Permeable Interlocking Concrete Pavements
A Low Impact Development Tool

Pavers by Ideal®
90 YEARS
Serving New England Since 1923

The Low Impact Development Center, Inc.

ICPI
INTERLOCKING CONCRETE PAVEMENT INSTITUTE®

Learning Objectives

- Issues with stormwater runoff
- Objectives of stormwater management
- Evaluating porous pavement solutions
- Design considerations & elements of PICPs
- Construction of PICPs
- Maintenance
- Costs

Structural Conveyance – Catch basin & Pipe


It’s Not Just Rain

Pavement is a Culprit in Flooding

"State and federal officials say flooding has been exacerbated by the roads, parking lots, patios, and yes, driveways that define our urban and suburban landscapes."

"Collective way we live as a society creates acres and acres of impervious surfaces we didn't have before…"

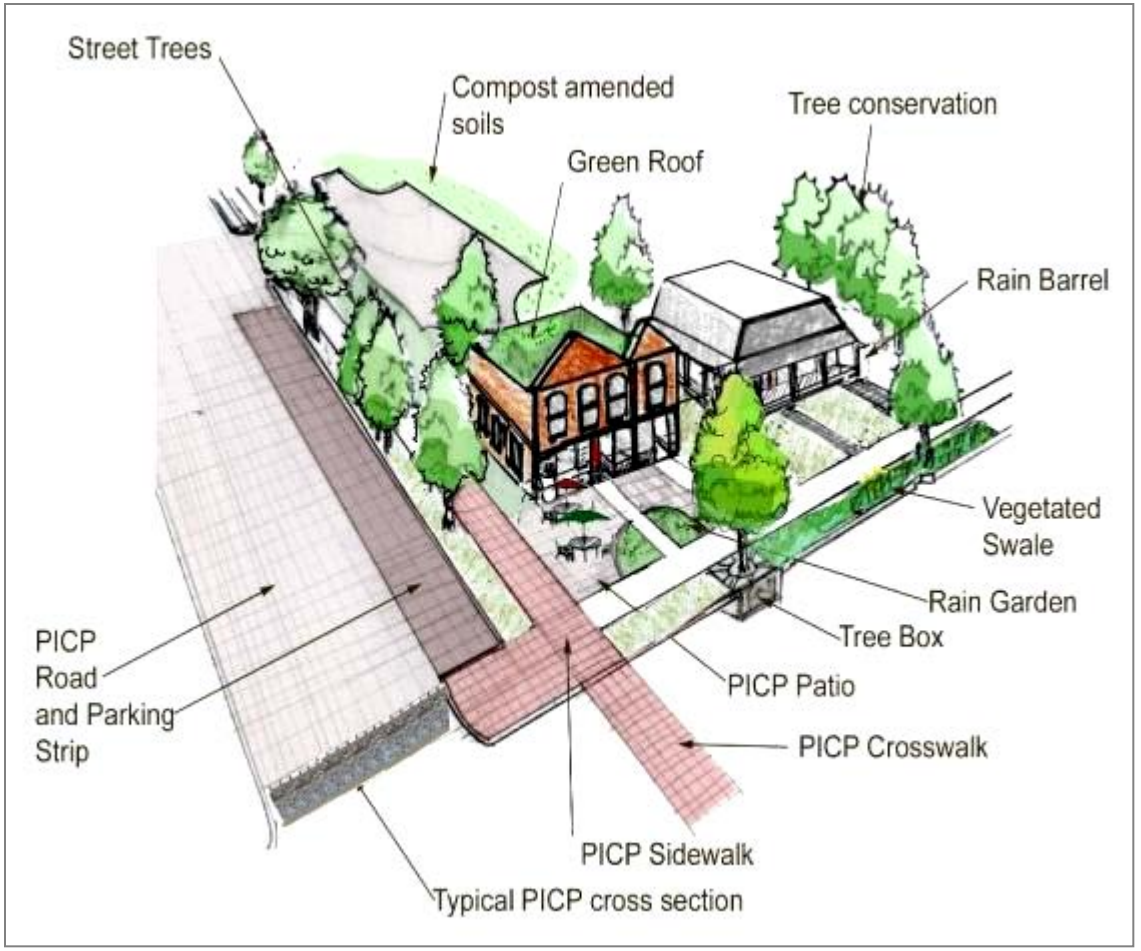
Boston Globe 4/5/2010

Stormwater Management Objectives

- Retain/infiltrate stormwater
- Capture first flush, e.g., first ½ inch
- Limit amount of impervious cover
- Imitate pre-development runoff volume
- Design to drainage system capacity

