Appendix

Porous Pavement Surfacing Systems: Will they Work in Northern Climates?

(Notes and Comments from the November 22, 2002, Workshop)

Presentations by the Two Principle Speakers:

Bruce Ferguson, University of Georgia: A Global Perspective on Porous Pavements. "Porous pavement is perhaps the greatest invention since the automobile!" Why, because roads and parking spaces cover roughly twice the area of their associated buildings and represent a good 50% of the built up area. They affect downstream water quality and temperature and even the health of urban trees.

Porous pavement has the potential to restore urban watersheds. Despite the many misgivings (water weakens pavement, won't work in northern climes, etc.), the topic is too important to simply discredit. Ferguson has examined over 300 systems in North America and concluded there is not a simple "yes" or "no" to the question.

Porous pavement got off to a bad start around 1970 when EPA began pushing porous asphalt on R&D projects. This was a big flop since asphalt is by its nature self-clogging.

Porous concrete works much better—especially, if it is made of single size aggregate (creates a medium with roughly 20% voids). This could easily be used for off-highway use and should cost about the same as regular concrete. Like a forest soil, it has its own storage capacity and retention and develops its own micro-ecosystem (moist, aerated bacteria) that has been shown capable of biodegrading oil products through a 12 inch layer. The problem lies in repeated freeze/thaw cycles that can reduce the pavement to powder over time. Ferguson believes this can be resolved within the next two years.

Some basic maintenance principles are to avoid sanding, but use angular, graded aggregate and keep drainage from soil off the pavement (as it can introduce fines). For strength, a minimum base course of six inches is required.

Corps of Engineers has developed nationwide curves on frost depth, etc., based on the number of freezing days at a site—e.g. a 10 year frost depth based on 2500 freezing days is 80 inches. For complete protection, one should build the sub-grade to the frost depth. However, for practical protection, 0.5 frost depth is generally used. Open voids allow some expansion during freezing and the ponded water within the system is, to a degree, self-insulating. Use graded material to avoid differential heaving (frost boils).

End result of using porous systems is cleaner water, longer lived trees, cooling (evapotranspiration), quieter streets, safer driving, beauty, reduced costs, and conformance to development regulations for stormwater management. It should be designed to drain away from the edges in all directions. It should not be used over drain fields, where there are leachable toxins, on steep slopes, near basements (20 feet) or water-supply wells.

Some myths are that they don't work over clay, require compacted subgrades, won't work in freezing climes, get clogged and fail quickly, are costly and "there is no experience of using them in our area." All of these myths can be debunked through proper design, construction and attention to site specific conditions. As familiarity and confidence with their use increases, the cost should also come down. Costs also come down when one includes the pavement as part of the entire drainage system (i.e. in place of some of the pipe and pondage that otherwise might be required).

Q/A: How long can such a system be expected to work without clogging? Generally, the greatest decline is in the first 6 – 8 years and can be avoided by designing it right in the first place to control sedimentation and clogging of the subgrade.

What about plowing and sanding? By using a roller on the plow or setting the blade one inch above the surface, there should be no problem. "And don't you dare sand!" (It shouldn't be necessary to sand if designed properly.)

What about spring snow melt? Don't you still need to design ponding for 100 yr event if part of an integrated design? Not completely. Jay Riggs noted that even in winter there is quite a bit of infiltration over porous pavement he has seen.

Construction sequencing?—i.e. the problem of building roads first and then clogging them up with a lot of sediment. Do the roads last or at least the final treatment.

William James, University of Guelph: Design and Testing of Interlocking Concrete Block Pavement. Porous pavement is good at reducing three main concerns from runoff: temperature, pH and turbidity. Traditional pond design is costly (earth moving), has a high maintenance cost, is aesthetically challenging and potentially dangerous. Porous pavement can provide flood control without ponds, water quality and temperature control, and help preserve aquatic ecology. Thermal pollution or "thermal enrichment" is directly proportional to a site's % impervious. Ecostone has approx. 12% voids and should not be put next to basements. It helps to aerate the underlying soil. Clogging occurs only in the top crust. Sand is itself dispersed by traffic in the driving lanes and has not been a problem at his test sites. Curbs are bad (just a guide for plows) and should not be used. Geotextiles provide a good substrate for microbes. The rough surfaces of the stone reduce ice problems. Pea gravel about ¼ inch in diameter is good for the fill and substrate. Fine particles do penetrate, but are ultimately snagged. Vegetation in the cells is not a problem and helps to keep fines out. A power washer is better than a brush/vacuum for cleaning cells (brush just skimmed the crust). Frost heave has not been a problem. Nor has ground water contamination (filtered by substrate). Stormwater Management Model (SWMM) provides design overkill for questions of water quality and quantity. One can install 800 square feet/hour by hand; 1200 square feet, mechanical.

