A.2 BIORETENTION SWALES

Location: Logan Avenue, San Diego, California.

Figure A.2-1. Bioretention Swale in roadway median (rendering).

A.2.1 Design

The design of a bioretention swale can be broken down to a nine-step process. Table A.2-1 summarizes the steps, which this chapter describes in greater detail.

Table A.2-1. Bioretention swale iterative design step process

Design step		Design component/ consideration	General specification
1	**Integrated Management Practice (IMP) Siting (A-26)**	Layout and site incorporation	Based on available space and maintenance access, incorporate into parking lot islands, medians, and perimeter; install along the roadway right-of-way; incorporate as landscaped areas throughout the property.
2	**Determine IMP Function and Configuration (A-27)**	Impermeable liner	If noninfiltrating, use an impermeable clay layer, geomembrane liner, and concrete (as described in Common Design Elements)
		Underdrain (required if subsoil infiltration rate is less than 0.5 inches per hour [in/hr], as in hydrologic soil groups C and D [HSG C & D])	Schedule 40 PVC pipe with perforations (slots or holes) every 6 inches. The 4-inch diameter lateral pipes should join a 6-inch collector pipe, which conveys drainage to the downstream storm network. Provide cleanout ports/observation wells for each underdrain pipe (see Common Design Elements).
		Internal water storage (IWS)	If using underdrain and infiltration, elevate the outlet to create a sump for additional moisture retention to promote plant survival and enhanced treatment. Top of IWS should be greater than 18 inches below surface.
		No underdrain	If design is fully infiltrating, ensure that subgrade compaction is minimized.
		Lateral hydraulic restriction barriers	Use a geomembrane, concrete, or bentonite clay to restrict lateral flows to adjacent subgrades, foundations, or utilities.
3	**Determine IMP Sizing Approach (A-29)**	Flow-based (common SUSMP methodology)	Refer to chapters 2 and 4 of the County SUSMP for appropriate sizing factors to determine surface area, ponding depth, and media depth. Step 4 of this design guidance section can be skipped when using this method.
		Volume-based (water quality methodology)	Per the County SUSMP, the volume of the 24-hour 85th percentile storm is required for the water quality treatment method.
4	**Size the System (A-29)**	Temporary ponding depth	6 to 18 inches (6 to 12 inches near schools or in residential areas); average ponding depth of 9 inches is recommended.
		Soil media depth	1.5 to 4 feet (deeper for better pollutant removal, hydrologic benefits, and deeper rooting depths).
		Slope and grade control	If necessary, use check dams to maintain maximum 2.5 percent bed slope. Install a 4-inch-deep layer of ASTM No. 57 stone (underlain by filter fabric) extending 2 feet downslope from check dam to prevent erosion.
		Surface area (volume-based water quality)	Find surface area required to store treatment volume within temporary ponding depth, soil media depth, and gravel drainage layer depth (media porosity ≈ 0.35 and gravel porosity ≈ 0.4).

Design step		Design component/ consideration	General specification
5	**Specify Soil Media (A-32)**	Composition and texture (by volume)	65 percent sand, 20 percent sandy loam, and 15 percent compost (from vegetation-based feedstock). Animal wastes or by-products should not be applied.
		Permeability	5 in/hr infiltration rate for the flow-based SUSMP method (1–6 in/hr for alternative designs, as approved by local jurisdiction).
		Chemical composition	Total phosphorus < 15 parts per million (ppm); pH 6–8; cation exchange capacity > 5 milliequivalents per 100 grams (meq/100 g) of soil; organic matter content < 5 percent by weight.
		Drainage layer	Separate soil media from underdrain layer with 2 to 4 inches of washed sand, followed by 2 inches of choking stone (ASTM No. 8) over a 1.5-foot envelope of ASTM No. 57 stone.
6	**Design Inlet and Pretreatment (A-32)**	Inlet	Provide stabilized inlets (see Common Design Elements).
		Pretreatment	Install rock-armored forebay (concentrated flow), gravel fringe and vegetated filter strip (sheet flow), or vegetated swale.
7	**Select and Design Overflow/Bypass Method (A-32)**	Outlet configuration	Online: All runoff is routed through system; install an elevated overflow structure or weir at the elevation of maximum ponding. Offline: Only treated volume is diverted to system; install a diversion structure or allow bypass of high flows (see Common Design Elements).
		Hydromodification control	Provide additional storage and size an appropriate nonclogging orifice or weir to dewater detention volume.
8	**Select Mulch and Vegetation (A-32)**	Mulch	Dimensional chipped hardwood or triple-shredded, well-aged hardwood mulch 3 inches deep.
		Vegetation	See Plant Palette (Appendix E).
9	**Design for Multi-Use Benefits (A-32)**	Additional benefits	Include features to enhance habitat, aesthetics, public education, and shade.

