



Reviewing Pervious Pavement Details and Volume Calculations

Renee Crawford, P.E.
SCVURPPP Staff

April 8, 2026

Presentation Overview

- Categorizing Pervious Pavement
- Types of Pervious Pavements
- Pervious Pavement Details
- Pervious Pavement Calculations

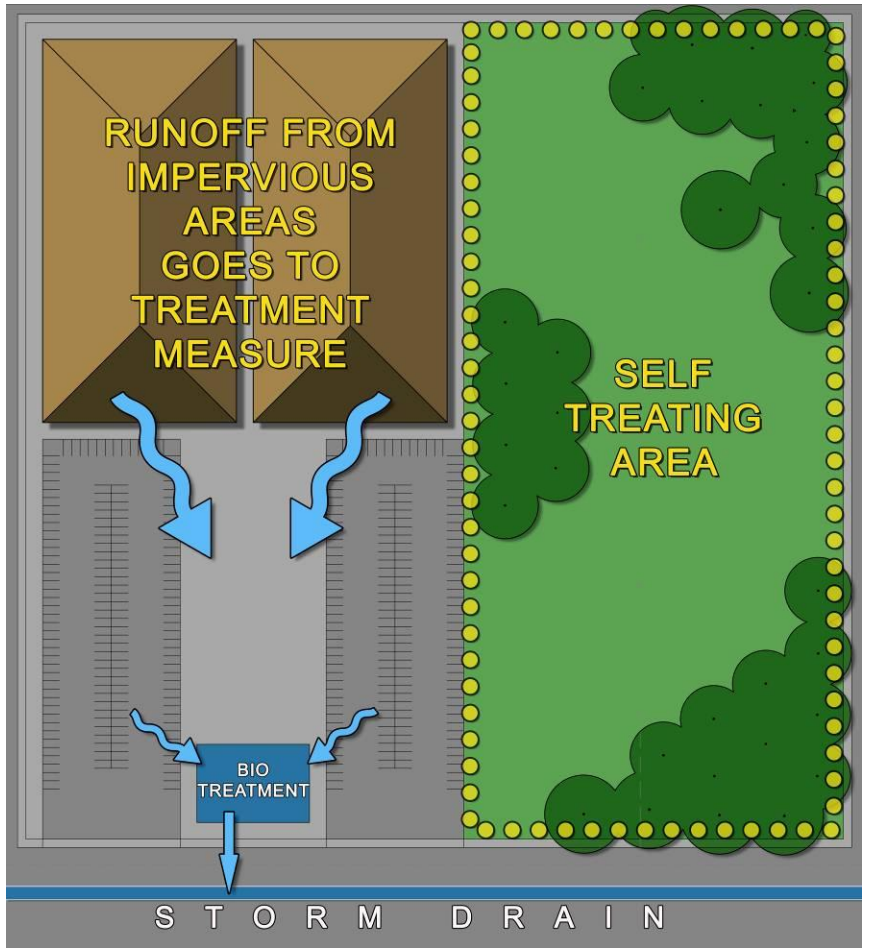
Self-Treating Area

- Pervious area that treats rain falling <u>on itself only</u>, via ponding, infiltration and/or evapotranspiration
  - Landscaping
  - Green roof
  - ***Pervious pavement***

- Landscaped areas must retain approximately 1” of rain
- Pervious pavement must be designed to store and infiltrate the C.3.d amount of runoff in order to qualify as self-treating areas

Self-Treating Areas Reduce the Area Requiring Treatment

- Runoff from **pervious** portions of the project (after infiltrating first 1”) can flow directly to the storm drain (if no mixing with runoff from impervious areas)
- Result: Runoff from **impervious** areas flows to smaller treatment measure

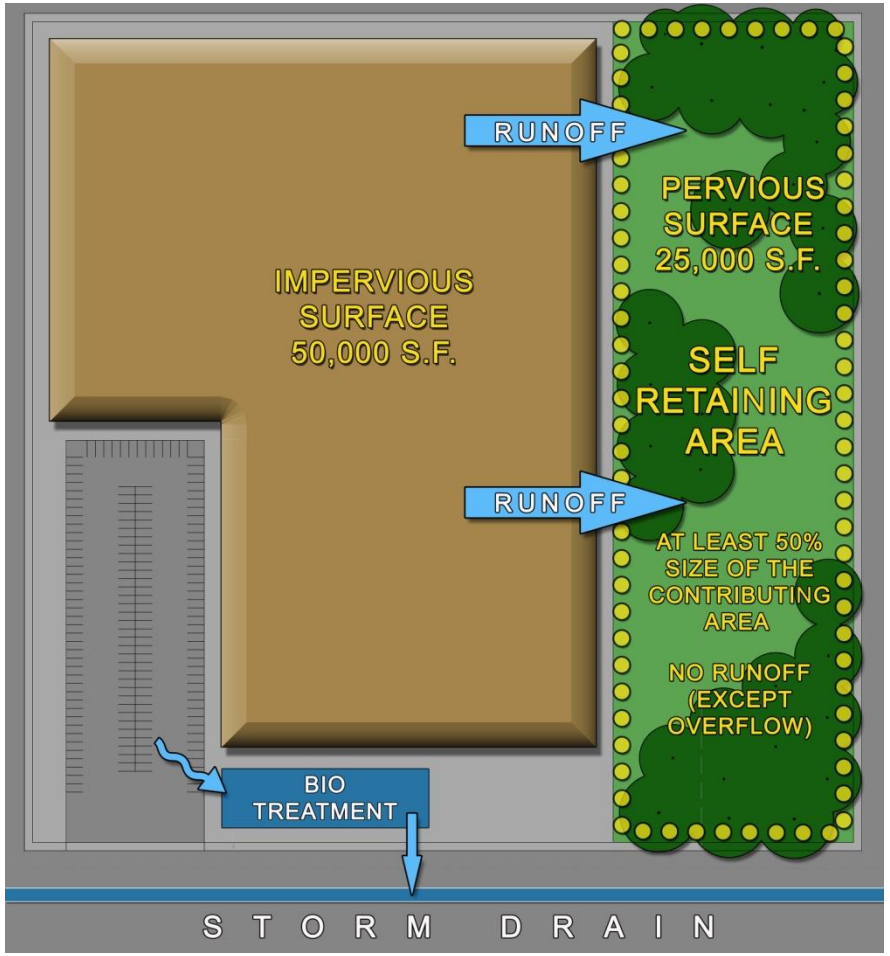


Self-Retaining Area

- Pervious area that retains first 1” of rainfall on itself and runoff from adjacent impervious area, up to a 2:1 ratio (impervious:pervious)
  - Roof runoff dispersion to depressed landscaped area
  - Partial green roofs
  - Pervious pavement (with adequate storage)
- No special soils required
- Area must be able to retain up to 3” of ponding

Self-Retaining Areas Reduce the Area that Requires Treatment

- Runoff from **impervious** portions of the project can flow directly to a **pervious** area that is at least 50% of the size of the contributing area (2:1 ratio)
- Result: Runoff from *other* impervious areas flows to smaller treatment measure



Pervious Pavement Categories

- Site Design Measure
  - Self-Treating
  - Self-Retaining
  - Often categorized as such to keep a project under impervious surface threshold (ex: single family home projects)
  - Only site design measure that requires O&M inspections (when installing ≥ 3,000 sf)
- Treatment Measure

Types of Pervious Pavements

- Pervious Pavers
- Pervious Concrete
- Pervious Asphalt
- Grid Pavements (e.g., Grasscrete)
- May be designed as pervious pavement
  - Gravel, including Decomposed Granite
  - Artificial/Synthetic Turf
  - Playground Surfacing

