icpi

Interlocking Concrete Pavement Institute

A New National ASCE/ANSI Standard on Permeable Interlocking Concrete Pavement

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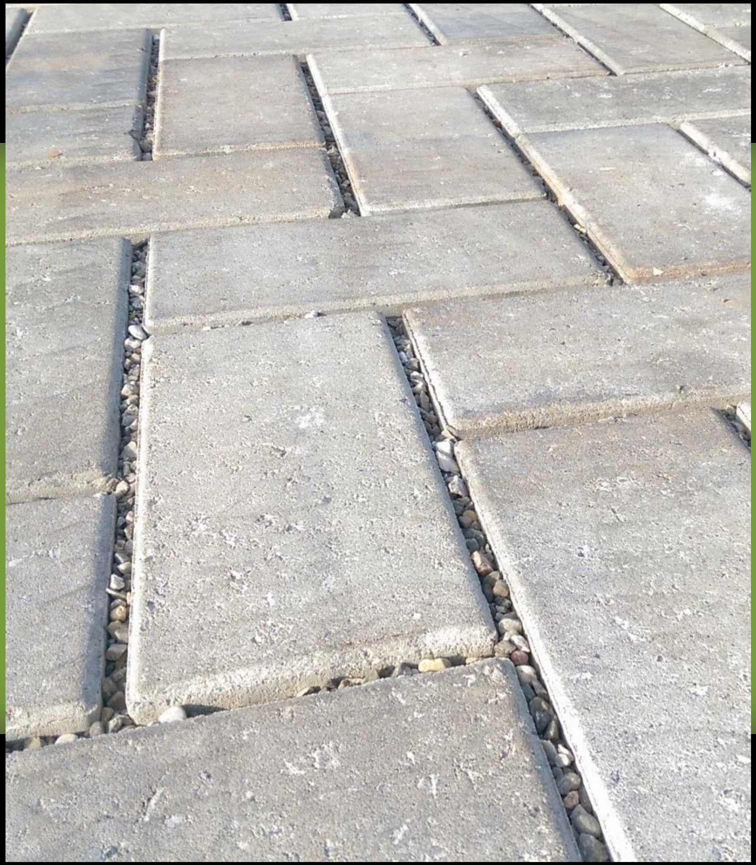
Questions to be answered

- What is PICP?
- How should I designing a PICP system?
  - Structural
  - Hydrologic
- What else can you tell me about the upcoming ASCE PICP Design Standard?

What is PICP?

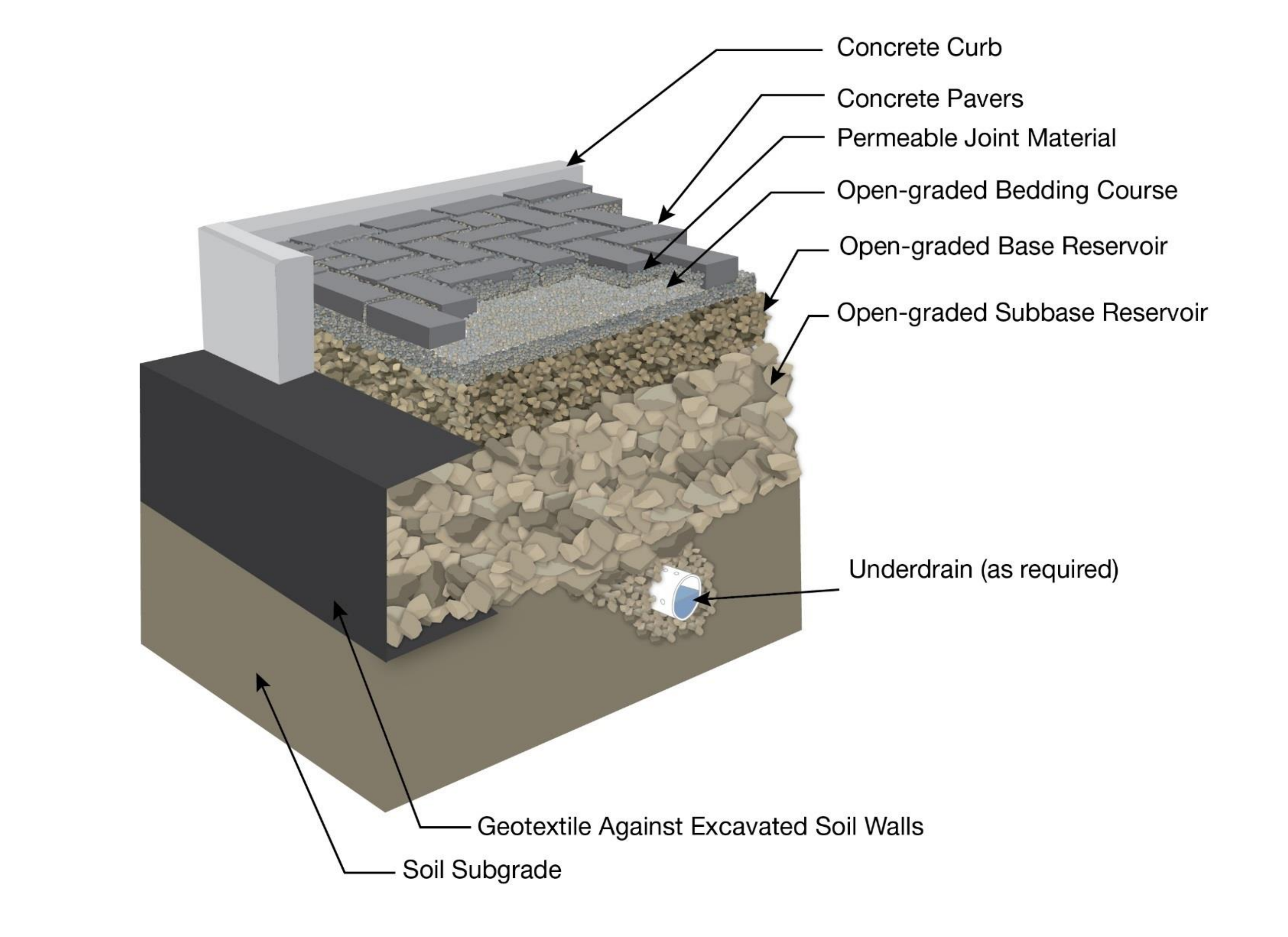


What is PICP?

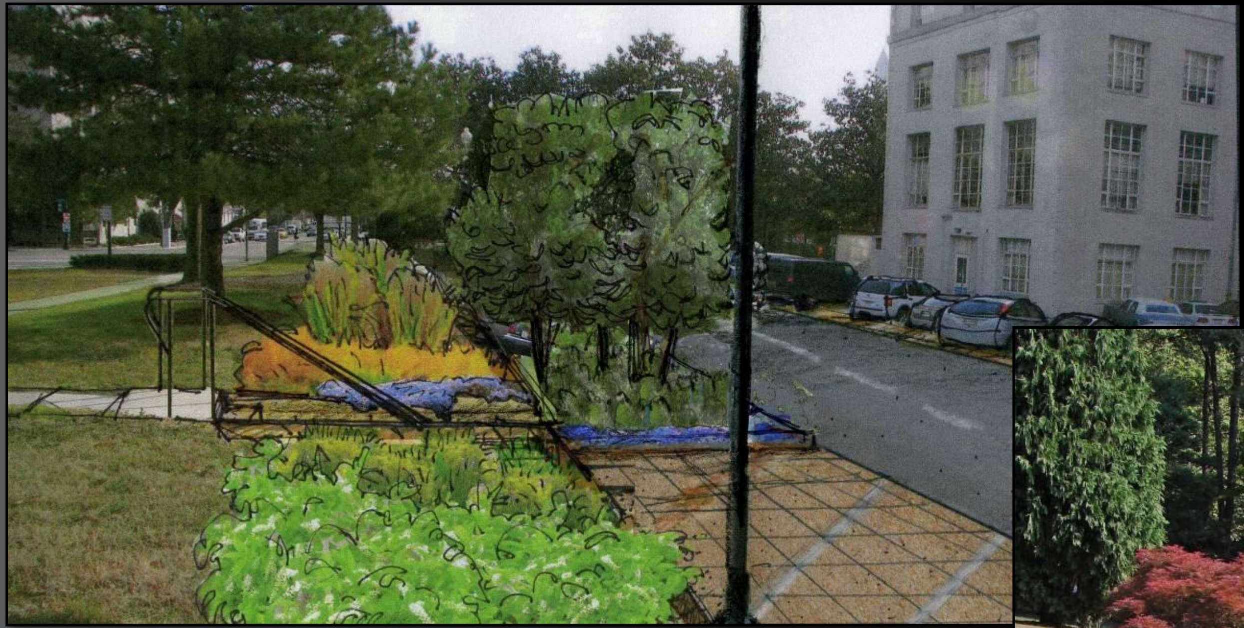
- Permeable Interlocking Concrete Pavement
- Address the need for paved surfaces and stormwater management systems
- Large area infiltration trench combined with a structural pavement surface

Interlocking Shapes/Patterns

System Components



Low Impact Design



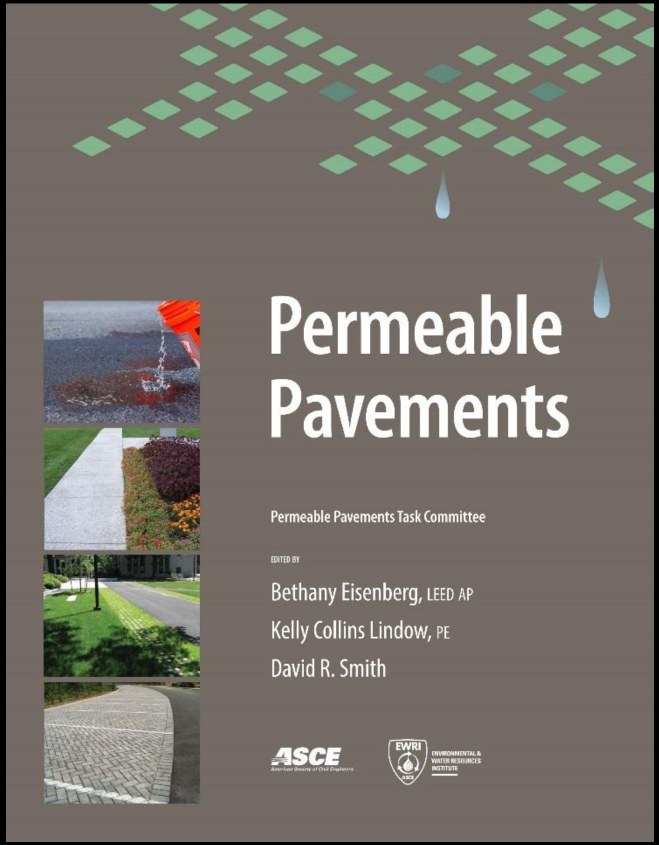
Minimize hydrologic impacts of development

PICP can work in tandem with other LID practices

How should I design PICP?

Permeable Pavements
Recommended Design Guidelines

- ASCE EWRI Committee Report
- Fact sheets
- Checklists
- Design information
- Maintenance
- Standards, guide specs & modeling methods
- Research needs



Establishes common terms for all permeable pavements

Need a standard to address…

- Permeable Interlocking Concrete Pavement
- Design
- Construction
- Maintenance

Assessing Suitability (S 3.1)

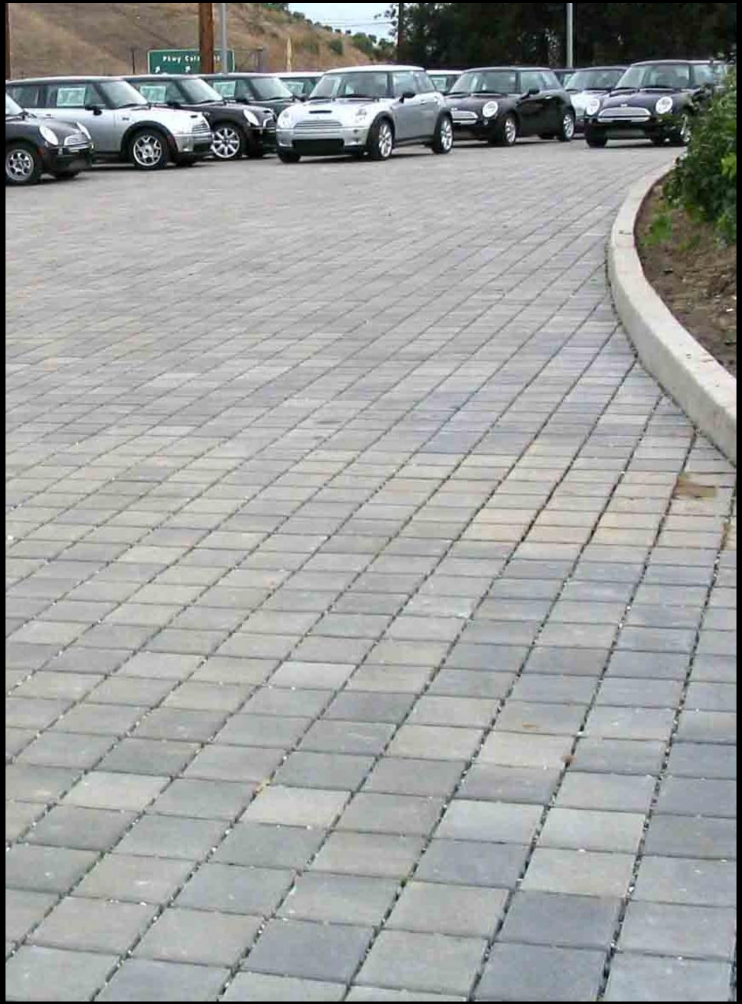
Considerations	Description
Cost efficiency (including life cycle costs)	Capital cost assessment needs to consider cost of pavement, drainage infrastructure, stormwater quality management, and land use. Overall long-term life-cycle costs can be very competitive if stormwater quality and quantity benefits are taken into account.
Environmental approval process	Verify permeable pavements are permitted, or if additional environmental approvals are required.
Stringent receiving water quality standards	The presence of protected watersheds, cold water streams, marshland, etc. may preclude the use of permeable pavement systems, or require more extensive water quality treatment.
Safety	Pavements are able to accommodate safety features such as traffic calming (rumble strips), and colored units for identification. Reduced ice formation and slip hazards.
Site grades	For grades of more than 5 percent, system will be less effective at promoting infiltration and have reduced water storage capabilities.
Depth of water table	Permeable pavements that include an infiltration component should not be used in areas where the water table is within 0.6 m (2ft) of the top of the soil subgrade.
Winter maintenance, winter sanding	Procedures for snow and ice removal are similar to those for conventional pavements. De-icing salt usage can be reduced, use of courser sand for traction control recommended. PICP are proven to perform even during below freezing conditions.
Risk of accidental chemical spill	PICP may assist in containment of accidental spills (requires the use of a geomembrane liner).

