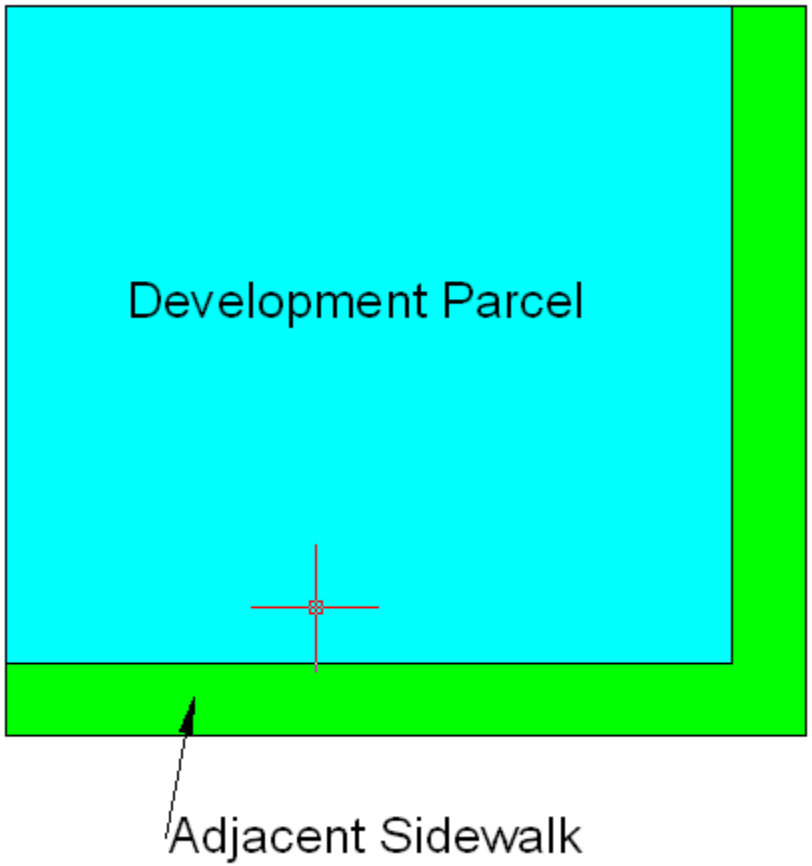
Design Example: Scenario

- Corner property includes 200’ x 10’ adjacent PROW disturbance (sidewalk)
- SWRv = 1.2” x (0.95x100%) x 2000 sf x 7.48/12
- SWRv = 1,421 gallons

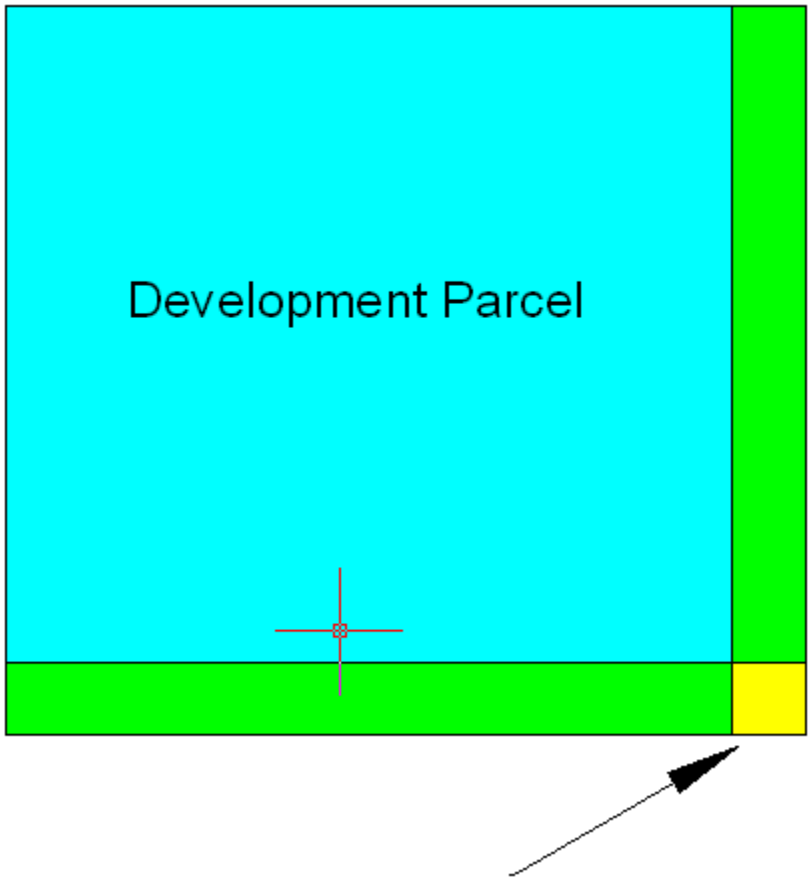
- Poor infiltration rate on site
- Sufficient head available for underdrain connections.

