic conductivity, internal well diameter, and design rainfall intensity on the water depth in the well. As a part of the analysis, the relationship between the parameters of the sand filter and the thickness of the water layer over the filter was also analysed. The obtained results can be helpful for decision-makers and engineers designing solutions that support stormwater management.

Materials and methods

The study aimed to analyze the impact of selected design parameters on the calculated water depth in the well, measured from the water table in the well to the bottom of the well. The following analysis was devoted to the influence of the parameters of the sand filter on the thickness of the water layer in the well h_w (the distance between the water table and the upper part of the sand filter. The analyses were divided into four groups:

- the influence of the design rainfall intensity (q) and the saturated hydraulic conductivity of the soil (k_s) on the depth of the water in the well (h_s).
- the influence of the dry well internal diameter d and the saturated hydraulic conductivity of the soil (k_s) on the depth of the water in the well (h_s).
- the influence of the thickness and the hydraulic conductivity of the upper sand filter layer (h_{f1} and k_{f1}, respectively) on the thickness of the water layer above the filter surface (h_w).
- the influence of the thickness and the hydraulic conductivity of the lower sand filter layer (h_{f2} and k_{f2}, respectively) on the thickness of the water layer above the filter surface (h_w).

Analyses of the impact of selected parameters on the final water depth and thickness required preliminary assumptions regarding the values of other relevant parameters. The assumed design data, categorized into four groups based on the specified analyses, are presented in Table 1.

Table 1. The design parameters assumed for all analyses

The parameter		Unit	Analysis No.			
			1	2	3	4
The number of wells	n	-	1	1	1	1
The well diameter	d	m	1.5	1.0–2.0*	1.5	1.5
The thickness of the upper sand filter	h_{f1}	m	0.3	0.3	0.15–0.48*	0.3
The thickness of the lower sand filter	h_{f2}	m	0.1	0.1	0.1	0.05–0.3*
The thickness of the upper gravel layer	h_{g1}	m	0.1	0.1	0.1	0.1

The thickness of the intermediate gravel layer	h_{g2}	m	0.1	0.1	0.1	0.1
The hydraulic conductivity of upper sand filter	k_{f1}	m/s	0.0027	0.0027	0.0002–0.005*	0.0027
The hydraulic conductivity of lower sand filter	k_{f2}	m/s	0.035	0.035	0.035	0.017–0.053*
The hydraulic conductivity of saturated soil	k_s	m/s	0.0005–0.004*	0.0005–0.004*	0.0018	0.0018
The design rainfall intensity	q	$dm^3/(s\cdot ha)$	120–300*	131.5	200	200
The horizontal projection of the catchment area	F_r	m^2	1000	1000	1000	1000

** variable parameters*

Results and Discussion

The results of calculations and analyses described in the section 3 are presented in Figures 3–6. Figure 3 shows the influence of the design rainfall intensity (q) and the saturated hydraulic conductivity of the soil (k_s) on the depth of the water in the well (h_s). The well parameters are presented in Table 1 (Analysis No. 1).

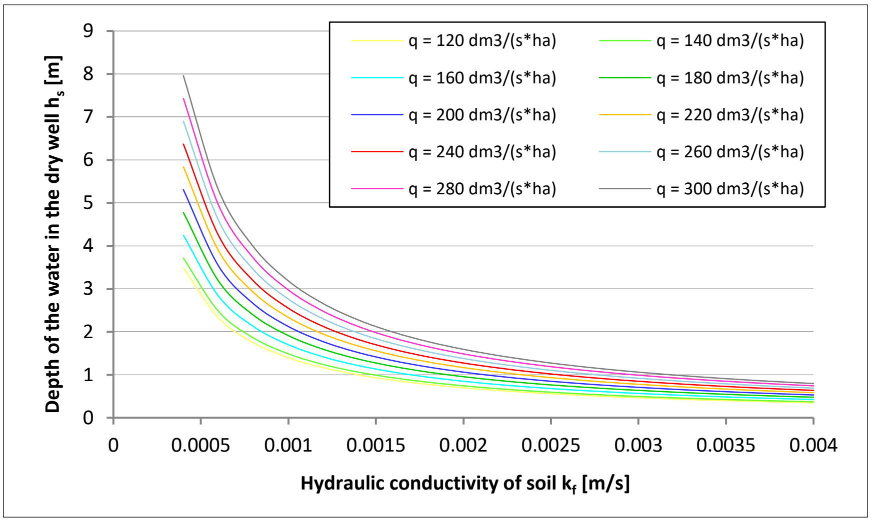

Fig 3. The influence of the design rainfall intensity q and the saturated hydraulic conductivity of soil k_s on the water depth in the infiltration well h_s (the distance between the water table in the well and the well bottom) at the well diameter d = 1.5 m and the reduced catchment area $F_r = 1000\ m^2$

