SCVURPPP C.3 Workshop – June 9, 2016

Introduction to Pervious Pavement Systems

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Outline of Presentation

- Pervious Pavement for MRP Compliance
- Types of Pervious Pavement and Applications
- Is the Site Appropriate for Pervious Pavement?
- Design Considerations (Hydrologic and Structural)
- Underdrains, Observation Wells and Check Dams
- Resources

Pervious Pavement for MRP Compliance

- Pervious pavement is defined as:
  - Pavement that stores and infiltrates rainfall at a rate equal to surrounding unpaved, landscaped areas; or
  - Pavement that stores and infiltrates the rainfall runoff volume described in Provision C.3.d.
- It’s an effective LID “site design” measure that:
  - Reduces impervious surface
  - Reduces runoff peak flow and volume
  - Provides treatment via infiltration to native soil
  - May help recharge local groundwater sources

Pervious Pavement for MRP Compliance, cont.

- MRP 2 stresses importance of proper pervious pavement design and maintenance
  - Permittees are required to, on a regional or countywide basis, develop and adopt design specifications for pervious pavement systems
    - **See SCVURPPP 2016 C.3 Handbook Updates**
  - Permittees are also required to conduct installation and O&M verification inspections of pervious pavement, and track as a <u>treatment</u> measure

Pavement Types

1. Permeable Interlocking Concrete Pavers (PICP)
2. Permeable Pavers (water flows through paver)
3. Pervious Concrete (poured in place)
4. Porous Asphalt (poured in place)
5. Grid pavement systems

Generic Cross Section

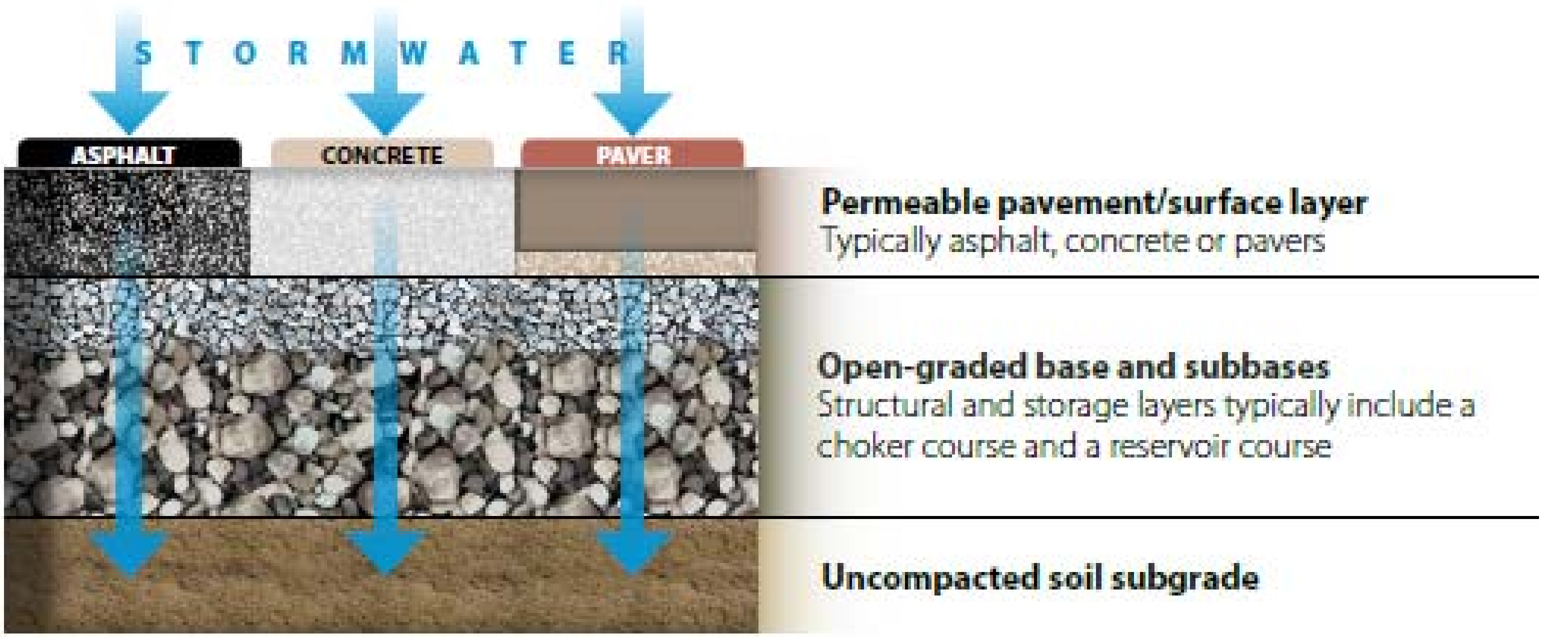
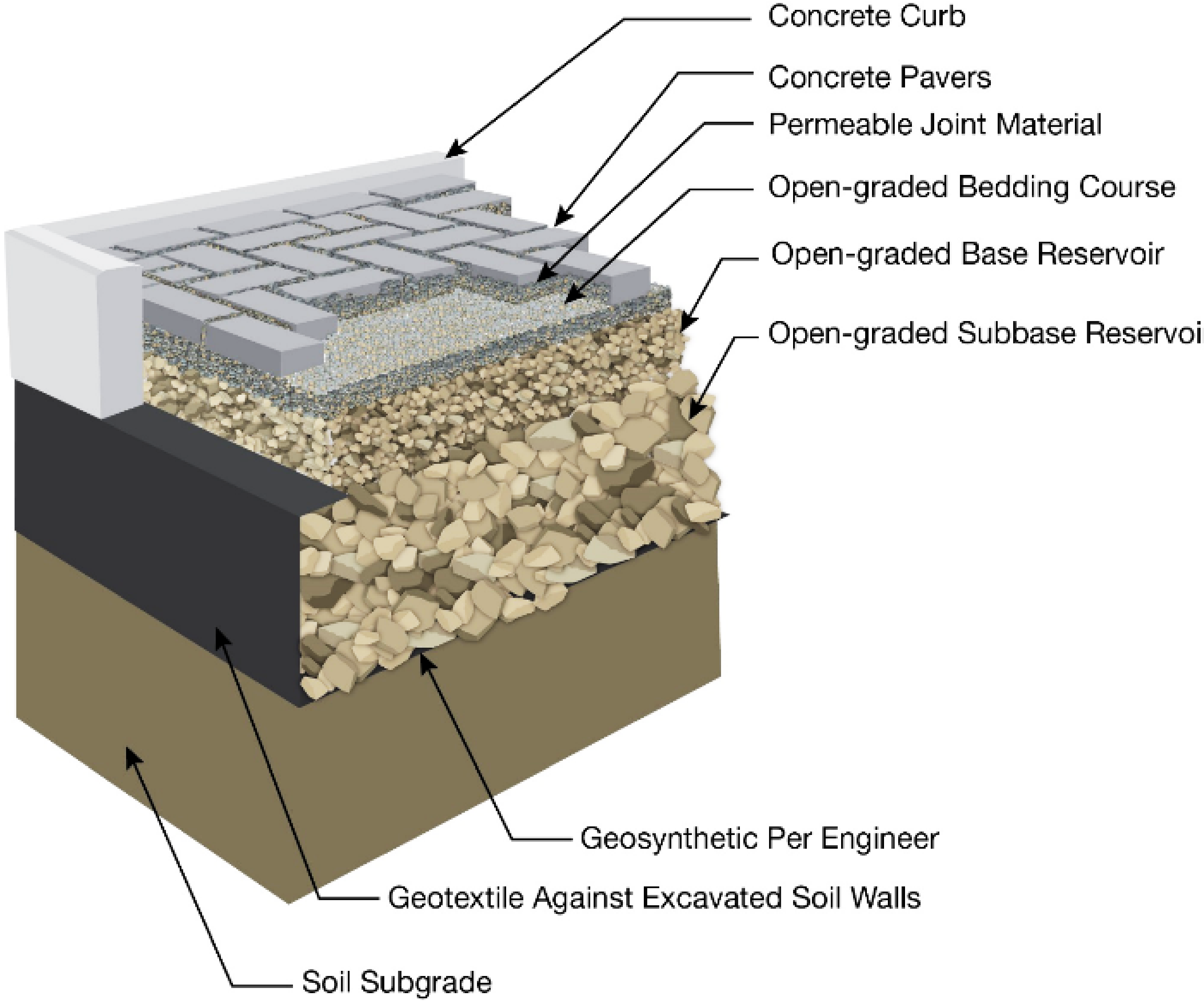