Design Example: Site Plan



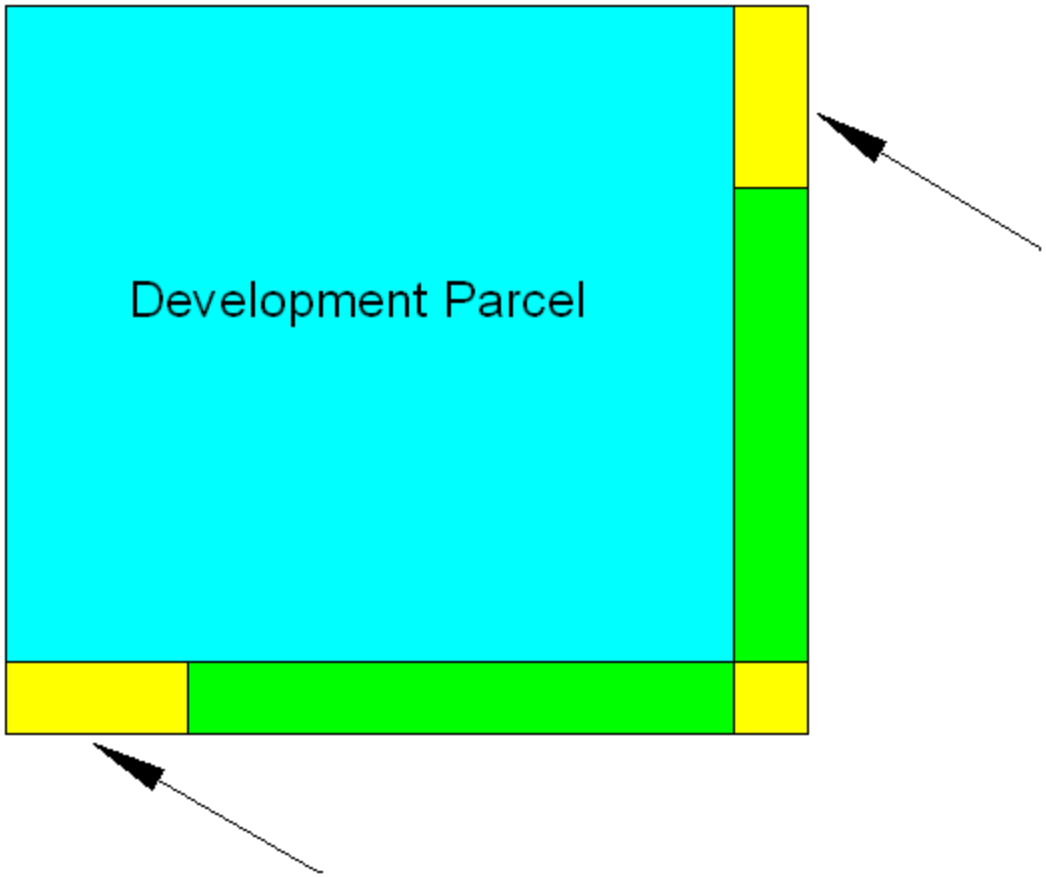
Design Example: Limitations

- ADA Crossing Requirements



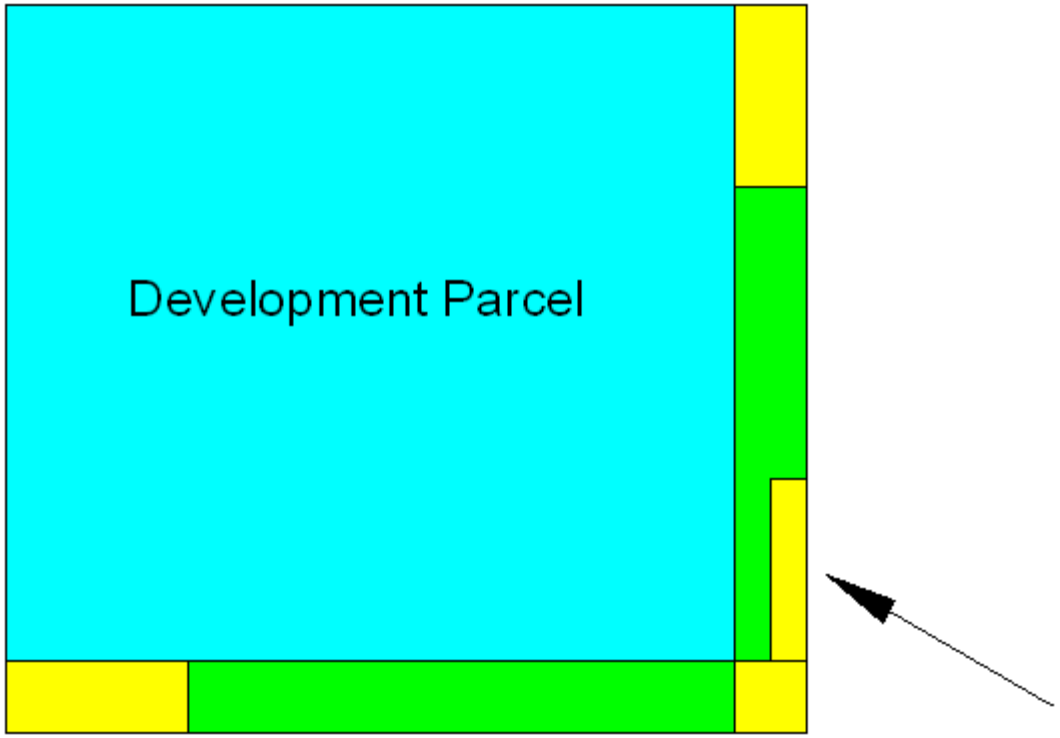
Design Example: Limitations

- Driveways



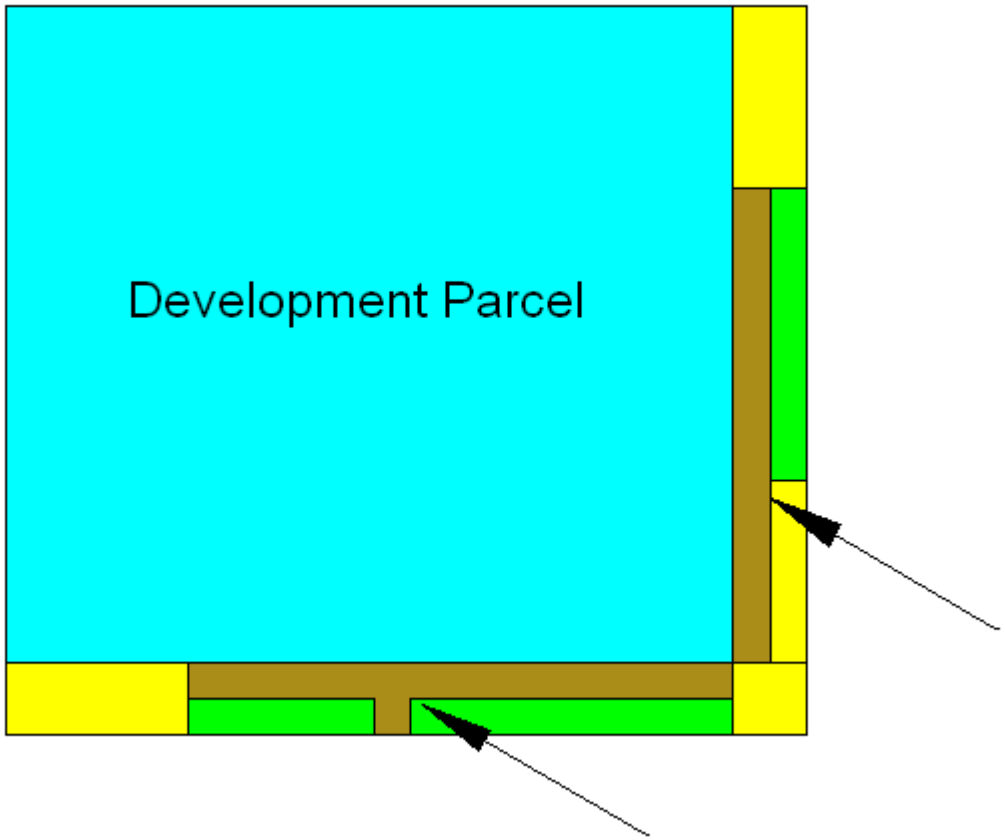
Design Example: Limitations

- Bus Stop



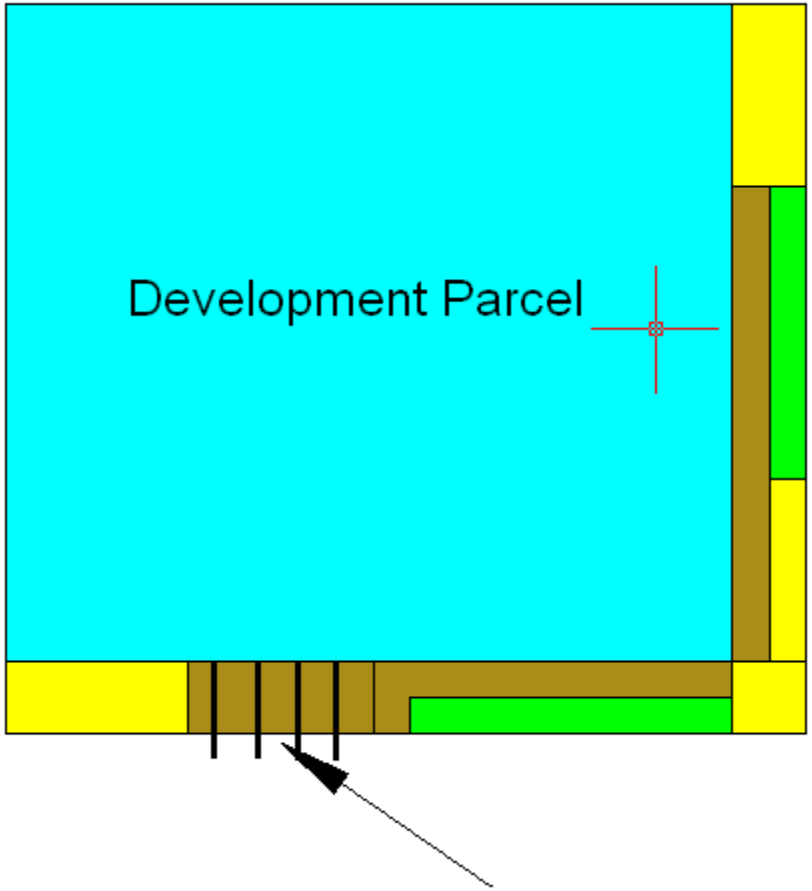
Design Example: Limitations

- Building Exit and 6’-Wide Sidewalk



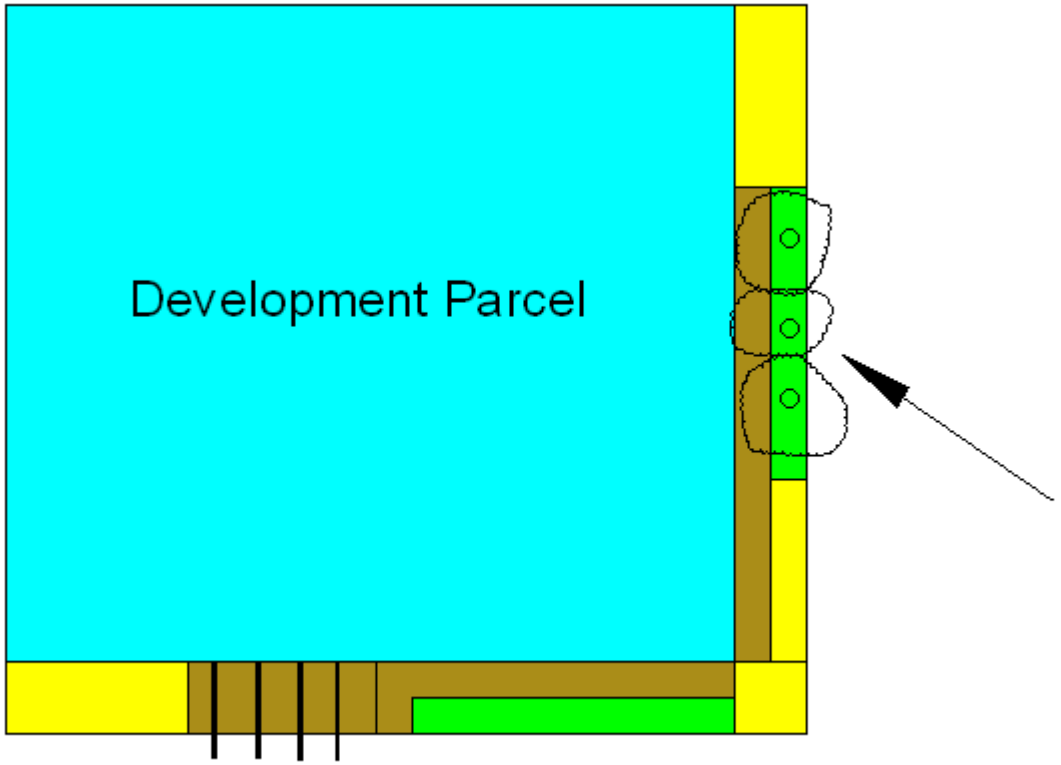
Design Example: Limitations

- Utilities



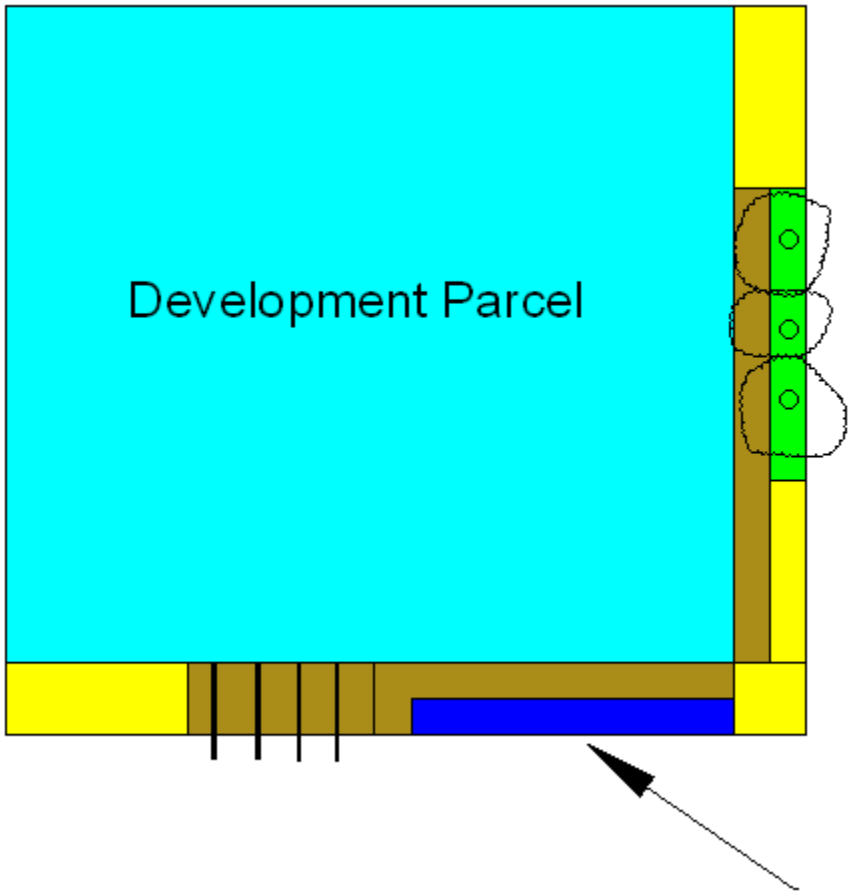
Design Example: Limitations

- Existing Trees



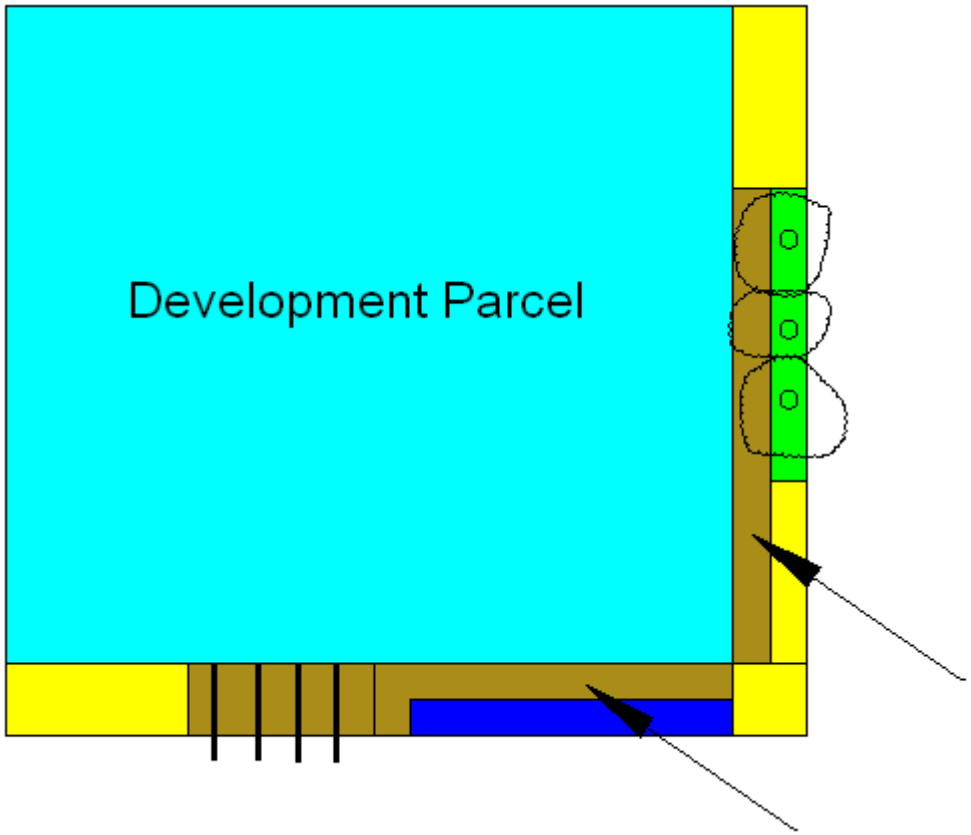
Design Example: BMPs

- Bioretention



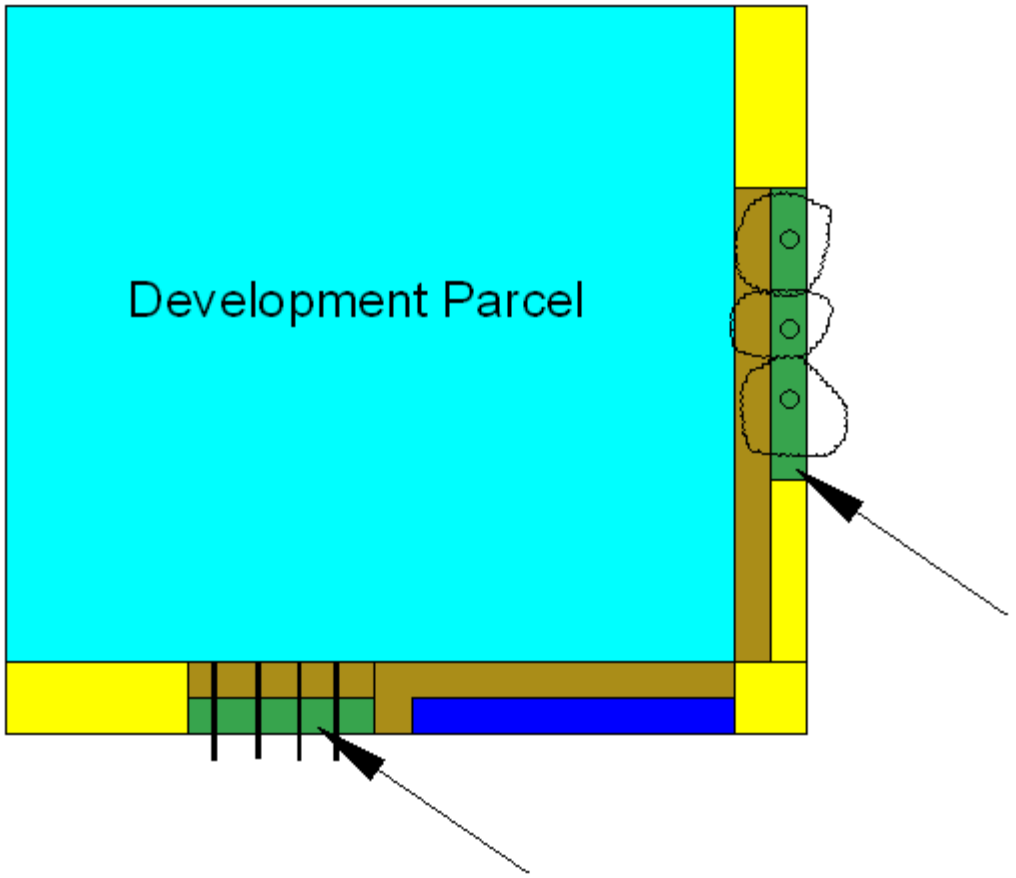
Design Example: BMPs

- Permeable Pavement considered, but trees and utilities limit space available and much of remaining sidewalk drains to bioretention area.



