

6.1 Bioretention Area

Overview



Figure 6-2: Bioretention area (Credit: City of Brisbane)

Description

Bioretention areas (also known as “rain gardens”) are concave or low and flat landscaped areas that function as soil and plant-based filtration devices that remove pollutants through physical and biological treatment processes. Bioretention areas can be any shape, including linear. Linear bioretention areas are sometimes referred to as stormwater planters. The GI Design Guide alternatively refers to bioretention areas as stormwater planters, stormwater curb extensions or rain gardens depending on the setting/location. Rain gardens in residential settings are sometimes simple bowl-shaped landscapes.

Bioretention areas consist of the following layers, starting from the top: a surface ponding area, plants, a layer of mulch, Biotreatment Soil Media (BSM), and an underlying layer of Class 2 Permeable material (Class 2 Perm) with an underdrain (if needed) that connects to the municipal storm drain system.

Bioretention areas should be designed to distribute stormwater runoff evenly within the surface ponding area. The water is temporarily stored in the ponding area and infiltrates through the BSM, which is engineered to have a high rate of permeability. From there, the water filters down into the underlying Class 2 Perm layer.

The Class 2 Perm layer of the bioretention area may be designed to either maximize infiltration or prevent infiltration to the underlying soils. In bioretention areas that maximize infiltration, the underdrain should be raised at least 6 inches above the bottom of the Class 2 Perm layer, and there should be no liner between the bottom of the Class 2 Perm layer and the surrounding soils. Maximizing infiltration is encouraged where conditions are suitable for infiltration – check with the geotechnical engineer. Where infiltration is precluded, the bioretention area should be fully lined with waterproof material, and the underdrain placed at the bottom of the Class 2 Perm layer.

Best uses

- Any type of development
- Drainage area up to two acres
- Landscape design element

Advantages

- Detains low flows
- Landscape feature
- Low maintenance
- Reliable once established

Limitations

- Not appropriate where soil is unstable
- Typically requires irrigation
- Susceptible to clogging if installed without protection from construction site soils

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For strategies and examples of how to retrofit sites and parcels to include bioretention areas, see Sections 3.2 and 3.3 of the GI Design Guide.

Remember that stormwater control measures should be located in areas that can be accessible at any given time for the purpose of operation and maintenance and inspections. Bioretention units should not be located on inaccessible private property such as residential backyards. See Table 6-3 below for recommended bioretention area locations.

Siting

Table 6-3: Recommended locations for bioretention areas (rain gardens)

Recommended Locations	Bioretention
Parking Lot	●
Roof	
Driveway	●
Podium-level	
Close to building	
Away from Buildings	●
Underground	



Figure 6-3: Bioretention area in a multi-family residential property in Redwood City (top; Credit: EOA, Inc.) and in a parking lot in Burlingame (bottom; Credit: SMCWPPP)

Design and Sizing Guidelines

Drainage Area and Setback Requirements

- Setback from structures 10' or as required by structural or geotechnical engineer, or local jurisdiction.
- Follow property line set-back requirements per local jurisdiction zoning. If the bioretention area is on or near the property line, consider if flow from adjacent properties that may cross the property line will affect the sizing of the system.
- Area draining to the bioretention area should not exceed 2 acres.
- Area draining to the bioretention area should not contain a significant source of soil erosion, such as high velocity flows along slopes not stabilized with vegetation or hardscape.
- Areas immediately adjacent to bioretention area should have slopes more than 0.5% for pavement and more than 1% for vegetated areas.

