POROUS PAVEMENT MAN

Stormwater management expert Bruce Ferguson gives landscape architects more tools to improve the built environment. By Linda McIntyre

IF YOU THINK stormwater management is a dull and esoteric subject, you should spend some time with Bruce Ferguson, FASLA.

Ferguson's name is familiar to landscape architects, engineers, planners, contractors, and anyone else with an interest in managing stormwater, especially in urban areas, in an ecologically sound manner. His books *Stormwater Infiltration* and *Introduction to Stormwater: Concept, Purpose, Design* have demystified those complex subjects for students and practitioners.

His latest volume, *Porous Pavements* (see "Books," *Landscape Architecture,* June 2006), exhaustively examines the possibilities for mitigating the environmental impact of paved surfaces, the most dominant feature of the contemporary urban landscape. Ferguson spent 7 years on the book, reading 800 technical papers, interviewing 170 researchers, designers, and suppliers, and looking at 270 installations.

Landscape Architecture visited Ferguson recently in Athens, Georgia, where he has taught environmental analysis, sustainable design, and landscape construction at the University of Georgia since 1982, to look at some examples of porous paving and to talk about his work.

Seeing the World In a Drop of Water

Ferguson grew up outside Pittsburgh and studied architecture as an undergraduate at Dartmouth. He went on to the University of Pennsylvania intending to pursue a master's degree in architecture, but he discovered Ian McHarg and transferred into the landscape architecture program. After completing his MLA, Ferguson worked for a small architecture and engineering firm in the Pittsburgh area, doing site planning and environmental reports for development

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projects, and then took up a teaching post at Penn State before moving to Athens.

His time in practice led him to his academic specialty. "My background at McHarg's Penn gave me an early strength on the natural-resource side of landscape architecture," he says. "But the environment as a whole is too big to be expert at; in order to be good at something I had to choose what it would be. My experience in practice soon made clear the importance specifically of water: As I presented every project, someone on the planning commission or elsewhere was vitally interested in water quality, or flooding, or erosion, or water supply, or water conservation."

Those who haven't met Ferguson might imagine him to be a dry, cerebral technician. But his appreciation of and enthusiasm for the multifaceted nature of landscape architecture is obvious. "The whole world is in landscape architecture," he says. "Everything that happens on the site is part of the landscape architectural problem, and every approach that enables us to solve the problem is part of our business. We must be equally ready to communicate about, understand, and contribute to our landscapes' economics, physics, geometry, sociology, perception, and ecology. To embrace less would be to turn our backs on our professional responsibility."

Technical correctness is important to Ferguson—"All professionals, including landscape architects, should have a greater respect for facts and a greater suspicion of rumor," he says—but so is effective communication. His books are clearly written and well organized, useful to the practitioner yet accessible to the lay reader, befitting a winner (in 1992, for "The Failure of Detention and the Future of Stormwater Design" in the December 1991 issue of *Landscape Architecture)* of the Bradford Williams Medal. Quantitative information and construction details are displayed simply and concisely. When he is talking about porous pavement on site, he always carries a bottle of water to pour on the pavement for illustration, and we had one with us at each stop as Ferguson took *Landscape Architecture* on a tour of installations in northeast Georgia and filled us in on the history, function, structure, and benefits of porous pavements.

On the Permeable Road

Our first stop was the Robson Center, an office building in Gainesville, about 40 miles from Athens. Its 8,200-square-foot parking lot, with a center drive of open-jointed concrete block with the joints filled with open-graded aggregate, was built in 2003 to comply with new local regulations limiting impervious cover and to squeeze the maximum economic benefit from the site's land, not as part of the site's stormwater management system. "The designers of the storm sewers did not take into account any stormwater reductions from the porous pavement or the underlying soil," says Ferguson, "although such reductions do in fact happen." The parking stalls, of dense (impervious) asphalt, drain onto the center drive. Ferguson was a consultant to the contractor of this project. The driveway looks sturdy and undamaged by traffic,

Workers install concrete blocks in a parking lot at the Robson Center in Gainesville, Georgia, *above.* Spacers on the blocks keep the joints open, allowing water to infiltrate. The finished installation, *below,* has held up well.

and the geometric pattern is attractive. "We had a terrific installer on this project," says Ferguson.

