Permeable Interlocking Concrete Pavement Performance (PICP) Over Clay Soils

Recipient: North Carolina State University.
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Project Summary: 7

icpi
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Background and Need

Contrary to opinions held by some, clay soils infiltrate which makes them eligible for use under PICP. This project provided data to support volume and pollutant reductions over a small PICP site with clay soils (hydrologic soil group D) in Durham, North Carolina.

Objectives

A doctoral candidate with North Carolina State University monitored the hydrologic and pollutant removal performance of PICP over a low-infiltration, clay soil from March 2014 through April 2015. Four parking stalls (540 ft2) shown at left were retrofitted with PICP to treat 1635 ft2 of contributing impervious area (3:1 run-on ratio). The PICP design followed standards outlined in the North Carolina Department of Environment and Natural Resources 2012 Best Management Practices Manual.

In late September 2014, a substantial portion of runoff was bypassing treatment along the curb adjacent to the permeable pavement. Subsequent monitoring of bypass volume determined 90% of the watershed was bypassing the system, reducing the treated watershed to 163.5 ft2 and the run-on ratio to 0.3:1. All subsequent analyses were interpreted based on the post-construction watershed of the system. The site incorporated a six-inch high internal water storage (IWS) zone of open-graded aggregate to increase infiltration to the subsoil via an elevated underdrain. This zone could store about 2 inches of water depth, thereby allowing for some infiltration in a subgrade with an infiltration rate of about 0.04 to 0.06 inches per hour.

Results from 13 months of monitoring indicated an average of 22% volume reduction via subgrade infiltration. Inter-rain event drawdown of the IWS zone created storage to capture over 70% of the runoff volume from storm events less than 0.30 inches, and peak flows were significantly reduced by a median of 84%. The site exhibited exceptional pollutant removal efficiency, with influent and effluent pollutant concentrations significantly reduced for total suspended solids at 99%, total nitrogen at 68%, and total phosphorous at 96%. The median effluent concentrations of total nitrogen (0.52 mg/L) and total phosphorous (0.02 mg/L) were below “excellent” ambient water quality thresholds for piedmont region of North Carolina. Cumulative loading reduction for the watershed was excellent with loading removal efficiencies of 98%, 73% and 95% for total suspended solids, total nitrogen and total phosphorous respectively.

Additional sampling of the various nitrogen forms 12, 36, 60, and 84 hours post-rainfall was conducted to better understand mechanisms of nitrogen removal in permeable pavement. Results

from one storm event indicated denitrification is likely occurring in the IWS zone of the pavement. Significant event mean concentration reductions were documented for copper at 79%, lead at 92% and zinc at 88%.

Outcomes

The study results demonstrated that PICP over low-infiltration, clay soils provide considerable improvement of water quality likely via cation exchange capacity of the soil subgrade, denitrification and infiltration, as well as moderate volume reductions via infiltration. A key point from the study is the clay soils do infiltrate water and provide modest volume reductions with very good pollutant reductions. The project was presented at several U.S. stormwater conferences and at the 11th International Conference on Concrete Block Paving in Dresden, Germany in 2015. Deliverables included a PowerPoint presentation and a final report. The report is available online.