Treatment Dimensions, Grading and Sizing

- It is recommended that bioretention areas be sized to 4% of the impervious surface area on the project site which corresponds to a surface loading rate of 5 inches per hour and a rainfall intensity of 0.2 inches per hour. The area of impervious surface multiplied by 0.04 sizing factor will equal the footprint of the bioretention area. Alternatively, if there are site or infiltration constraints, bioretention sizing may be calculated using the flow-based treatment standard, or the combination flow- and volume-based treatment standard described in Section 5.1 based on the flow entering the basin at the treatment flow rate over the initial hours of the storm until the treatment volume is attained. See Appendix E for more guidance on infiltration issues.
- Where there is a positive surface overflow, bioretention areas should have freeboard of at least 0.2 feet to the lowest structural member versus the 100-year storm water level in the bioretention area, unless local jurisdiction has other requirements.
- Where the bioretention area is in a sump that depends on outflow through a catch basin, the bioretention area should have a freeboard of at least 0.5 feet to the lowest building finished floor elevation (including garage and excluding crawl space) for conditions with the outlet 50 percent clogged, unless local jurisdiction has other requirements. Where the freeboard cannot be provided, an emergency pump may be allowed on a case-by-case basis.
- Allow 2 inches of freeboard between the rim elevation of the outfall grate and elevation of the emergency overflow above the overflow grate such as the top of a flow-through planter wall.
- Side slopes should not exceed 3:1; downstream slope for overflow should not exceed 3:1.
- Bioretention areas, including linear treatment measures, should not be constructed on slopes greater than 4%, unless constructed as a series of relatively horizontal bioretention cells. A bioretention facility should be one level (maximum 2% inner cell slope), shallow basin or a series of basins. As runoff enters each basin, it should flood and fill throughout before runoff overflows to the outlet or to the next downstream basin. This will help prevent movement of surface mulch and soil. In a linear bioretention area, check dams should be placed for every 4 to 6 inches of elevation change and so that the top of each dam is at least as high as the toe of the next upstream

dam. A similar principle applies to bioretention facilities built as terraced roadway shoulders³¹. The slope within cells should not exceed 2% and check dams should be used to hold flow above the 2% level before allowing flow to enter the next cell. Bioretention cells are not recommended if overall slope exceeds 8%. If designing a sloped bioretention area with a surface reservoir (volume method or combined flow and volume method), the slope will have to be factored in the calculation of the surface reservoir height. See Appendix E for more guidance on infiltration measures. **See Section 4.3 of the GI Design Guide for guidance on how to deal with steep topography** using check dams and weirs.

- Surface ponding depths may vary, with a recommended depth of 6 inches (measured from the top of the BSM layer – not the mulch layer - to the overflow rim elevation) and a maximum depth of 12 inches. If ponding depths exceed 6 inches, the landscape architect may want to consider effects on the planting palette. The 3" mulch layer can be within the 6" ponding depth.

Inlets to Treatment Measure

- Flow may enter the treatment measure in the following ways (see example drawings in Section 5.13):
 - As overland flow from landscaping (no special requirements);
 - As overland flow from pavement (cutoff wall required);
 - Through a curb opening;
 - Through a curb drain;
 - Within a drop structure through a stepped manhole (refer to Figure 5-1 in Section 5.6);
 - Through a bubble-up emitter; and/or
 - Through a roof leader or other conveyance from a building roof.
- Where flows enter the biotreatment area, allow a change in elevation of 4-6 inches between the paved surface and the biotreatment soil media elevation (i.e. a recommended 2" drop from the inlet to the mulch or splash block), so that vegetation or mulch build-up does not obstruct flow.
- Splash blocks or splash aprons with or without grouted cobble, pea gravel, plants or mulch should be installed to dissipate flow energy and velocity where runoff enters the treatment measure, and at the downstream side of tiers, weirs and check dams to prevent erosion.

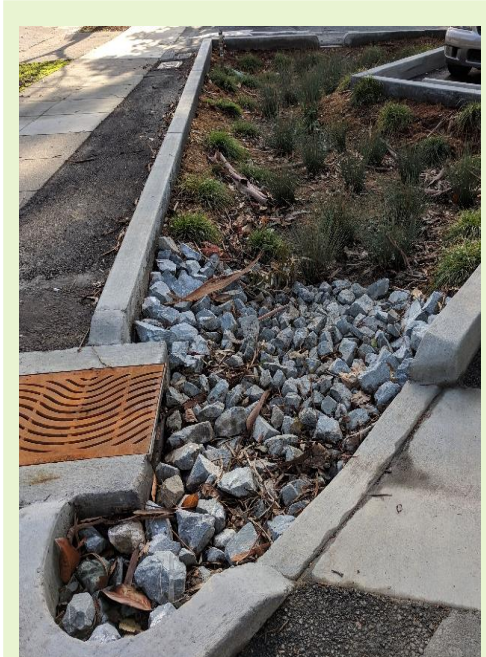


Figure 6-4: Examples of curb cut inlets at a bioretention area in Burlingame (Credit: City of Burlingame)

³¹ Contra Costa Clean Water Program. February 2012. C.3 Stormwater Guidebook, 6th Edition and Stormwater Management Handbook: Implementing Green Infrastructure in Northern Kentucky Communities, 2009. (www.epa.gov/smartgrowth/publications.htm)

- Curb openings should be a minimum of 18 inches wide (or 12" if allowed by the municipality), with the number and locations designed so that runoff is dispersed throughout the bioretention area or through the use of a flow spreading system.
- Bubble-up emitters and pipes to bubble-up emitters should have weep holes to avoid standing water inside after storm events.