Comments by DNR Staff who attended the Workshop

Fifteen DNR Waters staff attended the workshop; eleven provided written comments. Many respondents expressed skepticism. However, others noted that unless we encourage some use, it is not likely we will ever have much to review to see how well they do perform here. Here are some representative samples of the comments:

I'm still skeptical. Nothing was presented that showed alternative paving systems are a suitable substitute for a vegetated surface for things like thermal buffering, habitat for insects and other small critters, sediment entrapment. The visual impact, especially in the shore impact zone, could be significant.

Unless we encourage some installation, we probably won't see much put in and, therefore, will have few opportunities to evaluate and improve them.

For trout streams that are dependent on surface water (i.e. most of them in NE Minnesota), infiltration is important if stream temperatures are to be protected from development. We should promote systems that enhance infiltration where it makes sense to do so and there is some capacity to monitor the results.

Porous pavement will never replace fish and wildlife habitat. Its use should be limited, especially, in the shore impact zone.

Such systems would require close attention to onsite conditions, design, installation and maintenance. It is not a natural system where there is good interaction among plants, soil, air and water.

Even if they have the expertise, most local staff lack the time needed to ensure that systems are properly designed, installed and monitored.

Even if such systems are capable of mimicking natural soils and vegetation in their retention and treatment of surface water, they lack the aesthetic appeal of a natural shoreline and provide nothing to help screen structures.

We need to encourage these kinds of systems so we can learn about how they work here in Minnesota. If they were to be treated as permeable under shoreland rules, their experimental nature would still require the need for certain maintenance and monitoring conditions. In addition, the landowner should be required to do something extra on their property (enhance a natural buffer strip with native vegetation instead of sod, etc.) as an "insurance policy."

Concerned about the maintenance required—both public and private. In general, public works departments are poorly funded and poor at maintaining what they already have.

Conclusion

In examining both the pros and the cons to the use of permeable pavement systems in shoreland areas, it is worth noting the purpose for which the shoreland rules were written:

> *To manage the effects of shoreland and water surface crowding, to prevent pollution of surface and ground waters of the state, to provide ample space on lots for sewage treatment systems, to minimize flood damages, to maintain property values, to maintain historic values of significant historic sites, and to maintain natural characteristics of shorelands and adjacent water areas, shoreland controls must regulate lot sizes, placement of structures, and alterations of shoreland areas.* (Minnesota Rules 6120.3300, Subp. 1).

Because of the inter-related values that shoreland management addresses, one should proceed cautiously with any new technology, no matter how promising, that seeks to address certain discrete elements addressed in shoreland management.

For general purposes in shoreland management, permeable pavers should only be treated as truly permeable when they are part of a local government's comprehensive stormwater management program where it is but one of many tools (rainwater gardens, swales, preservation of natural vegetation, buffer strips, low impact development, etc.) designed to enhance infiltration and reduce surface runoff from developed areas into public waters. One way to accomplish this is through the flexibility provisions of the rules by any local government having the interest and resources that are clearly required if such systems are to be effectively used as both manufacturers and researchers intend for them.

For the vast majority of local governments who lack the capacity to effectively apply and oversee low impact design standards in stormwater management, permeable pavers may be allowed, but there should be no credit for their use in meeting the 25% impervious limitation. Instead, where development on a site exceeds 25% impervious and a variance is requested, the Board of Adjustment may, on a case-by-case basis, consider the use of permeable pavers provided there is sufficient guidance on their design, installation and maintenance. Other conditions a LGU should consider in its variance approval would be provisions to enhance or widen the use of natural vegetation within a buffer strip and no use of pavers within the Shore and Bluff Impact Zones.

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