Design Example: BMPs

- Reduce Impervious Cover



Design Example: Results

- Recalculate SWRv for Reduced Impervious Cover:
- SWRv =

  1.2” × (0.95 × 84% + 0.25 × 16%) x 2,000 sf × 7.48/12
- SWRv = 1,254 gallons

- Poor infiltration rate on site
- Sufficient head available for underdrain connections.

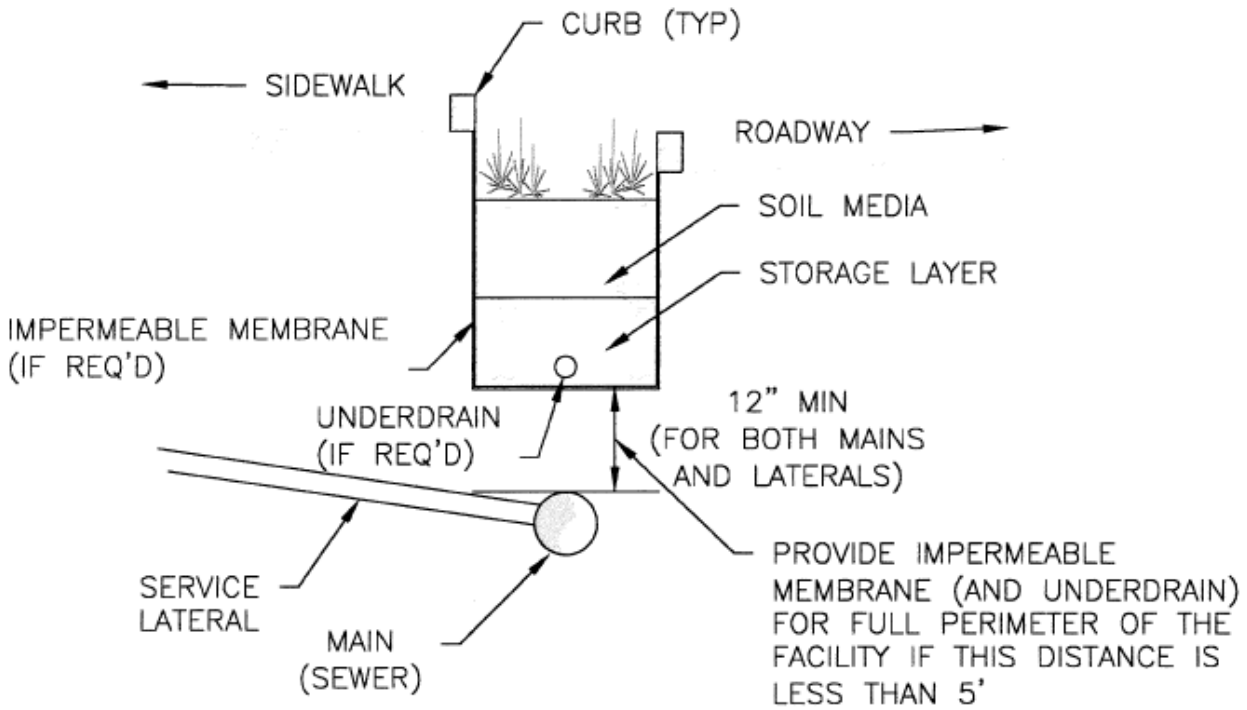
Design Example: Results

- SWRv Achieved:
- 3 existing trees × 20 cf × 7.48 = 449 gallons
- 220 sf bioretention area (with shallow ponding) provides 823 gallons of storage
- 823 gallons x 0.6 = 494 gallons
- SWRv Achieved = 943 gallons

- Required SWRv not met, but MEP process followed.

Utility Conflicts

DC Water Green Infrastructure Utility Protection Guidelines



SECTION A–A

Trees

- 3’ separation from edge of tree trunk to edge of pipe for water or sewer.
- 5’ separation from concrete box to edge of pipe for water or sewer.

Sewers

Mains and Laterals

- 3’ horizontal setback
- 5’ vertical setback from bottom of practice.
- Provide impermeable liner if setbacks are not possible.
- Minimum 12” vertical setback from bottom of practice.
- If no impermeable line is used, must line sewer from manhole to manhole.

Water Mains

Mains Only

- 12” minimum vertical setback between water main and bottom of bioretention area/permeable pavement.
- Maintain 4’ of cover over water main in permeable pavement areas.
- Service laterals can go through permeable pavement bedding.

Utility Surface Structures

Cleanouts, Valve Boxes, Etc.

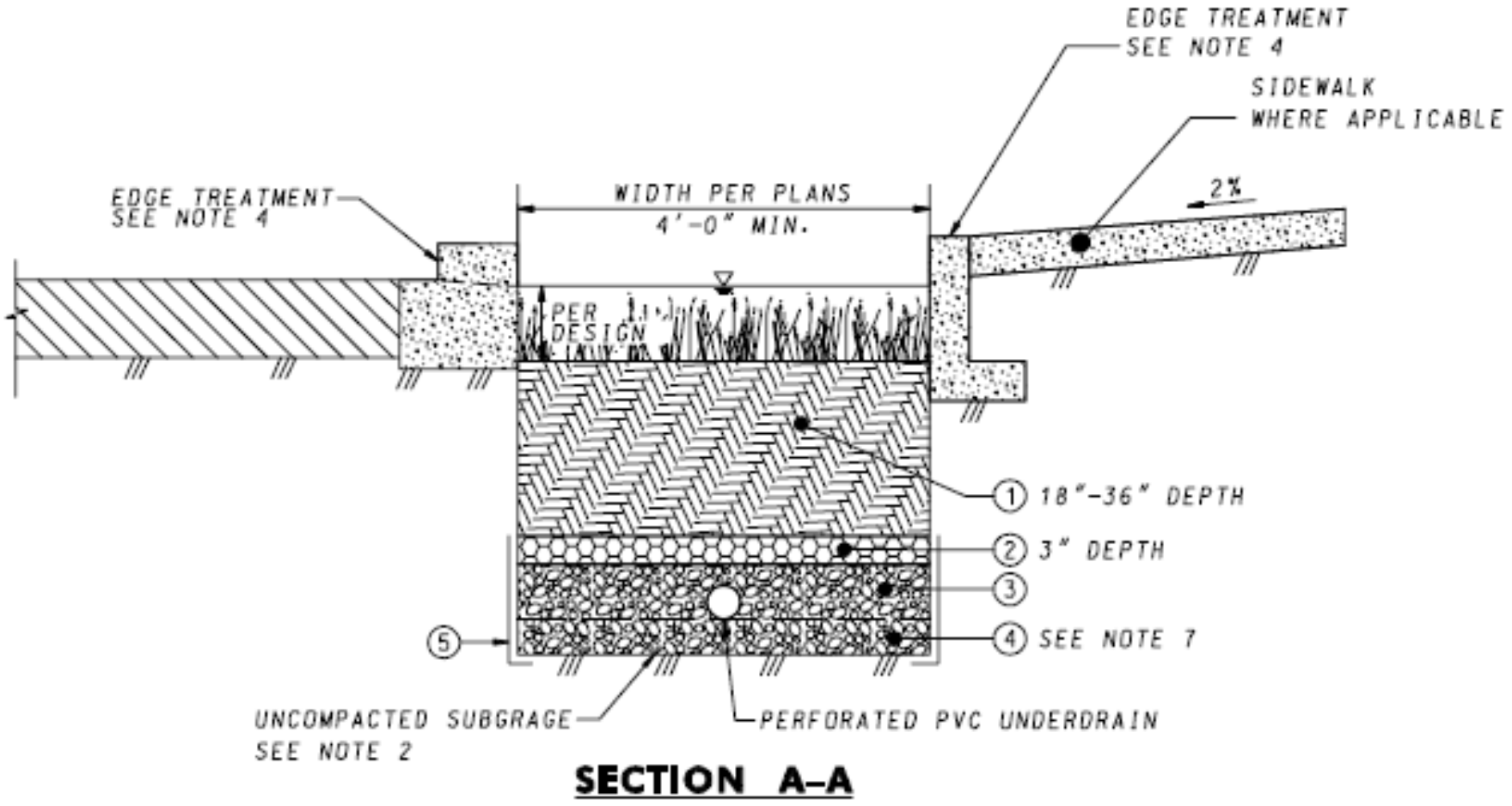
- 16” diameter concrete collar
- Extend collar 12” below grade
- Match top of structure to top of curb (higher than ponding depth)

Catch Basins

- Manhole/Sewer Connections are preferred.

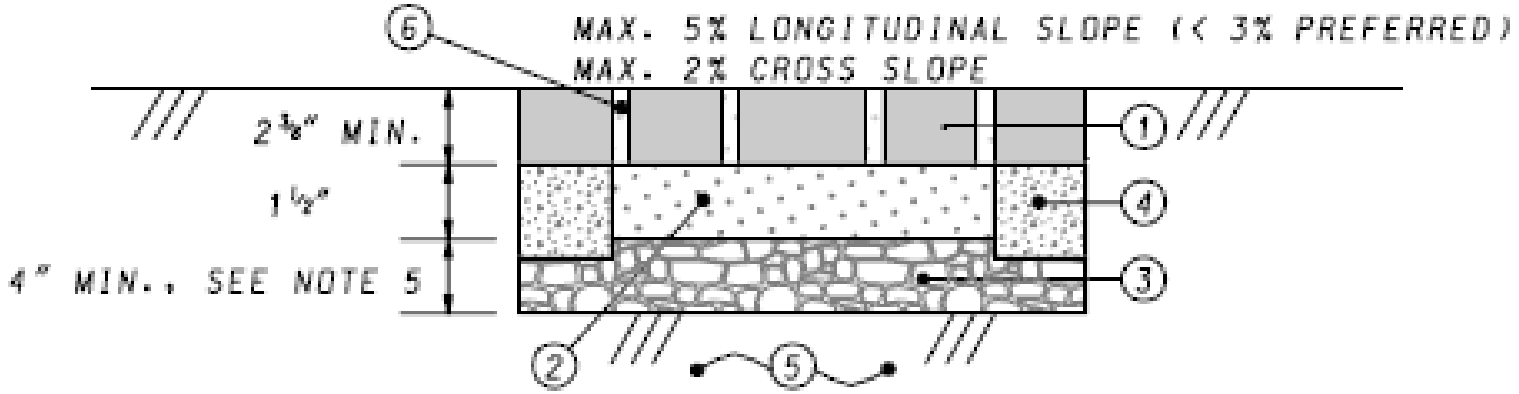
  (must be more than 20’ away from manhole/sewer to connect to a catch basin)
- 5’ maximum distance for Clean Out
- Underdrain must be 6” above top of outlet pipe

