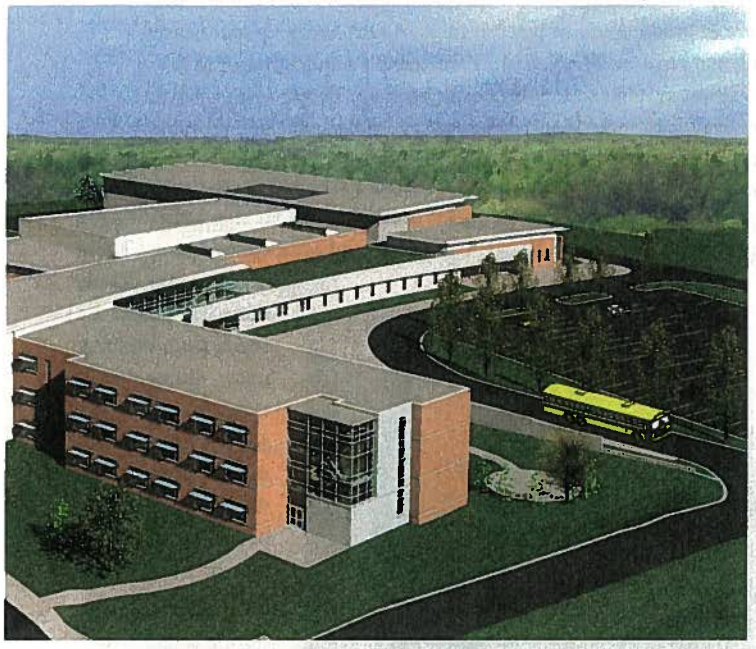
START TO FINISH

By Janet Aird



An artist's rendering shows the southern parcel, including the school building's partial green roof and a bioswale within the asphalt parking lot. The detention basin extends along the southern border of the site, on the adjacent property.

of them massive, and pipes in various configurations.

This second minimum measure also includes long-term operation and maintenance of the BMPs, which is beyond the scope of stormwater design and construction. The other four minimum stormwater runoff control measures—public education and outreach, public participation and involvement, illicit discharge detection and elimination, and pollution prevention and good housekeeping on municipal property—also are usually handled by others.

The New Hubble Middle School is an exception.

New Hubble Middle School

Controlling construction-site and post-construction runoff can be challenging, especially when the site looks something like a square with a lopsided letter "L" balanced on one of the top corners. This is the configuration that faced Vicki Sykes, senior project engineer for V3 Companies, in Woodridge, IL.

"The unusual footprint constrained how much I could change grades and get water from the north parcel to the southern detention basin," Sykes says. In spite of the restrictions, though, the school, which was started in 2008 and will be completed in the summer of 2009, is on track to qualify for "LEED for Schools" Silver Certification.

This is impressive: While most of the characteristics in the LEED (Leadership in Energy and Environmental Design) rating system concern the building itself, such as classroom acoustics and mold prevention, the system also emphasizes water conservation.

The New Hubble Middle School, located in Warrenville, IL, also received grant funding from the Illinois Clean Energy Community Foundation and the DuPage County Water Quality Improvements Program. The Clean Energy Community Foundation supports a variety of projects, including those that preserve and enhance natural areas and wildlife habitats in the state. The County Water Quality Improvements Program provides funding for improving water quality, water resource conservation, and restoration of the natural habitat and hydrology in the county.

The 18.8-acre school site is located within the West Branch of the DuPage River watershed. The northern L-shaped parcel has a student drop-off area, a permeable-paver parking lot with a bioswale down the center, and playing fields. It's connected to the southern square-shaped parcel by a narrow strip of land.

The LEED Rating System

The LEED (Leadership in Energy and Environmental Design) rating system is based on credits. Projects range from Platinum, the highest rating, to Gold, Silver, and LEED certifications. Most LEED credits are for design and construction categories in buildings—for example, energy efficiency and indoor air quality. However, two categories—which in fact mirror the NPDES Phase II requirements—apply directly to stormwater design and construction on development projects.

The goal of one of these categories, Construction Activity Pollution Prevention, is to reduce pollution from construction activities by controlling soil erosion, waterway sedimentation, and airborne dust.

The goal of the other, Stormwater Quantity and Quality Control, is to minimize stormwater runoff by reducing impervious cover and increasing onsite infiltration, as well as reducing or eliminating pollutants from stormwater runoff with structural and/or nonstructural BMPs.