A.2.1.1 Step 1. IMP Siting

Bioretention swales can be incorporated in many places to meet more than one project-level or watershed-scale objective. Examples include the following:

- Landscaped parking lot islands
- Between parking stalls in parking lots
- Rights-of-way along roads

The bioretention swale's configuration will determine the required components. Figure A.2-2 shows an example of the components of a typical bioretention swale. When siting bioretention swales, consideration must always be given to provide access for routine, intermittent, and rehabilitative maintenance activities.

Bioretention swales can be combined with other integrated management practices (IMPs) to form a treatment train that can enhance water quality treatment and reduce runoff volume and rate.

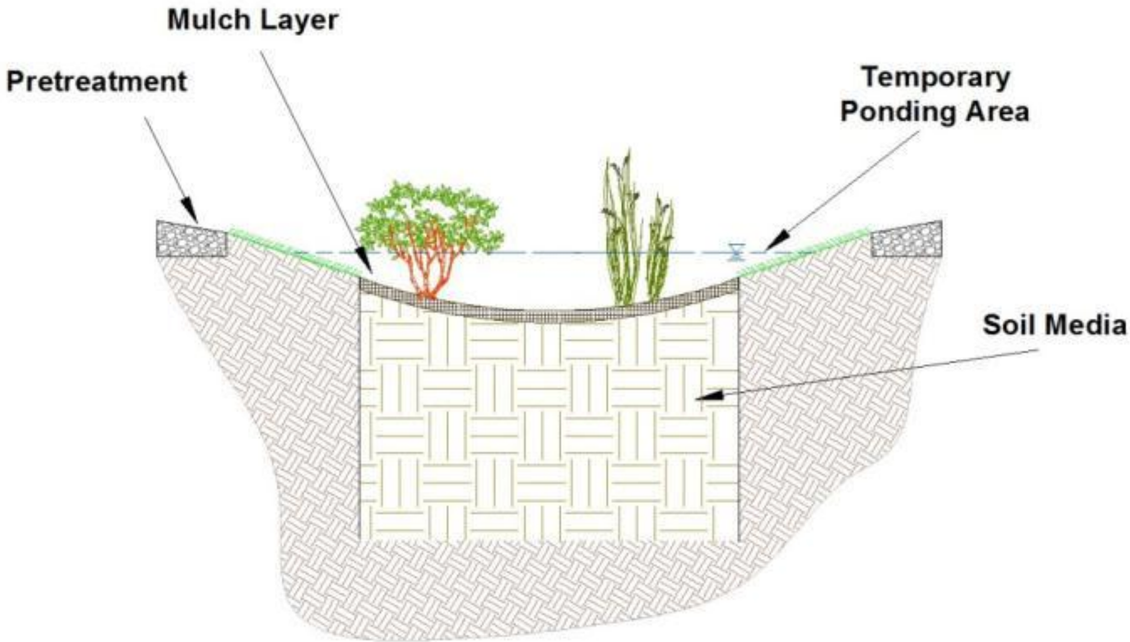

Figure A.2-2. Bioretention swale components.

A.2.1.2 Step 2. Determine IMP Function and Configuration

Bioretention swale configuration selection should follow the selection matrix outlined in the Bioretention section (A.1.1.2). Figure A.2-3 through Figure A.2-6 illustrate the recommended configurations.