PROW BMPs



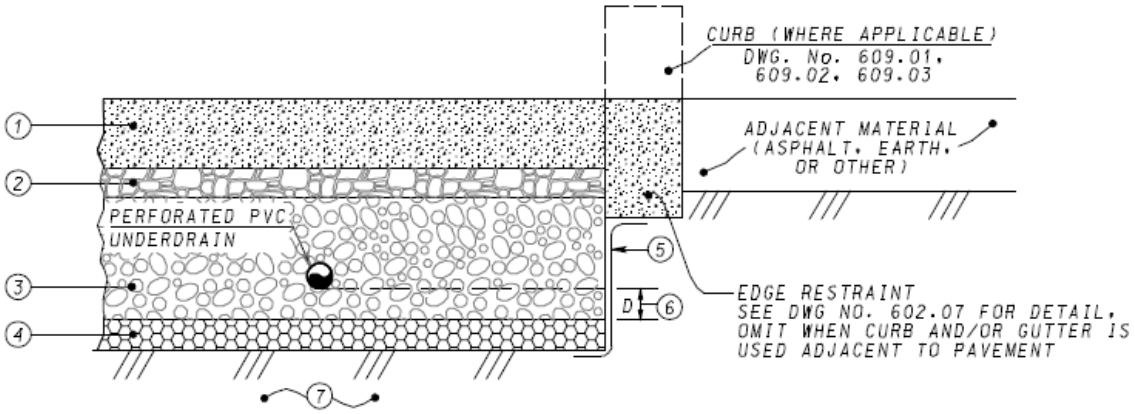
SECTION A-A

Permeable Pavement

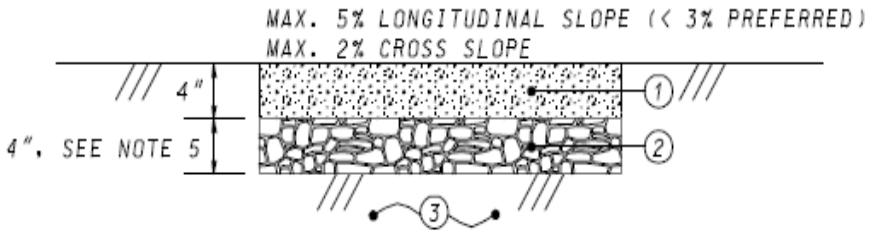


SIDEWALK SECTION

Pervious Concrete

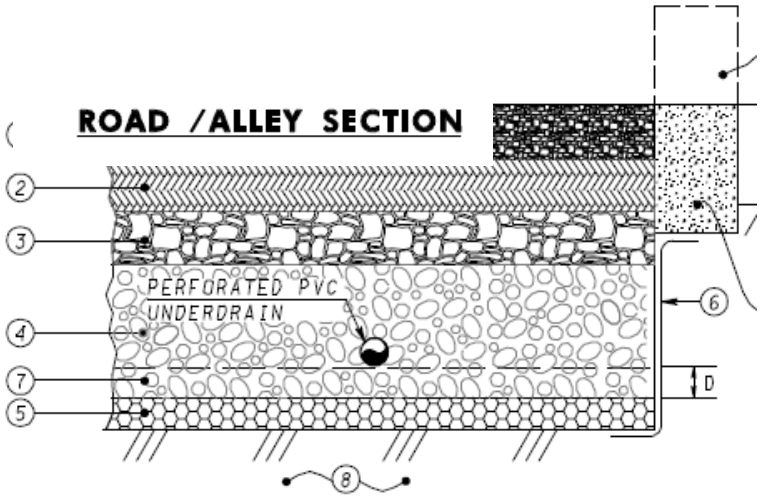


ROAD /ALLEY SECTION



SIDEWALK SECTION

Porous Asphalt



① POROUS ASPHALT SURFACE COURSE

② POROUS ASPHALT BASE COURSE

③ CHOKER LAYER, AASHTO #57, #8, OR APPROVED EQUIVALENT

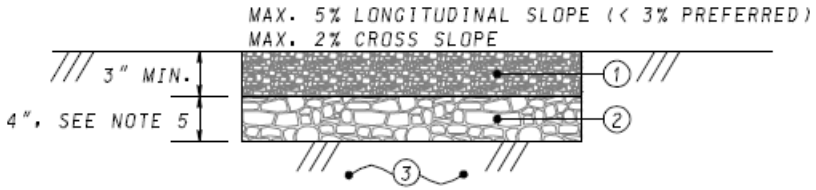
④ RESERVOIR LAYER, AASHTO #3, #2, OR #57, OR APPROVED EQUIV

⑤ FILTER LAYER (OPTIONAL, SEE NOTE 7), AASHTO #8 OR APPROVE

⑥ GEOTEXTILE CLASS 2, LOCATED ON SIDES OF PRACTICES ONLY

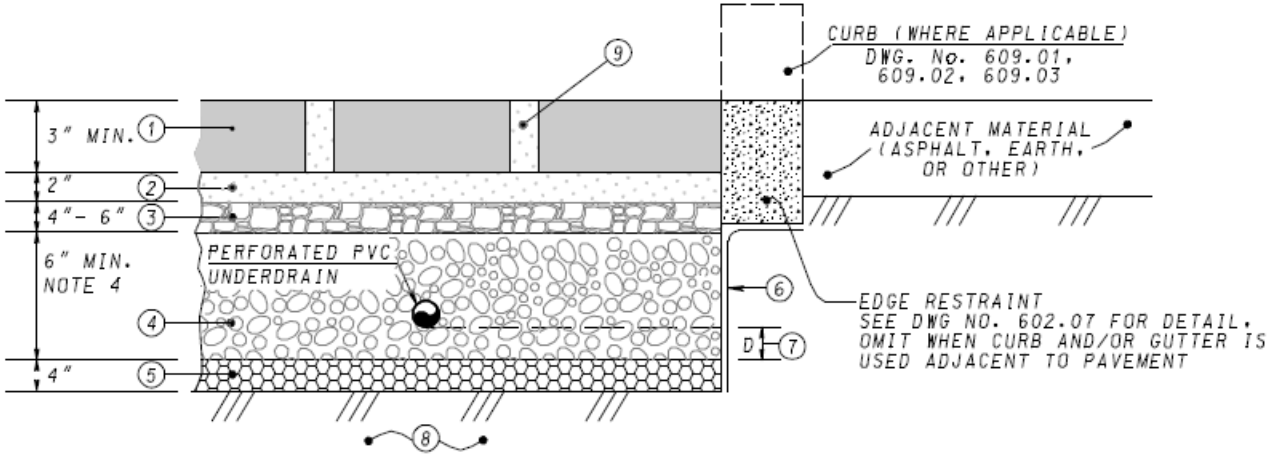
⑦ INFILTRATION SUMP. FOR STANDARD DESIGN, D = 0"
FOR ENHANCED DESIGN, SEE NOTE 6

⑧ UNCOMPACTED SUBGRADE FOR AREAS DESIGNED FOR INFILTRATION

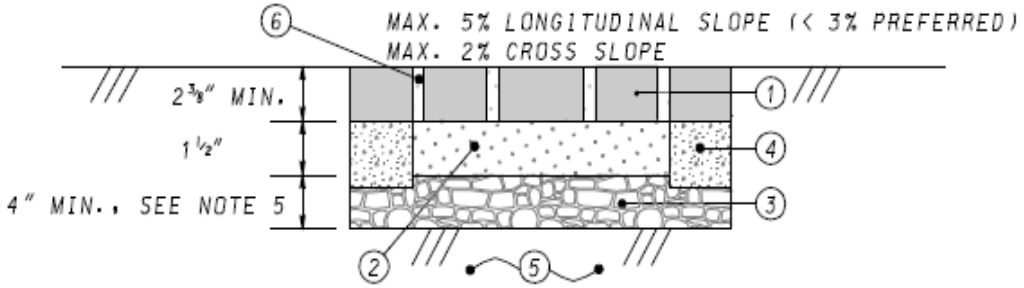


SIDEWALK SECTION

Interlocking Pavers



ROAD /ALLEY SECTION



SIDEWALK SECTION

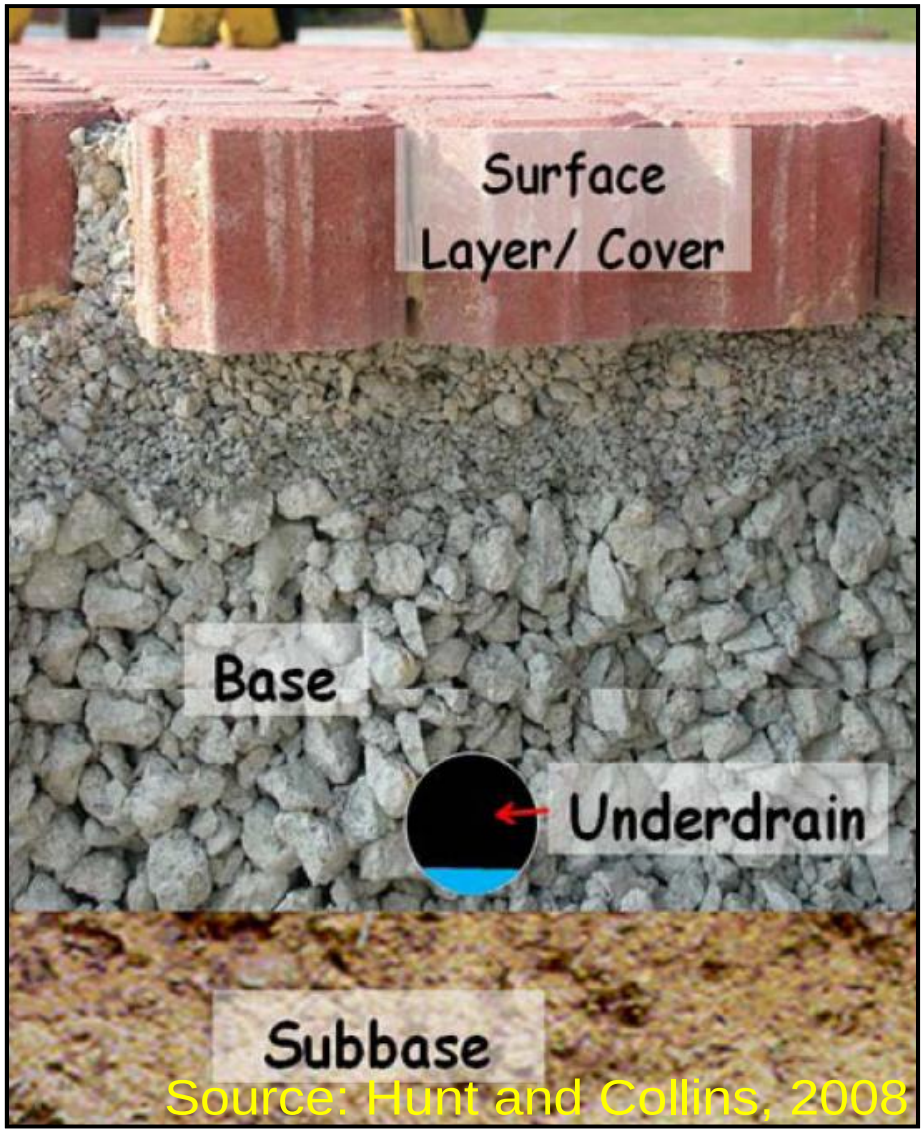
Permeable Pavement

Permeable Pavers

Pervious Concrete

Porous Asphalt

Permeable Pavement



Permeable Pavement Design Elements

- Traffic loadings, bearing capacity
- Surface types in the Contributing Drainage Area (max: 5:1)
- Pretreatment generally not required.
- Depth to storm drain (for underdrain tie-ins)
- Location of utility lines (existing and proprosed)

Permeable Pavement Design Elements

- Strength
  - Standard drawings developed for Local Street (class A) and Collector (class B)
  - Stone thickness variable – *to be designed by geotechnical methods based on soil bearing capacity and traffic loadings*

Concrete Pavement Option

MINIMUM PAVEMENT THICKNESSES

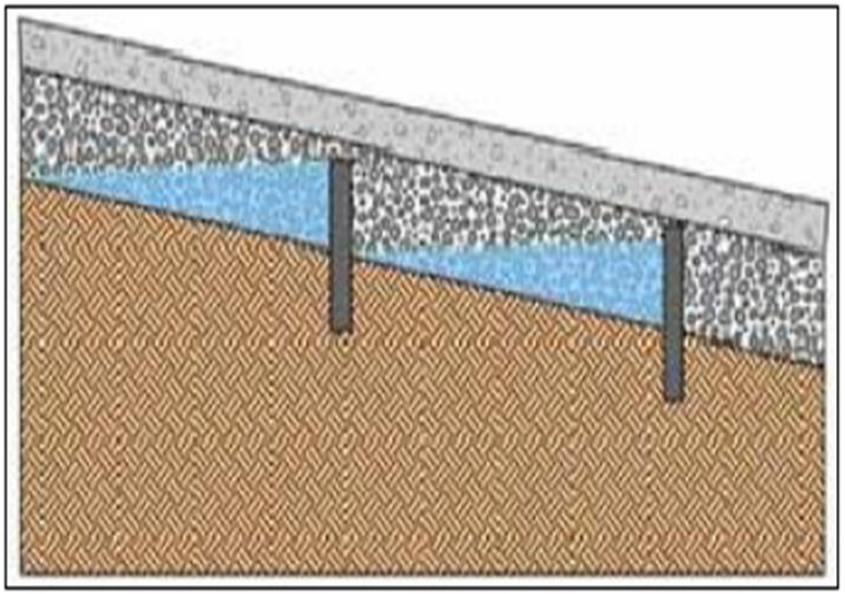
PAVEMENT ITEM	CLASS A	CLASS B
①	6"	8"
②	4"	4"
③	6", SEE NOTE 5	12", SEE NOTE 5
④	4"	4"

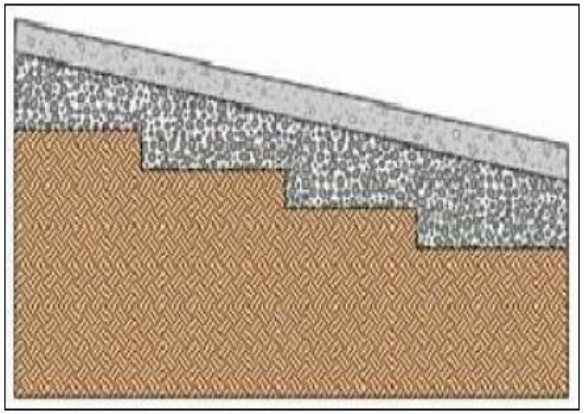
CLASS A: ALLEY, PARKING LANE, LOCAL STREET
CLASS B: COLLECTOR OR ARTERIAL

5. DEPTH OF RESERVOIR LAYER AS SHOWN ON DESIGN PLANS SHOULD BE SIZED TO ADDRESS STORMWATER MANAGEMENT REQUIREMENTS AND PAVEMENT STRUCTURAL DESIGN.