According to "LEED Initiatives in Government and Schools," published online by the US Green Building Council (USGBC) in February 2009, a wide variety of initiatives, including legislation, ordinances, and policies, require a large number of development projects to be LEED certified. These include projects funded by governments in 31 states and 122 municipalities, from Anchorage, AK, to York, ME, and 34 counties. LEED certification is also required by 12 federal agencies, including the US Forest Service and NASA, 15 public school jurisdictions, and 39 institutions of higher learning across the country.

The increase in the number of LEED projects isn't only because the certification is being required, or even because of the health and environmental benefits. There are financial advantages as well, according to the USGBC. While building costs are only about 2% higher than for traditional projects, operating costs are substantially lower.

It's also beneficial to companies that design, build, and support LEED projects, according to the USGBC. They gain recognition—and additional high-quality work.

The southern parcel contains the school building, with a partial green roof, and a second bioswale, this one within an asphalt parking lot. A large naturalized detention basin extends along the southern border of the site, within an easement on the adjacent property, which is owned by Amoco Oil Research Corp. (BP).

Most of the runoff from the detention basin flows south to a large depression on the BP property. The depression exhibits a few wetland characteristics, Sykes says, but not enough to qualify as a wetland. Still, the City of Warrenville saw it as an area to be preserved, and the school district design team ensured that the project wouldn't have a negative impact on it. The downstream BP depression has no pipe outlet, and water can drain out of the depression only via infiltration and evaporation.

A smaller amount of runoff from the school's detention basin drains to the Warrenville Office Center detention basin to the southwest. All runoff from the school eventually drains to the West Branch of the DuPage River.

The project has maintained predevelopment drainage patterns and has reduced predevelopment runoff rates. Although there's more onsite runoff volume because of the development, Sykes says, "Runoff goes to the detention basin first, so it drains slowly." Additionally some of that additional runoff volume is reduced via infiltration due to the onsite BMPs.

Balzer and Associates

The new Patient Services building has four Filterra units in the parking lot to treat runoff from upstream.

The bioswales, permeable paver parking lot, green roof, depressions, and detention basin treat and reduce automobile pollutants, runoff from parking lots and roadways, and runoff from adjacent farms and residential properties that are tributary to the school site and that eventually drain to the DuPage River. They also treat any pollutants that may have been introduced as a result of the school development.

BMPs During Construction. Crews placed silt fencing around virtually the entire perimeter of the site during construction. They also dug a temporary sediment basin, which hadn't been in the plans. "It was a challenge to keep water constrained on the site before the proposed retaining walls were constructed," Sykes says. "Drainage patterns change during mass grading operations. You have to do things on the fly."

Crews also used FLeXstorm Inlet Filters from Inlet & Pipe Protection Inc. in Naperville, IL, to prevent sediment from washing into the storm drains. "I usually put them on the plans for 'during construction,' mostly because of the overflow that's built in," says Sykes. "You can also retrofit them for post-construction."

FLeXstorm filters have two advantages over other systems. First, they're easy to use because they're adjustable and can be configured quickly to fit any size or shape grate. Second, they hang several inches below the grate. Filter baskets don't always get cleaned out when they fill up with silt, she says. Most filter fabrics—and the silt they trap—are at grade level, so when it rains, runoff backs up and causes flooding and erosion. FLeXstorm filters leave a gap for runoff to flow into the sewer system, so runoff doesn't back up. They come in woven or nonwoven geotextile filter fabrics and are replaceable and reusable, for short or long term.

Temporary erosion control blankets protected newly seeded areas in all the steep-sloped, vegetated areas throughout site, including the detention basin side slopes, bioswales, and landscaped berms. These blankets did double duty: They kept the seeds from washing away during heavy rainfalls, and they prevented geese and ducks from eating the seeds. Erosion control blankets cannot be used for the bottom of the detention basin where wet meadow plugs will be used, however. To keep geese and ducks from landing in this area and destroying the new plants, chicken wire cages will be installed around the planting area with twine overtop.

The city of Warrenville monitored the site regularly during construction. "The city has done a really good job of erosion control inspection," Sykes says. "They're watching out for the neighbors."