Assessing Suitability (cont.)

Considerations	Description
Amount and intensity of precipitation	Supplemental quantity control may be required in areas of frequent, high intensity storms.
Complexity of site conditions	The design and construction of permeable shoulders may be problematic in areas where retaining walls, utilities, septic systems, municipal or private wells are present.
Geotechnical Aspects	Presence of organics, fill soils, swelling clay soils, karst geology, or shallow bedrock may pose geotechnical risks that introduce added design complexity.
Mandates for water quality control	Permeable pavements may contribute substantially to water quality improvement.
Mandates for water quantity control	Permeable pavements provide stormwater management alternatives to more costly or complicated practices.
Maintenance protocols	Permeable pavement systems require mandatory non-traditional maintenance practices such as vacuum sweeping.
Structural design	Design of PICP for moderate to heavy axle loads or high traffic counts may require additional analysis and details.
Interest in innovation	Designs that include PICP can provide opportunity for innovation and sustainable benefits.
Owner experience and resources	Permeable pavements should be designed to address owners expectations for performance, aesthetics, inspections, maintenance, benefits, costs, etc.

Key Site Location Criteria

- Pedestrian areas, parking lots, low-speed residential roads
- 30 m from wells
- 3 m from building foundations unless waterproofed
- Infiltrating base: Min. 0.6 m to seasonal high water table
- Max. contributing impervious area: PICP = 5:1
- Surface slope: as much as 18%...w/ subgrade check dams
- Subgrade slope: >3% - use berms or check dams



Template Decision Matrix for Permeable Pavement

Scores are entered based on project information; weighting of factors can be adjusted

Decision range and scoring guidelines should be “calibrated” to local experience

1. Primary Considerations Part 1 Weighting: 60

Consideration	Project Score	Weighting	Weighted Score	A Favorable for Permeable Shoulders	B <<====================>>	C Not Favorable for Permeable Shoulders
				Project Scoring Guidelines		
Availability of Capital Funding	B	20.0	12.0	Project funded; requirement to implement	Need to justify funding	No specific funding available; no requirement to implement
[illegible] Environmental Approval	B	20.0	12.0	Approved	Approval pending	Application required
[illegible]	A	10.0	10.0	Minimal safety issues	Safety issues can be addressed	Significant safety issues
Significant Longitudinal Grades	B	10.0	6.0	Grades < 2 percent	Grades of 2 to 5 percent	Grades > 5 percent
Depth of Water Table	B	20.0	12.0	Water table > 1.5 m (5 ft) below subgrade	Water table 0.6-1.5 m (2-5 ft) below subgrade	Water table < 0.6 m (2 ft) below subgrade
Geotechnical Risks	B	10.0	6.0	Low complexity	Medium complexity	High complexity
Groundwater Contamination Risk	A	10.0	10.0	Low risk	Elevated Risk	High risk
Total		**100.0**	**68.0**	See Table 4.1 for guidance on scoring		
	Weighted Total Score:		**40.8**			

2. Secondary Considerations Part 2 Weighting: 30

Consideration	Project Score	Weighting	Weighted Score	A Favorable for Permeable Shoulders	B <<====================>>	C Not Favorable for Permeable Shoulders
				Project Scoring Guidelines		
Stringent Water Quality Standards	B	10.0	6.0	Regulations in place	Limited restriction	No restrictions
Sand use for Winter Maintenance	B	10.0	6.0	No sand use	Used < 2 times/year	Used > 2 times/year
Low Soil Infiltration Rates	A	10.0	10.0	Infiltration < 12 mm/hr (1/2 in./hr)	Infiltration >12mm/hr (1/2 in./hr) < 40 mm/hr (1.5 in./hr)	Infiltration > 40 mm/hr (1.5 in./hr)
Target Design Volumes and Runoff	A	10.0	10.0	Frequent/non-intense storm	Moderate frequency/intensity	Intense storms
Complexity of Geometric Conditions	A	10.0	10.0	Minimal geometric restrictions	Some geometric challenges	Significant geometric restrictions
Risk of Flooding	A	10.0	10.0	None	Occasional	Frequent
Mandates for Water Quality	B	10.0	6.0	Water quality concerns	Some water quality issues	No concerns
Mandates for Stormwater Management	A	10.0	10.0	Stormwater management concerns	Some stormwater management issues	No concerns
Maintenance Protocols	C	10.0	2.0	Proactive maintenance	Reactive maintenance	Minimal maintenance
Shoulder Utilization	B	10.0	6.0	Use for emergency stopping only	Occasional use for traffic	Regular use by traffic
Total		**100.0**	**76.0**	See Table 4.1 for guidance on scoring		
	Weighted Total Score:		**22.8**			

3. Other Considerations Part 3 Weighting: 10

Consideration	Project Score	Weighting	Weighted Score	A Favorable for Permeable Shoulders	B <<====================>>	C Not Favorable for Permeable Shoulders
				Project Scoring Guidelines		
Interest in Innovation	B	20.0	12.0	Regular innovation implementation	Innovation encouraged	Minimal interest
[illegible] of Utilities	B	20.0	12.0	None	Non-critical utilities	Critical utilities
[illegible] Site Conditions	B	20.0	12.0	Site conditions well known	Some site information available	No site specific information available
Risk of [illegible]	A	20.0	20.0	Limited exposure	Elevated risk of spills or elevated risk of gr	Elevated risk of spills and elevated risk of groundwater contamination
Owner Experience and Resources	[illegible]	20.0	4.0	Significant owner experience	Limited owner experience	No owner experience
Total		**[illegible]**	**60.0**	See Table 4.1 for guidance on scoring		
	Weighted Total [illegible]		**6.0**			

Sub Totals

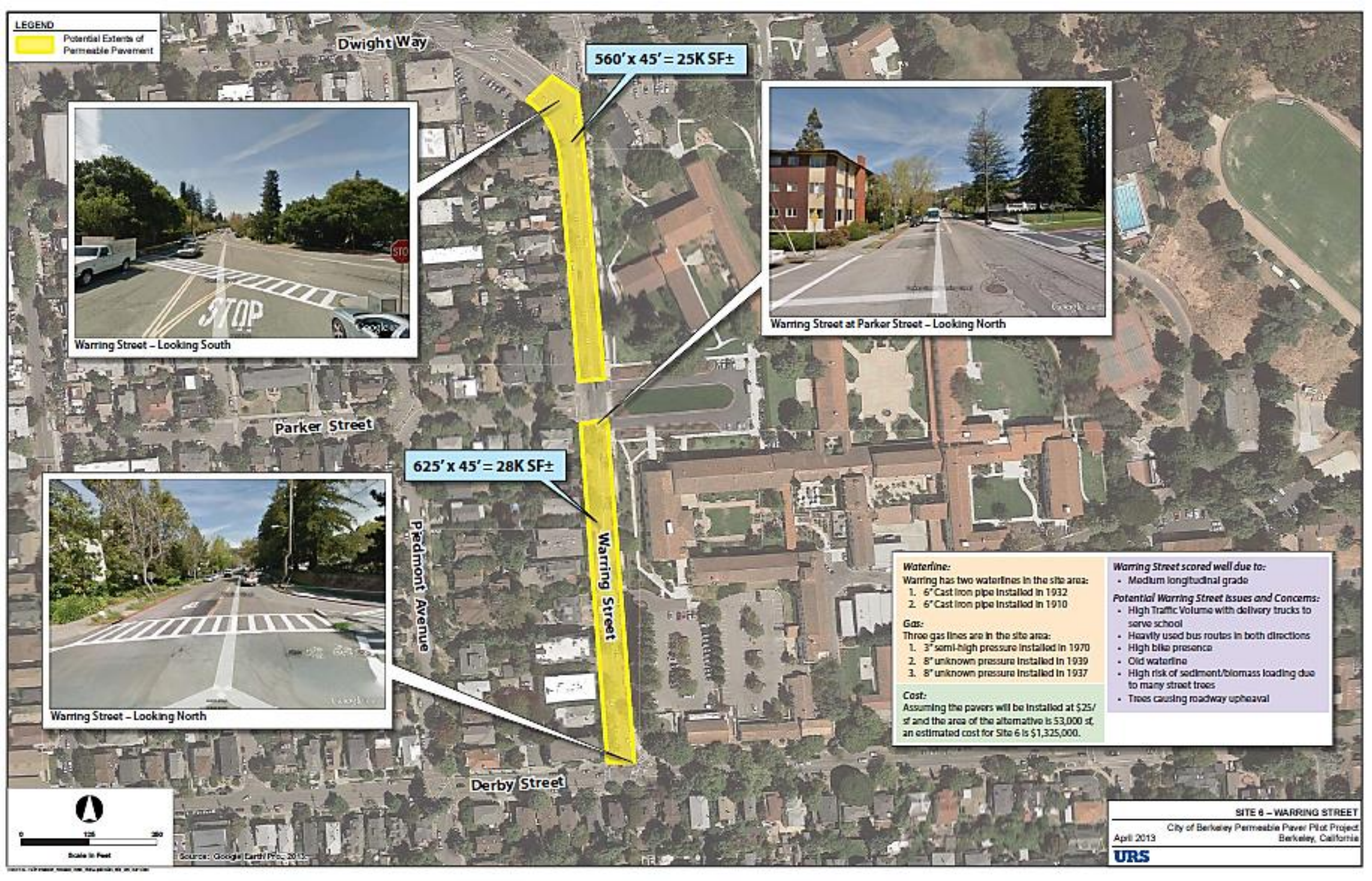
	Weighting	Score
1. Primary Considerations	60	40.8
2. Secondary Considerations	30	22.8
3. Other Considerations	10	6.0
Grand Total Project Score	**100**	**69.6**
Decision		**Can Consider**

Decision Range		
From	**To**	**Implement Alternative**
0	65	No
65	75	Can Consider
75	100	Yes