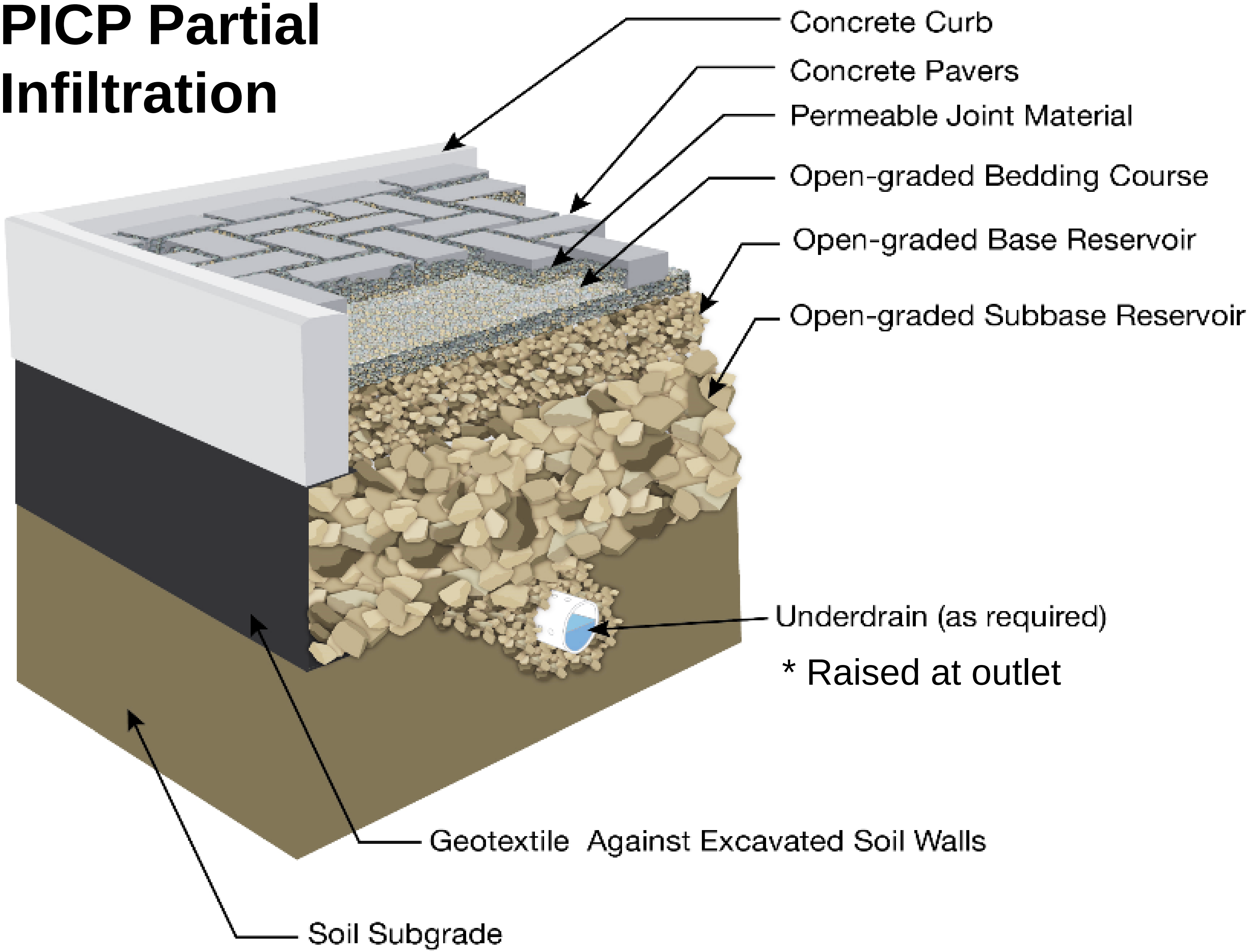
Figure 1-3
Generic permeable pavement cross-section
Source: © VHB

Source: ASCE Permeable Pavements, 2015

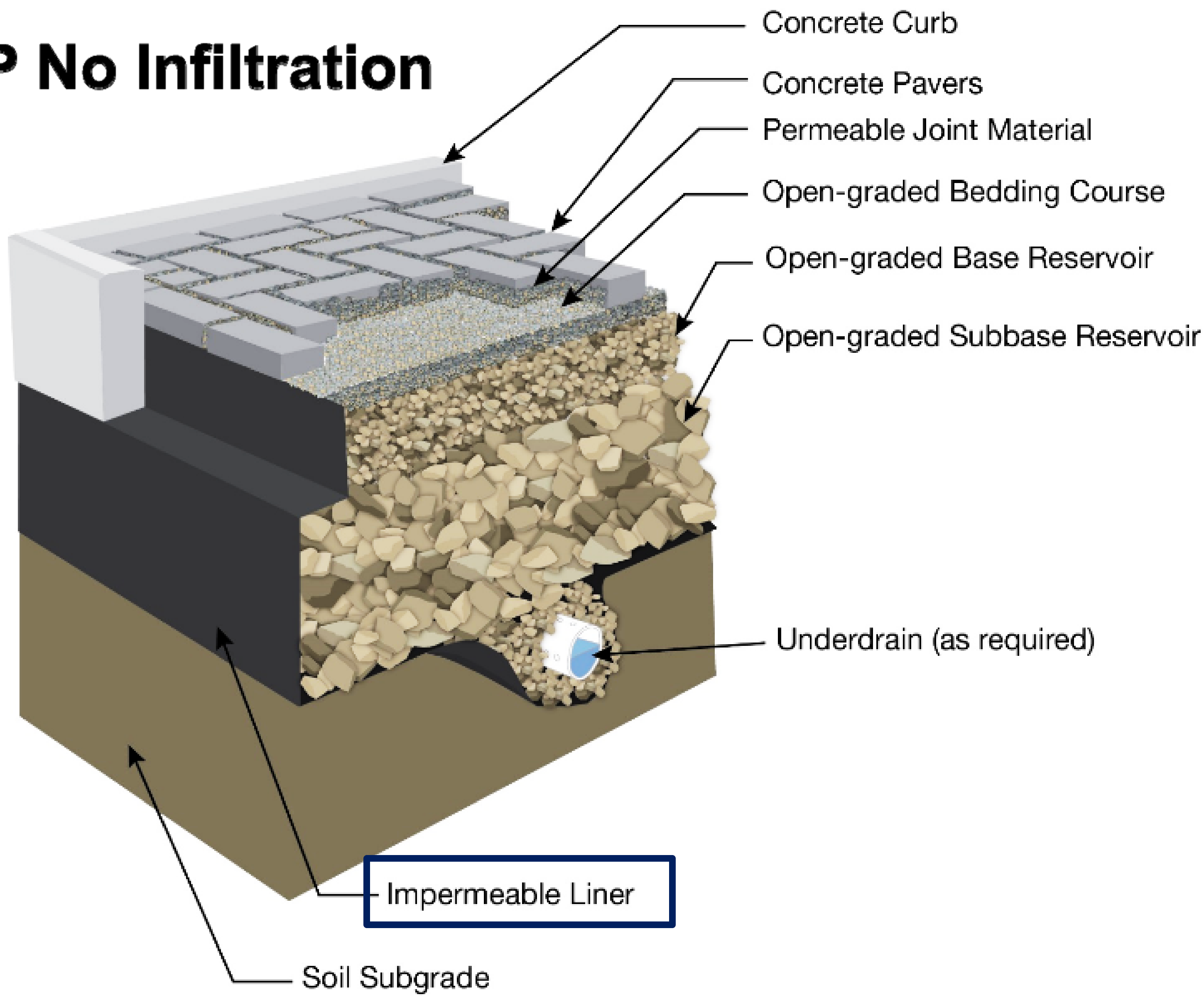
PICP Full Infiltration



PICP Partial Infiltration



PICP No Infiltration



Pervious Pavement Parking Lots

Pervious Pavement in Streets

Allston Way,
Berkeley

Southgate Neighborhood,
Palo Alto

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Pervious Pavement in Parks:
Commodore Park, San Jose