Types of Pervious Pavement

Generic Cross Section

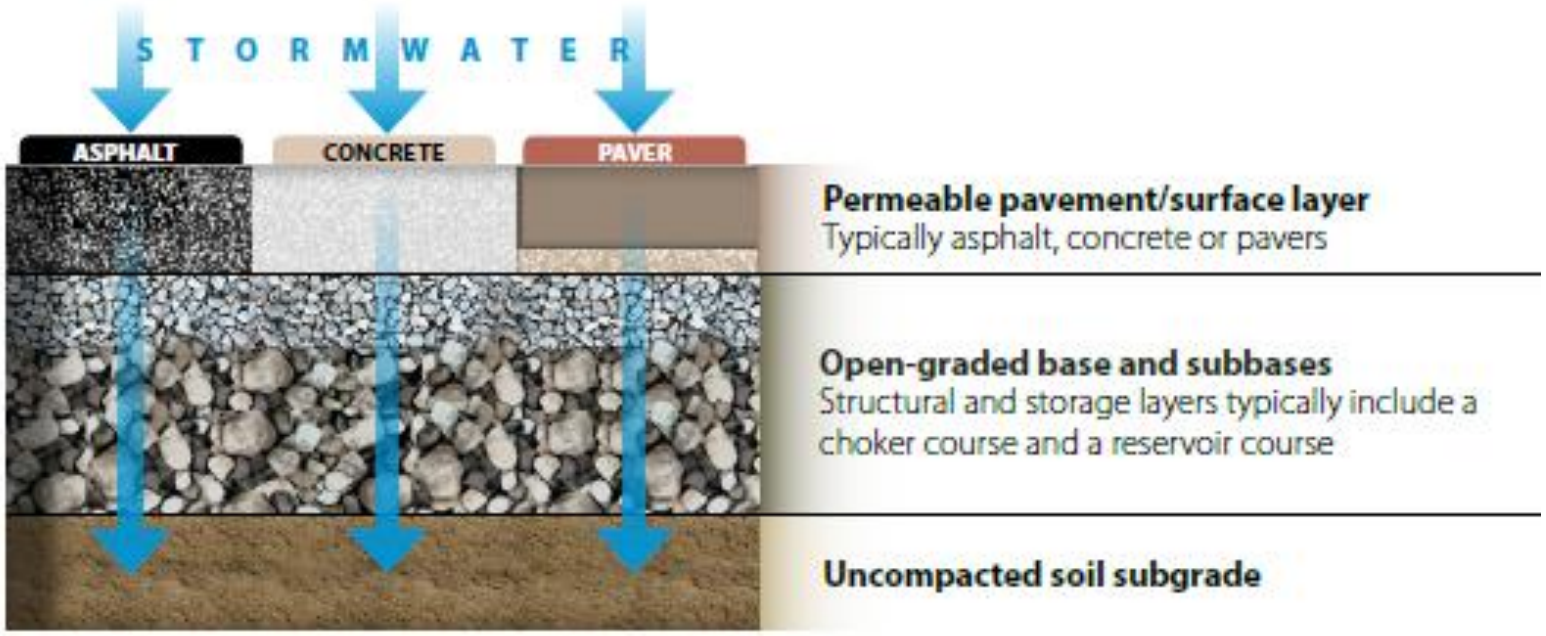
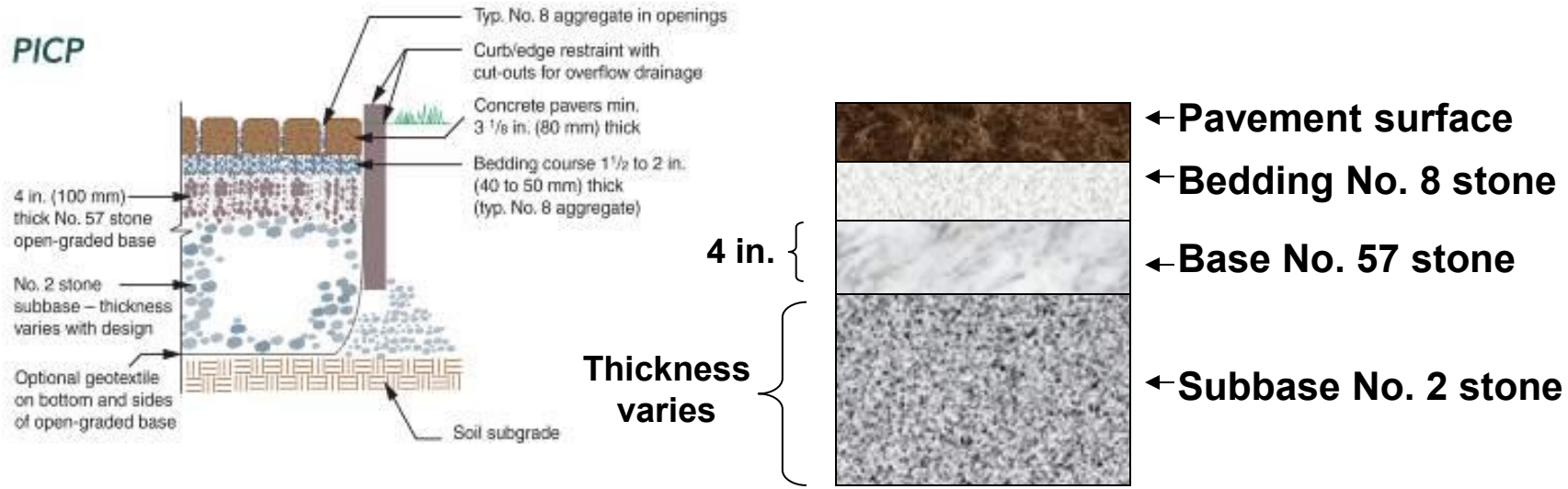