Permeable Pavement Design Elements

- Grades
  - Ideal slopes are 2% or less
  - Increase storage volume with terraced bottom slopes or check dams

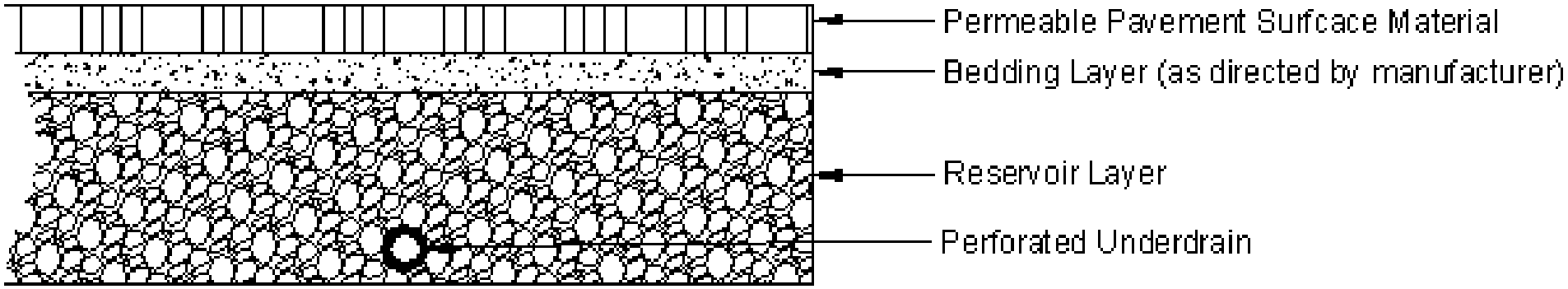




Permeable Pavement Retention Value Calculations

Standard Design

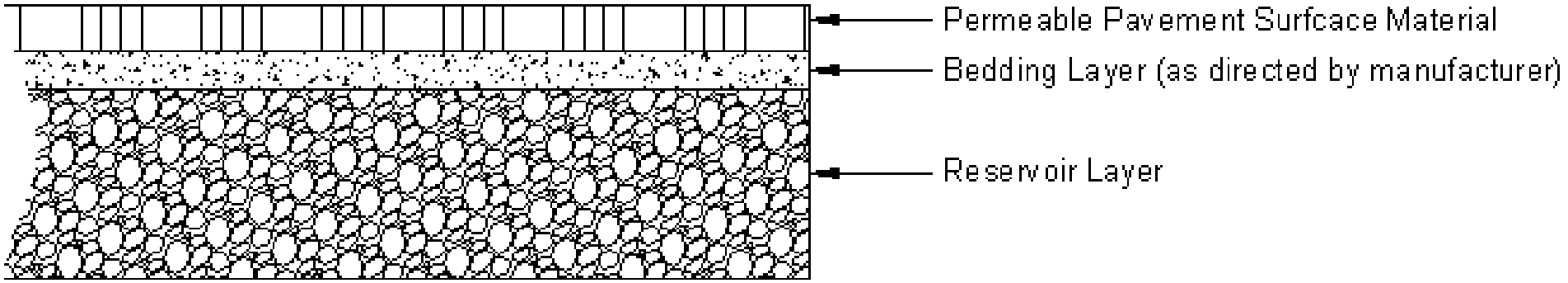
- Retention Value = 4.5 CF per 100 SF of practice area
  - ~ 45% volume reduction



Permeable Pavement Retention Value Calculations

Enhanced Design without Underdrain

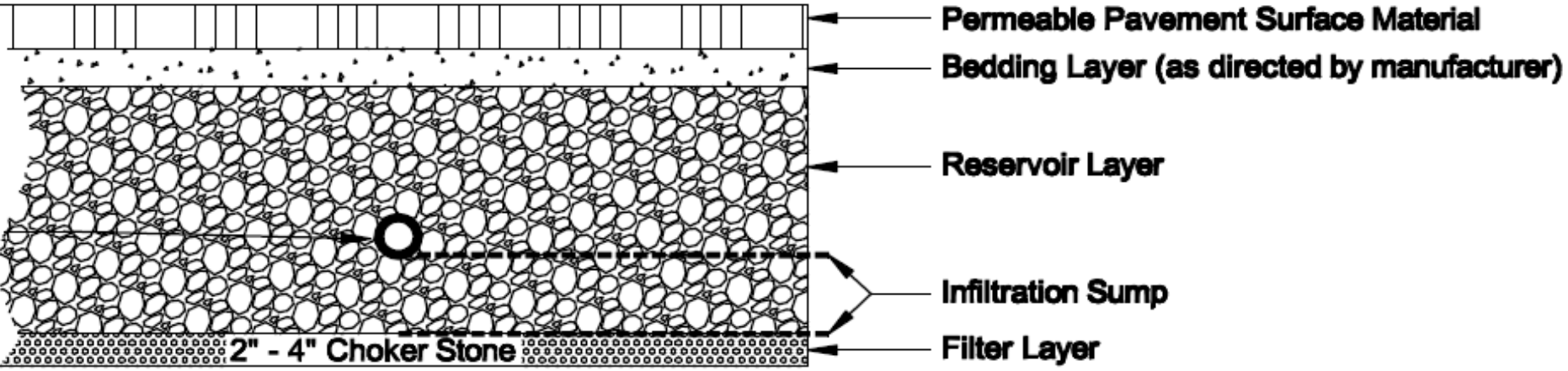
- Retention Value = 100% of Storage Volume in Reservoir Layer



Permeable Pavement Retention Value Calculations

Enhanced Design with Underdrain

- Retention Value = 100% of Storage Volume in Infiltration Sump Layer
- Additional 4.5 CF per 100 SF of practice area

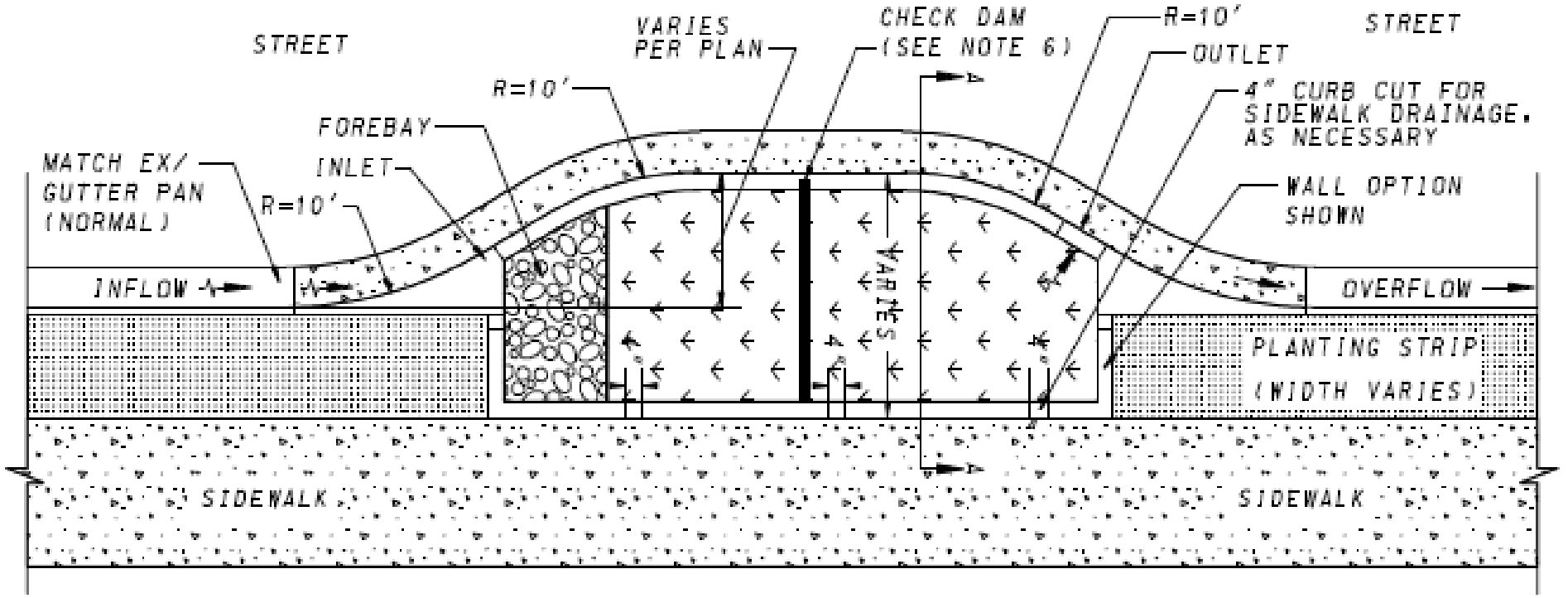


Questions?