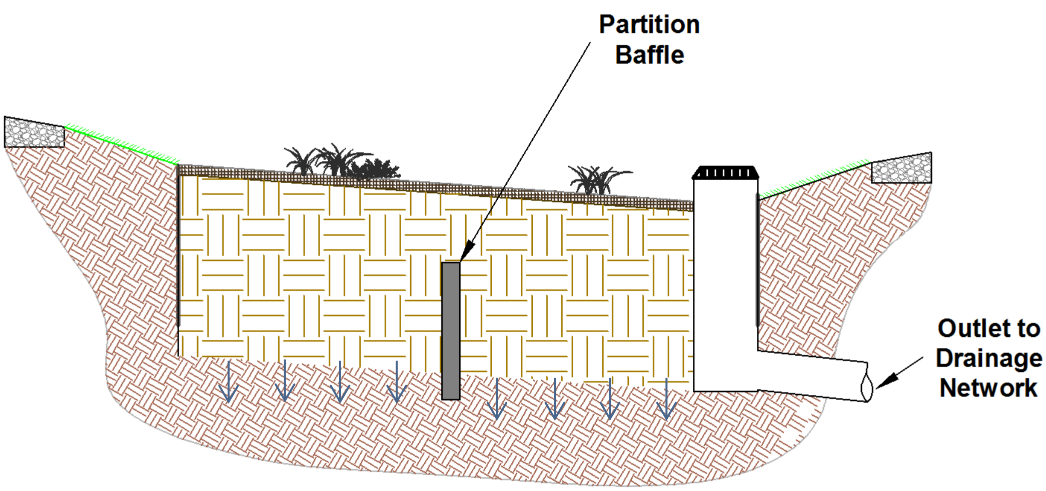

Figure A.2-3. Configuration 1 – Infiltration bioretention swale with no underdrain.

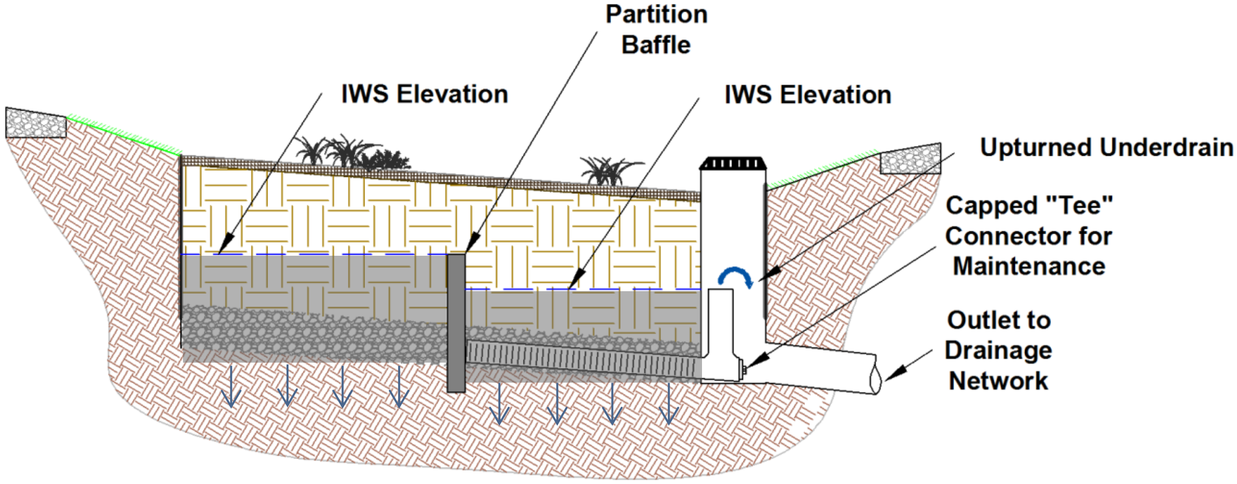

Figure A.2-4. Configuration 2 – Infiltration bioretention swale with upturned underdrain.

