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The Application of Permeable Pavements in Highways and Urban Roads

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POLICY BRIEF

Issue

Under current provision of the Clean Water Act (CWA) and the amended National Pollution Discharge Elimination System (NPDES) all communities with populations of 10,000 or more, which includes nearly all jurisdictions in the United States, are required to regulate and control the discharge of urban stormwater into receiving water bodies. All dischargers are also required to comply with the total maximum daily load (TMDL), which is the total amount of pollutant mass a receiving water body can receive and still meet water quality standards. If water quality standards are not met, then the water body is classified as impaired. Currently, California alone has over 7,000 impaired water bodies with identified sources of pollution that require the establishment of TMDL limitations. About 900 of the identified impaired water bodies are directly linked with organic and inorganic pollution originated from urban surfaces.

The CWA and related regulatory compliances and societal demands for clean water have exerted a tremendous amount of pressure on stormwater runoff dischargers throughout the United States to develop innovative stormwater treatment and management strategies. In order to meet CWA permit requirements, most municipalities and state department of transportations (DOTs) are obligated to use one or more best management practices (BMPs) to collect and treat runoff from road surfaces before it is discharged to receiving waters. Examples of current BMPs used by DOTs to effectively treat stormwater runoff pollution include sand filters, detention basins, and infiltration basins. The implementation of these BMPs on urban highways is challenging due to the lack of right-of-way and/or land availability.

Even when space is available, collecting and treating large volumes of runoff in urban areas is often cost prohibitive. Hence, current methods of stormwater management in urban areas are neither practical nor sustainable.

A more environmentally beneficial and cost-effective approach to capturing, treating, and slowing down water runoff generated by road surfaces is the use of a full depth permeable pavement shoulder design. Under this proposed design, most if not all runoff will be retained within the shoulder and there would not be a need for additional treatment. The use of permeable pavement shoulders in highly urbanized areas is particularly beneficial since finding sufficient land area to implement other solutions (such as infiltration or detention basins) is difficult.

Policy Implications

There is a growing “urban surface evolution” that is supporting the shift from gray infrastructure to green infrastructure. The increased use of permeable pavements is part of this movement given the many environmental, socioeconomic, and human health benefits these pavements provide, such as reduction in roadway noise, runoff, and urban heat island effect as well as improved water quality. Given these benefits, the United States Environmental Protection Agency (USEPA) characterizes permeable pavements as ‘cool pavements.’ There are potential tradeoffs though that include but are not limited to extra cost, moisture damage, and unknown impacts on ground water contamination.

In the future, with more stringent environmental regulations related to air quality and water quality, many municipalities in urban areas may be forced or encouraged to switch from current

impermeable land use development practices to permeable alternatives. This transitional change may require policy shifts and cooperation among dischargers (e.g., municipalities, state DOTs) and regulators (e.g., USEPA). Collaborative efforts between the agencies for collecting the scientific data and developing the design and monitoring guidelines is considered to be essential for successful shifts in policy and program implementations. For example, USEPA recently sued Caltrans for violating CWA requirements in California. Because of this law suit, Caltrans cooperated with the USEPA regulatory representative in California to develop several water quality design and monitoring guidance manuals that are now being used both in California and throughout the United States.

Research Findings

Compared with conventional pavements, the design and installation of permeable pavements is fairly new. Nevertheless, over the past two decades tremendous progress has been made with regards to the application of permeable pavements, specifically on issues related to structural design, hydrologic design, water quality, and pavement surface clogging.

There have been many successful permeable pavement installations in the United States though mostly in parking lots and other commercial areas with low speed and light traffic load. There have been only a handful of demonstration projects and simulations studies that evaluate the use of permeable pavement in highway environments, which have higher vehicle speeds and heavier loads. One notable field study in this area was completed by Minnesota Department of Transportation. Results

from this study revealed a positive picture for permeable pavements based on overall structural and hydrologic (i.e., infiltration and water quality) performance. The University of California Pavement Research Center and National Cooperative Highway Research Program have also completed studies on the performance of permeable pavements under highway conditions. Both studies produced promising and feasible results.

While tremendous amount of progress has been made with this relatively new pavement technology, knowledge gaps remain. There is a need for an integrated network approach that couples materials, energy, water and pollutant flows across complex pavement system boundaries. For example, pavement characteristics will influence vehicle fuel consumption, noise, safety, stormwater runoff pollution, and surface temperature and ultimately each of these parameters impact human health and the environment (Figure 1). Some of the integration challenges directly or indirectly related to permeable pavements identified for future consideration and research include: climate change, micrometeorology, stormwater pollution, cool island impact, noise impact, energy impact, and materials recycling impact.

Further Reading

This policy brief is drawn from the summar report, “The Application of Permeable Pavement with Emphasis on Successful Design, Water Quality Benefits, and Identification of Knowledge and Data Gaps,” authored by Masoud Kayhanian, Peter Weiss, Lev Khazanovich, and John Gulliver, found at: <http://bit.ly/1GqNhcr>

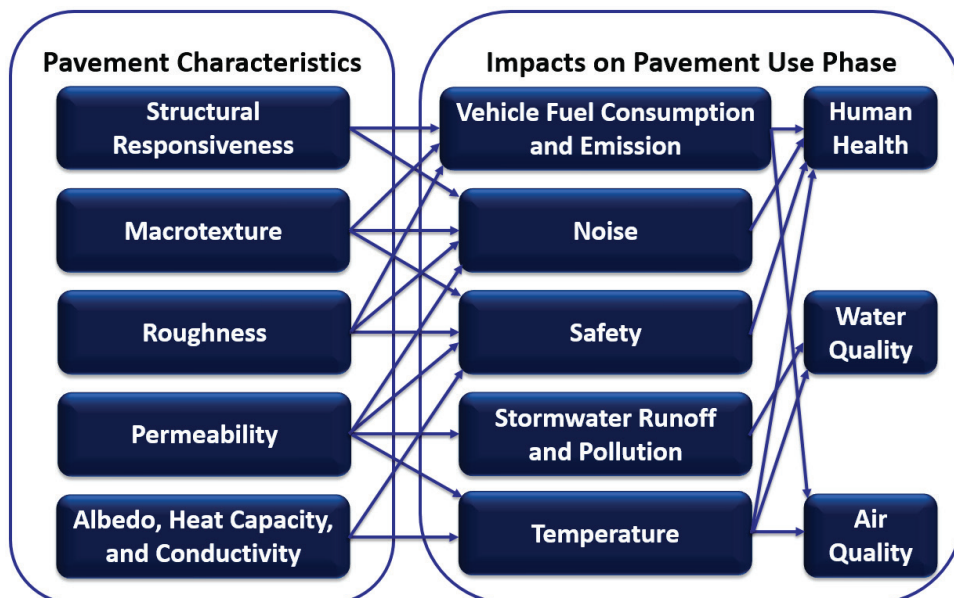


Figure 1: Future Direction of Sustainable Use of Permeable Pavements with End Use Objectives (Source: Van Dam et al., 2015)

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