Since the site was built on the heavy clay soil indigenous to northeast Georgia, stormwater could not be expected to infiltrate at the same rate it would in lighter soil, so perforated pipe was installed at the bottom of the crushed

COURTESY BRUCE K. FERGUSON, FASLA

granite base course to move any excess water into the storm sewer system. A thin layer of microorganisms in the aggregate, spread out over a vast surface area, cleanses the water of automotive pollutants such as oil, and the clay soil captures some metals dissolved in the runoff.

Blocks are expensive, says Ferguson, but there are benefits that offset their cost. "Each unit is a very strong and durable piece of concrete, and it's so easy to install properly," he says. "It's hard to screw up!" The block industry's early willingness to establish national standards has also been helpful in promoting the material's use. Paver installations like this one also have a traffic calming effect, says Ferguson, mentioning a study done in Amsterdam that showed an average reduction of 10 miles per hour. The sound and texture of the pavers seems to catch drivers' attention and make them slow down.

Sediment is a potential problem with open-jointed pavers as well as other porous pavements. Vacuuming to remove built-up sediment is the key maintenance element for most porous pavements, but in the southeastern United States, says Ferguson, sediment is less of a problem when porous pavements are properly sited because roads aren't treated with sand in the winter. At the Robson Center, no sediment was visible in the open joints, and the installation passed the water-bottle test with flying colors.

Ferguson, armed with his water bottle, can perform on-the-spot tests of the porosity of paved surfaces.

The prospect of sediment highlights an important point about the siting of porous pavement installations: Unlike many stormwater management measures, they should not be situated at the site's lowest point. As at the Robson Center, porous pavement can handle some runoff from adjacent clean pavements (and impervious roofs), but in most cases, sediment and excess runoff should wash off the edge of the pavement. For this reason, raised curbs shouldn't be used in most porous pavement projects.

Our next stop was the Gwinnett Environmental and Heritage Center (GEHC) in Buford. The center, which opened in October 2006, is seeking LEED (Leadership in Energy and Environmental Design) certification at the gold level. It shows off several varieties of porous paving—the parking lot alone features porous asphalt and concrete and open-jointed paving blocks. "We thought of the whole site as part of the educational process," says Dale Jaeger, FASLA, whose firm designed the landscape component of the project. The center is visited frequently by both student groups learning about conservation and design professionals looking for inspiration.

Porous concrete has been described (in *Land Development Today)* as resembling "a rock-hard Rice Krispies treat," and the comparison is apt on close inspection. From a distance, though, it looks more or less like dense concrete—its standard color is pale gray, but that can be changed with dyes or stains.

Installation and curing are critical—"It's not difficult, just different," says Ferguson. "You need qualified installers and engineers who are not averse to learning new things." The concrete industry is developing useful standards and certifications for porous applications, he says, but it has been slower off the mark than the block industry (but well ahead of the asphalt industry, which he says seems to be complacent and has lagged in investing in education and standards, limiting its use). Ferguson points out a couple of places where there might have been a little too much paste in the mix, leading to a more dense surface with less porosity. "It's like a chemistry experiment," he says. Overall, though, it stood up to the water-bottle test pretty well, as did two other concrete installations we saw later on the tour, one at a Sam's Club discount store, the other at the Athens Transit Center.

