County of San Diego BMP Design Manual

Appendices

FEBRUARY 2016



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Appendix

A

Submittal Templates

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Appendix A Submittal Templates

The forms and templates in this appendix have also been posted separately at:

http://www.sandiegocounty.gov/content/sdc/dpw/watersheds/DevelopmentandConstruction.html

Appendix A includes:

- Intake Form;
- Standard SWQMP;
- Priority Development Project (PDP) SWQMP;
- Green Streets PDP Exempt SWQMP; and
- Offsite Alternative Compliance Program (ACP) SWQMP

A.1 Intake Form

County of San Diego
Storm Water Intake Form for All Permit Applications

This form must be completed in its entirety and accompany applications for any of the discretionary or ministerial permits and approvals referenced in Sections 67.809 and 67.811 of the County of San Diego Watershed Protection, Stormwater Management and Discharge Control Ordinance (WPO). The purpose of this form is to establish the Stormwater Quality Management Plan (SWQMP) requirements applicable to the project.

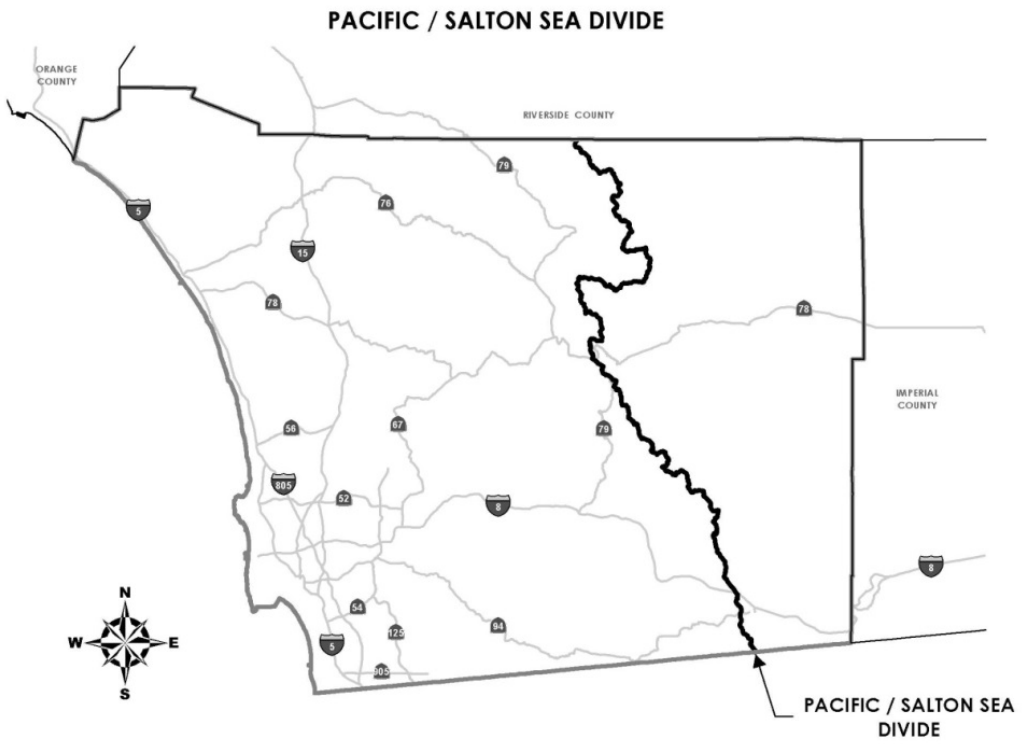
Step 1: Project identification

Applicant name:	APN:	Record ID:

Step 2: Geographic location

Step	Answer	Progression
Is the project west or east of the Pacific / Salton Sea Divide? See below for discussion and an exhibit of the Pacific / Salton Sea Divide.	☐West	**Go to Step 3.**
	☐East	Standard Project requirements apply, including Standard Project SWQMP. **Complete Standard Project SWQMP.**

PDP requirements in the BMP Design Manual only pertain to projects in areas west of the Pacific/Salton Sea Divide (Region 9 of the Water Quality Control Board). Projects east of the Pacific/Salton Sea Divide are subject to Standard Project requirements in the County BMP Design Manual and, as applicable, Post-Construction Standards of the Construction General Permit.



Show with an "X" the Approximate Project Location

Step 3: Project type determination (Standard or Priority Development Project)

Is the project part of another Priority Development Project (PDP)? ☐ Yes ☐ No If so, a PDP SWQMP is required. Go to Step 4.			
The project is (select one): ☐ New Development ☐ Redevelopment[1]			
The total proposed newly created or replaced impervious area is: _____ ft^2			
The total existing (pre-project) impervious area is: _____ ft^2			
The total area disturbed by the project is: _____ ft^2			
If the total area disturbed by the project is 1 acre (43,560 sq. ft.) or more OR the project is part of a larger common plan of development (e.g., a building permit within a previously approved subdivision) disturbing 1 acre or more, a Waste Discharger Identification (WDID) number must be obtained from the State Water Resources Control Board. WDID: _____			
Is the project in any of the following categories, (a) through (f)?[2]			
Yes ☐	No ☐	(a)	New development projects that create 10,000 square feet or more of impervious surfaces[3] (collectively over the entire project site). This includes commercial, industrial, residential, mixed-use, and public development projects on public or private land.
Yes ☐	No ☐	(b)	Redevelopment projects that create and/or replace 5,000 square feet or more of impervious surface (collectively over the entire project site on an existing site of 10,000 square feet or more of impervious surfaces). This includes commercial, industrial, residential, mixed-use, and public development projects on public or private land.
Yes ☐	No ☐	(c)	New and redevelopment projects that create and/or replace 5,000 square feet or more of impervious surface (collectively over the entire project site), and support one or more of the following uses: (i) Restaurants. This category is defined as a facility that sells prepared foods and drinks for consumption, including stationary lunch counters and refreshment stands selling prepared foods and drinks for immediate consumption (Standard Industrial Classification (SIC) code 5812). (ii) Hillside development projects. This category includes development on any natural slope that is twenty-five percent or greater. (iii) Parking lots. This category is defined as a land area or facility for the temporary parking or storage of motor vehicles used personally, for business, or for commerce. (iv) Streets, roads, highways, freeways, and driveways. This category is defined as any paved impervious surface used for the transportation of automobiles, trucks, motorcycles, and other vehicles.

[1] Redevelopment is defined as: The creation, addition, and or replacement of impervious surface on an already developed site. Examples include the expansion of a building footprint, road widening, the addition to or replacement of a structure. Replacement of impervious surfaces includes any activity where impervious material(s) are removed, exposing underlying soil during construction. Redevelopment does not include routine maintenance activities, such as trenching and resurfacing associated with utility work; pavement grinding; resurfacing existing roadways, sidewalks, pedestrian ramps, or bike lanes on existing roads; and routine replacement of damaged pavement, such as pothole repair.

[2] Applicants should note that any development project that will create and/or replace 10,000 square feet or more of impervious surface (collectively over the entire project site) is considered a new development.

[3] For solar energy farm projects, the area of the solar panels does not count toward the total impervious area of the site.

County of San Diego Storm Water Intake Form

Project type determination (continued)			
Yes ☐	No ☐	(d)	New or redevelopment projects that create and/or replace 2,500 square feet or more of impervious surface (collectively over the entire project site), and discharging directly to an Environmentally Sensitive Area (ESA). "Discharging directly to" includes flow that is conveyed overland a distance of 200 feet or less from the project to the ESA, or conveyed in a pipe or open channel any distance as an isolated flow from the project to the ESA (i.e. not commingled with flows from adjacent lands). *Note: ESAs are areas that include but are not limited to all Clean Water Act Section 303(d) impaired water bodies; areas designated as Areas of Special Biological Significance by the State Water Board and San Diego Water Board; State Water Quality Protected Areas; water bodies designated with the RARE beneficial use by the State Water Board and San Diego Water Board; and any other equivalent environmentally sensitive areas which have been identified by the Copermittees. See BMP Design Manual Section 1.4.2 for additional guidance.*
Yes ☐	No ☐	(e)	New development projects, or redevelopment projects that create and/or replace 5,000 square feet or more of impervious surface, that support one or more of the following uses: (i) Automotive repair shops. This category is defined as a facility that is categorized in any one of the following SIC codes: 5013, 5014, 5541, 7532-7534, or 7536-7539. (ii) Retail gasoline outlets (RGOs). This category includes RGOs that meet the following criteria: (a) 5,000 square feet or more or (b) a projected Average Daily Traffic (ADT) of 100 or more vehicles per day.
Yes ☐	No ☐	(f)	New or redevelopment projects that result in the disturbance of one or more acres of land and are expected to generate pollutants post construction. *Note: See BMP Design Manual Section 1.4.2 for additional guidance.*

Does the project meet the definition of one or more of the Priority Development Project categories (a) through (f) listed above?

☐ No – the project is <u>not</u> a Priority Development Project (Standard Project).

☐ Yes – the project is a Priority Development Project (PDP).

Further guidance may be found in Chapter 1 and Table 1-2 of the BMP Design Manual.

The following is for **redevelopment PDPs only**:

The area of existing (pre-project) impervious area at the project site is:: _____ ft^2 (A)

The total proposed newly created or replaced impervious area is _____ ft^2 (B)

Percent impervious surface created or replaced (B/A)*100: _____%

The percent impervious surface created or replaced is (select one based on the above calculation):

☐ less than or equal to fifty percent (50%) – **only newly created or replaced impervious areas are considered a PDP and subject to stormwater requirements.**

OR

☐ greater than fifty percent (50%) – **the entire project site is considered a PDP and subject to stormwater requirements.**

County of San Diego Storm Water Intake Form

Step 4: Storm Water Quality Management Plan requirements

Step	Answer	Progression
Is the project a Standard Project, Priority Development Project (PDP), or exception to PDP definitions? To answer this item, complete the Project Type Determination Checklist on Pages 2 and 3 of this form, and see PDP exemption information below. For further guidance, see Section 1.4 of the BMP Design Manual *in its entirety*.	☐ Standard Project	Standard Project requirements apply, including Standard Project SWQMP. **Complete Standard Project SWQMP.**
	☐ PDP	Standard and PDP requirements apply, including PDP SWQMP. **Complete PDP SWQMP.**
	☐ PDP Exemption	**Go to Step 5 below.**

Step 5: Exemption to PDP definitions

Is the project exempt from PDP definitions based on either of the following: ☐ Projects that are only new or retrofit paved sidewalks, bicycle lanes, or trails that meet the following criteria: (i) Designed and constructed to direct storm water runoff to adjacent vegetated areas, or other non-erodible permeable areas; OR (ii) Designed and constructed to be hydraulically disconnected from paved streets or roads [i.e., runoff from the new improvement does not drain directly onto paved streets or roads]; OR (iii) Designed and constructed with permeable pavements or surfaces in accordance with County of San Diego Guidance on Green Infrastructure;	If so: Standard Project requirements apply, AND any additional requirements specific to the type of project. County concurrence with the exemption is required. *Provide discussion and list any additional requirements below in this form.* **Complete Standard Project SWQMP**.
☐ Projects that are only retrofitting or redeveloping existing paved alleys, streets or roads that are designed and constructed in accordance with the County of San Diego Guidance on Green Infrastructure.	**Complete Green Streets PDP Exempt SWQMP.**
Discussion / justification, and additional requirements for exceptions to PDP definitions, if applicable:	

Step 6: Certification

Applicant Certification: I have read and understand that the County of San Diego has adopted minimum requirements for managing urban runoff, including storm water, from construction and land development activities, as described in the BMP Design Manual. I certify that this intake form has been completed to the best of my ability and accurately reflects the project being proposed. I also understand that non-compliance with the County's WPO and Grading Ordinance may result in enforcement by the County, including fines, cease and desist orders, or other actions.

Signature of Applicant:	*Date:*

For County Only:

☐ Standard SWQMP
☐ PDP SWQMP
☐ Green Streets PDP Exempt SWQMP
☐ ACP SWQMP

A.2 Standard SWQMP

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County of San Diego
Standard Project SWQMP

This Standard Project Stormwater Quality Management Plan (SWQMP) must be completed in its entirety and accompany applications to the County for a permit or approval associated with Standard development projects. To determine whether your project is required to submit a Standard Project SWQMP or Priority Development Project (PDP) SWQMP, please reference the County's "Storm Water Intake Form for All Permit Applications."

Step A: Project identification

Applicant name:	Applicant phone:	Applicant email:
Record ID:	Assessor's Parcel Number(s):	
Project address:		
Project estimated start date:	Project estimated completion date:	

Step B: Applicant Certification:

I have read and understand the County of San Diego has adopted minimum requirements for managing urban runoff, including storm water, from construction and land development activities, as described in the BMP Design Manual.

This Standard Project SWQMP is intended to comply with the Standard Project requirements of the County of San Diego BMP Design Manual, which is a design manual for compliance with local County of San Diego Watershed Protection Ordinance (Sections 67.801 et seq.) and regional MS4 Permit (California Regional Water Quality Control Board San Diego Region Order No. R9-2013-0001, as amended by Order No. R9-2015-0001 and Order No. R9-2015-0100) requirements for storm water management.

I certify the BMPs selected on this form will be implemented to minimize the potentially negative impacts of this project's construction and land development activities on water quality. I further agree to install, monitor, maintain, or revise the selected BMPs to ensure their effectiveness. I also understand that non-compliance with the County's Watershed Protection Ordinance and Grading Ordinance may result in enforcement by the County, including fines, cease and desist orders, or other actions.

Signature of applicant:	Date:

Step C: Construction Storm Water BMP Checklist

Minimum Required Standard Construction Storm Water BMPs

If you answer "Yes" to any of the questions below, your project is subject to Table 1 on the following page (Minimum Required Standard Construction Stormwater BMPs). As noted in Table 1, please select at least the minimum number of required BMPs, or as many as are feasible for your project. If no BMP is selected, an explanation must be given in the box provided. The following questions are intended to aid in determining construction BMP requirements for your project.

Note: All selected BMPs below must be included on the BMP plan incorporated into the construction plan sets.

1. Will there be soil disturbing activities that will result in exposed soil areas? (This includes minor grading and trenching.) **Reference Table 1 Items A, B, D, and E** Note: Soil disturbances NOT considered significant include, but are not limited to, change in use, mechanical/electrical/plumbing activities, signs, temporary trailers, interior remodeling, and minor tenant improvement.	☐Yes	☐No
2. Will there be asphalt paving, including patching? **Reference Table 1 Items D and F**	☐Yes	☐No
3. Will there be slurries from mortar mixing, coring, or concrete saw cutting? **Reference Table 1 Items D and F**	☐Yes	☐No
4. Will there be solid wastes from concrete demolition and removal, wall construction, or form work? **Reference Table 1 Items D and F**	☐Yes	☐No
5. Will there be stockpiling (soil, compost, asphalt, concrete, solid waste) for over 24 hours? **Reference Table 1 Items D and F**	☐Yes	☐No
6. Will there be dewatering operations? **Reference Table 1 Items C and D**	☐Yes	☐No
7. Will there be temporary on-site storage of construction materials, including mortar mix, raw landscaping and soil stabilization materials, treated lumber, rebar, and plated metal fencing materials? **Reference Table 1 Items E and F**	☐Yes	☐No
8. Will trash or solid waste product be generated from this project? **Reference Table 1 Item F**	☐Yes	☐No
9. Will construction equipment be stored on site (e.g.: fuels, oils, trucks, etc.?) **Reference Table 1 Item F**	☐Yes	☐No
10. Will Portable Sanitary Services ("Porta-potty") be used on the site? **Reference Table 1 Item F**	☐Yes	☐No

Table 1 Construction Storm Water BMP Checklist (continued)			
Minimum Required Best Management Practices (BMPs)	**CALTRANS SW Handbook[1] Detail or County Std. Detail**	**✔ BMP Selected**	**Reference sheet No's where each selected BMP is shown on the plans. If no BMP is selected, an explanation must be provided.**
A. Select Erosion Control Method for Disturbed Slopes (choose at least one for the appropriate season)			
Vegetation Stabilization Planting[2] (Summer)	SS-2, SS-4	☐	
Hydraulic Stabilization Hydroseeding[2] (Summer)	SS-4	☐	
Bonded Fiber Matrix or Stabilized Fiber Matrix[3] (Winter)	SS-3	☐	
Physical Stabilization Erosion Control Blanket[3] (Winter)	SS-7	☐	
B. Select erosion control method for disturbed flat areas (slope < 5%) (choose at least one)			
County Standard Lot Perimeter Protection Detail	PDS 659[4], SC-2	☐	
Will use erosion control measures from Item A on flat areas also	SS-3, 4, 7	☐	
County Standard Desilting Basin (must treat all site runoff)	PDS 660[5], SC-2	☐	
Mulch, straw, wood chips, soil application	SS-6, SS-8	☐	

[1] State of California Department of Transportation (Caltrans). 2003. Storm Water Quality Handbooks, Construction Site Best Management Practices (BMPs) Manual. March. Available online at: http://www.dot.ca.gov/hq/construc/stormwater/manuals.htm.

[2] If Vegetation Stabilization (Planting or Hydroseeding) is proposed for erosion control it may be installed between May 1st and August 15th. Slope irrigation is in place and needs to be operable for slopes >3 feet. Vegetation must be watered and established prior to October 1st. The owner must implement a contingency physical BMP by August 15th if vegetation establishment does not occur by that date. If landscaping is proposed, erosion control measures must also be used while landscaping is being established. Established vegetation must have a subsurface mat of intertwined mature roots with a uniform vegetative coverage of 70 percent of the natural vegetative coverage or more on all disturbed areas.

[3] All slopes over three feet must have established vegetative cover prior to final permit approval.

[4] County of San Diego, Planning & Development Services. 2012. Standard Lot Perimeter Protection Design System. Building Division. PDS 659. Available online at http://www.sandiegocounty.gov/pds/docs/pds659.pdf.

[5] County of San Diego, Planning & Development Services. 2012. County Standard Desilting Basin for Disturbed Areas of 1 Acre or Less Building Division. PDS 659. Available online at http://www.sandiegocounty.gov/pds/docs/pds660.pdf.

Table 1 Construction Storm Water BMP Checklist (continued)			
Minimum Required Best Management Practices (BMPs)	**CALTRANS SW Handbook Detail or County Std. Detail**	**✔ BMP Selected**	**Reference sheet No's where each selected BMP is shown on the plan If no BMP is selected, an explanation must be provided.**
C. If runoff or dewatering operation is concentrated, velocity must be controlled using an energy dissipater			
Energy Dissipater Outlet Protection[6]	SS-10	☐	
D. Select sediment control method for all disturbed areas (choose at least one)			
Silt Fence	SC-1	☐	
Fiber Rolls (Straw Wattles)	SC-5	☐	
Gravel & Sand Bags	SC-6 & 8	☐	
Dewatering Filtration	NS-2	☐	
Storm Drain Inlet Protection	SC-10	☐	
Engineered Desilting Basin (sized for 10-year flow)	SC-2	☐	
E. Select method for preventing offsite tracking of sediment (choose at least one)			
Stabilized Construction Entrance	TC-1	☐	
Construction Road Stabilization	TC-2	☐	
Entrance/Exit Tire Wash	TC-3	☐	
Entrance/Exit Inspection & Cleaning Facility	TC-1	☐	
Street Sweeping and Vacuuming	SC-7	☐	
F. Select the general site management BMPs			
F.1 Materials Management			
Material Delivery & Storage	WM-1	☐	
Spill Prevention and Control	WM-4	☐	
F.2 Waste Management[7]			
Waste Management Concrete Waste Management	WM-8	☐	
Solid Waste Management	WM-5	☐	
Sanitary Waste Management	WM-9	☐	
Hazardous Waste Management	WM-6	☐	

Note: The Construction General Permit (Order No. 2009-0009-DWQ) also requires all projects not subject to the BMP Design Manual to comply with runoff reduction requirements through the implementation of post-construction BMPs as described in Section XIII of the order.

[6] Regional Standard Drawing D-40 – Rip Rap Energy Dissipater is also acceptable for velocity reduction.
[7] Not all projects will have every waste identified. The applicant is responsible for identifying wastes that will be onsite and applying the appropriate BMP. For example, if concrete will be used, BMP WM-8 must be selected.

Step D: Post-Construction Source Control BMP Checklist

Source Control BMPs

All development projects must implement source control BMPs 4.2.1 through 4.2.6 where applicable and feasible. See Chapter 4.2 and Appendix E of the County BMP Design Manual for information to implement source control BMPs shown in this checklist.

Answers for each source control requirement must be pursuant to the following:

- "Yes" means the project will implement the source control BMP as described in Chapter 4.2 and/or Appendix E of the County BMP Design Manual. Discussion/justification is not required.
- "No" means the BMP is applicable to the project but not feasible to implement. Discussion/justification must be provided.
- "N/A" means the BMP is not applicable at the project site because the project does not include the feature addressed by the BMP (e.g., the project has no outdoor materials storage areas). Discussion/justification must be provided.

Note: All selected BMPs below must be included on the BMP plan incorporated into the construction plan sets.

Source Control Requirement	Applied?		
4.2.1 Prevention of Illicit Discharges into the MS4	☐Yes	☐No	☐N/A
4.2.2 Storm Drain Stenciling or Signage	☐Yes	☐No	☐N/A
4.2.3 Protect Outdoor Materials Storage Areas from Rainfall, Run-On, Runoff, and Wind Dispersal	☐Yes	☐No	☐N/A
4.2.4 Protect Materials Stored in Outdoor Work Areas from Rainfall, Run-On, Runoff, and Wind Dispersal	☐Yes	☐No	☐N/A
4.2.5 Protect Trash Storage Areas from Rainfall, Run-On, Runoff, and Wind Dispersal	☐Yes	☐No	☐N/A
4.2.6 Additional BMPs Based on Potential Sources of Runoff Pollutants (must answer for each source listed below):			
☐ A. On-site storm drain inlets	☐Yes	☐No	☐N/A
☐ B. Interior floor drains and elevator shaft sump pumps	☐Yes	☐No	☐N/A
☐ C. Interior parking garages	☐Yes	☐No	☐N/A
☐ D. Need for future indoor & structural pest control	☐Yes	☐No	☐N/A
☐ E. Landscape/outdoor pesticide use	☐Yes	☐No	☐N/A
☐ F. Pools, spas, ponds, fountains, and other water features	☐Yes	☐No	☐N/A
☐ G. Food service	☐Yes	☐No	☐N/A
☐ H. Trash or Refuse areas	☐Yes	☐No	☐N/A
☐ I. Industrial processes	☐Yes	☐No	☐N/A
☐ J. Outdoor storage of equipment or materials	☐Yes	☐No	☐N/A
☐ K. Vehicle and equipment cleaning	☐Yes	☐No	☐N/A
☐ L. Vehicle/equipment repair and maintenance	☐Yes	☐No	☐N/A
☐ M. Fuel dispensing areas	☐Yes	☐No	☐N/A
☐ N. Loading docks	☐Yes	☐No	☐N/A
☐ O. Fire sprinkler test water	☐Yes	☐No	☐N/A
☐ P. Miscellaneous drain or wash water	☐Yes	☐No	☐N/A
☐ Q. Plazas, sidewalks, driveways, and parking lots	☐Yes	☐No	☐N/A

Discussion/justification for all "No" answers shown above:

Attach additional pages as necessary.

Step E: Post-Construction Site Design BMP Checklist

Site Design BMPs

All development projects must implement site design BMPs 4.3.1 through 4.3.8 where applicable and feasible. See Chapter 4.3 and Appendix E of the County BMP Design Manual for information to implement site design BMPs shown in this checklist.

Answers for each site design requirement must be pursuant to the following:

- "Yes" means the project will implement the site design BMP as described in Chapter 4.3 and/or Appendix E of the County BMP Design Manual. Discussion/justification is not required.
- "No" means the BMP is applicable to the project but not feasible to implement. Discussion/justification must be provided.
- "N/A" means the BMP is not applicable at the project site because the project does not include the feature addressed by the BMP (e.g., the project site has no existing natural areas to conserve). Discussion/justification must be provided.

Note: All selected BMPs below must be included on the BMP plan incorporated into the construction plan sets.

Site Design Requirement	Applied?		
4.3.1 Maintain Natural Drainage Pathways and Hydrologic Features	☐Yes	☐No	☐N/A
4.3.2 Conserve Natural Areas, Soils, and Vegetation	☐Yes	☐No	☐N/A
4.3.3 Minimize Impervious Area	☐Yes	☐No	☐N/A
4.3.4 Minimize Soil Compaction	☐Yes	☐No	☐N/A
4.3.5 Impervious Area Dispersion	☐Yes	☐No	☐N/A
4.3.6 Runoff Collection	☐Yes	☐No	☐N/A
4.3.7 Landscaping with Native or Drought Tolerant Species	☐Yes	☐No	☐N/A
4.3.8 Harvesting and Using Precipitation	☐Yes	☐No	☐N/A

Discussion/justification for all "No" answers shown above:

Attach additional pages as necessary.

