Permeable Pavement and Bioretention Swale Demonstration Project

Seneca College, King City, Ontario

Urban development alters the natural hydrologic cycle by replacing pervious vegetated areas with impervious roofs and pavements. These changes in surface cover reduce infiltration, and dramatically increase surface runoff, resulting in erosion of stream channels and increased potential for downstream flooding. As these higher runoff volumes enter receiving waters, they carry with them a variety of pollutants that ultimately degrade river ecosystems and contaminate swimming areas.

The use of permeable pavement and bioretention swales for treatment of runoff from parking lots, driveways and roads allows rainwater to slowly infiltrate into the ground, as it did prior to urbanization. As more water infiltrates, less runs off, providing for improved protection of downstream aquatic habitat, property and swimming areas.

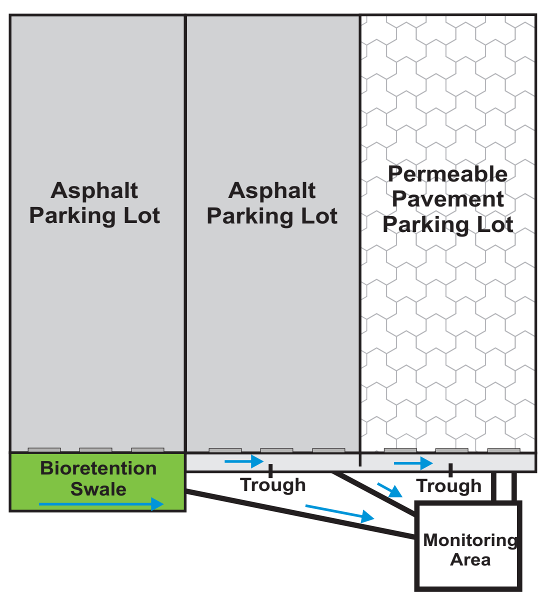
Study Objectives

This evaluation examines the long-term performance and effectiveness of permeable interlocking concrete pavers (PICPs) and bioretention swales for stormwater management under climate and soil conditions representative of the Greater Toronto Area. The study addresses benefits and limitations of the technologies relating to runoff reduction, the effects of road runoff infiltration on soil and groundwater quality, long-term clogging and durability, heat island mitigation and the structural integrity of permeable pavements.

Site Description

The study site at Seneca College in King City was specially designed to facilitate evaluation of the two technologies. The parking lot was divided into three equally sized areas with PICP, a bioretention swale and a conventional asphalt control. Runoff was collected both at the road surface level and as infiltrate from the soils approximately 1.5 metres beneath the PICP and bioswale. Monitoring of flows and water quality was conducted year round in an underground vault powered by a wind turbine and three solar panels.

Pressure transducers installed in the pavement base and on top of the swale provided continuous data on storage volumes and drawdown times after storm events. Temperature sensors embedded at different depths within the surface materials on all three sections helped to assess freeze-thaw cycles and relative contributions to summer heat island effects.



Six older PICP and bioswale sites of varying ages were surveyed in 2006 and 2007. The surveys included investigations of surface infiltration rates, soil quality and the physical condition of the practices.

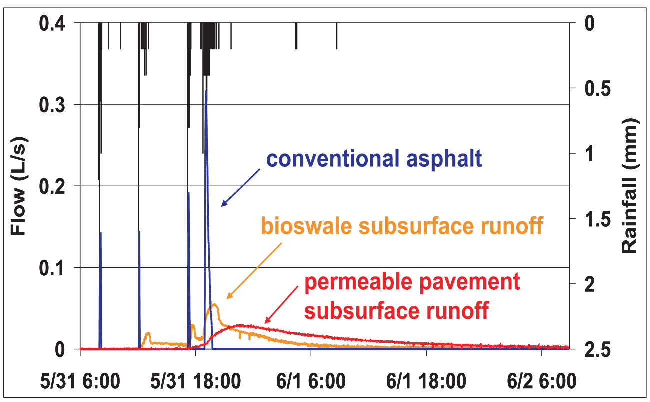
Results

Over a 30 month period, 99% of rainfall on the permeable pavement infiltrated.

The bioswale met its design objective of infiltrating and evapotranspiring all runoff for events up to approximately 15 to 20 mm .

Both technologies functioned well during the winter with temperatures in the lower base and surface soils rarely falling below zero degrees.

Older PICPs surveyed had lower surface infiltration rates than newer sites due to poor maintenance and/or design shortcomings.



Flow from the permeable pavement, bioswale, and control during a 21 mm event on May 31, 2006 No surface runoff was measured from the permeable pavement. Bioswale overflows were not monitored.

- Sampling from over 50 events show that stormwater infiltrated through the PICP and bioswale contained significantly lower levels of typical parking lot contaminants such as zinc, lead and hydrocarbons, relative to conventional asphalt runoff.
- Nutrients and undegraded oils in the organic bioswale soils contributed to elevated levels of these constituents in the bioswale infiltrate.
- Depth profiles of soil chemistry from older PICP and bioswale sites indicated contaminant levels typically below Ontario background concentrations for non-agricultural land uses.

Applying de-icing salts to permeable pavements may pose a risk to groundwater quality as the concentrations of these chemicals were not reduced by infiltration through the soil or granular media.

Structural tests at two PICP sites using a portable falling weight deflectometer during the fall, winter and spring indicated that the asphalt and PICPs were comparable in strength. All the older PICP sites surveyed were found to be in reasonably good structural condition.

The temperature of the asphalt surface exceeded 20 degrees Celsius roughly 12% more often than the pavers, suggesting that PICPs may help to mitigate against undesirable effects associated with the urban heat island.

Although surface temperatures of asphalt and PICPs were similar during the winter, the capacity of PICPs to infiltrate water helped reduce the incidence of ponding and ice build-up.

For more information on this project or the Sustainable Technologies Evaluation Program, contact Tim Van Seters at (289) 268-3902. The final report for this study is available for download from the STEP website at www.sustainabletechnologies.ca.

Project Funding Partners

Great Lakes Sustainability Fund
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