Bioretention

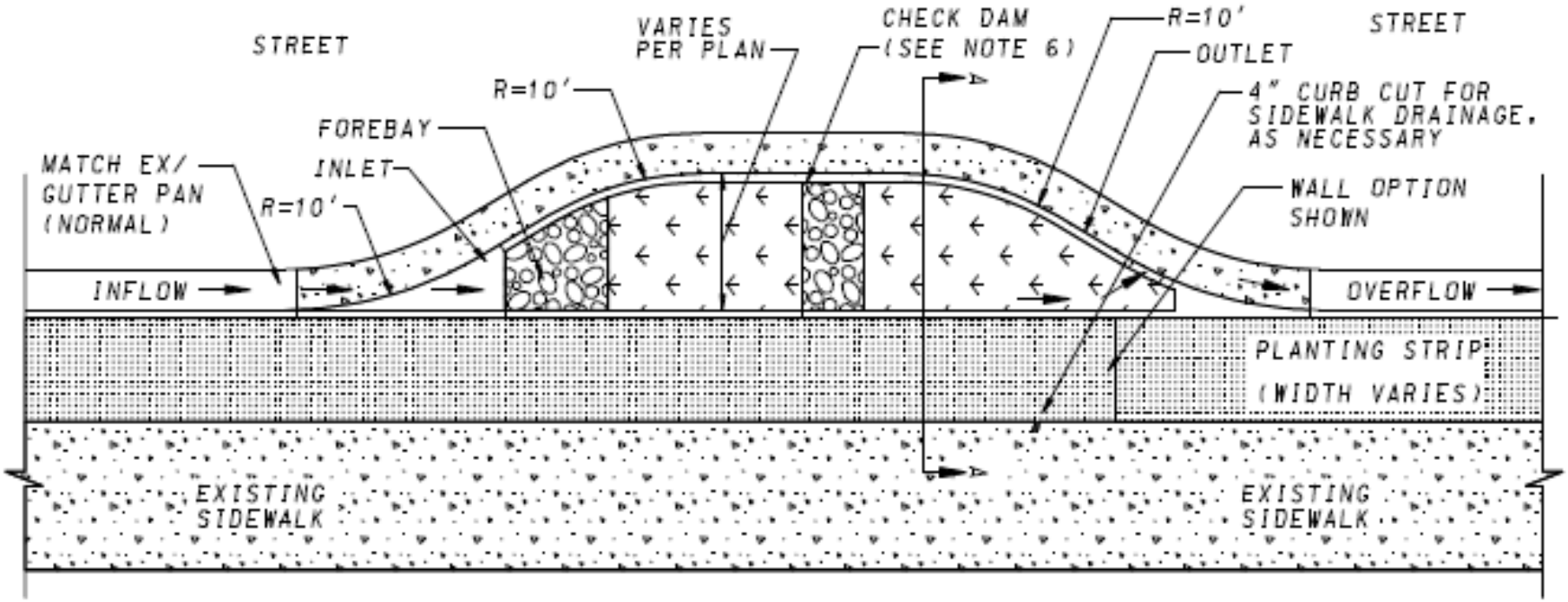
http://twicsy.com/i/GHbDxd

Bioretention – Curb Extension 1



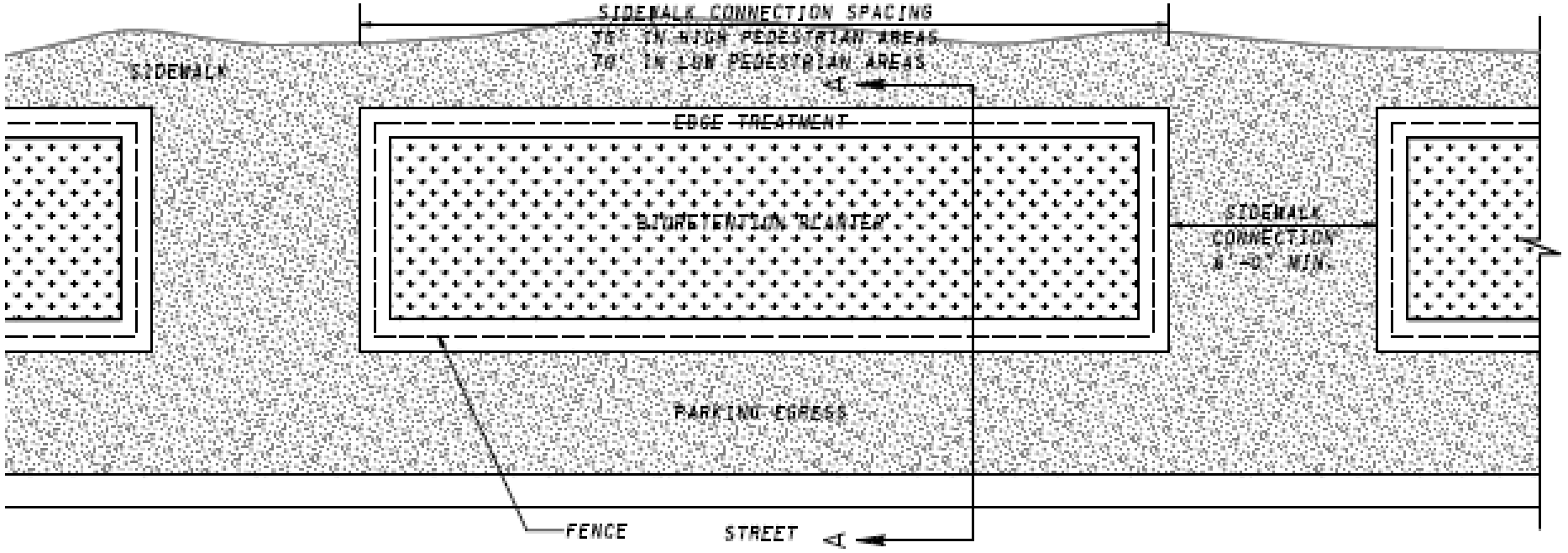
PLAN VIEW

Bioretention – Curb Extension 2

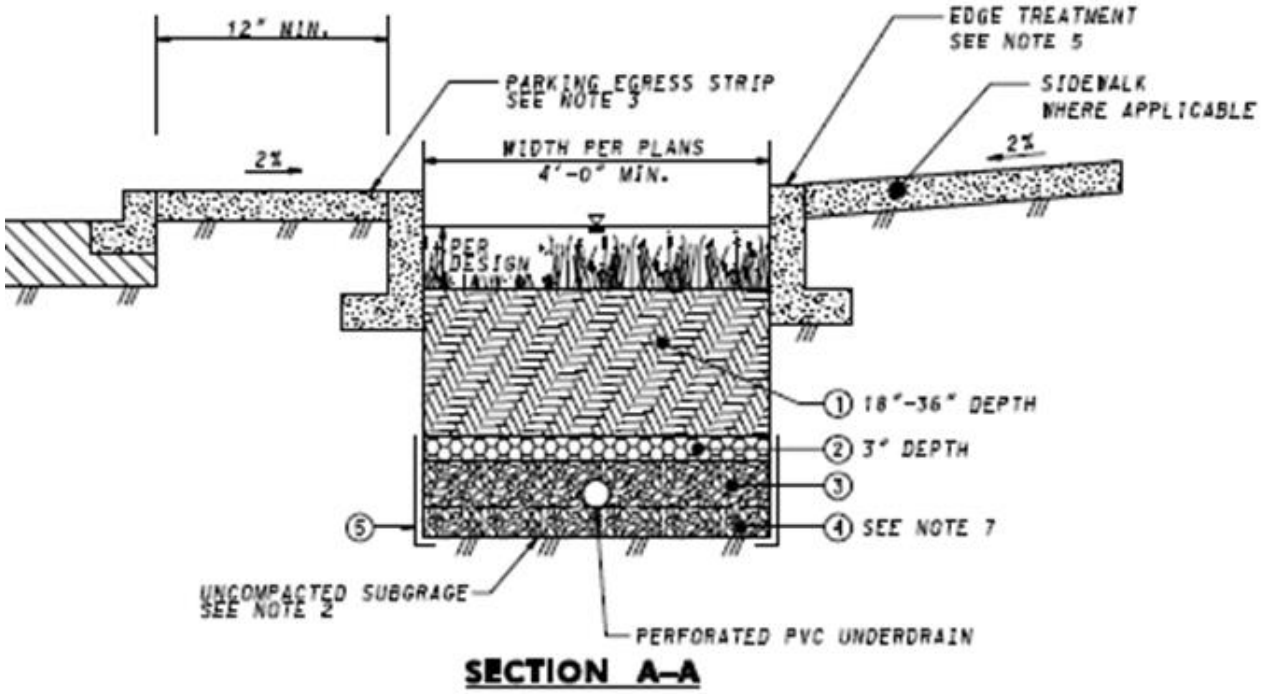


PLAN VIEW

Streetscape Bioretention Planter



Streetscape Bioretention Planter



SECTION A–A

Option adjacent to parking lane

Bioretention Design Criteria

- Maximum ponding depth
  - 18” with 3:1 side slopes
- Minimum filter depth
  - 24” for enhanced designs
  - 18” for small-scale practices
- Infiltration designs
  - Must infiltrate within 72 hours.

Bioretention Design Criteria

- Maximum filter media depth
  - The runoff coefficient of the CDA to the BMP (RvCDA)
  - The bioretention ratio of BMP surface area to the BMP CDA (SA:CDA) (in percent)
  - See Table 3.21

Table 3.21 Determining Maximum Filter Media Depth (feet)

SA:CDA (%)	RvCDA								
	0.25	**0.3**	**0.40**	**0.50**	**0.60**	**0.70**	**0.80**	**0.90**	**0.95**
0.5	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
1.0	5.0	5.5	6.0	6.0	6.0	6.0	6.0	6.0	6.0
1.5	3.5	4.0	5.0	6.0	6.0	6.0	6.0	6.0	6.0
2.0	2.5	3.0	4.0	5.0	5.5	6.0	6.0	6.0	6.0
2.5	2.0	2.5	3.5	4.0	4.5	5.0	5.5	6.0	6.0
3.0	1.5	2.0	3.0	3.5	4.0	4.5	5.0	5.5	5.5
3.5	1.5	1.5	2.5	3.0	3.5	4.0	4.5	5.0	5.0
4.0	1.5	1.5	2.0	2.5	3.0	3.5	4.0	4.5	4.5
4.5	1.5	1.5	2.0	2.5	3.0	3.5	3.5	4.0	4.5
5.0	1.5	1.5	1.5	2.0	2.5	3.0	3.5	4.0	4.0
5.5	1.5	1.5	1.5	2.0	2.5	2.5	3.0	3.5	3.5
6.0	1.5	1.5	1.5	1.5	2.0	2.5	3.0	3.0	3.5
6.5	1.5	1.5	1.5	1.5	2.0	2.5	2.5	3.0	3.0
7.0	1.5	1.5	1.5	1.5	1.5	2.0	2.5	3.0	3.0
7.5	1.5	1.5	1.5	1.5	1.5	2.0	2.5	2.5	2.5
8.0	1.5	1.5	1.5	1.5	1.5	2.0	2.0	2.5	2.5
8.5	1.5	1.5	1.5	1.5	1.5	1.5	2.0	2.0	2.5
9.0	1.5	1.5	1.5	1.5	1.5	1.5	2.0	2.0	2.0
9.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	2.0	2.0
10.0	1.5	1.5	1.5	1.5	1.5	1.5	1.5	2.0	2.0

Bioretention Design Criteria

- Filter Media Specifications
  - 80%-90% sand (at least 75% is classified as coarse or very coarse sand)
  - 10%-20% soil fines (silt and clay; maximum 10% clay)
  - 3%-5% organic matter (leaf compost)
  - P concentrations between 5 and 15 mg/kg (Mehlich I) or 18 and 40 mg/kg (Mehlich III)

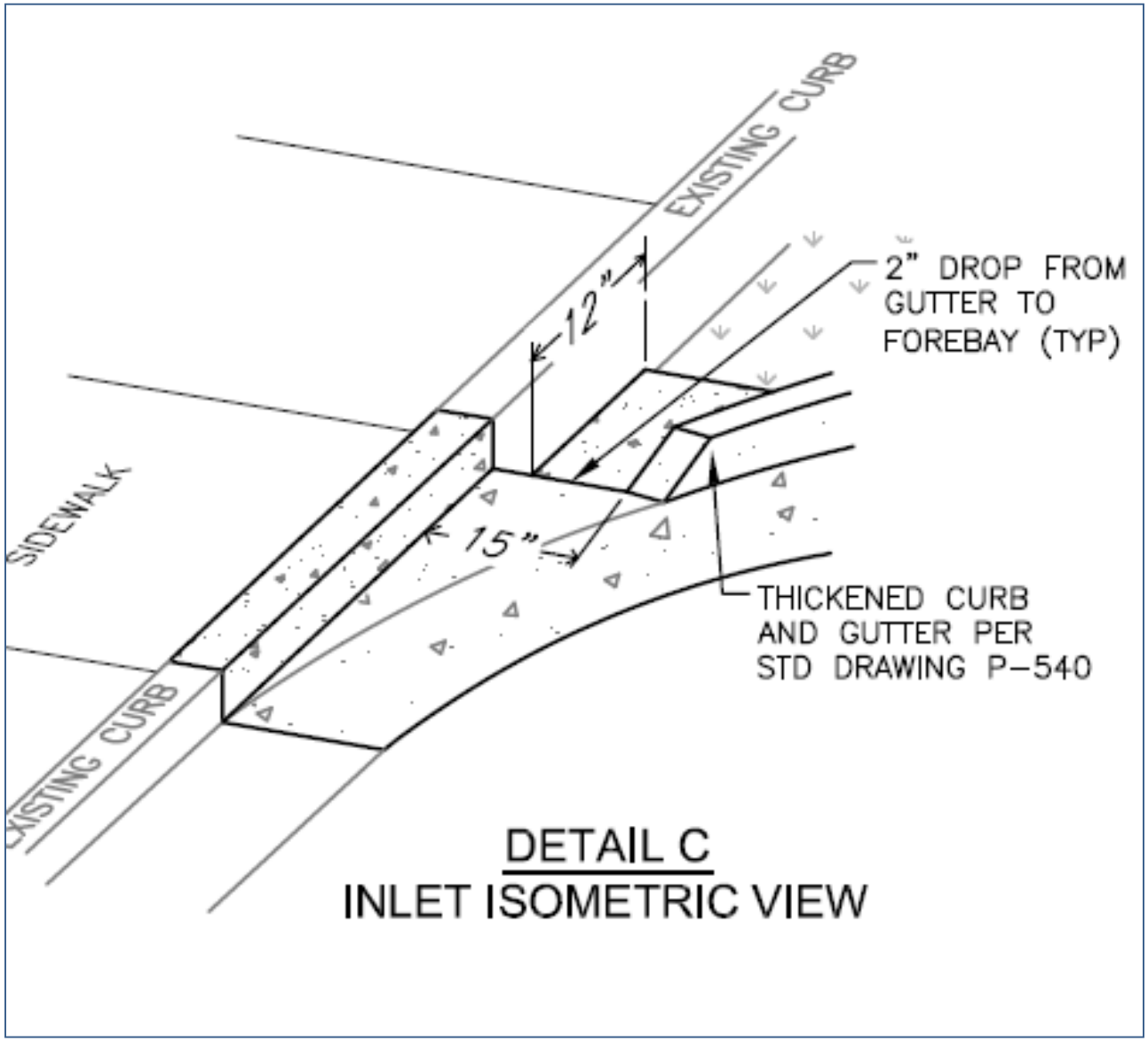
Bioretention Design Criteria

- Filter Media Specifications Continued
  - DDOE mix stated by Percent Mass
  - DDOT mix stated by Percent Volume