A.3 Priority Development Project (PDP) SWQMP

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County of San Diego
PRIORITY DEVELOPMENT PROJECT (PDP) SWQMP

[INSERT PROJECT NAME]
[INSERT RECORD ID (PERMIT) NUMBERS]

[INSERT PROJECT ADDRESS]
[INSERT PROJECT CITY, STATE ZIP CODE]

ASSESSOR'S PARCEL NUMBER(S):
[INSERT APN(S)]

ENGINEER OF WORK:

[INSERT CIVIL ENGINEER'S NAME AND PE NUMBER HERE, PROVIDE WET SIGNATURE AND STAMP ABOVE LINE]

PREPARED FOR:

[INSERT APPLICANT NAME]
[INSERT ADDRESS]
[INSERT CITY, STATE ZIP CODE]
[INSERT TELEPHONE NUMBER]

PDP SWQMP PREPARED BY:

[INSERT COMPANY NAME]
[INSERT ADDRESS]
[INSERT CITY, STATE ZIP CODE]
[INSERT TELEPHONE NUMBER]

DATE OF SWQMP:
[INSERT MONTH, DAY, YEAR]

PLANS PREPARED BY:
[INSERT CIVIL ENGINEER OR ARCHITECT]
[INSERT ADDRESS]
[INSERT CITY, STATE ZIP CODE]
[INSERT TELEPHONE NUMBER]

SWQMP APPROVED BY:

APPROVAL DATE:

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Attachments

Attachment 1: Backup for PDP Pollutant Control BMPs
- Attachment 1a: Storm Water Pollutant Control Worksheet Calculations
- Attachment 1b: DMA Exhibit
- Attachment 1c: Individual Structural BMP DMA Mapbook

Attachment 2: Backup for PDP Hydromodification Control Measures
- Attachment 2a: Flow Control Facility Design
- Attachment 2b: Hydromodification Management Exhibit
- Attachment 2c: Management of Critical Coarse Sediment Yield Areas
- Attachment 2d: Geomorphic Assessment of Receiving Channels (optional)
- Attachment 2e: Vector Control Plan (if applicable)

Attachment 3: Structural BMP Maintenance Plan
- Attachment 3a: Structural BMP Maintenance Thresholds and Actions
- Attachment 3b: Draft Maintenance Agreements / Notifications(when applicable)

Attachment 4: County of San Diego PDP Structural BMP Verification for DPW Permitted Land Development Projects

Attachment 5: Copy of Plan Sheets Showing Permanent Storm Water BMPs

Attachment 6: Copy of Project's Drainage Report

Attachment 7: Copy of Project's Geotechnical and Groundwater Investigation Report

Acronyms

ACP	Alternative Compliance Project
APN	Assessor's Parcel Number
BMP	Best Management Practice
BMP DM	Best Management Practice Design Manual
HMP	Hydromodification Management Plan
HSG	Hydrologic Soil Group
MS4	Municipal Separate Storm Sewer System
N/A	Not Applicable
NRCS	Natural Resources Conservation Service
PDCI	Private Development Construction Inspection Section
PDP	Priority Development Project
PDS	Planning and Development Services
PE	Professional Engineer
RPO	Resource Protection Ordinance
SC	Source Control
SD	Site Design
SDRWQCB	San Diego Regional Water Quality Control Board
SIC	Standard Industrial Classification
SWQMP	Storm Water Quality Management Plan
WMAA	Watershed Management Area Analysis
WPO	Watershed Protection Ordinance
WQIP	Water Quality Improvement Plan

PDP SWQMP Preparer's Certification Page

Project Name: [Insert Project Name]
Permit Application Number: [Insert Permit Application Number]

PREPARER'S CERTIFICATION

I hereby declare that I am the Engineer in Responsible Charge of design of storm water best management practices (BMPs) for this project, and that I have exercised responsible charge over the design of the BMPs as defined in Section 6703 of the Business and Professions Code, and that the design is consistent with the PDP requirements of the County of San Diego BMP Design Manual, which is a design manual for compliance with local County of San Diego Watershed Protection Ordinance (Sections 67.801 et seq.) and regional MS4 Permit (California Regional Water Quality Control Board San Diego Region Order No. R9-2013-0001 as amended by R9-2015-0001 and R9-2015-0100) requirements for storm water management.

I have read and understand that the County of San Diego has adopted minimum requirements for managing urban runoff, including storm water, from land development activities, as described in the BMP Design Manual. I certify that this PDP SWQMP has been completed to the best of my ability and accurately reflects the project being proposed and the applicable BMPs proposed to minimize the potentially negative impacts of this project's land development activities on water quality. I understand and acknowledge that the plan check review of this PDP SWQMP by County staff is confined to a review and does not relieve me, as the Engineer in Responsible Charge of design of storm water BMPs for this project, of my responsibilities for project design.

_____
Engineer of Work's Signature, PE Number & Expiration Date

_____
Print Name

_____
Company

_____
Date

Engineer's Seal:

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Submittal Record

Use this Table to keep a record of submittals of this PDP SWQMP. Each time the PDP SWQMP is re-submitted, provide the date and status of the project. In column 4 summarize the changes that have been made or indicate if response to plancheck comments is included. When applicable, insert response to plancheck comments behind this page.

Preliminary Design / Planning / CEQA

Submittal Number	Date	Summary of Changes
1		Initial Submittal
2		
3		
4		

Final Design

Submittal Number	Date	Summary of Changes
1		Initial Submittal
2		
3		
4		

Plan Changes

Submittal Number	Date	Summary of Changes
1		Initial Submittal
2		
3		
4		

Project Vicinity Map

Project Name: [Insert Project Name]
Record ID: [Insert Record ID or Permit Application Number]

[Insert Project Vicinity Map here]

Step 1: Project type determination (Standard or Priority Development Project)

Is the project part of another Priority Development Project (PDP)? If so, a PDP SWQMP is required. Go to Step 2.			(☐ Yes ☐ No
The project is (select one): ☐ New Development ☐ Redevelopment[1]			
The total proposed newly created or replaced impervious area is:			ft^2
The total existing (pre-project) impervious area is:			ft^2
The total area disturbed by the project is:			ft^2
If the total area disturbed by the project is 1 acre (43,560 sq. ft.) or more OR the project is part of a larger common plan of development disturbing 1 acre or more, a Waste Discharger Identification (WDID) number must be obtained from the State Water Resources Control Board. WDID: ___			
Is the project in any of the following categories, (a) through (f)?[2]			
Yes ☐	No ☐	(a)	New development projects that create 10,000 square feet or more of impervious surfaces[3] (collectively over the entire project site). This includes commercial, industrial, residential, mixed-use, and public development projects on public or private land.
Yes ☐	No ☐	(b)	Redevelopment projects that create and/or replace 5,000 square feet or more of impervious surface (collectively over the entire project site on an existing site of 10,000 square feet or more of impervious surfaces). This includes commercial, industrial, residential, mixed-use, and public development projects on public or private land.
Yes ☐	No ☐	(c)	New and redevelopment projects that create and/or replace 5,000 square feet or more of impervious surface (collectively over the entire project site), and support one or more of the following uses: (i) Restaurants. This category is defined as a facility that sells prepared foods and drinks for consumption, including stationary lunch counters and refreshment stands selling prepared foods and drinks for immediate consumption (Standard Industrial Classification (SIC) code 5812). (ii) Hillside development projects. This category includes development on any natural slope that is twenty-five percent or greater. (iii) Parking lots. This category is defined as a land area or facility for the temporary parking or storage of motor vehicles used personally, for business, or for commerce. (iv) Streets, roads, highways, freeways, and driveways. This category is defined as any paved impervious surface used for the transportation of automobiles, trucks, motorcycles, and other vehicles.

[1] Redevelopment is defined as: The creation and/or replacement of impervious surface on an already developed site. Examples include the expansion of a building footprint, road widening, the addition to or replacement of a structure, and creation or addition of impervious surfaces. Replacement of impervious surfaces includes any activity that is not part of a routine maintenance activity where impervious material(s) are removed, exposing underlying soil during construction. Redevelopment does not include routine maintenance activities, such as trenching and resurfacing associated with utility work; pavement grinding; resurfacing existing roadways; new sidewalks construction; pedestrian ramps; or bike lanes on existing roads; and routine replacement of damaged pavement, such as pothole repair.

[2] Applicants should note that any development project that will create and/or replace 10,000 square feet or more of impervious surface (collectively over the entire project site) is considered a new development.

[3] For solar energy farm projects, the area of the solar panels does not count toward the total impervious area of the site.

Project type determination (continued)

Yes ☐	No ☐	(d)	New or redevelopment projects that create and/or replace 2,500 square feet or more of impervious surface (collectively over the entire project site), and discharging directly to an Environmentally Sensitive Area (ESA). "Discharging directly to" includes flow that is conveyed overland a distance of 200 feet or less from the project to the ESA, or conveyed in a pipe or open channel any distance as an isolated flow from the project to the ESA (i.e. not commingled with flows from adjacent lands). *Note: ESAs are areas that include but are not limited to all Clean Water Act Section 303(d) impaired water bodies; areas designated as Areas of Special Biological Significance by the State Water Board and San Diego Water Board; State Water Quality Protected Areas; water bodies designated with the RARE beneficial use by the State Water Board and San Diego Water Board; and any other equivalent environmentally sensitive areas which have been identified by the Copermittees. See BMP Design Manual Section 1.4.2 for additional guidance.*
Yes ☐	No ☐	(e)	New development projects, or redevelopment projects that create and/or replace 5,000 square feet or more of impervious surface, that support one or more of the following uses: (i) Automotive repair shops. This category is defined as a facility that is categorized in any one of the following SIC codes: 5013, 5014, 5541, 7532-7534, or 7536-7539. (ii) Retail gasoline outlets (RGOs). This category includes RGOs that meet the following criteria: (a) 5,000 square feet or more or (b) a projected Average Daily Traffic (ADT) of 100 or more vehicles per day.
Yes ☐	No ☐	(f)	New or redevelopment projects that result in the disturbance of one or more acres of land and are expected to generate pollutants post construction. *Note: See BMP Design Manual Section 1.4.2 for additional guidance.*

Does the project meet the definition of one or more of the Priority Development Project categories (a) through (f) listed above?

☐ No – the project is not a Priority Development Project (Standard Project).

☐ Yes – the project is a Priority Development Project (PDP).

Further guidance may be found in Chapter 1 and Table 1-2 of the BMP Design Manual.

The following is for **redevelopment PDPs only**:

The area of existing (pre-project) impervious area at the project site is: ft^2 (A)
The total proposed newly created or replaced impervious area is ft^2 (B)
Percent impervious surface created or replaced (B/A)*100: %
The percent impervious surface created or replaced is (select one based on the above calculation):

☐ less than or equal to fifty percent (50%) – **only newly created or replaced impervious areas are considered a PDP and subject to stormwater requirements**

OR

☐ greater than fifty percent (50%) – **the entire project site is considered a PDP and subject to stormwater requirements**

Step 1.1: Storm Water Quality Management Plan requirements

Step	Answer	Progression
Is the project a Standard Project, Priority Development Project (PDP), or exception to PDP definitions? To answer this item, complete Step 1 Project Type Determination Checklist on Pages 1 and 2, and see PDP exemption information below. For further guidance, see Section 1.4 of the BMP Design Manual *in its entirety*.	☐ Standard Project	Standard Project requirements apply, including Standard Project SWQMP. **Complete Standard Project SWQMP.**
	☐ PDP	Standard and PDP requirements apply, including PDP SWQMP. **Complete PDP SWQMP.**
	☐ PDP with ACP	If participating in offsite alternative compliance, **complete Step 6.3 and an ACP SWQMP.**
	☐ PDP Exemption	**Go to Step 1.2 below.**

Step 1.2: Exemption to PDP definitions

Is the project exempt from PDP definitions based on either of the following: ☐ Projects that are only new or retrofit paved sidewalks, bicycle lanes, or trails that meet the following criteria: (i) Designed and constructed to direct storm water runoff to adjacent vegetated areas, or other non-erodible permeable areas; OR (ii) Designed and constructed to be hydraulically disconnected from paved streets or roads [i.e., runoff from the new improvement does not drain directly onto paved streets or roads]; OR (iii) Designed and constructed with permeable pavements or surfaces in accordance with County of San Diego Guidance on Green Infrastructure;	If so: Standard Project requirements apply, AND any additional requirements specific to the type of project. County concurrence with the exemption is required. *Provide discussion and list any additional requirements below in this form.* **Complete Standard Project SWQMP**
☐ Projects that are only retrofitting or redeveloping existing paved alleys, streets or roads that are designed and constructed in accordance with the County of San Diego Guidance on Green Infrastructure.	**Complete Green Streets PDP Exempt SWQMP.**
Discussion / justification, and additional requirements for exceptions to PDP definitions, if applicable:	

Step 2: Construction Storm Water BMP Checklist

Minimum Required Standard Construction Storm Water BMPs		
If you answer "Yes" to any of the questions below, your project is subject to Table 1 on the following page (Minimum Required Standard Construction Stormwater BMPs). As noted in Table 1, please select at least the minimum number of required BMPs, or as many as are feasible for your project. If no BMP is selected, an explanation must be given in the box provided. The following questions are intended to aid in determining construction BMP requirements for your project. **Note: All selected BMPs below must be included on the BMP plan incorporated into the construction plan sets.**		
1. Will there be soil disturbing activities that will result in exposed soil areas? (This includes minor grading and trenching.) **Reference Table 1 Items A, B, D, and E** Note: Soil disturbances NOT considered significant include, but are not limited to, change in use, mechanical/electrical/plumbing activities, signs, temporary trailers, interior remodeling, and minor tenant improvement.	☐Yes	☐No
2. Will there be asphalt paving, including patching? **Reference Table 1 Items D and F**	☐Yes	☐No
3. Will there be slurries from mortar mixing, coring, or concrete saw cutting? **Reference Table 1 Items D and F**	☐Yes	☐No
4. Will there be solid wastes from concrete demolition and removal, wall construction, or form work? **Reference Table 1 Items D and F**	☐Yes	☐No
5. Will there be stockpiling (soil, compost, asphalt, concrete, solid waste) for over 24 hours? **Reference Table 1 Items D and F**	☐Yes	☐No
6. Will there be dewatering operations? **Reference Table 1 Items C and D**	☐Yes	☐No
7. Will there be temporary on-site storage of construction materials, including mortar mix, raw landscaping and soil stabilization materials, treated lumber, rebar, and plated metal fencing materials? **Reference Table 1 Items E and F**	☐Yes	☐No
8. Will trash or solid waste product be generated from this project? **Reference Table 1 Item F**	☐Yes	☐No
9. Will construction equipment be stored on site (e.g.: fuels, oils, trucks, etc.?) **Reference Table 1 Item F**	☐Yes	☐No
10. Will Portable Sanitary Services ("Porta-potty") be used on the site? **Reference Table 1 Item F**	☐Yes	☐No

Table 1. Construction Storm Water BMP Checklist

Minimum Required Best Management Practices (BMPs)	CALTRANS SW Handbook[4] Detail or County Std. Detail	✔ BMP Selected	Reference sheet No.'s where each selected BMP is shown on the plans. If no BMP is selected, an explanation must be provided.
A. Select Erosion Control Method for Disturbed Slopes (choose at least one for the appropriate season)			
Vegetation Stabilization Planting[5] (Summer)	SS-2, SS-4	☐	
Hydraulic Stabilization Hydroseeding[2] (Summer)	SS-4	☐	
Bonded Fiber Matrix or Stabilized Fiber Matrix[6] (Winter)	SS-3	☐	
Physical Stabilization Erosion Control Blanket[3] (Winter)	SS-7	☐	
B. Select erosion control method for disturbed flat areas (slope < 5%) (choose at least one)			
County Standard Lot Perimeter Protection Detail	PDS 659[7], SC-2	☐	
Will use erosion control measures from Item A on flat areas also	SS-3, 4, 7	☐	
County Standard Desilting Basin (must treat all site runoff)	PDS 660[8], SC-2	☐	
Mulch, straw, wood chips, soil application	SS-6, SS-8	☐	

4 State of California Department of Transportation (Caltrans). 2003. Storm Water Quality Handbooks, Construction Site Best Management Practices (BMPs) Manual. March. Available online at: http://www.dot.ca.gov/hq/construc/stormwater/manuals.htm.

5 If Vegetation Stabilization (Planting or Hydroseeding) is proposed for erosion control it may be installed between May 1st and August 15th. Slope irrigation is in place and needs to be operable for slopes >3 feet. Vegetation must be watered and established prior to October 1st. The owner must implement a contingency physical BMP by August 15th if vegetation establishment does not occur by that date. If landscaping is proposed, erosion control measures must also be used while landscaping is being established. Established vegetation must have a subsurface mat of intertwined mature roots with a uniform vegetative coverage of 70 percent of the natural vegetative coverage or more on all disturbed areas.

6 All slopes over three feet must have established vegetative cover prior to final permit approval.

7 County of San Diego, Planning & Development Services. 2012. Standard Lot Perimeter Protection Design System. Building Division. PDS 659. Available online at http://www.sandiegocounty.gov/pds/docs/pds659.pdf.

8 County of San Diego, Planning & Development Services. 2012. County Standard Desilting Basin for Disturbed Areas of 1 Acre or Less Building Division. PDS 659. Available online at http://www.sandiegocounty.gov/pds/docs/pds660.pdf.

Table 1. Construction Storm Water BMP Checklist (continued)

Minimum Required Best Management Practices (BMPs)	CALTRANS SW Handbook Detail or County Std. Detail	✔ BMP Selected	Reference sheet No.'s where each selected BMP is shown on the plans. If no BMP is selected, an explanation must be provided.
C. If runoff or dewatering operation is concentrated, velocity must be controlled using an energy dissipater			
Energy Dissipater Outlet Protection[9]	SS-10	☐	
D. Select sediment control method for all disturbed areas (choose at least one)			
Silt Fence	SC-1	☐	
Fiber Rolls (Straw Wattles)	SC-5	☐	
Gravel & Sand Bags	SC-6 & 8	☐	
Dewatering Filtration	NS-2	☐	
Storm Drain Inlet Protection	SC-10	☐	
Engineered Desilting Basin (sized for 10-year flow)	SC-2	☐	
E. Select method for preventing offsite tracking of sediment (choose at least one)			
Stabilized Construction Entrance	TC-1	☐	
Construction Road Stabilization	TC-2	☐	
Entrance/Exit Tire Wash	TC-3	☐	
Entrance/Exit Inspection & Cleaning Facility	TC-1	☐	
Street Sweeping and Vacuuming	SC-7	☐	
F. Select the general site management BMPs			
F.1 Materials Management			
Material Delivery & Storage	WM-1	☐	
Spill Prevention and Control	WM-4	☐	
F.2 Waste Management[10]			
Waste Management Concrete Waste Management	WM-8	☐	
Solid Waste Management	WM-5	☐	
Sanitary Waste Management	WM-9	☐	
Hazardous Waste Management	WM-6	☐	

Note: The Construction General Permit (Order No. 2009-0009-DWQ) also requires all projects not subject to the BMP Design Manual to comply with runoff reduction requirements through the implementation of post-construction BMPs as described in Section XIII of the order.

[9] Regional Standard Drawing D-40 – Rip Rap Energy Dissipater is also acceptable for velocity reduction.

[10] Not all projects will have every waste identified. The applicant is responsible for identifying wastes that will be onsite and applying the appropriate BMP. For example, if concrete will be used, BMP WM-8 must be selected.

Step 3: County of San Diego PDP SWQMP Site Information Checklist

Step 3.1: Description of Existing Site Condition

Project Watershed (Complete Hydrologic Unit, Area, and Subarea Name with Numeric Identifier)	

Current Status of the Site (select all that apply):

- ☐ Existing development
- ☐ Previously graded but not built out
- ☐ Demolition completed without new construction
- ☐ Agricultural or other non-impervious use
- ☐ Vacant, undeveloped/natural

Description / Additional Information:

Existing Land Cover Includes (select all that apply and provide each area on site):

- ☐ Vegetative Cover _____ Acres (_____ Square Feet)
- ☐ Non-Vegetated Pervious Areas _____ Acres (_____ Square Feet)
- ☐ Impervious Areas _____ Acres (_____ Square Feet)

Description / Additional Information:

Underlying Soil belongs to Hydrologic Soil Group (select all that apply):

- ☐ NRCS Type A
- ☐ NRCS Type B
- ☐ NRCS Type C
- ☐ NRCS Type D

Approximate Depth to Groundwater (GW) (or N/A if no infiltration is used):

- ☐ GW Depth < 5 feet
- ☐ 5 feet < GW Depth < 10 feet
- ☐ 10 feet < GW Depth < 20 feet
- ☐ GW Depth > 20 feet

Existing Natural Hydrologic Features (select all that apply):

- ☐ Watercourses
- ☐ Seeps
- ☐ Springs
- ☐ Wetlands
- ☐ None
- ☐ Other

Description / Additional Information:

Step 3.2: Description of Existing Site Drainage Patterns

How is storm water runoff conveyed from the site? At a minimum, this description should answer:

(1) Whether existing drainage conveyance is natural or urban;
(2) Is runoff from offsite conveyed through the site? if yes, quantify all offsite drainage areas, design flows, and locations where offsite flows enter the project site, and summarize how such flows are conveyed through the site;
(3) Provide details regarding existing project site drainage conveyance network, including any existing storm drains, concrete channels, swales, detention facilities, storm water treatment facilities, natural or constructed channels; and
(4) Identify all discharge locations from the existing project site along with a summary of conveyance system size and capacity for each of the discharge locations. Provide summary of the pre-project drainage areas and design flows to each of the existing runoff discharge locations.

Describe existing site drainage patterns:

Step 3.3: Description of Proposed Site Development

Project Description / Proposed Land Use and/or Activities:
List/describe proposed impervious features of the project (e.g., buildings, roadways, parking lots, courtyards, athletic courts, other impervious features):
List/describe proposed pervious features of the project (e.g., landscape areas):
Does the project include grading and changes to site topography? ☐Yes ☐No *Description / Additional Information:*

Insert acreage or square feet for the different land cover types in the table below:

Change in Land Cover Type Summary			
Land Cover Type	Existing (acres or ft^2)	Proposed (acres or ft^2)	Percent Change
Vegetation			
Pervious (non-vegetated)			
Impervious			

Step 3.4: Description of Proposed Site Drainage Patterns

Does the project include changes to site drainage (e.g., installation of new storm water conveyance systems)?

☐Yes

☐No

If yes, provide details regarding the proposed project site drainage conveyance network, including storm drains, concrete channels, swales, detention facilities, storm water treatment facilities, natural or constructed channels, and the method for conveying offsite flows through or around the proposed project site. Identify all discharge locations from the proposed project site along with a summary of the conveyance system size and capacity for each of the discharge locations. Provide a summary of pre- and post-project drainage areas and design flows to each of the runoff discharge locations. Reference the drainage study for detailed calculations.

Describe proposed site drainage patterns:

Step 3.5: Potential Pollutant Source Areas

Identify whether any of the following features, activities, and/or pollutant source areas will be present (select all that apply). Select "Other" if the project is a phased development and provide a description:

- ☐ On-site storm drain inlets
- ☐ Interior floor drains and elevator shaft sump pumps
- ☐ Interior parking garages
- ☐ Need for future indoor & structural pest control
- ☐ Landscape/Outdoor Pesticide Use
- ☐ Pools, spas, ponds, decorative fountains, and other water features
- ☐ Food service
- ☐ Refuse areas
- ☐ Industrial processes
- ☐ Outdoor storage of equipment or materials
- ☐ Vehicle and Equipment Cleaning
- ☐ Vehicle/Equipment Repair and Maintenance
- ☐ Fuel Dispensing Areas
- ☐ Loading Docks
- ☐ Fire Sprinkler Test Water
- ☐ Miscellaneous Drain or Wash Water
- ☐ Plazas, sidewalks, and parking lots
- ☐ Other (provide description)

Description / Additional Information:

Step 3.6: Identification and Narrative of Receiving Water and Pollutants of Concern

Describe flow path of storm water from the project site discharge location(s), through urban storm conveyance systems as applicable, to receiving creeks, rivers, and lagoons as applicable, and ultimate discharge to the Pacific Ocean (or bay, lagoon, lake or reservoir, as applicable):

List any 303(d) impaired water bodies[11] within the path of storm water from the project site to the Pacific Ocean (or bay, lagoon, lake or reservoir, as applicable), identify the pollutant(s)/stressor(s) causing impairment, and identify any TMDLs and/or Highest Priority Pollutants from the WQIP for the impaired water bodies:

303(d) Impaired Water Body	Pollutant(s)/Stressor(s)	TMDLs / WQIP Highest Priority Pollutant

Identification of Project Site Pollutants*

*Identification of project site pollutants below is only required if flow-thru treatment BMPs are implemented onsite in lieu of retention or biofiltration BMPs. Note the project must also participate in an alternative compliance program (unless prior lawful approval to meet earlier PDP requirements is demonstrated).

