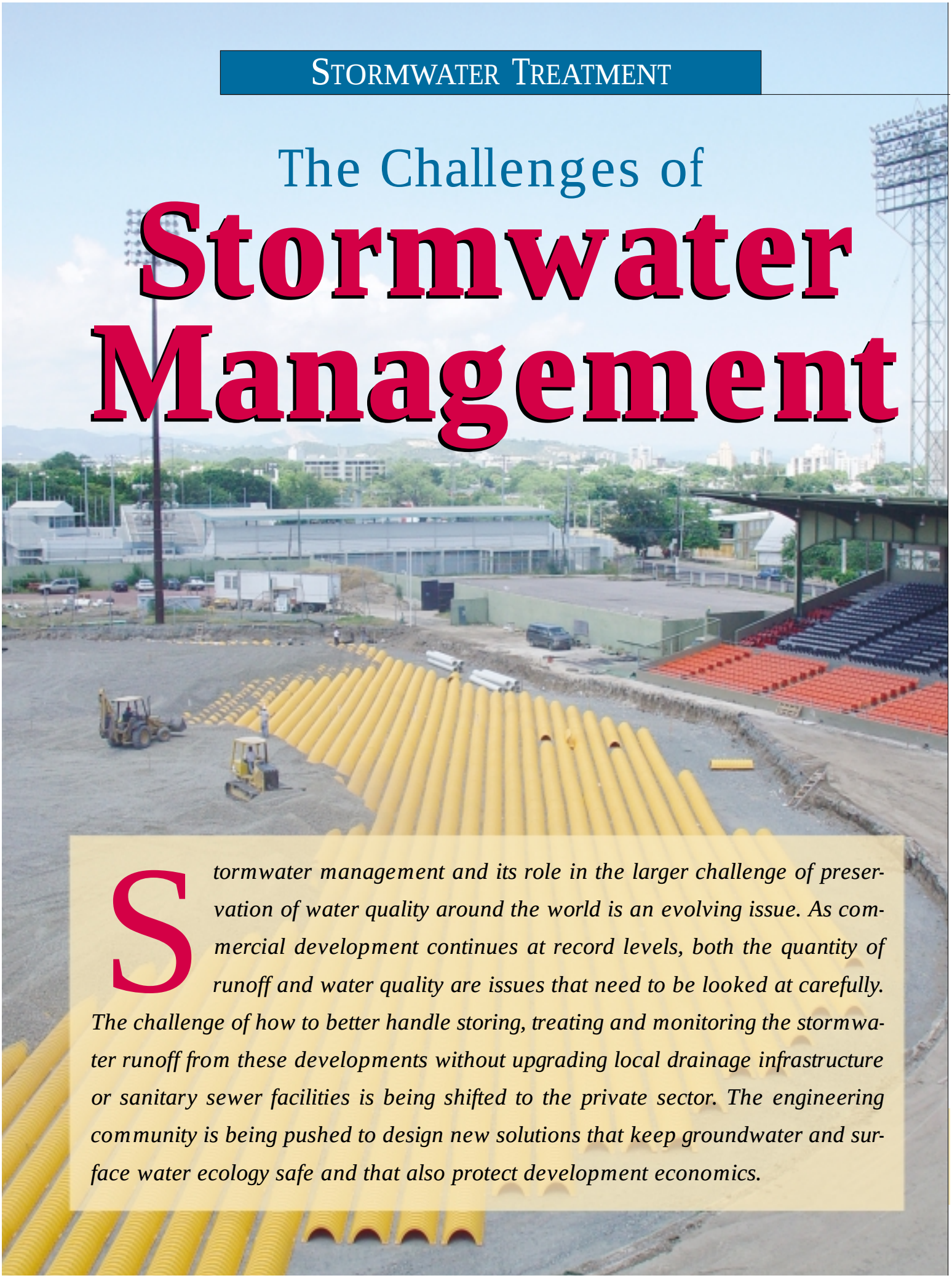
The Challenges of Stormwater Management



Stormwater management and its role in the larger challenge of preservation of water quality around the world is an evolving issue. As commercial development continues at record levels, both the quantity of runoff and water quality are issues that need to be looked at carefully. The challenge of how to better handle storing, treating and monitoring the stormwater runoff from these developments without upgrading local drainage infrastructure or sanitary sewer facilities is being shifted to the private sector. The engineering community is being pushed to design new solutions that keep groundwater and surface water ecology safe and that also protect development economics.