Figure 1-3
Generic permeable pavement cross-section
Source: © VHB

Source: ASCE Permeable Pavements, 2015

Pervious Pavement Details

Typical Section

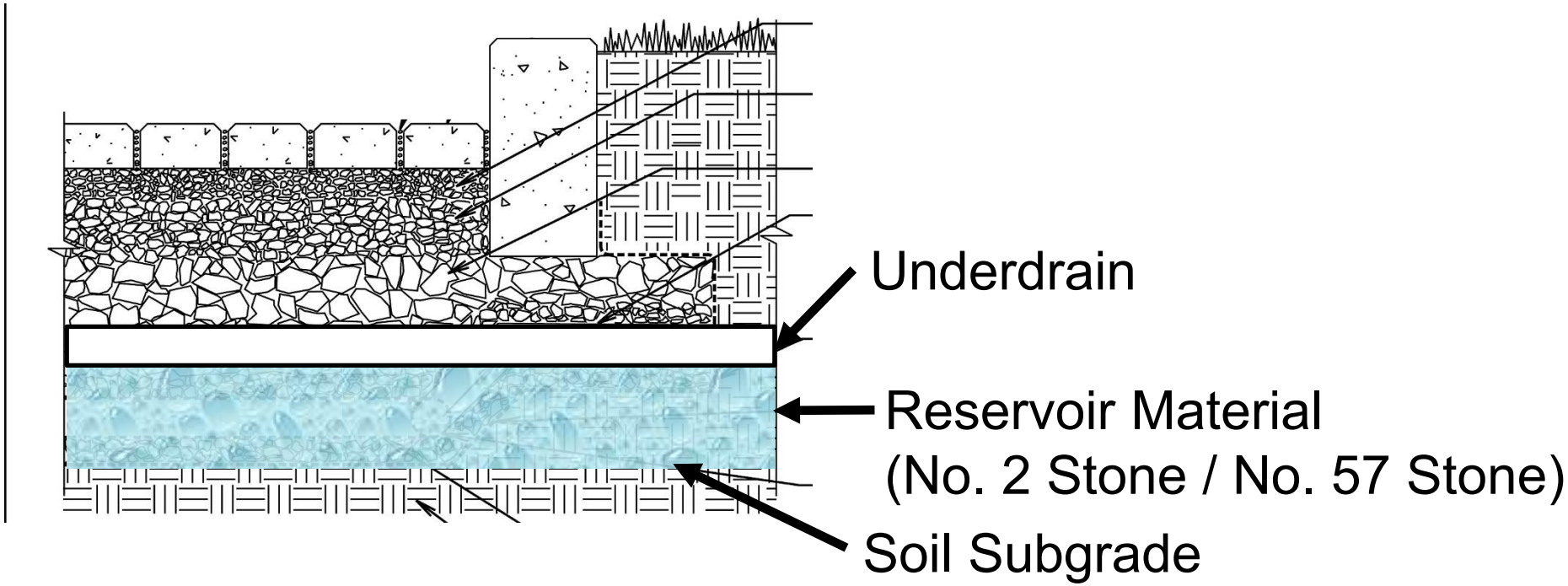


- Base and subbase layers available for water storage

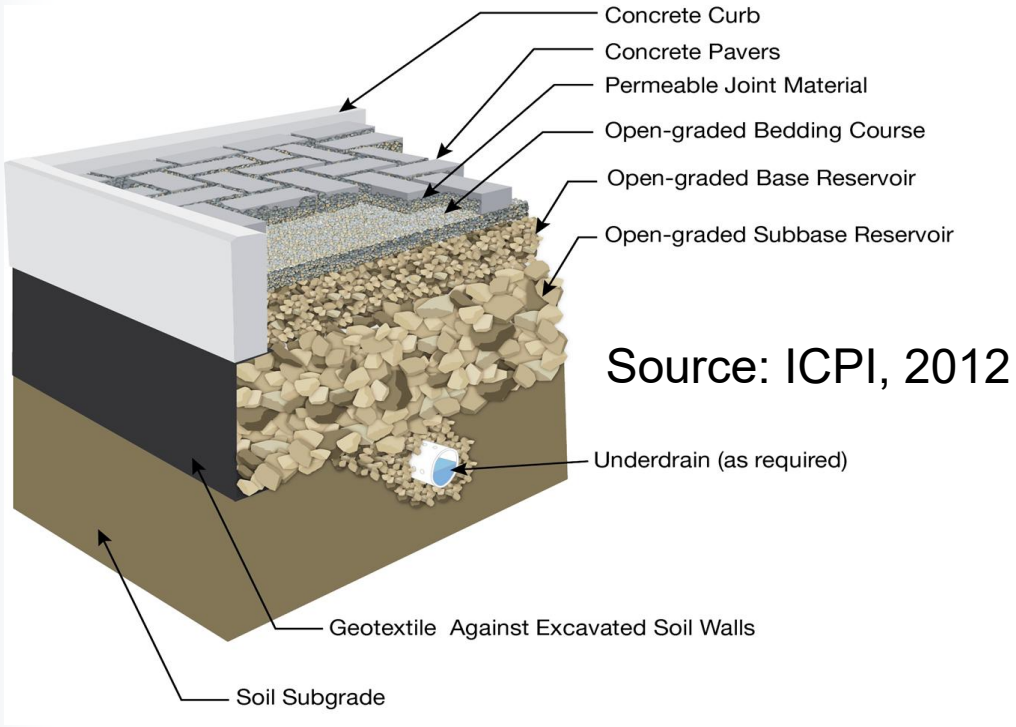
Reservoir Materials

- C.3 Handbook and ASCE Pervious Pavement Guidance
  - Maximize void space for storage
  - Use open graded / uniformly graded materials
  - No. 2 Stone, No. 57 Stone
    - generally accepted to have 35% - 40% void ratio
- Other materials commonly submitted
  - Class 2 Permeable Material - permeable, well graded, lower void ratio (20% - 25%, estimated)
  - Class 2 Aggregate Base – impermeable, negligible void ratio