Identify pollutants expected from the project site based on all proposed use(s) of the site (see BMP Design Manual Appendix B.6):

Pollutant	Not Applicable to the Project Site	Anticipated from the Project Site	Also a Receiving Water Pollutant of Concern
Sediment	☐	☐	☐
Nutrients	☐	☐	☐
Heavy Metals	☐	☐	☐
Organic Compounds	☐	☐	☐
Trash & Debris	☐	☐	☐
Oxygen Demanding Substances	☐	☐	☐
Oil & Grease	☐	☐	☐
Bacteria & Viruses	☐	☐	☐
Pesticides	☐	☐	☐

[11] The current list of Section 303(d) impaired water bodies can be found at http://www.waterboards.ca.gov/water_issues/programs/water_quality_assessment/#impaired

Step 3.7: Hydromodification Management Requirements

Do hydromodification management requirements apply (see Section 1.6 of the BMP Design Manual)?

☐Yes, hydromodification management requirements for flow control and preservation of critical coarse sediment yield areas are applicable.

☐No, the project will discharge runoff directly to existing underground storm drains discharging directly to water storage reservoirs, lakes, enclosed embayments, or the Pacific Ocean.

☐No, the project will discharge runoff directly to conveyance channels whose bed and bank are concrete-lined all the way from the point of discharge to water storage reservoirs, lakes, enclosed embayments, or the Pacific Ocean.

☐No, the project will discharge runoff directly to an area identified as appropriate for an exemption by the WMAA[12] for the watershed in which the project resides.

Description / Additional Information (to be provided if a 'No' answer has been selected above):

[12] The Watershed Management Area Analysis (WMAA) is an optional element for inclusion in the Water Quality Improvement Plans (WQIPs) described in the 2013 MS4 Permit [Provision B.3.b.(4)]. It is available online at the Project Clean Water website: http://www.projectcleanwater.org/index.php?option=com_content&view=article&id=248

Step 3.7.1: Critical Coarse Sediment Yield Areas*

***This Section only required if hydromodification management requirements apply**

Projects must satisfy critical coarse sediment yield area (CCSYA) requirements by characterizing the project as one of the scenario-types presented below and satisfying associated criteria. Projects must appropriately satisfy all requirements for identification, avoidance, and bypass, OR may alternatively elect to demonstrate no net impact.

☐ **Scenario 1**: Project is subject to and in compliance with RPO requirements *(without utilization of RPO exemptions 86.604(e)(2)(cc) or 86.604(e)(3) that result in impacts to more than 15% of the project-scale CCSYAs)*.

- ☐ Identify: Project has identified both onsite and upstream CCSYAs as areas that are coarse, ≥25% slope, and ≥50' tall. *(Optional refinement methods may be performed per guidance in Section H.1.2). AND,*
- ☐ Avoid: Project has avoided onsite CCSYAs per existing RPO steep slope encroachment criteria. AND,
- ☐ Bypass: Project has demonstrated that both onsite and upstream CCSYAs are bypassed through or around the project site with a 2 year peak storm velocity of 3 feet per second or greater. OR,
- ☐ No Net Impact: Project does not satisfy all Scenario 1 criteria above and must alternatively demonstrate no net impact to the receiving water.

☐ **Scenario 2**: Project is entirely exempt/not subject to RPO requirements without utilization of RPO exemptions 86.604(e)(2)(cc) or 86.604(e)(3).

- ☐ Identify: Project has identified upstream CCSYAs that are coarse, ≥25% slope, and ≥50' tall. *(Optional refinement methods may be performed per guidance in Section H.1.2). AND,*
- ☐ Avoid: Project is not required to avoid onsite CCSYAs as none were identified in the previous step. AND,
- ☐ Bypass: Project has demonstrated that upstream CCSYAs are bypassed through or around the project site with a 2 year peak storm velocity of 3 feet per second or greater. OR,
- ☐ No Net Impact: Project does not satisfy all Scenario 2 criteria above and must alternatively demonstrate no net impact to the receiving water. *(Skip to next row).*

☐ **Scenario 3**: Project utilizes exemption(s) via RPO Section 86.604(e)(2)(cc) or 86.604(e)(3) and impacts more than 15% of the project-scale CCSYAs.

- ☐ No Net Impact: Project is not eligible for traditional methods of identification, avoidance, and bypass. Project must demonstrate no net impact to the receiving water.

Critical Coarse Sediment Yield Areas Continued
Demonstrate No Net Impact
If the project elects to satisfy CCSYA criteria through demonstration of no net impact to the receiving water. Applicants must identify the methods utilized from the list below and provide supporting documentation in Attachment 2c of the SWQMP. Check all that are applicable. ☐ N/A, the project appropriately identifies, avoids, and bypasses CCSYAs. ☐ Project has performed additional analysis to demonstrate that impacts to CCSYAs satisfy the no net impact standard of Ep/Sp≤1.1. ☐ Project has provided alternate mapping of CCSYAs. ☐ Project has implemented additional onsite hydromodification flow control measures. ☐ Project has implemented an offsite stream rehabilitation project to offset impacts. ☐ Project has implemented other applicant-proposed mitigation measures.

Step 3.7.2: Flow Control for Post-Project Runoff*

*This Section only required if hydromodification management requirements apply
List and describe point(s) of compliance (POCs) for flow control for hydromodification management (see Section 6.3.1). For each POC, provide a POC identification name or number correlating to the project's HMP Exhibit and a receiving channel identification name or number correlating to the project's HMP Exhibit.
Has a geomorphic assessment been performed for the receiving channel(s)? ☐ No, the low flow threshold is 0.1Q2 (default low flow threshold) ☐ Yes, the result is the low flow threshold is 0.1Q2 ☐ Yes, the result is the low flow threshold is 0.3Q2 ☐ Yes, the result is the low flow threshold is 0.5Q2 *If a geomorphic assessment has been performed, provide title, date, and preparer:* *Discussion / Additional Information: (optional)*

Step 3.8: Other Site Requirements and Constraints

When applicable, list other site requirements or constraints that will influence storm water management design, such as zoning requirements including setbacks and open space, or local codes governing minimum street width, sidewalk construction, allowable pavement types, and drainage requirements.

Optional Additional Information or Continuation of Previous Sections As Needed

This space provided for additional information or continuation of information from previous sections as needed.

Step 4: Source Control BMP Checklist

Source Control BMPs

All development projects must implement source control BMPs 4.2.1 through 4.2.6 where applicable and feasible. See Chapter 4.2 and Appendix E of the County BMP Design Manual for information to implement source control BMPs shown in this checklist.

Answer each category below pursuant to the following:

- "Yes" means the project will implement the source control BMP as described in Chapter 4.2 and/or Appendix E of the County BMP Design Manual. Discussion / justification is not required.
- "No" means the BMP is applicable to the project but it is not feasible to implement. Discussion / justification must be provided.
- "N/A" means the BMP is not applicable at the project site because the project does not include the feature that is addressed by the BMP (e.g., the project has no outdoor materials storage areas). Discussion / justification must be provided.

Source Control Requirement	Applied?		
4.2.1 Prevention of Illicit Discharges into the MS4	☐Yes	☐No	☐N/A
Discussion / justification if 4.2.1 not implemented:			
4.2.2 Storm Drain Stenciling or Signage	☐Yes	☐No	☐N/A
Discussion / justification if 4.2.2 not implemented:			
4.2.3 Protect Outdoor Materials Storage Areas from Rainfall, Run-On, Runoff, and Wind Dispersal	☐Yes	☐No	☐N/A
Discussion / justification if 4.2.3 not implemented:			
4.2.4 Protect Materials Stored in Outdoor Work Areas from Rainfall, Run-On, Runoff, and Wind Dispersal	☐Yes	☐No	☐N/A
Discussion / justification if 4.2.4 not implemented:			

Source Control Requirement	Applied?		
4.2.5 Protect Trash Storage Areas from Rainfall, Run-On, Runoff, and Wind Dispersal	☐Yes	☐No	☐N/A
Discussion / justification if 4.2.5 not implemented:			
4.2.6 Additional BMPs Based on Potential Sources of Runoff Pollutants (must answer for each source listed below):			
☐ A. On-site storm drain inlets	☐Yes	☐No	☐N/A
☐ B. Interior floor drains and elevator shaft sump pumps	☐Yes	☐No	☐N/A
☐ C. Interior parking garages	☐Yes	☐No	☐N/A
☐ D. Need for future indoor & structural pest control	☐Yes	☐No	☐N/A
☐ E. Landscape/outdoor pesticide use	☐Yes	☐No	☐N/A
☐ F. Pools, spas, ponds, fountains, and other water features	☐Yes	☐No	☐N/A
☐ G. Food service	☐Yes	☐No	☐N/A
☐ H. Refuse areas	☐Yes	☐No	☐N/A
☐ I. Industrial processes	☐Yes	☐No	☐N/A
☐ J. Outdoor storage of equipment or materials	☐Yes	☐No	☐N/A
☐ K. Vehicle and equipment cleaning	☐Yes	☐No	☐N/A
☐ L. Vehicle/equipment repair and maintenance	☐Yes	☐No	☐N/A
☐ M. Fuel dispensing areas	☐Yes	☐No	☐N/A
☐ N. Loading docks	☐Yes	☐No	☐N/A
☐ O. Fire sprinkler test water	☐Yes	☐No	☐N/A
☐ P. Miscellaneous drain or wash water	☐Yes	☐No	☐N/A
☐ Q. Plazas, sidewalks, and parking lots	☐Yes	☐No	☐N/A
Discussion / justification if 4.2.6 not implemented. Clearly identify which sources of runoff pollutants are discussed. Justification must be provided for <u>all</u> "No" answers shown above.			

Note: Show all source control measures described above that are included in design capture volume calculations in the plan sheets of Attachment 5.

Step 5: Site Design BMP Checklist

Site Design BMPs
All development projects must implement site design BMPs SD-A through SD-H where applicable and feasible. See Chapter 4.3 and Appendix E of the County BMP Design Manual for information to implement site design BMPs shown in this checklist. Answer each category below pursuant to the following: • "Yes" means the project will implement the site design BMP as described in Chapter 4.3 and/or Appendix E of the County BMP Design Manual. Discussion / justification is not required. • "No" means the BMP is applicable to the project but it is not feasible to implement. Discussion / justification must be provided. • "N/A" means the BMP is not applicable at the project site because the project does not include the feature that is addressed by the BMP (e.g., the project site has no existing natural areas to conserve). Discussion / justification must be provided.

Site Design Requirement	Applied?		
4.3.1 Maintain Natural Drainage Pathways and Hydrologic Features	☐Yes	☐No	☐N/A
Discussion / justification if 4.3.1 not implemented:			
4.3.2 Conserve Natural Areas, Soils, and Vegetation	☐Yes	☐No	☐N/A
Discussion / justification if 4.3.2 not implemented:			
4.3.3 Minimize Impervious Area	☐Yes	☐No	☐N/A
Discussion / justification if 4.3.3 not implemented:			
4.3.4 Minimize Soil Compaction	☐Yes	☐No	☐N/A
Discussion / justification if 4.3.4 not implemented:			
4.3.5 Impervious Area Dispersion	☐Yes	☐No	☐N/A
Discussion / justification if 4.3.5 not implemented:			

Site Design Requirement	Applied?		
4.3.6 Runoff Collection	☐Yes	☐No	☐N/A
Discussion / justification if 4.3.6 not implemented:			
4.3.7 Landscaping with Native or Drought Tolerant Species	☐Yes	☐No	☐N/A
Discussion / justification if 4.3.7 not implemented:			
4.3.8 Harvesting and Using Precipitation	☐Yes	☐No	☐N/A
Discussion / justification if 4.3.8 not implemented:			

Note: Show all site design measures described above that are included in design capture volume calculations in the plan sheets of Attachment 5.

Step 6: PDP Structural BMPs

All PDPs must implement structural BMPs for storm water pollutant control (see Chapter 5 of the BMP Design Manual). Selection of PDP structural BMPs for storm water pollutant control must be based on the selection process described in Chapter 5. PDPs subject to hydromodification management requirements must also implement structural BMPs for flow control for hydromodification management (see Chapter 6 of the BMP Design Manual). Both storm water pollutant control and flow control for hydromodification management can be achieved within the same structural BMP(s).

PDP structural BMPs must be verified by the County at the completion of construction. This may include requiring the project owner or project owner's representative and engineer of record to certify construction of the structural BMPs (see Section 1.12 of the BMP Design Manual). PDP structural BMPs must be maintained into perpetuity, and the County must confirm the maintenance (see Section 7 of the BMP Design Manual).

Use this section to provide narrative description of the general strategy for structural BMP implementation at the project site in the box below. Then complete the PDP structural BMP summary information sheet (Step 6.2) for each structural BMP within the project (copy the BMP summary information sheet [Step 6.2] as many times as needed to provide summary information for each individual structural BMP).

Step 6.1: Description of structural BMP strategy

Describe the general strategy for structural BMP implementation at the site. This information must describe how the steps for selecting and designing storm water pollutant control BMPs presented in Section 5.1 of the BMP Design Manual were followed, and the results (type of BMPs selected). For projects requiring hydromodification flow control BMPs, indicate whether pollutant control and flow control BMPs are integrated or separate. At the end of this discussion provide a summary of all the structural BMPs within the project including the type and number.

(Continue on following page as necessary.)

Description of structural BMP strategy continued
(Page reserved for continuation of description of general strategy for structural BMP implementation at the site)

(Continued from previous page)

Step 6.2: Structural BMP Checklist

(Copy this page as needed to provide information for each individual proposed structural BMP)	
Structural BMP ID No.	
Construction Plan Sheet No.	
Type of structural BMP: ☐ Retention by harvest and use (HU-1) ☐ Retention by infiltration basin (INF-1) ☐ Retention by bioretention (INF-2) ☐ Retention by permeable pavement (INF-3) ☐ Partial retention by biofiltration with partial retention (PR-1) ☐ Biofiltration (BF-1) ☐ Biofiltration with Nutrient Sensitive Media Design (BF-2) ☐ Proprietary Biofiltration (BF-3) meeting all requirements of Appendix F ☐ Flow-thru treatment control with prior lawful approval to meet earlier PDP requirements (provide BMP type/description in discussion section below) ☐ Flow-thru treatment control included as pre-treatment/forebay for an onsite retention or biofiltration BMP (provide BMP type/description and indicate which onsite retention or biofiltration BMP it serves in discussion section below) ☐ Flow-thru treatment control with alternative compliance (provide BMP type/description in discussion section below) ☐ Detention pond or vault for hydromodification management ☐ Other (describe in discussion section below)	
Purpose: ☐ Pollutant control only ☐ Hydromodification control only ☐ Combined pollutant control and hydromodification control ☐ Pre-treatment/forebay for another structural BMP ☐ Other (describe in discussion section below)	
Who will certify construction of this BMP? Provide name and contact information for the party responsible to sign BMP verification forms (See Section 1.12 of the BMP Design Manual)	
Who will be the final owner of this BMP?	☐ HOA ☐ Property Owner ☐ County ☐ Other (describe)
Who will maintain this BMP into perpetuity?	☐ HOA ☐ Property Owner ☐ County ☐ Other (describe)
What Category (1-4) is the Structural BMP? Refer to the Category definitions in Section 7.3 of the BMP DM. Attach the appropriate maintenance agreement in Attachment 3.	
Discussion (as needed): *(Continue on subsequent pages as necessary)*	

Step 6.3: Offsite Alternative Compliance Participation Form

PDP INFORMATION	
Record ID:	
Assessor's Parcel Number(s) [APN(s)]	
What are your PDP Pollutant Control Debits? *See Attachment 1 of the PDP SWQMP	
What are your PDP HMP Debits? (if applicable) *See Attachment 2 of the PDP SWQMP	
ACP Information	
Record ID:	
Assessor's Parcel Number(s) [APN(s)]	
Project Owner/Address	
What are your ACP Pollutant Control Credits? *See Attachment 1 of the ACP SWQMP	
What are your ACP HMP Debits? (if applicable) *See Attachment 2 of the ACP SWQMP	
Is your ACP in the same watershed as your PDP? ☐ Yes ☐ No	Will your ACP project be completed prior to the completion of the PDP? ☐ Yes ☐ No
Does your ACP account for all Deficits generated by the PDP? ☐ Yes ☐ No (PDP and/or ACP must be redesigned to account for all deficits generated by the PDP.	What is the difference between your PDP debits and ACP Credits? *(ACP Credits -Total PDP Debits = Total Earned Credits)

ATTACHMENT 1

BACKUP FOR PDP POLLUTANT CONTROL BMPS

This is the cover sheet for Attachment 1.

Indicate which Items are Included behind this cover sheet:

Attachment Sequence	Contents	Checklist
Attachment 1a	Storm Water Pollutant Control Worksheet Calculations -Worksheet B.3-1 (Required) -Worksheet B.1-1 (Required) -Worksheet B.4-1 (if applicable) -Worksheet B.4-2 (if applicable) -Worksheet B.5-1 (if applicable) -Worksheet B.5-2 (if applicable) -Worksheet B.5-3 (if applicable) -Worksheet B.6-1 (if applicable) -Summary Worksheet (optional)	☐ Included
Attachment 1b	Form I-8, Categorization of Infiltration Feasibility Condition (Required unless the project will use harvest and use BMPs) Refer to Appendices C and D of the BMP Design Manual to complete Form I-8.	☐ Included ☐ Not included because the entire project will use harvest and use BMPs
Attachment 1c	DMA Exhibit (Required) See DMA Exhibit Checklist on the back of this Attachment cover sheet.	☐ Included
Attachment 1d	Individual Structural BMP DMA Mapbook (Required) -Place each map on 8.5”x11” paper. -Show at a minimum the DMA, Structural BMP, and any existing hydrologic features within the DMA.	☐ Included

Use this checklist to ensure the required information has been included on the DMA Exhibit:

The DMA Exhibit must identify:

☐ Underlying hydrologic soil group
☐ Approximate depth to groundwater
☐ Existing natural hydrologic features (watercourses, seeps, springs, wetlands)
☐ Critical coarse sediment yield areas to be protected
☐ Existing topography and impervious areas
☐ Existing and proposed site drainage network and connections to drainage offsite
☐ Proposed demolition
☐ Proposed grading
☐ Proposed impervious features
☐ Proposed design features and surface treatments used to minimize imperviousness
☐ Drainage management area (DMA) boundaries, DMA ID numbers, and DMA areas (square footage or acreage), and DMA type (i.e., drains to BMP, self-retaining, or self-mitigating)
☐ Potential pollutant source areas and corresponding required source controls (see Chapter 4, Appendix E.1, and Step 3.5)
☐ Structural BMPs (identify location, structural BMP ID#, type of BMP, and size/detail)

ATTACHMENT 2

BACKUP FOR PDP HYDROMODIFICATION CONTROL MEASURES

This is the cover sheet for Attachment 2.

☐ Mark this box if this attachment is empty because the project is exempt from PDP hydromodification management requirements.

Indicate which Items are Included behind this cover sheet:

Attachment Sequence	Contents	Checklist
Attachment 2a	Flow Control Facility Design, including Structural BMP Drawdown Calculations and Overflow Design Summary (Required) See Chapter 6 and Appendix G of the BMP Design Manual	☐ Included ☐ Submitted as separate stand-alone document
Attachment 2b	Hydromodification Management Exhibit (Required)	☐ Included See Hydromodification Management Exhibit Checklist on the back of this Attachment cover sheet.
Attachment 2c	Management of Critical Coarse Sediment Yield Areas See Section 6.2 and Appendix H of the BMP Design Manual.	☐ Exhibit depicting onsite and/or upstream sources of critical coarse sediment as mapped by Regional or Jurisdictional approaches outlined in Appendix H.1 AND, ☐ Demonstration that the project effectively avoids and bypasses sources of mapped critical coarse sediment per approaches outlined in Appendix H.2 and H.3. OR, ☐ Demonstration that project does not generate a net impact on the receiving water per approaches outlined in Appendix H.4.
Attachment 2d	Geomorphic Assessment of Receiving Channels (Optional) See Section 6.3.4 of the BMP Design Manual.	☐ Not performed ☐ Included ☐ Submitted as separate stand-alone document
Attachment 2e	Vector Control Plan (Required when structural BMPs will not drain in 96 hours)	☐ Included ☐ Not required because BMPs will drain in less than 96 hours

Use this checklist to ensure the required information has been included on the Hydromodification Management Exhibit:

The Hydromodification Management Exhibit must identify:

- ☐ Underlying hydrologic soil group
- ☐ Approximate depth to groundwater
- ☐ Existing natural hydrologic features (watercourses, seeps, springs, wetlands)
- ☐ Critical coarse sediment yield areas to be protected
- ☐ Existing topography
- ☐ Existing and proposed site drainage network and connections to drainage offsite
- ☐ Proposed grading
- ☐ Proposed impervious features
- ☐ Proposed design features and surface treatments used to minimize imperviousness
- ☐ Point(s) of Compliance (POC) for Hydromodification Management
- ☐ Existing and proposed drainage boundary and drainage area to each POC (when necessary, create separate exhibits for pre-development and post-project conditions)
- ☐ Structural BMPs for hydromodification management (identify location, type of BMP, and size/detail)

ATTACHMENT 3

Structural BMP Maintenance Information

This is the cover sheet for Attachment 3.

Indicate which Items are Included behind this cover sheet:

Attachment Sequence	**Contents**	**Checklist**
Attachment 3a	Structural BMP Maintenance Plan (Required)	☐ Included See Structural BMP Maintenance Information Checklist on the back of this Attachment cover sheet.
Attachment 3b	Draft Stormwater Maintenance Notification / Agreement (when applicable)	☐ Included ☐ Not Applicable

Use this checklist to ensure the required information has been included in the Structural BMP Maintenance Information Attachment:

Attachment 3a must identify:

- ☐ Specific maintenance indicators and actions for proposed structural BMP(s). This must be based on Section 7.7 of the BMP Design Manual and enhanced to reflect actual proposed components of the structural BMP(s)
- ☐ How to access the structural BMP(s) to inspect and perform maintenance
- ☐ Features that are provided to facilitate inspection (e.g., observation ports, cleanouts, silt posts, or other features that allow the inspector to view necessary components of the structural BMP and compare to maintenance thresholds)
- ☐ Manufacturer and part number for proprietary parts of structural BMP(s) when applicable
- ☐ Maintenance thresholds specific to the structural BMP(s), with a location-specific frame of reference (e.g., level of accumulated materials that triggers removal of the materials, to be identified based on viewing marks on silt posts or measured with a survey rod with respect to a fixed benchmark within the BMP)
- ☐ Recommended equipment to perform maintenance
- ☐ When applicable, necessary special training or certification requirements for inspection and maintenance personnel such as confined space entry or hazardous waste management

Attachment 3b: For all Structural BMPs, Attachment 3b must include a draft maintenance agreement in the County's standard format depending on the Category (PDP applicant to contact County staff to obtain the current maintenance agreement forms). Refer to Section 7.3 in the BMP Design Manual for a description of the different categories.

ATTACHMENT 4

County of San Diego PDP Structural BMP Verification for Permitted Land Development Projects

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County of San Diego BMP Design Manual Verification Form	
Project Summary Information	
Project Name	
Record ID (e.g., grading/improvement plan number)	
Project Address	
Assessor's Parcel Number(s) (APN(s))	
Project Watershed (Complete Hydrologic Unit, Area, and Subarea Name with Numeric Identifier)	
Responsible Party for Construction Phase	
Developer's Name	
Address	
Email Address	
Phone Number	
Engineer of Work	
Engineer's Phone Number	
Responsible Party for Ongoing Maintenance	
Owner's Name(s)*	
Address	
Email Address	
Phone Number	
*Note: If a corporation or LLC, provide information for principal partner or Agent for Service of Process. If an HOA, provide information for the Board or property manager at time of project closeout.	

County of San Diego BMP Design Manual Verification Form Page 2 of 4					
Stormwater Structural Pollutant Control & Hydromodification Control BMPs* (List all from SWQMP)					
Description/Type of Structural BMP	**Plan Sheet #**	**STRUCT-URAL BMP ID#**	**Maint-enance Category**	**Maintenance Agreement Recorded Doc #**	**Revisions**
*All Priority Development Projects (PDPs) require a Structural BMP					

Note: If this is a partial verification of Structural BMPs, provide a list and map denoting Structural BMPs that have already been submitted, those for this submission, and those anticipated in future submissions.