Post-Development BMPs. The permeable-paver parking lot gets a lot of water, both from onsite and offsite areas. The pavers are on top of 20 inches of aggregate base, which rests on the existing permeable subgrade consisting of sand and gravel soils.

"Water hits the pavers and soaks into the ground," Sykes says. Because of the existing permeable soils, the parking lot has no underdrains and by itself can handle a two-year to five-year storm. With the bioswale, it can handle a 10-year storm. There are overland flow routes to the southern detention basin for the larger storms events.

The bioswales in both parking lots are approximately 200 feet long and surrounded by curb and gutters. Runoff enters through curb cuts. Each curb cut has cobblestone on a layer of geotextile fabric to prevent erosion and reduce the velocity of the runoff. The bioswales are planted with native plants and trees in engineered soil consisting of sand, double-shredded mulch, and topsoil above a layer of pea gravel and aggregate wrapped in a filter fabric. They each have a 6-inch subdrain connected to the storm sewer system.

Together, the permeable parking lot and the bioswales provide run-

off reduction, stormwater infiltration, and groundwater recharge. They can remove or reduce pollutants, including total suspended solids (TSS), phosphorus, nitrogen, trace metals, oil, and grease.

There are five naturalized depressions between the two school buildings, Sykes says. The space is used as a nature area and has sandy and gravel soils, native plantings, a sidewalk, and seating for occasional classes. During large storms, water flows overland to the detention basin.

The green roof covers approximately 4,000 square feet of the building, and plant material covers about 3,000 square feet of the green roof. It will reduce the amount of runoff from that portion of the roof by up to 95% after a 1-inch rainfall event. A roof underdrain system connects to the storm sewer system.

"Storm sewers were installed throughout the project," Sykes says, "even when we're counting on infiltration. But there aren't as many as there would be without all the BMPs."

Every open-grated storm sewer has a FLeXstorm litter/leaf bag filter to keep leaves and litter such as cigarette butts out of the storm sewer system and detention basin. FLeXstorm also makes replaceable booms that absorb oil and repel water for parking lots and gas stations.

The detention basin, just south of the school property, spreads out over approximately 3.5 acres and provides 12.4 acre-feet of stormwater detention. "Our detention basin is on BP's property, on a permanent easement," she says. "The school district worked out an agreement with BP to build it with extra storage for BP in exchange for the easement. It's beneficial for both."

The basin provides the required amount of detention for the school, 7.0 acre-feet, for a 100-year, 24-hour storm. The agreement added another 5.4 acre-feet to account for future development within the BP property. It's expected that during a 2-year, 24-hour storm, the maximum depth will be 1.3 feet and will take 40 hours to return to normal water level.

The bottom of the detention basin is flat and 3 inches below the elevation of the outlets. It usually has about 3 inches of standing water, although, since there's no steady water supply, it may dry out a little, Sykes says.

Wet meadow plants, including marsh milkweed, fox sedge, and monkey flower, line the bottom. Native prairie grasses and wildflowers such as butterfly weed, purple coneflower, and wild bergamot are along the sides, and trees including swamp white oak and shagbark hickory are around the perimeter. Once the vegetation is established, it should attract and provide habitat for grassland and wetland bird species, small mammals, frogs, and turtles.

The detention basin can remove a number of pollutants, including TSS, nutrients, and trace metals, via filtration, absorption, microbial transformation, sedimentation, and uptake by the vegetation. It has two outlets. One is to the BP depression 500 feet away, and the other is to the Warrenville Office Center detention basin.

Additional Measures. The school is addressing one additional minimum stormwater runoff control measure, public education, and outreach, as well as maintenance and monitoring of the BMPs.

In addition to the nature area outside, students can access the green roof, which will be used to teach them about such environmental issues as water quality, green design, and construction. Displays about environmental issues throughout the school explain the LEED process, green technologies in building, and native plants.

The city of Warrenville requires the contractor to maintain the BMPs and send an annual report to its stormwater permitting authority for three years while the vegetation is stabilizing. Maintenance consists of mowing and weed control for the vegetated areas, including the green roof. Once they're established, these areas don't need very much maintenance, Sykes says.

Beginning the fourth year, school staff will maintain the site. This includes cleaning the areas between the permeable pavers, cleaning out the inlet filters, and caring for the vegetated areas. Although inlet filters are usually removed after construction, the school district owns these and will use them after construction is complete to provide an ongoing water-quality benefit.