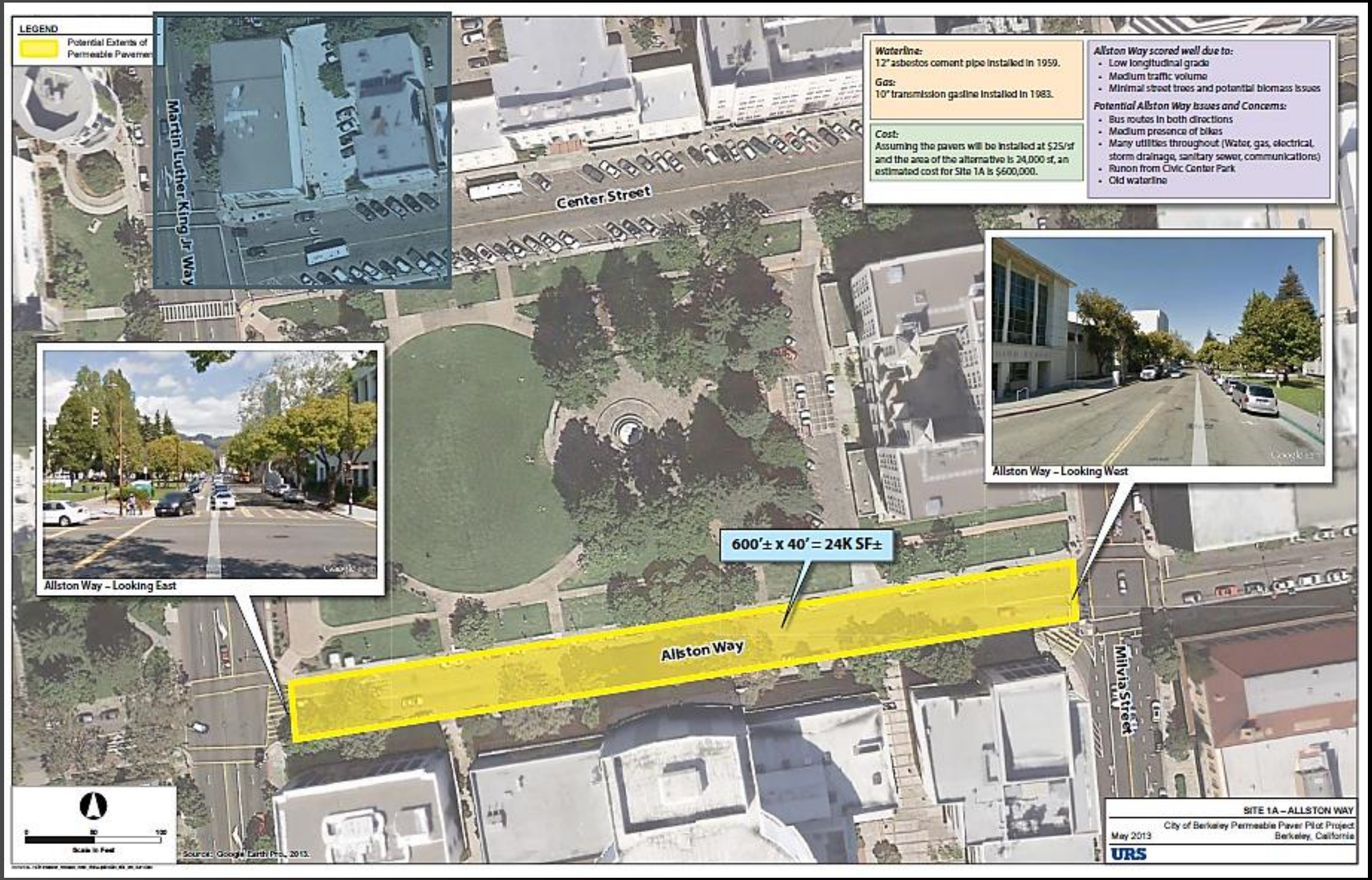
Project Suitability – Berkley, CA

Site No.	Location	Positive	Negative
1	Center Street	No trees, low traffic	Bike lanes, bus traffic, slope,
2A	Addison West	No trees, little slope	Buses, utilities, contributing area (park)
2B	Addison East	No bikes, no trees, no buses	Heavy trucks, steep, possible soft soil?
3	Hopkins Triangle	Low slope, low traffic	Buses
4A	Cedar West		High speed, buses, steep, many trees, BART, many utilities
4B	Cedar East	Minimal trees, no bikes	Buses, residential area
5	Hopkins Street	No bikes, good pavement	Many trees, buses, downspouts in curbs, high traffic, narrow road
6	Warring Street	Many trees, flat slope	Very high traffic, buses, utilities
7	Allston Way	Some contributing area	Occasional buses

Project Suitability – Berkley, CA



Project Suitability – Berkley, CA



Decision Support Tools

A. Primary Evaluation Criteria

Part A Weighting: 60

	Consideration	Performance Score	Weighting	Weighted Value	Performance Scoring Guidelines: Low = 0.2	Medium = 0.6	High = 1
1	Significant Longitudinal Grades	High	20.0	20.0	Grades > 5 percent	Grades of 3 to 4 percent	Grades < 3 percent
2	Geotechnical Risks	High	15.0	15.0	High complexity	Medium complexity	Low complexity
3	Presence of Utilities	Medium	25.0	15.0	Waterline > 50 years old	Waterline between 30 and 50 years old	Waterline < 30 years old
4	Traffic Volume (ADT)	High	20.0	20.0	High Traffic Volume	Medium Traffic Volume	Low Traffic Volume
5	Presence of Bike Paths	High	20.0	20.0	Regular/designated use	Occasional use	No use
	Total		**100.0**	**90.0**			
			Weighted Total:	**54.0**			

B. Secondary Considerations

Part B Weighting: 40

	Consideration	Rating	Weighting	Weighted Value	Performance Scoring Guidelines: Low	Medium	High
6	Groundwater Contamination Risk	High	20.0	20.0	Existing contaminants present	Potential for contaminants	No contaminants present
7	Soil Infiltration Rates	Low	20.0	4.0	Infiltration < 0.5 in/hr	Infiltration >0.5 in/hr < 1.5 in/hr	Infiltration > 1.5 in/hr
8	Potential for Sediment/Biomass Loading	High	20.0	20.0	Significant risk of sediment loading	Potential risk of sediment loading	No risk
9	Target Design Volumes and Runoff	Medium	20.0	12.0	Intense storms	Moderate frequency/intensity	Frequent/non-intense storm
10	Risk of Flooding	High	20.0	20.0	Frequent	Occasional	None
	Total		**100.0**	**56.0**			
			Weighted Total:	**22.4**			

Sub Totals

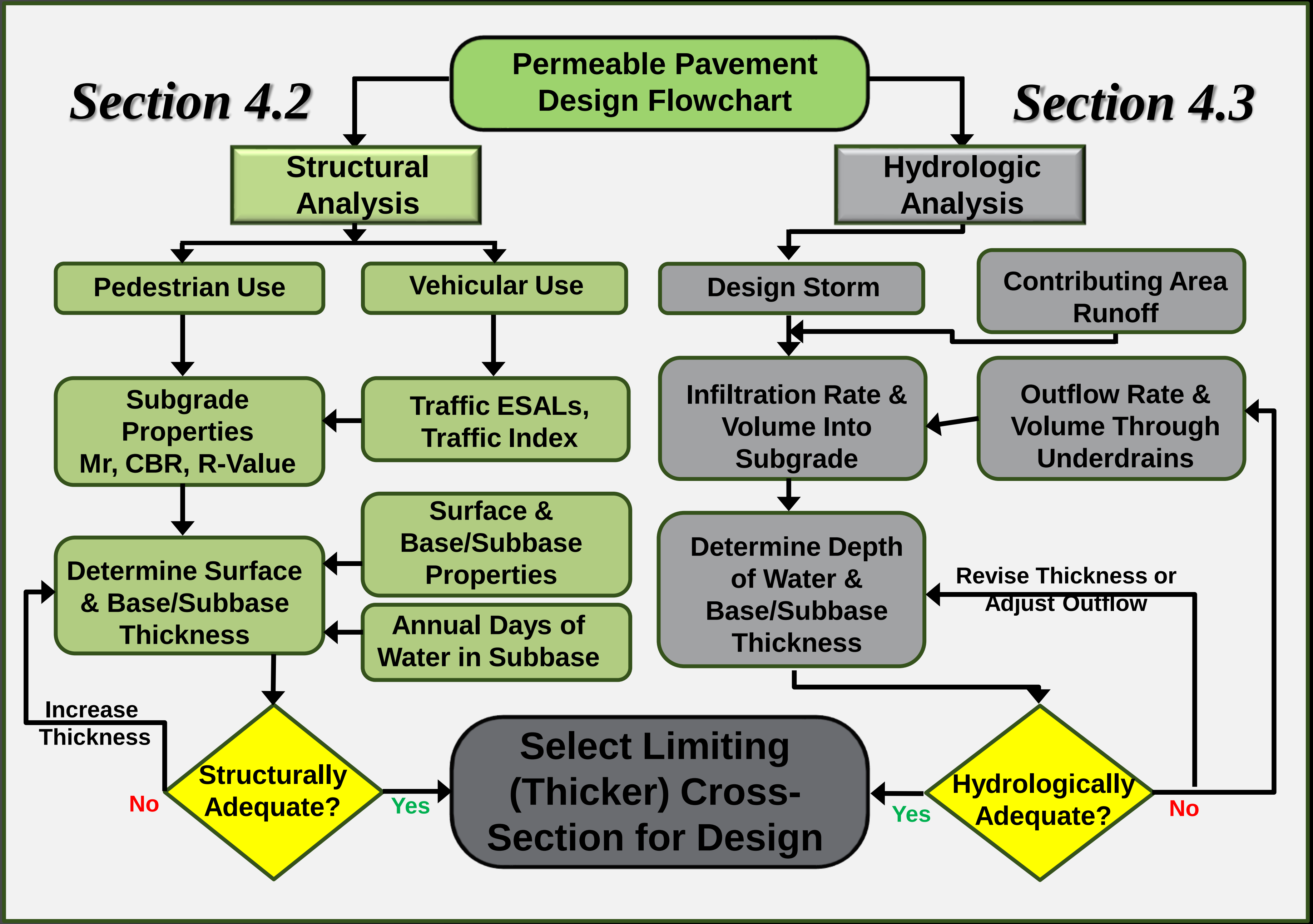
A. Primary Considerations	60	54.0
B. Secondary Considerations	40	22.4
Grand Total	**100**	**76.4**
Decision		Yes

Decision Range

From	To	Implement Alternative
0	65	No
65	75	Can Consider
75	100	Yes

Project Suitability

Site No.	Location	Primary	Secondary	Total	Evaluation
1	Center Street	43.2	28.8	72.0	Can Consider
2A	Addison Street West	44.4	28.8	73.2	Can Consider
2B	Addison Street East	26.4	25.6	52.0	No
3	Hopkins Triangle	44.4	25.6	70.0	Can Consider
4A	Cedar Street West	21.6	25.6	47.2	No
4B	Cedar Street East	40.8	25.6	66.4	Can Consider
5	Hopkins Street	40.8	25.6	66.4	Can Consider
6	Warring Street	26.4	25.6	52.0	No
7	Allston Way	54.0	25.6	79.6	Yes



Permeable Pavement Design Flowchart
Section 4.2
Section 4.3
Structural Analysis
Hydrologic Analysis
Pedestrian Use
Vehicular Use
Design Storm
Contributing Area Runoff
Subgrade Properties Mr, CBR, R-Value
Traffic ESALs, Traffic Index
Infiltration Rate & Volume Into Subgrade
Outflow Rate & Volume Through Underdrains
Surface & Base/Subbase Properties
Determine Surface & Base/Subbase Thickness
Annual Days of Water in Subbase
Determine Depth of Water & Base/Subbase Thickness
Revise Thickness or Adjust Outflow
Increase Thickness
No
Structurally Adequate?
Yes
Select Limiting (Thicker) Cross-Section for Design
Yes
Hydrologically Adequate?
No

How should I design PICP?

Structural Analysis

Traffic Loading and Design

Pavement Class	Description	Design ESALs	Design TI
Arterial	Through traffic with access to high-density, regional, commercial and office developments or downtown streets. General traffic mix.	9,000,000	11.5
Major Collector	Traffic with access to low-density, local, commercial and office development or high density, residential sub-divisions. General traffic mix	3,000,000	10
Minor Collector	Through traffic with access to low-density, neighborhood, commercial development or low-density, residential sub-divisions. General traffic mix.	1,000,000	9
Bus Terminal	Public Transport Centralized facility for buses to pick up passengers from other modes of transport, or for parking of city or school buses.	500,000	8.5
Local Commercial	Commercial and limited through traffic with access to commercial premises and multi-family and single-family residential roads. Used by private automobiles, service vehicles and heavy delivery trucks	330,000	8
Residential	No through traffic with access to multi-family and single-family residential properties. Used by private automobiles, service vehicles and light delivery trucks, including limited construction traffic.	110,000	7
Facility Parking	Open parking areas for private automobiles at large facilities with access for emergency vehicles and occasional use by service vehicles or heavy delivery trucks.	90,000	7
Commercial Parking	Restricted parking and drop-off areas associated with business premises, mostly used by private automobiles and occasional light delivery trucks. No construction traffic over finished surface.	30,000	6
Commercial Plaza	Predominantly pedestrian traffic, but with access for occasional heavy maintenance and emergency vehicles. No construction traffic over finished surface.	10,000	5

Define soil strength

Resilient Modulus or M_r (PSI or MPa)

- Measures stiffness (resistance to loads)
- Dynamic test (repeated loads) on a soil or base sample under simulated confining stresses (from field tests)

California Bearing Ratio (CBR in percent)

- Tests vertical bearing capacity compared to a
- high-quality compacted aggregate base