Pervious pavers

Pervious concrete

Permeable rubber

Porous asphalt

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Pervious Pavement Over Infiltration Trench

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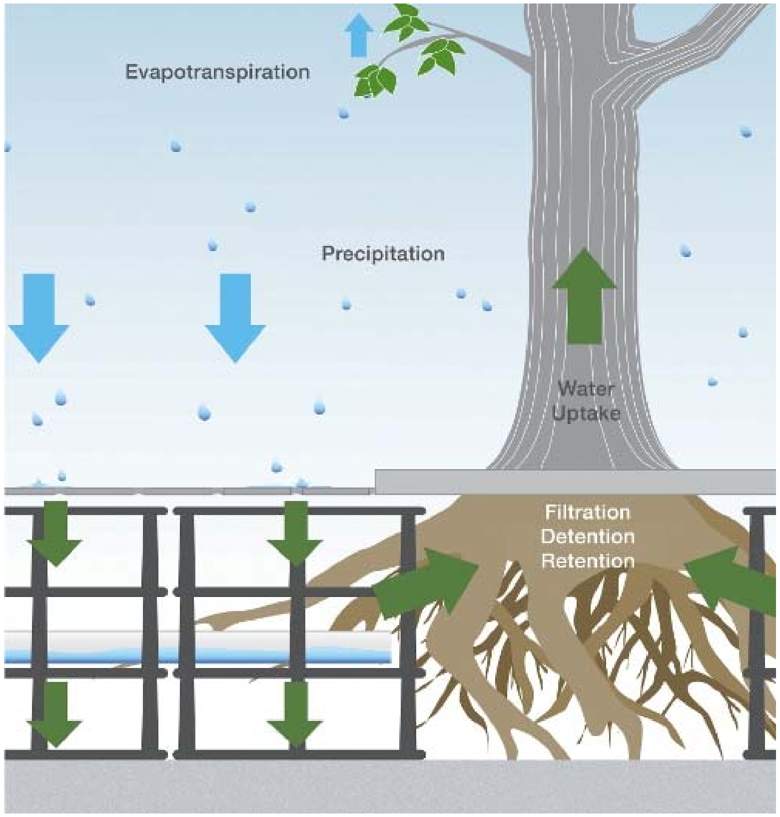
Pervious Pavement Over Tree Trench



Key Considerations for Site Applicability

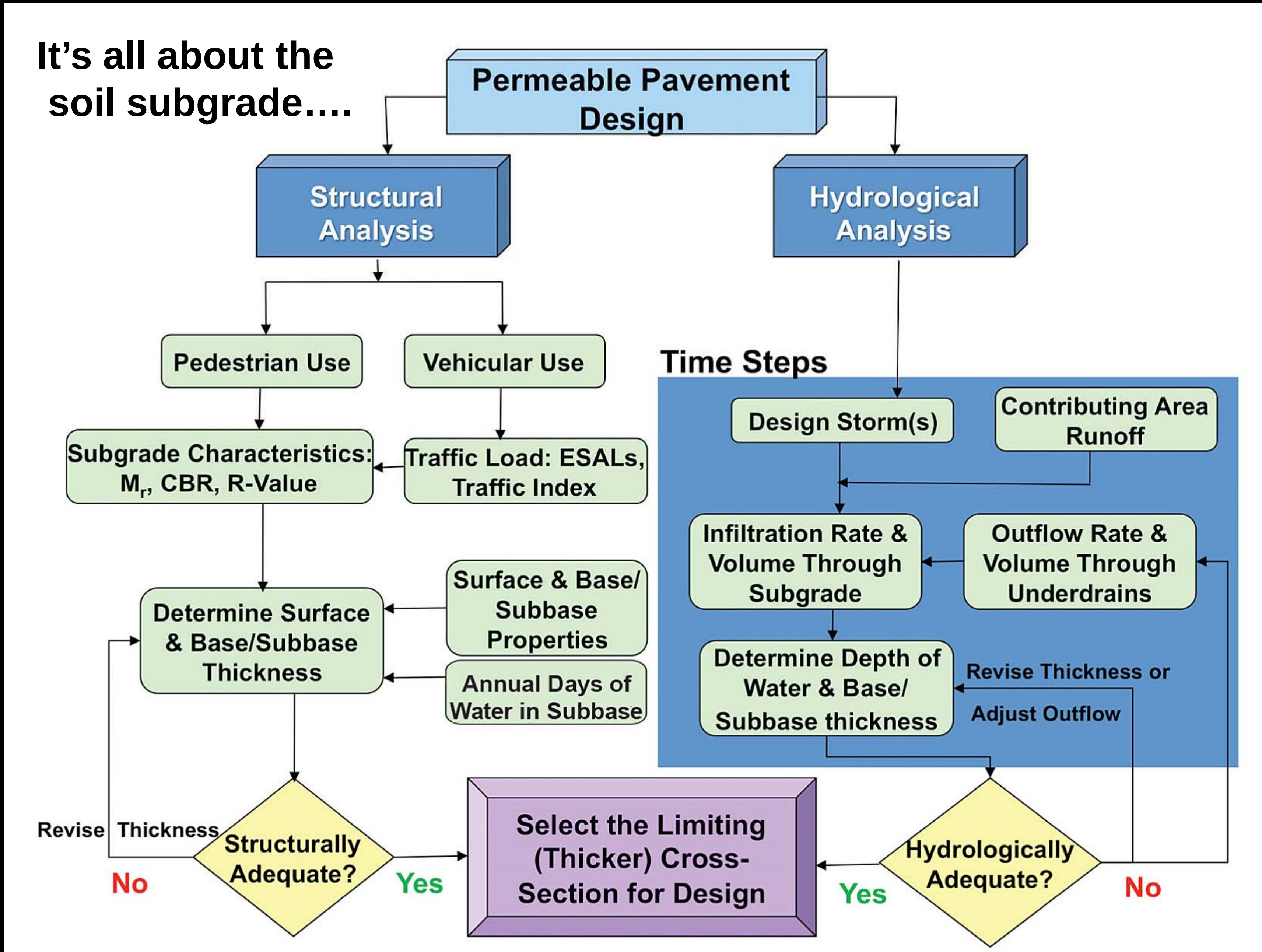
Consideration	Possible Remedies
Significant longitudinal grades	Subgrades > 3% require check dams
Geotechnical risks	Design for subgrade condition; may need underdrains and/or impermeable liners
Groundwater contamination risk	Consider potential pollutant sources; maintain ≥ 5 ft. separation between bottom of subbase and high groundwater level
Presence of utilities	May require liner wrapping, vertical liners against subgrade at penetrations, or encasing in flowable concrete fill
Traffic volume/turning movements/heavy loads	Best for low volume, speeds < 35 mph. Bus and truck routes may require thicker or stabilized permeable bases

Key Considerations for Site Applicabilty

Consideration	Possible Remedies
Target design volumes and runoff rates	**Run-on from adjacent impervious surfaces limited by reservoir storage depth and soil infiltration rates**
Low soil infiltration rates	Ok for infiltrating small volumes; may **require underdrains**
Complexity of geometric conditions	**Geometric constraints may arise from horizontal or vertical grades, bridge structures, curbs, retaining walls, etc.**
Peak flow control	**May be less costly than alternatives that provide drainage and peak flow control**
Maintenance protocols	**Maintenance such as vacuum sweeping required at regular intervals**
Potential for sediment loading	**Evaluate construction/adjacent land use and sediment transport potential – deploy mitigation measures**

