

Thinking Green with Porous Asphalt

By Dan Brown

All over the nation, stormwater drainage is becoming more of an issue in site development. One solution that is becoming increasingly popular is the use of stormwater recharge beds topped with porous asphalt pavement for parking lots.

Conventional practice in site development has been to build large detention basins that receive surface runoff from the impermeable structures on the site. Most of that water does not infiltrate the soil and recharge the groundwater, as nature intended.

Pointing to one solution, the city of Eugene, Oregon built a porous asphalt pavement for the parking lot at its equipment maintenance facility. "It works very well," says Paul Klope, principal engineer for the city of Eugene. The city simply used the Oregon DOT's asphalt mix design for Open Graded Friction Course (OGFC) and placed the pavement an estimated 6 inches thick.

About 10 years ago, the city of Eugene created a separate stormwater utility, which now charges businesses and users – even the city itself – an impact fee based upon the amount of impermeable surface owned by that entity.

"We have a user fee charged against impermeable surfaces placed anywhere in town. The fee is for parking lots, roofs, patios, and it applies to streets. So some businesses have gone in and reduced the

amount of impermeable surface and replaced it with landscaping."

The city's use of a permeable parking lot offered a different approach. "It soaks up all the water, and structurally it's held up very well. It's been there for three years. It's a thoroughfare for our Vector trucks."

The city hopes to encourage developers to build porous parking lots on their own sites. "That is one of our Best Management Practices," he says. "We are receiving inquiries all the time from architects and engineers who are considering alternatives to impermeable lots – and one of those alternatives is porous parking lots. So I expect to see some of them built in the near future."

Recharging the groundwater

"Big detention basins take on this huge flush of runoff water, hold it back for a little bit, and release it into a stream in a very short time," says Wesley Horner, principal planner with Cahill Associates Inc., an environmental consultant based in West Chester, Pennsylvania. "The water is lost for future use as groundwater, for whatever purpose it could serve."

By contrast, with a porous asphalt pavement, rainwater passes through and into a recharge bed containing clean, coarse stone. The water re-enters the ground naturally and recharges the groundwater table as well as superficial streams. In the past 25 years, the Cahill firm has



This photograph of the parking lot at Philadelphia's Morris Arboretum, taken during Hurricane Floyd, shows how stormwater will pool on the conventional driving surface and be absorbed through the porous pavement in the parking bays.

CAHILL ASSOCIATES PHOTO

designed 40 or more such stormwater recharge beds. A large majority of them have been topped with porous, open-graded asphalt pavements.

"We absolutely prefer asphalt," says Horner. "We find that it's very cost-effective, and the fines can be screened out relatively easily and inexpensively. Most asphalt plants are able to satisfy the specifications that we write. Asphalt is not terribly temperamental; it gives you more flexibility in its placement. It's not as time-sensitive as concrete."

Dramatic upturn

From 1975 to 1990, Cahill designed one or perhaps two porous pavement projects per year, Horner says. But in recent years, the firm has consulted for up to four such projects per year. "There's been a very dramatic upturn in the popularity of these things," says Horner. "We get more requests than we can handle."

In fact, much of the surge in popularity of porous pavement can be explained by stormwater regulations backed by federal, state and local laws. "People are taking both water quality and water quantity issues more seriously, so as a result, this kind of technology is being embraced with great eagerness," says Horner. "We have been designing these recharge beds for over 25 years now, and we have numerous projects that have achieved lasting success for that time period."

"In terms of water quality, these recharge beds filter out non-point source pollutants through an array of physical, chemical and biological mechanisms," says Horner. "In that way, these systems achieve a high level of water quality mitigation."

Cahill has designed porous pavement projects for a wide array of clients, including corporate office complexes, industrial facilities, and universities. Recent projects include Ford Motor Co.'s reconstruction of the Rouge River Plant in Detroit.

Other clients are DuPont, SmithKlineBeecham, and Siemens Corp. Plus, Cahill has designed large projects for the University of North Carolina, Pennsylvania State University, and the University of Rhode Island. "A lot of our corporate clients want to appear environmentally sophisticated and green, and this allows them to do that in a very cost-effective way," says Horner.

System design

Stormwater recharge systems are not complicated to design, but they must be built correctly in order to function properly. First, the recharge beds must be built over permeable soil. "You've got to do a moderate amount of soil testing for permeability," says Horner. "You can't be on top of the water table and you can't build these systems over bedrock."

The excavation is typically about three feet deep. The bottom of the bed must be below the frost line, which ensures that even in the winter, water will permeate through the recharge bed. "We don't want water to freeze in the bed," says Horner.

The bottom of the recharge bed must be level. That way, after the water passes through the pavement and through the stone bed, it enters the earth evenly, avoiding concentrations of water in any given area.

"You can't run your construction equipment back and forth repeatedly across the bed," says Horner. That would compact the soil excessively and hurt the permeability of the soil beneath the recharge system.

Following excavation and leveling, the contractor places a filter fabric over the bottom of the recharge bed to prevent soil from migrating up into the stone and clogging the system. Next, the layer of crushed stone is added to the infiltration bed. The stones typically run about two inches in size.

"Make sure it's cleaned and screened," says Horner. "If you don't

Porous Success Story Walden Pond Parking Lot Demonstrates Longevity

A. Richard Miller, a physicist from Natick, Massachusetts who lives in an environmentally sensitive area, offers an informed layman's view of permeable pavements. Miller was actively involved in the design and construction of a porous asphalt parking lot at Walden Pond State Reservation in 1977. More than 25 years later, the parking lot is still functioning well.