Underdrain Placement



Pervious Pavement Underdrains

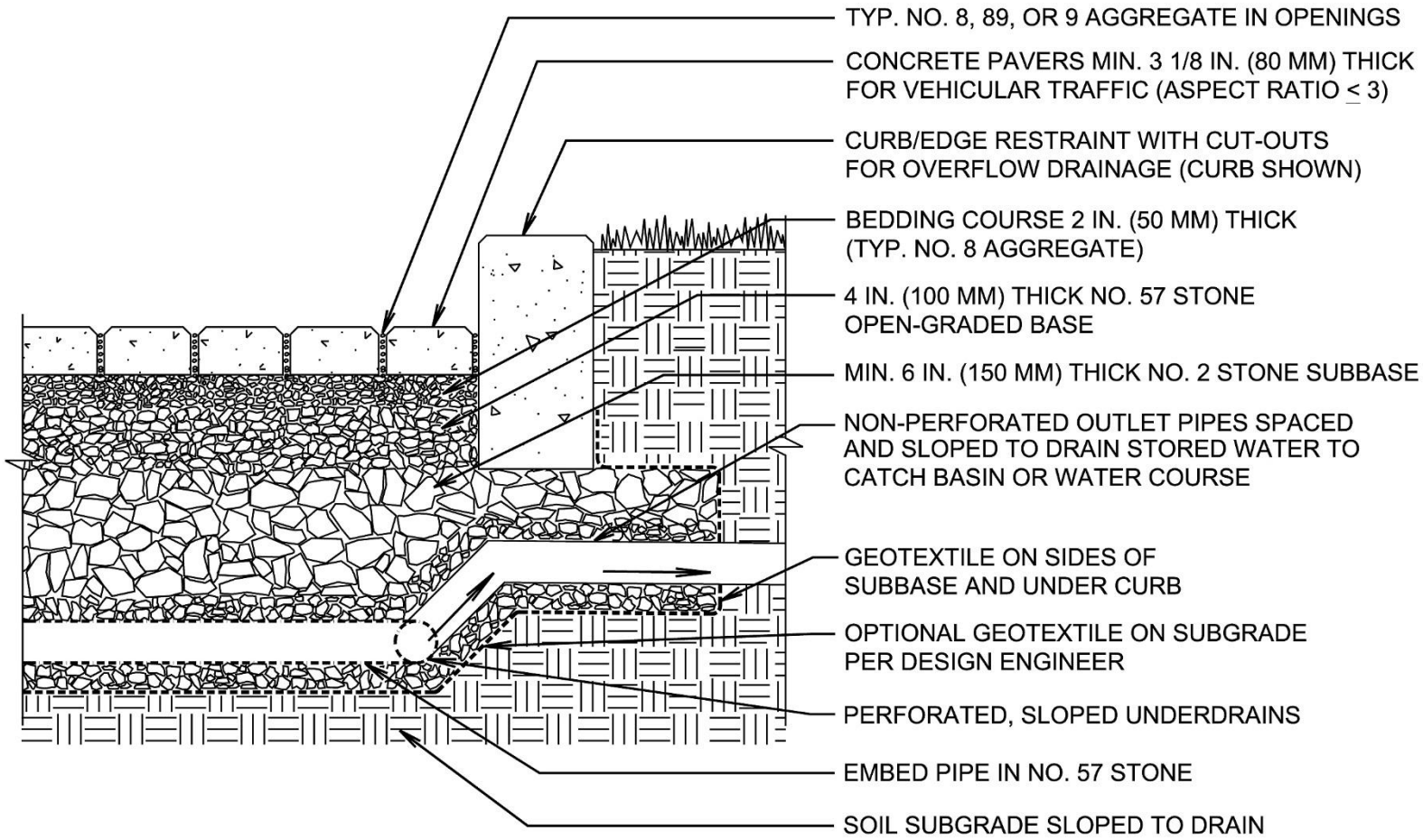


Source: ICPI, 2012

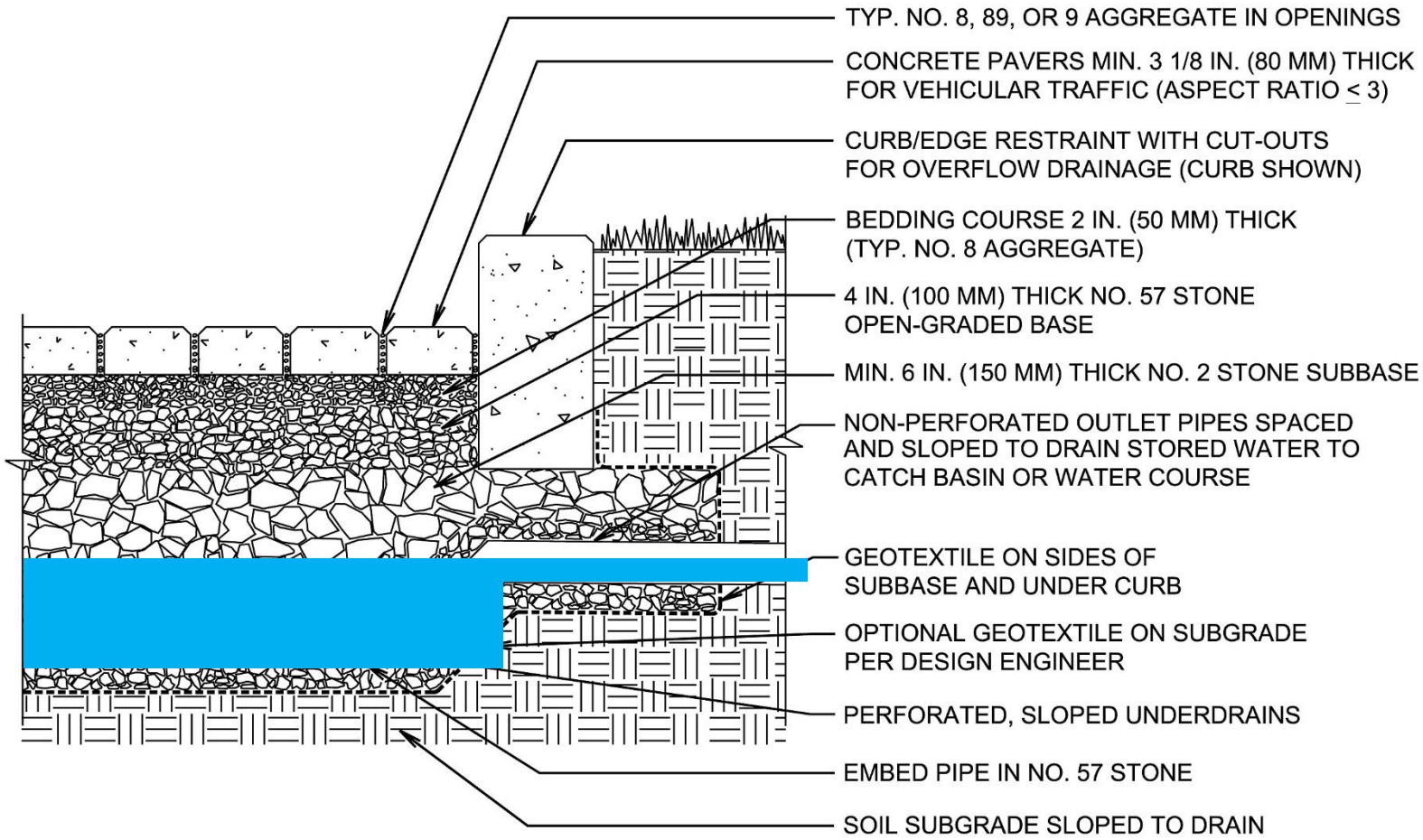
- Detail intended to prevent damage to underdrain
- Underdrain at this elevation with gravity connection will not promote storage and infiltration

- Underdrain placed in trench at bottom of section is OK **with raised outlet** (upturned elbow) to promote storage in subbase