County of San Diego BMP Design Manual Verification Form Page 3 of 4

Checklist for Applicant to submit to PDCI:

- ☐ Copy of the final accepted SWQMP and any accepted addendum.
- ☐ Copy of the most current plan showing the Stormwater Structural BMP Table, plans/cross-section sheets of the Structural BMPs and the location of each verified as-built Structural BMP.
- ☐ Photograph of each Structural BMP.
- ☐ Photograph(s) of each Structural BMP during the construction process to illustrate proper construction.
- ☐ Copy of the approved Structural BMP maintenance agreement and associated security

By signing below, I certify that the Structural BMP(s) for this project have been constructed and all BMPs are in substantial conformance with the approved plans and applicable regulations. I understand the County reserves the right to inspect the above BMPs to verify compliance with the approved plans and Watershed Protection Ordinance (WPO). Should it be determined that the BMPs were not constructed to plan or code, corrective actions may be necessary before permits can be closed.

Please sign your name and seal.

Professional Engineer's Printed Name: _____

Professional Engineer's Signed Name: _____

Date: _____

[SEAL]

County of San Diego BMP Design Manual Verification Form Page 4 of 4

COUNTY - OFFICIAL USE ONLY:

For PDCI: Verification Package #: _____

PDCI Inspector: _____

Date Project has/expects to close: _____

Date verification received from EOW: _____

By signing below, PDCI Inspector concurs that every noted Structural BMP has been installed per plan.

PDCI Inspector's Signature: _____ Date: _____

FOR WPP:

Date Received from PDCI: _____

WPP Submittal Reviewer: _____

WPP Reviewer concurs that the information provided for the following Structural BMPs is acceptable to enter into the Structural BMP Maintenance verification inventory:

List **acceptable** Structural BMPs:

WPP Reviewer's Signature: _____ Date: _____

ATTACHMENT 5

Copy of Plan Sheets Showing Permanent Storm Water BMPs, Source Control, and Site Design

This is the cover sheet for Attachment 5.

Use this checklist to ensure the required information has been included on the plans:

The plans must identify:

- ☐ Structural BMP(s) with ID numbers matching Step 6 Summary of PDP Structural BMPs
- ☐ The grading and drainage design shown on the plans must be consistent with the delineation of DMAs shown on the DMA exhibit
- ☐ Details and specifications for construction of structural BMP(s)
- ☐ Signage indicating the location and boundary of structural BMP(s) as required by County staff
- ☐ How to access the structural BMP(s) to inspect and perform maintenance
- ☐ Features that are provided to facilitate inspection (e.g., observation ports, cleanouts, silt posts, or other features that allow the inspector to view necessary components of the structural BMP and compare to maintenance thresholds)
- ☐ Manufacturer and part number for proprietary parts of structural BMP(s) when applicable
- ☐ Maintenance thresholds specific to the structural BMP(s), with a location-specific frame of reference (e.g., level of accumulated materials that triggers removal of the materials, to be identified based on viewing marks on silt posts or measured with a survey rod with respect to a fixed benchmark within the BMP)
- ☐ Recommended equipment to perform maintenance
- ☐ When applicable, necessary special training or certification requirements for inspection and maintenance personnel such as confined space entry or hazardous waste management
- ☐ Include landscaping plan sheets showing vegetation requirements for vegetated structural BMP(s)
- ☐ All BMPs must be fully dimensioned on the plans
- ☐ When proprietary BMPs are used, site-specific cross section with outflow, inflow, and model number must be provided. Photocopies of general brochures are not acceptable.
- ☐ Include all source control and site design measures described in Steps 4 and 5 of the SWQMP. Can be included as a separate exhibit as necessary.

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ATTACHMENT 6

Copy of Project's Drainage Report

This is the cover sheet for Attachment 6.

If hardcopy or CD is not attached, the following information should be provided:

Title:
Prepared By:
Date:

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ATTACHMENT 7

Copy of Project's Geotechnical and Groundwater Investigation Report

This is the cover sheet for Attachment 7.

If hardcopy or CD is not attached, the following information should be provided:

Title:
Prepared By:
Date:

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A.4 Green Streets PDP Exempt SWQMP

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County of San Diego
GREEN STREETS PDP EXEMPT SWQMP

[INSERT PROJECT NAME]
[INSERT RECORD ID (PERMIT) NUMBERS]

[INSERT PROJECT ADDRESS]
[INSERT PROJECT CITY, STATE ZIP CODE]

ASSESSOR'S PARCEL NUMBER(S):
[INSERT APN(S)]

ENGINEER OF WORK:

[INSERT CIVIL ENGINEER'S NAME AND PE NUMBER HERE, PROVIDE WET SIGNATURE AND STAMP ABOVE LINE]

PREPARED FOR:

[INSERT APPLICANT NAME]
[INSERT ADDRESS]
[INSERT CITY, STATE ZIP CODE]
[INSERT TELEPHONE NUMBER]

SWQMP PREPARED BY:

[INSERT COMPANY NAME]
[INSERT ADDRESS]
[INSERT CITY, STATE ZIP CODE]
[INSERT TELEPHONE NUMBER]

DATE OF SWQMP:
[INSERT MONTH, DAY, YEAR]

PLANS PREPARED BY:
[INSERT CIVIL ENGINEER OR ARCHITECT]
[INSERT ADDRESS]
[INSERT CITY, STATE ZIP CODE]
[INSERT TELEPHONE NUMBER]

SWQMP APPROVED BY:

APPROVAL DATE:

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Attachments

Attachment 1: Backup for Green Streets Strategies
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    Attachment 1b: DMA Exhibit
Attachment 2: Green Streets Strategies Maintenance Plan
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Attachment 3: Copy of Plan Sheets Showing Green Streets Strategies
Attachment 4: Copy of Project's Drainage Report
Attachment 5: Copy of Project's Geotechnical and Groundwater Investigation Report

Acronyms

ACP	Alternative Compliance Project
APN	Assessor's Parcel Number
BMP	Best Management Practice
BMP DM	Best Management Practice Design Manual
GS	Green Streets
HSG	Hydrologic Soil Group
MS4	Municipal Separate Storm Sewer System
N/A	Not Applicable
NRCS	Natural Resources Conservation Service
PDP	Priority Development Project
PDS	Planning and Development Services
PE	Professional Engineer
RPO	Resource Protection Ordinance
SC	Source Control
SD	Site Design
SDRWQCB	San Diego Regional Water Quality Control Board
SIC	Standard Industrial Classification
SWQMP	Storm Water Quality Management Plan
WPO	Watershed Protection Ordinance

Green Streets PDP Exempt SWQMP Preparer's Certification Page

Project Name: [Insert Project Name]
Permit Application Number: [Insert Permit Application Number]

PREPARER'S CERTIFICATION

I hereby declare that I am the Engineer in Responsible Charge of design of storm water best management practices (BMPs) for this project, and that I have exercised responsible charge over the design of the BMPs as defined in Section 6703 of the Business and Professions Code, and that the design is consistent with the PDP requirements of the County of San Diego BMP Design Manual, which is a design manual for compliance with local County of San Diego Watershed Protection Ordinance (Sections 67.801 et seq.) and regional MS4 Permit (California Regional Water Quality Control Board San Diego Region Order No. R9-2013-0001 as amended by R9-2015-0001 and R9-2015-0100) requirements for storm water management.

I have read and understand that the County of San Diego has adopted minimum requirements for managing urban runoff, including storm water, from land development activities, as described in the BMP Design Manual. I certify that this PDP SWQMP has been completed to the best of my ability and accurately reflects the project being proposed and the applicable BMPs proposed to minimize the potentially negative impacts of this project's land development activities on water quality. I understand and acknowledge that the plan check review of this PDP SWQMP by County staff is confined to a review and does not relieve me, as the Engineer in Responsible Charge of design of storm water BMPs for this project, of my responsibilities for project design.

_____
Engineer of Work's Signature, PE Number & Expiration Date

_____
Print Name

_____
Company

_____
Date

Engineer's Seal:

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Submittal Record

Use this Table to keep a record of submittals of this PDP SWQMP. Each time the PDP SWQMP is re-submitted, provide the date and status of the project. In column 4 summarize the changes that have been made or indicate if response to plancheck comments is included. When applicable, insert response to plancheck comments behind this page.

Preliminary Design / Planning / CEQA

Submittal Number	Date	Summary of Changes
1		Initial Submittal
2		
3		
4		

Final Design

Submittal Number	Date	Summary of Changes
1		Initial Submittal
2		
3		
4		

Plan Changes

Submittal Number	Date	Summary of Changes
1		Initial Submittal
2		
3		
4		

Project Vicinity Map

Project Name: [Insert Project Name]
Record ID: [Insert Record ID or Permit Application Number]

[Insert Project Vicinity Map here]

Step 1: Project type determination

Is the project part of another Priority Development Project (PDP)? If so, a PDP SQWMP is required. Go to Step 2.	☐ Yes ☐ No
The project is (select one): ☐ New Development ☐ Redevelopment[1]	
The total proposed newly created or replaced impervious area is:	ft^2
The total existing (pre-project) impervious area is:	ft^2
The total area disturbed by the project is:	ft^2
If the total area disturbed by the project is 1 acre (43,560 sq. ft.) or more OR the project is part of a larger common plan of development disturbing 1 acre or more, a Waste Discharger Identification (WDID) number must be obtained from the State Water Resources Control Board. WDID: ___	

Is the project in any of the following categories, (a) through (f)?

Yes ☐	No ☐	(a)	New development projects that create 10,000 square feet or more of impervious surfaces (collectively over the entire project site). This includes commercial, industrial, residential, mixed-use, and public development projects on public or private land.
Yes ☐	No ☐	(b)	Redevelopment projects that create and/or replace 5,000 square feet or more of impervious surface (collectively over the entire project site on an existing site of 10,000 square feet or more of impervious surfaces). This includes commercial, industrial, residential, mixed-use, and public development projects on public or private land.
Yes ☐	No ☐	(c)	New and redevelopment projects that create and/or replace 5,000 square feet or more of impervious surface (collectively over the entire project site), and support one or more of the following uses: (i) Restaurants. This category is defined as a facility that sells prepared foods and drinks for consumption, including stationary lunch counters and refreshment stands selling prepared foods and drinks for immediate consumption (Standard Industrial Classification (SIC) code 5812). (ii) Hillside development projects. This category includes development on any natural slope that is twenty-five percent or greater. (iii) Parking lots. This category is defined as a land area or facility for the temporary parking or storage of motor vehicles used personally, for business, or for commerce. (iv) Streets, roads, highways, freeways, and driveways. This category is defined as any paved impervious surface used for the transportation of automobiles, trucks, motorcycles, and other vehicles.

Project type determination (continued)

Yes	No	(d)	New or redevelopment projects that create and/or replace 2,500 square feet or more

[1] Redevelopment is defined as: The creation, addition, and or replacement of impervious surface on an already developed site. Examples include the expansion of a building footprint, road widening, the addition to or replacement of a structure. Replacement of impervious surfaces includes any activity where impervious material(s) are removed, exposing underlying soil during construction. Redevelopment does not include routine maintenance activities, such as trenching and resurfacing associated with utility work; pavement grinding; resurfacing existing roadways, sidewalks, pedestrian ramps, or bike lanes on existing roads; and routine replacement of damaged pavement, such as pothole repair.

Applicants should note that any development project that will create and/or replace 10,000 square feet or more of impervious surface (collectively over the entire project site) is considered a new development.

For solar energy farm projects, the area of the solar panels does not count toward the total impervious area of the site.

☐	☐		of impervious surface (collectively over the entire project site), and discharging directly to an Environmentally Sensitive Area (ESA). "Discharging directly to" includes flow that is conveyed overland a distance of 200 feet or less from the project to the ESA, or conveyed in a pipe or open channel any distance as an isolated flow from the project to the ESA (i.e. not commingled with flows from adjacent lands). *Note: ESAs are areas that include but are not limited to all Clean Water Act Section 303(d) impaired water bodies; areas designated as Areas of Special Biological Significance by the State Water Board and San Diego Water Board; State Water Quality Protected Areas; water bodies designated with the RARE beneficial use by the State Water Board and San Diego Water Board; and any other equivalent environmentally sensitive areas which have been identified by the Copermittees. See BMP Design Manual Section 1.4.2 for additional guidance.*
Yes ☐	No ☐	(e)	New development projects, or redevelopment projects that create and/or replace 5,000 square feet or more of impervious surface, that support one or more of the following uses: (i) Automotive repair shops. This category is defined as a facility that is categorized in any one of the following SIC codes: 5013, 5014, 5541, 7532-7534, or 7536-7539. (ii) Retail gasoline outlets (RGOs). This category includes RGOs that meet the following criteria: (a) 5,000 square feet or more or (b) a projected Average Daily Traffic (ADT) of 100 or more vehicles per day.
Yes ☐	No ☐	(f)	New or redevelopment projects that result in the disturbance of one or more acres of land and are expected to generate pollutants post construction. *Note: See BMP Design Manual Section 1.4.2 for additional guidance.*

Does the project meet the definition of one or more of the Priority Development Project categories (a) through (f) listed above?

☐ No – the project is <u>not</u> a Priority Development Project (Standard Project).

☐ Yes – the project is a Priority Development Project (PDP).

Further guidance may be found in Chapter 1 and Table 1-2 of the BMP Design Manual.

The following is for **redevelopment PDPs only**:

The area of existing (pre-project) impervious area at the project site (limit of work) is: ft^2 (A)
The total proposed newly created or replaced impervious area is: ft^2 (B)
Percent impervious surface created or replaced (B/A)*100: %
The percent impervious surface created or replaced is (select one based on the above calculation):

☐ less than or equal to fifty percent (50%) – **only new impervious areas are considered a PDP and subject to stormwater requirements**

OR

☐ greater than fifty percent (50%) – **the entire project site is considered a PDP and subject to stormwater requirements**

Step 1.1: Storm Water Quality Management Plan requirements

Step	Answer	Progression
Is the project a Standard Project, Priority Development Project (PDP), or exception to PDP definitions? To answer this item, complete Step 1 Project Type Determination Checklist on Pages 1 and 2, and see PDP exemption information below. For further guidance, see Section 1.4 of the BMP Design Manual *in its entirety*.	☐ Standard Project	Standard Project requirements apply, including Standard Project SWQMP. **Complete Standard Project SWQMP.**
	☐ PDP	Standard and PDP requirements apply, including PDP SWQMP. **Complete PDP SWQMP.**
	☐ PDP Exemption	**Go to Step 1.2 below.**

Step 1.2: Exemption to PDP definitions

Is the project exempt from PDP definitions based on either of the following: ☐ Projects that are only new or retrofit paved sidewalks, bicycle lanes, or trails that meet the following criteria: (i) Designed and constructed to direct storm water runoff to adjacent vegetated areas, or other non-erodible permeable areas; OR (ii) Designed and constructed to be hydraulically disconnected from paved streets or roads [i.e., runoff from the new improvement does not drain directly onto paved streets or roads]; OR (iii) Designed and constructed with permeable pavements or surfaces in accordance with County of San Diego Guidance on Green Infrastructure;	If so: Standard Project requirements apply, AND any additional requirements specific to the type of project. County concurrence with the exemption is required. *Provide discussion and list any additional requirements below in this form.* **Complete Standard Project SWQMP**
☐ Projects that are only retrofitting or redeveloping existing paved alleys, streets or roads that are designed and constructed in accordance with the County of San Diego Guidance on Green Infrastructure.	**Complete Green Streets PDP Exempt SWQMP.**
Discussion / justification, and additional requirements for exceptions to PDP definitions, if applicable:	

Step 2: Construction Storm Water BMP Checklist

Minimum Required Standard Construction Storm Water BMPs		
If you answer "Yes" to any of the questions below, your project is subject to Table 1 on the following page (Minimum Required Standard Construction Stormwater BMPs). As noted in Table 1, please select at least the minimum number of required BMPs, or as many as are feasible for your project. If no BMP is selected, an explanation must be given in the box provided. The following questions are intended to aid in determining construction BMP requirements for your project. **Note: All selected BMPs below must be included on the BMP plan incorporated into the building sets.**		
1. Will there be soil disturbing activities that will result in exposed soil areas? (This includes minor grading and trenching.) **Reference Table 1 Items A, B, D, and E** Note: Soil disturbances NOT considered significant include, but are not limited to, change in use, mechanical/electrical/plumbing activities, signs, temporary trailers, interior remodeling, and minor tenant improvement.	☐Yes	☐No
2. Will there be asphalt paving, including patching? **Reference Table 1 Items D and F**	☐Yes	☐No
3. Will there be slurries from mortar mixing, coring, or concrete saw cutting? **Reference Table 1 Items D and F**	☐Yes	☐No
4. Will there be solid wastes from concrete demolition and removal, wall construction, or form work? **Reference Table 1 Items D and F**	☐Yes	☐No
5. Will there be stockpiling (soil, compost, asphalt, concrete, solid waste) for over 24 hours? **Reference Table 1 Items D and F**	☐Yes	☐No
6. Will there be dewatering operations? **Reference Table 1 Items C and D**	☐Yes	☐No
7. Will there be temporary on-site storage of construction materials, including mortar mix, raw landscaping and soil stabilization materials, treated lumber, rebar, and plated metal fencing materials? **Reference Table 1 Items E and F**	☐Yes	☐No
8. Will trash or solid waste product be generated from this project? **Reference Table 1 Item F**	☐Yes	☐No
9. Will construction equipment be stored on site (e.g.: fuels, oils, trucks, etc.?) **Reference Table 1 Item F**	☐Yes	☐No
10. Will Portable Sanitary Services ("Porta-potty") be used on the site? **Reference Table 1 Item F**	☐Yes	☐No

Table 1. Construction Storm Water BMP Checklist

Minimum Required Best Management Practices (BMPs)	CALTRANS SW Handbook[2] Detail or County Std. Detail	✔ BMP Selected	Each selected BMP must be shown on the plan. If no BMP is selected, an explanation must be provided.
A. Select Erosion Control Method for Disturbed Slopes (choose at least one for the appropriate season)			
Vegetation Stabilization Planting[3] (Summer)	SS-2, SS-4	☐	
Hydraulic Stabilization Hydroseeding[2] (Summer)	SS-4	☐	
Bonded Fiber Matrix or Stabilized Fiber Matrix[4] (Winter)	SS-3	☐	
Physical Stabilization Erosion Control Blanket[3] (Winter)	SS-7	☐	
B. Select erosion control method for disturbed flat areas (slope < 5%) (choose at least one)			
County Standard Lot Perimeter Protection Detail	PDS 659[5], SC-2	☐	
Will use erosion control measures from Item A on flat areas also	SS-3, 4, 7	☐	
County Standard Desilting Basin (must treat all site runoff)	PDS 660[6], SC-2	☐	
Mulch, straw, wood chips, soil application	SS-6, SS-8	☐	

2 State of California Department of Transportation (Caltrans). 2003. Storm Water Quality Handbooks, Construction Site Best Management Practices (BMPs) Manual. March. Available online at: http://www.dot.ca.gov/hq/construc/stormwater/manuals.htm.

3 If Vegetation Stabilization (Planting or Hydroseeding) is proposed for erosion control it may be installed between May 1st and August 15th. Slope irrigation is in place and needs to be operable for slopes >3 feet. Vegetation must be watered and established prior to October 1st. The owner must implement a contingency physical BMP by August 15th if vegetation establishment does not occur by that date. If landscaping is proposed, erosion control measures must also be used while landscaping is being established. Established vegetation must have a subsurface mat of intertwined mature roots with a uniform vegetative coverage of 70 percent of the natural vegetative coverage or more on all disturbed areas.

4 All slopes over three feet must have established vegetative cover prior to final permit approval.

5 County of San Diego, Planning & Development Services. 2012. Standard Lot Perimeter Protection Design System. Building Division. PDS 659. Available online at http://www.sandiegocounty.gov/pds/docs/pds659.pdf.

6 County of San Diego, Planning & Development Services. 2012. County Standard Desilting Basin for Disturbed Areas of 1 Acre or Less Building Division. PDS 659. Available online at http://www.sandiegocounty.gov/pds/docs/pds660.pdf.

Table 1. Construction Storm Water BMP Checklist (continued)

Minimum Required Best Management Practices (BMPs)	CALTRANS SW Handbook Detail or County Std. Detail	✔ BMP Selected	Each selected BMP must be shown on the plan. If no BMP is selected, an explanation must be provided.
C. If runoff or dewatering operation is concentrated, velocity must be controlled using an energy dissipater			
Energy Dissipater Outlet Protection[7]	SS-10	☐	
D. Select sediment control method for all disturbed areas (choose at least one)			
Silt Fence	SC-1	☐	
Fiber Rolls (Straw Wattles)	SC-5	☐	
Gravel & Sand Bags	SC-6 & 8	☐	
Dewatering Filtration	NS-2	☐	
Storm Drain Inlet Protection	SC-10	☐	
Engineered Desilting Basin (sized for 10-year flow)	SC-2	☐	
E. Select method for preventing offsite tracking of sediment (choose at least one)			
Stabilized Construction Entrance	TC-1	☐	
Construction Road Stabilization	TC-2	☐	
Entrance/Exit Tire Wash	TC-3	☐	
Entrance/Exit Inspection & Cleaning Facility	TC-1	☐	
Street Sweeping and Vacuuming	SC-7	☐	
F. Select the general site management BMPs			
F.1 Materials Management			
Material Delivery & Storage	WM-1	☐	
Spill Prevention and Control	WM-4	☐	
F.2 Waste Management[8]			
Waste Management Concrete Waste Management	WM-8	☐	
Solid Waste Management	WM-5	☐	
Sanitary Waste Management	WM-9	☐	
Hazardous Waste Management	WM-6	☐	

Note: The Construction General Permit (Order No. 2009-0009-DWQ) also requires all projects not subject to the BMP Design Manual to comply with runoff reduction requirements through the implementation of post-construction BMPs as described in Section XIII of the order.

[7] Regional Standard Drawing D-40 – Rip Rap Energy Dissipater is also acceptable for velocity reduction.

[8] Not all projects will have every waste identified. The applicant is responsible for identifying wastes that will be onsite and applying the appropriate BMP. For example, if concrete will be used, BMP WM-8 must be selected.

Step 3: County of San Diego Green Streets PDP Exempt SWQMP Site Information Checklist

Step 3.1: Description of Existing Site Condition

Project Watershed (Complete Hydrologic Unit, Area, and Subarea Name with Numeric Identifier)	

Current Status of the Site (select all that apply):

- ☐ Existing development
- ☐ Previously graded but not built out
- ☐ Demolition completed without new construction
- ☐ Agricultural or other non-impervious use
- ☐ Vacant, undeveloped/natural

Description / Additional Information:

Existing Land Cover Includes (select all that apply and provide each area on site):

- ☐ Vegetative Cover _____ Acres (_____ Square Feet)
- ☐ Non-Vegetated Pervious Areas _____ Acres (_____ Square Feet)
- ☐ Impervious Areas _____ Acres (_____ Square Feet)

Description / Additional Information:

Underlying Soil belongs to Hydrologic Soil Group (select all that apply):

- ☐ NRCS Type A
- ☐ NRCS Type B
- ☐ NRCS Type C
- ☐ NRCS Type D

Approximate Depth to Groundwater (GW) (or N/A if not using infiltration):

- ☐ GW Depth < 5 feet
- ☐ 5 feet < GW Depth < 10 feet
- ☐ 10 feet < GW Depth < 20 feet
- ☐ GW Depth > 20 feet

Existing Natural Hydrologic Features (select all that apply):

- ☐ Watercourses
- ☐ Seeps
- ☐ Springs
- ☐ Wetlands
- ☐ None
- ☐ Other

Description / Additional Information:

Step 3.2: Description of Existing Site Drainage Patterns

How is storm water runoff conveyed from the site? At a minimum, this description should answer:

(1) Whether existing drainage conveyance is natural or urban;
(2) Is runoff from offsite conveyed through the site? if yes, quantify all offsite drainage areas, design flows, and locations where offsite flows enter the project site, and summarize how such flows are conveyed through the site;
(3) Provide details regarding existing project site drainage conveyance network, including any existing storm drains, concrete channels, swales, detention facilities, storm water treatment facilities, natural or constructed channels; and
(4) Identify all discharge locations from the existing project site along with a summary of conveyance system size and capacity for each of the discharge locations. Provide summary of the pre-project drainage areas and design flows to each of the existing runoff discharge locations.

Describe existing site drainage patterns:

Step 3.3: Description of Proposed Site Development

Project Description / Proposed Land Use and/or Activities:
List/describe proposed impervious features of the project (e.g., buildings, roadways, parking lots, courtyards, athletic courts, other impervious features):
List/describe proposed pervious features of the project (e.g., landscape areas):
Does the project include grading and changes to site topography? ☐Yes ☐No *Description / Additional Information:*

Insert acreage or square feet for the different land cover types in the table below:

Change in Land Cover Type Summary			
Land Cover Type	Existing (acres or ft^2)	Proposed (acres or ft^2)	Percent Change
Vegetation			
Pervious (non-vegetated)			
Impervious			

Step 3.4: Description of Proposed Site Drainage Patterns

Does the project include changes to site drainage (e.g., installation of new storm water conveyance systems)?