LID – an integrated approach

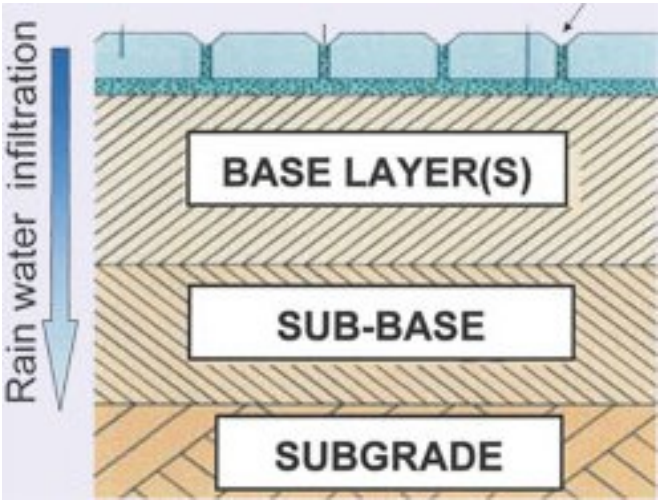
- Grass swales
- Vegetated strips
- Bio-retention cells
- Rain gardens
- Reduced pavement widths
- Permeable pavement



Pervious, Porous and Permeable Pavements

Porous Pavement

- Water drains through the surface into base
  - Captured
  - Stored
  - Filters contaminants
- Reduces runoff
- Replenish groundwater
- Cool air
- Sustains tree growth
- Cost competitive to conventional methods



Monolithic Porous Pavements

- Pervious Concrete

- Porous Asphalt

Permeable Interlocking Concrete Pavement - PICP

EcoStone

Aqua Bric

Concrete Paver Characteristics

- Meet or exceed ASTM C-936
  - High Strength - 8000+ psi
  - Low Absorption - Maximum 5%
- Skid & Slip Resistance
- Choice of Colors
- Design Flexibility
- High Quality & Exceptional Durability
- Low Maintenance
- Easy to Repair

The PICP Advantage!

- 100% Infiltration
  - Captures 1st flush
- High strength 9000 psi
  - Supports heavy loads
- Unaffected by tire shear
- Factory made – ready to install year-round
- No cure time – traffic ready!
- Does not use petroleum based material that leach into the soil
- Winter friendly
  - Snow Plow Safe
  - Minimizes ice & deicer use
- Summer friendly
  - Unaffected by heat
  - No binder drain –down
- Units can be removed and reinstated
  - No evidence of patch
- Easy to clean & maintain
- Cost competitive


Permeable Interlocking Concrete Pavements
A Beautiful Solution to Stormwater Management
Pavers by Ideal


Pavers by
Ideal


AquaBric


Pavers by
Ideal


EcoStone

Harvard Univ.


North Hampton, NH
1999


North Hampton, NH.
2006


Wells, ME.


