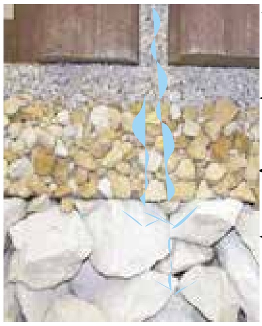
Interlocking Concrete Pavement Institute®

# Permeable Interlocking Concrete Pavement (PICP) For Design Professionals

FACT SHEET

## PICP Stormwater Benefits

- Infiltrates, filters and decreases stormwater runoff rate and reduces Total Maximum Daily Loads (TMDLs)
- LEED® points eligible for Sustainable Sites, Water Efficiency, Materials & Resources and /or Innovative Design; Contributes to Green Globe points
- Meets U.S. Environmental Protection Agency (EPA) stormwater performance criteria as a structural best management practice (BMP) while providing parking, road and pedestrian surfaces
- Helps meet local, state and provincial stormwater drainage design criteria and provides compliance with the U.S. National Pollutant Discharge Elimination System (NPDES) regulations
- Provides 100% pervious surface by runoff passing through small, aggregate-filled openings between solid high-strength durable concrete pavers
- Reduces or eliminates stormwater detention and retention ponds, storm sewers, drainage appurtenances and related costs
- May be used on sloped sites with proper design
- The modular concrete units allow for project phasing; open-graded base and subbase materials are typically available locally.
- Reduces contained sewer overflows (CSO) and supports green infrastructure programs
- May be designed with underground stormwater storage systems, over many slower-draining clay soils and in cold climates
- Processes and reduces pollutants from vehicular oil drippings



3 1/8 in. (80 mm) thick pavers with permeable joints

Open-graded bedding course

Open-graded base course

Open-graded subbase on non-compacted soil subgrade

*Permeable interlocking concrete pavement (PICP) with open-graded base and subbase for storage and infiltration.*

PICP is a cost effective LID stormwater management tool

*PICP and bioswales work together as LID tools to increase infiltration at Morton Arboretum in Lisle, IL.*

### Application Opportunities

- **Urban**: Office plazas, sidewalk replacement, street tree planting areas, on-street parking, parking lots, parks and outdoor seating areas
- **Suburban**: Parking lots, parks, driveways, parking bays on roadways, subdivision roads and sidewalks
- **Redevelopment Sites**: Parking areas, plazas and public spaces, sidewalks and brownfields

### Pollutant removal efficiencies

(Compared to impervious pavement runoff)
Zinc: 62-88%
Copper: 50-89%
Total Suspended Solids: 60-90%
Total Phosphorous: 65%

ATTRACTIVE | DURABLE | ENVIRONMENTALLY COMPLIANT

## Permeable Interlocking Concrete Pavement: A Low Impact Development Tool

**PICP supports LID Principles**

1. Conserve vital ecological and natural resources: trees, streams, wetlands and drainage courses

2. Minimize hydrologic impacts by reducing imperviousness, conserving natural drainage courses, reducing clearing, grading and pipes

3. Maintain pre-development time of concentration for runoff by routing flows to maintain travel times and discharge control

4. Provide runoff storage and infiltration uniformly throughout the landscape with small, on-site decentralized infiltration, detention and retention practices such as permeable pavement, bioretention, rain gardens, open swales and roof gardens

5. Educate the public and property owners on runoff and pollution prevention measures and benefits

## Permeable Interlocking Concrete Pavement Meets Low Impact Development Goals

- Conserves on-site space: roads, parking, stormwater infiltration and retention all combined into the same space creating more green space or building opportunities
- Preserves wooded areas that would otherwise be cleared for stormwater detention or retention ponds
- Increases site infiltration that helps maintain pre-development runoff volumes, peak flows and time of concentration
- Promotes tree survival and growth
- Contributes to urban heat island reduction through evaporation and reflective, light colored pavers
- Highly visible, cost effective exemplary demonstration of cornerstone LID technique for public and private development

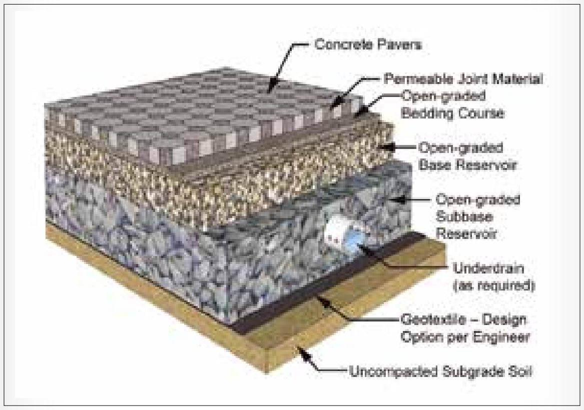
## Design Software Available

Software from ICPI for permeable pavement called *Permeable Design Pro* incorporates research from a range of university research studies.

Contact ICPI for further information.

