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The formulae $\frac{\partial \rho U_i}{\partial t}+\frac{\partial}{\partial x_j}(\rho U_i U_j)=-\frac{\partial P}{\partial x_i}+\frac{\partial}{\partial x_j}\left(\mu\frac{\partial U_i}{\partial x_j}\right)+g_i(\rho-\rho_0)$ for building $\frac{\partial}{\partial x_j}(\rho \overline{U_i}\,\overline{U_j})=-\frac{\partial \overline{P}}{\partial x_i}+\frac{\partial}{\partial x_j}\left(\mu\frac{\partial \overline{U_i}}{\partial x_j}-\rho\overline{u_i'u_j'}\right)+g_i(\rho-\rho_0)$ state of the art $\frac{\partial}{\partial x_i}(\rho \overline{U_i}\,\overline{H})=\frac{\partial}{\partial x_i}\left(\lambda\frac{\partial \overline{T}}{\partial x_i}-\rho\overline{u_i'h'}\right)$ biomedical research facilities.

Stormwater Management

Stormwater management is the process of managing the rainfall that strikes an impervious area, such as a building or road, or a pervious area that is saturated from previous stormwater events. Stormwater management uses various methods aimed at controlling and mitigating the adverse impacts of stormwater runoff on the environment. Best Management Practices (BMPs) help manage stormwater runoff effectively and can prevent pollution, flooding, and erosion. This article explores some stormwater management techniques used to address diverse environmental challenges.

Detention Basins

Detention basins temporarily store stormwater runoff, reducing peak flow rates and minimizing the risk of downstream flooding. They then return to their normal dry state, allowing stored stormwater to gradually flow out through an outlet that controls the rate of discharge, mimicking natural drainage patterns. These are commonly used as part of a comprehensive stormwater management strategy. Because they are normally dry, they do not present the risks associated with stagnant water, but they do require periodic maintenance, such as mowing and trash removal.

Retention Basins

Retention basins are designed to permanently retain a certain level of stormwater and to temporarily detain additional capacity immediately following a storm event. This mitigates the immediate discharge of excess stormwater from the site, reducing the immediate demand on the local storm sewer pipe system and natural hydrologic features and thereby reducing the likelihood of downstream flooding. Retention basins can be designed to be aesthetically pleasing and are often combined with recreational features while still contributing significantly to improving water quality. These basins generally require maintenance programs to prevent them from becoming public health risks.

Bioretention Basins

Bioretention basins (including rain gardens and engineered wetlands) utilize specifically selected plants and engineered soils to filter pollutants from stormwater, which improves water quality. The vegetation helps reduce the urban heat island effect, enhancing local climate resilience and improving the overall quality of the environment. Moreover, these basins capture excess runoff, improving groundwater recharge. They can be easily integrated into landscape designs.

Bioretention basin infrastructure can be challenging to implement on a scale necessary to manage stormwater effectively in areas with space constraints. Regular maintenance, including pruning, weeding, and sediment removal, is necessary to sustaining these basins and ensure their effectiveness. The initial costs associated with designing and installing green infrastructure can be higher compared to conventional engineered stormwater management approaches.

Permeable Pavements

Permeable pavements allow stormwater to infiltrate through the surface, reducing runoff volume and promoting groundwater recharge. The permeable surface filters pollutants, such as oil and sediments, thereby improving water quality. Permeable pavements also help reduce surface temperatures and enhance overall microclimate conditions. However, they are not suitable for areas requiring higher load-bearing capacity and are often combined with more robust paving systems for driving and turning areas. Permeable pavements alone are generally utilized in passenger vehicle parking areas, walkways, and similar spaces. The freeze-thaw cycles in cold climates may damage the pavement, though changes in the mixture design and subsurface drainage detailing are currently being studied to allow more widespread use in areas that see more freeze-thaw cycles throughout the year. These pavements require regular maintenance, including regular flushing and vacuuming, or they can become clogged with debris, reducing their percolation rate over time.

Conclusion

Successful implementation and management of a stormwater program demands a clear understanding of stormwater management BMPs, site characteristics, local hydrology, landscape, regulatory compliance, and long-term maintenance. Stormwater management BMPs offer many advantages in improving water quality, ground water recharge, and flood prevention. However, they also come with some limitations. These limitations can be managed with early community engagement and proper monitoring and adaptation.

‘Design Requirements Manual (DRM) News to Use’ is a monthly ORF publication featuring salient technical information that should be applied to the design of NIH biomedical research laboratories and animal facilities. NIH Project Officers, A/E’s and other consultants to the NIH, who develop intramural, extramural and American Recovery and Reinvestment Act (ARRA) projects will benefit from ‘News to Use’. **Please address questions or comments to:** megan.teague@nih.gov