Electrical
Specialist
BRISTOL COUNTY
AquaBric


US Forest Service
Campton, NH


US Forest Service
Campton, NH


Wendy's
CVS
EcoStone

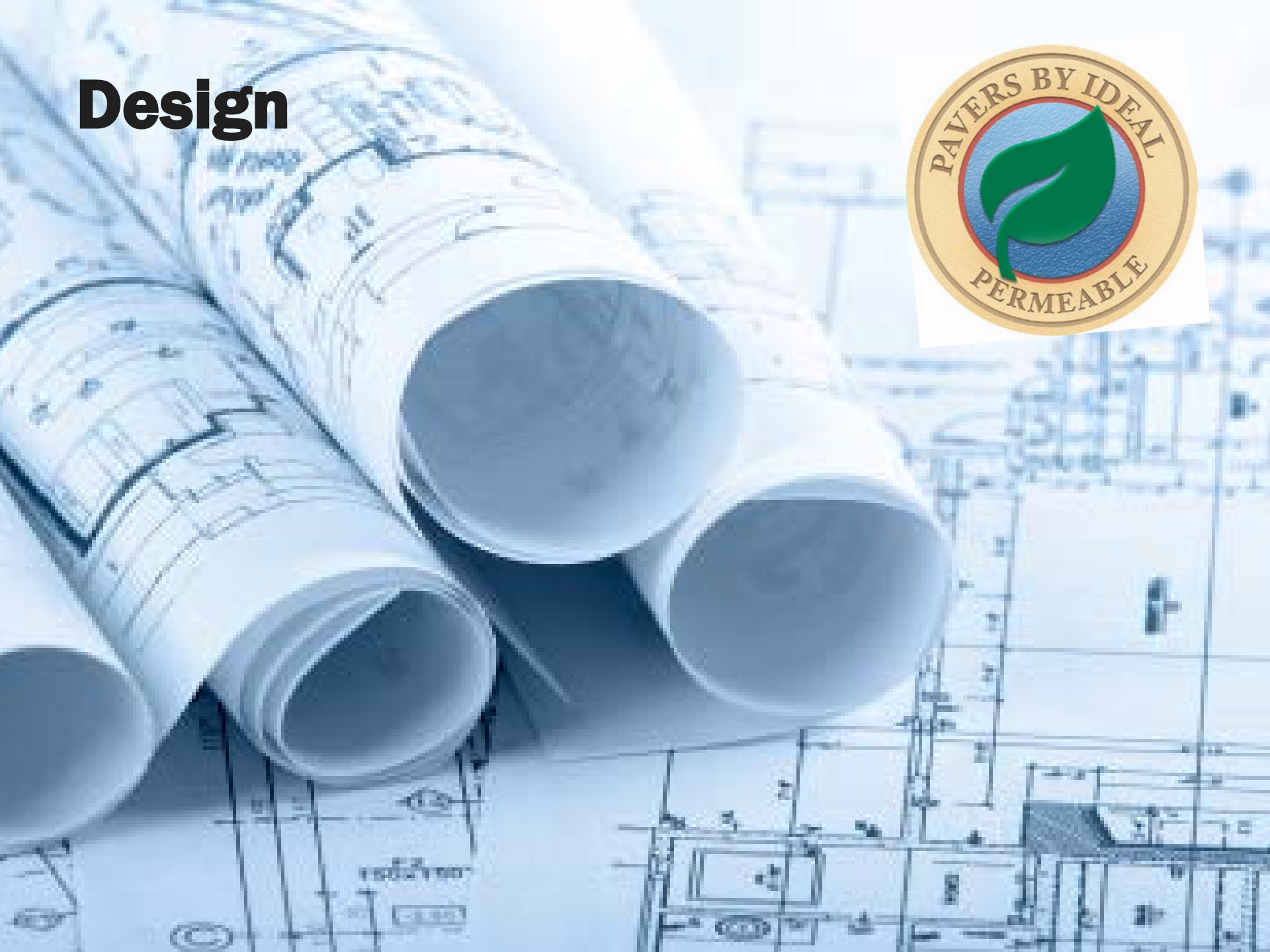

AquaBric IV


Westmorleand, ORE.

Features of the PICP System

- Combine beauty & strength
  - Manufactured to ASTM 936