Vegetation



Figure 6-5: Bioretention area featuring several plant types (Credit: City of Burlingame)

- Plant species should be suitable to well-drained soil and occasional inundation. See planting guidance in Appendix A.
- Shrubs and small trees should be placed to anchor the bioretention area cover.
- Tree planting should be as required by the municipality. If larger trees are selected, plant them at the periphery of the bioretention area, where roots can access non-BSM soils outside the area.
- Underdrain trenches can be placed at the edge of tree planting zones, as needed, to maximize distance between tree roots and the underdrain, but the underdrain trench must still be located somewhere under the BSM section and within the Class 2 Perm material layer.
- Use integrated pest management (IPM) and/or Bay-Friendly principles in the landscape design to help avoid or minimize any use of synthetic pesticides and quick-release fertilizer. Check with the local jurisdiction for any local policies regarding the use of pesticides and fertilizers.
- Irrigation should be provided as needed to maintain plant health. If irrigation cannot be provided, then watering by hand should be accommodated weekly through plant establishment – typically through the first six months depending on the season and levels of precipitation.
- Trees and vegetation should not block inflow, create traffic or safety issues, or obstruct utilities.

Soil and Drainage Considerations Specific to Bioretention Areas

- Consideration of groundwater level and placement of the underdrain:
 1. If there is less than a 5-foot separation between the bottom of the facility and the seasonal high groundwater level, or infiltration is not allowed due to other site constraints, an impermeable liner should be placed between the Class 2 Perm and the bottom of the facility and the underdrain placed on top of that liner.
 2. If there is at least a 5-foot separation between the bottom of the facility and the seasonal high groundwater level, and geotechnical conditions allow infiltration, the facility should be unlined and the underdrain should be raised at least 6 inches above the bottom of the Class 2 Perm to allow storage and infiltration of treated water.

Soil and Drainage Considerations for All Biotreatment Systems

- Soil used in the bioretention area must meet the biotreatment soil media (BSM) specification included in Appendix K. Check with municipality for any additional requirements.
- Bioretention areas should have a minimum BSM depth of 18 inches.
- Install and maintain a 3-inch layer of composted arbor mulch (also called “aged mulch”) in areas between plantings. Rock mulches such as river cobble or pea gravel, or other mulches that resist floating may be used, but large rock mulch, such as cobble, should be used sparingly and only where absolutely necessary. Dyed, “micro-bark”, or “gorilla hair” mulches, as well as chipped wood mulch from recycled pallets and dimensional lumber, are not recommended. **See Sections 4.9 and 6.3 of the GI Design Guide** for more information on mulch.
- An underdrain system is generally required. Depending on the permeability of in situ soils, the local jurisdiction may allow installation without an underdrain on a case-by-case basis.
- Filter fabric should not be used around the underdrain or between the BSM and Class 2 Perm layer. Class 2 Perm performs the function of filter fabric (keeping the BSM from exiting the system through the underdrain) but is less prone to clogging.
- The underdrain should consist of a solid perforated or slotted HDPE or PVC pipe connected to a cleanout pipe(s) and to a storm drain or discharge point. Solid HDPE or triple-walled HDPE pipe, with smooth inner and outer layers and a corrugated middle layer, are recommended. The cleanout should consist of a vertical, rigid, non-perforated, non-corrugated PVC or HDPE pipe, with a minimum diameter of 4 inches and a watertight cap fit, raised or flush with the ground, or as required by municipality. There should be adequate fall (min. 0.5% slope) from the underdrain to the storm drain or discharge point. See Section 5.14 for more information on underdrains.
- The underdrain should be placed in a 12-inch thick layer of Caltrans Class 2 permeable material, or similar municipality-approved material. See Section 5.14 for more information on Class 2 permeable material.

