CONTROLLING THE STORMWATER

Out-of-sight, out-of-mind is an outdated — and potentially dangerous — tactic to take with stormwater. When captured and cleaned, hundreds of millions of gallons of stormwater can be used to improve communities while protecting streams and water quality in the process.

Heavy rain fell in northern Wisconsin and northern Michigan in June 2018, dumping more than 6 inches of rain in under nine hours. Four months later, Storm Callum tore through the U.K., bringing torrential rainfall and 76 mph winds. Significant rain events like these are happening more frequently across the globe, leaving cities to deal with the aftermath: massive flooding channeled through antiquated systems that pour polluted runoff into lakes and streams.

Historically, stormwater has been blamed for the costly cleanup, which is why it's rushed out of cities as quickly as possible through piping systems designed to do just that — without considering the damage it's doing downstream. To better safeguard cities and waterways, plans and perceptions are evolving. However, stormwater management standards — many drafted in the '60s and still in place today — are based solely on conveying the peak flow rate (maximum rate of runoff) of one rainfall event.

"Solutions look a lot different when viewing them from the river's or the lake's point of view than if you're sitting at the top of the hill," says Andy Sauer,

BIG CANYON CREEK RESTORATION AND WATER QUALITY IMPROVEMENT PROJECT
Newport Beach, California

> *We are letting go of the out-of-sight, out-of-mind mentality of yesterday and moving forward with thinking of stormwater as a resource rather than a waste product.*
>
> **Brenda Macke**

stormwater and green infrastructure leader at Burns & McDonnell. "Our current design standards absolutely mitigate risk for the person at the top of the hill without considering those at the bottom, including rivers, streams and lakes. We need to look at a range of different rainfall events to discover how a system should perform during each."

As municipalities work on implementing best management practices to meet combined sewer and water quality obligations at the federal level, they're also changing their perception — and design direction — of stormwater management.

"Water doesn't make 90-degree turns, so we have to start recognizing that it's good to preserve some of its natural flow paths," says Brenda Macke, stormwater and green infrastructure project manager at Burns & McDonnell. "That's why we're designing with them in mind. By capturing and treating stormwater on-site or at the surface, we can help preserve our streams' health."

This new mindset is flipping stormwater master plans on their heads. Instead of developing a capital infrastructure project list, which is generally cost-prohibitive, cities are finding value in transforming impractical plans by implementing digital mapping tools and retrofits to existing infrastructure.

For instance, detention basins can provide better channel protection and water quality performance with an outlet control structure retrofit — installing a bypass lessens instream flow for small events while maintaining current level of service. Detaining, then slowly releasing, stormwater helps keep rivers and streams from rapidly eroding.

Additionally, these vital systems can be improved by implementing real-time flow technology on existing stormwater infrastructure. Digital databases and mapping tools — the look of some cities' new master plans — allow city engineers to view the entire system at a glance, making stormwater easier to manage on a daily basis. Using current city data, a digital tool

set provides real-time analysis of stormwater issues, including hydrologic and hydraulic calculations and parameters for delineated watersheds, major overland flow paths, obstructions, and drainage service request layers. This big-picture view, coupled with a wealth of data, also could help determine necessary capital improvements for the transportation industry.

Then there's the option of optimizing an existing system by incorporating green stormwater infrastructure (GSI). Whether for new developments or redevelopments, this sustainability concept has caught on in a big way, emerging as the foundation of a resilient community in the making, according to Sauer.

But what exactly is GSI? It's a range of technologies that communities use to collect and store rainwater while also providing a useful, aesthetic benefit to the community. It supplements traditional stormwater

REDUCED FLOODING ON THE EAST COAST

MONITORED GSI SITES RETAINED:

79%
of the precipitation volume during Hurricane Irene

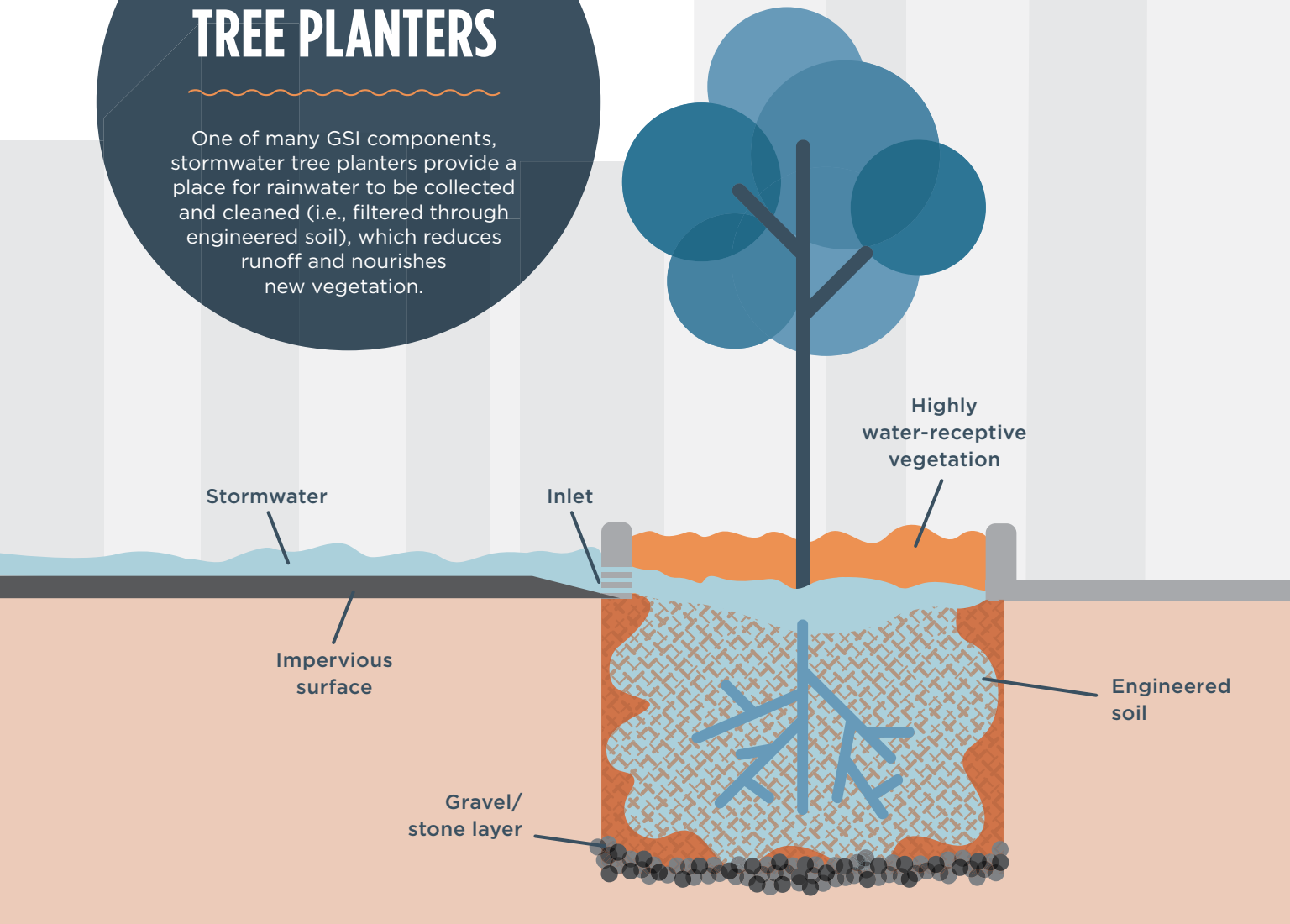
100%
of the precipitation volume during Superstorm Sandy

Source: New York Department of Parks and Recreation

Why? Because "stormwater runoff had somewhere to go at the surface rather than being directed to traditional gray (human-engineered) solutions," Brenda Macke says.

STORMWATER TREE PLANTERS

One of many GSI components, stormwater tree planters provide a place for rainwater to be collected and cleaned (i.e., filtered through engineered soil), which reduces runoff and nourishes new vegetation.



> *From what I've seen, the cities that support GSI solutions the most are the ones that are seeing significant redevelopment spurred by younger generations moving back into the heart of the city.*
>
> **Andy Sauer**

inlets and pipe systems, but there isn't a one-size-fits-all approach. Each GSI plan, customized for each specific location and drainage area, has its own look and function. Examples include introducing stormwater tree planters alongside urban streets and integrating pervious pavers or pavement to capture water where it makes sense. From Newport Beach, California, to Washington, D.C., municipal leaders are opening up their minds and plans to green solutions.

The building blocks of GSI, as Macke calls them, include inlets, energy dissipation and pretreatment, above-grade barriers, permeable pavement, soil and aggregate media, media liners, landscaping, piping and outlets. (*See chart on page 20 for full list.*)

"When we put all these pieces together, we can start to design our GSI facilities," she says. "We need to get back to true stormwater design, and be smart about it, instead of just plugging in details."

Philadelphia, Pennsylvania, which has the largest green infrastructure program in the U.S. to date, has been implementing numerous tree planters with

THE WAY OF THE WEST COAST

On the West Coast, cities are implementing stormwater best management practices (BMPs) to meet stringent regulations outlined in National Pollutant Discharge Elimination System (NPDES) permits, which focus on maintaining water quality. Continual drought, particularly in Southern California, also has alerted residents to the importance of capturing as much stormwater as possible and using it as a resource rather than considering it a waste to be pushed out into the ocean. In December 2018, 75 percent of California still was experiencing moderate to extreme drought, according to the U.S. Drought Monitor.