☐Yes
☐No

If yes, provide details regarding the proposed project site drainage conveyance network, including storm drains, concrete channels, swales, detention facilities, storm water treatment facilities, natural or constructed channels, and the method for conveying offsite flows through or around the proposed project site. Identify all discharge locations from the proposed project site along with a summary of the conveyance system size and capacity for each of the discharge locations. Provide a summary of pre- and post-project drainage areas and design flows to each of the runoff discharge locations. Reference the drainage study for detailed calculations.

Describe proposed site drainage patterns:

Step 3.5: Potential Pollutant Source Areas

Identify whether any of the following features, activities, and/or pollutant source areas will be present (select all that apply). Select "Other" if the project is a phased development and provide a description:

- ☐ On-site storm drain inlets
- ☐ Interior floor drains and elevator shaft sump pumps
- ☐ Interior parking garages
- ☐ Need for future indoor & structural pest control
- ☐ Landscape/Outdoor Pesticide Use
- ☐ Pools, spas, ponds, decorative fountains, and other water features
- ☐ Food service
- ☐ Refuse areas
- ☐ Industrial processes
- ☐ Outdoor storage of equipment or materials
- ☐ Vehicle and Equipment Cleaning
- ☐ Vehicle/Equipment Repair and Maintenance
- ☐ Fuel Dispensing Areas
- ☐ Loading Docks
- ☐ Fire Sprinkler Test Water
- ☐ Miscellaneous Drain or Wash Water
- ☐ Plazas, sidewalks, and parking lots
- ☐ Other (provide description)

Description / Additional Information:

Step 3.6: Identification and Narrative of Receiving Water and Pollutants of Concern

Describe flow path of storm water from the project site discharge location(s), through urban storm conveyance systems as applicable, to receiving creeks, rivers, and lagoons as applicable, and ultimate discharge to the Pacific Ocean (or bay, lagoon, lake or reservoir, as applicable):
List any 303(d) impaired water bodies within the path of storm water from the project site to the Pacific Ocean (or bay, lagoon, lake or reservoir, as applicable), identify the pollutant(s)/stressor(s) causing impairment, and identify any TMDLs and/or Highest Priority Pollutants from the WQIP for the impaired water bodies:

303(d) Impaired Water Body	Pollutant(s)/Stressor(s)	TMDLs / WQIP Highest Priority Pollutant

Step 3.7: Other Site Requirements and Constraints

When applicable, list other site requirements or constraints that will influence storm water management design, such as zoning requirements including setbacks and open space, or local codes governing minimum street width, sidewalk construction, allowable pavement types, and drainage requirements.

Optional Additional Information or Continuation of Previous Sections As Needed

This space provided for additional information or continuation of information from previous sections as needed.

Step 4: Source Control BMP Checklist

Source Control BMPs			
All development projects must implement source control BMPs 4.2.1 through 4.2.6 where applicable and feasible. See Chapter 4.2 and Appendix E of the County BMP Design Manual for information to implement source control BMPs shown in this checklist. Answer each category below pursuant to the following: • "Yes" means the project will implement the source control BMP as described in Chapter 4.2 and/or Appendix E of the County BMP Design Manual. Discussion / justification is not required. • "No" means the BMP is applicable to the project but it is not feasible to implement. Discussion / justification must be provided. • "N/A" means the BMP is not applicable at the project site because the project does not include the feature that is addressed by the BMP (e.g., the project has no outdoor materials storage areas). Discussion / justification must be provided.			
Source Control Requirement	**Applied?**		
4.2.1 Prevention of Illicit Discharges into the MS4	☐Yes	☐No	☐N/A
Discussion / justification if 4.2.1 not implemented:			
4.2.2 Storm Drain Stenciling or Signage	☐Yes	☐No	☐N/A
Discussion / justification if 4.2.2 not implemented:			
4.2.3 Protect Outdoor Materials Storage Areas from Rainfall, Run-On, Runoff, and Wind Dispersal	☐Yes	☐No	☐N/A
Discussion / justification if 4.2.3 not implemented:			
4.2.4 Protect Materials Stored in Outdoor Work Areas from Rainfall, Run-On, Runoff, and Wind Dispersal	☐Yes	☐No	☐N/A
Discussion / justification if 4.2.4 not implemented:			

Source Control Requirement	Applied?		
4.2.5 Protect Trash Storage Areas from Rainfall, Run-On, Runoff, and Wind Dispersal	☐Yes	☐No	☐N/A
Discussion / justification if 4.2.5 not implemented:			
4.2.6 Additional BMPs Based on Potential Sources of Runoff Pollutants (must answer for each source listed below):			
☐ A. On-site storm drain inlets	☐Yes	☐No	☐N/A
☐ B. Interior floor drains and elevator shaft sump pumps	☐Yes	☐No	☐N/A
☐ C. Interior parking garages	☐Yes	☐No	☐N/A
☐ D. Need for future indoor & structural pest control	☐Yes	☐No	☐N/A
☐ E. Landscape/outdoor pesticide use	☐Yes	☐No	☐N/A
☐ F. Pools, spas, ponds, fountains, and other water features	☐Yes	☐No	☐N/A
☐ G. Food service	☐Yes	☐No	☐N/A
☐ H. Refuse areas	☐Yes	☐No	☐N/A
☐ I. Industrial processes	☐Yes	☐No	☐N/A
☐ J. Outdoor storage of equipment or materials	☐Yes	☐No	☐N/A
☐ K. Vehicle and equipment cleaning	☐Yes	☐No	☐N/A
☐ L. Vehicle/equipment repair and maintenance	☐Yes	☐No	☐N/A
☐ M. Fuel dispensing areas	☐Yes	☐No	☐N/A
☐ N. Loading docks	☐Yes	☐No	☐N/A
☐ O. Fire sprinkler test water	☐Yes	☐No	☐N/A
☐ P. Miscellaneous drain or wash water	☐Yes	☐No	☐N/A
☐ Q. Plazas, sidewalks, and parking lots	☐Yes	☐No	☐N/A
Discussion / justification if 4.2.6 not implemented. Clearly identify which sources of runoff pollutants are discussed. Justification must be provided for <u>all</u> "No" answers shown above.			

Note: Show all source control measures described above that are included in design capture volume calculations in the plan sheets of Attachment 5.

Step 5: Site Design BMP Checklist

Site Design BMPs
All development projects must implement site design BMPs SD-A through SD-H where applicable and feasible. See Chapter 4.3 and Appendix E of the County BMP Design Manual for information to implement site design BMPs shown in this checklist. Answer each category below pursuant to the following: • "Yes" means the project will implement the site design BMP as described in Chapter 4.3 and/or Appendix E of the County BMP Design Manual. Discussion / justification is not required. • "No" means the BMP is applicable to the project but it is not feasible to implement. Discussion / justification must be provided. • "N/A" means the BMP is not applicable at the project site because the project does not include the feature that is addressed by the BMP (e.g., the project site has no existing natural areas to conserve). Discussion / justification must be provided.

Site Design Requirement	Applied?		
4.3.1 Maintain Natural Drainage Pathways and Hydrologic Features	☐Yes	☐No	☐N/A
Discussion / justification if 4.3.1 not implemented:			
4.3.2 Conserve Natural Areas, Soils, and Vegetation	☐Yes	☐No	☐N/A
Discussion / justification if 4.3.2 not implemented:			
4.3.3 Minimize Impervious Area	☐Yes	☐No	☐N/A
Discussion / justification if 4.3.3 not implemented:			
4.3.4 Minimize Soil Compaction	☐Yes	☐No	☐N/A
Discussion / justification if 4.3.4 not implemented:			
4.3.5 Impervious Area Dispersion	☐Yes	☐No	☐N/A
Discussion / justification if 4.3.5 not implemented:			

Site Design Requirement	Applied?		
4.3.6 Runoff Collection	☐Yes	☐No	☐N/A
Discussion / justification if 4.3.6 not implemented:			
4.3.7 Landscaping with Native or Drought Tolerant Species	☐Yes	☐No	☐N/A
Discussion / justification if 4.3.7 not implemented:			
4.3.8 Harvesting and Using Precipitation	☐Yes	☐No	☐N/A
Discussion / justification if 4.3.8 not implemented:			

Note: Show all site design measures described above that are included in design capture volume calculations in the plan sheets of Attachment 5.

Step 6: Summary of Green Infrastructure Strategies

Green Streets PDP exempt projects must implement Green Infrastructure strategies for storm water pollutant control (see Chapter 5 of the BMP Design Manual). Selection of Green Infrastructure strategies for storm water pollutant control must be based on the selection process described in Chapter 5.

Use this section to provide narrative description of the plan of action for Green Infrastructure strategies implementation at the project site in the box below.

Step 6.1: Description of Green Infrastructure strategy

Describe the plan of action for Green Infrastructure strategies implementation at the site. This information must describe how the steps for selecting and designing storm water pollutant control BMPs presented in Section 5.1 of the BMP Design Manual were followed, and the results (type of Green Infrastructure strategies selected). At the end of this discussion provide a summary of all the Green Infrastructure strategies within the project including the type and number.

(Continue on following page as necessary.)

Plan of action for Green Infrastructure strategies Continued
(Page reserved for continuation of description of plan of action for Green Infrastructure strategies implementation at the site)

(Continued from previous page)

Step 6.2: Green Infrastructure Strategies Summary Information

<table>
<tr><td colspan="2">(Copy this page as needed to provide information for each individual proposed Green Infrastructure strategy)</td></tr>
<tr><td colspan="2">Green Infrastructure Strategies ID No.</td></tr>
<tr><td colspan="2">Construction Plan Sheet No.</td></tr>
<tr><td colspan="2">Type of Green Infrastructure strategy:
☐ Retention by harvest and use (HU-1)
☐ Retention by infiltration basin (INF-1)
☐ Retention by bioretention (INF-2)
☐ Retention by permeable pavement (INF-3)
☐ Partial retention by biofiltration with partial retention (PR-1)
☐ Biofiltration (BF-1)
☐ Biofiltration with Nutrient Sensitive Media Design (BF-2)
☐ Proprietary Biofiltration (BF-3) meeting all requirements of Appendix F
☐ Flow -thru treatment control included as pre-treatment/forebay for an onsite retention or biofiltration BMP (provide BMP type/description and indicate which onsite retention or biofiltration BMP it serves in discussion section below)
☐ Flow -thru treatment control with alternative compliance (provide BMP type/description in discussion section below)
☐ Other (describe in discussion section below)</td></tr>
<tr><td colspan="2">Purpose:
☐ Pollutant control only
☐ Pre -treatment/forebay for another Green Infrastructure strategy
☐Other (describe in discussion section below)</td></tr>
<tr><td>Who will be the final owner of this Green Infrastructure strategy?</td><td>☐ HOA ☐ Property Owner ☐ County
☐ Other (describe)</td></tr>
<tr><td>Who will maintain this Green Infrastructure strategy into perpetuity?</td><td>☐ HOA ☐ Property Owner ☐ County
☐ Other (describe)</td></tr>
<tr><td>What Category (1-4) is the Green Infrastructure strategy?
Refer to the Category definitions in Section 7.3 of the BMP DM.</td><td></td></tr>
<tr><td colspan="2">Discussion (as needed):

(Continue on subsequent pages as necessary)</td></tr>
</table>

ATTACHMENT 1

BACKUP FOR PDP POLLUTANT CONTROL BMPS

This is the cover sheet for Attachment 1.

Indicate which Items are Included behind this cover sheet:

Attachment Sequence	Contents	Checklist
Attachment 1a	Storm Water Pollutant Control Worksheet Calculations -Worksheet B.2-1 (Required) -Worksheet B.4-1 (if applicable) -Worksheet B.4-2 (if applicable) -Worksheet B.5-1 (if applicable) -Worksheet B.5-2 (if applicable) -Worksheet B.5-3 (if applicable) -Worksheet B.6-1 (if applicable) -Worksheet B.3-1 (optional) -Summary Worksheet (optional)	☐ Included
Attachment 1b	Form I-8, Categorization of Infiltration Feasibility Condition (Required unless the project will use harvest and use BMPs) Refer to Appendices C and D of the BMP Design Manual to complete Form I-8.	☐ Included ☐ Not included because the entire project will use harvest and use BMPs
Attachment 1c	DMA Exhibit (Required) See DMA Exhibit Checklist on the back of this Attachment cover sheet.	☐ Included
Attachment 1d	Individual Green Infrastructure Strategies DMA Mapbook (Required) -Place each map on 8.5”x11” paper. -Show at a minimum the DMA, Green Infrastructure Strategies, and any existing hydrologic features within the DMA.	☐ Included

Use this checklist to ensure the required information has been included on the DMA Exhibit:

The DMA Exhibit must identify:

☐ Underlying hydrologic soil group
☐ Approximate depth to groundwater
☐ Existing natural hydrologic features (watercourses, seeps, springs, wetlands)
☐ Critical coarse sediment yield areas to be protected
☐ Existing topography and impervious areas
☐ Existing and proposed site drainage network and connections to drainage offsite
☐ Proposed demolition
☐ Proposed grading
☐ Proposed impervious features
☐ Proposed design features and surface treatments used to minimize imperviousness
☐ Drainage management area (DMA) boundaries, DMA ID numbers, and DMA areas (square footage or acreage), and DMA type (i.e., drains to BMP, self-retaining, or self-mitigating)
☐ Potential pollutant source areas and corresponding required source controls (see Chapter 4, Appendix E.1, and Step 3.5)
☐ Green Infrastructure Strategies (identify location,structural BMP ID #, type of BMP, and size/detail)

ATTACHMENT 2

Green Infrastructure Strategies Maintenance Information

This is the cover sheet for Attachment 2.

Indicate which Items are Included behind this cover sheet:

Attachment Sequence	Contents	Checklist
Attachment 2a	Green Infrastructure strategies Maintenance Plan (Required)	☐ Included See Green Infrastructure strategies Maintenance Information Checklist on the back of this Attachment cover sheet.

Use this checklist to ensure the required information has been included in the Green Infrastructure Strategies Maintenance Information Attachment:

Attachment 2a must identify:

- ☐ Specific maintenance indicators and actions for proposed Green Infrastructure strategy(ies). This must be based on Appendix K.4 of the BMP Design Manual and enhanced to reflect actual proposed components of the Green Infrastructure strategy.
- ☐ How to access the Green Infrastructure strategies to inspect and perform maintenance
- ☐ Features that are provided to facilitate inspection (e.g., observation ports, cleanouts, silt posts, or other features that allow the inspector to view necessary components of the Green Infrastructure strategies and compare to maintenance thresholds)
- ☐ Manufacturer and part number for proprietary parts of Green Infrastructure strategies when applicable
- ☐ Maintenance thresholds specific to the Green Infrastructure strategies, with a location-specific frame of reference (e.g., level of accumulated materials that triggers removal of the materials, to be identified based on viewing marks on silt posts or measured with a survey rod with respect to a fixed benchmark within the Green Infrastructure strategy)
- ☐ Recommended equipment to perform maintenance
- ☐ When applicable, necessary special training or certification requirements for inspection and maintenance personnel such as confined space entry or hazardous waste management

ATTACHMENT 3

Copy of Plan Sheets Showing Green Infrastructure Strategies, Source Control, and Site Design

This is the cover sheet for Attachment 5.

Use this checklist to ensure the required information has been included on the plans:

The plans must identify:

☐ Green Infrastructure Strategies(s) with ID numbers matching Step 6 Summary of Green Infrastructure Strategies
☐ The grading and drainage design shown on the plans must be consistent with the delineation of DMAs shown on the DMA exhibit
☐ Details and specifications for construction of Green Infrastructure Strategies
☐ Signage indicating the location and boundary of Green Infrastructure Strategies(s) as required by County staff
☐ How to access the Green Infrastructure Strategies to inspect and perform maintenance
☐ Features that are provided to facilitate inspection (e.g., observation ports, cleanouts, silt posts, or other features that allow the inspector to view necessary components of the Green Infrastructure Strategies and compare to maintenance thresholds)
☐ Manufacturer and part number for proprietary parts of Green Infrastructure Strategies when applicable
☐ Maintenance thresholds specific to the Green Infrastructure Strategies, with a location-specific frame of reference (e.g., level of accumulated materials that triggers removal of the materials, to be identified based on viewing marks on silt posts or measured with a survey rod with respect to a fixed benchmark within the BMP)
☐ Recommended equipment to perform maintenance
☐ When applicable, necessary special training or certification requirements for inspection and maintenance personnel such as confined space entry or hazardous waste management
☐ Include landscaping plan sheets showing vegetation requirements for vegetated Green Infrastructure Strategies
☐ All BMPs must be fully dimensioned on the plans
☐ When proprietary BMPs are used, site-specific cross section with outflow, inflow, and model number must be provided. Photocopies of general brochures are not acceptable.
☐ Include all source control and site design measures described in Steps 4 and 5 of the SQWMP. Can be included as a separate exhibit as necessary.

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ATTACHMENT 4

Copy of Project's Drainage Report

This is the cover sheet for Attachment 4.

If hardcopy or CD is not attached, the following information should be provided:

Title:
Prepared By:
Date:

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ATTACHMENT 5

Copy of Project's Geotechnical and Groundwater Investigation Report

This is the cover sheet for Attachment 5.

If hardcopy or CD is not attached, the following information should be provided:

Title:
Prepared By:
Date:

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A.5 Offsite Alternative Compliance Program (ACP) SWQMP

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County of San Diego
ALTERNATIVE COMPLIANCE PROJECT (ACP) SWQMP

[INSERT PROJECT NAME]
[INSERT RECORD ID (PERMIT) NUMBERS]

[INSERT PROJECT ADDRESS]
[INSERT PROJECT CITY, STATE ZIP CODE]

ASSESSOR'S PARCEL NUMBER(S):
[INSERT APN(S)]

ENGINEER OF WORK:

[INSERT CIVIL ENGINEER'S NAME AND PE NUMBER HERE, PROVIDE WET SIGNATURE AND STAMP ABOVE LINE]

PREPARED FOR:

[INSERT APPLICANT NAME]
[INSERT ADDRESS]
[INSERT CITY, STATE ZIP CODE]
[INSERT TELEPHONE NUMBER]

SWQMP PREPARED BY:

[INSERT COMPANY NAME]
[INSERT ADDRESS]
[INSERT CITY, STATE ZIP CODE]
[INSERT TELEPHONE NUMBER]

DATE OF SWQMP:
[INSERT MONTH, DAY, YEAR]

PLANS PREPARED BY:
[INSERT CIVIL ENGINEER OR ARCHITECT]
[INSERT ADDRESS]
[INSERT CITY, STATE ZIP CODE]
[INSERT TELEPHONE NUMBER]

ACP SWQMP APPROVED BY:

APPROVAL DATE:

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Attachments

Attachment 1: Backup for PDP Pollutant Control BMPs
- Attachment 1a: Storm Water Pollutant Control Worksheet Calculations
- Attachment 1b: DMA Exhibit
- Attachment 1c: Individual STRUCTURAL BMP DMA Mapbook

Attachment 2: Backup for PDP Hydromodification Control Measures
- Attachment 2a: Flow Control Facility Design
- Attachment 2b: Hydromodification Management Exhibit
- Attachment 2c: Geomorphic Assessment of Receiving Channels (optional)
- Attachment 2d: Vector Control Plan (if applicable)

Attachment 3: Structural BMP Maintenance Plan
- Attachment 3a: Structural BMP Maintenance Thresholds and Actions
- Attachment 3b: Draft Maintenance Agreements / Notifications (when applicable)

Attachment 4: County of San Diego PDP Structural BMP Verification for DPW Permitted Land Development Projects

Attachment 5: Copy of Plan Sheets Showing Permanent Storm Water BMPs

Attachment 6: Copy of Project's Drainage Report

Attachment 7: Copy of Project's Geotechnical and Groundwater Investigation Report

Acronyms

ACP	Alternative Compliance Project
APN	Assessor's Parcel Number
BMP	Best Management Practice
HMP	Hydromodification Management Plan
HSG	Hydrologic Soil Group
MS4	Municipal Separate Storm Sewer System
N/A	Not Applicable
NRCS	Natural Resources Conservation Service
PDCI	Private Development Construction Inspection Section
NSMP	Natural System Management Practice
PDP	Priority Development Project
PDS	Planning and Development Services
PE	Professional Engineer
RPO	Resource Protection Ordinance
SC	Source Control
SD	Site Design
SDRWQCB	San Diego Regional Water Quality Control Board
SIC	Standard Industrial Classification
SWQMP	Storm Water Quality Management Plan
WMAA	Watershed Management Area Analysis
WPO	Watershed Protection Ordinance
WQE	Water Quality Equivalency
WQIP	Water Quality Improvement Plan

ACP SWQMP Preparer's Certification Page

Project Name: [Insert Project Name]
Permit Application Number: [Insert Permit Application Number]

PREPARER'S CERTIFICATION

I hereby declare that I am the Engineer in Responsible Charge of design of storm water best management practices (BMPs) for this project, and that I have exercised responsible charge over the design of the BMPs as defined in Section 6703 of the Business and Professions Code, and that the design is consistent with the PDP requirements of the County of San Diego BMP Design Manual, which is a design manual for compliance with local County of San Diego Watershed Protection Ordinance (Sections 67.801 et seq.), and regional MS4 Permit (California Regional Water Quality Control Board San Diego Region Order No. R9-2013-0001 as amended by R9-2015-0001 and R9-2015-0100) requirements for storm water management. This project has been designed as an Offsite Alternative Compliance Project consistent with the Region 9 Water Quality Equivalency Guidance Document accepted on December 17, 2015, by the San Diego Regional Water Quality Control Board Executive Officer.

I have read and understand that the County of San Diego has adopted minimum requirements for managing urban runoff, including storm water, from land development activities, as described in the BMP Design Manual. I certify that this ACP SWQMP has been completed to the best of my ability and accurately reflects the project being proposed and the applicable BMPs proposed to provide a greater water quality benefit associated with PDP land development activities. I understand and acknowledge that the plan check review of this ACP SWQMP by County staff is confined to a review and does not relieve me, as the Engineer in Responsible Charge of design of storm water BMPs for this project, of my responsibilities for project design.

_____
Engineer of Work's Signature, PE Number & Expiration Date

_____
Print Name

_____
Company

_____
Date

Engineer's Seal:

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Submittal Record

Use this Table to keep a record of submittals of this ACP SWQMP. Each time the ACP SWQMP is re-submitted, provide the date and status of the project. In column 4 summarize the changes that have been made or indicate if response to plancheck comments is included. When applicable, insert response to plancheck comments behind this page.

Preliminary Design / Planning / CEQA

Submittal Number	Date	Summary of Changes
1		Initial Submittal
2		
3		
4		

Final Design

Submittal Number	Date	Summary of Changes
1		Initial Submittal
2		
3		
4		

Plan Changes

Submittal Number	Date	Summary of Changes
1		Initial Submittal
2		
3		
4		

Project Vicinity Map

Project Name: [Insert Project Name]
Record ID: [Insert Record ID or Permit Application Number]

[Insert Project Vicinity Map here]

Step 1: Purpose of Project

Is this project designed primarily to improve water quality? (☐ Yes ☐ No

Is this project adding, expanding, and/or renovating any impervious surfaces? (☐ Yes ☐ No

Does this project propose alterations or revisions to the current site layout? (☐ Yes ☐ No

Does the project generate impervious surfaces which would trigger a PDP? (☐ Yes ☐ No

The total proposed newly created or replaced impervious area is:	ft^2
The total existing (pre-project) impervious area is:	ft^2
The total area disturbed by the project is:	ft^2

Determination of applicability of Construction of Stormwater BMPs:

Applicant must complete the construction stormwater BMP checklist (Step 2.1) to determine if stormwater BMPs are applicable to project.