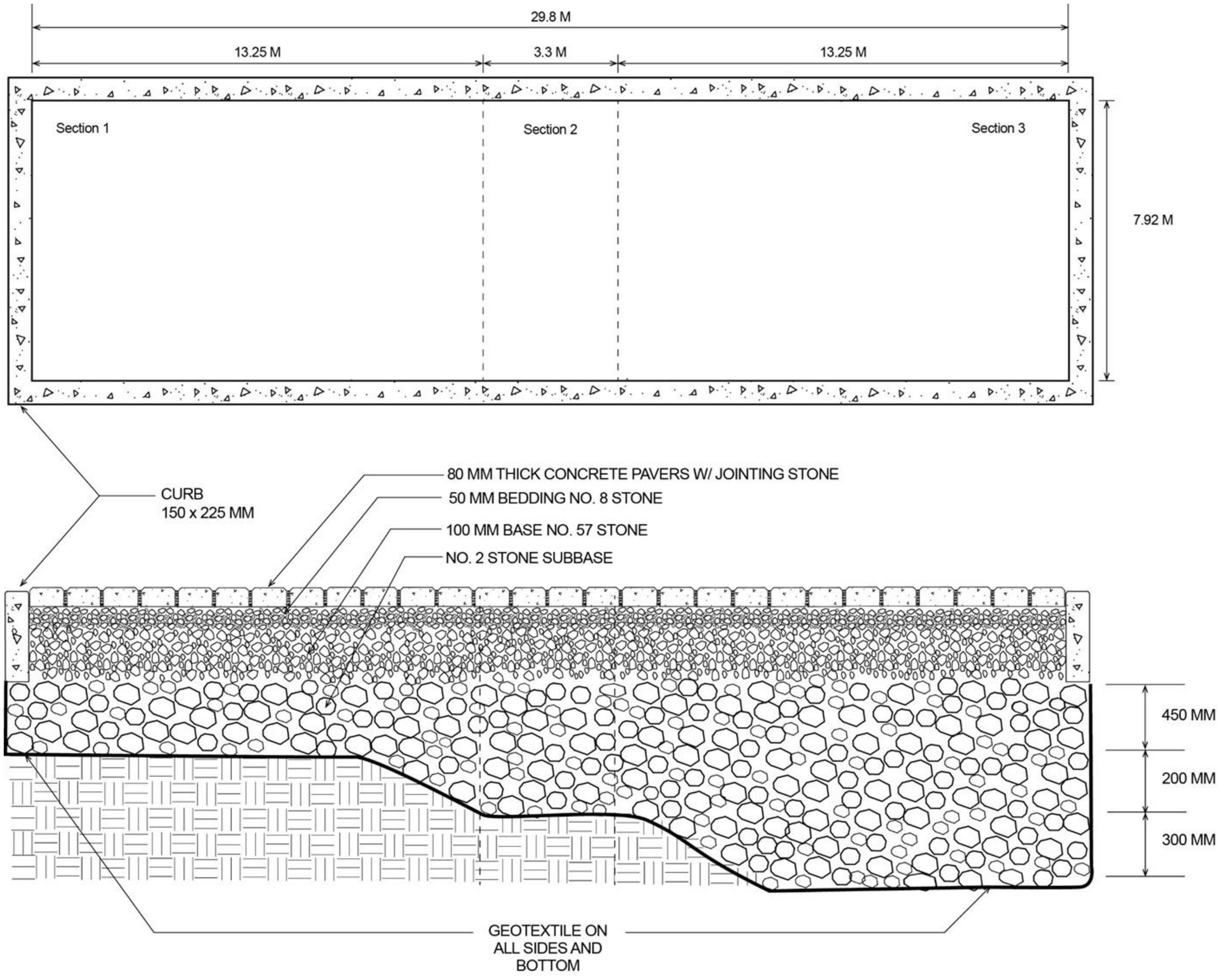
Resistance or R-value (dimensionless number)

- Tests vertical bearing and horizontal shear
- Used in California & a few other states

Strengths correlate to each other

UC Davis Pavement Research Center

- Prepare accelerated load testing plan based on the results of the mechanistic analysis
- Test responses/failure of three PICP structures in dry and wet condition with a Heavy Vehicle Simulator (HVS)
- Analyze the results revise/update ICPI structural design tables as needed



29.8 M
13.25 M
3.3 M
13.25 M
Section 1
Section 2
Section 3
7.92 M
CURB
150 x 225 MM
80 MM THICK CONCRETE PAVERS W/ JOINTING STONE
50 MM BEDDING NO. 8 STONE
100 MM BASE NO. 57 STONE
NO. 2 STONE SUBBASE
450 MM
200 MM
300 MM
GEOTEXTILE ON
ALL SIDES AND
BOTTOM

Native Soil Subgrade Moisture

Wheel Load (kN)	Load Repetitions	ESALs	Surface Rut Depths, mm		
			450 mm Subbase	650 mm Subbase	950 mm Subbase
25	100,000	13,890	8.6	7.7	9.4
40	100,000	100,000	13.6	12.9	13.7
60	140,000	768,619	23.7	22.0	20.4
Total	340,000	882,509			

Saturated Subbase & Soil

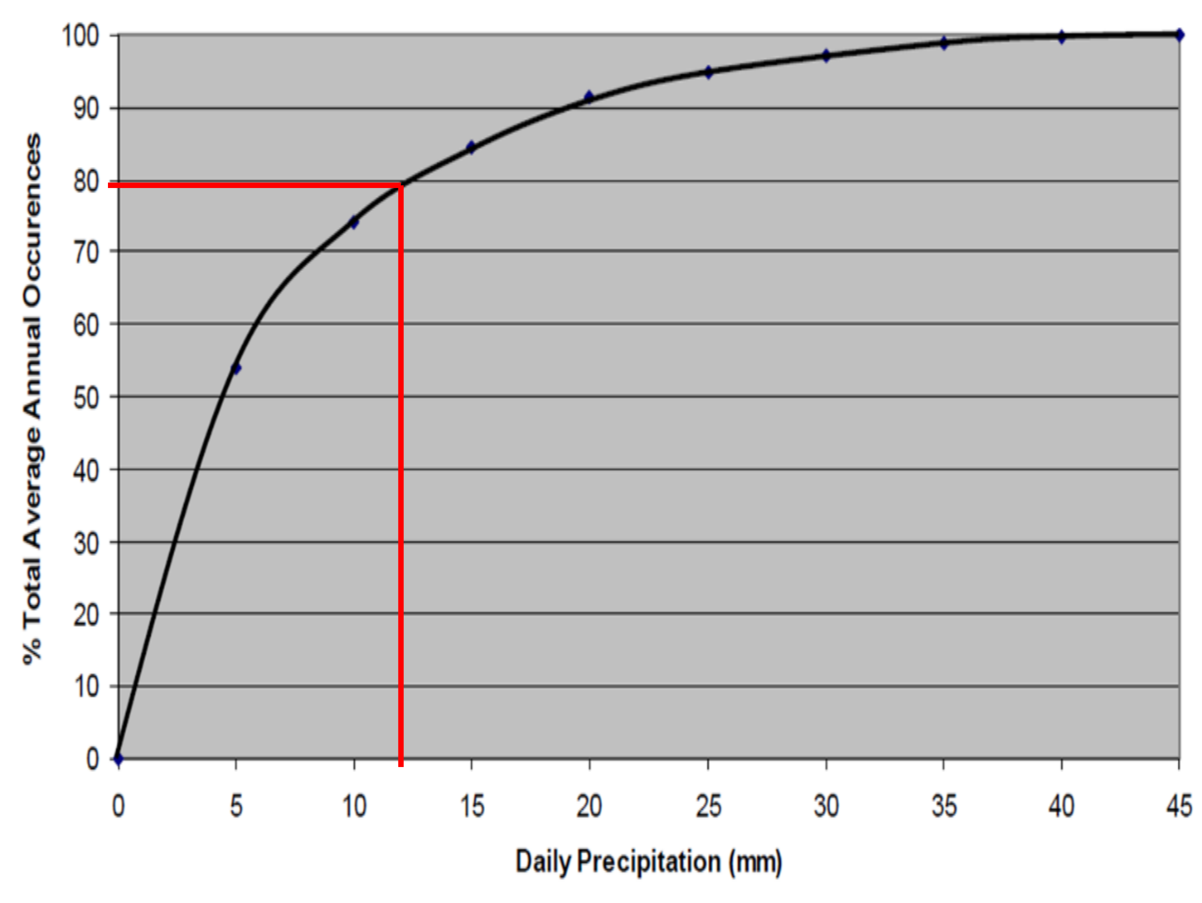
Wheel Load (kN)	Load Repetitions	ESALs	Surface Rut Depths, mm		
			450 mm Subbase	650 mm Subbase	950 mm Subbase
25	100,000	13,890	13.7	11.8	11.2
40	100,000	100,000	25.2	20.8	20.3
60	140,000	768,619	47.2	37.9	34.8
80	40,000	735,167	58.0	46.9	40.8
Total	380,000	1,617,676			

Drained Subbase & Soil

Wheel Load (kN)	Load Repetitions	ESALs	Surface Rut Depths, mm		
			450 mm Subbase	650 mm Subbase	950 mm Subbase
25	100,000	13,890	9.5	9.1	9.1
40	25,000	25,000	11.0	10.6	10.6
Total	140,000	38,890			

Saturated Subgrade

- For days where subbase has standing water:
  - From rainfall intensity curve of total average annual occurrences versus daily precipitation
  - From curve only 20% of rain days exceed 12.5 mm (1 in) of rain
  - 139 days of rain x 20% = 27.8 days can cause standing water on the subgrade surface



Example Design Tables

Number of Days in a Year When the Subbase has Standing Water (Wet Days)		0				10				30			
Resilient Modulus of Subgrade (ksi)	Dry	5.8	8.7	11.6	14.5	5.8	8.7	11.6	14.5	5.8	8.7	11.6	14.5
	Wet	3.5	5.2	6.7	8.7	3.5	5.2	6.7	8.7	3.5	5.2	6.7	8.7
Cohesion (psi), Internal Friction Angle of Subgrade (°)[1]	Dry	1.5, 20	2.2, 25	2.9, 30	3.6, 35	1.5, 20	2.2, 25	2.9, 30	3.6, 35	1.5, 20	2.2, 25	2.9, 30	3.6, 35
	Wet	0.9, 12	1.3, 15	1.7, 22	2.2, 25	0.9, 12	1.3, 15	1.7, 22	2.2, 25	0.9, 12	1.3, 15	1.7, 22	2.2, 25
Lifetime ESALs (Traffic Index)		Minimum Subbase Thickness in inches[2] ASTM #2 for 1 in. Allowable Rut Depth (All designs have 3.2 in. Paver, 2 in. ASTM #8 Bedding Layer, & 4 in. ASTM #57 Base Layer)											
50,000 (6.3)		6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
100,000 (6.8)		6.0	6.0	6.0	6.0	8.5	6.0	6.0	6.0	10.5	6.0	6.0	6.0
200,000 (7.4)		9.0	6.0	6.0	6.0	12.5	8.5	6.0	6.0	14.5	10.0	6.5	6.0
300,000 (7.8)		11.5	7.0	6.0	6.0	15.0	10.5	7.0	6.0	17.0	12.5	8.5	6.0
400,000 (8.1)		13.0	9.0	6.0	6.0	17.0	12.0	8.5	6.0	19.0	14.0	10.0	7.0
500,000 (8.3)		14.5	10.0	6.5	6.0	18.0	13.5	9.5	6.5	20.0	15.0	11.0	8.0
600,000 (8.5)		15.5	11.0	7.5	6.0	19.0	14.5	10.5	7.0	21.0	16.0	12.0	9.0
700,000 (8.6)		16.5	12.0	8.0	6.0	20.0	15.0	11.0	8.0	22.0	17.0	13.0	10.0
800,000 (8.8)		17.0	12.5	9.0	6.0	20.5	16.0	12.0	8.5	22.5	17.5	13.5	10.5
900,000 (8.9)		17.5	13.0	9.5	6.0	21.0	16.5	12.5	9.0	23.5	18.0	14.0	11.0
1,000,000 (9.0)		18.0	13.5	10.0	6.5	22.0	17.0	13.0	9.5	24.0	19.0	14.5	11.5

[1] Default values based on testing cited in the literature *(10,12)*

[2] Subbase thickness calculated by dividing metric thickness by 25 and then rounding to nearest 0.5 in.

Example Design Tables

Number of Days in a Year When the Subbase has Standing Water (Wet Days)		50				90				120			
Resilient Modulus of Subgrade (ksi)	Dry	5.8	8.7	11.6	14.5	5.8	8.7	11.6	14.5	5.8	8.7	11.6	14.5
	Wet	3.5	5.2	6.7	8.7	3.5	5.2	6.7	8.7	3.5	5.2	6.7	8.7
Cohesion (psi), Internal Friction Angle of Subgrade (°)[1]	Dry	1.5, 20	2.2, 25	2.9, 30	3.6, 35	1.5, 20	2.2, 25	2.9, 30	3.6, 35	1.5, 20	2.2, 25	2.9, 30	3.6, 35
	Wet	0.9, 12	1.3, 15	1.7, 22	2.2, 25	0.9, 12	1.3, 15	1.7, 22	2.2, 25	0.9, 12	1.3, 15	1.7, 22	2.2, 25
Lifetime ESALs (Traffic Index)		Minimum Subbase Thickness in inches[2] ASTM #2 for 1 in. Allowable Rut Depth (All designs have 3.2 in. Paver, 2 in. ASTM #8 Bedding Layer, & 4 in. ASTM #57 Base Layer)											
50,000 (6.3)		7.0	6.0	6.0	6.0	8.5	6.0	6.0	6.0	9.0	6.0	6.0	6.0
100,000 (6.8)		11.5	7.0	6.0	6.0	13.0	8.5	6.0	6.0	13.5	9.5	6.0	6.0
200,000 (7.4)		16.0	11.5	7.5	6.0	17.0	13.0	8.5	6.0	18.0	13.5	9.5	6.0
300,000 (7.8)		18.0	13.5	9.5	6.5	20.0	15.0	11.0	8.0	20.5	16.0	11.5	8.5
400,000 (8.1)		20.0	15.0	11.0	8.0	21.5	16.5	12.5	9.5	22.0	17.5	13.0	10.0
500,000 (8.3)		21.0	16.5	12.0	9.0	23.0	18.0	13.5	10.5	23.5	18.5	14.0	11.0
600,000 (8.5)		22.0	17.5	13.0	10.0	24.0	19.0	14.5	11.0	24.5	19.5	15.0	12.0
700,000 (8.6)		23.0	18.0	14.0	11.0	25.0	19.5	15.0	12.0	25.5	20.5	16.0	12.5
800,000 (8.8)		24.0	19.0	14.5	11.5	25.5	20.0	16.0	12.5	26.5	21.0	16.5	13.5
900,000 (8.9)		24.5	19.5	15.0	12.0	26.0	21.0	16.5	13.0	27.0	21.5	17.0	14.0
1,000,000 (9.0)		25.0	20.0	15.5	12.5	27.0	21.5	17.0	13.5	27.5	22.0	17.5	14.5

[1] Default values based on testing cited in the literature *(10,12)*

[2] Subbase thickness calculated by dividing metric thickness by 25 and then rounding to nearest 0.5 in.