Successful Project

Hydrologic & Structural Design Overview

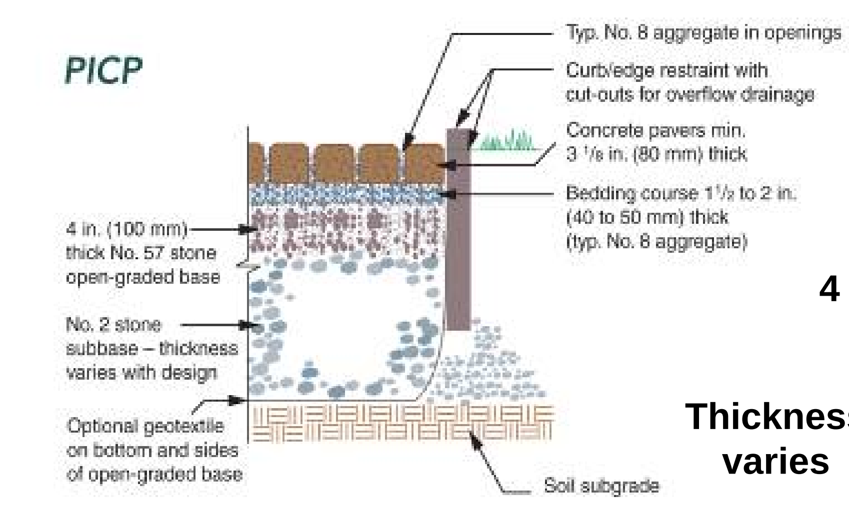


Hydrologic Design of Pervious Pavement Systems

- Can only be considered a “pervious area” if designed to store & infiltrate the water quality design (WQD) volume
- May be self-treating area (treats only rain falling on itself) or self-retaining area (accepts runoff from adjacent impervious areas)
- If self-retaining area, recommend maximum 2:1 ratio of adjacent impervious area to pervious pavement area
- Determine unit basin storage (UBS) volumes from curves in C.3 Stormwater Handbook, Appendix B
    - Assume pervious pavement and/or adjacent areas are 100% impervious

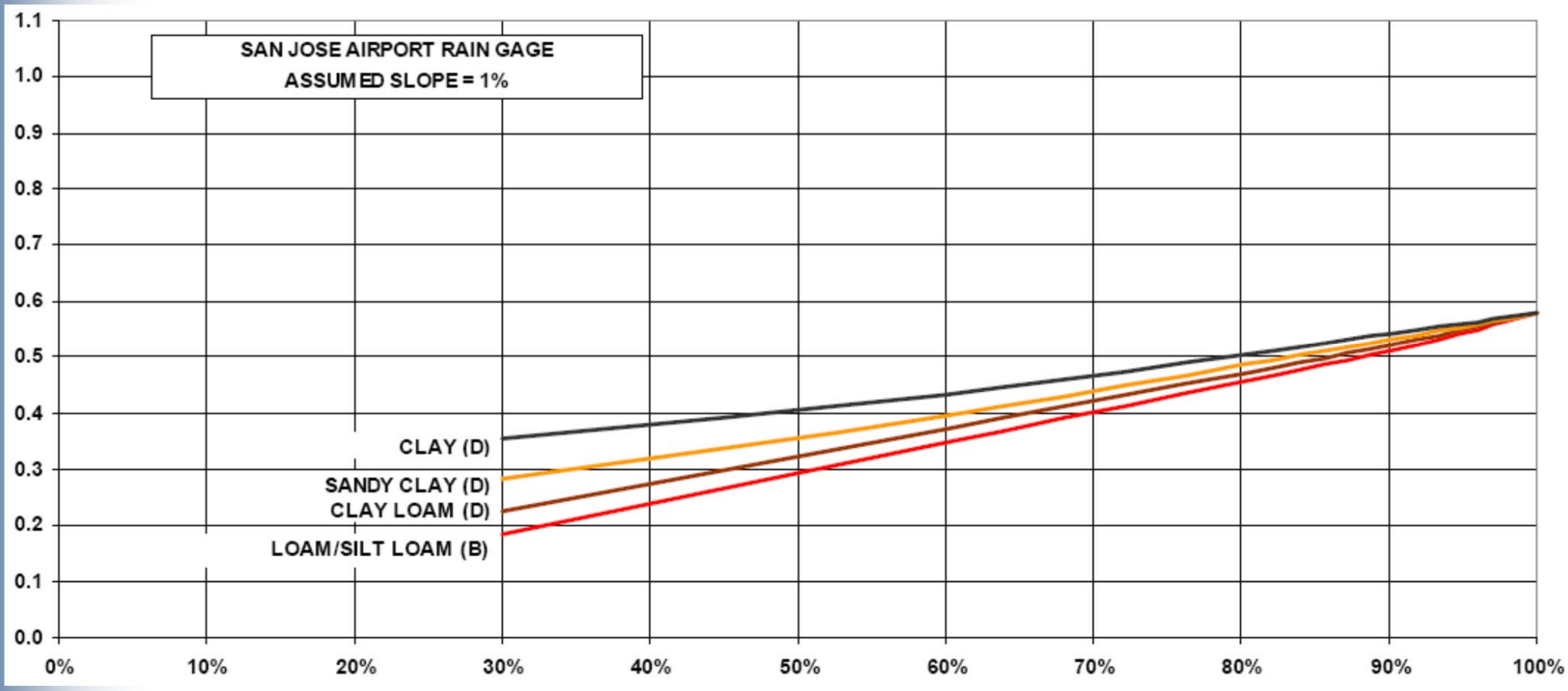
Pervious Pavement Typical Section

- Base and subbase layers available for water storage
- Both typically have 40% void space



Unit Basin Storage Volume for 80% Capture (inches)

San Jose Rain Gage, 1% Slope



Percent Imperviousness

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Approach to Hydrologic Sizing

- Self-Treating Area
  - Check the depth of the WQD volume in the base/subbase:
    UBS volume (in.) ÷ 0.40 = Depth (in.)

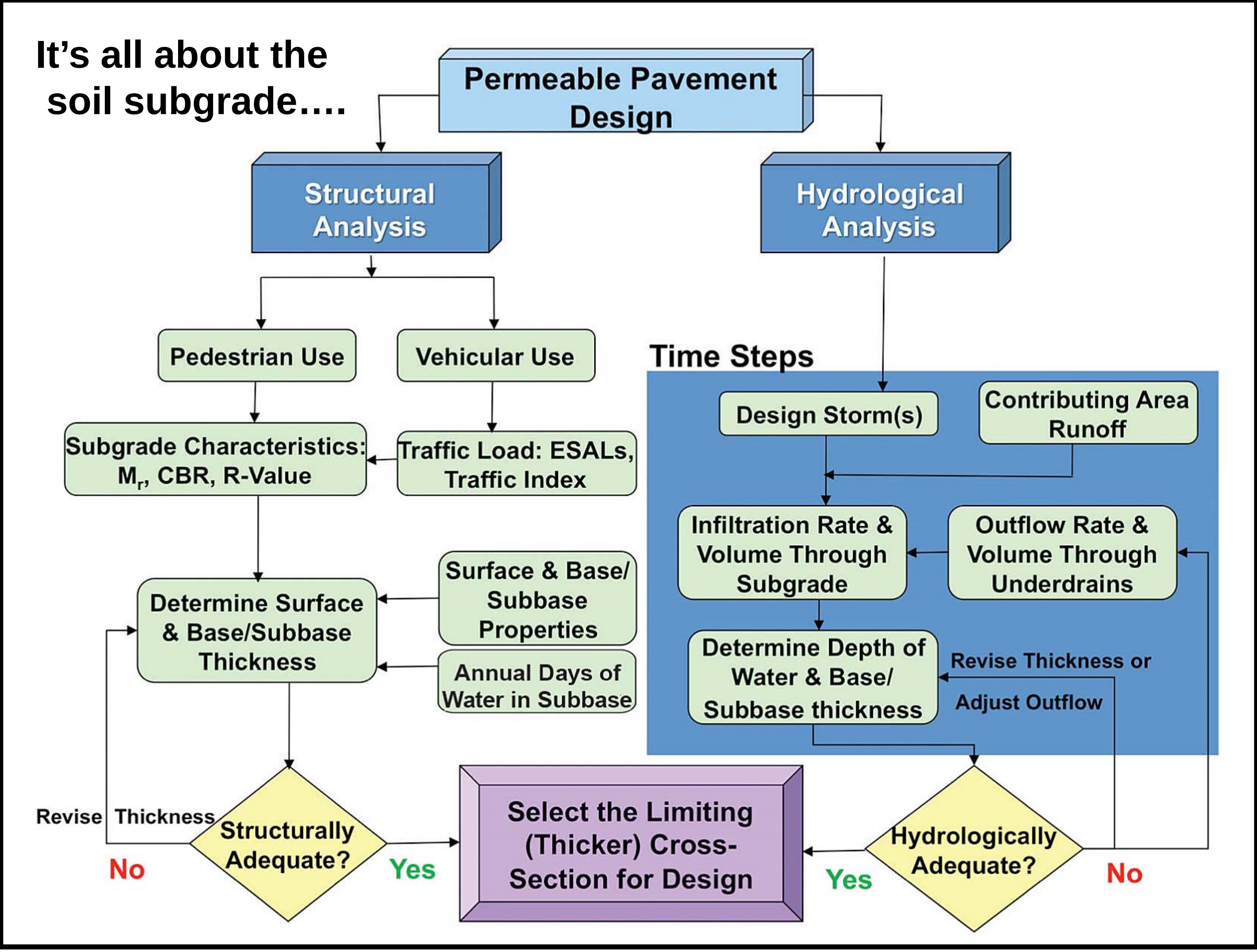
    Example: UBS volume = 1.0 in., depth = 2.5 in.
  - Check the time required for the stored water to drain:
    UBS Vol. (in.) ÷ Infil. rate (in/hr) = Drain time (hrs)
    (recommend < 48 hrs)