If the total area disturbed by the project is 1 acre (43,560 sq. ft.) or more **OR** the project is part of a larger common plan of development disturbing 1 acre or more, a Waste Discharger Identification (WDID) number must be obtained from the State Water Resources Control Board.
WDID: ___

Describe how your proposed project qualifies as an Alternative Compliance Project (ACP)

Step 1.1: Storm Water Quality Management Plan requirements

Step	Answer	Progression
Is the project a Standard Project, Priority Development Project (PDP), exception to PDP definitions, or an ACP project?	☐ Alternative Compliance Project	Standard Project requirements apply, **Fill out Intake Form and Complete ACP SWQMP.**
	☐ PDP	Standard and PDP requirements apply, including PDP SWQMP. **Consult with County of San Diego Staff before Completing PDP SWQMP.**

Step 1.2: Construction Storm Water Minimum BMP Checklist

Minimum Required Standard Construction Storm Water BMPs		
If you answer "Yes" to any of the questions below, your project is subject to Table 1 on the following page (Minimum Required Standard Construction Stormwater BMPs). As noted in Table 1, please select at least the minimum number of required BMPs, or as many as are feasible for your project. If no BMP is selected, an explanation must be given in the box provided. The following questions are intended to aid in determining construction BMP requirements for your project. **Note: All selected BMPs below must be included on the BMP plan incorporated into the building sets.**		
1. Will there be soil disturbing activities that will result in exposed soil areas? (This includes minor grading and trenching.) **Reference Table 1 Items A, B, D, and E** Note: Soil disturbances NOT considered significant include, but are not limited to, change in use, mechanical/electrical/plumbing activities, signs, temporary trailers, interior remodeling, and minor tenant improvement.	☐Yes	☐No
2. Will there be asphalt paving, including patching? **Reference Table 1 Items D and F**	☐Yes	☐No
3. Will there be slurries from mortar mixing, coring, or concrete saw cutting? **Reference Table 1 Items D and F**	☐Yes	☐No
4. Will there be solid wastes from concrete demolition and removal, wall construction, or form work? **Reference Table 1 Items D and F**	☐Yes	☐No
5. Will there be stockpiling (soil, compost, asphalt, concrete, solid waste) for over 24 hours? **Reference Table 1 Items D and F**	☐Yes	☐No
6. Will there be dewatering operations? **Reference Table 1 Items C and D**	☐Yes	☐No
7. Will there be temporary on-site storage of construction materials, including mortar mix, raw landscaping and soil stabilization materials, treated lumber, rebar, and plated metal fencing materials? **Reference Table 1 Items E and F**	☐Yes	☐No
8. Will trash or solid waste product be generated from this project? **Reference Table 1 Item F**	☐Yes	☐No
9. Will construction equipment be stored on site (e.g.: fuels, oils, trucks, etc.?) **Reference Table 1 Item F**	☐Yes	☐No
10. Will Portable Sanitary Services ("Porta-potty") be used on the site? **Reference Table 1 Item F**	☐Yes	☐No

Step 1.3: Construction Storm Water BMP Implementation Checklist

Minimum Required Best Management Practices (BMPs)	CALTRANS SW Handbook[1] Detail or County Std. Detail	BMP Selected	Each selected BMP must be shown on the plan. If no BMP is selected, an explanation must be provided.
A. Select Erosion Control Method for Disturbed Slopes (choose at least one for the appropriate season)			
Vegetation Stabilization Planting[2] (Summer)	SS-2, SS-4	☐	
Hydraulic Stabilization Hydroseeding[2] (Summer)	SS-4	☐	
Bonded Fiber Matrix or Stabilized Fiber Matrix[3] (Winter)	SS-3	☐	
Physical Stabilization Erosion Control Blanket[3] (Winter)	SS-7	☐	
B. Select erosion control method for disturbed flat areas (slope < 5%) (choose at least one)			
County Standard Lot Perimeter Protection Detail	PDS 659[4], SC-2	☐	
Will use erosion control measures from Item A on flat areas also	SS-3, 4, 7	☐	
County Standard Desilting Basin (must treat all site runoff)	PDS 660[5], SC-2	☐	
Mulch, straw, wood chips, soil application	SS-6, SS-8	☐	
C. If runoff or dewatering operation is concentrated, velocity must be controlled using an energy dissipater			
Energy Dissipater Outlet Protection[6]	SS-10	☐	

[1] State of California Department of Transportation (Caltrans). 2003. Storm Water Quality Handbooks, Construction Site Best Management Practices (BMPs) Manual. March. Available online at: http://www.dot.ca.gov/hq/construc/stormwater/manuals.htm.

[2] If Vegetation Stabilization (Planting or Hydroseeding) is proposed for erosion control it may be installed between May 1st and August 15th. Slope irrigation is in place and needs to be operable for slopes >3 feet. Vegetation must be watered and established prior to October 1st. The owner must implement a contingency physical BMP by August 15th if vegetation establishment does not occur by that date. If landscaping is proposed, erosion control measures must also be used while landscaping is being established. Established vegetation must have a subsurface mat of intertwined mature roots with a uniform vegetative coverage of 70 percent of the natural vegetative coverage or more on all disturbed areas.

[3] All slopes over three feet must have established vegetative cover prior to final permit approval.

[4] County of San Diego, Planning & Development Services. 2012. Standard Lot Perimeter Protection Design System. Building Division. PDS 659. Available online at http://www.sandiegocounty.gov/pds/docs/pds659.pdf.

[5] County of San Diego, Planning & Development Services. 2012. County Standard Desilting Basin for Disturbed Areas of 1 Acre or Less Building Division. PDS 659. Available online at http://www.sandiegocounty.gov/pds/docs/pds660.pdf.

[6] Regional Standard Drawing D-40 – Rip Rap Energy Dissipater is also acceptable for velocity reduction.

Minimum Required Best Management Practices (BMPs)	CALTRANS SW Handbook[7] Detail or County Std. Detail	BMP Selected	Each selected BMP must be shown on the plan. If no BMP is selected, an explanation must be provided.
D. Select sediment control method for all disturbed areas (choose at least one)			
Silt Fence	SC-1	☐	
Fiber Rolls (Straw Wattles)	SC-5	☐	
Gravel & Sand Bags	SC-6 & 8	☐	
Dewatering Filtration	NS-2	☐	
Storm Drain Inlet Protection	SC-10	☐	
Engineered Desilting Basin (sized for 10-year flow)	SC-2	☐	
E. Select method for preventing offsite tracking of sediment (choose at least one)			
Stabilized Construction Entrance	TC-1	☐	
Construction Road Stabilization	TC-2	☐	
Entrance/Exit Tire Wash	TC-3	☐	
Entrance/Exit Inspection & Cleaning Facility	TC-1	☐	
Street Sweeping and Vacuuming	SC-7	☐	
F. Select the general site management BMPs			
F.1 Materials Management			
Material Delivery & Storage	WM-1	☐	
Spill Prevention and Control	WM-4	☐	
F.2 Waste Management[8]			
Waste Management Concrete Waste Management	WM-8	☐	
Solid Waste Management	WM-5	☐	
Sanitary Waste Management	WM-9	☐	
Hazardous Waste Management	WM-6	☐	

Note: The Construction General Permit (Order No. 2009-0009-DWQ) also requires all projects not subject to the BMP Design Manual to comply with runoff reduction requirements through the implementation of post-construction BMPs as described in Section XIII of the order.

[7] State of California Department of Transportation (Caltrans). 2003. Storm Water Quality Handbooks, Construction Site Best Management Practices (BMPs) Manual. March. Available online at: http://www.dot.ca.gov/hq/construc/stormwater/manuals.htm.

[8] Not all projects will have every waste identified. The applicant is responsible for identifying wastes that will be onsite and applying the appropriate BMP. For example, if concrete will be used, BMP WM-8 must be selected.

Step 2: County of San Diego ACP SWQMP Site Information Checklist

Project Summary Information	
Project Name	
Project Address	
Project Owner	

Assessor's Parcel Number(s) (APN(s))	
Record ID Number:	
Type of Alternative Compliance Project:	☐ Pollutant Control ☐ Hydromodification ☐ Pollutant Control & Hydromodification
What Pollutant Control approach does your project plan to utilize?	☐ Structural Pollutant Control/s ☐ Natural System Management Projects (NSMP) ☐ Structural & NSMP
Project Watershed Management Area and Hydrologic Unit Select one:	**Watershed Management Area** - (Hydrologic Unit) ☐ Santa Margarita River - (Santa Margarita 902.00) ☐ San Luis Rey - (San Luis Rey 903.00) ☐ Carlsbad – (Carlsbad 904.00) ☐ San Dieguito River - (San Dieguito 905.00) ☐ Peñsaquitos - (Peñsaquitos 906.00) ☐ San Diego River - (San Diego 907.00) ☐ San Diego Bay - (Pueblo 908.00) ☐ San Diego Bay - (Sweetwater 909.00) ☐ San Diego Bay - (Otay 910.00) ☐ Tijuana River - (Tijuana 911.00)
Project Hydrologic Area and Subarea *(Hydrologic Unit, Area, and Subarea Name with Numeric Identifier)*	

Step 2.1: Exhibit of Existing Site Condition & Existing Site Drainage Patterns

Provide an exhibit(s) that clearly identifies the pre-development site conditions and pre-development site drainage conditions of the proposed project site and attach in Attachment 1c. At a minimum, this exhibit should clearly identify:

- Existing and surrounding land uses, tributary drainage areas, current or previously graded but not built out areas, demolition areas, agricultural or other non-impervious areas, vacant/undeveloped/natural, vegetation and biological areas, depth to ground water, underlying soil types and existing natural hydrologic features.

- Whether existing drainage conveyance is natural or urban;

- How runoff from offsite conveyed through the site? (e.g.) location of offsite drainage areas, design flows, and locations where offsite flows enter the pre-development project site, channels, and natural drainages

- Display pre-development project site drainage conveyance network, including: existing storm drains, concrete channels, swales, detention facilities, storm water treatment facilities, natural or constructed channels;

- Identify all discharge locations from the pre-development project site.

Provide a thorough summary of the pre-development site conditions

Provide a thorough summary of the pre-development drainage conditions:

Step 2.2: Exhibit of Proposed Site Development & Proposed Site Drainage Patterns

Provide an exhibit(s) that identify of the proposed site development and the proposed site drainage patterns for post development conditions and attach in Attachment 1c. At a minimum, this exhibit should clearly identify:

- Proposed impervious features of the project (e.g., buildings, roadways, parking lots, courtyards, athletic courts, other impervious features, etc.)
- Proposed pervious features of the project (e.g., landscape areas, natural space, open space preservation):
- Changes to site layout and site topography
- Proposed project site drainage conveyance network, including storm drains, concrete channels, swales, detention facilities, storm water treatment facilities, natural or constructed channels, and the method for conveying offsite flows through or around the proposed project site.
- Identify all discharge locations from the proposed project site along
- Provide an exhibit of pre- and post-project drainage areas and how flows will be designed to discharge to each of the runoff discharge locations.
- Provide exhibit showing references to the drainage study and detailed calculations.
- Identify any potential pollutant sources within the area of work for your proposed project (e.g. on-site stormdrain inlets, landscape/outdoor, sidewalks, agricultural areas, etc.)

Provide a thorough summary of the proposed project site drainage conveyance network including a summary of the conveyance system size and capacity for each of the discharge locations. Provide a summary of pre- and post-project drainage areas and design flows to each of the runoff discharge locations. Reference the drainage study for detailed calculations:

Step 2.3: Pollutant Control Requirements

Have you calculated the ACPs Impacted Condition Design Capture Volume (V_1), Mitigated Condition Design Capture Volume (V_2) and change in Design Capture Volume as specified in Section 2 of the WQE?	☐ Yes ☐ No
Have you determined the Land Use Factor for your Alternative Compliance Project as specified in Section 2 of the WQE? If so, your project must also identify the associated PDPs Land Use Factors and attach map in Attachment 1c.	☐ Yes ☐ No
Have you determined your projects BMP Efficacy Factor(s) as specified in Section 2 of the WQE?	☐ Yes ☐ No
Has your ACP determined the earned stormwater pollutant control volume as specified in Section 2 of the WQE (*Equation 2-1)?	☐ Yes ☐ No
Have you provided and attached all required WQE worksheets and associated effective treatment calculations?	☐ Yes ☐ No

Step 2.4: Hydromodification Management Requirements

The proposed PDP project is (select one):

☐ New Development
☐ Redevelopment (without additional impervious service)
☐ Redevelopment (with additional impervious service)

To generate Hydromodification Credits through the implementation of an ACP, your project must demonstrate the ACP is sensitive to Hydromodification.
(*Identified in PDP SWQMP)

☐ Yes, hydromodification management requirements for flow control and preservation of critical coarse sediment yield areas are applicable to my PDP project.
☐ No, the project will discharge runoff directly to existing underground storm drains discharging directly to water storage reservoirs, lakes, enclosed embayments, or the Pacific Ocean.
☐ No, the project will discharge runoff directly to conveyance channels whose bed and bank are concrete-lined all the way from the point of discharge to water storage reservoirs, lakes, enclosed embayments, or the Pacific Ocean.
☐ No, the project will discharge runoff directly to an area identified as appropriate for an exemption by the WMAA[9] for the watershed in which the project resides.

Description / Additional Information (to be provided if a 'No' answer has been selected above):

Does your ACP elect to generate HMP Credits	☐ Yes ☐ No
Have you certified that your ACP project is located based upon the PDP scenario type (WQE Table 3-1) If yes, it must be referenced in the ACP Participation form in the PDP SWQMP.	☐ Yes ☐ No
Have you calculated your earned Directly Connected Impervious Area (DCIA) as specified in the Section 3 of the WQE and attached as Attachment 2b	☐ Yes ☐ No
Have you included HMP modeling, including outputs associated with PDP HMP modeling, and attached as Attachment 2b?	☐ Yes ☐ No

[9] The Watershed Management Area Analysis (WMAA) is an optional element for inclusion in the Water Quality Improvement Plans (WQIPs) described in the 2013 MS4 Permit [Provision B.3.b.(4)]. It is available online at the Project Clean Water website: http://www.projectcleanwater.org/index.php?option=com_content&view=article&id=248

Step 2.5: Flow Control for Post-Project Runoff*

***This Section only required if hydromodification management credits apply**
List and describe point(s) of compliance (POCs) for flow control for hydromodification management (see Section 6.3.1). For each POC, provide a POC identification name or number correlating to the project's HMP Exhibit and a receiving channel identification name or number correlating to the project's HMP Exhibit.
Has a geomorphic assessment been performed for the receiving channel(s)? ☐ No, the low flow threshold is 0.1Q2 (default low flow threshold) ☐ Yes, the result is the low flow threshold is 0.1Q2 ☐ Yes, the result is the low flow threshold is 0.3Q2 ☐ Yes, the result is the low flow threshold is 0.5Q2 If a geomorphic assessment has been performed, provide title, date, and preparer: *Discussion / Additional Information: (optional)*

Step 2.6: Other Site Requirements and Constraints

When applicable, list other site requirements or constraints that will influence storm water management design, such as zoning requirements including setbacks and open space, or local codes governing minimum street width, sidewalk construction, allowable pavement types, and drainage requirements.

Optional Additional Information or Continuation of Previous Sections As Needed
This space provided for additional information or continuation of information from previous sections as needed.

Step 3: Source Control BMP Checklist

Source Control BMPs			
All development projects must implement source control BMPs 4.2.1 through 4.2.6 where applicable and feasible. See Chapter 4.2 and Appendix E of the County BMP Design Manual for information to implement source control BMPs shown in this checklist. Answer each category below pursuant to the following. • "Yes" means the project will implement the source control BMP as described in Chapter 4.2 and/or Appendix E of the County BMP Design Manual. Discussion / justification is not required. • "No" means the BMP is applicable to the project but it is not feasible to implement. Discussion / justification must be provided. • "N/A" means the BMP is not applicable at the project site because the project does not include the feature that is addressed by the BMP (e.g., the project has no outdoor materials storage areas). Discussion / justification may be provided.			
Source Control Requirement	**Applied?**		
4.2.1 Prevention of Illicit Discharges into the MS4	☐Yes	☐No	☐N/A
Discussion / justification if 4.2.1 not implemented:			
4.2.2 Storm Drain Stenciling or Signage	☐Yes	☐No	☐N/A
Discussion / justification if 4.2.2 not implemented:			
4.2.3 Protect Outdoor Materials Storage Areas from Rainfall, Run-On, Runoff, and Wind Dispersal	☐Yes	☐No	☐N/A
Discussion / justification if 4.2.3 not implemented:			
4.2.4 Protect Materials Stored in Outdoor Work Areas from Rainfall, Run-On, Runoff, and Wind Dispersal	☐Yes	☐No	☐N/A
Discussion / justification if 4.2.4 not implemented:			

Source Control Requirement	Applied?		
4.2.5 Protect Trash Storage Areas from Rainfall, Run-On, Runoff, and Wind Dispersal	☐Yes	☐No	☐N/A
Discussion / justification if 4.2.5 not implemented:			
4.2.6 Additional BMPs Based on Potential Sources of Runoff Pollutants (must answer for each source listed below):			
☐ A. On-site storm drain inlets	☐Yes	☐No	☐N/A
☐ B. Interior floor drains and elevator shaft sump pumps	☐Yes	☐No	☐N/A
☐ C. Interior parking garages	☐Yes	☐No	☐N/A
☐ D. Need for future indoor & structural pest control	☐Yes	☐No	☐N/A
☐ E. Landscape/outdoor pesticide use	☐Yes	☐No	☐N/A
☐ F. Pools, spas, ponds, fountains, and other water features	☐Yes	☐No	☐N/A
☐ G. Food service	☐Yes	☐No	☐N/A
☐ H. Refuse areas	☐Yes	☐No	☐N/A
☐ I. Industrial processes	☐Yes	☐No	☐N/A
☐ J. Outdoor storage of equipment or materials	☐Yes	☐No	☐N/A
☐ K. Vehicle and equipment cleaning	☐Yes	☐No	☐N/A
☐ L. Vehicle/equipment repair and maintenance	☐Yes	☐No	☐N/A
☐ M. Fuel dispensing areas	☐Yes	☐No	☐N/A
☐ N. Loading docks	☐Yes	☐No	☐N/A
☐ O. Fire sprinkler test water	☐Yes	☐No	☐N/A
☐ P. Miscellaneous drain or wash water	☐Yes	☐No	☐N/A
☐ Q. Plazas, sidewalks, and parking lots	☐Yes	☐No	☐N/A
Discussion / justification if 4.2.6 not implemented. Clearly identify which sources of runoff pollutants are discussed. Justification must be provided for <u>all</u> "No" answers shown above.			

Note: Show all source control measures described above that are included in design capture volume calculations in the plan sheets of Attachment 5.

Step 4: Site Design BMP Checklist

Site Design BMPs
All development projects must implement site design BMPs SD-A through SD-H where applicable and feasible. See Chapter 4.3 and Appendix E of the County BMP Design Manual for information to implement site design BMPs shown in this checklist. Answer each category below pursuant to the following. • "Yes" means the project will implement the site design BMP as described in Chapter 4.3 and/or Appendix E of the County BMP Design Manual. Discussion / justification is not required. • "No" means the BMP is applicable to the project but it is not feasible to implement. Discussion / justification must be provided. • "N/A" means the BMP is not applicable at the project site because the project does not include the feature that is addressed by the BMP (e.g., the project site has no existing natural areas to conserve). Discussion / justification may be provided.

Site Design Requirement	Applied?		
4.3.1 Maintain Natural Drainage Pathways and Hydrologic Features	☐Yes	☐No	☐N/A
Discussion / justification if 4.3.1 not implemented:			
4.3.2 Conserve Natural Areas, Soils, and Vegetation	☐Yes	☐No	☐N/A
Discussion / justification if 4.3.2 not implemented:			
4.3.3 Minimize Impervious Area	☐Yes	☐No	☐N/A
Discussion / justification if 4.3.3 not implemented:			
4.3.4 Minimize Soil Compaction	☐Yes	☐No	☐N/A
Discussion / justification if 4.3.4 not implemented:			
4.3.5 Impervious Area Dispersion	☐Yes	☐No	☐N/A
Discussion / justification if 4.3.5 not implemented:			

Site Design Requirement	Applied?		
4.3.6 Runoff Collection	☐Yes	☐No	☐N/A
Discussion / justification if 4.3.6 not implemented:			
4.3.7 Landscaping with Native or Drought Tolerant Species	☐Yes	☐No	☐N/A
Discussion / justification if 4.3.7 not implemented:			
4.3.8 Harvesting and Using Precipitation	☐Yes	☐No	☐N/A
Discussion / justification if 4.3.8 not implemented:			

Note: Show all site design measures described above that are included in design capture volume calculations in the plan sheets of Attachment 5.

Step 5: ACP Structural BMPs

ACP structural BMPs must be verified by the County at the completion of construction. This may include requiring the project owner or project owner's representative and engineer of record to certify construction of the structural BMPs (see Section 1.12 of the BMP Design Manual). ACP structural BMPs must be maintained into perpetuity and the County must confirm the maintenance (see Section 7 of the BMP Design Manual).

Use this section to provide narrative description of the general strategy for structural BMP implementation at the project site in the box below (Step 4.1). Then complete the ACP structural BMP summary information sheet (Step 4.2) for each structural BMP within the project (copy the BMP summary information sheet [Step 4.2] as many times as needed to provide summary information for each individual structural BMP).

Step 5.1: Description of structural BMP strategy

Describe the general strategy for structural BMP implementation at the site. This information must describe how the steps for selecting and designing storm water pollutant control BMPs presented in Section 5.1 of the BMP Design Manual were followed, and the results (type of BMPs selected). For projects requiring hydromodification flow control BMPs, indicate whether pollutant control and flow control BMPs are integrated or separate. At the end of this discussion provide a summary of all the structural BMPs within the project including the type and number.

(Continue on following page as necessary.)

Description of structural BMP strategy Continued (Page reserved for continuation of description of general strategy for structural BMP implementation at the site)
(Continued from previous page)

Step 5.2: ACP Structural BMP Information

(Copy this page as needed to provide information for each individual proposed ACP structural BMP)	
ACP Structural BMP ID No.	
Construction Plan Sheet No.	
Type of structural BMP: ☐ Retention by harvest and use (HU-1) ☐ Retention by infiltration basin (INF-1) ☐ Retention by bioretention (INF-2) ☐ Retention by permeable pavement (INF-3) ☐ Partial retention by biofiltration with partial retention (PR-1) ☐ Biofiltration (BF-1) ☐ Biofiltration with Nutrient Sensitive Media Design (BF-2) ☐ Proprietary Biofiltration (BF-3) meeting all requirements of Appendix F ☐ Flow-thru treatment control included as pre-treatment/forebay for an onsite retention or biofiltration BMP (provide BMP type/description and indicate which onsite retention or biofiltration BMP it serves in discussion section below) ☐ Detention pond or vault for hydromodification management ☐ Other (describe in discussion section below)	
Purpose: ☐ Pollutant control only ☐ Hydromodification control only ☐ Combined pollutant control and hydromodification control ☐ Pre-treatment/forebay for another structural BMP ☐ Other (describe in discussion section below)	
Who will certify construction of this BMP? Provide name and contact information for the party responsible to sign BMP verification forms (See Section 1.12 of the BMP Design Manual)	
Who will be the final owner of this BMP?	☐ HOA ☐ Property Owner ☐ County ☐ Other (describe)
Who will maintain this BMP into perpetuity?	☐ HOA ☐ Property Owner ☐ County ☐ Other (describe)
Have you included WQE worksheets A1-A4 (as applicable) for each structural BMP that is to be implemented at the project?	☐ Yes ☐ No

Discussion of ACP Structural BMP Information (as needed):

.

ATTACHMENT 1

BACKUP FOR ACP POLLUTANT CONTROL BMPS

This is the cover sheet for Attachment 1.

Indicate which Items are Included behind this cover sheet:

Attachment Sequence	Contents	Checklist
Attachment 1a	Storm Water Pollutant Control Worksheet Calculations -Worksheet B.2-1 (Required) -Worksheet B.4-1 (if applicable) -Worksheet B.4-2 (if applicable) -Worksheet B.5-1 (if applicable) -Worksheet B.5-2 (if applicable) -Worksheet B.5-3 (if applicable) -Worksheet B.6-1 (if applicable) -Worksheet B.3-1 (optional) -Summary Worksheet (optional)	☐ Included
Attachment 1b	DMA Exhibit (Required) See DMA Exhibit Checklist on the back of this Attachment cover sheet.	☐ Included
Attachment 1c	Individual ACP STRUCTURAL BMP DMA Mapbook (Required) -Place each map on 8.5”x11” paper. -Show at a minimum the DMA, ACP Structural BMP(s), and any existing hydrologic features within the DMA.	☐ Included

Use this checklist to ensure the required information has been included on the DMA Exhibit:

The DMA Exhibit must identify:

- ☐ Underlying hydrologic soil group
- ☐ Approximate depth to groundwater
- ☐ Existing natural hydrologic features (watercourses, seeps, springs, wetlands)
- ☐ Critical coarse sediment yield areas to be protected
- ☐ Existing topography and impervious areas
- ☐ Existing and proposed site drainage network and connections to drainage offsite
- ☐ Proposed demolition
- ☐ Proposed grading
- ☐ Proposed impervious features
- ☐ Proposed design features and surface treatments used to minimize imperviousness
- ☐ Drainage management area (DMA) boundaries, DMA ID numbers, and DMA areas (square footage or acreage), and DMA type (i.e., drains to BMP, self-retaining, or self-mitigating)
- ☐ Potential pollutant source areas and corresponding required source controls (see Chapter 4, Appendix E.1, and Step 3.5)
- ☐ ACP Structural BMPs (identify location,structural BMP number ID, type of BMP, and size/detail)

ATTACHMENT 2

BACKUP FOR ACP HYDROMODIFICATION CONTROL MEASURES

This is the cover sheet for Attachment 2.