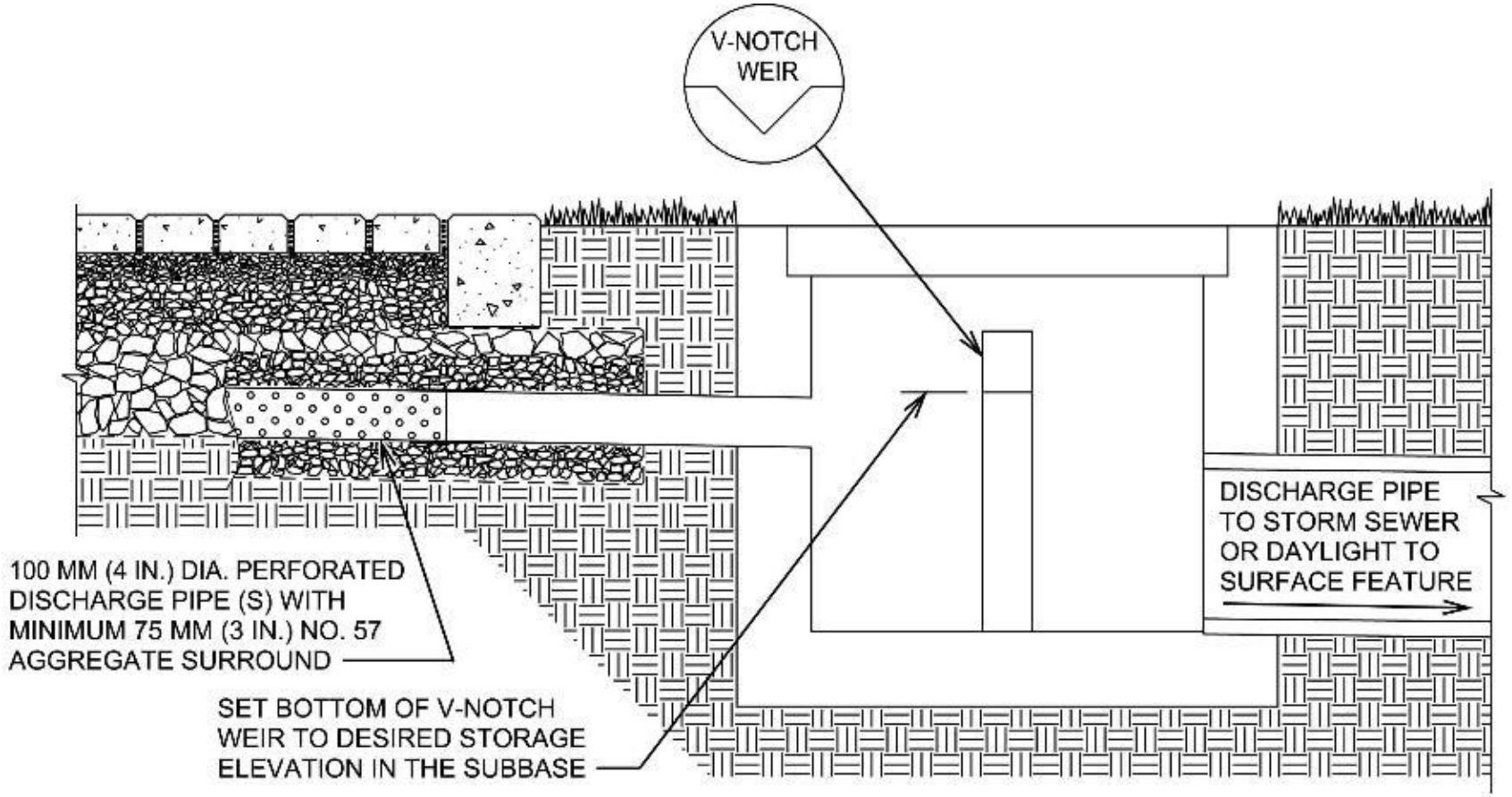
Underdrain: Upturned Elbow



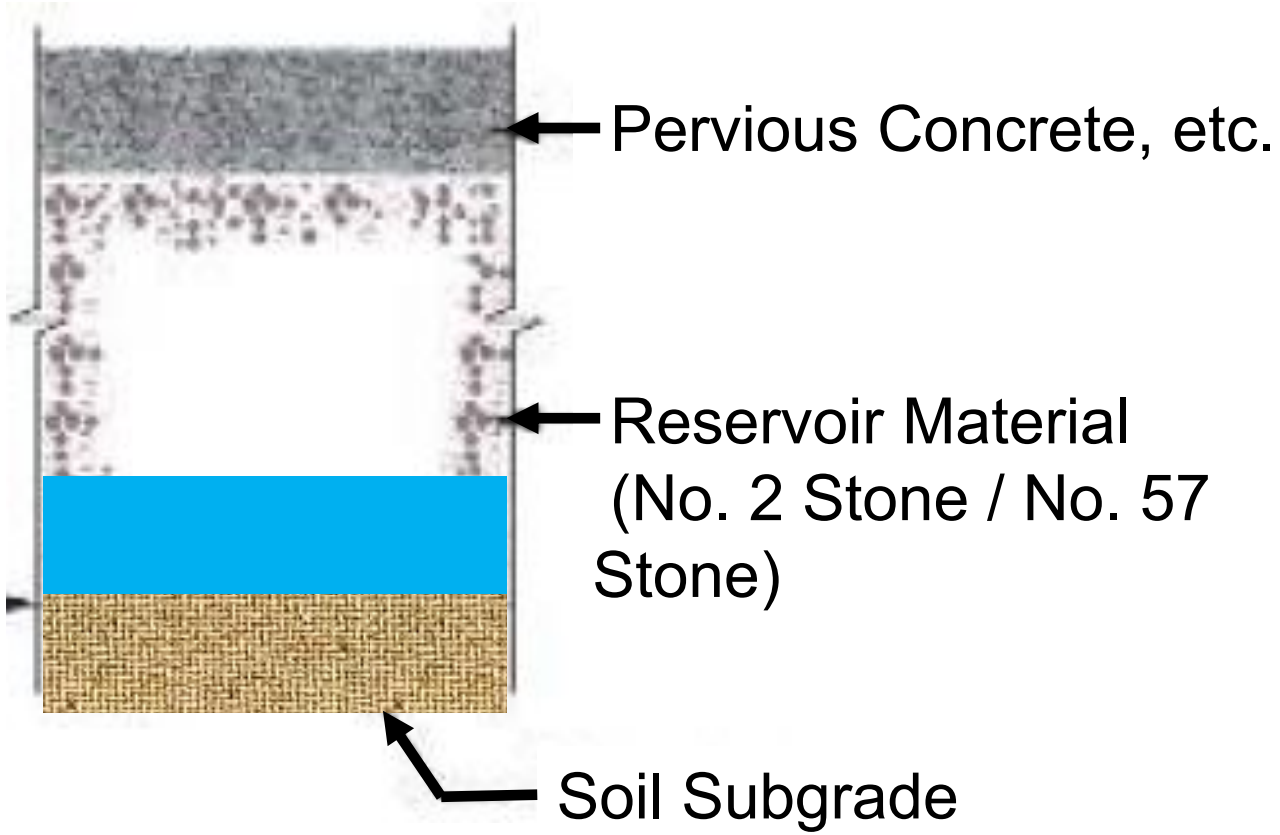
Underdrain: Upturned Elbow



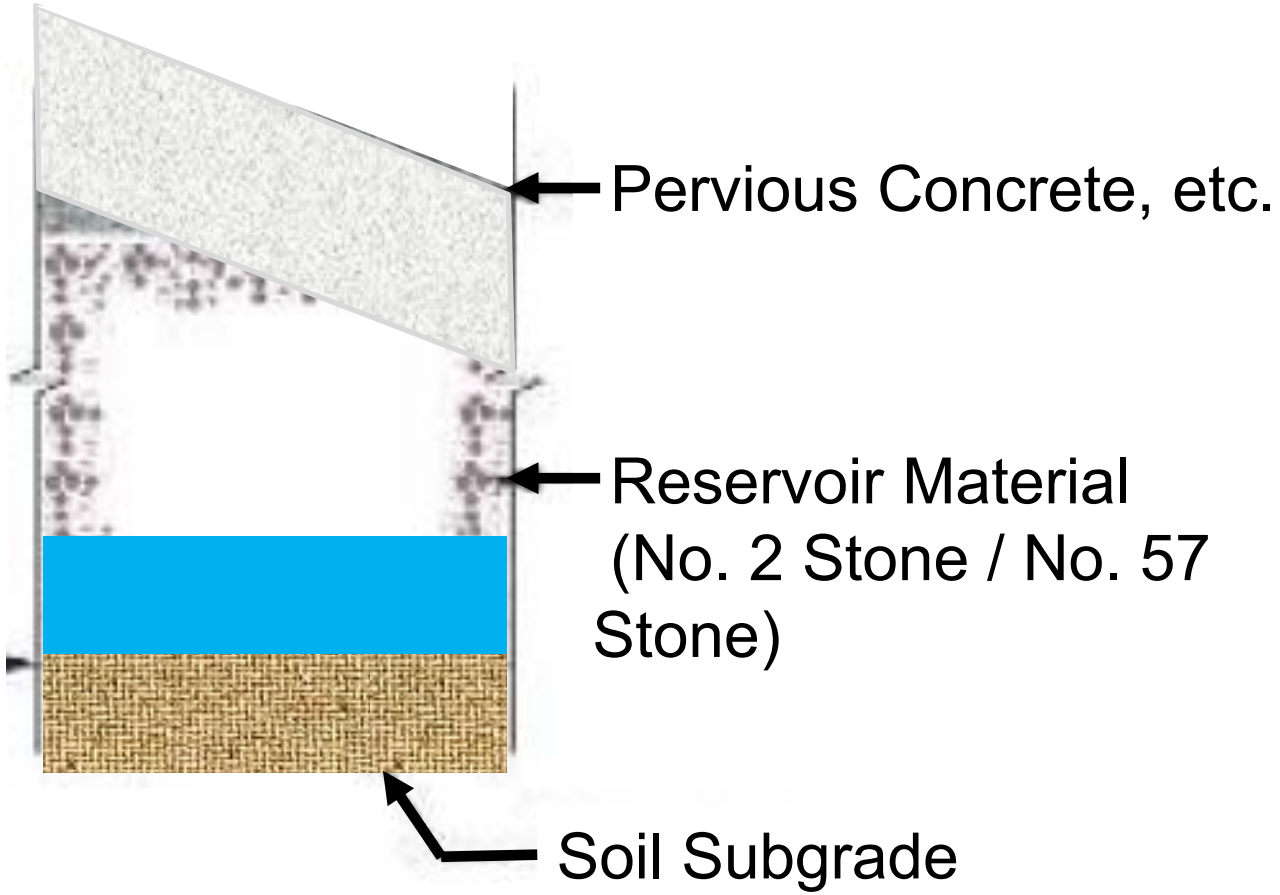
Underdrain: Connection to Catch Basin or Utility Structure