Approach to Hydrologic Sizing

- Self-Retaining Area
  - Add the WQD volume for adjacent areas to the WQD volume for the pervious paving area itself (should not exceed 2:1 ratio of contributing area to pervious area)
  - Divide total WQD volume by pervious paving area and convert to inches
  - Check depth of total WQD volume in base/subbase: WQD volume (in.) ÷ 0.40 = Depth (in.)

    Example: Total WQD volume = 3.0 in., depth = 7.5 in.
  - Check the time required for stored water to drain: UBS Vol. (in.) ÷ Infiltration rate (in/hr) = Drain time (hrs)

Hydrologic & Structural Design Overview

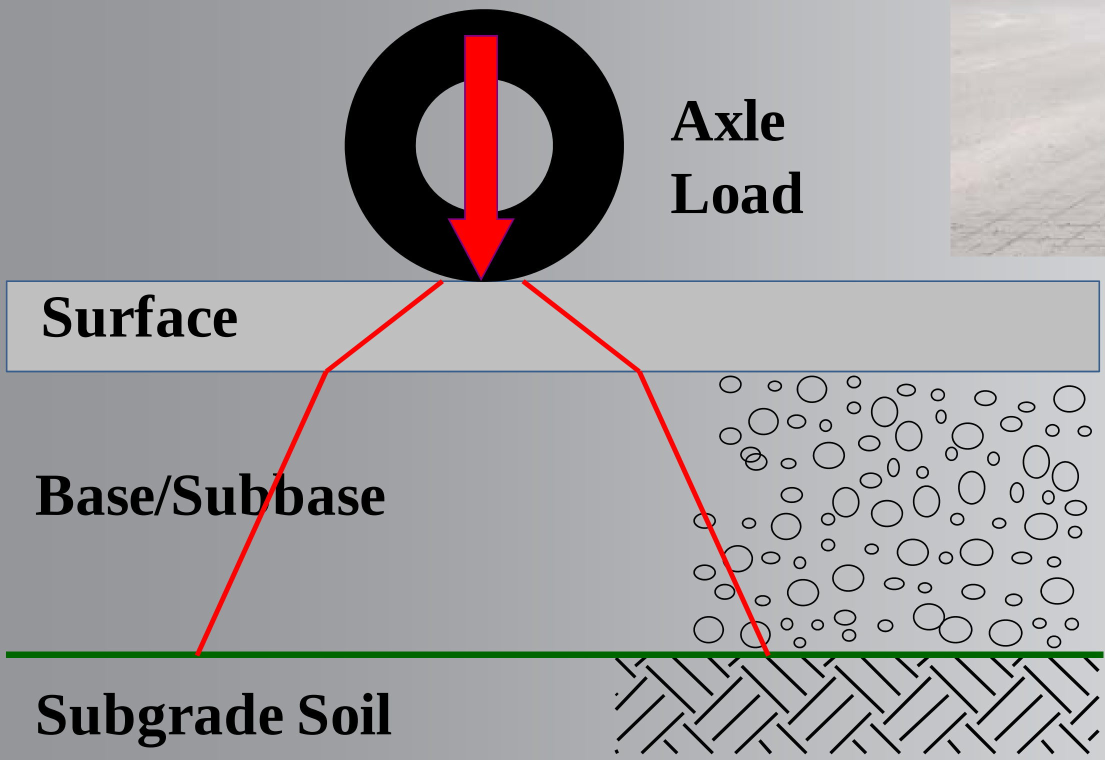


Approach to Structural Analysis

- Determine whether pedestrian or vehicle use
- If vehicle use:
  - Get data on types and frequency of heavy vehicles
  - Determine design traffic load in "ESALs" or Traffic Index (Caltrans)
- Determine type of soil in subgrade and amount of support it can provide <u>when saturated</u>
- Determine surface, base, and subbase thicknesses