The porous asphalt in the parking lot is less shiny and smooth than ordinary asphalt owing to the large and consistent size of its aggregate. Like dense asphalt, it never hardens to the extent concrete does because its binder is more flexible. "It's always potentially mobile," says Ferguson, "so there will be problems unless you take measures to counteract that." These problems include ruts, bulges, or waves formed when traffic is very heavy or the subgrade or base material is weak. When properly specified and installed, however, the adhesion of the binder and the interlock of the aggregate particles make for a stable surface. In addition, since research on its use as a stormwater management measure began in the early 1970s, advocates have worked to ameliorate "drain-down" problems with porous asphalt—the migration of binder through voids, partially or completely blocking the movement of water through the system.

No such problems were evident at the GEHC; there was a small patched area, but the new material, Ferguson noted with approval, appeared identical to that used in the rest of the installation. The whole area appeared free of sediment and easily passed the water-bottle test. Like porous concrete, porous asphalt can be maintained by regular vacuuming if there are sediment sources nearby.

Further afield of the parking area, pedestrian paths on the site were laid with SlateScape, a loose porous aggregate product made of thin, angular bits of slate. Even on relatively steep slopes the material has stayed in place, providing a neat yet informal appearance and a comfortable walking surface.

After the GEHC, we looked at an installation of porous turf used in an overflow parking area at the sprawling Mall of Georgia in Buford. The overflow lot accommodates about 100 cars on Bermuda grass parking stalls, grown in one-half to one inch of sand and laid as sod on the clay soil without a base course, connected by lanes of dense asphalt. This installation has been only partially successful.

Parking is rare in the overflow lot during the growing season,

COURTESY DEREK E. FERGUSON

but our visit took place during the December shopping season, and cars were parked here even in the middle of a weekday. While some of the turf parking bays were healthy, other areas showed ample evidence of soil compaction and a "wave" effect—a lot of wear and damage to grass at the edge of the pavement and soil past the pavement edge that was rutted and depressed. Ironically, this turf surface was the only one we saw that failed the water-bottle test—water actually beaded on the surface of the dormant Bermuda grass.

Porous concrete is "like a chemistry experiment," says Bruce Ferguson. Skilled installation and curing, *top left,* are critical. Too much paste in the mix, *top right,* can result in dense spots.

Laying out turf parking areas to minimize wheels turning on grass surfaces can help avoid excessive wear; reinforcement measures can also help resist damage. Some reinforcement products can be laid on or near the root zone of the grass, or even over existing turf. The mall's property owners considered using a reinforcing structure such as GrassPave, Ferguson says, but decided not to owing to its cost. A problem with porous turf, however, says Ferguson, is that "there are no standards or guidance for stabilization products."

Back in Athens, the Tailgate Station football parking facility (see "RipRap," page 26) used turf for the parking spaces to satisfy stormwater management regulations. A Belgian product called GrassTrac was laid a couple of inches under the soil surface to help distribute the point load from cars and pedestrian traffic. The turf parking spots here, which are only used during the University of Georgia's home football games, are in good shape, with no evidence of wear visible from the locked gate around the perimeter of the facility.

At another porous parking lot in Athens, for the regional hospital's satellite offices, results were mixed. The entire lot was paved about three years ago with aggregate reinforced by plastic lattice geocells. Most of the parking stalls were in good condition, but there was much more wear along the driveway area, where the aggregate layer was thinned out and the lattice reinforcement structure was clearly visible and, in many places, heavily worn or broken. "The plastic rings of the geocells," says Ferguson, "fail when they have to carry too much traffic."

An overflow parking lot at the Mall of Georgia, *bottom left,* has asphalt driving lanes and turf parking spaces. In some heavily used areas, *bottom right,* the turf has been less successful.

COURTESY BRUCE K. FERGUSON, FASLA, TOP AND BOTTOM LEFT; LINDA MCINTYRE, TOP AND BOTTOM RIGHT

He Sought the Storms

Ferguson is a technical expert, but he sees his work in a larger humanist context and his technical knowledge as a means to help people. "The problems that I found myself confronted with have been technical," he says. "For example, a fundamental understanding of how hydrology works in nature made stormwater infiltration an obvious way to restore a natural process with vast human benefits. But in my early work I was prevented from doing it, sometimes by arbitrary technical regulations and sometimes by elaborate technical arguments."