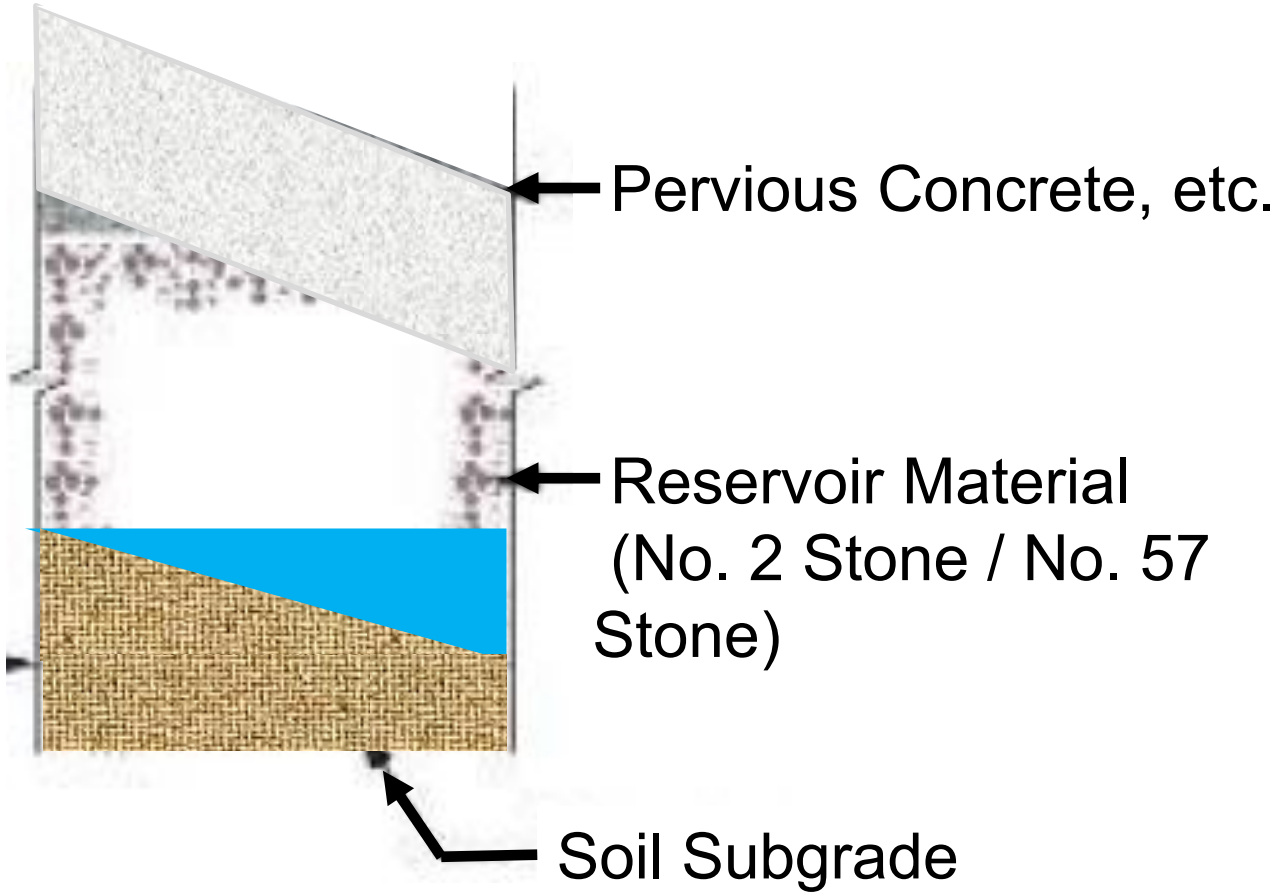
Reservoir Storage – Ideal



Reservoir Storage – Ideal



Reservoir Storage – Sloped Subgrade



Check Dams

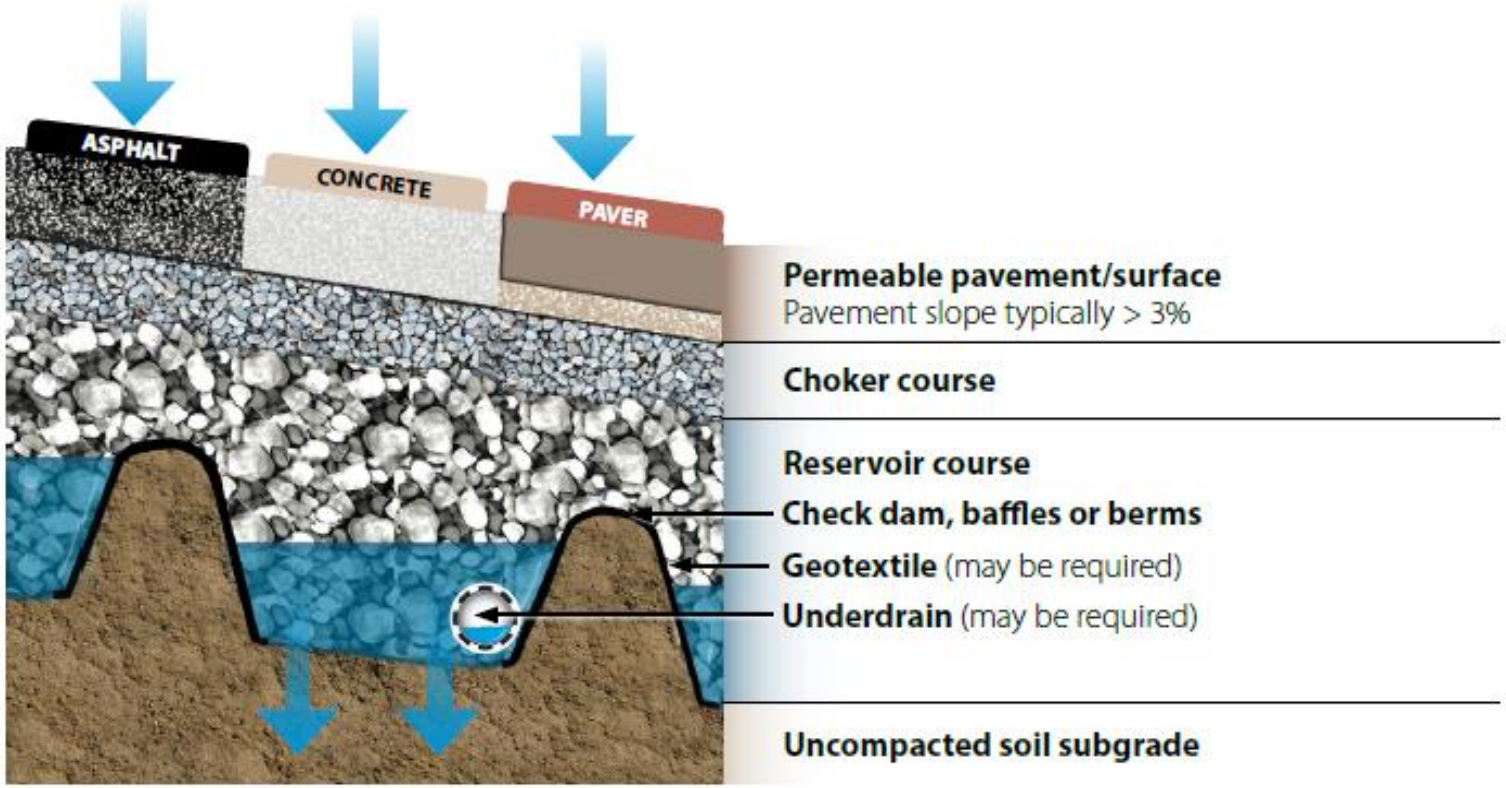


Figure 1-13
Sloped permeable pavement with checkdams, baffles or berms *(exaggerated depiction)*
Source: © VHB