"The parking lot was constructed out of asphalt. It stands up and looks like a standard pavement for a parking lot, road, driveway, or superhighway," he said.

In the 1970s, Miller was Executive Director of the Lake Cochituate Watershed Association. The group learned about porous pavement through a technology transfer program of the U.S. Environmental Protection Agency. They thought it would be ideal for resurfacing the worn-out parking lots at internationally famous – and environmentally sensitive – Walden Pond. (Walden is one of a chain of ponds that make up Lake Cochituate.) "People come from around the world to see where Henry David Thoreau set up his cabin by Walden Pond," Miller continued. "We felt that the parking lots at its visitor center would be a fine place to showcase the new technology."

The EPA had based its recommendation on a document on porous pavements published by the Franklin Institute in Philadelphia. Miller was skeptical

initially. "I didn't believe it when I read it. I'm not a road expert, but I drive in Massachusetts. Eastern Massachusetts has more freeze-thaw cycling than most places in the U.S. We are at the weather edge where it freezes and thaws, over and over. That is the source of our New England potholes. So, I said that's a great technology for Florida and California, but it will never work here."

To demonstrate its durability in real conditions, the parking lot was paved with porous asphalt. Now, explains Miller, "My original opinion was wrong and I'm glad I was wrong. The pavement has gone through hundreds of rounds of freeze-thaw cycling and has been heavily used. The visitor center is open every day of the year. The parking lot carries tour buses as well as cars. So, we now know that it works in Massachusetts."

The advantages of a permeable pavement are many, Miller said. "You don't need road salt in winter. You get a much better grip on it as you drive across it, much better road adhesion. It looks relatively dry. It darkens when it gets wet, but you don't get that slick surface that can cause glare. It gives good visibility when it is raining hard. For the fellow installing it, he doesn't need new materials, doesn't need new equipment. It

doesn't significantly change installation costs. It just needs some different thinking." The pavement had a capacity of absorbing an astonishing 60 inches of rainfall per hour when it was new, according to Miller.

Maintenance of the lot at Walden Pond has been uncomplicated. "Even in freezing weather, you don't need to sand it. In fact, you shouldn't, because sanding eventually can close up the pores," commented Miller.

Miller pointed out that Massachusetts has a tradition of porous pavements. "On Cape Cod, most of the driveways and some roads are paved with crushed clamshells. That is porous pavement, too," he said.

An avid bicyclist and hiker, Miller is enthusiastic about porous pavements for bicycle paths and hiking paths that will not get plowed or treated regularly. "There are thousands of miles of rail trails being constructed every year. Railroads have ballasted roadbeds, which provides a great base for porous pavements. Using a porous pavement gives extra days of use for walkers and bicyclists in the cold months," he added.

A brochure that Miller authored about this project is available online at www.millermicro.com/porpave.html.

screen it and get the fines out, you'll sacrifice your critical storage volume. It needs to have 40 percent void space (storage space)." Screening out the fines also adds to the expected life span of the system, because excessive fines may clog the fabric pores and limit infiltration.

The recharge bed is topped with a one-inch-thick "choker course" of finer gravel. That smoothes out the recharge bed and forms a surface for the pavement. The porous asphalt pavement is then laid down, typically two to three inches thick, Horner says.

The Cahill firm likes to use crushed limestone in the recharge beds. "A limestone bed becomes a wonderful neutralizing treatment mechanism for acid rain," says Horner. "As the water drains through the crushed stone, the alkaline limestone neutralizes the acidity in acid rain."

Cost-effective solution

Stormwater recharge systems can be built for the same cost or only slightly more than conventional drainage systems, Horner says. A recharge bed incurs costs for the excavation, a small amount for filter fabric, and a cost for the clean, crushed stone. The open-graded asphalt mix "hardly costs any more than conventional mixes," says Horner.

"So we have some additional costs balanced against the whole array of things with conventional drainage," he notes. "You've got the cost of the land for one or more detention basins, the cost of excavating the

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detention basins, inlet and outlet structures – and elaborate systems for conveying water all over the place. So when you add that all up and do a fair comparison, stormwater recharge beds with porous pavements really eliminate a lot of extra items. The good news is, you can achieve tremendous increases in environmental benefits without a tremendous increase in costs."

The long-term maintenance of porous asphalt is not difficult. "We take great pains to make sure managers never apply sealant or grit to these parking lots," says Horner. "That would clog the pores in the pavement." For the same reason, one should also ensure that mud cannot wash onto the parking lot surface.

Horner says the critical concept is to achieve a broad, even distribution of water and to replicate the way the water entered the ground before the pavement was built. "If you can make that happen, you'll have a good result," says Horner.

Proven durability

The asphalt mixture used for porous pavements is the same as that used by highway departments for OGFC. "I'm comfortable that the porous asphalt pavements can hold up," says Jim Huddleston, executive director, Asphalt Pavement Association of Oregon. "We've been building porous pavements for highways in Oregon since 1979 and they've taken truck traffic and held up very well.

"We started using OGFC back in the '70s," says Huddleston, who is a former Oregon DOT official. "We were real aggressive with a thicker 2-inch course of open-graded asphalt, and that lasted for 20 years."

Just like the porous pavements used on parking lots, the Open

Graded Friction Courses used on highways have well-documented environmental and safety benefits. They reduce noise pollution, making them ideal for applications in urban areas. In addition, the way they drain rainwater off the surface during a

rainstorm decreases splash and spray from vehicle tires, improving visibility in wet weather. **HMAT**

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