☐ Mark this box if this attachment is empty because the project is exempt from PDP hydromodification management requirements.

Indicate which Items are Included behind this cover sheet:

Attachment Sequence	**Contents**	**Checklist**
Attachment 2a	Flow Control Facility Design, including Structural BMP Drawdown Calculations and Overflow Design Summary (Required) See Chapter 6 and Appendix G of the BMP Design Manual	☐ Included ☐ Submitted as separate stand-alone document
Attachment 2b	Hydromodification Management Exhibit (Required if applicable)	☐ Included See Hydromodification Management Exhibit Checklist on the back of this Attachment cover sheet.
Attachment 2c	Geomorphic Assessment of Receiving Channels (Optional) See Section 6.3.4 of the BMP Design Manual.	☐ Not performed ☐ Included ☐ Submitted as separate stand-alone document
Attachment 2d	Vector Control Plan (Required when structural BMPs will not drain in 96 hours)	☐ Included ☐ Not required because BMPs will drain in less than 96 hours

Use this checklist to ensure the required information has been included on the Hydromodification Management Exhibit:

The Hydromodification Management Exhibit must identify (of applicable):

- ☐ Underlying hydrologic soil group
- ☐ Approximate depth to groundwater
- ☐ Existing natural hydrologic features (watercourses, seeps, springs, wetlands)
- ☐ Critical coarse sediment yield areas to be protected (if applicable)
- ☐ Existing topography
- ☐ Existing and proposed site drainage network and connections to drainage offsite
- ☐ Proposed grading
- ☐ Proposed impervious features
- ☐ Proposed design features and surface treatments used to minimize imperviousness
- ☐ Point(s) of Compliance (POC) for Hydromodification Management
- ☐ Existing and proposed drainage boundary and drainage area to each POC (when necessary, create separate exhibits for pre-development and post-project conditions)
- ☐ Structural BMPs for hydromodification management (identify location, type of BMP, and size/detail)

ATTACHMENT 3

Structural BMP Maintenance Information

This is the cover sheet for Attachment 3.

Indicate which Items are Included behind this cover sheet:

Attachment Sequence	Contents	Checklist
Attachment 3a	Structural BMP Maintenance Plan (Required)	☐ Included See Structural BMP Maintenance Information Checklist on the back of this Attachment cover sheet.
Attachment 3b	Draft Stormwater Maintenance Notification / Agreement (when applicable)	☐ Included ☐ Not Applicable

Use this checklist to ensure the required information has been included in the Structural BMP Maintenance Information Attachment:

Attachment 3a must identify:

- ☐ Specific maintenance indicators and actions for proposed structural BMP(s). This must be based on Section 7.7 of the BMP Design Manual and enhanced to reflect actual proposed components of the structural BMP(s)
- ☐ How to access the structural BMP(s) to inspect and perform maintenance
- ☐ Features that are provided to facilitate inspection (e.g., observation ports, cleanouts, silt posts, or other features that allow the inspector to view necessary components of the structural BMP and compare to maintenance thresholds)
- ☐ Manufacturer and part number for proprietary parts of structural BMP(s) when applicable
- ☐ Maintenance thresholds specific to the structural BMP(s), with a location-specific frame of reference (e.g., level of accumulated materials that triggers removal of the materials, to be identified based on viewing marks on silt posts or measured with a survey rod with respect to a fixed benchmark within the BMP)
- ☐ Recommended equipment to perform maintenance
- ☐ When applicable, necessary special training or certification requirements for inspection and maintenance personnel such as confined space entry or hazardous waste management

Attachment 3b: For all ACP BMPs, Attachment 3b must include a draft maintenance agreement in the County's standard format depending on the Category (ACP applicant to contact County staff to obtain the current maintenance agreement forms). Refer to Section 7.3 in the BMP Design Manual for a description of the different categories.

ATTACHMENT 4

County of San Diego ACP Structural BMP Verification for Permitted Land Development Projects

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County of San Diego BMP Design Manual Verification Form	
Project Summary Information	
Project Name	
Record ID (e.g., grading/improvement plan number)	
Project Address	
Assessor's Parcel Number(s) (APN(s))	
Project Watershed (Complete Hydrologic Unit, Area, and Subarea Name with Numeric Identifier)	
Responsible Party for Construction Phase	
Developer's Name	
Address	
Email Address	
Phone Number	
Engineer of Work	
Engineer's Phone Number	
Responsible Party for Ongoing Maintenance	
Owner's Name(s)*	
Address	
Email Address	
Phone Number	
*Note: If a corporation or LLC, provide information for principal partner or Agent for Service of Process. If an HOA, provide information for the Board or property manager at time of project closeout.	

County of San Diego BMP Design Manual Verification Form Page 2 of 4					
Stormwater Structural Pollutant Control & Hydromodification Control BMPs* (List all from SWQMP)					
Description/Type of Structural BMP	**Plan Sheet #**	**STRUCT-URAL BMP ID#**	**Maint-enance Category**	**Maintenance Agreement Recorded Doc #**	**Revisions**
*All Priority Development Projects (PDPs) require a Structural BMP					

Note: If this is a partial verification of STRUCTURAL BMPs, provide a list and map denoting STRUCTURAL BMPs that have already been submitted, those for this submission, and those anticipated in future submissions.

County of San Diego BMP Design Manual Verification Form Page 3 of 4

Checklist for Applicant to submit to PDCI:

- ☐ Copy of the final accepted SWQMP and any accepted addendum.
- ☐ Copy of the most current plan showing the Stormwater Structural BMP Table, plans/cross-section sheets of the Structural BMPs and the location of each verified as-built Structural BMP.
- ☐ Photograph of each Structural BMP.
- ☐ Photograph(s) of each Structural BMP during the construction process to illustrate proper construction.
- ☐ Copy of the approved Structural BMP maintenance agreement and associated security

By signing below, I certify that the Structural BMP(s) for this project have been constructed and all BMPs are in substantial conformance with the approved plans and applicable regulations. I understand the County reserves the right to inspect the above BMPs to verify compliance with the approved plans and Watershed Protection Ordinance (WPO). Should it be determined that the BMPs were not constructed to plan or code, corrective actions may be necessary before permits can be closed.

Please sign your name and seal.

Professional Engineer's Printed Name: _____

Professional Engineer's Signed Name: _____

Date: _____

[SEAL]

County of San Diego BMP Design Manual Verification Form Page 4 of 4

COUNTY - OFFICIAL USE ONLY:

For PDCI: Verification Package #: _____

PDCI Inspector: _____

Date Project has/expects to close: _____

Date verification received from EOW: _____

By signing below, PDCI Inspector concurs that every noted Structural BMP has been installed per plan.

PDCI Inspector's Signature: _____ Date: _____

FOR WPP:

Date Received from PDCI: _____

WPP Submittal Reviewer: _____

WPP Reviewer concurs that the information provided for the following Structural BMPs is acceptable to enter into the Structural BMP Maintenance verification inventory:

List **acceptable** Structural BMPs:

WPP Reviewer's Signature: _____ Date: _____

ATTACHMENT 5

Copy of Plan Sheets Showing Permanent Storm Water BMPs, Source Control, and Site Design

This is the cover sheet for Attachment 5.

Use this checklist to ensure the required information has been included on the plans:

The plans must identify:

- ☐ Structural BMP(s) with ID numbers matching Step 6 Summary of ACP Structural BMPs
- ☐ The grading and drainage design shown on the plans must be consistent with the delineation of DMAs shown on the DMA exhibit
- ☐ Details and specifications for construction of structural BMP(s)
- ☐ Signage indicating the location and boundary of structural BMP(s) as required by County staff
- ☐ How to access the structural BMP(s) to inspect and perform maintenance
- ☐ Features that are provided to facilitate inspection (e.g., observation ports, cleanouts, silt posts, or other features that allow the inspector to view necessary components of the structural BMP and compare to maintenance thresholds)
- ☐ Manufacturer and part number for proprietary parts of structural BMP(s) when applicable
- ☐ Maintenance thresholds specific to the structural BMP(s), with a location-specific frame of reference (e.g., level of accumulated materials that triggers removal of the materials, to be identified based on viewing marks on silt posts or measured with a survey rod with respect to a fixed benchmark within the BMP)
- ☐ Recommended equipment to perform maintenance
- ☐ When applicable, necessary special training or certification requirements for inspection and maintenance personnel such as confined space entry or hazardous waste management
- ☐ Include landscaping plan sheets showing vegetation requirements for vegetated structural BMP(s)
- ☐ All BMPs must be fully dimensioned on the plans
- ☐ When proprietary BMPs are used, site-specific cross section with outflow, inflow, and model number must be provided. Photocopies of general brochures are not acceptable.
- ☐ Include all source control and site design measures described in Steps 4 and 5 of the SWQMP. Can be included as a separate exhibit as necessary.

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ATTACHMENT 6

Copy of Project's Drainage Report

This is the cover sheet for Attachment 6.

If hardcopy or CD is not attached, the following information should be provided:

Title:
Prepared By:
Date:

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ATTACHMENT 7

Copy of Project's Geotechnical and Groundwater Investigation Report

This is the cover sheet for Attachment 7.

If hardcopy or CD is not attached, the following information should be provided:

Title:
Prepared By:
Date:

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Appendix

B

Storm Water Pollutant Control Hydrologic Calculations and Sizing Methods

February 26, 2016

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Appendix B Storm Water Pollutant Control Hydrologic Calculations and Sizing Methods

Table of Contents:

B.1. DCV

B.2. Adjustments to Account for Site Design BMPs

B.3. BMP Feasibility

B.4. Infiltration BMPs

B.5. Biofiltration BMPs

B.6. Flow-Thru Treatment Control BMPs (for use with Alternative Compliance)

B.1 DCV

DCV is defined as the volume of storm water runoff resulting from the 85th percentile, 24-hr storm event. The following hydrologic method must be used to calculate the DCV:

$$DCV = C \times d \times A \times 43{,}560\ sf/ac \times 1/12\ in/ft$$

$$DCV = 3{,}630 \times C \times d \times A$$

Where:

DCV = Design Capture Volume in cubic feet

C = Runoff factor (unitless); standard runoff factors are discussed in section B.1.1, adjustment factors are discussed in Section B.2.

d = 85th percentile, 24-hr storm event rainfall depth (inches), refer to section B.1.3

A = Tributary area (acres) which includes the total area draining to the BMP, including any offsite or onsite areas that comingles with project runoff and drains to the BMP. Refer to Chapter 3, Section 3.3.3 for additional guidance. Street redevelopment projects consult section 1.4.3.

*Note that additional volume reductions may be applied through appropriate incorporation of tree wells and rain barrels as identified in section B.2.

Worksheet B.1-1 on the following page allows applicants to determine the initial design capture volume and apply any applicable reductions associated with site design techniques including dispersion to pervious surfaces, incorporation of tree wells, and incorporation of rain barrels.

Worksheet B.1-1. DCV

Category	#	Description	Value	Units
Standard Drainage Basin Inputs	0	Drainage Basin ID or Name		unitless
	1	Basin Drains to the Following BMP Type		unitless
	2	85th Percentile 24-hr Storm Depth		inches
	3	Impervious Surfaces Not Directed to Dispersion Area (C=0.90)		sq-ft
	4	Semi-Pervious Surfaces Not Serving as Dispersion Area (C=0.30)		sq-ft
	5	Engineered Pervious Surfaces Not Serving as Dispersion Area (C=0.10)		sq-ft
	6	Natural Type A Soil Not Serving as Dispersion Area (C=0.10)		sq-ft
	7	Natural Type B Soil Not Serving as Dispersion Area (C=0.14)		sq-ft
	8	Natural Type C Soil Not Serving as Dispersion Area (C=0.23)		sq-ft
	9	Natural Type D Soil Not Serving as Dispersion Area (C=0.30)		sq-ft
Dispersion, Tree Well, & Rain Barrel Inputs (Optional)	10	Does Tributary Incorporate Dispersion, Tree Wells, and/or Rain Barrels?		yes/no
	11	Impervious Surfaces Directed to Dispersion Area per SD-B (Ci=0.90)		sq-ft
	12	Semi-Pervious Surfaces Serving as Dispersion Area per SD-B (Ci=0.30)		sq-ft
	13	Engineered Pervious Surfaces Serving as Dispersion Area per SD-B (Ci=0.10)		sq-ft
	14	Natural Type A Soil Serving as Dispersion Area per SD-B (Ci=0.10)		sq-ft
	15	Natural Type B Soil Serving as Dispersion Area per SD-B (Ci=0.14)		sq-ft
	16	Natural Type C Soil Serving as Dispersion Area per SD-B (Ci=0.23)		sq-ft
	17	Natural Type D Soil Serving as Dispersion Area per SD-B (Ci=0.30)		sq-ft
	18	Number of Tree Wells Proposed per SD-A		#
	19	Average Mature Tree Canopy Diameter		ft
	20	Number of Rain Barrels Proposed per SD-E		#
	21	Average Rain Barrel Size		gal
Final Adjusted Runoff Factor Calculations	22	Total Area Tributary to BMP		sq-ft
	23	Composite Runoff Factor for Standard Drainage Areas		unitless
	24	Initial Composite Runoff Factor for Dispersed & Dispersion Areas		unitless
	25	Total Impervious Area Dispersed to Pervious Surface		sq-ft
	26	Total Pervious Dispersion Area		sq-ft
	27	Dispersed Impervious Area / Pervious Dispersion Area		ratio
	28	Adjustment Factor for Dispersed & Dispersion Areas		ratio
	29	Final Adjusted Tributary Runoff Factor		unitless
Volume Reduction Calculations	30	Final Effective Tributary Area		sq-ft
	31	Initial Design Capture Volume		cubic-feet
	32	Volume Reduction per Tree Well		cubic-feet
	33	Total Tree Well Volume Reduction		cubic-feet
	34	Total Rain Barrel Volume Reduction		cubic-feet
Result	35	Design Capture Volume Tributary to BMP		cubic-feet

Worksheet B.1-1 General Notes:

A. Applicants may use this worksheet to calculate design capture volumes. Applicants must provide inputs for yellow shaded cells and calculate appropriate values for unshaded cells. Notes corresponding with each line item are provided on the following page. An automated version of this worksheet is available for download at the County of San Diego Department of Public Works website.

B. Impervious surfaces include roofs, concrete, asphalt, or pervious pavements with an impervious liner.

C. Semi-pervious surfaces include decomposed granite, cobbles, crushed aggregate, or compacted soils such as unpaved parking.

D. Engineered pervious surfaces include pervious pavements providing full retention of the 85th percentile rainfall depth, or areas with soils that have been amended and mulched per Section 86.709 of the Landscape Ordinance.

E. Dispersion areas are pervious or semi-pervious surfaces that receive runoff from impervious surfaces (C=0.90) and reduce stormwater runoff as outlined in Fact Sheet SD-B.

Worksheet B.1-1 Line Item Notes

0. User Input from stormwater plans.

1. User Input from stormwater plans.

2. User Input from Figure B.1-1.

3. User Input from stormwater plans.

4. User Input from stormwater plans.

5. User Input from stormwater plans.

6. User Input from stormwater plans.

7. User Input from stormwater plans.

8. User Input from stormwater plans.

9. User Input from stormwater plans.

10. User Input (Default="No").

11. User Input from stormwater plans. Must satisfy criteria from Fact Sheet SD-B.

12. User Input from stormwater plans. Must satisfy criteria from Fact Sheet SD-B.

13. User Input from stormwater plans. Must satisfy criteria from Fact Sheet SD-B.

14. User Input from stormwater plans. Must satisfy criteria from Fact Sheet SD-B.

15. User Input from stormwater plans. Must satisfy criteria from Fact Sheet SD-B.

16. User Input from stormwater plans. Must satisfy criteria from Fact Sheet SD-B.

17. User Input from stormwater plans. Must satisfy criteria from Fact Sheet SD-B.

18. User Input. Must satisfy criteria from Fact Sheet SD-A.

19. User Input. Must satisfy criteria from Fact Sheet SD-A. Acceptable range from 0-30 feet.

20. User Input. Must satisfy criteria from Fact Sheet SD-E. Cannot provide more than 0.25DCV volume reduction.

21. User Input. Must satisfy criteria from Fact Sheet SD-E. Acceptable range 0-100 gallons for generic volume reductions.

22. Sum of Lines 3 through 17.

23. [0.9(Line 3) + 0.3(Line 4 + Line 9) + 0.1(Line 5 + Line 6) + 0.14(Line 7) + 0.23(Line 8)] /(Line 3 + Line 4 + Line 5 + Line 6 + Line 7 + Line 8 + Line 9)

24. [0.9(Line 11) + 0.3(Line 12 + Line 17) + 0.1(Line 13 + Line 14) + 0.14(Line 15) + 0.23(Line 16)] /(Line 11 + Line 12 + Line 13 + Line 14 + Line 15 + Line 16 + Line 17)

25. Line 11

26. Summation of Lines 12-17.

27. [Line 25 / Line 26]. If greater than 4.0 dispersion benefits are not quantified.

28. Lookup values from Table B.2-1 weighted with respect to distribution of dispersion areas specified in Lines 12-17.

29. [Line 23 x (Line 3 + Line 4 + Line 5 + Line 6 + Line 7 + Line 8 + Line 9) + Line 24 x Line 28 x (Line 11 + Line 12 + Line 13 + Line 14 + Line 15 + Line 16 + Line 17)] / Line 22

30. Line 22 x Line 29

31. [(Line 2/12) x Line 30]

32. Lookup value from Section B.2.2.1 of BMP Design Manual.

33. [Line 18 x Line 32]

34. [Line 20 x Line 21/7.48]. If Line 21>100 or Line 10 is "n/a" or "no", then this value must be zero.

35. [Line 31 - Line 33 - Line 34]. Minimum of 0.

B.1.1 Runoff Factor

Estimate the area weighted runoff factor for the tributary area to the BMP using runoff factor (from Table B.1-1) and area of each surface type in the tributary area and the following equation:

$$C = \frac{\sum C_x A_x}{\sum A_x}$$

Where:

C_x = Runoff factor for area X

A_x = Tributary area X (acres)

These runoff factors apply to areas receiving direct rainfall only. For conditions in which runoff is routed onto a surface from an adjacent surface, see Section B.2 for determining composite runoff factors for these areas.

Table B.1-1: Runoff factors for surfaces draining to BMPs – Pollutant Control BMPs

Surface	Runoff Factor
Roofs[9]	0.90
Concrete or Asphalt[1]	0.90
Unit Pavers (grouted)[1]	0.90
Decomposed Granite	0.30
Cobbles or Crushed Aggregate	0.30
Mulched and Amended Soils per the Water Conservation in Landscaping Ordinance, Section 86.709 & Fact Sheet SD-F in Appendix E	0.10
Compacted Soil (e.g., unpaved parking)	0.30
Natural (A Soil)	0.10
Natural (B Soil)	0.14
Natural (C Soil)	0.23
Natural (D Soil)	0.30
Swimming pools, fountains, ponds, and other impoundments with appropriate freeboard.	0.00

[9] Surface is considered impervious and could benefit from use of Site Design BMPs and adjustment of the runoff factor per Section B.2.1.

B.1.2 Offline BMPs

Diversion flow rates for offline BMPs must be sized to convey the maximum flow rate of runoff produced from a rainfall intensity of 0.2 inch of rainfall per hour, for each hour of every storm event. The following hydrologic method must be used to calculate the diversion flow rate for off-line BMPs:

$$Q = C \times i \times A$$

Where:

Q = Diversion flow rate in cubic feet per second

C = Runoff factor, area weighted estimate using Table B.1

i = Rainfall intensity of 0.2 in/hr

A = Tributary area (acres) which includes the total area draining to the BMP, including any offsite or onsite areas that comingle with project runoff and drain to the BMP. Refer to Chapter 3, Section 3.3.3 for additional guidance. Street redevelopment projects also consult Section 1.4.3.

B.1.3 85th Percentile, 24-Hour Storm Event

The 85th percentile, 24-hour isopluvial map is provided as Figure B.1-1. The rainfall depth to estimate the DCV must be determined using Figure B.1-1. The methodology used to develop this map is presented below:

B.1.3.1 Gage data and calculation of 85th percentile

The method of calculating the 85th percentile is to produce a list of values, order them from smallest to largest, and then pick the value that is 85 percent of the way through the list. Only values that are capable of producing run off are of interest for this purpose. Lacking a legislative definition of rainfall values capable of producing runoff, Flood Control staff in San Diego County have observed that the point at which significant runoff begins is rather subjective, and is affected by land use type and soil moisture. In highly-urbanized areas, the soil has a high impermeability and runoff can begin with as little as 0.02" of rainfall. In rural areas, soil impermeability is significantly lower and even 0.30" of rain on dry soil will frequently not produce significant runoff. For this reason, San Diego County has chosen to use the more objective method of including all non-zero 24-hour rainfall totals when calculating the 85th percentile. To produce a statistically significant number, only stations with 30 years or greater of daily rainfall records are used.

B.1.3.2 Mapping the gage data

A collection of 56 precipitation gage points was developed with 85th percentile precipitation values based on multiple years of gage data. A raster surface (grid of cells with values) was interpolated from that set of points. The surface initially did not cover the County's entire jurisdiction. A total of 13 dummy points were added. Most of those were just outside the County boundary to enable the software to generate a surface that covered the entire County. A handful of points were added to enforce a plausible surface. In particular, one point was added in the desert east of Julian, to enforce a gradient from high precipitation in the mountains to low precipitation in the desert. Three points were added near the northern boundary of the County to adjust the surface to reflect the

effect of elevation in areas lacking sufficient operating gages.

Several methods of interpolation were considered. The method chosen is named by Environmental Systems Research Institute as the Natural Neighbor technique. This method produces a surface that is highly empirical, with the value of the surface being a product of the values of the data points nearest each cell. It does not produce peaks or valleys of surface based on larger area trends, and is free of artifacts that appeared with other methods.

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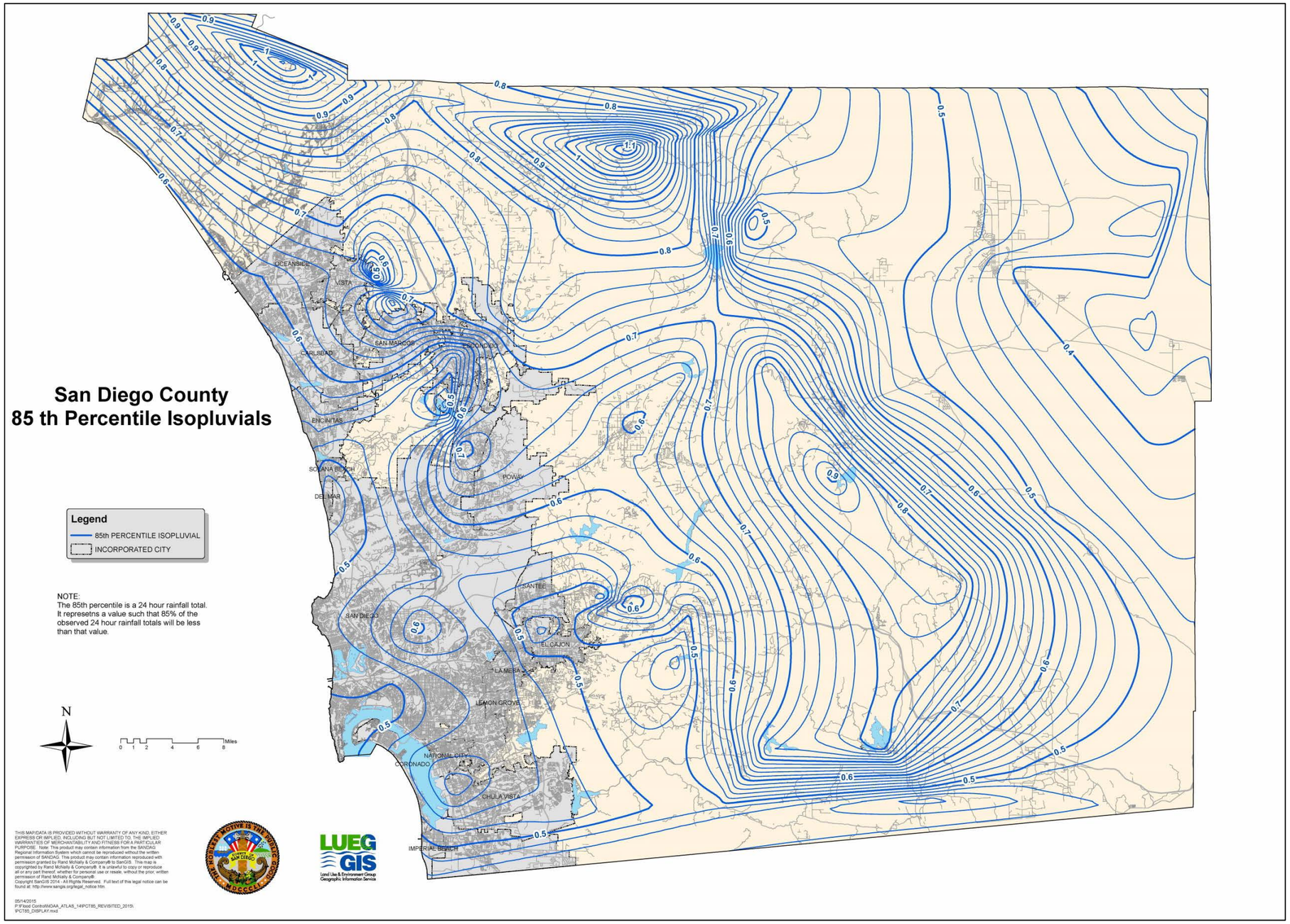

Figure B.1-1: 85th Percentile 24-hour Isopluvial Map

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B.2 Adjustments to Account for Site Design BMPs

This section provides methods to adjust the DCV (for sizing pollutant control BMPs) as a result of implementing site design BMPs. The adjustments are provided by one of the following two methods:

- Adjustment to impervious runoff factor
- Adjustment to DCV

B.2.1 Adjustment to Impervious Runoff Factor

When one of the following site design BMPs is implemented the runoff factor of 0.9 for impervious surfaces identified in Table B.1-1 should be adjusted using the factors listed below and an adjusted area weighted runoff factor must be estimated following guidance from Section B.1.1 and used to calculate the DCV.