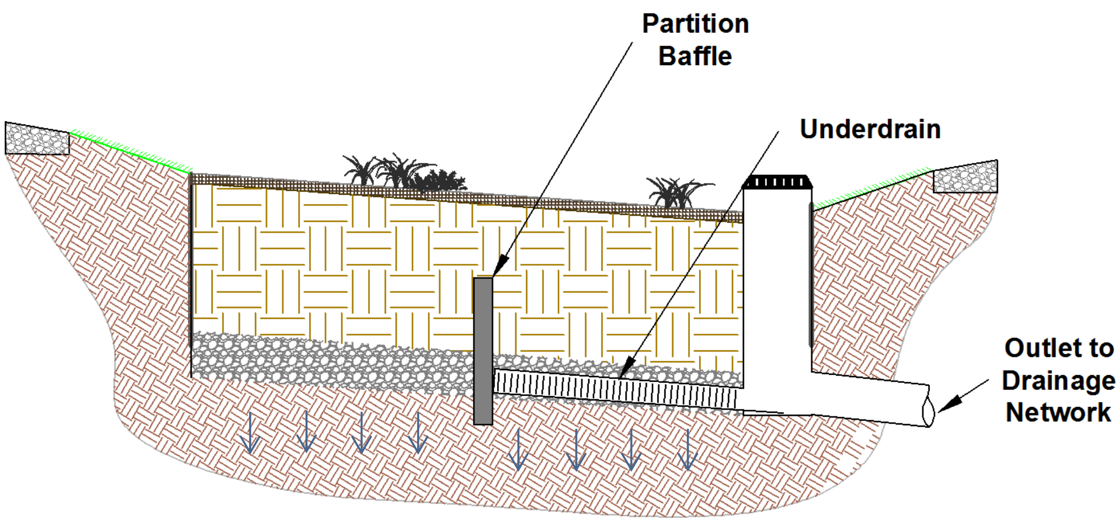

Figure A.2-5. Configuration 3 – Infiltration bioretention swale with underdrain on the subgrade.

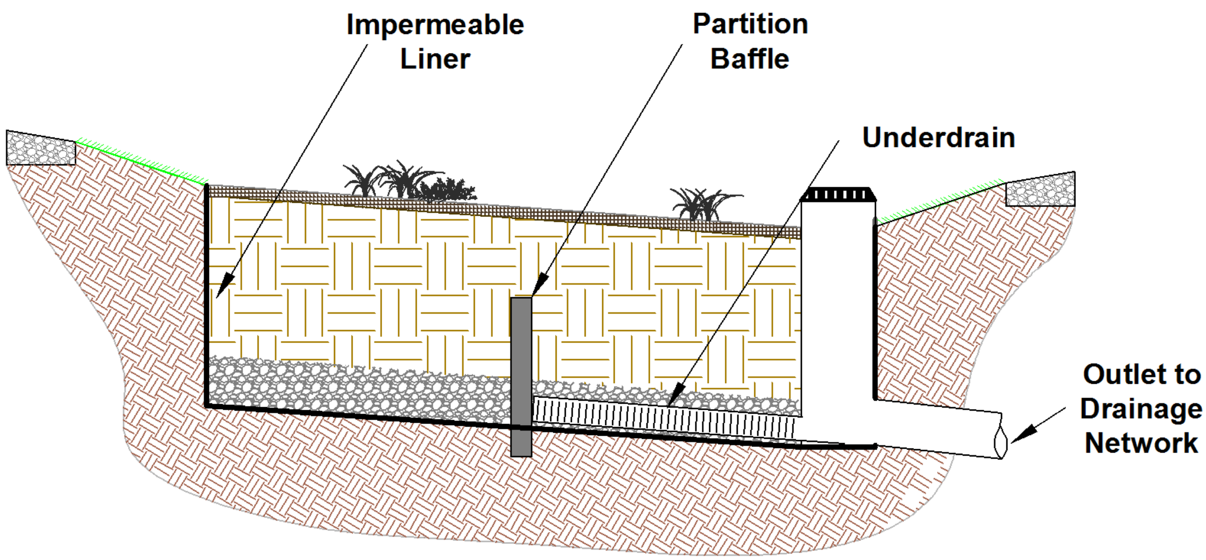

Figure A.2-6. Configuration 4 – Filtration bioretention swale with impermeable liner and underdrain on the subgrade.

