

# Permeability Restoration of Permeable Interlocking Concrete Pavements

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## Background and Need

Permeable interlocking concrete pavement (PICP) expanded in Canada and the US at the start of the 21<sup>st</sup> century. Since then, millions of square feet (m<sup>2</sup>) in sidewalks, plazas, parking lots, alleys and roads reduce runoff and water pollution. PICP receiving no run-on from adjacent impervious surfaces typically renders high infiltration rates for years without cleaning. However, PICP accepting run-on from impervious surfaces requires routine cleaning to prevent clogging. Industry equipment demonstrations and university research on PICP over the past 15 years resulted in guidelines to maintain infiltration rates. Recommendations emphasize periodic, preventive surface cleaning to remove accumulated sediment and detritus from the joints well before compaction into them occurs.

Unfortunately, many PICP owners were not willing or able to conduct periodic, routine cleaning. This results in reduced surface infiltration rates and the need for more powerful equipment to increase and restore them. This project addressed the need to test performance of several cleaning equipment technologies on simulated, highly clogged PICP. Efficient restorative cleaning methods are needed to reduce maintenance intervals and life cycle costs while continuing runoff and pollutant reductions. While the equipment tested represented a range of cleaning technologies, other methods can be used provided that their effectiveness is demonstrated.

## Objectives

- Test performance of various cleaning equipment technologies and develop best management practices for surface infiltration restoration.
- Investigate pre-cleaning practices (e.g. power washing) that might increase efficiency and effectiveness of various cleaning equipment technologies for restoring surface infiltration rates.
- Investigate cohesive vs non-cohesive sediments on their response to various cleaning equipment technologies and cleaning frequencies.

To meet these objectives, a PICP test pad was constructed in 2017 at the Toronto and Region Conservation Authority's Kortright Centre for Conservation in Vaughan, Ontario. This pad consisted of seven 3 m (10 ft) square PICP cells with an underdrain. Five test cells were clogged with street sweepings that matched sediments sampled from mature PICP parking lots within the Greater Toronto Area. The PICP joints were clogged using a controlled procedure developed by the University. This resulted in a consistent mix of materials used to clog the joints. In addition, a mix of cohesive, clay-based sediment was developed, typical to that found in existing PICP sites in the region.

ASTM C1781 was used to measure surface infiltration rates on new, progressively clogged, and cleaned PICP joints. Restorative maintenance was required when mean surface infiltration measurements approached 250 mm/hr (10 in./hr). Equipment was allowed one pass at normal operating speeds. Effectiveness could be increased by performing multiple passes in actual field applications. Five equipment technologies were evaluated as shown below:



**Regenerative air machine**



**True vac machine**



**Waterless Mechanical Sweeper**



**Power washing before applying a Shop Vac**



**High pressure air and vacuum system**



### **Outcomes**

The regenerative air machine restored 20% of the surface permeability. This confirms the use of this equipment for routine cleaning to remove loose dirt, leaves, litter, etc. and not on clogged surfaces. The true vac produced the most variable results. On average, the PICP's surface infiltration capacity was

~7,500 mm/hr (295 in./hr) or 70% of post-construction surface infiltration. Measurements ranged from 1,280 mm/hr (50 in./hr) to 13,900 mm/hr (547 in./hr). Power washing and a Shop Vac improved surface infiltration by 25%. The waterless mechanical street sweeper restored the PICP's surface infiltration capacity to 35% of its original condition, or about 3,540 mm/hr (139 in./hr). The high pressurized-air and vacuum system fully restored the PICP to its baseline, post-construction surface infiltration. Average surface infiltration rates were 2 to 6 times higher than from other equipment, ~12,900 mm/hr or 508 in./hr for cohesionless soil mixed with jointing stone.

### **Other conclusions:**

- The depth of evacuation into joints was a strong indicator of overall maintenance effectiveness when clogged with similar materials, but not when clogged with different materials.
- Orientation of street sweeper suction/collection heads greatly influenced the amount of joint materials removed. Passes in all joint directions can likely provide the highest results.
- Cohesive soils in the joints significantly decreased the effectiveness of restorative maintenance. The high pressure-air/vacuum system was only able to restore the PICP's surface infiltration to approximately 50% of the pavement's original surface infiltration while removing cohesive sediment. In contrast, this equipment was able to fully restore infiltration when non-cohesive materials occupied the joints.

The complete research report can be downloaded [here](#).