Source: ASCE Permeable Pavements, 2015

Check Dams

- Concrete, earthen berms, aggregate berms
- Geomembrane / impermeable liner

Source:
2016 Slide from Interlocking Concrete Pavement Institute

Sizing Pervious Pavement

- General Principles
  - Store the $\mathbf{V_{WQ}}$ in void space of stone base/subbase and infiltrate into subgrade
  - Surface allows water to infiltrate at a high rate
  - Any underdrains must be placed above the void space needed to store and infiltrate the $\mathbf{V_{WQ}}$

Sizing Pervious Pavement

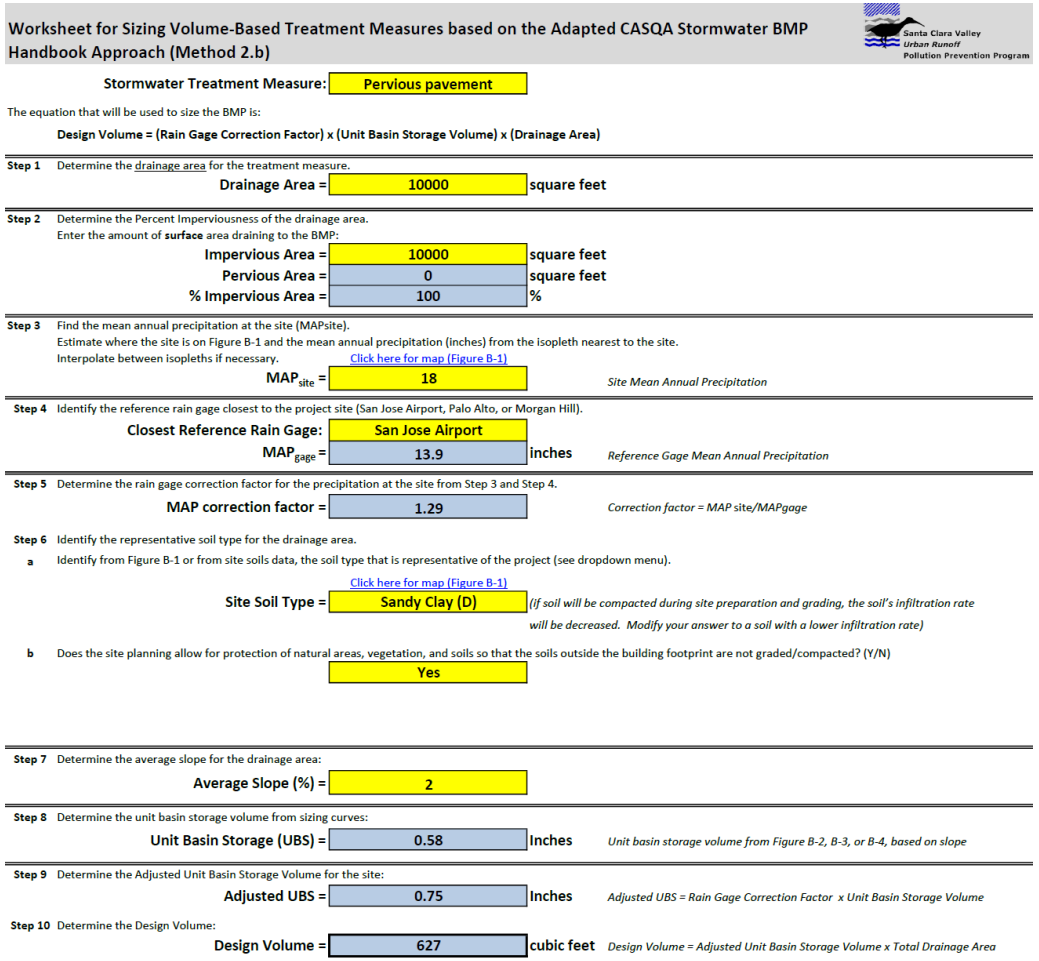
- Pervious Pavement
  - May be self-treating area or self-retaining area (accept runoff from other areas)
  - Can only be considered a “pervious area” if stone base/subbase designed to store and infiltrate the $\mathbf{V_{WQ}}$
  - Can work where native soils have low infiltration rates (stored water depths are relatively small)
  - Surface area is usually predetermined
  - Base and subbase thickness usually determined by expected traffic load and saturated soil strength
  - Slope should be $\leq$ 3% (or use check dams/trenches)

Sizing Pervious Pavement

- Approach to Sizing Pervious Pavement Reservoir
  - Do not exceed 2:1 ratio of contributing area to pervious area
  - For calculations, the pervious pavement is impervious surface
  - Use volume calculation – SCVURPPP Worksheet
  - Storage depth is contingent upon:
    - Water Quality Volume, $\mathbf{V_{WQ}}$
    - Pervious Pavement Area
    - Reservoir Material Void Ratio

Volume-Based Sizing Worksheet

- Available on SCVURPPP Website
- https://scvurppp.org/newdev/



Worksheet for Sizing Volume-Based Treatment Measures based on the Adapted CASQA Stormwater BMP Handbook Approach (Method 2.b)

Santa Clara Valley Urban Runoff Pollution Prevention Program

Stormwater Treatment Measure: Pervious pavement

The equation that will be used to size the BMP is:

Design Volume = (Rain Gage Correction Factor) x (Unit Basin Storage Volume) x (Drainage Area)

Step 1 Determine the drainage area for the treatment measure.

Drainage Area = 10000 square feet

Step 2 Determine the Percent Imperviousness of the drainage area.

Enter the amount of **surface** area draining to the BMP:

Impervious Area = 10000 square feet

Pervious Area = 0 square feet

% Impervious Area = 100 %

Step 3 Find the mean annual precipitation at the site (MAPsite).

Estimate where the site is on Figure B-1 and the mean annual precipitation (inches) from the isopleth nearest to the site.

Interpolate between isopleths if necessary. Click here for map (Figure B-1)

MAP_{site} = 18 *Site Mean Annual Precipitation*

Step 4 Identify the reference rain gage closest to the project site (San Jose Airport, Palo Alto, or Morgan Hill).

Closest Reference Rain Gage: San Jose Airport

MAP_{gage} = 13.9 inches *Reference Gage Mean Annual Precipitation*

Step 5 Determine the rain gage correction factor for the precipitation at the site from Step 3 and Step 4.

MAP correction factor = 1.29 *Correction factor = MAP site/MAPgage*

Step 6 Identify the representative soil type for the drainage area.

a Identify from Figure B-1 or from site soils data, the soil type that is representative of the project (see dropdown menu).