Ferguson chose to grapple directly with these obstacles to more ecologically sound stormwater management, despite difficulties and frustrations along the way. "I dove into hydrologic technicalities like Beowulf diving into the monster's lair," he says. "I made myself better at the technicalities than those who used them as excuses to avoid thinking about progress."

It hasn't always been a lot of fun, and Ferguson did not always make a lot of friends. "I have fought uniform stormwater detention and uniformly impervious pavements. Each battle has cost me many gray hairs. I have had people leaning over me, red-faced, yelling that I shouldn't be doing that, that there are reasons for established conventions, that everybody knows that the alternatives don't work, that I was only going to hurt people by advocating the wrong things."

But he stood by the evidence and now, after years of teaching and writing three seminal books, Ferguson can see the impact he and other like-minded landscape architects, many also influenced by McHarg, are making. "Today the barriers have in fact been largely dissolved, and regulations not only permit such integration with natural process, they encourage it, with a full understanding of what it does and what it means."

The high level of interest in *Porous Pavements* reflects this paradigm shift. Ferguson, who has traveled all over North America to talk about the book, attributes this to "the cultural and intellectual transformation of municipal agencies and others due to the NPDES [National Pollutant Discharge Elimination System] regulations" as well as competition among the producers of porous pavements. "There's an economic driver," he says, "because the various paving materials industries—concrete, asphalt, and concrete blocks—see porous pavement's environmental performance as a selling point."

FERGUSON CONSIDERS his broad liberal arts education an integral part of his work and his teaching. He reads widely, "everything from history to geology to thermodynamics to economics and politics," and writes widely too, claiming to be "the only human being whose work has been published in both the *San Fernando Poetry Journal* and the *Journal of Irrigation and Drainage Engineering.* "I pursue complete breadth of understanding because of its necessity for my profession and, I believe, for any responsible profession," he says. "The relevance and usefulness of [landscape architecture] comes from its placement upon that broad, complete platform."

But there is an opportunity cost to specialization. "Frankly, I would rather have spent many of those years as an artist, raising my applied designs to the highest levels of inspiring integration of environment, human community, and meaning, with all the world understanding and applauding the effort," he says. "But the times did not allow that. The barriers had first to be taken down, and I accepted the battle. My contribution has been more to enable my profession and the world with new, freer, and better technologies and approaches."

Plastic geocells are not sturdy enough to support heavy traffic, as in this Athens, Georgia, parking lot.

And his work isn't finished yet. "Today, the trial of technical barrier breaking is behind us. We know what the right thing is to do for water itself. The question now is how to integrate natural process artistically and correctly into the urban landscapes where people live and work," he says.

Cities, says Ferguson, especially densely populated low-income neighborhoods, are ripe for sustained attention from landscape architects and other designers. "We have to define conclusively what are sound criteria for successful urban design," he says. "Unfounded and unexamined agendas for urban design abound, as they have always done for environmental design. The next fundamental contribution to be made is in integrative urban design, using criteria for both the biophysical environment and human communities."

Quite a tall order, but Ferguson is up for it. "This is the next Grendel's lair," he says, "into which we must dive." LAM

Resources

- *Porous Pavements,* by Bruce K. Ferguson, FASLA; Boca Raton, Florida: Taylor & Francis Group, 2005.
- *Stormwater Infiltration,* by Bruce K. Ferguson, FASLA; Boca Raton, Florida: Lewis Publishers/CRC Press, 1994.
- *Introduction to Stormwater: Concept, Purpose, Design,* by Bruce K. Ferguson, FASLA; Hoboken, New Jersey: John Wiley & Sons, 1998.
- National Stone, Sand, and Gravel Association, *www.nssga.org*
- Interlocking Concrete Pavement Institute, *www.icpi.org*
- National Ready Mixed Concrete Association, *www.pervious pavement.org*
- Portland Cement Association, *www.cement.org*

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