## LID DESIGN APPLICATION

***350,000 sf (3.2 ha) of PICP at a Burnaby, BC shopping center infiltrates runoff from roofs.***




***Typical PICP cross section***

***By eliminating detention pond, the subdivision layout conserves trees while 15,000 sf (1500 m²) PICP in the cul-de-sac returns rainfall to the water table in Glen Brook Green subdivision in Waterford, CT.***

# Technical Guidelines

- Pavers conform to ASTM C936 in the U.S. or CSA A231.2 in Canada
- Open-graded crushed stone recommended for all aggregates
- Joint filling stone gradation: ASTM No. 8, 87, 89 or 9
- 100% permeable surface
- Base gradation: ASTM No. 57
- Subbase gradation: ASTM No. 2, 3 or 4
- Optional geotextile: consult manufacturers for selection
- Soil subgrade: classified per ASTM D2487; tested for permeability per ASTM D3385
- Structural design: ICPI design chart determines minimum base thickness to support pedestrian and vehicular traffic (see references)

# Construction Checklist

- No compaction of native soil subgrade – excavate and trim native soil
- Geotextile, drainage pipes and overflow vary with design
- Ensure no sediment from equipment-borne mud on aggregates
- Install and compact aggregate subbase and base with standard paving equipment
- Specialty equipment used for screeding bedding layer and for mechanical paver installation
- Mechanical installation equipment accelerates construction; minimum 5,000 sf (500 m²)/machine/day
- Pavers, non-frozen bedding material & base/subbase installable in freezing temperatures over non-frozen soil subgrade
- Paver joints filled with aggregate and compacted
- No curing time – ready to use upon installation; modular construction allows for project phasing
- Specify experienced ICPI certified installers with PICP Specialist Certificate on construction knowledge

*Base construction uses locally available materials.*



*Aggregate base and subbase are spread and compacted; pavers are delivered ready to install. After placement, joints and/or openings are filled with small aggregate. Then pavers are compacted.*

*Mechanical sweeping of fine aggregate into paver joints*

### *Curve Number and Rational Method Runoff Coefficients*

NRCS Curve Numbers (CN) and Rational Method runoff coefficients ('C' value) used depend on the soil infiltration rate, base storage and design storm. In every case, PICP yields significantly lower CN and C values than impervious pavement per the table below:

| Land Cover | Infiltration Rates in./hr (mm/hr) | Curve Number CN | Runoff Co-efficient, C |
|---|---|---|---|
| **Permeable Interlocking Concrete Pavement** | *Up to 50 in./ hr (1270 mm/hr) with maintenance 3-4 in./hr (75-100 mm/hr) with no maintenance* | *45 – 80* | *0.00 – 0.30* |
| **Impervious Asphalt or Concrete Pavement** | *0 in./hr (0 mm/ hr)* | *95 – 98* | *0.90 – 0.95* |

# Construction Guidelines

Pavers are delivered ready to place, joints filled, compacted and then are ready for traffic.

# Performance

## Volume Reduction

Research has demonstrated that PICP can reduce runoff as much as 100% from a 3 in. (75 mm) rain event with sandy soil and a minimum 12 in. (300 mm) thick open-graded aggregate base.

Given regional variations in annual rainstorms and PICP base storage capacities, PICP can reduce annual outflows between 30% and 80%. Well-maintained PICP can reduce flow rates by 70% to 90% from intense rain events and up to 100% for many storms. *This yields a corresponding reduction in runoff pollution.*

## Peak Flow Reduction and Delay

PICP can reduce peak flow by as much as 89%, producing a hydrograph nearer to pre-development conditions. Peak flow is generally proportional to rainfall intensity. Permeable pavers delay the timing of peak flow runoff from several hours to several days.

## Additional Benefits

- ADA compliant
- Concrete pavers available in various shapes and colors from local ICPI members; colored pavers mark lanes and parking spaces
- Simplifies surface and subsurface repairs by reinstating the same paving units; no unsightly patches or weakened pavement cuts

## Water Quality Improvement

PICP treats stormwater by slowing runoff velocities to allow for sedimentation and filtering by aggregates in the surface openings and base. Oils adhere to small soil particles and aggregates and then are digested by bacteria.

## FAQs

**Can PICP be used on clay soils?** *Yes. Even in clay soils, PICP reduces runoff and helps to capture "first flush" run-off and reduce pollution.*

**Can PICP be used to replace conventional stormwater management tools such as detention basins?** *Yes. In both colder and warmer climates, PICP has been used to reduce or eliminate the need for conventional stormwater pipe infrastructure, detention basins and drop inlets.*

**Is Maintaining PICP difficult?** *No. PICP can be maintained through street sweeping and vacuuming based on periodic inspection.*

**Can PICP be used in cold climates?** *Yes, PICP has been very successful in many Canadian and northern United States applications. It remains stable through freezing and thawing cycles.*

## References


Ferguson, B. K. *Porous Pavements*. Boca Raton, FL:CRC Press, 2005.

Smith, David R. *Permeable Interlocking Concrete Pavements: Selection • Design • Construction • Maintenance*, Herndon, VA: ICPI 4th ed., 2011. www.icpi.org.


For more information pertaining to permeable interlocking concrete pavement, please visit the Interlocking Concrete Pavement Institute (**icpi.org**) or the Low Impact Development Center (**lowimpactdevelopment.org**).

**Other Fact Sheets available for Developers, Municipal Officials and Schools/Universities**

The Low Impact Development Center, Inc.

*Disclaimer: The content of this brochure is intended for use only as a guideline. It is not intended for use or reliance upon as an industry standard, certification or specification. ICPI & LIDC make no promises, representations or warranties of any kind, express or implied, as to the content of this brochure. Professional assistance should be sought with respect to the design, specifications and construction of each permeable interlocking concrete pavement project.*

icpi Interlocking Concrete Pavement Institute®




14801 Murdock Street
Suite 230
Chantilly, VA 20151-1037
Tel: 703-657-6900
Fax:703-657-6901
Email: icpi@icpi.org
Web: www.icpi.org

CANADA
P.O. Box 1150
Uxbridge, ON L9P 1N4
Canada