A.2.1.2.1 Determine If Lateral Hydraulic Restriction Barriers are Needed

Lateral restriction barrier guidance should follow the requirements outlined in the Bioretention section (A.1.1.2.4).

A.2.1.3 Step 3. Determine IMP Sizing Approach

The bioretention swale must be sized according to the methods outlined in the County SUSMP. The SUSMP allows a flow-based sizing and volume-based sizing methodology. If sizing using the flow-based methodology, chapters 2 and 4 of the County SUSMP present relevant sizing regulatory requirements, and step 4 of this design guidance section can be bypassed. If sizing using the volume-based methodology, step 4 of this section presents relevant sizing requirements.

A.2.1.4 Step 4. Size the System (Volume Based)

Chapter 4 of the County SUSMP addresses methods for determining the size of the IMP area. The following sections present additional considerations when using this method, such as targeted pollutant removal and the media depths required for supporting the desired vegetation.

Chapter 2 of the County SUSMP describes an alternative method to meet required water quality treatment volume. This method can be used to determine the volume of water that must be treated. Once the treatment volume is determined, vertical dimensions should be selected on the basis of pollutants of concern and site constraints before calculating the IMP footprint. The following subsections provide guidance on sizing the surface ponding depth, media depth, and footprint of bioretention swales.

A.2.1.4.1 Surface Ponding Depth

Surface ponding depth should follow the methods specified in the Bioretention section (A.1.1.4.1).

A.2.1.4.2 Soil Media Depth

Soil media depth should follow the methods specified in the Bioretention section (A.1.1.4.2).

A.2.1.4.3 Slope and Grade Control

If the bioretention swale will have longitudinal slope (parallel to flow), flow velocity should not exceed 1 foot per second in mulched swales and 3 feet per second in grassed swales. The Vegetative/Rock Swales section (A.9.1.4) provides guidance for calculating flow velocity.

Check dams might be required to ensure retention and infiltration of the design storm volume into the soil media. The maximum bed slope of the bioretention swale may not exceed 2.5 percent to prevent erosion, but bioretention swales with check dams may contain average slopes (from upslope to downslope end) of up to 4 percent. (The bed slope of each section between check dams must be 2.5 percent or less.)

Check dams should be adequately embedded in the side slopes and can be constructed of concrete, metal sheet pile, or wood (Figure A.2-7). Earthen and stone check dams should not be used because of risk of erosion. The area downslope of check dams should be armored with at least a 4-inch-deep gravel or cobble layer extending 2 feet from the base of the check dam (as shown in Figure A.2-8). Gravel should consist of No. 57 stone and should be underlain by geotextile to prevent scour and erosion of underlying soil. Cobble can be mortared to prevent removal.

Figure A.2-7. Bioretention swale with a check dam.