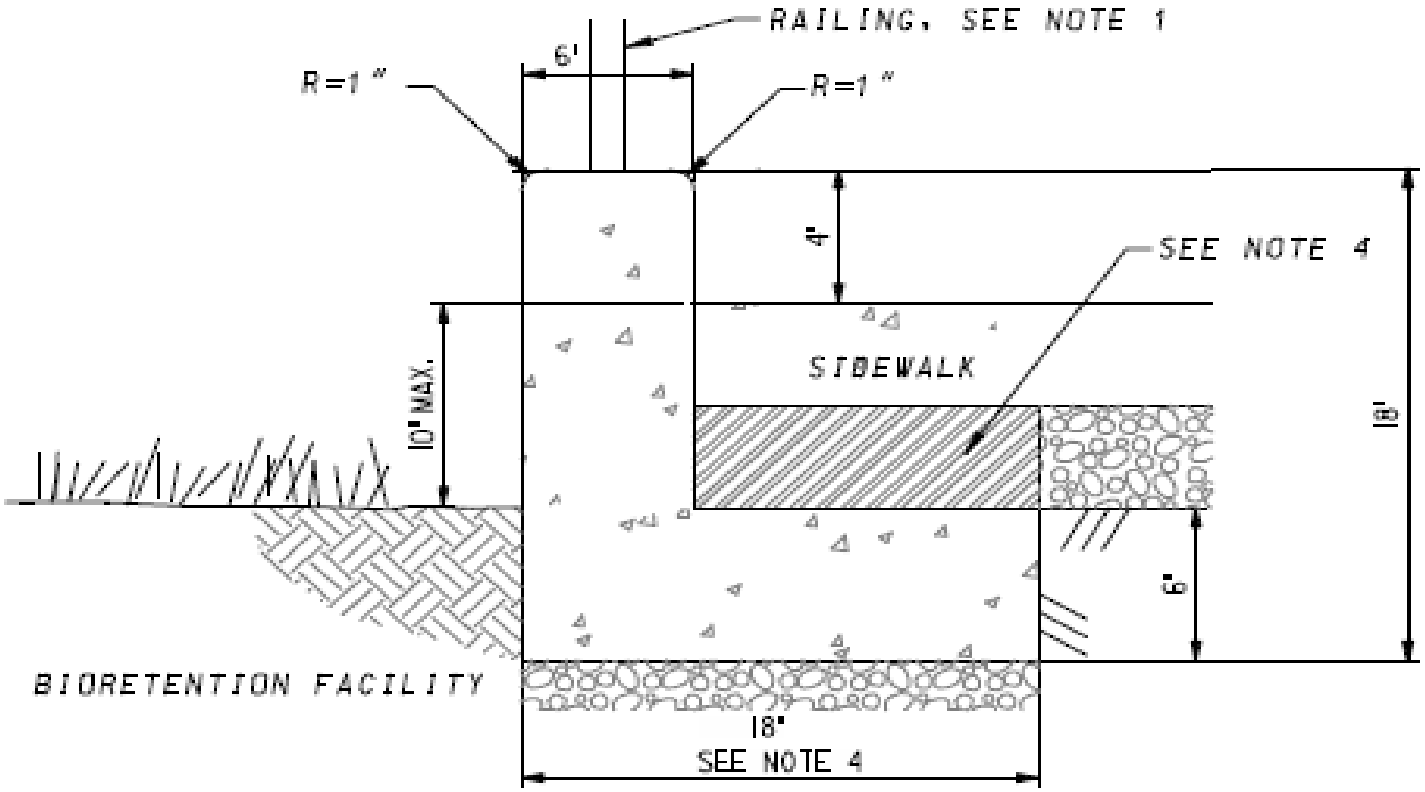
Bioretention Design Criteria

- Safety and access
  - Maximum Ponding Depth for Situation
  - Pedestrian Circulation
  - Vehicular
- Depth to underdrain & overflow tie-ins
- Location of utilities
  - Existing and proposed

Online Bioretention

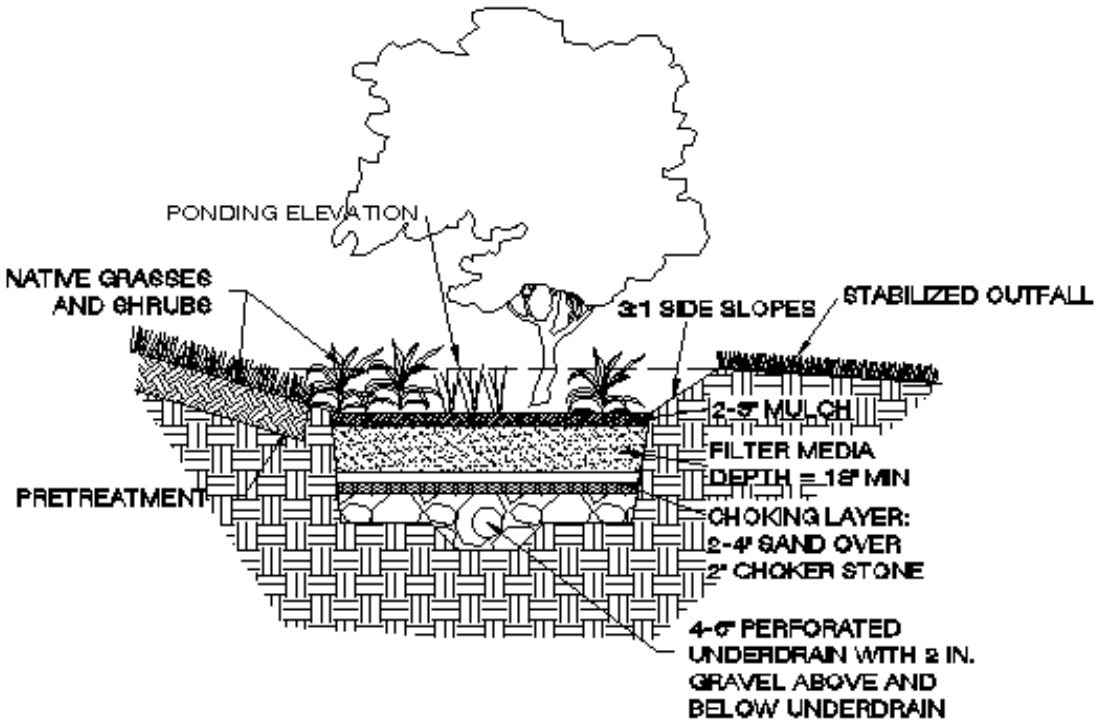


Bioretention – Safety and Access



L–WALL (WITH REVEAL)

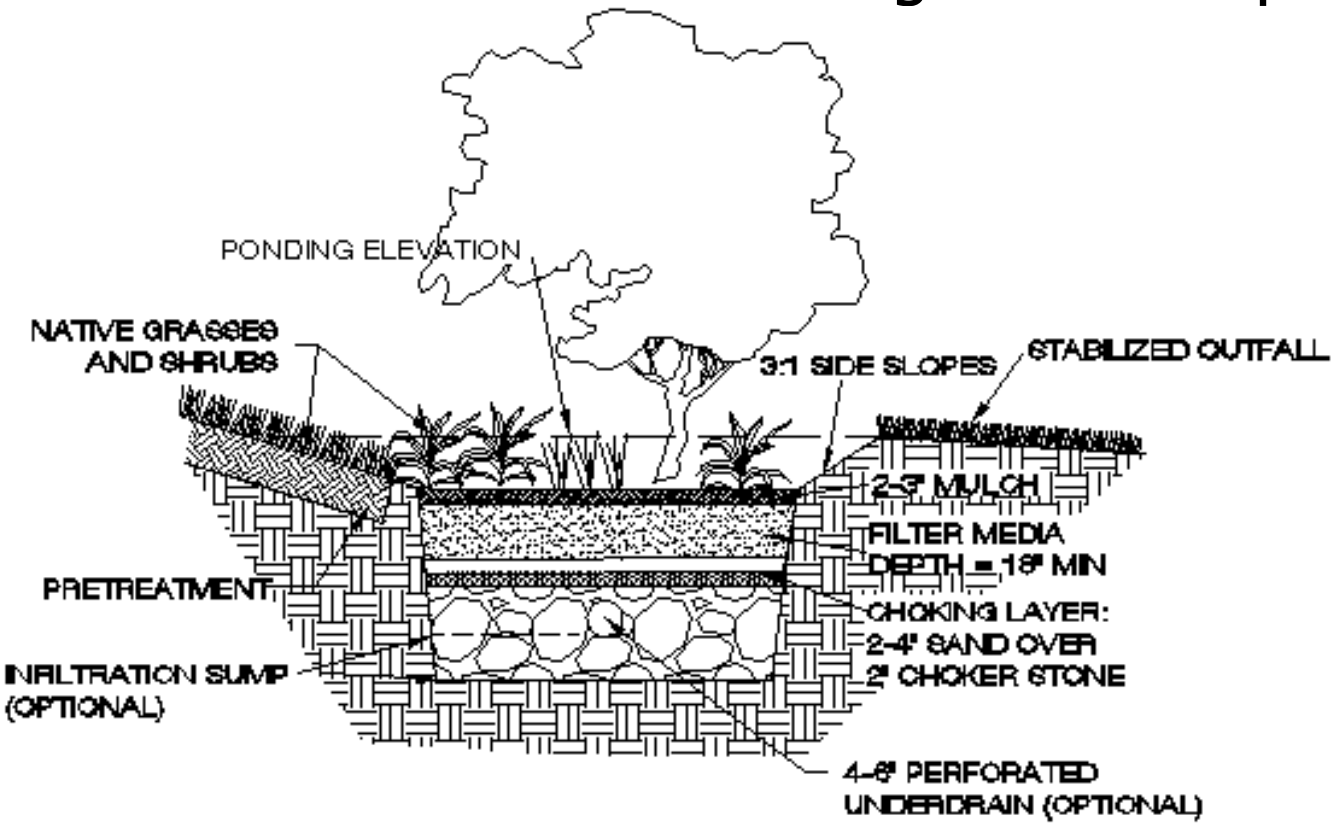
Standard Bioretention Design



- Underdrain designs without enhanced features
- < 24” media
- 60% retention value for the design storm captured
- Additional TSS removal
- Oversizing practice can result in meeting full criteria

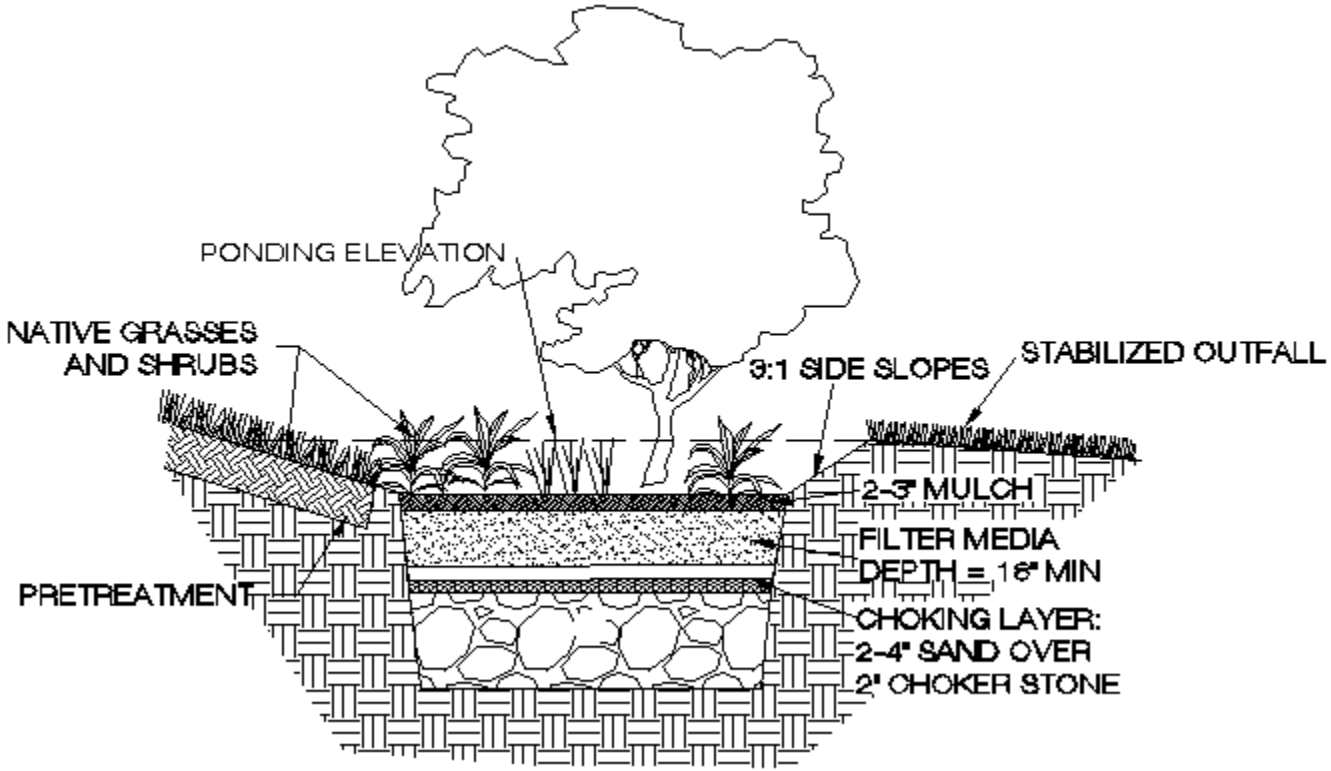
Enhanced Bioretention 1

- Underdrain designs with infiltration sump and 24” media
- 100% retention value for the design storm captured