"The permits have changed in the last couple of years, moving from pollutant identification studies and assessment to implementation of BMPs, mandating that municipalities, particularly in California, start to put things in the ground that will capture, treat and reuse stormwater," says Steve Gruber, who focuses on safe and sustainable water solutions within the environmental field at Burns & McDonnell.

Newport Beach, California, for example, is realizing multiple benefits with a treatment wetlands project.

Big Canyon Creek, which drains into the Upper Newport Bay Ecological Preserve, was causing several environmental challenges for the City of Newport Beach. Gruber and team

stormwater features — they're connected below grade, beneath the soil mixtures. DC Water in Washington, D.C., also has a robust program, while New York City is known for its multitude of blue roofs (designed for storing water) and green roofs (lush with vegetation). Additionally, the success of two sustainable stormwater improvement projects in Kansas City, Missouri, landed the projects in the 2016 Landscape Architecture Foundation Case Study Investigation (CSI) program.

"From what I've seen, the cities that support GSI solutions the most are the ones that are seeing significant redevelopment spurred by younger generations moving back into the heart of the city," Sauer says. "And because the system in the ground is so old, the economics make sense. You have to start realizing that every drop counts."

Logistics aside, adding lush vegetation to impervious areas simply makes residents feel better. Research conducted by the College of the Environment at the University of Washington found that "urban nature,

worked with the city to design a plan that would reduce stormwater runoff pollutants (bacteria, nutrients, metals and organics); restore 6 acres of degraded instream, riparian and flood plain habitat; and improve water quality in the creek through a natural, integrated design.

"Natural treatment systems remove bacteria and pollutants through natural means, and typically involve natural filtration," Gruber says. "In most sites we work on, we try to get that pollutant to be taken up by vegetation or reduce concentrations through infiltration. Basically, we're trying to mimic Mother Nature in an urban setting, pouring as little concrete as possible. Natural treatment systems are much more attractive for the community, and they're much less expensive in terms of ongoing maintenance."

This project to restore and improve water quality was funded by a $2.3 million grant secured by Burns & McDonnell from the Orange County Transit Authority. During the three-year project duration, the team conducted monitoring of groundwater, surface water and stream bank sediment to identify hot spots of selenium in the creek and maximize efficiency of the project design.

Turning the design into reality, construction was finished in 2017, and restoration planting has been completed. Initial dry-weather monitoring results indicate a fourfold reduction of selenium concentrations in Big Canyon Creek; wet-weather monitoring in 2019 will assess stormwater pollutant-reduction effectiveness.

Interested in reading more about the restoration of Big Canyon Creek? Visit burnsmcd.com/TreatTheCreek.

PUTTING THE (GSI) PIECES TOGETHER

Solutions for implementing green stormwater infrastructure

GSI PRACTICE	INLETS	ENERGY DISSIPATION & RETREATMENT	ABOVE-GRADE BARRIERS	PERMEABLE PAVEMENT	SOIL & AGGREGATE MEDIA	MEDIA LINERS	LANDSCAPING	PIPING	OUTLETS
BIORETENTION BASIN	●	●	●		●	●	●	●	●
BIOSWALE/NATIVE VEGETATION SWALE	●	●	●		●	●	●	●	●
EXTENDED DRY DETENTION BASIN	●	●	●		●	●	●	●	●
EXTENDED WET DETENTION BASIN	●	●	●		●	●	●	●	●
GREEN ROOF					●	●	●	●	●
INFILTRATION TRENCH	●	●	●		●	●		●	●
NONSTRUCTURAL NATIVE VEGETATION	●	●	●		●		●		
PERMEABLE PAVERS		●	●	●	●	●		●	
PERVIOUS CONCRETE		●	●	●	●	●		●	
POROUS ASPHALT		●	●	●	●	●		●	
PROPRIETARY MEDIA FILTRATION	●	●							
RAIN GARDEN	●	●	●		●		●		
SAND FILTER	●	●	●		●	●		●	●
WETLAND/EXTENDED DETENTION WETLAND	●	●	●		●	●	●	●	●

when provided as parks and walkways and incorporated into building design, provides calming and inspiring environments and encourages learning, inquisitiveness and alertness."

And that's just one of many studies out there that tout similar results.

"If you want to have a resilient city, you have to look at stormwater as a resource," Sauer says. "If we capture it near the source, use it to create vegetative amenities and adaptively manage excess runoff, there are multiple benefits. Pollutants will settle out in a rain garden or bioretention cell, improving water quality, and you'll be extending the life of the existing system. This is part of an adaptive, resilient system."

Intrigued by the potential of GSI? Learn more about its benefits at **burnsmcd.com/ApplyGSI**.