Construction Requirements and Maintenance Plans

Construction Requirements for All Biotreatment Systems

- When excavating, avoid spreading fines of the soils on bottom and side slopes. Remove any smeared soiled surfaces and provide a natural soil interface into which water may percolate.
- Minimize compaction of existing soils. Protect from construction traffic.
- Protect the area from construction site runoff. Runoff from unstabilized areas should be diverted away from biotreatment facility.
- ***For additional construction guidelines, see Chapters 2, 4 and 5 of the GI Design Guide.*** Specifically, see Sections 4.3 through 4.9 for construction strategies for dealing with slopes, overflows, poor soils, utilities, runoff capture, etc.

Remember

Maintenance Considerations for All Treatment Measures

- See Chapter 8 of this Guide for specific maintenance guidance. Specifically, see Section 8.3.1 for common maintenance concerns encountered for bioretention areas.
- ***See Chapter 6 of the GI Design Guide*** for landscape maintenance recommendations and information.
- A Maintenance Agreement should be provided and should state the parties' responsibility for maintenance and upkeep.
- Prepare a maintenance plan and submit with Maintenance Agreement. Maintenance plan templates are in Appendix G

Typical Design Details

Note that even though not shown in the details below, 3" of mulch will need to be added on top of the biotreatment soil media for all bioretention area measures - 2" of freeboard is also recommended.