Structural Design

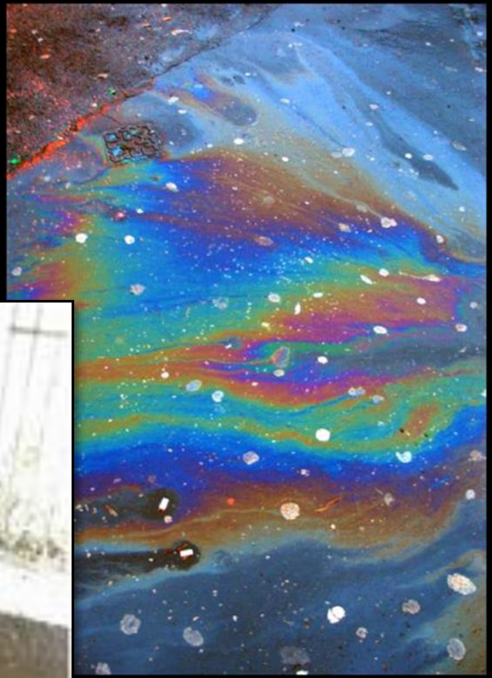
- **Traffic Type and Composition -** Permeable pavements can be used heavy vehicular applications, but a qualified pavement engineer should be consulted for these applications
- **Limitations** – speed limit less than 65kph (40 mph)

How should I design PICP?

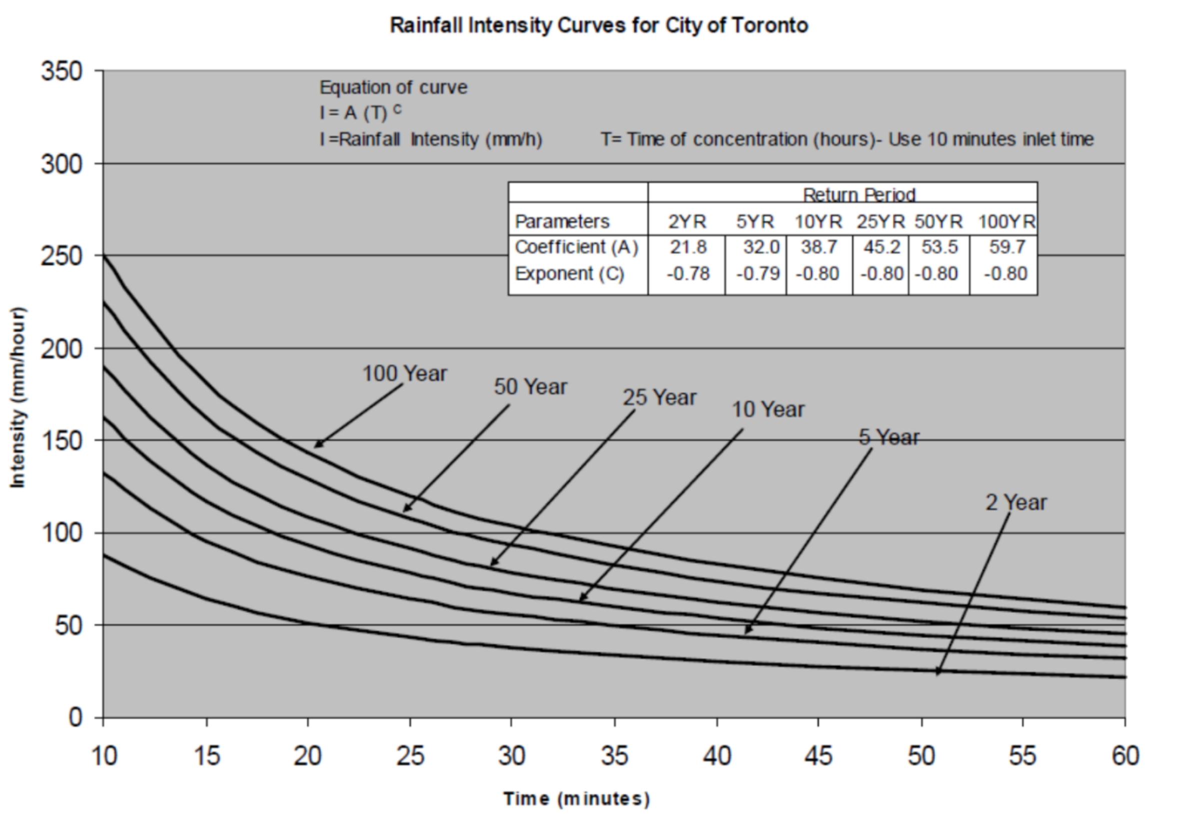
Hydrologic Analysis

Hydrologic Design (S4.3)

- Determine Hydraulic Goals
- Volume control (maintain pre-development conditions)
- Water quality (catch first flush)
- Thermal quality
- Peak flow control
- Downstream erosion control
- Infiltration/recharge targets
- Ecosystem/habitat maintenance



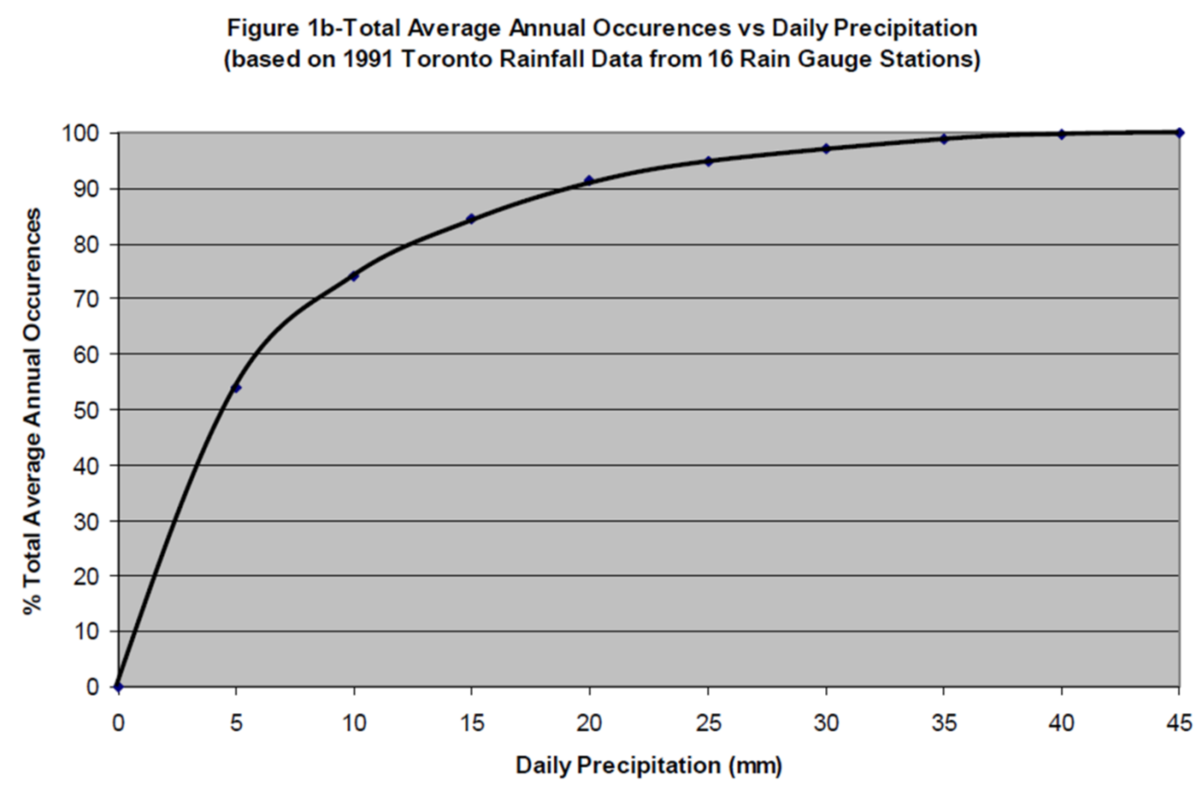
Precipitation Data



	Return Period					
Parameters	2YR	5YR	10YR	25YR	50YR	100YR
Coefficient (A)	21.8	32.0	38.7	45.2	53.5	59.7
Exponent (C)	-0.78	-0.79	-0.80	-0.80	-0.80	-0.80

Intensity Duration Frequency Curves

Percentile Storm Data



Subgrade Infiltration

- Double ring infiltrometer test
- Use avg. infiltration rate
- Apply safety factor for clogging & construction compaction

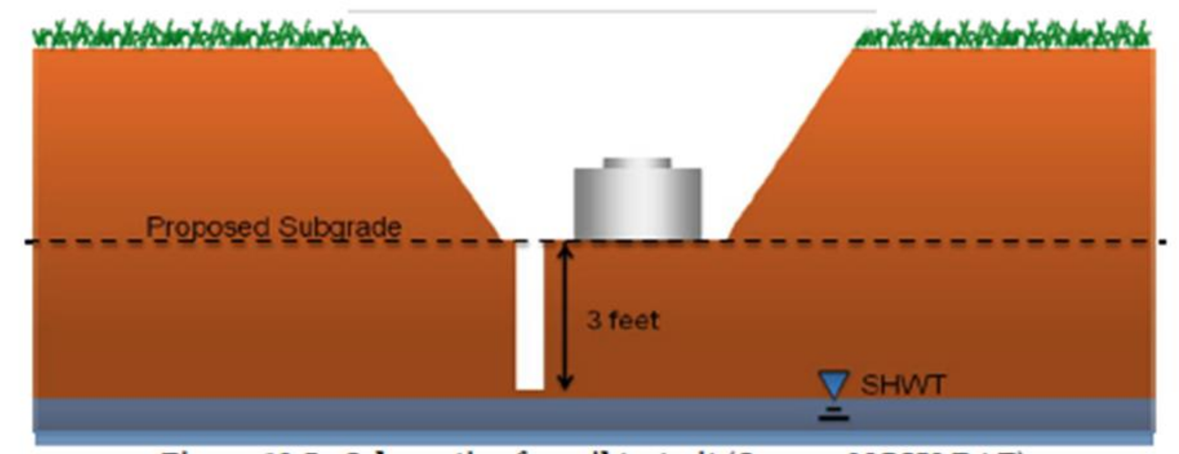


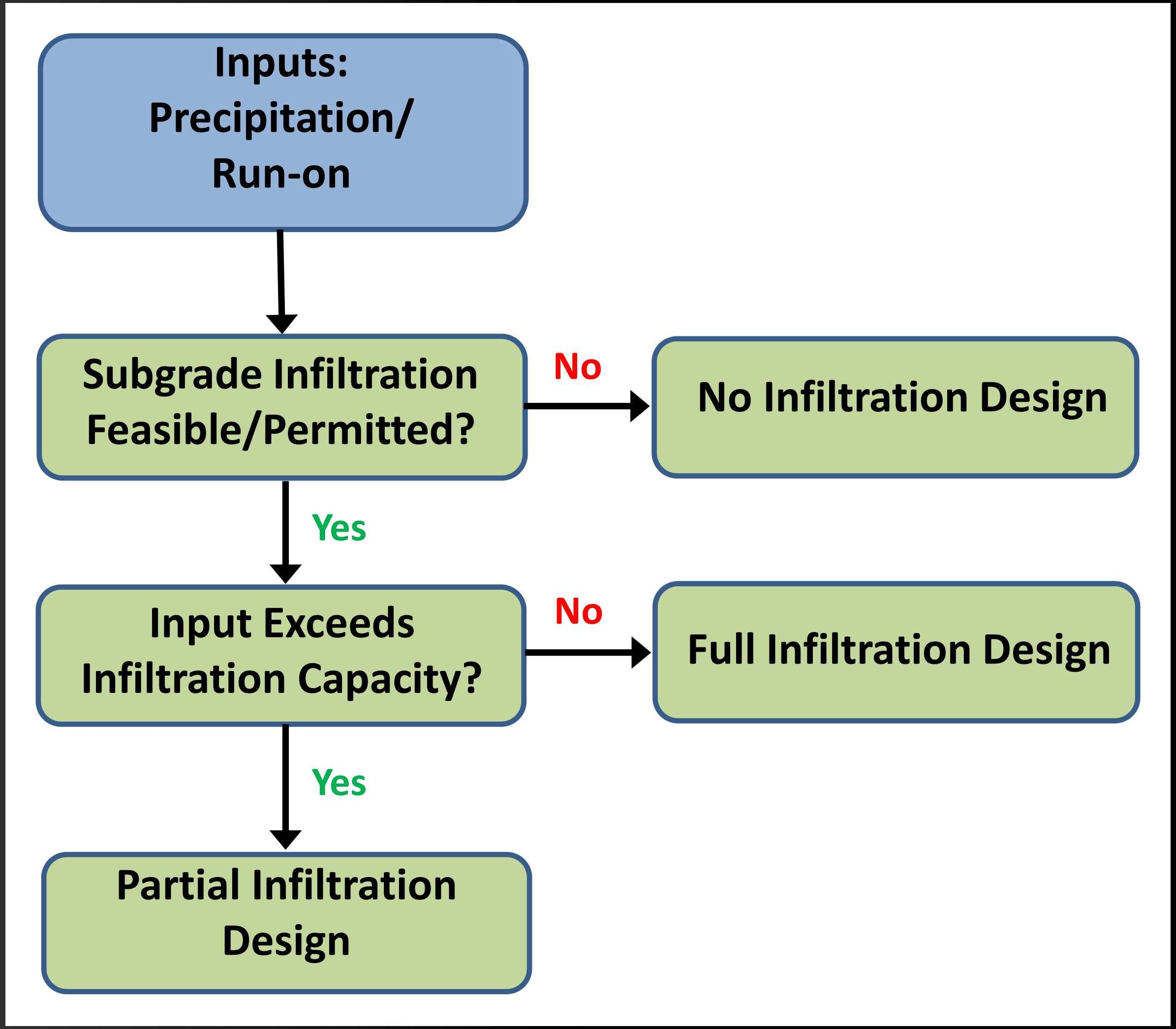
Figure 18-5. Schematic of a soil test pit (Source: NCSU-BAE)