- Provide high infiltration
- Suitable for
  - Driveways
  - Parking Lots
  - Low speed roadways
- Snow Plow Safe!!!!

Design



Interlocking Pavements

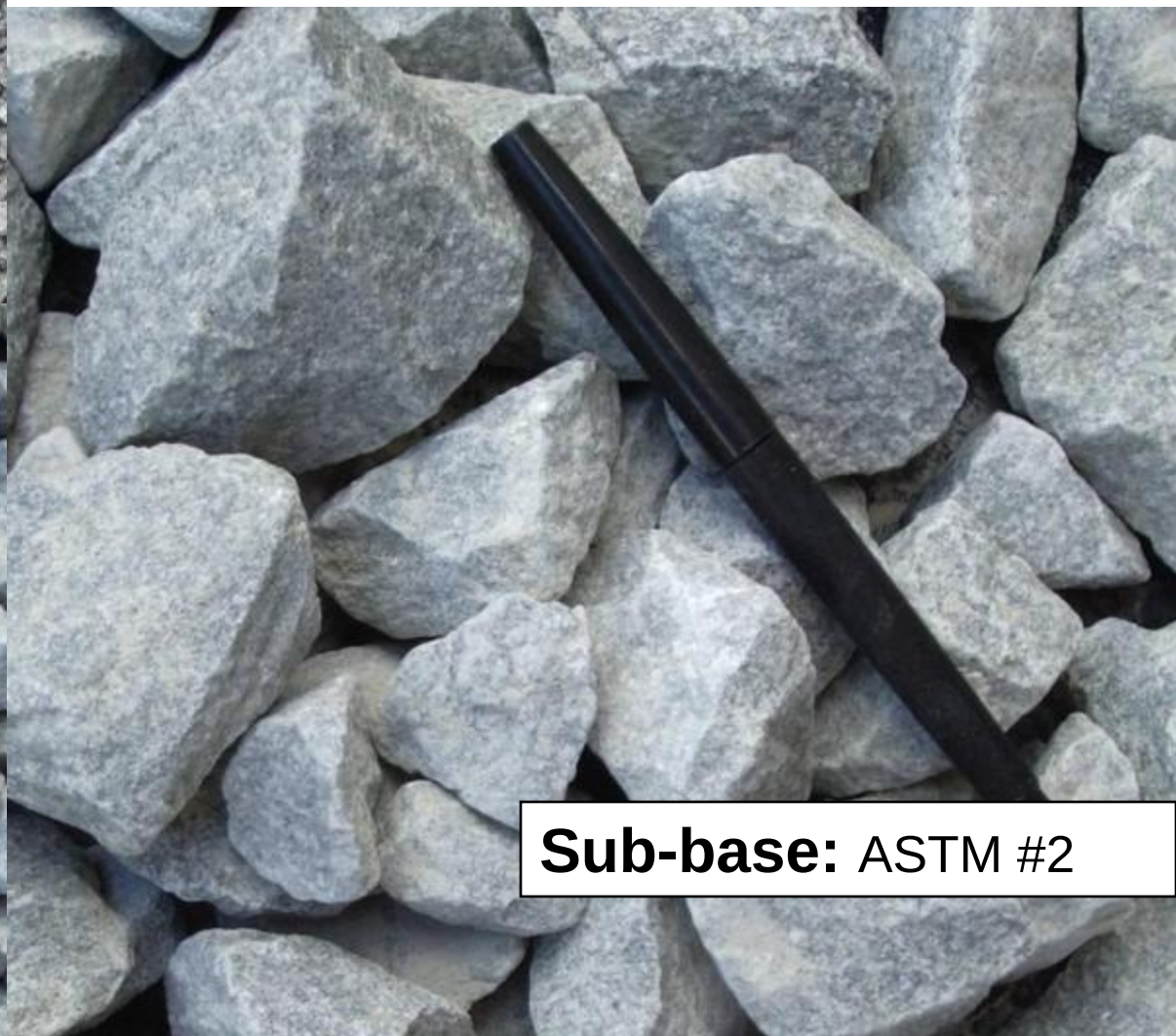
- High strength concrete pavers
- Sand setting bed
- Edge Restraint
- Compacted granular base
- Sub-grade