The results indicate that the depth of water in the well (h_s) increases with an increase in the design rainfall intensity (for a constant reduced catchment area, which amounted to 1000 m^3). At the same time, the water depth (h_s) decreases as the saturated hydraulic conductivity of the soil increases. Additionally, it is worth noting that the slopes of the curves increase for lower values of hydraulic conductivity. Therefore, the higher the hydraulic conductivity, the lower the observed increase in the required well depth. On the other hand, for soils with low permeability, a relatively small decrease in the hydraulic conductivity can significantly affect the increase in the required depth of water h_s. If calculated values of h_s are high, increasing the number of wells should be considered. The depth of the well depends on the level of the groundwater table. The bottom of the well should be at least 1.5 m above the groundwater table. However, in practice, it is often assumed that the total depth of absorption wells, measured from the ground surface to the bottom, should not exceed 3 m.

Figure 4 shows the influence of both the dry well internal diameter d = (1,0 m – 2,0 m) and the saturated hydraulic conductivity of the soil (k_s) on the depth of the water in the well (h_s). The assumed well diameters were as follows: 1.0 m, 1.25 m, 1.5 m, 1.75 m, and 2.0 m. The hydraulic conductivity values (k_s) ranged from

0.0004 to 0.004 m/s. Analysis was performed for the design rainfall intensity (q) equal to 131.5 dm^3/(s·ha). The remaining dry well design parameters are presented in Table 1 (Analysis No. 2).

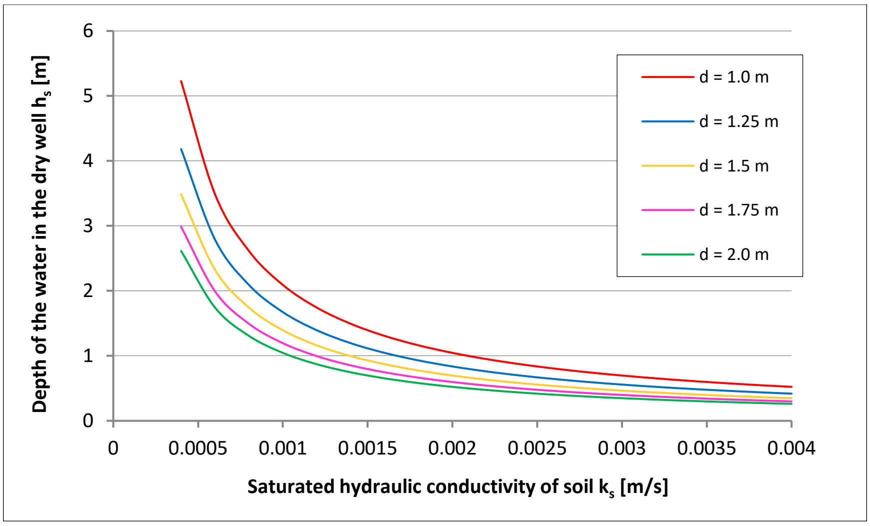

Fig 4. The influence of the internal well diameter (d) and the saturated hydraulic conductivity of soil (k_s) on the water depth in the infiltration well h_s (the distance between the water table in the well and the well bottom), for the design rainfall intensity q = 131.5 dm^3/(s·ha) and the reduced catchment area F_r = 1000 m^2

The results presented in Figure 4 indicate that the water depth in the well (h_s) decreases with an increase in the internal diameter of the dry well (d). Additionally, the water depth in the well (h_s) decreases with an increase in the saturated hydraulic conductivity of soil (k_s). It should be emphasized that the observed changes in water depth (resulting from changes in the filtration coefficients) were significantly greater in the case of wells with smaller diameters.

Figure 5 shows the influence of the thickness and the hydraulic conductivity of the upper filter layer (h_{f1} and k_{f1}, respectively) on the thickness of the water layer above the filter surface (marked as h_w in Figure 2). The assumed design rainfall intensity (q) amounts to 200 dm^3/(s·ha), the reduced catchment area is 1000 m^2, and the saturated hydraulic conductivity of the soil, k_s amounts to 0.0018 m/s. The remaining dry well design parameters are presented in Table 1 (Analysis No. 3).