"The school district is making every effort to improve the environment," she says. "They're willing to go further than what's required."

Patient Services Inc., Clover Hill District

Sometimes it isn't the shape of a site but the size that's the challenge.

The new Patient Services Inc. Managed Care Concepts building and its parking lot take up almost half of a 2-acre site in an office park in Chesterfield County, VA. The site is sloped, has poor soils, and has stormwater detention requirements due to downstream flooding.

"The soils were such that infiltration wasn't feasible, and there was no area for a pond," says Aaron Breed, vice president of Balzer and Associates in Richmond, VA, who designed the stormwater plans for the company. "We had to look at alternatives."

Post-construction water quality was essential: Runoff from this site flows through a concrete drainage ditch into a stream to the Swift Creek Reservoir, which is used for both potable water and recreation.

BMPs During Construction. Crews cleared a 20-foot strip and placed silt fencing around the entire perimeter of the construction site. Although the fences were necessary for sediment control in most places, some were placed to show the limits of soil disturbance, Breed says. Crews also built a temporary diversion dike to direct sediment-laden runoff away from an adjacent property to a temporary sediment trap onsite, which they also built. They also installed a gravel drop inlet sediment filter to protect the existing storm drain inlet.

"Probably the biggest challenge was transitioning from the temporary sediment trap to the underground pipes for stormwater detention," Breed says. "But it was done in a dry period, which made the transition easier."

Post-Construction BMPs. Controlling pollutant-laden runoff from a small site with poor soil infiltration requires an efficient system, he says. He chose Filterra Bioretention Systems, a low-impact development system he'd used before, to treat and remove pollutants. The parking lot has four units.

According to the company, a Filterra system can treat more than 90% of the total annual volume of rainfall under optimum conditions. It removes bacteria, including 57% to 76% of fecal coliforms, up to 95% of TSS, 82% total phosphorus, 76% total nitrogen, and from 33% to 91% of heavy metals, as well as organics, including up to 85% of oil and grease.

Filterra units consist of a large concrete container with a 3-inch layer of mulch, an engineered soil mix, and landscape plants, which can include flowers, grasses, shrubs, and trees. A concrete slab and a tree grate, if there is one, cover the mulch and soil, either at or slightly below grade. The grate opens so debris and mulch can be removed and new mulch added. There's also an observation/cleanout pipe and an underdrain.

"There are drop inlets to Filterra on the curb line," Breed says. "Water comes down the parking lot and flows along the curb and the

gutter and into a Filterra unit. Any overflow is captured by the drop inlets."

Runoff filters through the mulch, the soil mix, and the plants. As the unit fills up, treated water flows out of the system through the underdrain, which is connected to a catch basin connected to the sewer system. When the unit is full, runoff bypasses it and flows directly into the catch basin.

It looks and sounds simple enough. But the Filterra system uses very specific design and construction standards to maximize infiltration and to capture, remove, and recycle a wide variety of pollutants. The soil mix is a combination of sand, which bonds with some pollutants, and organic matter, which soaks up others. Together they can remove pollutants less than one micron in size. Suspended solids and heavy metals, which are typically attached to the solids, are removed through sedimentation. Bacteria in the soil mix transform nitrogen into cell tissue or harmless nitrogen gas. They bind with organic matter and heavy metals and detoxify them.

The plants are chosen to suit the location and the climate as well as for their ability to remove pollutants. They use organic matter in runoff as an energy source and metabolize it into water and carbon dioxide. They transform pollutants such as nitrogen, phosphorus, carbon, and oil products into less harmful chemicals or compounds, or use them for food, energy production, and growth. And they remove volatile organic substances, such as gasoline, carbon dioxide, and nitrogen, from the soil and transpire them back into the atmosphere.

As the plants and bacteria grow, the system can capture and process more pollutants. If toxic levels build up, the mulch, soil mix, and plants can be replaced.

Although Filterra provides some infiltration, the site also needed a stormwater detention system.

"The biggest hurdle was reducing the post-development runoff rate," Breed says. The site had a requirement that called for storage of a 100-year rain event to be released at the 2-year predevelopment rate. Runoff is stored underground in 30-inch-diameter storm pipes, connected at junction boxes, in four parallel runs. An orifice controls the runoff rate and releases water slowly into the stormwater system at the allowable rate.

