Porous asphalt has been used very successfully in colder climates. One of the oldest porous asphalt systems in the U.S. was built at Walden Pond in northeastern Massachusetts and has continued to work for over 20 years (read a good description at http://www.millermicro.com/porpave.html). We have designed other success stories in north-central Pennsylvania, Michigan, Rhode Island, central New York, and Colorado. One of our clients in Michigan reported to us that they rarely had to plow their parking lot over the winter of 2000-2001. Considerable research has been done in NORTHERN SWEDEN which has concluded that porous pavement performed better or equivalent to conventional pavement across the board (Porous Pavement in a Cold Climate, Magnus Backstrom, 1999):

"Porous pavements have the potential to reduce meltwater runoff, avoid excessive water on the road during the snowmelt period... The porous pavement was more resistant to freezing than the impermeable pavement, ... Thawing of porous pavement was a rapid process, ... The full-scale porous pavement construction was not damaged by frost heave and the frost heave ... was less or equal to ... comparable impermeable pavement." He also reports that a porous asphalt system in Haparanda (Northern Sweden) has been functioning for over 9 years WITHOUT any maintenance. He reports another system, 4.5 years old, which had an infiltration rate of 65 mm/min (153 inches/hour). He states that approximately 300 porous pavement systems were installed in Sweden during the 1980s.

David Swisher studied Cahill Associates' porous pavement system at Pennsylvania State University in State College, PA for over two years. (On average, State College is slightly colder and snowier than Boston, MA.) He concluded (*Chemical and Hydraulic Performance of a Porous Pavement Parking Lot with Infiltration to Groundwater*, Masters Thesis, Pennsylvania State University, December 2002):

> "All of the stormwater that flowed into the porous pavement system was infiltrated into the underlying soils. This means that the stormwater BMP [porous pavement] at the Visitor's Center has achieved zero discharge over the past two years, despite very heavy rainfalls [and snow]." It should be noted that this 0.3-acre porous pavement system manages the runoff from over 1.5 acres. He also reported the parking lots did not receive deicing agents or anti-skid materials "mainly because there has not been a need for them."

Although the Swedish research claimed that anti-skid abrasives were okay for use on porous asphalt as long as they were coarse, we have always recommended that our porous asphalt systems not be sanded or cindered (deicing agents are fine). Again, this typically hasn't been a problem because the porous asphalt systems tend to need much less winter maintenance and the formation of dangerous "black ice" is almost nonexistent.

Pollutant Removal Through Infiltration and Porous Pavement

The protection of groundwater quality is of utmost importance when designing infiltration systems. The potential to contaminate groundwater by infiltrating stormwater in properly designed and constructed BMPs with proper pretreatment is low. Numerous studies have shown that stormwater infiltration BMPs have a minor risk of contaminating either groundwater or soil.

Perhaps the most comprehensive research was conducted by the U.S. Environmental Protection Agency and is summarized in "Potential Groundwater Contamination from Intentional and Nonintentional Stormwater Infiltration." (Pitt et al., 1994) Their conclusions are summarized in a table that identifies the potential of pollutants to contaminate groundwater as either low, low/moderate, moderate, or high. Of the 25 physical pollutants listed, only one has a "high" potential (chloride), and only two have even "moderate" potential (fluoranthene and pyrene) for polluting groundwater through the use of shallow infiltration systems with some sediment pretreatment. Even nitrate, which is soluble and mobile, is only assigned a "low/moderate" potential. The remaining 21 contaminants, including anthracene, naphthalena, pentachlorophenol, cadmium, zinc, chromium, and lead are classified as having a "low" contamination potential. Chloride should not pose a risk because we anticipate that a minimal amount of deicing salt will be applied to the porous pavement lots and groundwater is relatively tolerant to chloride (the U.S. EPA's National Secondary Drinking Water Regulations recommend a maximum chloride concentration of 250 mg/L for cosmetic/aesthetic reasons). Runoff entering the porous pavement system is not expected to have significant levels of either fluoranthene or pyrene.

Legret et al. (1999) simulated the long term effects of heavy metals in infiltrating stormwater and concluded that the "long-term pollution risks for both soil and groundwater are low," and "metals are generally well retained in the upper layers of the soil (0-20 cm) [0-8 inches]…" Barraud et al. (1999) studied a thirty year-old infiltration BMP and found that both metal and hydrocarbon concentrations in the soil under the infiltration device decreased rapidly with depth "to a low level after a few decimeters down [3 decimeters = 1 foot]…" A study concerning the infiltration of highway runoff (Dierkes and Geiger, 1999) found that polycyclic aromatic hydrocarbons (PAH) were effectively removed in the upper 4 inches of the soil and that runoff that had passed through 14 inches of soil met drinking water standards for cadmium, zinc, and copper. This extremely high pollutant removal and retention capacity of soils is the result of a multitude of natural processes including physical filtering, ion exchange, adsorption, biological processing, conversion, and uptake.

Several studies have also found that porous pavement and stone-filled subsurface infiltration beds can significantly reduce the pollutant concentrations (especially hydrocarbons and heavy metals) of stormwater runoff before it even reaches the underlying soil due to adsorption, filtering, sedimentation, and bio-degradation by a diverse microbial community in the pavement and infiltration beds (Legret and Colandini, 1999; Balades et al., 1995; Swisher, 2002; Newman et al., 2002; and Pratt et al., 1999).

Median Pollutant Removal (%) of Stormwater Treatment Practices

POLLUTANT	INFILTRATION PRACTICES	*Stormwater Wetlands*	*Stormwater Ponds Wet*	*Filtering Practices*	*Water Quality Swales*	*Stormwater Dry Ponds*
Total Phosphorus	70	49	51	59	34	19
Soluble Phosphorus	85	35	66	3	38	-6
Total Nitrogen	51	30	33	38	84	25
Nitrate	82	67	43	-14	31	4
Copper	N/A	40	57	49	51	26
Zinc	99	44	66	88	71	26
TSS	95	76	80	86	81	47

Source: Winer, Rebecca, "National Pollutant Removal Performance Database for Stormwater Treatment Practices", 2nd Edition, June 2000, Center for Watershed Protection, Ellicott City, Maryland.

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