Conventional Sand-set

Open-graded Stone Layers

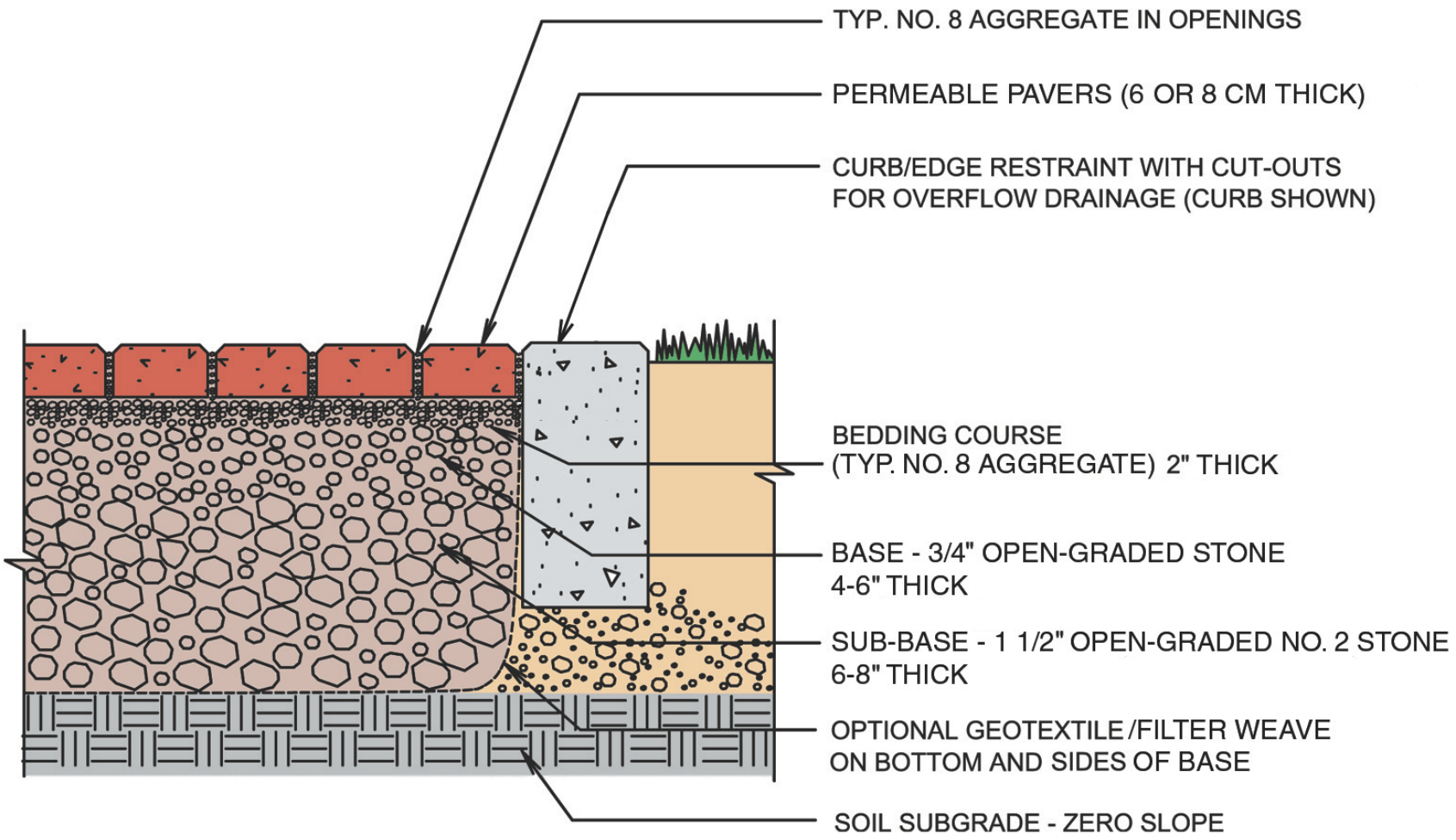
Bedding: ASTM #8 or #9

Base: ASTM #57



Sub-base: ASTM #2

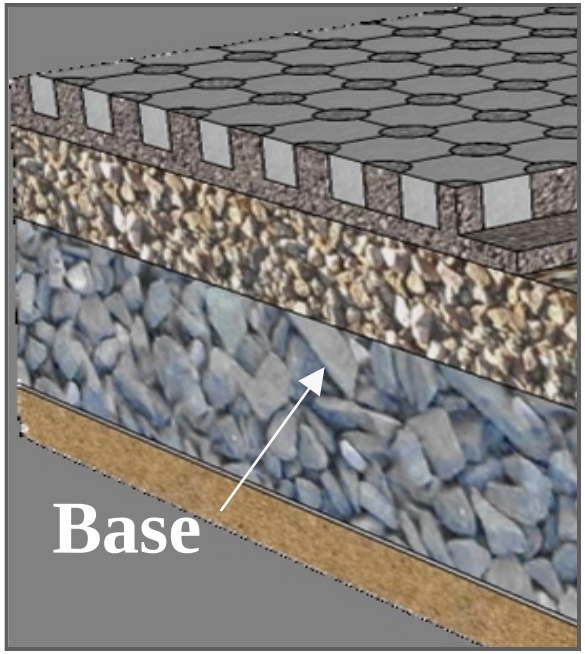
PICP System Components



Base thickness

- Walkway or Patio
  - 6“ to 8“ thick
- Driveway
  - 8“ to 12“ thick

Hydrologic Objective -
Base Storage Capacity



- Calculate amount of “Run-on”
  - Adjacent pavement
- Volume of water to collect & store

- 1” water = 2½" to 3" Base
  - 30% to 40% void space

- Design for 24 -48 hour storage

Final Pavement Thickness

- Know the thickness for:
  - Walkway, patio or driveway
  - Quantity of water to infiltrate
- Use the thicker of the two!
- Example
  - Hydrological = 6” thick
  - Driveway = 8” thick
  - Final thickness = 8”

Construction of PICPs

- Excavate area
- Compact sub-grade as needed*
- Place & compact base in lifts
- Install edge restraints
- Place & screed stone setting bed
- Place & cut pavers
- Fill joints, sweep & compact
- Repeat sweeping & compaction

Excavation & Thickness

Project	Excavation Depth	Base Thickness
Walkway/Patio	10" - 12"	6" - 8"
Driveway	12" - 16"	8" - 12"

Base Material

Traditional Sand-set

- Granular
  - 1½” processed gravel
  - ¾” crusher run / dense graded
- Asphalt
- Concrete
- Flowable Fill

Permeable

- Open-Graded Crushed Stone
  - 1½” or ASTM #2
  - ¾” or ASTM #57
- Processed gravel

Open Graded Aggregates –

- Base
  - 1½" stone
  - ¾" stone
- Setting Bed
  - ⅜" stone
- Joint/Void Fill
  - ¼" crushed stone sand

Amount of Base

- For every 100 sf base area
  - 6” thick - 3 tons
  - 8” thickness - 4 tons
  - 12” thickness – 6 tons

Bedding & Joint Sand

Traditional Sand-Set

- Concrete sand ASTM C33
  - Uniform depth: 1”-1½” thick
- Masonry sand ASTM C144 for joints
  - After initial sweeping with concrete sand!
- Avoid stone dust!

Permeable

- Bedding
  - 3/8” stone or ASTM #8
  - 2”thick: 1700 lbs/100sf
  - 3” thick: 2550 lbs/100sf
- Joints & Void Fill
  - ¼” stone – ASTM # 9
  - 6cm AquaBric: 2 lbs/sf
  - 8cm AquaBricIV: 2.66 lbs/sf
  - 8cm EcoStone: 3 lbs/sf

Permeable Pavers

- Measure the area to be paved
- Perimeter
  - Soldier or sailor course
  - Edge restraint
- Determine quantity of pavers
  - 3% cuts & waste
- Check availability

Getting the Base Right!

- Use the right tools & equipment
- Spread in 3” to 4” layers
- Compact
  - compact
    - compact some more!