Traffic Considerations

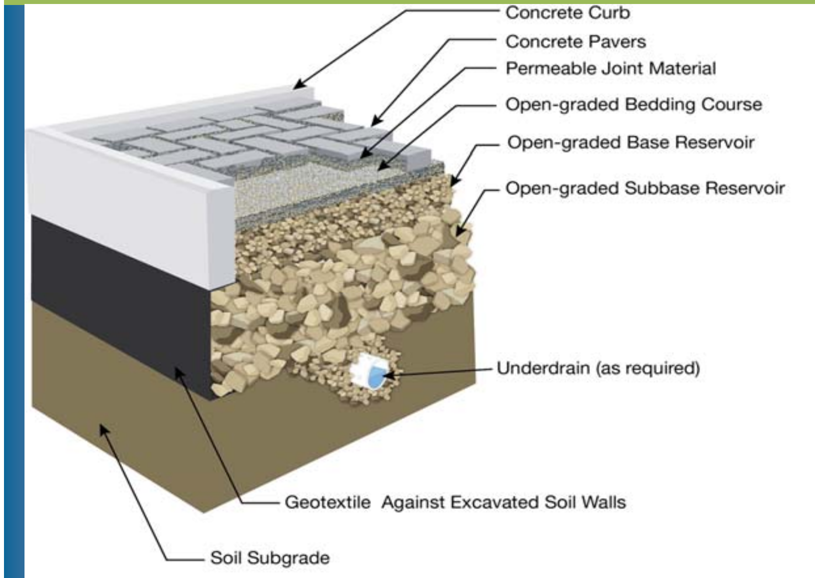
ESALs = Equivalent Single Axle Loads

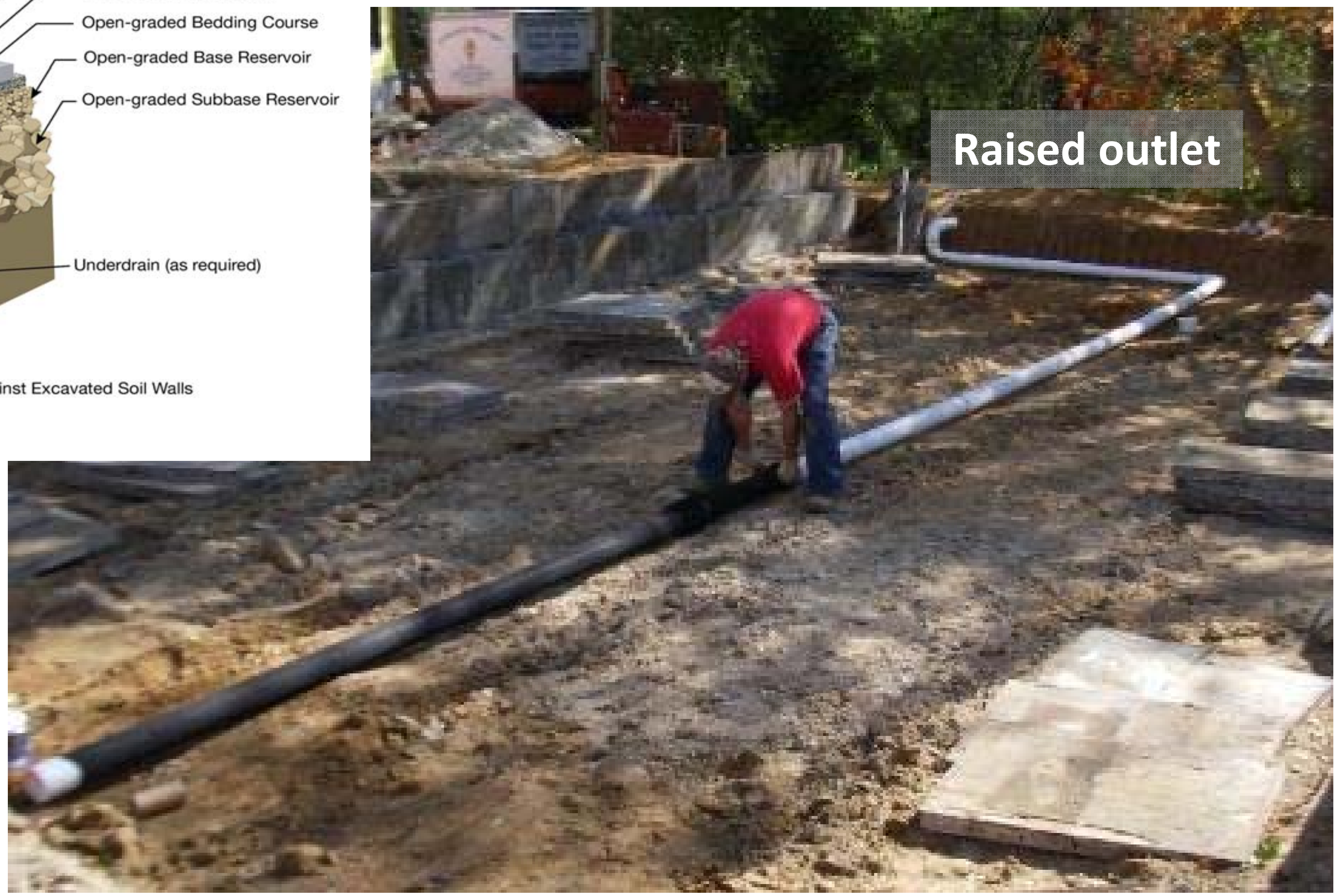


UC Davis/Caltrans PICP Subbase Thickness Table

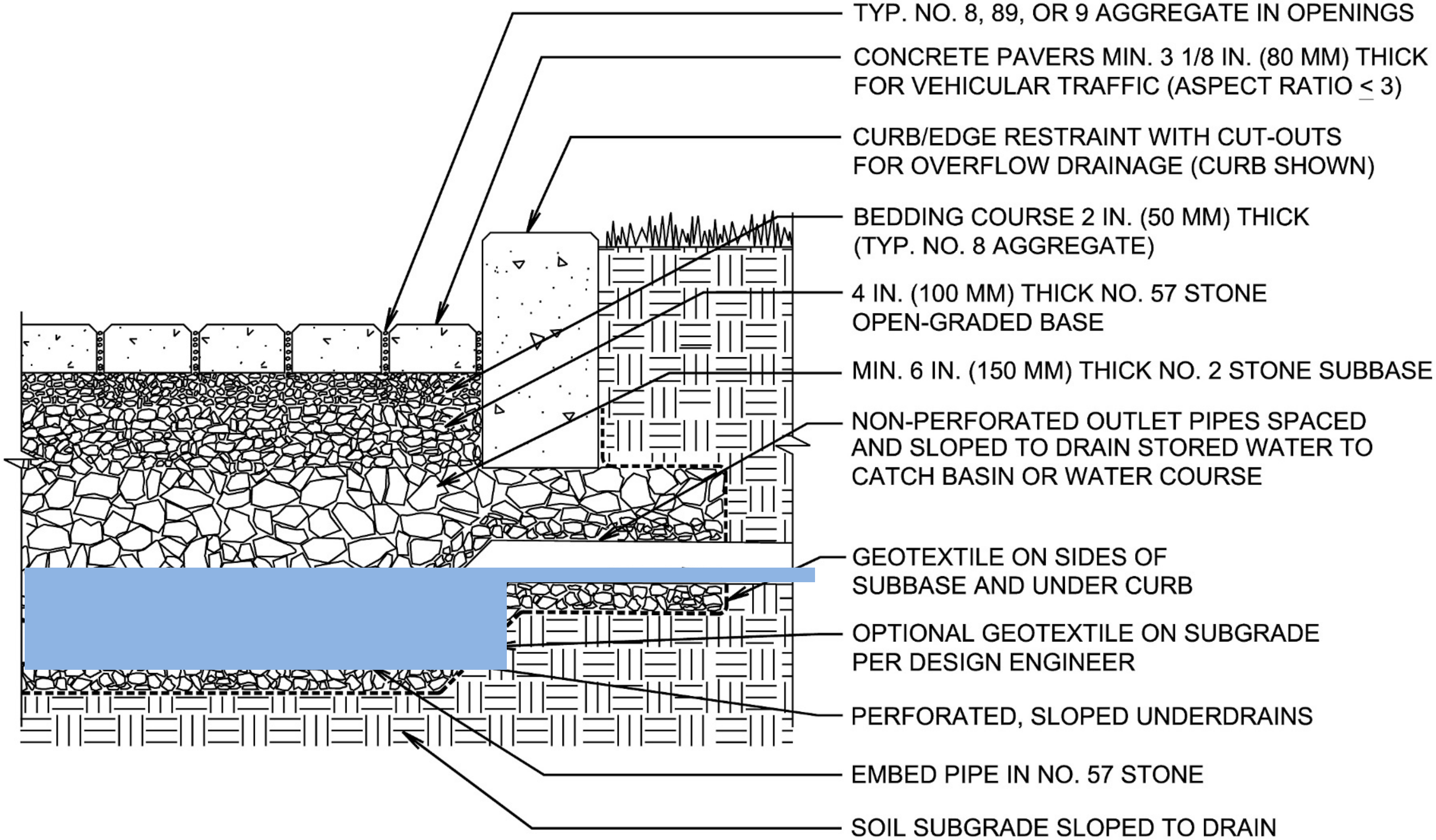
Number of Days/year w/ Water in Subbase	10 or less				11 to 30			
Resilient Modulus of Subgrade, MPa R-value	24 4	36 7	48 10	60 13	24 4	36 7	48 10	60 13
Lifetime ESALs (Traffic Index)	Min. Subbase Thickness, inches for ASTM No. 2, 3 or 4 stone or Caltrans Class 4 AB Allowable Rut Depth = 1 in.							
50,000 (6.3)	6.0							
100,000 (6.8)	8.5	6.0	6.0	6.0	10.5	6.0	6.0	6.0
200,000 (7.4)	12.5	8.5	6.0	6.0	14.5	10.0	6.5	6.0
300,000 (7.8)	15.0	10.5	7.0	6.0	17.0	12.5	8.5	6.0
400,000 (8.1)	17.0	12.0	8.5	6.0	19.0	14.0	10.0	7.0
500,000 (8.3)	18.0	13.5	9.5	6.5	20.0	15.0	11.0	8.0
600,000 (8.5)	19.0	14.5	10.5	7.0	21.0	16.0	12.0	9.0
700,000 (8.6)	20.0	15.0	11.0	8.0	22.0	17.0	13.0	10.0
800,000 (8.8)	20.5	16.0	12.0	8.5	22.5	17.5	13.5	10.5
900,000 (8.9)	21.0	16.5	12.5	9.0	23.5	18.0	14.0	11.0
1,000,000 (9.0)	22.0	17.0	13.0	9.5	24.0	19.0	14.5	11.5

