Permeable Pavement Systems in Shoreland Areas,
A Guidance to Local Governmental Units
DNR Waters, St. Paul, Minnesota
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Background

The impact of impervious surfaces upon public waters has always been a concern of the statewide Shoreland Management Program. When the statewide standards were revised in 1989, the established limit of 30% impervious for shoreland lots was reduced to 25%. The reason behind this reduction was explained in the Statement and Need of Reasonableness (SONAR) for the rules. The SONAR noted that most development rarely exceeds 30% and that 25% was still a "large percentage." "This is needed to prevent the excessive amount of runoff that will be generated during a rainstorm by an enlarged impervious area. Such excessive runoff will cause erosion and transport of pollutants to public waters thereby degrading water quality."

Since then, much more has been learned about the impacts of impervious cover on aquatic systems. In March, 2003, the Center for Watershed Protection issued a report that summarized the results of 225 studies involving the use of 26 different stream indicators. These verified earlier studies that showed that the effects of increasing impervious cover on a healthy stream begin to be seen when the impervious cover exceeds 10%. Indicators show stressed conditions for streams having impervious watershed cover between 10 and 25%. Beyond 25%, severe degradation takes place.

The report cautioned that these data have not yet been validated for non-stream conditions. However, some of the referenced studies involved lakes and drinking water reservoirs. These noted that phosphorus export to a water body increases steadily as the percent of impervious cover increases. Aggressive watershed protection strategies were recommended for reservoirs having 10 – 25 % impervious cover. Data indicate that reservoirs having over 25% impervious cover cannot sustain safe drinking water supplies.

While the indicators are useful in estimating trends and cumulative impacts, the report cautioned that they should not be used empirically. In general, the rule of thumb applies: the greater the percent of impervious surface, the greater the impact to water quality and natural systems. Other parameters like percent of forest cover or natural vegetation appear to become more important when the percentage of impervious cover is low. When it is high, the impacts from stormwater over-ride other factors. The report suggests that non-native vegetation like turf can be included with impervious surfaces when analyzing impacts to urban streams. Stormwater ponds, while effective at removing pollutants, were observed to have little effect in improving stream biodiversity. In fact, the study cautioned that no community has yet demonstrated that it can achieve water quality standards in an urban watershed that exceeds 25% impervious cover. "Managers should be extremely cautious in setting high expectations for how much watershed treatment can mitigate impervious cover… Both watershed research techniques and practice implementations need to be greatly improved (Tom Schueler. 2003. *Impacts of Impervious Cover on Aquatic Systems*. Center for Watershed Protection. p. 21)."

Workshop on Porous Pavement Surfacing Systems, November, 2002

DNR Waters field staff involved with shoreland management met on May 16, 2002, with Peder Otterson, Shoreland Hydrologist, and Jay Michels, Minnesota Erosion Control Association (MECA), to discuss the use of permeable pavement systems in shoreland management. Various concerns were discussed and recommendations made. One recommendation was that MECA sponsor a workshop of skilled researchers who could address the questions being raised by field staff and local governmental units. The workshop took place November 22, 2002, as described below.

Bruce Ferguson, an authority on stormwater management from the University of Georgia, noted that roads and parking surfaces cover approximately twice the area of their associated buildings and represent a good 50% of a built up urban area. For this reason alone, it is important that everyone involved in land development take seriously the emerging technologies of porous pavement systems. However, it must always begin with proper site analysis and matching the right system in the right place. He noted that porous pavement should not be used over drainfields, on steep slopes or near basements or water-supply wells. The thickness of the subbase largely determines the surface's load-bearing capability. The thickness can also be used to increase storage of infiltrating stormwater where underlying soils have limited percolation. For safety, some construct the subbase to the frost depth. However, Ferguson noted that for practical protection 0.5 frost depth should suffice since the open voids allow for some expansion during freeze/thaw and the system is, to a degree, self-insulating.

William James provided details of the studies he has made using cement pavers in the laboratory and field at the University of Guelph, Ontario, Canada. His studies show the positive effects such pavers can have over impervious pavement in reducing the impacts of temperature, pH and turbidity of the stormwater runoff. He found little problem with frost heave or ground water contamination. The subbase acts to retard and break down pollutants in much the same way as natural soils. Clogging with fine material seemed limited to just the upper surface of the spaces between the pavers. Use of a power washer to clean clogged surfaces proved superior to brush/vacuum which just skimmed the surface and did not remove the clogged layer.

Both presenters stressed that surface drainage should be sloped away from the porous pavement areas to reduce the amount of clogging. This led to a number of questions concerning street sanding, routine maintenance, stormwater retention during early spring, etc. Both presenters stressed that with a properly designed and installed permeable pavement system, it should not be necessary to sand or salt the roadway since meltwater is absorbed into the pavement. A member of the audience noted that he had seen proof of this in local installations where there was observable retention of stormwater and resultant dry surface conditions during winter months. Ferguson indicated that the time is coming when porous concrete itself may provide a relatively low cost alternative to standard paved surfaces once the issue of freeze/thaw has been resolved.