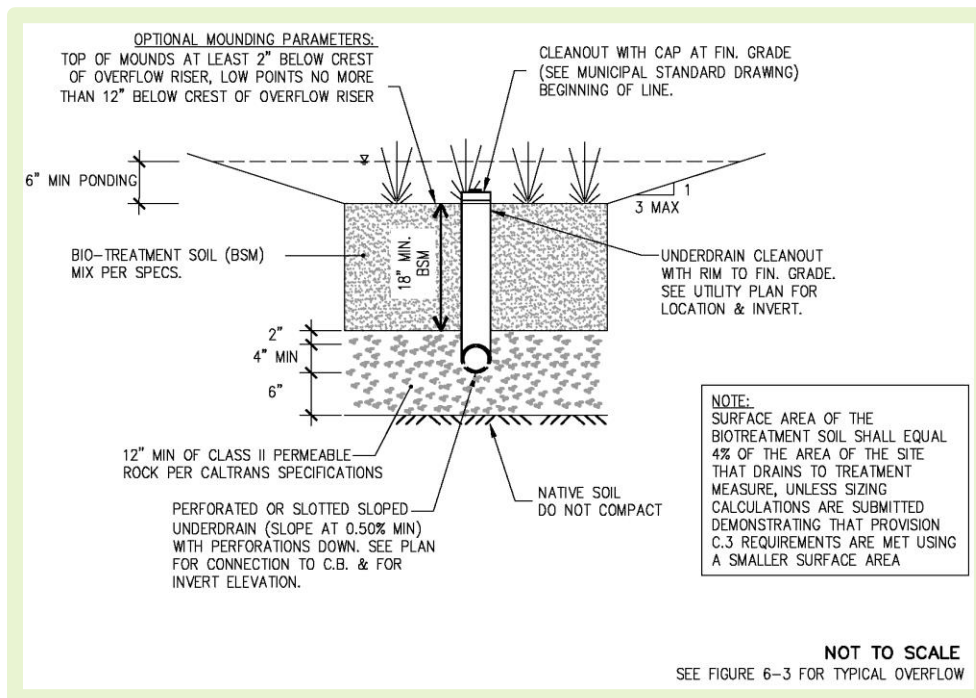


Figure 6-6: Cross Section, Bioretention Area with Infiltration

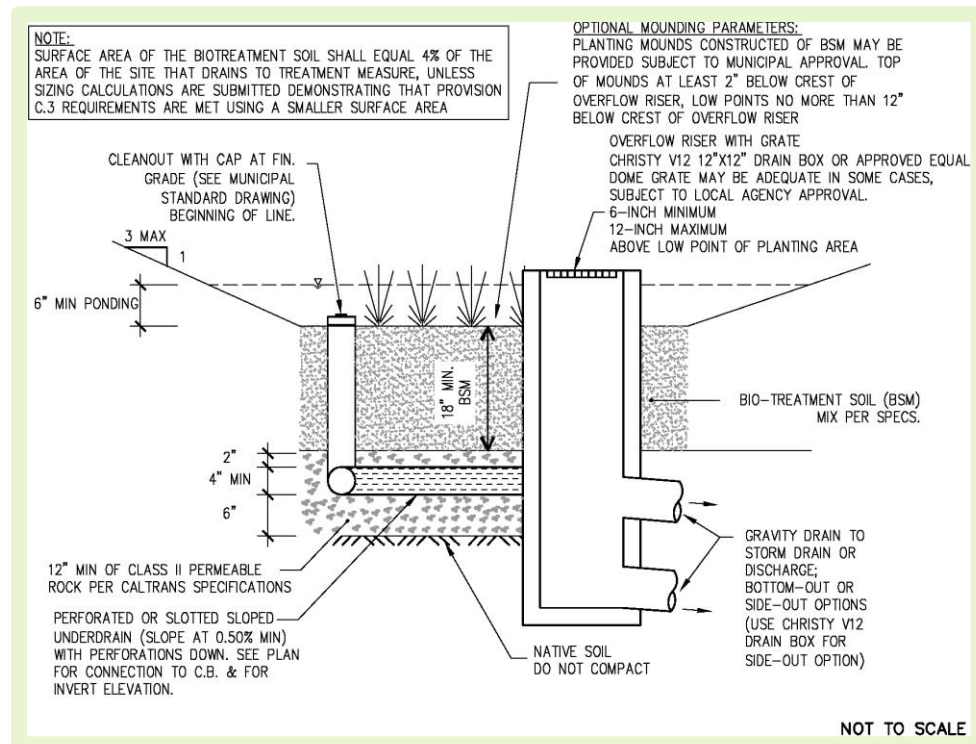


Figure 6-7: Cross Section, Bioretention Area (side view) with Infiltration

6.1 Bioretention Area

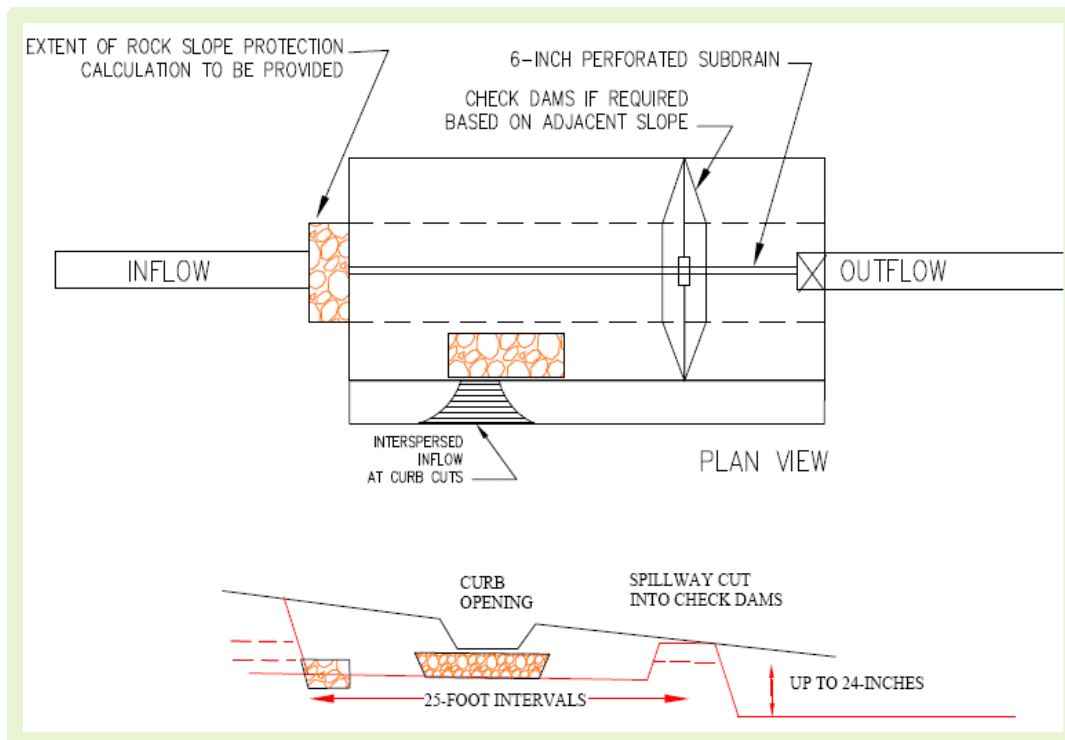


Figure 6-8: Check dam (plan view and profile) for installing a series of linear bioretention cells in sloped area