New EPA Requirements

The increased pressure on engineers with regard to stormwater is mainly attributable to the new Environmental Protection Agency's National Pollutant Discharge Elimination System (NPDES) requirements. The EPA finalized the revised rule for the NPDES Phase II permit in 1999 to include small, municipal, separate storm sewer systems (those serving fewer than 100,000 persons) and construction sites that disturb one to five acres. The developments and communities under this jurisdiction need to obtain coverage under the NPDES permit by March 2003. The expectations are many. The EPA expects "significant reductions in pollutant discharges and an improvement in surface water quality" with this revised rule. It also believes the rules will result in measurable financial, recreational and health benefits for communities. They also expect benefits to wildlife, endangered and threatened species and tourism as well as a reduction in the costs for siting reservoirs.

The Challenge for Municipalities

Stormwater is a challenge for municipalities that can affect the community at the macro and micro level. From a macro standpoint, most local municipalities that encompass a given watershed cannot handle the increased runoff themselves, and rely on the water management district to develop a solution. Essentially, the regulatory community has two choices in dealing with the problem: build more municipal infrastructures to handle the runoff, or create local regulation that requires those public or private developments to detain or retain stormwater runoff onsite. The former option is obviously costly and unlikely to be a viable solution to the problem. The latter, onsite retention/detention, is the most realistic and environmentally-friendly approach.

This stormwater system at Estadio Paquito Montaner baseball park is covered with gravel. Water enters the subsurface directly throught the soil and infiltrates into the chambers. There are no catch basins or inlet structures.

Ponds have been used for years to manage stormwater. Today, their use comes under scrutiny due to escalating land values, public safety, maintenance and aesthetic issues. Ponds also impose a liability to developers, especially in residential communities that have small children. In urban environments, ponds establish breeding grounds for mosquitos and, if not properly maintained, can impair the aesthetics of developments.

The Developers' Role

On a micro level, developers are faced with the challenge of complying with the new, stricter regulations. They are looking for solutions that are both effective and affordable within the scope of the development project in question. If stormwater runoff must be stored onsite, then the design of the new facility must make provisions for this volume of water. The result is a challenge for sustainable development. The land developer must weigh land utility against the cost and benefit of each potential solution.

Past Options, New Solutions

Ponds have been effectively used in the past to manage stormwater. Escalating land values, public safety, maintenance, aesthetics and the availability of new, cost-effective technology have brought the use of ponds into question. The high construction costs associated with large diameter pipe used for retention and detention have left some with the impression that subsurface stormwater management is expensive. Large diameter pipe is equipment and labor intensive because of its weight, the necessary fittings and the significant machine time needed for installation. This pipe also offers little design flexibility for odd shaped or constrained areas where subsurface storage is needed.

The high cost of land has motivated engineers to look below the surface for storage and treatment options. Conventional solutions such as ponds are not a viable option when land values dictate utilization of every possible developable area to make the economics work. Smart subsurface technologies, coupled with water quality devices, are being viewed as the answer. If water quality and quantity issues are handled subsurface, the developer has more room for parking, landscaping or building and the municipality is ensured environmentally effective treatment.

Depending on the site, subsurface treatment can provide the best option for all parties. When the soil is used as a part of the treatment process, just as it is for residential wastewater treatment, a large percentage of contaminants can be removed naturally and effectively. When compared to traditional approaches, subsurface stormwater management offers lower overall installed cost, design flexibility and enhanced performance.

The Role of the Soil

Soil's inherent filtration capabilities are not new news. In Delaware, sand filters have been used for years for the treatment of stormwater runoff. Sand filters provide the necessary treatment values for many municipalities around the Chesapeake Bay area, a highly sensitive watershed. Biofiltration swales also are an accepted method of using a combination of vegetation and soil to remove contaminants within stormwater runoff. Currently, the California Transportation Dept. (CalTrans) is conducting roadway tests to monitor the treatment of vegetated and non-vegetated slopes to infiltration swales.