Subgrade Infiltration

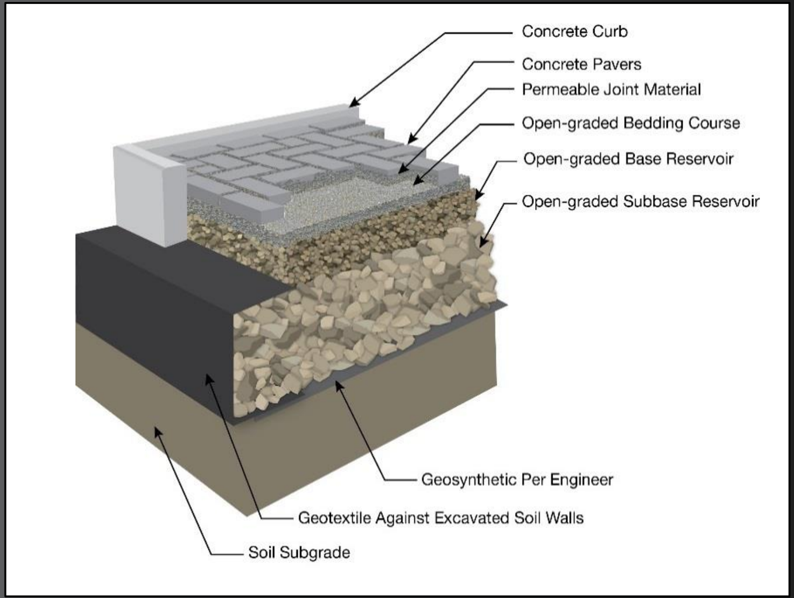
TEXTURE CLASS	MINIMUM FILTRATION RATE (f) inch per hour	HYDROLOGIC SOIL GROUPING
Sand	8.27	A
Loamy Sand	2.41	A
Sandy Loam	1.02	B
Loam	0.52	B
Silt Loam	0.27	C
Sandy Clay Loam	0.17	C
Clay Loam	0.09	D
Silty Clay Loam	0.06	D
Sandy Clay	0.05	D
Silty Clay	0.04	D
Clay	0.02	D

Source: Virginia Stormwater Management Program Manual

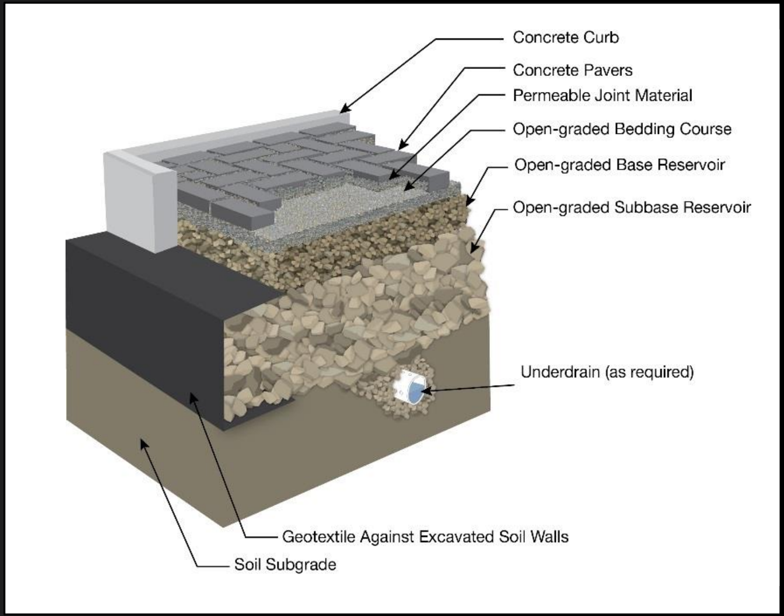
Selecting the PICP System Type



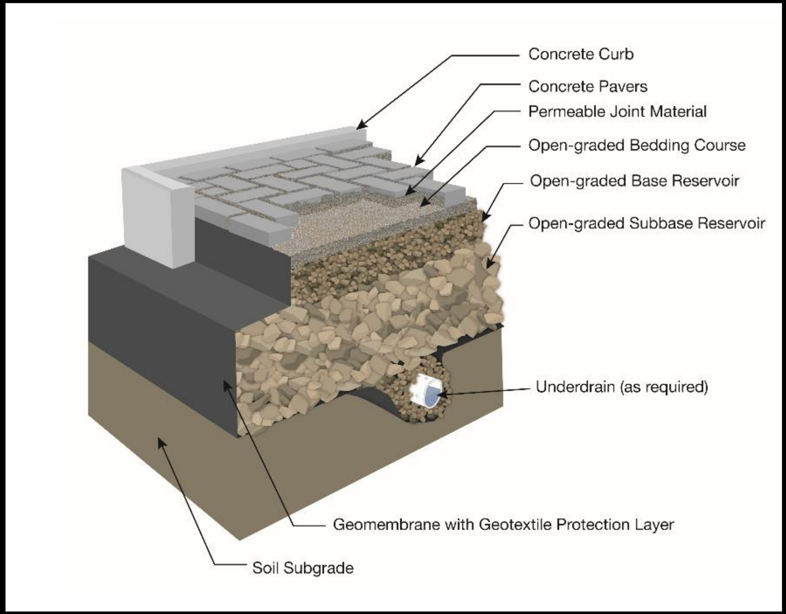
Different assemblies for different objectives



Full Infiltration

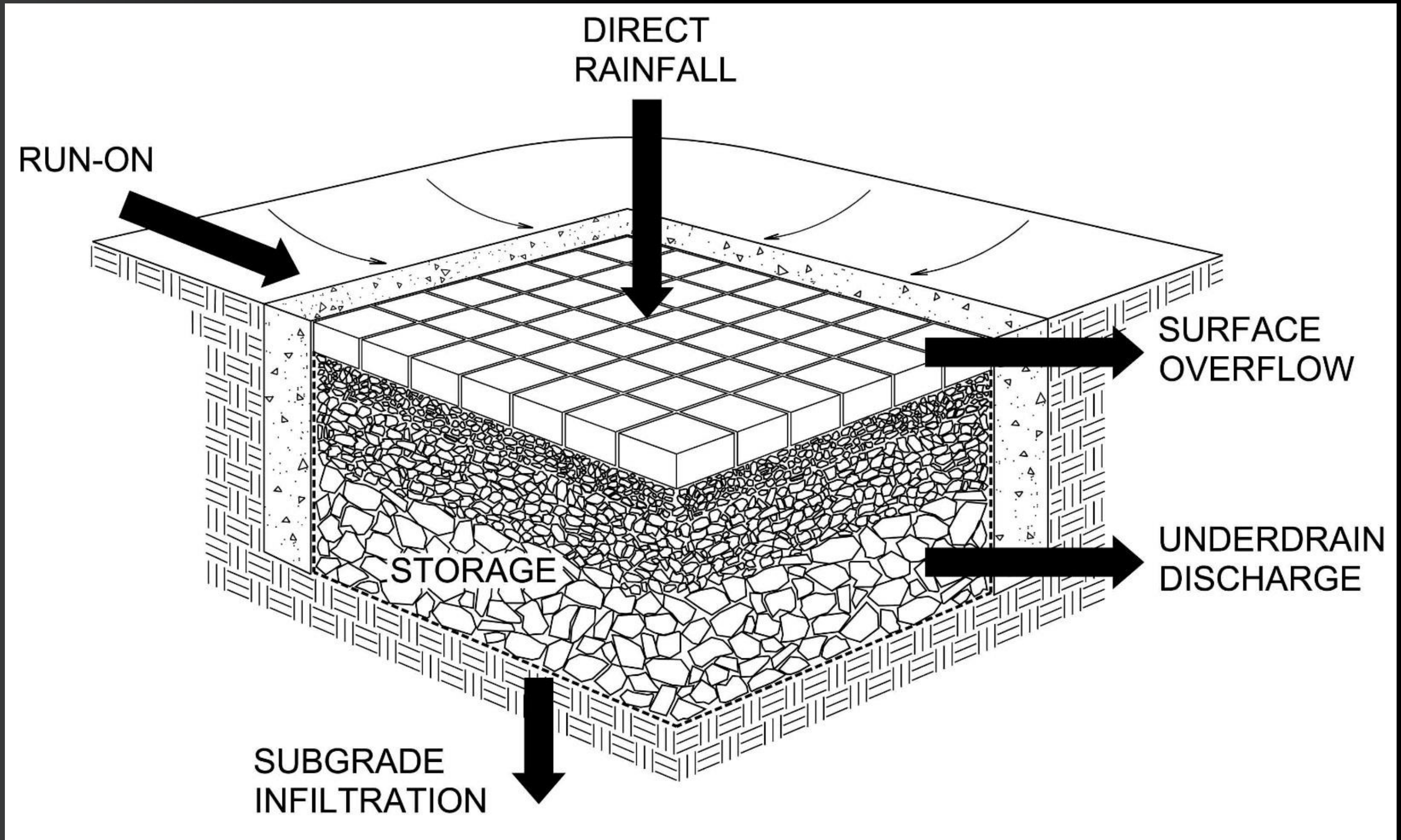


Partial Infiltration



No Infiltration

Water Balance



Input = Output

What else can you tell me about the upcoming

ASCE PICP Design Standard

ASCE PICP Standard

Section 1 – General Scope

Section 2 – Definitions

Section 3 – Preliminary Assessment

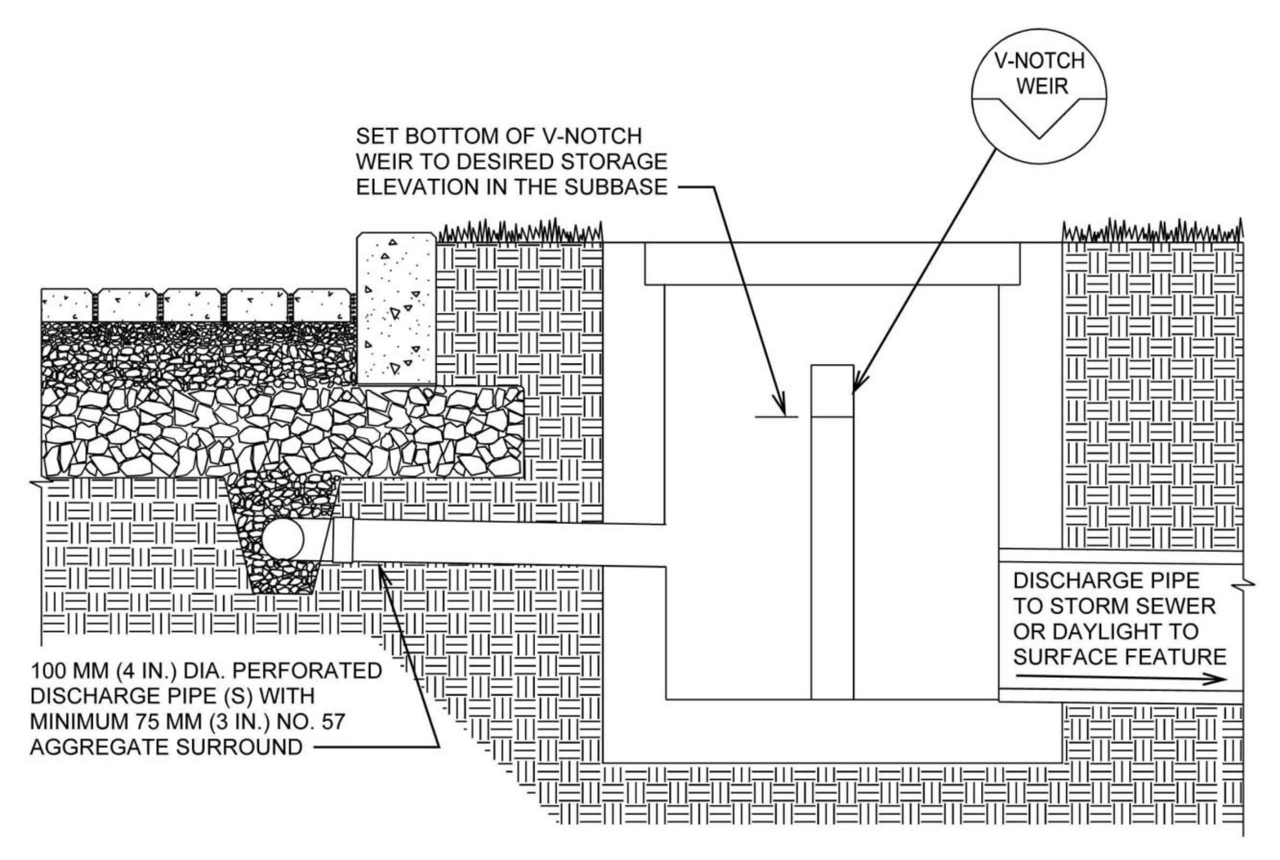
Section 4 – Design (structural & hydrologic analysis, additional considerations)