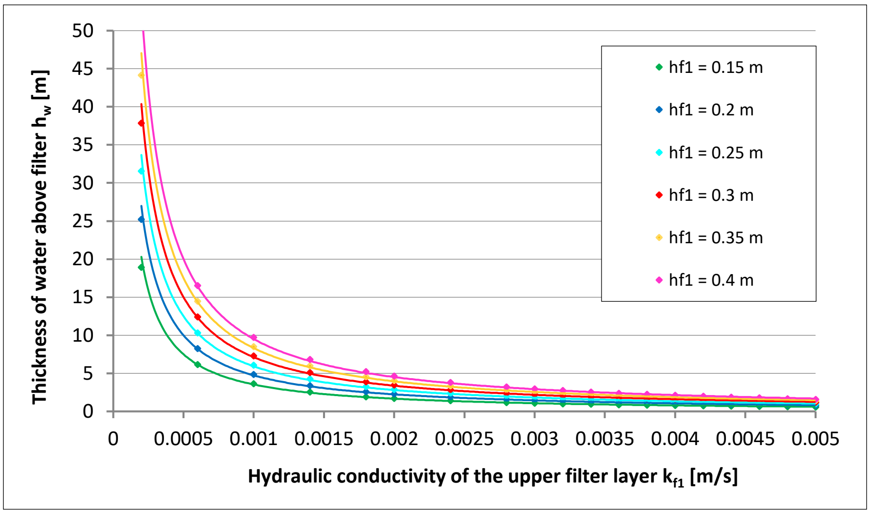

Fig 5. The influence of the thickness h_{f1} and the hydraulic conductivity k_{f1} of the upper layer of the sand filter on the thickness of the water layer above the filter surface h_w for the reduced catchment area F_r = 1000 m^2 and the design rainfall intensity q = 200 dm^3/(s·ha)

The results presented in Figure 5 indicate that both the hydraulic conductivity and the thickness of the upper part of the sand filter (k_{f1} and h_{f1}, respectively) have a very significant impact on the thickness of the water layer (h_w), which should accumulate in the well above the filter surface during a specified design rainfall. The combined effect of the hydraulic conductivity and thickness of the first filter layer can lead to an increase in the required water layer thickness by more than ten times. In practice, this means that if the permeability of the upper part of the filter is low, a larger number of wells should be used.

Figure 6 shows the influence of the thickness and the hydraulic conductivity of the lower, coarser sand filter layer (h_{f2} and k_{f2}, respectively) on the thickness of the water layer above the filter surface (h_w). The remaining dry well design parameters are the same, as in the case of Analysis No. 3. They are presented in Table 1 (see Analysis No. 4).

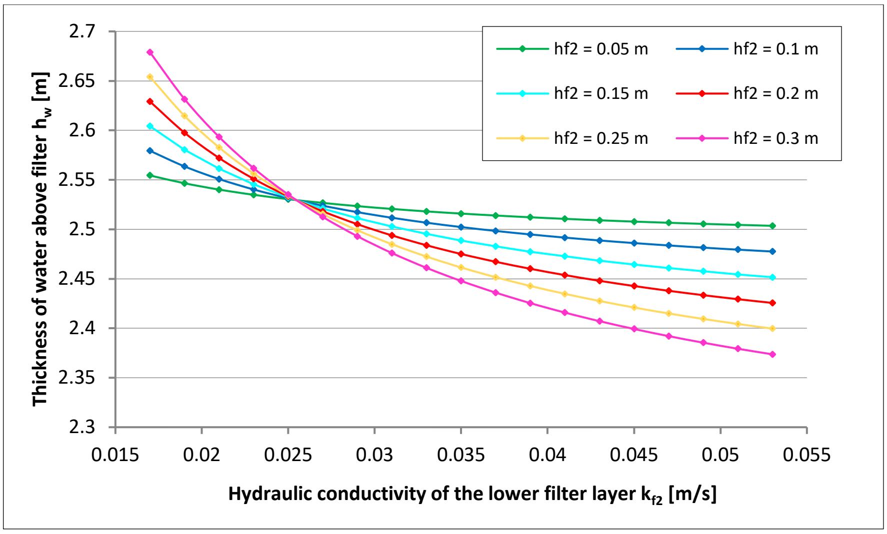

Fig 6. The influence of the thickness h_{f2} and the hydraulic conductivity k_{f2} of the lower layer of the sand filter on the thickness of the water layer above the filter surface, h_w, for the reduced catchment area F_r = 1000 m^2 and the design rainfall intensity q = 200 $dm^3/(s\cdot ha)$