Underdrains: New Approach

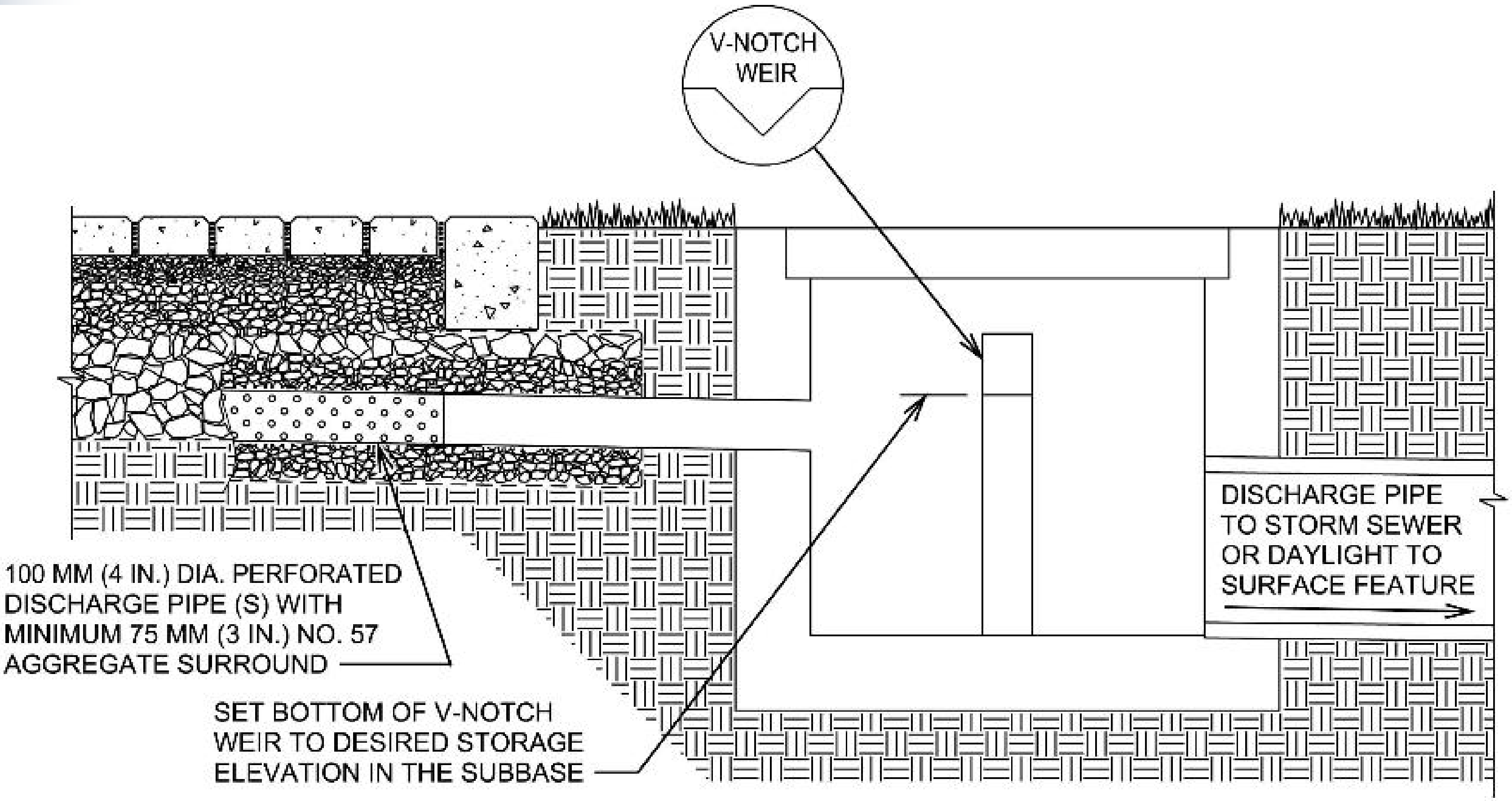




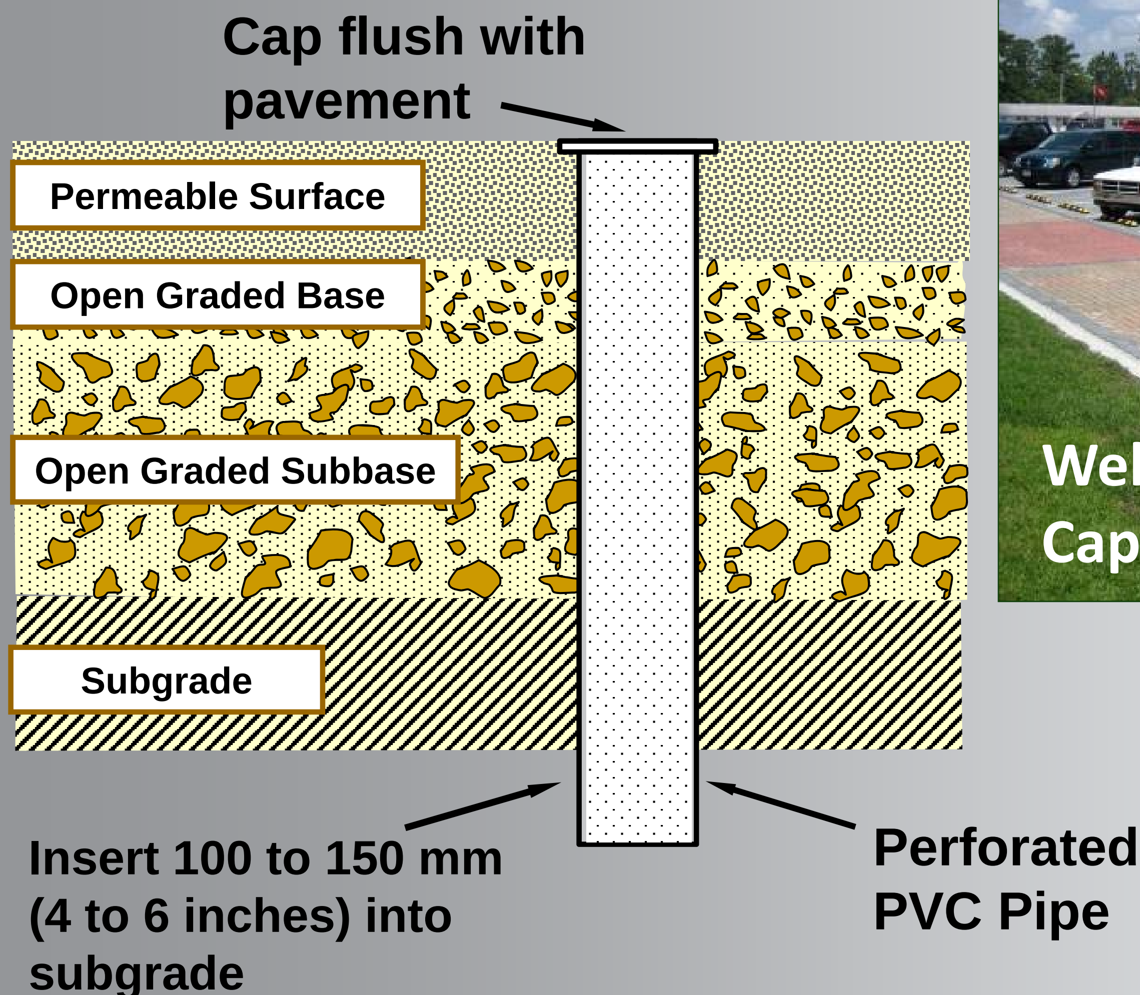
Underdrain: Upturned Elbow



Underdrain: Connection to Catch Basin/Utility Structure



Observation Well

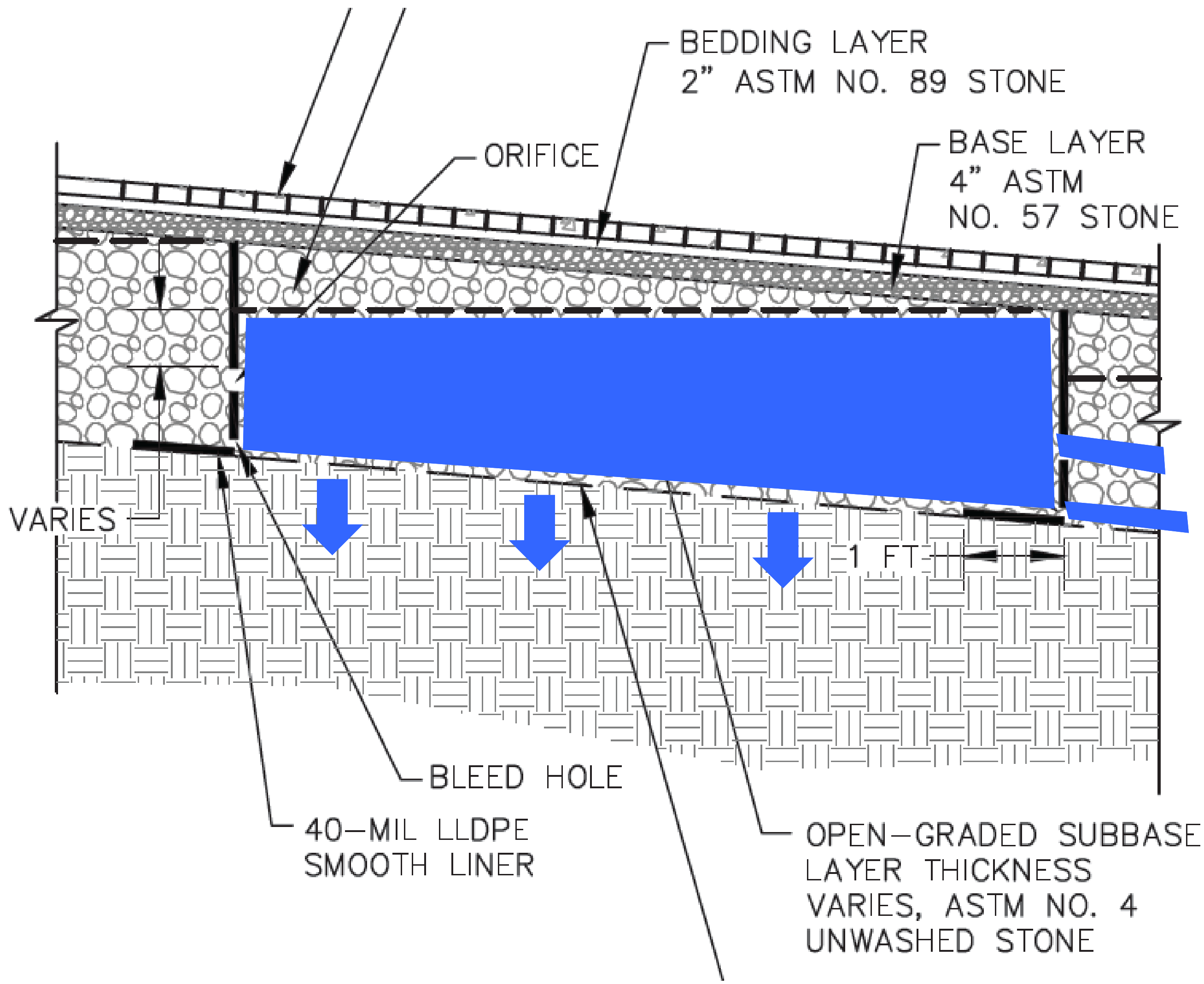


Check Dams for Sloped Subgrades

- **Generally used on 3% or greater subgrade slopes**
- **Old school: Concrete, earthen berms, aggregate berms**
  ***New* school: Geomembrane (impermeable liner) only**

Aggregate berm covered with an impermeable liner

Impermeable Liner Check Dams