Section 4 – Construction guidelines

Section 5 – Maintenance guidelines

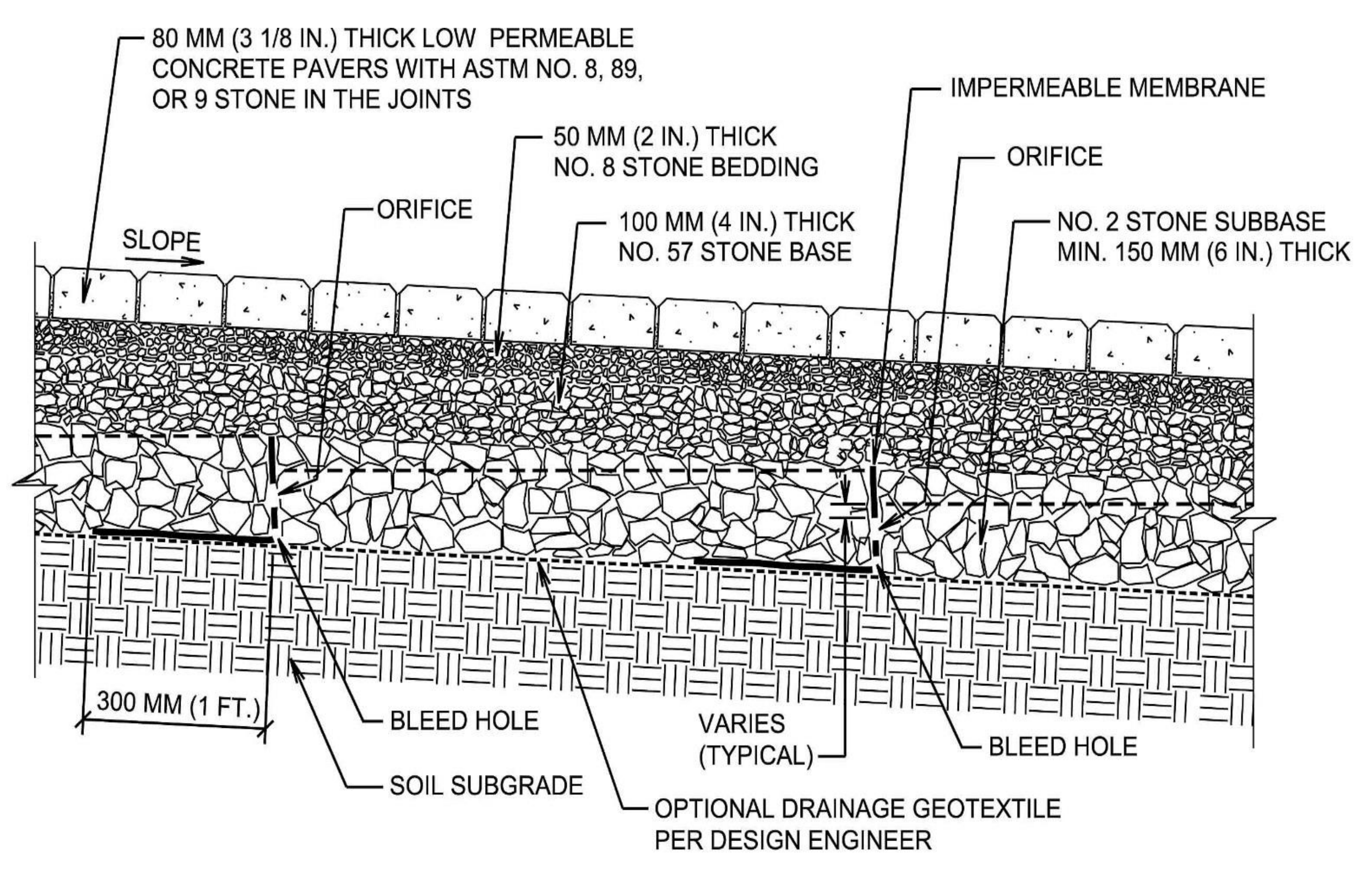
Additional Design Considerations (S 4.5)

- Outlet structures provide for future modifications to the storage depth plus a convenient monitoring location



Additional Design Considerations

- Subgrade slopes over 3% often require buffers, weirs, check dams, etc. to control water flow

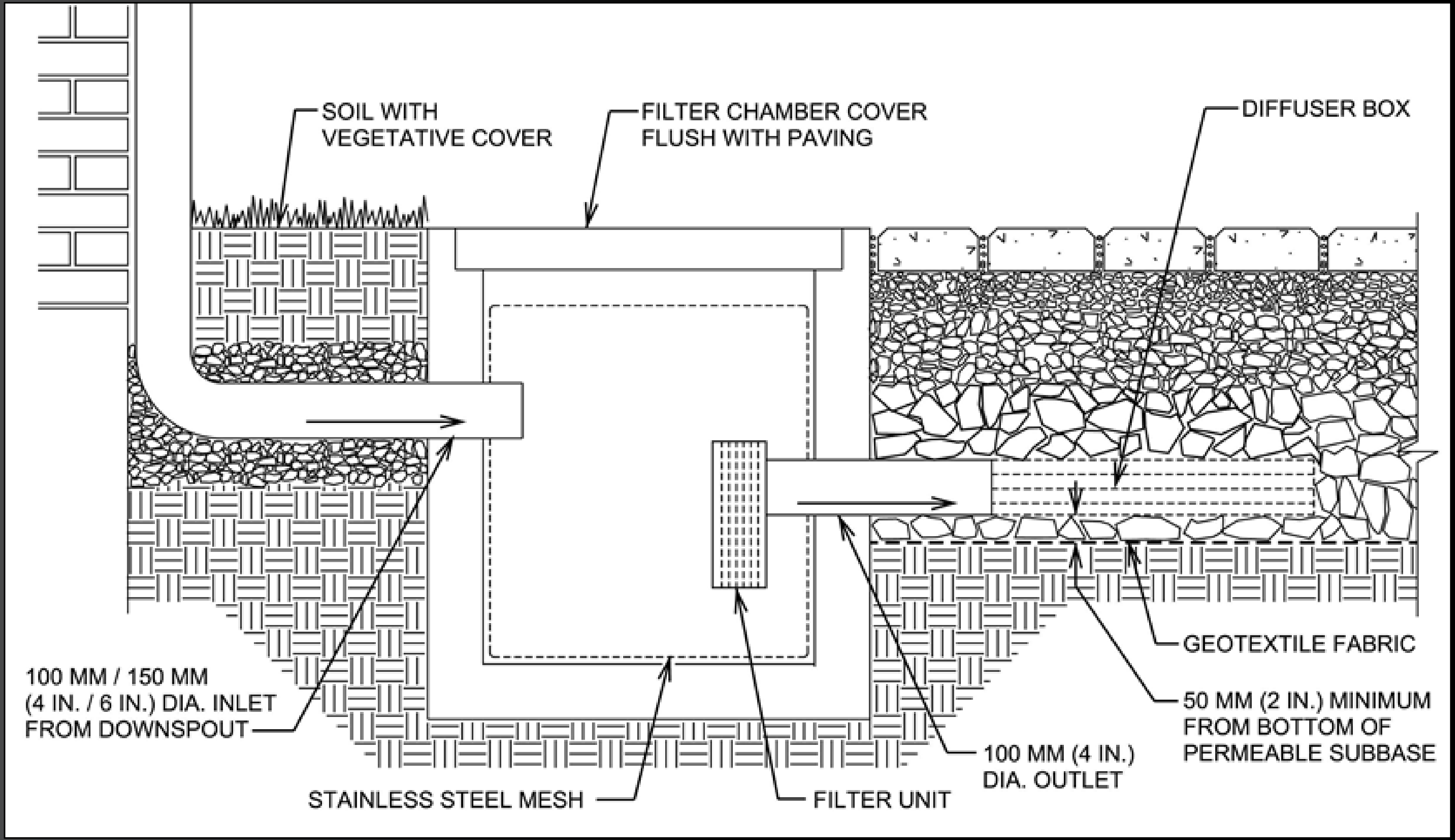


Additional Design Considerations

Baffel Construction

Additional Design Considerations

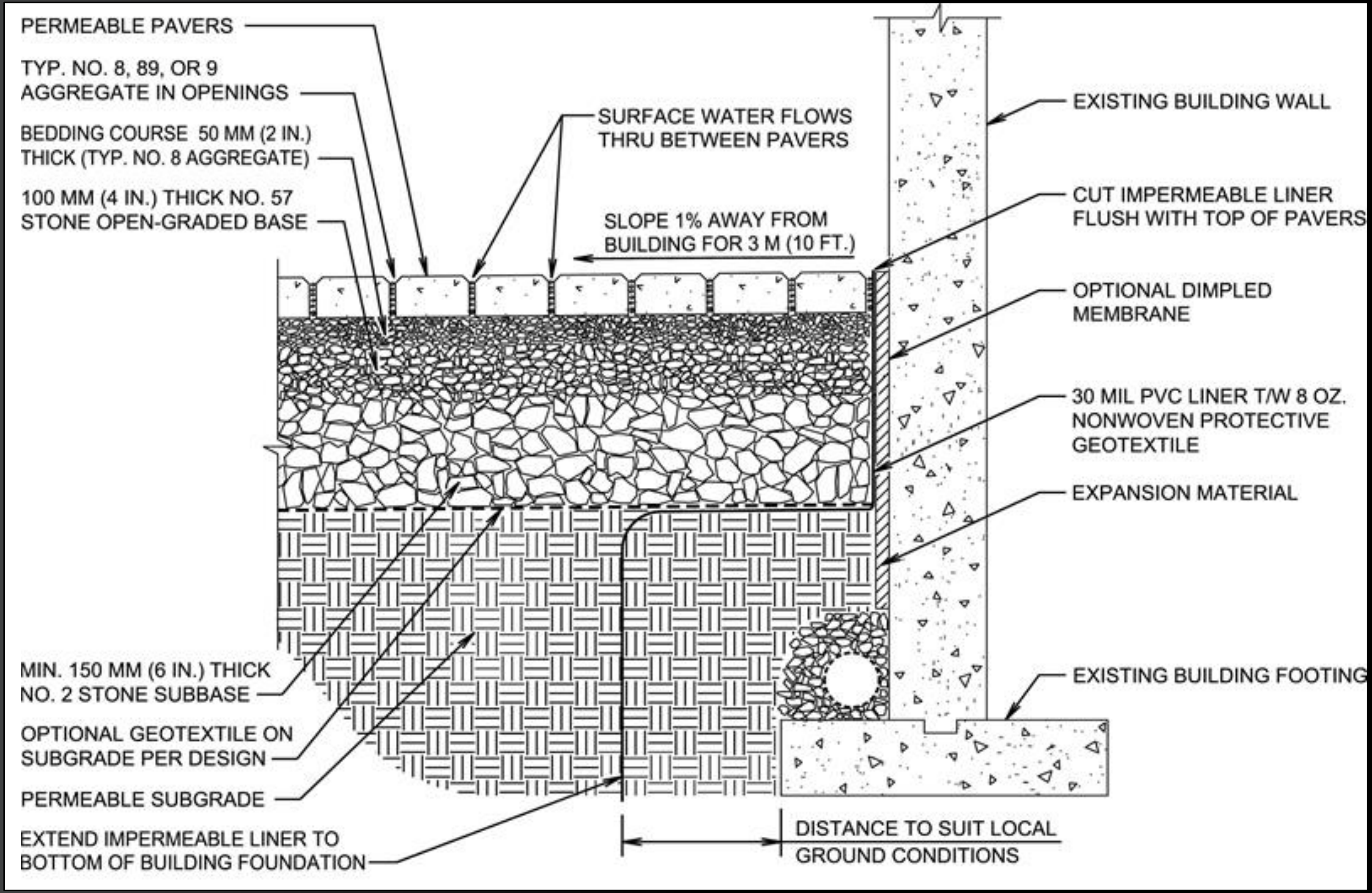
- Roof water discharged onto, or into, the pavement.