The results presented in Figure 6 show that the combined effect of both the thickness and the hydraulic conductivity of the lower sand filter layer (h_{f2} and k_{f2}, respectively) has a significantly smaller impact on the thickness of the water layer in the dry well than the previously analyzed parameters of the upper sand filter layer. In each case, as the hydraulic conductivity of the lower filter layer decreased, the thickness of the water accumulated above the filter (h_w) increased. On the other hand, the increase in the h_w value depended on the thickness of the lower part of the filter h_{f2}. Within the range of analyzed values, the most significant difference in h_w was observed for the largest assumed h_{f2} (in the current analysis, it was 0.3 m). It is worth noting that for the accepted initial data, all curves intersect in proximity to a single point, corresponding to a k_{f2} value of approximately 0.0253 m/s and an h_w value of approximately 2.53 m. These curve patterns result from equation 9 used to calculate h_w, where at least one of the variables analyzed in Figure 6 affects the parameters contained in both the numerator and the denominator of the subtrahend, as well as in the subtrahend of the equation.

The use of dry wells has many advantages. An additional advantage of using infiltration wells is the possibility of recharging the aquifer, which allows for increased protection of water resources and avoids wasting rainwater, a very valuable natural resource, especially in view of progressive global warming (Edwards et al., 2016). However, dry wells also have disadvantages, such as the limited time during which adequate infiltration efficiency can be maintained due to mechanical, chemical, and biological clogging (Edwards et al., 2016). Edwards et al. (2016) recommend monitoring the quality of rainwater and runoff at the planned dry well site for a period sufficient to capture seasonal trends. At the same time, groundwater quality should be monitored to detect any adverse effects resulting from rainwater infiltration. Infiltration wells, typically used for rainwater drainage, are usually shallow, with a depth not exceeding 3 meters. However, if these wells are also used for groundwater recharge, their depth may be considerable. For example, Netzer et al. (2025) presented research conducted in an absorption well, where the filter was located between 22 and 27 m below ground level. At the same time, the depth to the water table at this location is 40 m below ground level.

Conclusions

Based on the literature review, as well as on calculations and analyses performed, the following conclusions were formulated:

1. Proper stormwater management is crucial in the current situation resulting from ongoing climate change. Among the adverse changes, global warming plays a particularly significant role, contributing to both more frequent heavy rainfalls and worsening droughts, which limit the availability of water for domestic, economic, industrial, and agricultural purposes in some areas of the world.

2. The use of sustainable drainage systems is a solution that allows rainwater to be managed at the point of precipitation, helping to minimize the risk of flooding. Such measures and devices should complement traditional sewage systems. However, before designing such systems, the quality of the rainwater that the measure will absorb should be analyzed, and if necessary, water pre-treatment devices should be used.

3. The use of sustainable drainage systems helps protect and restore groundwater resources. It is one of the most sustainable ways of managing rainwater, treating it as a valuable resource rather than a waste product.

4. The results of the analyses indicate that the correct design of the infiltration well requires the analysis and preliminary selection of a large number of variables, such as the number of wells, the diameter of the wells, the thickness and permeability of both the filter and gravel layers. The analyses indicate that the preliminary values of these parameters can have a significant impact on determining the water depth in the well, which directly affects the required well depth, the number of wells, and their absorption capacity.

5. The results indicate that the design rainfall intensity, the diameter of the well, and the hydraulic conductivity of the soil affect the depth of water in the well, which in turn influences the depth of the well and its absorption capacity. The smaller the diameter of the well and the lower the hydraulic conductivity of the soil, the greater the water depth in the well.

6. The sand filter parameters have a significant impact on the required depth of the well and its absorption capacity. The results indicate that the thickness and the hydraulic conductivity of the upper sand filtration layer have a much greater impact on the required water depth in the well. The most significant impact was observed in the range of low hydraulic conductivities. The results confirm that the parameters of the lower, coarser-grained filtration layer do not significantly affect the water depth in the well and, consequently, its infiltration capacity.

The results of the analyses have limited application, as they are only valid for the input data used. Therefore, they cannot be used directly to select well parameters. However, they can serve as a guide to show how specific parameters affect the change in water depth in the well. However, generating such curves for specific data, such as the reduced catchment area, the soil hydraulic conductivity, and the design rainfall intensity, can be of great help in making decisions about the construction of the well: e.g., determining the number and diameter of wells and the parameters of filtration layers, which ultimately have a decisive impact on the depth of the well and its absorption capacity. Further analyses are planned, covering a larger number of variable parameters.

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