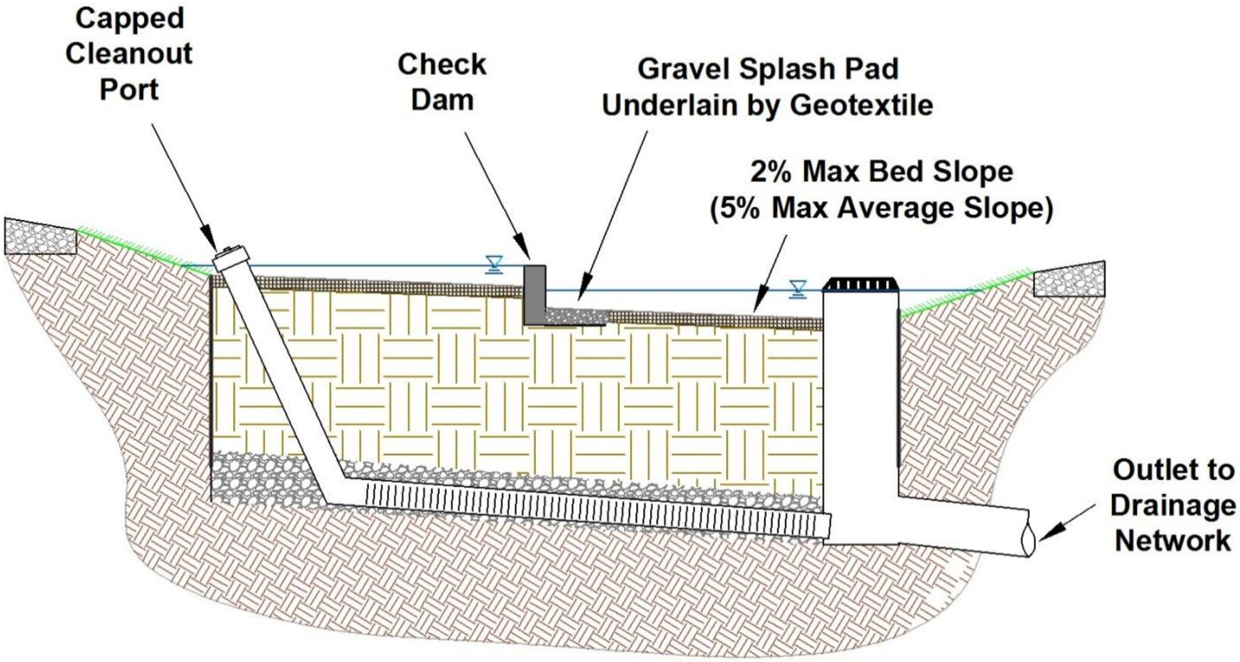

Figure A.2-8. Example profile of a bioretention swale with a check dam to retain the design storm volume.

A.2.1.4.4 Size Surface Area

Surface area calculations should follow the methods outlined in the Bioretention section (A.1.1.4.3).

A.2.1.4.5 Required Number of Check Dams

If the bed of the bioretention swale is sloped, the required number of check dams to create the desired ponding depth can be estimated using the following equations:

$$N = \frac{L_{swale} \times S}{h_{dam}}$$

$$L_{dam} = \frac{L_{swale}}{N}$$

where

N = number of check dams required
L_{swale} = total length of bioretention swale (ft)
S = longitudinal slope of bioretention swale (ft/ft)
h_{dam} = ($2 \times D_{surface}$) = height of check dams (ft; use a maximum height of 1.5)
L_{dam} = distance between check dams (ft)

The above equation is simplified and should be adjusted on the basis of specific site conditions and bioretention swale configuration.

A.2.1.5 Step 5. Specify Soil Media

Soil media specifications should meet the requirements outlined in the Bioretention section (A.1.1.5).

A.2.1.6 Step 6. Design Inlet and Pretreatment

Inlet and pretreatment specifications should meet the requirements outlined in the Bioretention section (A.1.1.6).

A.2.1.7 Step 7. Select and Design Overflow/Bypass Method

Overflow/bypass methods should follow the guidance given in the Bioretention section (A.1.1.7).

A.2.1.8 Step 8. Select Mulch and Vegetation

Mulch and vegetation specifications should meet the requirements outlined in the Bioretention section (A.1.1.8).

A.2.1.9 Step 9. Design for Multi-Use Benefits

Multi-use benefits are the same as those outlined in the Bioretention section (A.1.1.9).

A.2.2 Critical Construction Considerations

Construction technique and sequencing should follow those presented in the Bioretention section (A.1.2) and chapter 4.

A.2.3 Operations and Maintenance

Operation and maintenance tasks follow those outlined in the Bioretention section (A.1.3).

A.2.4 References

County of San Diego. 2012. *County of San Diego SUSMP: Standard Urban Stormwater Mitigation Plan Requirements for Development Applications*. http://www.sdcounty.ca.gov/dpw/watersheds/susmp/susmppdf/susmp_manual_2012.pdf.