Source: Todd Hill, PE. Atlanta Dept. of Watershed Management

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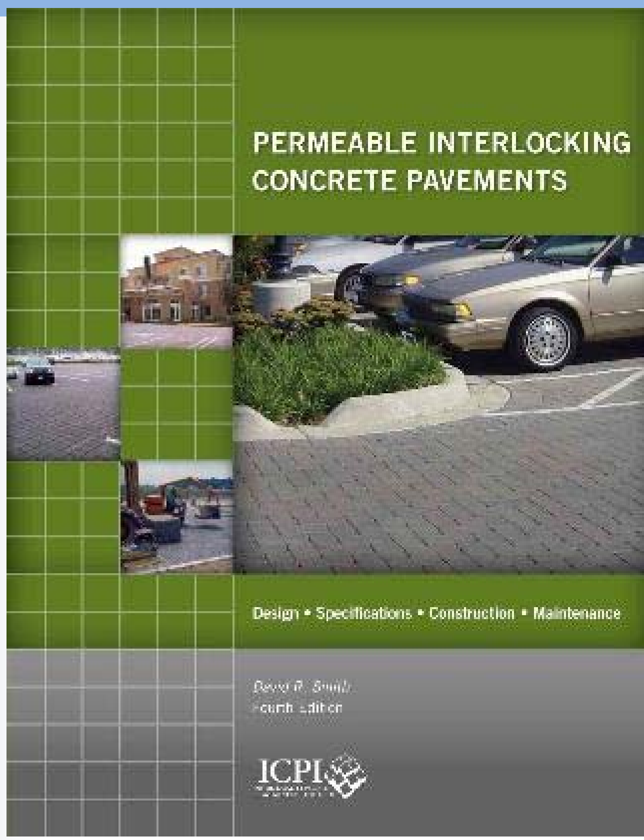
ICPI & ASCE Resources

Permeable Interlocking Concrete Pavements

Design, Specifications, Construction & Maintenance

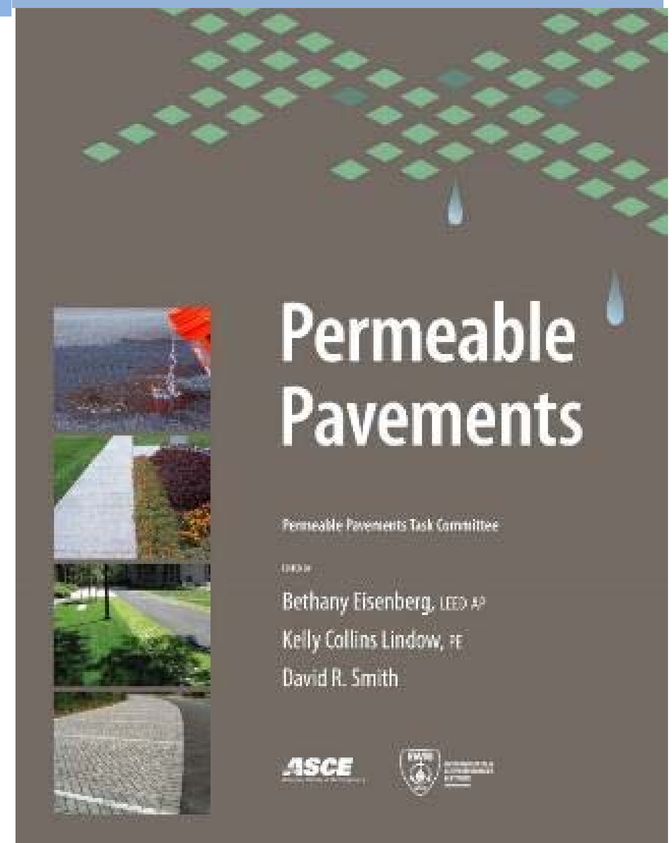
(100 pages)



Permeable Pavements

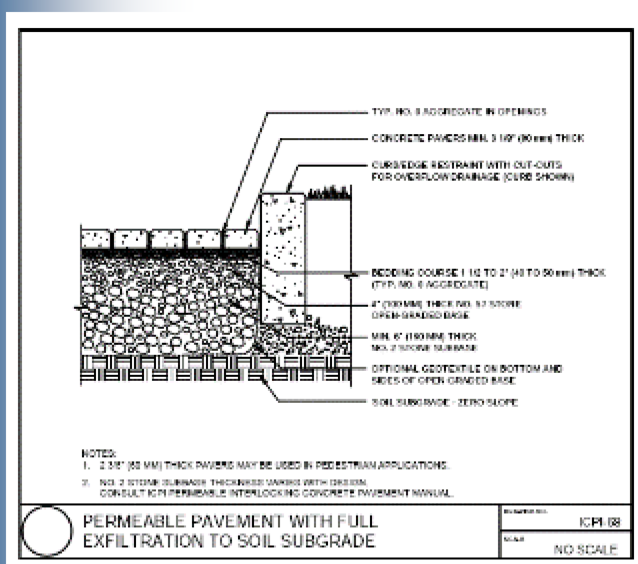
ASCE e-book

(250 pages)



ICPI Resources

- Interlock Design Magazine
- Tech Specs
- Specs & Details
- www.icpi.org



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