5 Most Difficult Areas!

- Corners
- Against curbs
- Against walls
- Next to utility structures
- On/over wet soils

Base

- Compacted Thickness
  - -¾” to +1” within recommended thickness
  - Finish surface with +/- 1” over 10’
- Elevations
  - 6 cm pavers
    - 3¾” - 4” lower than finished elevation
  - 8 cm pavers
    - 4¼” – 4¾” lower than finished elevation

The Layout…it's hip to be square!

- Remember the "3-4-5" magic number
- You must start at a 90° corner
- Patterns
  - Herringbone
  - Running bond

Placement...click and drop

- Work off paver surface
- Click and drop!
  - Never slide across the setting bed
- Work up-hill on inclines
- Take pavers from several cubes

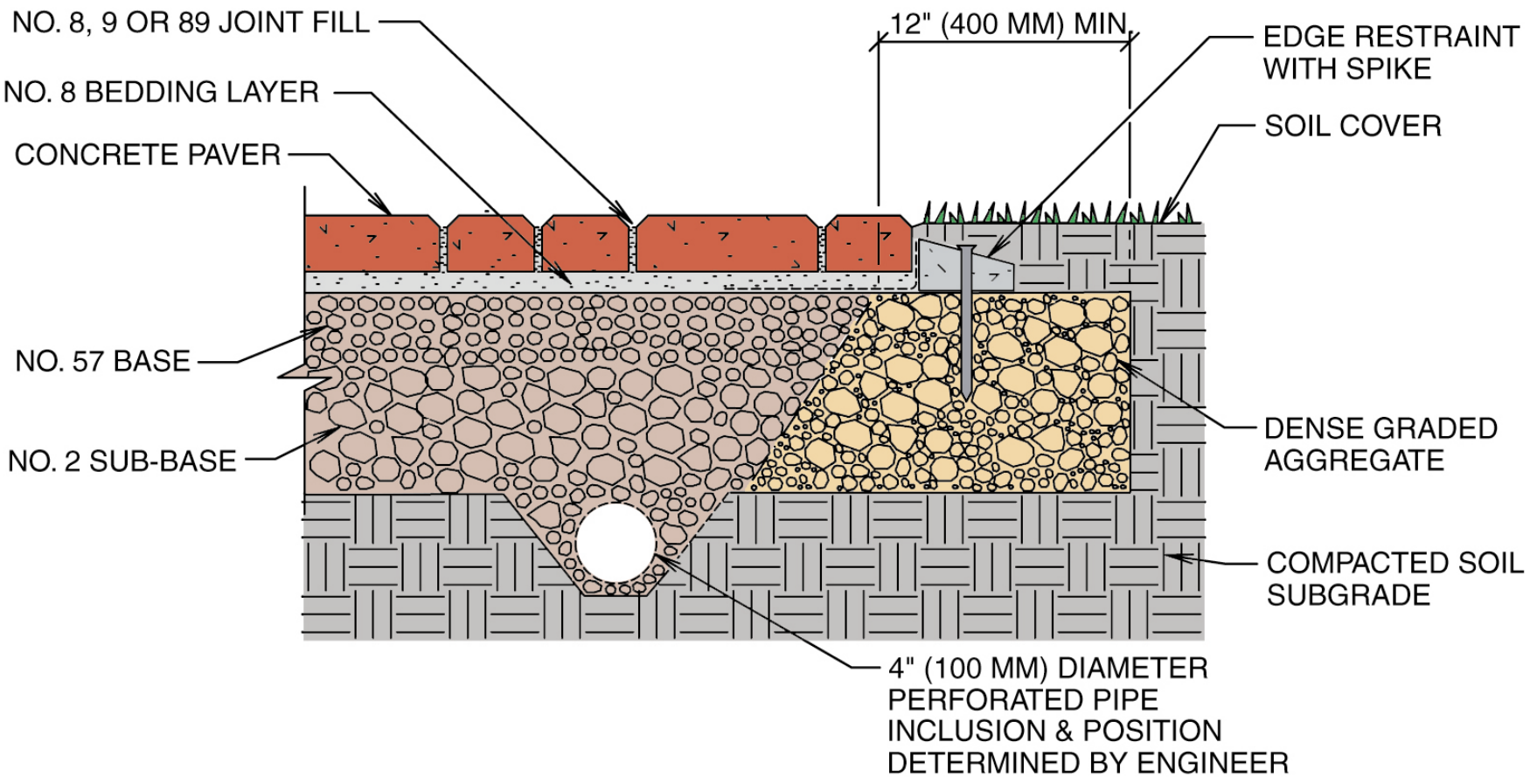
Keeping it straight!

- Snap chalk lines on setting bed
- Pave around openings
  - Snap lines on all 4 sides
  - Lay one side, then the other
  - Cut to fit or pour a collar
- Never open joints around curves

Pavers by Ideal®

■ Interlocking Concrete Pavers ■ Landscape Retaining Walls

Holding it together!