Click here for map (Figure B-1)

Site Soil Type = Sandy Clay (D) *(if soil will be compacted during site preparation and grading, the soil's infiltration rate will be decreased. Modify your answer to a soil with a lower infiltration rate)*

b Does the site planning allow for protection of natural areas, vegetation, and soils so that the soils outside the building footprint are not graded/compacted? (Y/N)

Yes

Step 7 Determine the average slope for the drainage area:

Average Slope (%) = 2

Step 8 Determine the unit basin storage volume from sizing curves:

Unit Basin Storage (UBS) = 0.58 Inches *Unit basin storage volume from Figure B-2, B-3, or B-4, based on slope*

Step 9 Determine the Adjusted Unit Basin Storage Volume for the site:

Adjusted UBS = 0.75 Inches *Adjusted UBS = Rain Gage Correction Factor x Unit Basin Storage Volume*

Step 10 Determine the Design Volume:

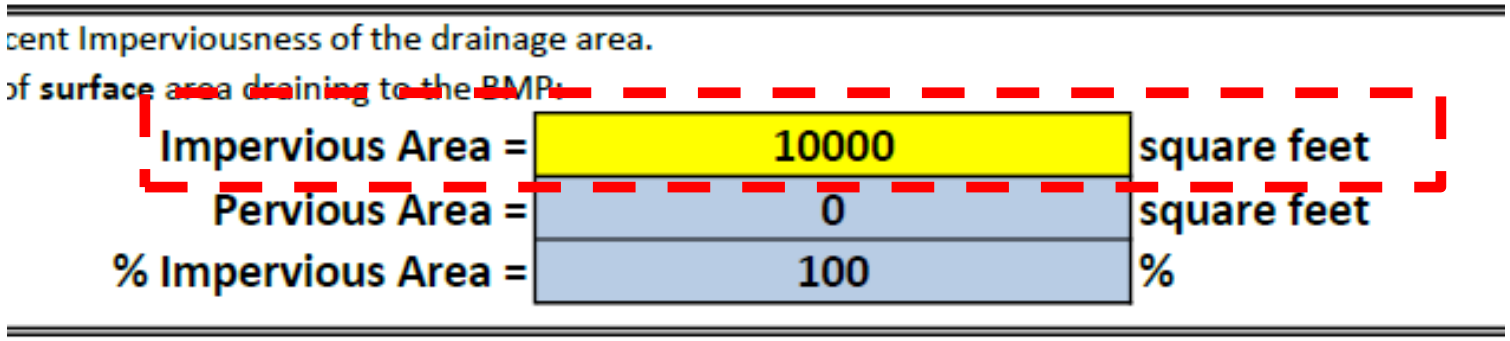
Design Volume = 627 cubic feet *Design Volume = Adjusted Unit Basin Storage Volume x Total Drainage Area*

Santa Clara Valley *Urban Runoff* Pollution Prevention Program

EOA inc.

Volume-Based Sizing Worksheet

- Pervious Pavement is **impervious surface** in the Sizing Calculation



Volume-Based Sizing Worksheet

- Result: V_{WQ}

Worksheet for Sizing Volume-Based Treatment Measures based on the Adapted CASQA Stormwater BMP Handbook Approach (Method 2.b)

Santa Clara Valley Urban Runoff Pollution Prevention Program

	Stormwater Treatment Measure:	Pervious pavement		
	The equation that will be used to size the BMP is:			
	Design Volume = (Rain Gage Correction Factor) x (Unit Basin Storage Volume) x (Drainage Area)			
Step 1	Determine the drainage area for the treatment measure.			
	Drainage Area =	10000	square feet	
Step 2	Determine the Percent Imperviousness of the drainage area.			
	Enter the amount of **surface** area draining to the BMP:			
	Impervious Area =	10000	square feet	
	Pervious Area =	0	square feet	
	% Impervious Area =	100	%	
Step 3	Find the mean annual precipitation at the site (MAPsite).			
	Estimate where the site is on Figure B-1 and the mean annual precipitation (inches) from the isopleth nearest to the site.			
	Interpolate between isopleths if necessary. Click here for map (Figure B-1)			
	MAP_{site} =	18		*Site Mean Annual Precipitation*
Step 4	Identify the reference rain gage closest to the project site (San Jose Airport, Palo Alto, or Morgan Hill).			
	Closest Reference Rain Gage:	San Jose Airport		
	MAP_{gage} =	13.9	inches	*Reference Gage Mean Annual Precipitation*
Step 5	Determine the rain gage correction factor for the precipitation at the site from Step 3 and Step 4.			
	MAP correction factor =	1.29		*Correction factor = MAP site/MAPgage*
Step 6	Identify the representative soil type for the drainage area.			
a	Identify from Figure B-1 or from site soils data, the soil type that is representative of the project (see dropdown menu).			
	Click here for map (Figure B-1)			
	Site Soil Type =	Sandy Clay (D)		*(if soil will be compacted during site preparation and grading, the soil's infiltration rate will be decreased. Modify your answer to a soil with a lower infiltration rate)*
b	Does the site planning allow for protection of natural areas, vegetation, and soils so that the soils outside the building footprint are not graded/compacted? (Y/N)			
		Yes		
Step	Determine the average slope for the drainage area:			
	Average Slope (%) =	2		
Step 8	Deter[illegible]e the unit basin storage volume from sizing curves:			
	Unit Basin Storage (UBS) =	0.58	Inches	*Unit basin storage volume from Figure B-2, B-3, or B-4, based on slope*
Step 9	Determine the [illegible]usted Unit Basin Storage Volume for the site:			
	Adjusted UBS =	0.75	Inches	*Adjusted UBS = Rain Gage Correction Factor x Unit Basin Storage Volume*
Step 10	Determine the Design[illegible]me:			
	Design Volume =	627	cubic feet	*Design Volume = Adjusted Unit Basin Storage Volume x Total Drainage Area*

Reservoir Sizing

- Approach to Sizing Pervious Pavement Reservoir
  - Check reservoir volume required:
    V_{WQ} (cf) ÷ Void Ratio = Reservoir Rock Volume, (cf)
  - Check the resultant reservoir depth

    Rock V_{WQ} (cf) ÷ Pervious Pavement Area (sf) * 12 (in/ft) = Reservoir depth, (in)
  - Check the time required for stored water to drain (drawdown):
    [V_{WQ} (cf) ÷ Pervious Pavement Area (sf)] ÷ [Infiltration rate (in/hr) ÷ 12 in/ft] = Drain time (hrs)

Reservoir Sizing – Contributing Area Impact

	Example 1 Pervious Pavement Contributing (Self-Treating)
Pervious Pavement Area (sf)	10,000 sf
Additional Impervious Area (sf)	0 sf
Total Contributing Area (sf)	10,000 sf
WQV (cf)	500 cf
Reservoir Material Void Ratio	0.4
Reservoir Rock Volume (cf)	1,250 cf
Reservoir Depth (in)	1.5 in

Reservoir Sizing – Contributing Area Impact

	Example 1 Pervious Pavement Contributing (Self-Treating)	Example 2 Pervious Pavement + Add'l IA Contributing (Self-Retaining)
Pervious Pavement Area (sf)	10,000 sf	**5,000 sf**
Additional Impervious Area (sf)	0 sf	**5,000 sf**
Total Contributing Area (sf)	10,000 sf	10,000 sf
WQV (cf)	500 cf	500 cf
Reservoir Material Void Ratio	0.4	0.4
Reservoir Rock Volume (cf)	1,250 cf	1,250 cf
Reservoir Depth (in)	1.5 in	**3.0 in**

Reservoir Sizing – Material Selection Impact

	Example 3 Uniformly Graded Reservoir Material (Self-Treating)
Total Contributing Area (sf)*	10,000 sf
WQV (cf)	500 cf
Reservoir Material	No. 2 Stone
Reservoir Material Void Ratio	0.4
Reservoir Rock Volume (cf)	1,250 cf
Reservoir Depth (in)	1.5 in

**For this set of examples, total contributing area = pervious pavement area*

Reservoir Sizing – Material Selection Impact

	Example 3 Uniformly Graded Reservoir Material (Self-Treating)	**Example 4 Non-Uniformly Graded Reservoir Material (Self-Treating)**
Total Contributing Area (sf)*	10,000 sf	10,000 sf
WQV (cf)	500 cf	500 cf
Reservoir Material	No. 2 Stone	Class 2 Permeable
Reservoir Material Void Ratio	0.4	**0.2 (est.)**
Reservoir Rock Volume (cf)	1,250 cf	**2,500 cf**
Reservoir Depth (in)	1.5 in	**3.0 in**

**For this set of examples, total contributing area = pervious pavement area*

Questions?

Renee Crawford, P.E.

rcrawford@eoainc.com