Infiltration can provide many treatment benefits. It also provides groundwater recharge. Stormwater management plans are just now taking into consideration the predevelopment infiltration rates on proposed developments in order to replicate nature's own process of groundwater recharge. As we continue to develop land and pave over permeable surface areas, we not only change the surface hydrology by increasing peak runoff flows, but we also dramatically change the subsurface hydrology. Replicating predevelopment infiltration in post development has been deemed vital to sustaining growth in some communities around the country. For those communities that rely on groundwater for their potable water supplies, recharge to this resource is imperative. Without recharge the resource can be depleted.

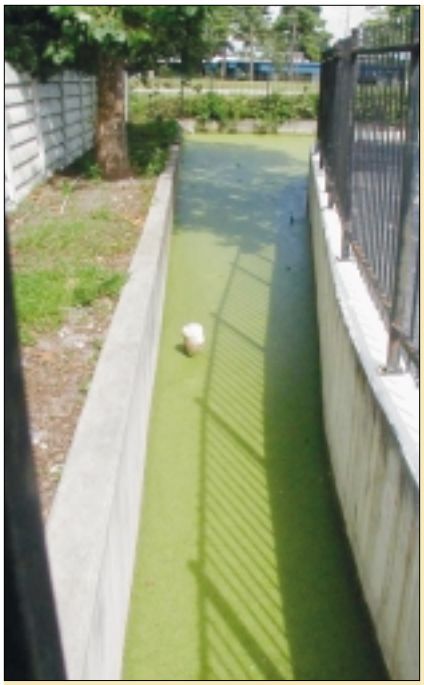
Regional Approaches to the Challenge

How stormwater management issues are addressed varies, depending on the region of the country, the state and the municipality. Some communities mandate zero net runoff or no more runoff from a site than in preexisting conditions. However, due to a lack of funding, enforcement is spotty. Some communities in California are developing task forces in which officers travel to various construction sites inspecting for violations. In these cases, the subject fines are generating the revenue for the continued enforcement.

One regional example where regulations have been developed to solve local water problems is Southern California, where groundwater is a crucial resource for the community. Currently, runoff is collected and channeled to the ocean through huge concrete culverts to prevent flooding. This concept of flood prevention is wasting water that could be recharging fresh water aquifers under an area in dire need of potable water supplies. In the past, Los Angeles has channeled its potable water all the way from the Colorado River. This is an extremely costly program. Now, this stormwater is being used to replenish Southern California's ever-depleting groundwater resources. Throughout the area, the option of recharging groundwater resources instead of channeling this fresh water to the ocean will sustain positive growth.

Massachusetts has a similar regulation regarding replication of predevelopment infiltration rates in the post development form. This view regards groundwater as a valuable resource. Nationwide, states that have coastal areas or that encompass surface waters are following a "zero-net runoff" model where all increases in stormwater runoff have to be stored onsite.

The states outside of EPA direct management (e.g., Massachusetts) have begun to develop training programs and workshops to learn how to comply with the effects of the new Phase II requirements. Most of these states have the resources in place to review compliance; however, development costs may rise with more stringent regulations. Because these NPDES Phase II permits are not required until 2003, smaller projects (those that do not fall under Phase I) continue to be a



Detention basins often are used to collect stormwater above ground. Like ponds, they can present a nuisance, limit design flexibility and be unsightly.

main contributor to the stormwater problem. These smaller projects are more prevalent than the larger five-acre developments that have been required to provide, under NPDES Phase I, erosion and runoff quantity control. After 2003, a one-acre development that previously required no erosion control or stormwater management permit may now need one under Phase II.

These new regulations do not mean that development costs on these small sites will increase dramatically. Sometimes the controls needed are minor and the use of new technology will make the controls more cost effective. Municipal management is already in place for many of these developments as it is for the communities under Phase I. The increase in developments affected by regulation will drive regulatory agencies to create better tracking systems, most likely electronic methods. Undoubtedly, there will be more capital costs tied to regulatory monitoring. To assist with these new costs, the federal government is making grants available

Subsurface systems save valuable land area and can be used under such structures as parking lots, recreational areas and playing fields.