Finishing

- Sweep surface clean
- Fill openings and joints…
  - Sweep clean
- Compact
  - 2 passes –
    - 2nd perpendicular
- Remove & replace any damaged pavers
- Top off joints & sweep clean

PICP Budget Costs

- Hand Set
  - Labor : $7.00 - $12.00/sf
  - Setting bed stone @ 1-2" thick
  - Labor to screed setting bed stone
  - Placing, cutting & compacting pavers
  - Filling voids
- Pavers:
  - 6 cm Aqua-Bric……$ 2.75/sf
  - 8 cm Aqua-Bric IV & Eco-Stone……$ 3.45/sf
- Gap-graded stone base (material & labor w/o excavation)
  - $2.00 - $4.00/sf

Maximizing Long Term Performance

- Keep pavement clean
  - Sweep periodically
  - Avoid high pressure washing
  - Vacuum when infiltration significantly reduced
- Replenish aggregate as needed
- Repair ruts & deformation exceeding ½“
- Replace broken pavers
- Minimize use of sand & de-icing salts

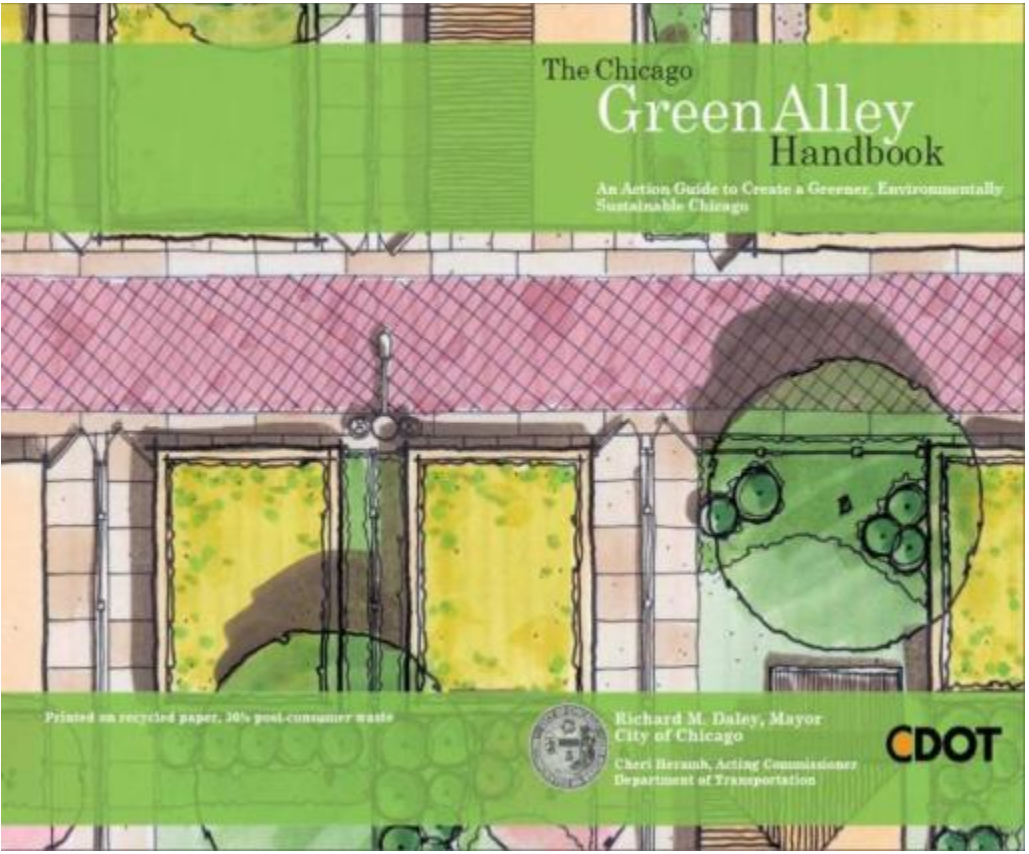

Winter Melt

Restoring Infiltration

- Clogging occurs in top 1” of opening
- Sweeping breaks up crust
- Hydro-vac when clogged
  - Re-fill openings

Chicago Green Alley Program

Issue: Flooding and CSO reduction
Strategy: LID Retrofit Pilot Programs
Tool: PICP



Images courtesy of Chicago Department of Transportation


Silver Lake PICP


Jordan Cove
6 years Post
Construction

Hartford Green Capitals Project
Field Permeability Test Results

Pavement Type	Ht of Water Column (in.)	Infiltration Rate in/hr	Ave. Infiltration in/hr
Pervious Concrete		1710	
	9.19	1096	1600
		1993	
Permeable Pavers		2605	
	9.19	2289	2470
		2515	
Porous Asphalt		1628	
	9.19	1421	1876
		2580	