Monitoring and Maintenance. The locality requires the systems to be inspected every three years, Breed says. Both Filterra and the underground storage pipes have been in the ground four years now, and they're still working well.

"The project went pretty smoothly," he says. "They got lucky with the weather. The biggest challenge was trying not to interfere with the existing office traffic and activities taking place next door." **EC**

*Writer **Janet Aird** specializes in agricultural and landscaping topics.*

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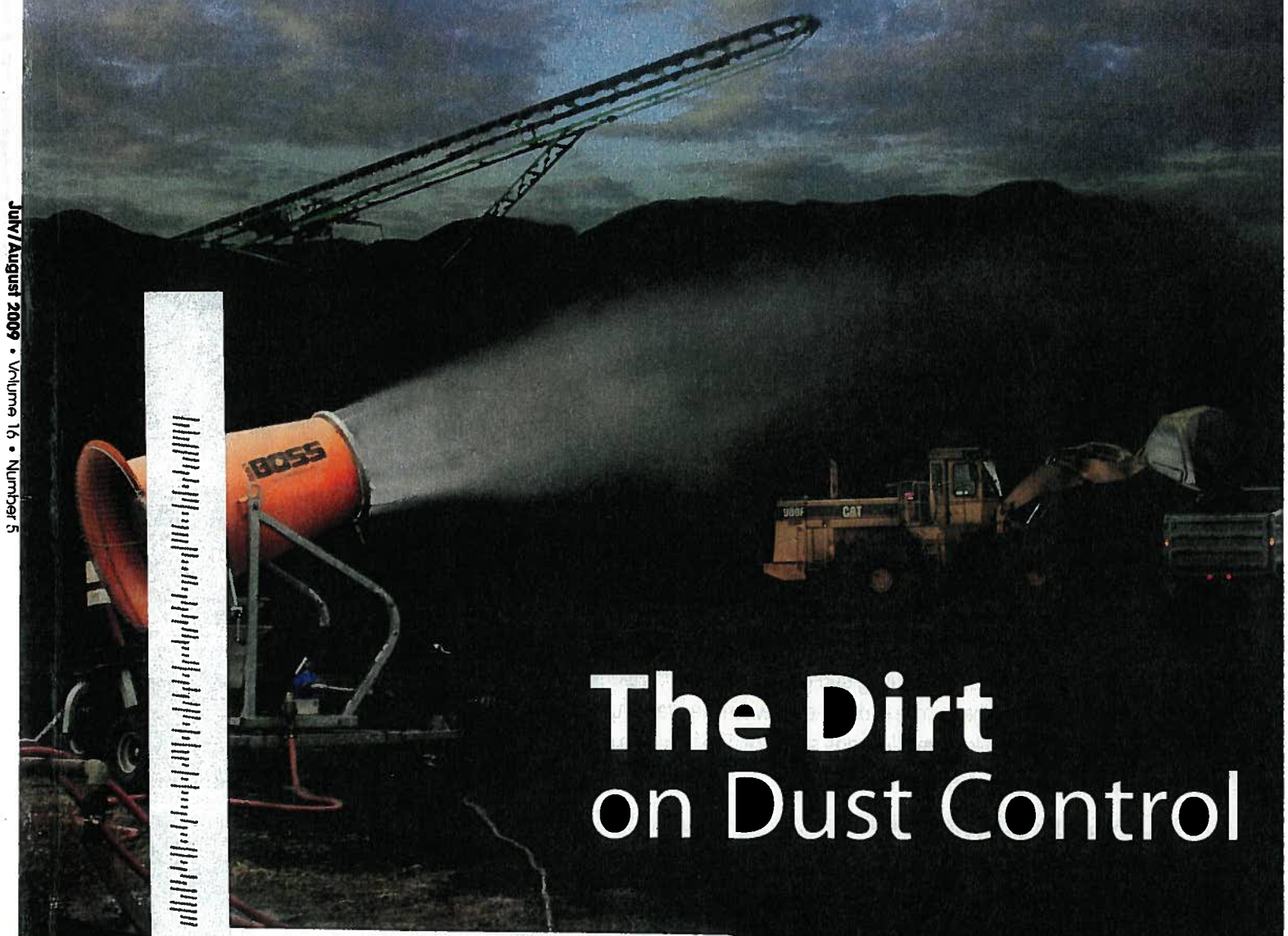

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