Recommendations on the Use of Permeable Pavement Systems in Shoreland Areas

Often, the term "porous" and "permeable" are used interchangeably. Technically, porosity refers to the amount of connected open spaces a material has while permeability is a measurement of the rate at which water is able to pass through it. The surface of a paving stone is often impermeable while the large pore spaces between stones allow for water to flow through. The pavement surface may have high porosity (lots of pores or holes), but the system may still be relatively impermeable if the subbase is not properly designed and constructed. Rather than focusing on either the surface of the material or the subbase, it is better to consider the full design and function of the entire system. Finally, although a permeable pavement system can indeed be designed and installed to meet any given stormwater requirement, the system itself can never replace the many benefits that native soils and vegetation provide in shoreland areas: such things like habitat, nutrient uptake, soil and pollutant retention, vegetative screening, and aesthetics.

DNR Waters recommends that local governments include in their zoning ordinances a definition for impervious surfaces. The Minnesota Pollution Control Agency's new stormwater management rules define "impervious surface" to be:

> **"Impervious surface"** means a constructed hard surface that either prevents or retards the entry of water into the soil and causes water to run off the surface in greater quantities and at an increased rate of flow than prior to development. Examples include rooftops, sidewalks, patios, driveways, parking lots, storage areas, and concrete, asphalt or gravel roads."

A similar definition can be found in the Blue Earth County, MN, Shoreland Ordinance:

> **Impervious Surface.** The surface area of a lot which has been physically altered in a manner which impacts the ability of the lot to percolate water into the ground, causing runoff. Impervious surfaces include rooftops of buildings, blacktopped or concrete driveways and patios, and areas of landscaping underlain with plastic or other impermeable liners.

If taken as part of the overall site design and used as part of a larger stormwater management plan, permeable pavement systems can compensate for some of the impacts that other impervious surfaces have on a lot. However, they do not take the place of native vegetation and undisturbed soils, especially, in the Shore Impact Zone, that area which is closest to the shore and extends to half the setback of the structures.

DNR Waters recommends the following as a reasonable approach for local governments to follow on the use of emergent technologies like permeable pavement systems in shoreland areas until such time as greater research, experience and testing can answer the questions raised. Based on the information provided by the Center for Water Protection referenced earlier, it appears that such use may be more beneficial when applied to areas of new development and as part of an integrated stormwater management plan, related stormwater management ordinance or NPDES, Phase II permit. On degraded sites where 25% impervious is already exceeded, the retrofitting of permeable pavement systems may be of lesser value. Exercise caution in using infiltration techniques in areas of ground water sensitivity like wellhead protection zones or sites of known surface contaminants.

1. **Areas of New Development.** Strict adherence to shoreland standards. Where possible, encourage limiting percent of impervious cover to below 10%. No credit for permeable pavement systems unless included in a comprehensive stormwater management plan that emphasizes infiltration and onsite retention of stormwater through a combination of methods including buffer strips, swales, rainwater gardens and other low impact development methods. This assumes LGU oversight of design, construction and future maintenance.

2. **Areas of Redevelopment.** Where existing percent impervious varies between 10 and 25%, LGUs are encouraged to adopt comprehensive stormwater management controls as described above, giving credit for those that help to reduce percent impervious. LGUs should strive to limit overall percent impervious to under 25%, as required in shoreland management rules. For lots exceeding 25%, redevelopment must reduce impervious surfaces to 25% or less. Otherwise, a variance is required.

3. **Redevelopment or enlargement of nonconforming structures on lots exceeding 25% impervious.** Under Minnesota Statutes, the required variance is to be acted upon by the local Board of Adjustment according to standards established in statute, rule and local ordinance. Should the Board decide to grant a variance involving the use of permeable pavement systems, DNR recommends consideration of the following conditions to the variance:

    a. No permeable pavement system in Bluff Impact Zone or Shore Impact Zone (area to be maintained or restored to natural vegetative buffer);
    b. Where native vegetation is lacking in the above zones, additional vegetation may be required in order to enhance buffer and screening.
    c. The base of the installed system (subbase) must be above the established ground water table (DNR recommends three feet of separation similar to onsite sewage treatment systems to ensure soil absorption and enhanced retention of stormwater);
    d. System to be designed and certified by a registered engineer or landscape architect and installed by someone qualified in the particular system used;
    e. System should be set back from structures having basements, septic system leach fields, steep slopes and wells;
    f. The design should allow for the infiltration of the first inch of any storm. If stormwater retention is a goal, DNR recommends that the design meet the two year 24 hour storm (approximately 2.5 inches);
    g. The site should be inspected during construction for compliance.
    h. The designer must include maintenance instructions to the property owner along with a maintenance schedule with copy to the Zoning Administrator or Building Inspector to be filed along with the permit.
    i. When possible, the system should be designed so that it can be periodically monitored to ensure it continues to work as planned.
    j. System must be compatible with local stormwater management plans, ordinances, and NPDES Phase II stormwater permits, where required.