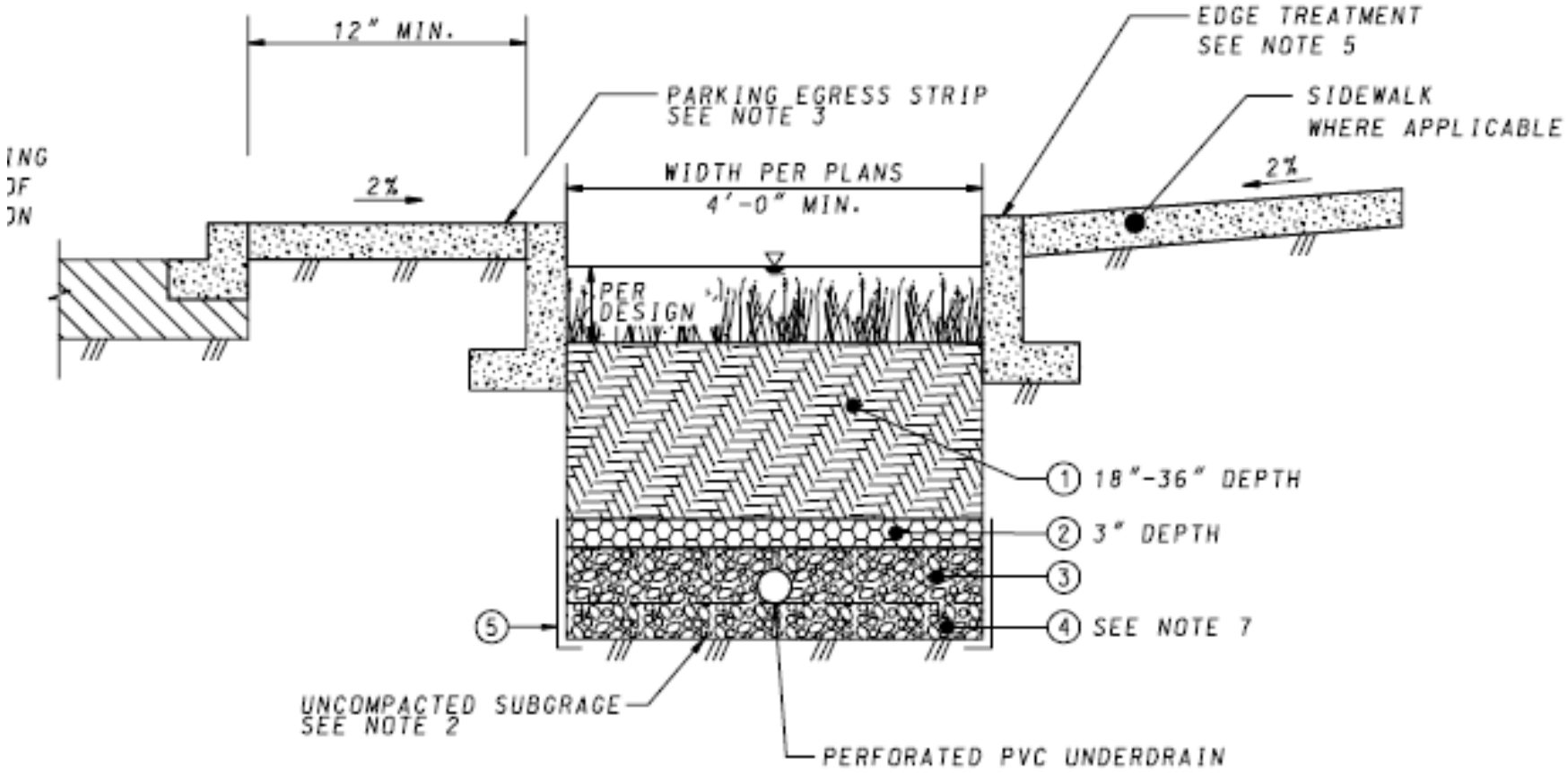


Enhanced Bioretention 2 (Infiltration)

- For infiltration designs (storage volume must infiltrate within **72 hours**)
- Retention value for the design storm captured



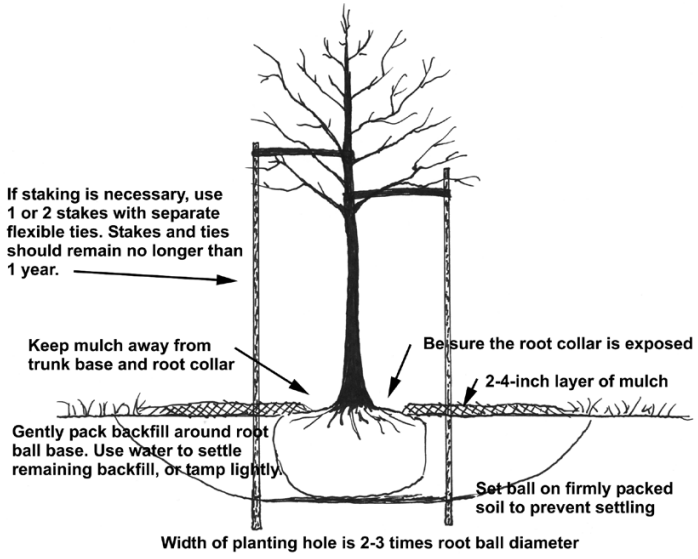
Questions?



SECTION A-A

Tree Planting and Preservation

- Gives Retention Value for individual trees
- Each preserved tree gets 20 cubic foot retention value
- Each newly planted tree gets 10 cubic foot retention value



Trees with Enhanced Soil Volume

- Rootable soil volumes based on tree size at maturity

DDOE planted tree Retention Value *is 10 cf per new large tree.*

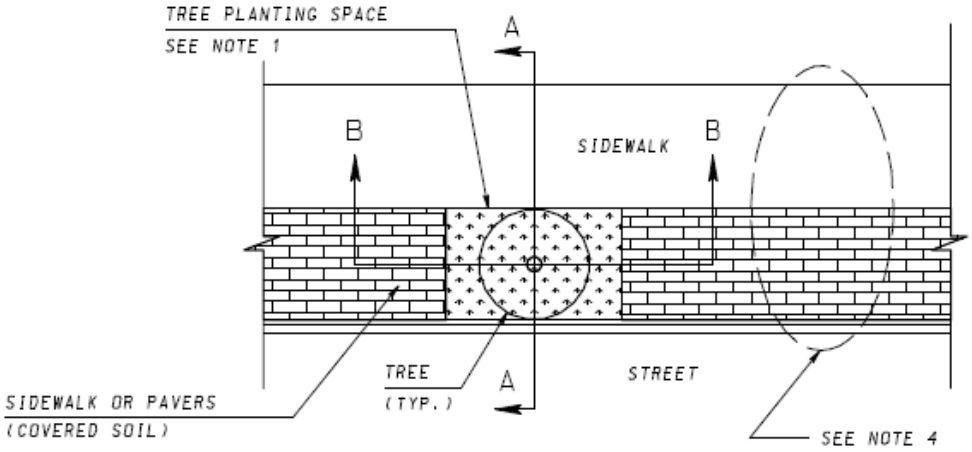
  - Large Trees: 1,500 CF within 27 foot radius
  - Medium Trees: 1,000 CF within 22 foot radius
  - Small Trees: 600 CF within 16 foot radius

- Where trees overlap, soil volume reduction allowed
- Consider open area connected to tree space as part of required soil volume

Creating Rootable Soil Volumes

- Structural Soils
  - Sand Based Structural Soil (SBSS)
  - Patented Soils: E.g. CU Soil™, STALITE Aggregate
- Suspended Pavements
  - E.g. Silva Cell

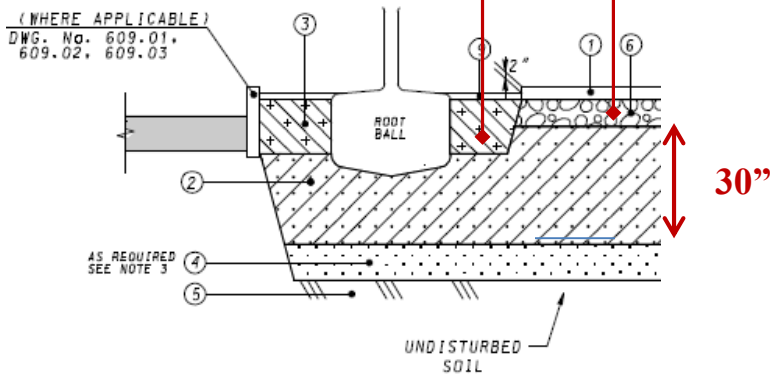
Layouts to Meet Minimum Rootable Soil Volumes



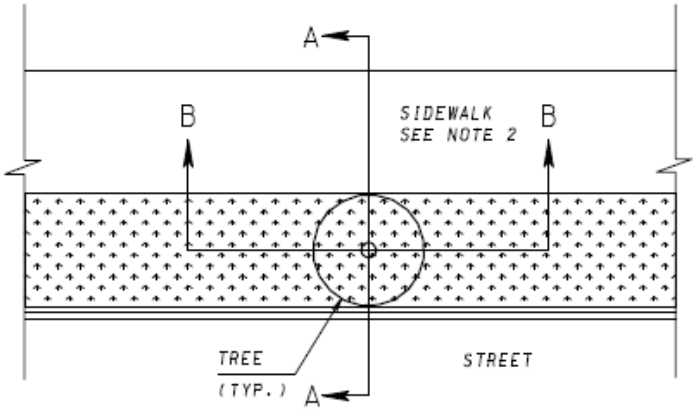
Covered Soil

12” Planting Soil

6” Washed #57

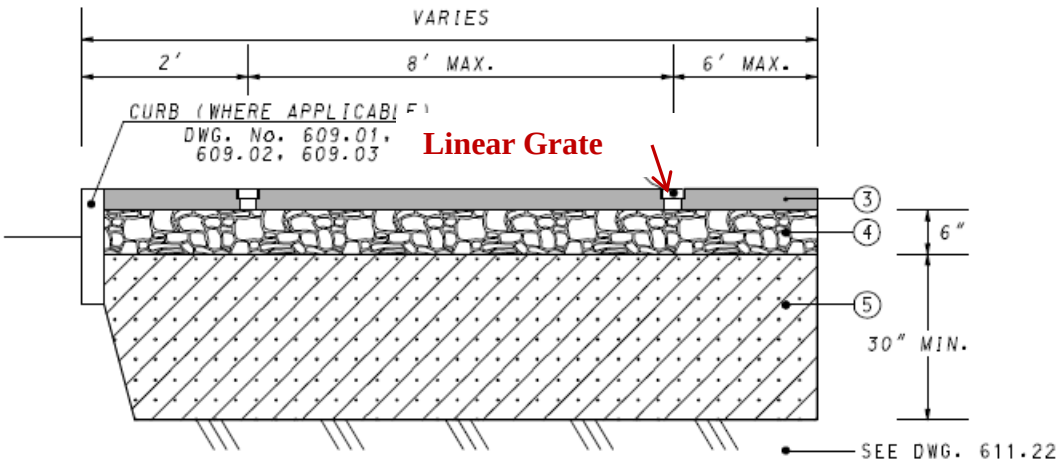


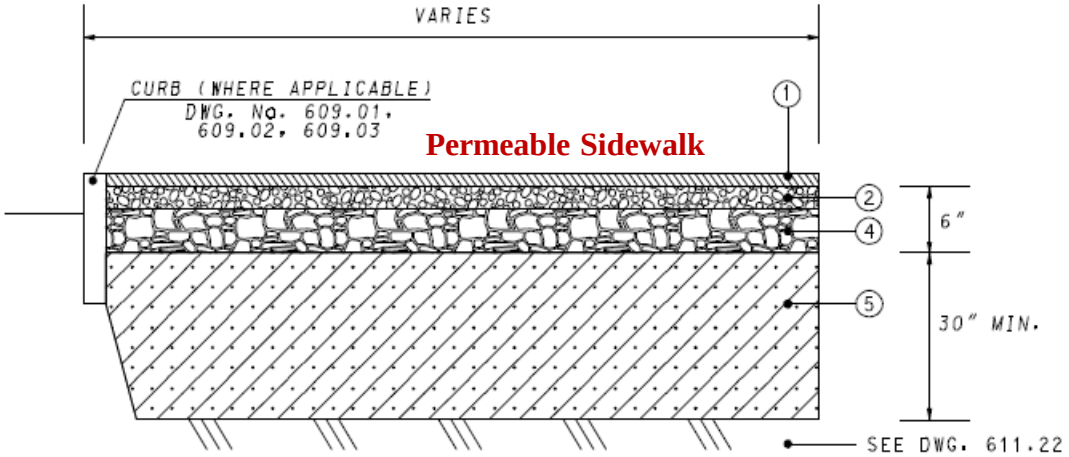
SECTION A–A



Continuous Green Strip

Getting Water to the System





Options to convey water to covered soils,

- *Impervious sidewalk ≤ 6', no special treatment*
- *Permeable Sidewalk*
- *Impervious Sidewalk w/linear grates or sidewalk catch basins*

Access and Safety Barriers

- Parking Egress Strips: 18” to 36”
- Pedestrian Crossings
- Fencing/Railing to protect soil

Design Exercise: Constraints and Assumptions

Potential Constraints

- 12’ recommended sidewalk width
- Utility leads (gas and electric)
- Bike Share
- Sidewalk Dining?
- Others?

Assumptions

Infiltration Rate = 0.1” per hour

Bioretention

1.88’ of storage per sf of practice

Retention = 100% for unlined;
60% for lined practice

Permeable Pavement

4.5 cf/100 sf of practice

Tree Planting

500 sf needed per tree