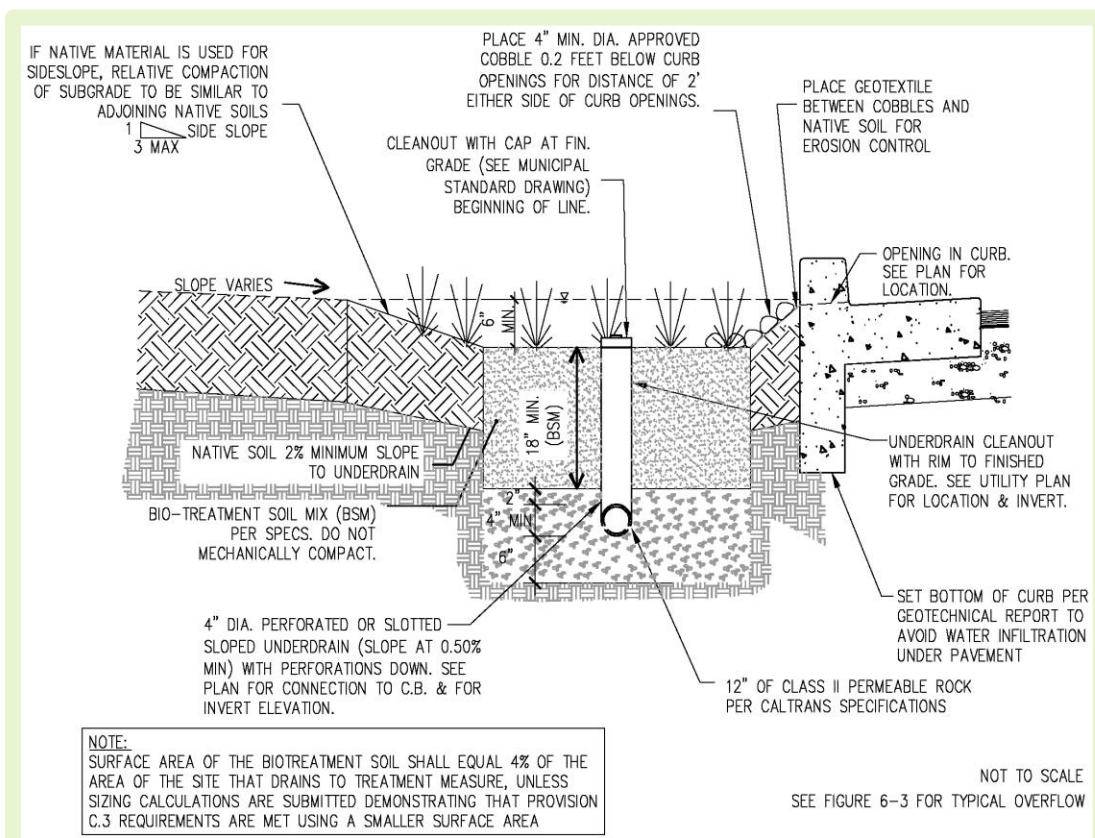


Figure 6-9: Cross section of bioretention area with infiltration showing inlet from pavement.