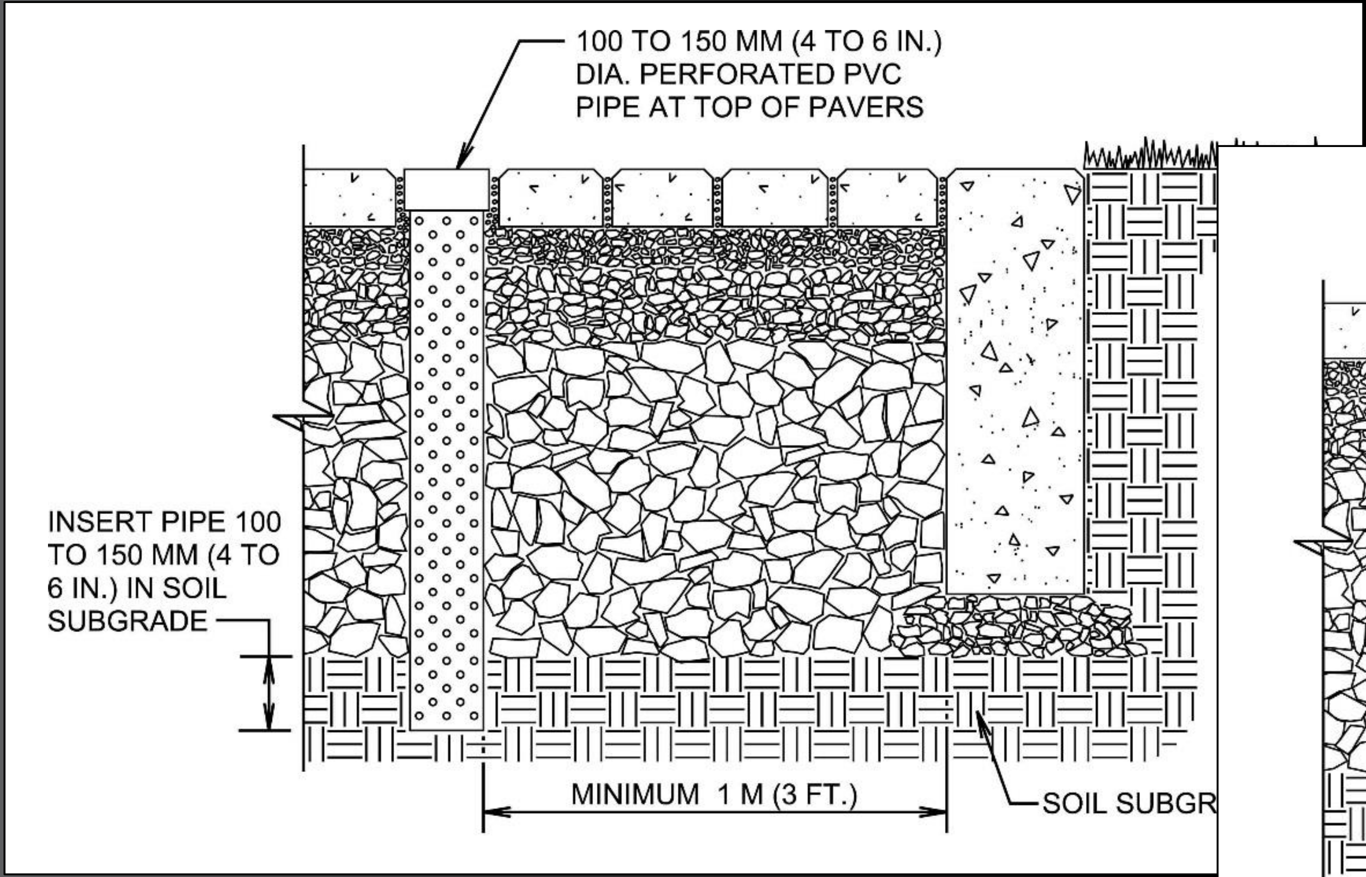
Additional Design Considerations

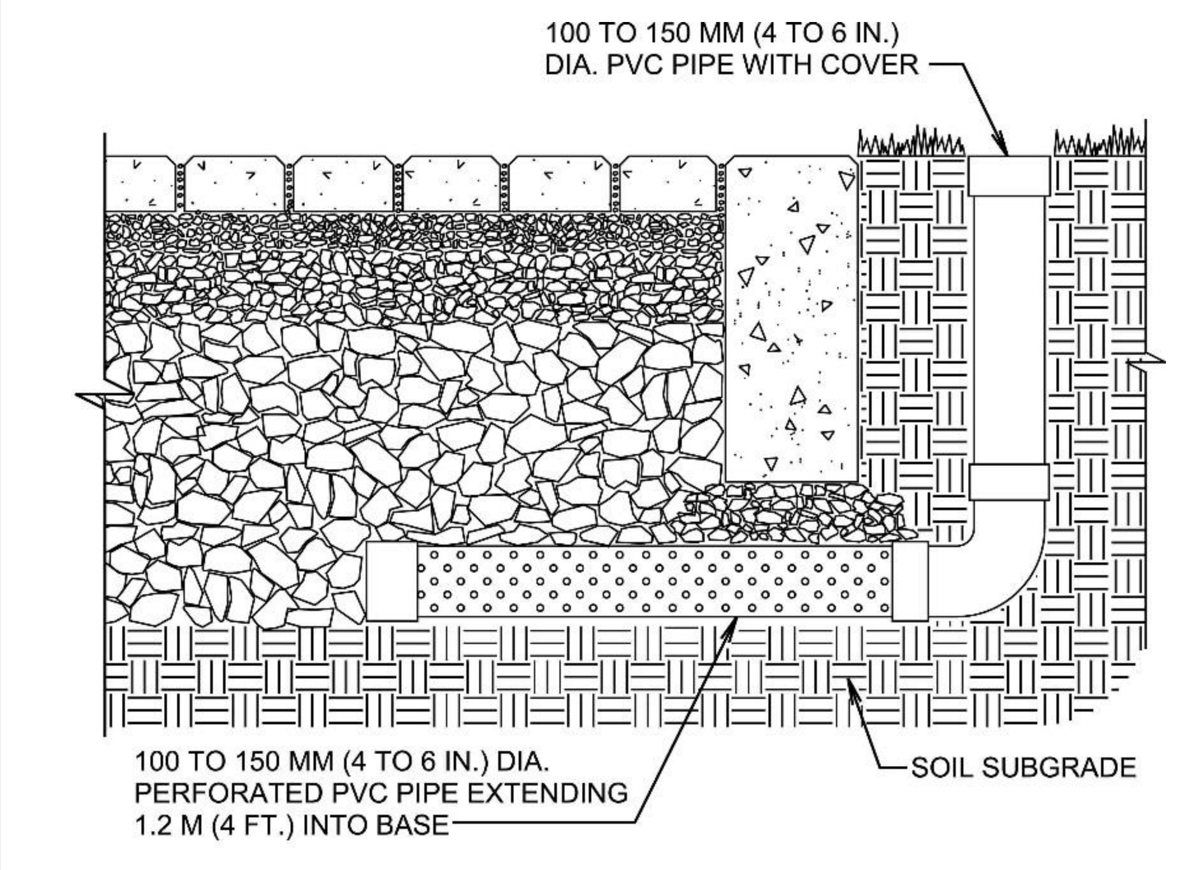
Additional Design Considerations

- Impermeable liners used adjacent to buildings



Hydrologic Design - Monitoring





Additional Design Considerations

- Pavement transitions
- Utility Trenches
- Pre-construction meetings (S 5.2)
- Erosion and Sediment Control (S 5.3)
- Construction Inspection Checklist (S 5.4)

- Pavement Maintenance (S 6.1)
- Routine Maintenance (S 6.1.3
- Remedial Maintenance (S 6.1.4)

Pavement Maintenance

- Inspection tasks may include the following:
  - Review maintenance and operations records and incidences to determine if there have been any issues
  - Document general site features, take photographs, etc.
  - Note any surface contamination or clogging
  - Note obvious sources of surface contaminants
  - Identify the extent and severity of any damage or deficiencies (e.g. settlement, ponding, cracked pavers, etc.)
  - Identify any changes in adjacent land use that may impact contributing area runoff

Pavement Maintenance

- Inspection tasks may include the following:
  - Inspect vegetation around PICP for cover and soil stability
  - Ensure edge restraints are performing
  - Check underdrains to ensure that they are still draining water from the pavement structure
  - Check observation wells for water storage
  - If a significant reduction in permeability from the last inspection, complete infiltration testing

Permeability Testing – ASTM C1781-13

Permeability Improvements

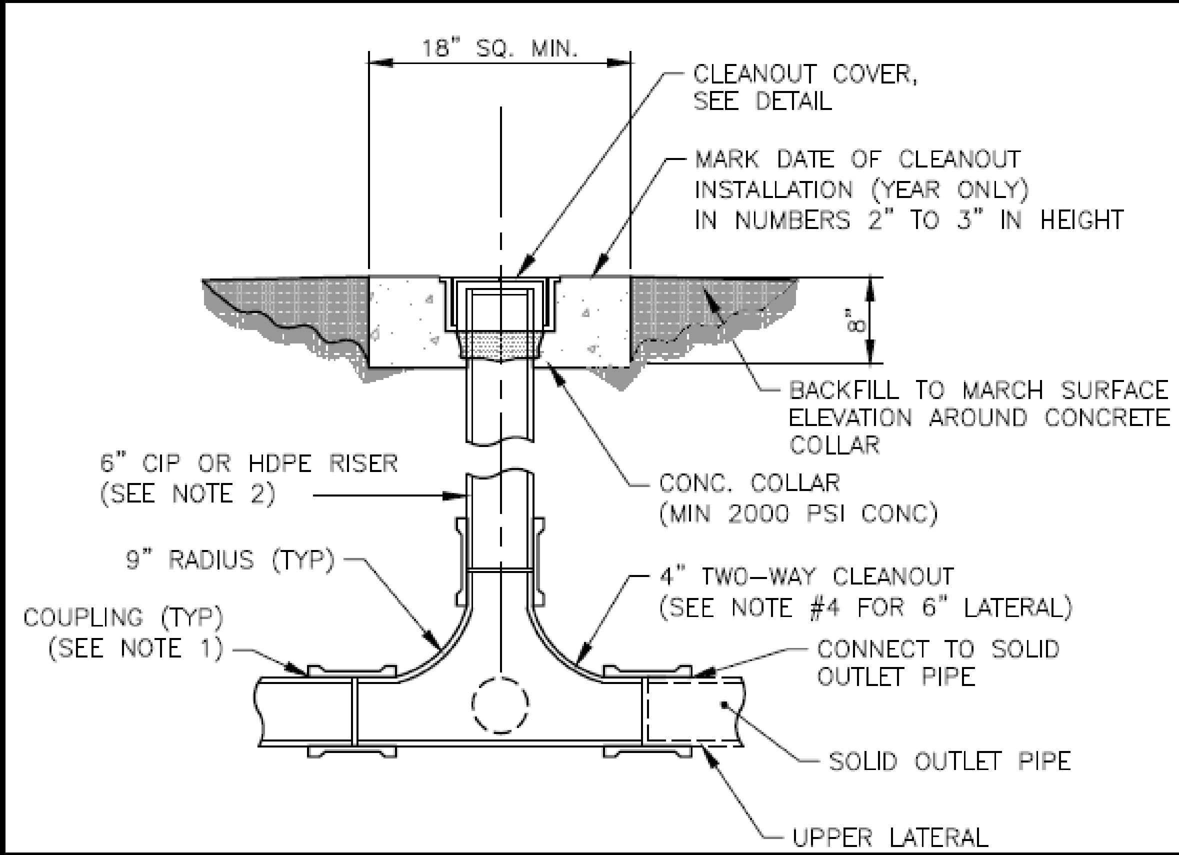
Permeable Paver Joint Aggregate

Top up of joint aggregate within 6 months of construction

Localized Settlement Repair

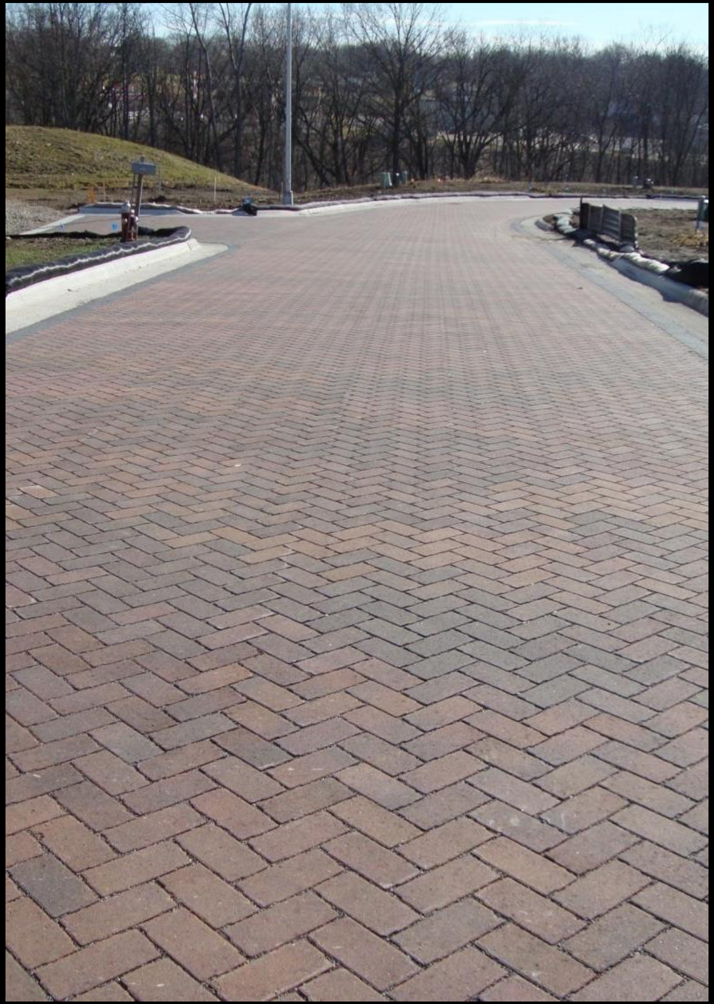
- Remove pavers from affected area
- Level bedding layer, add new material as necessary
- Replace pavers and jointing material

Underdrain Cleanout



Status of ASCE Standard Guideline

- Public comment period closed April 1, 2018
- Committee will review and address all comments and make modifications if necessary
- ASCE editors will complete final review and then public the standard
- Intent to publish standard in 2018



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