CDM Smith


UNH Stormwater Facility

PICP Contributes to LEED Credits

- Materials & Resources
  - 1 - 2 points Regional Materials
  - 1 - 2 points Materials Reuse
  - 1 -2 points Recycled Content
- Sustainable Sites
  - 1 point -Quantity Control
  - 1 point – Quality Control
- Water Efficiency
  - 2-4 points – water harvesting
- Energy & Atmosphere
  - 1-7points – Renewable Energy
    - PICP with heat pump

ICPI TECH SPEC
INTERLOCKING CONCRETE PAVEMENT INSTITUTE
NUMBER • 16

Achieving LEED® Credits with Segmental Concrete Pavement

Background

Rapidly rising energy and material costs have accelerated energy and natural resource conservation in design and construction. Sustainable development has evolved as a response and ethos to encourage conservation. It is also a framework for creating environments that enhance human existence and natural processes.

Broadly defined, sustainable development meets the needs of the present without compromising the ability of future generations to meet their needs. Within the North American design and construction community, a means for addressing sustainability or 'green building' is through LEED® or Leadership in Energy and Environmental Design. Developed by the U.S. Green Building Council (USGBC) in 1998, LEED® provides voluntary guidelines for reducing energy and wasted resources from building and site design. The Canadian Green Building Council (CaGBC) formed in 2005 published similar LEED® guidelines tailored to Canadian climates. U.S. and Canadian guidelines were developed by a range of representatives from the building industry and environmental sciences.

LEED® establishes a consensus-based means for measuring building and site performance. It promotes designs that integrate energy and resource conservation. LEED® is being applied to many publicly funded projects and a growing number of private ones. A primary objective of LEED® is to help facility owners reduce maintenance and life-cycle costs. This is accomplished by including all players in an integrated development process during the design stages of a project.

Purpose

LEED® rating systems have been developed or are under development for:

- New Commercial Construction and Major Renovation projects
- Existing Building Operations and Maintenance
- Commercial Interior projects
- Core and Shell Development projects
- Homes
- Neighborhood Development
- Guidelines for Multiple Buildings and On-Campus Building Projects
- LEED® for Schools

This publication provides guidance on applying the rating system for New Commercial Construction and Major Renovation projects or LEED-NC to the family of segmental concrete pavement products. This family includes interlocking concrete pavements, permeable interlocking concrete pavements, concrete grid pavements and precast concrete paving slabs. The products can also be used to satisfy the requirements in the other rating systems listed above.

LEED-NC version 2.2 is promulgated by the USGBC and version 1.0 by the CaGBC. Excerpts from each version that relate to segmental concrete pavement are presented in this technical bulletin with application guidance. Each version has similar evaluation criteria for sustainable design and some minor differences. USGBC LEED-NC version 2.2 likely will be adopted by CaGBC in 2007, thereby making each organization's version identical or very similar. Readers should check with www.usgbc.org and www.cagbc.org for the most current versions.

The LEED® Process

The decision to apply for LEED® certification must occur early in the design process. The project owner and designers evaluate categories and associated criteria explained in the rating categories below for compatibility with the project, architectural program, budget

Figure 1. Sustainability for buildings extends to the site with sustainable paving that promotes infiltration and reflects sunlight.

Pavers by Ideal

A Detention Facility that Supports Vehicles…!

Limitations…

- For pedestrian or low-speed roadways
  - parking lots, local & collector roads
- Requires greater site evaluation/design effort
- Demands high level of construction skill
- Requires regular maintenance

Avoid…

- Drinking water wells (100 ft. min. distance)
- High water tables (< 3 ft from surface)
- High bedrock
- Industrial sites, fueling stations
- Expansive and fill soils

Why Use Permeable Pavements?

- Reduce stormwater runoff
  - 100% reduction for low intensity storms
- Captures first flush
- Meet national/state stormwater regulations:
  - BMP / LID
- Preserves water by increasing groundwater recharge
- Cleans water
  - filters & reduces nitrogen, phosphorous, metals & oil drippings

Why Use Permeable Pavements?

- Conserve space
  - pavement on detention facility
- Infiltration capacity can be restored
- Cost competitive
- Cooler
  - Air temperature
  - Water temperature
  - Provide evaportranspiration
    - Admit air & water into soil - Good for trees
- Maintain beauty –
  - allow reinstatement of surface after repairs

Pavers by Ideal®

■ Interlocking Concrete Pavers ■ Landscape Retaining Walls

EcoStone & Millstone

Design Versatility !!!!


AquaBric
BRISTOL COUNTY
PLUMBING & HEATING
714 - 5701

The Solution to Stormwater Runoff is Right Under Your Feet

- Built-in technology - pavement and base act as a stormwater treatment system

- Reduces or eliminates runoff to reduce pollutants and improve water quality

Pavers by Ideal

idealconcreteblock.com

Smile please...!!!


Good for the Community!
Good for the Environment!
Thank You