6.1 Bioretention Area

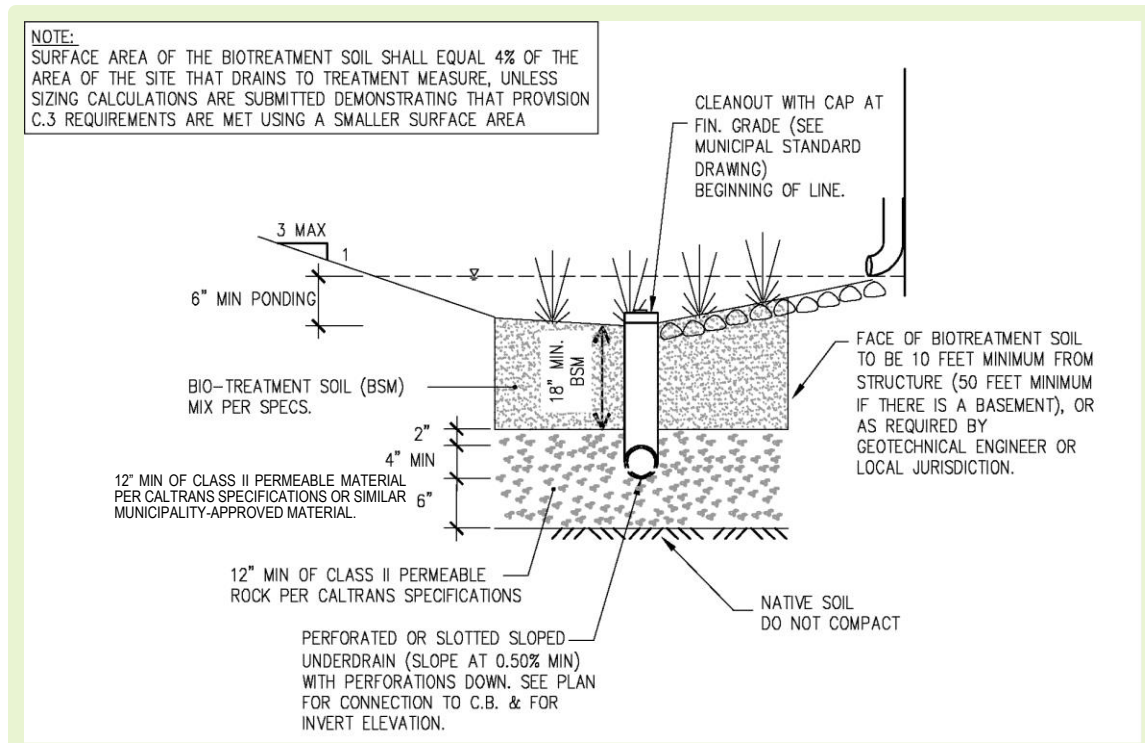


Figure 6-10: Bioretention area in landscaping to treat runoff from rainwater leaders (Not to Scale)

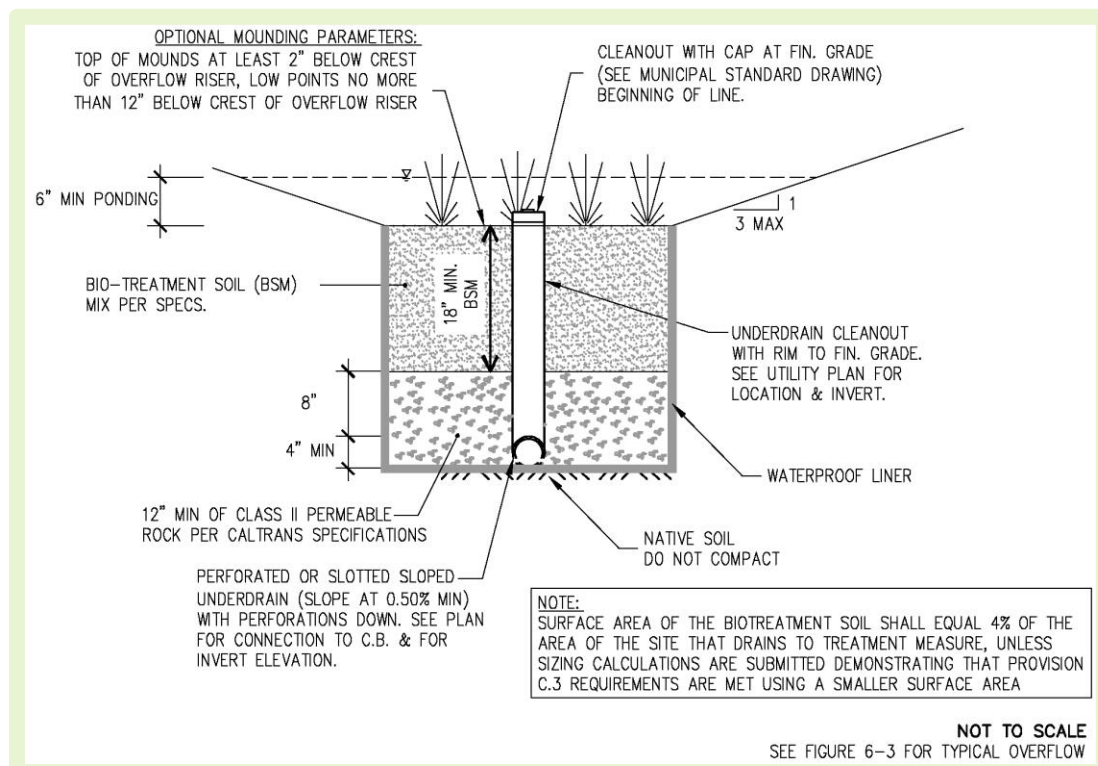


Figure 6-11: Cross section of lined bioretention area, for locations where infiltration is precluded.