When the town of Taunton, Mass., purchased the land behind their courthouse for additional municipal parking, they found that the soil was contaminated with waste from the auto garage that used to be there. They excavated and remediated the native soils and installed a subsurface chamber system with a pretreatment device to separate the oil and sediment upstream from the chambers. Monitoring wells also were installed to test water quality below the chamber system to determine if old contaminants were getting through.

for those who do not have the capital, human resources or the departmental infrastructure to execute effective programs. In these cases, the EPA offers to manage the programs for them. This is already happening in nine regions.

The Stormwater Industry's Commitment

Some stormwater management companies are working to develop economical and effective technologies that comply with regulations and environmental codes, while allowing the developer to meet his space and economic objectives. Economical, environmentally friendly solutions created by the industry allow regulatory agencies and developers to harmoniously exist and to improve our environment.

On the water quality side of the stormwater market, there are many companies trying to achieve some national verification of their technology. Many of these same companies are participating in the EPA's Environmental Technologies Verification (ETV) program, using the program as a vehicle toward attaining a national approval of their technologies. This program is generating a standard protocol for testing of the treatment values of the participating manufacturers in order to more accurately compare technologies. Similarly, the water quantity side of the stormwater market also is trying to follow nationally accepted standards, but the focus here is more on the structural integrity of the technologies or the materials they use to manufacture their products.

New Standards for Stormwater Products

Many new products are in development or have been recently introduced to attempt to solve the problem of stormwater management. While some of these new products do offer better treatment and safe groundwater recharge, they are not all alike. In order to meet this new objective for stormwater management, some manufacturers have taken a fresh look at the needs for the technology and have raised the standard for product design, manufacturing and testing to ensure performance above and beyond the AASHTO guidelines.

Technology, Testing and Performance

Subsurface systems require solid structural performance as well as the engineered ability to address water quality issues. Structure demands a rigorous analysis, nationally accepted design methodology, superior manufacturing and materials to produce a technology

that will satisfy the industry performance needs. Currently there are no requirements or accepted structural validation standards for water quantity technologies other than for pipe and concrete systems. Nationally recognized standards for structural performance, especially the AASHTO LRFD Design Methods for HS-20 Live Loads and Earth Loads, are the best models to follow to validate technologies.

Environmental stress cracking is one problem that hampers High Density Polyethylene (HDPE), the plastic used to manufacture products like pipe. This is the premature initiation of cracking and embrittlement of a plastic due to the simultaneous action of stress and strain and contact with specific fluids. The source of the stress is often processed in during molding. Therefore, applied stress is not a prerequisite for this condition. Some new products are manufactured with polypropylene resins, a material inherently resistant to environmental stress cracking. All systems should be thoroughly tested. Engineers should take a look at how they evaluate and specify subsurface stormwater systems to consider product design, structural integrity, manufacturing and validation of performance.

Conclusion

Stormwater master planning is one way to address all of the needs and potential threats to the watershed. However, implementation of these practices can be difficult and may not be economically feasible for many communities. Manufacturers who develop economical solutions that address stormwater runoff issues can lead the industry and provide the regulatory community with solutions that meet EPA standards. In order for a given community to effectively enforce laws and regulations for the future they need the technological support of the stormwater management industry today.

While technology will help solve the problem for new development applications, the current status of our degrading water resources is primarily from existing developments. Older, existing facilities must be held accountable for managing their stormwater runoff. Strategies need to be developed to retrofit existing developments, bringing them up to the new standard.

In the future, water quality and water quantity will be linked. Standardized testing protocols will be required for both. Conscientious regulation will promote subsurface technology for groundwater recharge and sustainable development.

About the Author

Bryan A. Coppes is the vice president of research and development for Storm Tech, Inc. He is responsible for product development and R & D at Infiltrator Systems. Since 1993, he has been involved in the design process for Infiltrator's product lines and has assisted in establishing the StormTech subsidiary. Prior to joining Infiltrator Systems, Coppes worked in engineering and product development in the lift industry. He has a BS in mechanical engineering from the University of Connecticut and an MBA from Rensselaer Polytechnical Institute.