- SD-B Impervious area dispersion
- SD-C Green roofs
- SD-D Permeable pavement

B.2.1.1 Impervious area dispersion (SD-B)

Adjustment to conventional runoff factors may be permitted when storm water runoff from impervious surfaces is dispersed through pervious dispersion areas in accordance with the SD-B fact sheet located in Appendix E. Among other criteria, this fact sheets requires dispersion areas to be pervious, have a minimum width of 10 feet, and a maximum slope of 5%.

Runoff factor adjustments may be applied to drainage areas with a 4:1 maximum ratio of impervious to pervious area. In order to be eligible for runoff factor adjustments, impervious areas must have a runoff factor of 0.9 and must be directed towards a pervious dispersion area. In order to provide runoff factor adjustments, pervious dispersion areas must have a runoff factor of less than 0.30 and must receive runoff from an adjacent impervious surface.

As depicted in Table B.2-1 runoff factor adjustments are a function of the ratio of impervious to pervious area and the hydrologic soil group of the pervious dispersion area. If an applicant proposes amended soils per the Water Conservation in Landscaping Ordinance Section 86.709 and the SD-F fact sheet, the underlying hydrologic soil group need not be considered. Applicants applying runoff reduction factors must identify appropriate factors presented in the table below and multiply that factor by the original composite runoff factor of the impervious area and the dispersion area.

.

Table B.2-1: Impervious area adjustment factors that accounts for dispersion

Pervious area hydrologic soil group	Ratio = Impervious area/Pervious area			
	<=1	2	3	4
A/Amended Soil	0.00	0.00	0.21	0.32
B	0.00	0.24	0.38	0.48
C	0.31	0.50	0.60	0.67
D	0.77	0.84	0.87	0.90

Continuous simulation modeling in accordance with Appendix G is required to develop adjustment factors for surfaces that have an unadjusted runoff factor less than 0.9. Approval of adjustment factors for surfaces that have an unadjusted runoff factor less than 0.9 is at the discretion of County staff.

The adjustment factors in Table B.2-1 were developed by performing continuous simulations in SWMM with default parameters from Appendix G and impervious to pervious area ratios of 1, 2, 3, and 4. When using adjustment factors from Table B.2-1:

- **Linear interpolation** must be performed if the impervious to pervious area ratio of the site is in between one of ratios for which an adjustment factor was developed;
- Use adjustment factor for a ratio of 1 when the impervious to pervious area ratio is less than 1; and
- Adjustment factor is not allowed when the impervious to pervious area ratio is greater than 4, when the pervious area is designed as a site design BMP.

Example B.2-1: DMA is comprised of one acre of impervious area that drains to a 0.4 acre hydrologic soil group B pervious area and then the pervious area drains to a BMP. Impervious area dispersion is implemented in the DMA in accordance with SD-B factsheet. Estimate the adjusted runoff factor for the DMA.

- Initial Runoff Factor: Per problem statement and Table B.1-1, [(1*0.9+0.4*0.14)/1.4] = 0.68
- Impervious to Pervious Ratio: Per problem statement, 1 acre/0.4 acres = 2.5
- Adjustment Factor: From Table B.2-1 the adjustment factor for hydrologic soil group B and a ratio of 2.5 can be linearly interpolated as 0.31
- **Final Adjusted Runoff Factor:** Initial Runoff Factor * Adjustment Factor = 0.68 * 0.31 **= 0.21**

B.2.1.2 Green Roofs

When green roofs are implemented in accordance with the SD-C factsheet the green roof footprint must be assigned a runoff factor of 0.10 for adjusted runoff factor calculations.

B.2.1.3 Permeable Pavement

When a permeable pavement is implemented in accordance with the SD-D factsheet and it **does not have an impermeable liner** and has an equivalent storage depth greater than the 85th percentile 24 hour precipitation depth below the underdrain, if an underdrain is present, then the footprint of the permeable pavement must be assigned a runoff factor of 0.10 for adjusted runoff factor calculations.

Permeable Pavement can also be designed as a structural BMP to treat run on from adjacent areas. Refer to INF-3 factsheet and Appendix B.4 for additional guidance.

B.2.2 Adjustment to DCV

When the following site design BMPs are implemented the anticipated volume reduction from these BMPs must be deducted from the DCV to estimate the volume for which the downstream structural BMP should be sized for:

- SD-A: Tree Wells
- SD-E Rain barrels

B.2.2.1 Tree Wells

Tree Well credit volume (tree BMPs) is a sum of three runoff reduction volumes provided by trees that decrease the required DCV for a tributary area. The following reduction in DCV is allowed per tree based on the mature diameter of the tree canopy, when trees are implemented in accordance with SD-A factsheet:

Mature Tree Canopy Diameter (ft)	Tree Well Credit Volume (ft^3/tree)
5	10
10	40
15	100
20	180
25	290
30	420

Basis for the reduction in DCV:

Tree Well credit volume is estimated based on typical characteristics of Tree Wells as follows:

It is assumed that each tree is considered a single BMP, with calculations based on the soil media reservoir volume and/or the individual tree within the tree BMP as appropriate. Tree Well credit volume is calculated as:

$$\boldsymbol{TWCV = TIV + TCIV + TETV}$$

Where:

- *TWCV* = Tree Well credit volume (ft^3)
- *TIV* = Total infiltration volume of all storage layers within tree BMPs (ft^3)
- *TCIV* = Total canopy interception volume of tree BMPs (ft^3)
- *TETV* = Total evapotranspiration volume, sums the media evapotranspiration storage within each tree BMP (ft^3)

Total infiltration volume is calculated as the total volume stored within the tree BMP soil media reservoir. Infiltration volume was assumed to be 20% of the total BMP soil media reservoir volume, the available pore space in the soil media reservoir (porosity – field capacity).

Total canopy interception volume was calculated as the average interception capacity for the entire mature tree canopy projection area. Interception capacity was determined to be 0.04 inches per square foot for all tree sizes, an average from the findings published by Breuer et al (2003) for coniferous and deciduous trees.

Total evapotranspiration volume is the available evapotranspiration storage volume (field capacity – wilting point) within the BMP storage layer media. TEVT is assumed to be 10% of the minimum soil volume. The minimum soil volume as required by SD-A fact sheet of 2 cubic feet per unit canopy projection area was assumed for estimating reduction in DCV.

There may be rain events that generate more runoff than the tree well can handle. Installing an overflow above the design storm water retention level of the reservoir can prevent system failure during extreme weather events. Placement of the overflow should be determined based on the infiltration rate of the subsoil.. If infiltration is not adequate to remove water from the rooting zone (the top 18 to 24 inches of soil media reservoir) within 48 hours, the depth of the soil media reservoir may be increased, and the overflow should be placed such that if water rises to the level of the rooting zone it will drain in less than 48 hours.

B.2.2.2 Rain Barrels

Rain barrels are containers that can capture rooftop runoff and store it for future use. Credit can be taken for the full rain barrel volume when each barrel volume is smaller than 100 gallons, implemented per SD-E fact sheet and meet the following criteria:

- Total rain barrel volume is less than 0.25 DCV and
- Landscape areas are greater than 30 percent of the project footprint.

Credit for harvest and use systems that do not meet the above criteria must be based on the criteria in Appendix B.3 and HU-1 fact sheet.

B.3 BMP Feasibility

The purpose of this section is to determine the BMP types that are acceptable for implementation at the project site. Through completion of Worksheet B.3-1, applicants will evaluate the feasibility of harvest & use, full retention, and partial retention BMPs at their project site.

Worksheet B.3-1. Project-Scale BMP Feasibility Analysis

Category	#	Description	Value	Units
Capture & Use Inputs	0	Design Capture Volume for Entire Project Site		cubic-feet
	1	Proposed Development Type		unitless
	2	Number of Residents or Employees at Proposed Development		#
	3	Total Planted Area within Development		sq-ft
	4	Water Use Category for Proposed Planted Areas		unitless
Infiltration Inputs	5	Is Average Site Infiltration Rate Less than 0.5 Inches per Hour?		yes/no
	6	Is Retention of the Full DCV Anticipated to Produce Negative Impacts?		yes/no
	7	Is Retention of Any Volume Anticipated to Produce Negative Impacts?		yes/no
Calculations	8	36-Hour Toilet Use Per Resident or Employee		cubic-feet
	9	Subtotal: Anticipated 36 Hour Toilet Use		cubic-feet
	10	Anticipated 1 Acre Landscape Use Over 36 Hours		cubic-feet
	11	Subtotal: Anticipated Landscape Use Over 36 Hours		cubic-feet
	12	Total Anticipated Use Over 36 Hours		cubic-feet
	13	Total Anticipated Use / Design Capture Volume		cubic-feet
	14	Are Full Capture and Use Techniques Feasible for this Project?		unitless
	15	Is Full Retention Feasible for this Project?		yes/no
	16	Is Partial Retention Feasible for this Project?		yes/no
Result	17	Feasibility Category		1, 2, 3, 4, 5

Worksheet B.3-1 General Notes:

A. Applicants may use this optional worksheet to determine the feasibility of implementing capture and use techniques on their project site. Applicants should provide inputs for yellow shaded cells and calculate appropriate values for unshaded cells. Projects demonstrating feasibility or potential feasibility via this worksheet are encouraged to incorporate capture and use features in their project. An automated version of this worksheet is available for download at the County of San Diego Department of Public Works website.

B. Negative impacts associated with retention may include geotechnical, groundwater, water balance, or other issues identified by a geotechnical engineer and substantiated through completion of Form I-8.

C. Feasibility Category 1: Applicant must implement capture & use, retention, and/or infiltration elements for the entire DCV.

D. Feasibility Category 2: Applicant must implement capture & use elements for the entire DCV.

E. Feasibility Category 3: Applicant must implement retention and/or infiltration elements for the entire DCV.

F. Feasibility Category 4: Applicant must implement partial retention BMPs.

G. Feasibility Category 5: Applicant must implement biofiltration BMPs.

H. PDPs participating in an offsite alternative compliance program are not held to the feasibility categories presented herein.

Worksheet B.3-1 Line Item Notes:

0. User input determined by summing all Design Capture Volumes within the Project footprint.
1. User input based on predominate land use type within the project footprint.
2. User input.
3. User input from stormwater plans.
4. User Input from stormwater plans.
5. User Input from site soils investigation.
6. User Input from site soils investigation as supported by Form I-8.
7. User Input from site soils investigation as supported by Form I-8.
8. Lookup Value from Table B.3-1 divided by 7.48 and multiplied by 1.50 to get cubic-feet per 36 hours.
9. Line 2 x Line 8
10. Lookup value from Table B.3-3 divided by 7.48 to get cubic-feet per 36 hours.
11. (Line 3/43,560) x Line 10
12. Line 9 + Line 11
13. Line 12 / Line 0
14. If Line 13 ≥ 1.0 then "Yes", otherwise "No".
15. If Line 5 = "No" AND Line 6="No", then result is "Yes". All other combinations result in "No".
16. If Line 5 = "Yes" AND Line 7="No", then result is "Yes"
17. Based on Results of Line 14:Line 15:Line 16. (1=Yes:Yes:Yes), (2=Yes:No:No or Yes:No:Yes), (3=No:Yes:Yes), (4=No:No:Yes), (5=No:No:No)

B.3.1 Planning Level Harvest and Use Feasibility

Harvest and use feasibility should be evaluated at the scale of the entire project, and not limited to a single DMA. For the purpose of initial feasibility screening, it is assumed that harvested water collected from one DMA could be used within another. Types of non-potable water demand that may apply within a project include:

- Toilet and urinal flushing*
- Irrigation
- Vehicle washing
- Evaporative cooling
- Dilution water for recycled water systems
- Industrial processes
- Other non-potable uses

Worksheet B.3-1 provides a screening process for determining the preliminary feasibility for harvest and use BMPs. This worksheet should be completed for the overall project.

Note: At the time of publication of this document, there is not a program in place to permit the use of storm water for indoor use. Check with PDS prior to calculating indoor water use.

B.3.2 Harvested Water Demand Calculation

The following sections provide technical references and guidance for estimating the harvested water demand of a project. These references are intended to be used for the planning phase of a project for feasibility screening purposes.

B.3.2.1 Toilet and Urinal Flushing Demand Calculations*

The following guidelines should be followed for computing harvested water demand from toilet and urinal flushing:

- If reclaimed water is planned for use for toilet and urinal flushing, then the demand for harvested storm water is equivalent to the total demand minus the reclaimed water supplied, and should be reduced by the amount of reclaimed water that is available during the wet season.
- Demand calculations for toilet and urinal flushing should be based on the average rate of use during the wet season for a typical year.
- Demand calculations should include changes in occupancy over weekends and around holidays and changes in attendance/enrollment over school vacation periods.
- For facilities with generally high demand, but periodic shut downs (e.g., for vacations, maintenance, or other reasons), a project specific analysis should be conducted to determine whether the long term storm water capture performance of the system can be maintained despite shut downs.
- Such an analysis should consider the statistical distributions of precipitation and demand, most importantly the relationship of demand to the wet seasons of the year.

Table B.3-1 provides planning level demand estimates for toilet and urinal flushing per resident, or employee, for a variety of project types. The per capita use per day is based on daily employee or resident usage. For non-residential types of development, the "visitor factor" and "student factor" (for schools) should be multiplied by the employee use to account for toilet and urinal usage for non-employees using facilities.

Note: At the time of publication of this document, there is not a program in place to permit the use of storm water for indoor use. Check with PDS prior to calculating indoor water use.

Table B.3-1. Toilet and Urinal Water Usage per Resident or Employee

Land Use Type	Toilet User Unit of Normalization	Per Capita Use per Day		Visitor Factor[4]	Water Efficiency Factor	Total Use per Resident or Employee
		Toilet Flushing[1,2]	Urinals[3]			
Residential	Resident	18.5	NA	NA	0.5	9.3
Office	Employee (non-visitor)	9.0	2.27	1.1	0.5	7 (avg)
Retail	Employee (non-visitor)	9.0	2.11	1.4	0.5	
Schools	Employee (non-student)	6.7	3.5	6.4	0.5	33
Various Industrial Uses (excludes process water)	Employee (non-visitor)	9.0	2	1	0.5	5.5

1 - Based on American Waterworks Association Research Foundation,1999. Residential End Uses of Water. Denver, CO: AWWARF

2 - Based on use of 3.45 gallons per flush and average number of per employee flushes per subsector, Table D-1 for MWD (Pacific Institute, 2003)

3 - Based on use of 1.6 gallons per flush, Table D-4 and average number of per employee flushes per subsector, Appendix D (Pacific Institute, 2003)

4 - Multiplied by the demand for toilet and urinal flushing for the project to account for visitors. Based on proportion of annual use allocated to visitors and others (includes students for schools; about 5 students per employee) for each subsector in Table D-1 and D-4 (Pacific Institute, 2003)

5 - Accounts for requirements to use ultra low flush toilets in new development projects; assumed that requirements will reduce toilet and urinal flushing demand by half on average compared to literature estimates. Ultra low flush toilets are required in all new construction in California as of January 1, 1992. Ultra low flush toilets must use no more than 1.6 gallons per flush and Ultra low flush urinals must use no more than 1 gallon per flush. Note: If zero flush urinals are being used, adjust accordingly.

B.3.2.2 General Requirements for Irrigation Demand Calculations

The following guidelines should be followed for computing harvested water demand from landscape irrigation:

- If reclaimed water is planned for use for landscape irrigation, then the demand for harvested storm water should be reduced by the amount of reclaimed water that is available during the wet season.
- Irrigation rates should be based on the irrigation demand exerted by the types of landscaping that are proposed for the project, with consideration for water conservation requirements.
- Irrigation rates should be estimated to reflect the average wet season rates (defined as October through April) accounting for the effect of storm events in offsetting harvested water demand. In the absence of a detailed demand study, it should be assumed that irrigation demand is not present during days with greater than 0.1 inches of rain and the subsequent 3-day period. This irrigation shutdown period is consistent with standard practice in land application of wastewater and is applicable to storm water to prevent irrigation from resulting in dry weather runoff. Based on a statistical analysis of San Diego

County rainfall patterns, approximately 30 percent of wet season days would not have a demand for irrigation.

- If land application of storm water is proposed (irrigation in excess of agronomic demand), then this BMP must be considered to be an infiltration BMP and feasibility screening for infiltration must be conducted. In addition, it must be demonstrated that land application would not result in greater quantities of runoff as a result of saturated soils at the beginning of storm events. Agronomic demand refers to the rate at which plants use water.

The following sections describe methods that should be used to calculate harvested water irrigation demand. While these methods are simplified, they provide a reasonable estimate of potential harvested water demand that is appropriate for feasibility analysis and project planning. These methods may be replaced by a more rigorous project-specific analysis that meets the intent of the criteria above.

B.3.2.2.1 Demand Calculation Method

This method is based on the San Diego Municipal Code Land Development Code Landscape Standards Appendix E which includes a formula for estimating a project's annual estimated total water use based on reference evaporation, plant factor, and irrigation efficiency.

For the purpose of calculating harvested water irrigation demand applicable to the sizing of harvest and use systems, the estimated total water use has been modified to reflect typical wet-season irrigation demand. This method assumes that the wet season is defined as October through April. This method further assumes that no irrigation water will be applied during days with precipitation totals greater than 0.1 inches or within the 3 days following such an event. Based on these assumptions and an analysis of Lake Wohlford, Lindbergh and Oceanside precipitation patterns, irrigation would not be applied during approximately 30 percent of days from October through April.

The following equation is used to calculate the Modified Estimated Total Water Usage:

$$\text{Modified ETWU} = ETo_{Wet} \times [[\Sigma(PF \times HA)/IE] + SLA] \times 0.015$$

Where:

Modified ETWU = Estimated daily average water usage during wet season
ETo_{Wet} = Average reference evapotranspiration from October through April (use 2.7 inches per month, using CIMS Zone 4 from Table G.1-1)
PF = Plant Factor

Table B.3-2. Planning Level Plant Factor Recommendations

Plant Water Use	Plant Factor	Also Includes
Low	< 0.1 – 0.2	Artificial Turf
Moderate	0.3 – 0.7	
High	0.8 and greater	Water features
Special Landscape Area	1.0	

HA = Hydrozone Area (sq-ft); A section or zone of the landscaped area having plants with similar water needs.
Σ(PF x HA) = The sum of PF x HA for each individual Hydrozone (accounts for different landscaping zones).
IE = Irrigation Efficiency (assume 90 percent for demand calculations)
SLA = Special Landscape Area (sq-ft); Areas used for active and passive recreation areas, areas solely dedicated to the production of fruits and vegetables, and areas irrigated with reclaimed water.

In this equation, the coefficient (0.015) accounts for unit conversions and shut down of irrigation during and for the three days following a significant precipitation event:

0.015 = (1 mo/30 days)×(1 ft/12 in)×(7.48 gal/cu-ft)×(approximately 7 out of 10 days with irrigation demand from October through April)

B.3.2.2.2 Planning Level Irrigation Demands

To simplify the planning process, the method described above has been used to develop daily average wet season demands for a one-acre irrigated area based on the plant/landscape type. These demand estimates can be used to calculate the drawdown of harvest and use systems for the purpose of LID BMP sizing calculations.

Table B.3-3. Planning Level Irrigation Demand by Plant Factor and Landscape Type

General Landscape Type	36-Hour Planning Level Irrigation Demand (gallons per irrigated acre per 36 hour period)
Hydrozone – Low Plant Water Use	390
Hydrozone – Moderate Plant Water Use	1,470
Hydrozone – High Plant Water Use	2,640
Special Landscape Area	2,640

B.3.2.3 Calculating Other Harvested Water Demands

Calculations of other harvested water demands should be based on the knowledge of land uses, industrial processes, and other factors that are project-specific. Demand should be calculated based on the following guidelines:

- Demand calculations should represent actual demand that is anticipated during the wet season (October through April).
- Sources of demand should only be included if they are reliably and consistently present during the wet season.
- Where demands are substantial but irregular, a more detailed analysis should be conducted based on a statistical analysis of anticipated demand and precipitation patterns.

B.3.3 Sizing Harvest and Use BMPs

Sizing calculations must demonstrate that one of two equivalent performance standards is met:

1. Harvest and use BMPs are sized to drain the tank in 36 hours following the end of rainfall. The size of the BMP is dependent on the demand (Section B.3.2) at the site.
2. Harvest and use BMP is designed to capture at least 80 percent of average annual (long term) runoff volume.

B.3.4 Consideration of Retention and Partial Retention

If an applicant is not fully implementing capture & use techniques, the feasibility of storm water infiltration must be investigation through geotechnical analysis as outlined in Appendix C.

B.4 Bioretention and Infiltration BMPs

Sizing calculations for BMPs solely providing bioretention or infiltration treatment measures must demonstrate the following performance standard is met:

1. The BMP or series of BMPs infiltrates at least 80 percent of average annual (long term) runoff volume. This can be demonstrated using the percent capture method (Section B.4.1), through reporting of output from the San Diego Hydrology Model, or through other continuous simulation modeling meeting the criteria in Appendix G, as acceptable to County staff. This method is **not** applicable for sizing biofiltration BMPs.

Worksheets B.4-1 and B.4-2 on the pages that follow allow applicants to determine how effectively a proposed bioretention or infiltration BMP addresses the performance standard above. These worksheets require basic inputs for tributary and BMP characteristics and provided standardized calculations to determine associated drawdown times, infiltration volumes, and BMP effectiveness. The result of these worksheets is a "deficit of effectively treated storm water". BMPs that are in compliance with performance standards have a deficit of zero. BMPs with a negative deficit value are not in compliance with performance standards and must be redesigned or augmented with flow-thru treatment and mitigated for through an offsite alternative compliance project.

Worksheet B.4-1: Sizing Infiltration BMPs

Category	#	Description	Value	Units
BMP Inputs	0	Drainage Basin ID or Name		unitless
	1	Design Capture Volume Tributary to BMP		cubic-feet
	2	Provided Infiltration Surface Area		sq-ft
	3	Provided Surface Ponding Depth		inches
	4	Provided Soil Media Thickness		inches
	5	Provided Gravel Storage Thickness		inches
	6	Native Soil Infiltration Rate		in/hr
Infiltration Calculations	7	Volume Infiltrated Over 6 Hour Storm		cubic-feet
	8	Soil Media Pore Space	0.40	unitless
	9	Gravel Pore Space	0.40	unitless
	10	Effective Depth of Infiltration Storage		inches
	11	Drawdown Time for Surface Ponding (Post-Storm)		hours
	12	Drawdown Time for Entire Infiltration Basin (Including 6 Hour Storm)		hours
	13	Volume Infiltrated by BMP		cubic-feet
	14	Fraction of DCV Infiltrated		ratio
	15	Percentage of Performance Requirement Satisfied		ratio
Result	16	**Deficit of Effectively Treated Stormwater**		cubic-feet

Worksheet B.4-1 General Notes:

A. Applicants may use this worksheet to size Infiltration-Only BMPs (INF-1). Applicants must provide inputs for yellow shaded cells and calculate appropriate values for unshaded cells. Notes corresponding with each line item are provided below. An automated version of this worksheet is available for download at the County of San Diego Department of Public Works website.

Worksheet B.4-1 Line Item Notes

0. Populated per result of Worksheet B.1-1
1. Populated per result of Worksheet B.1-1
2. User Input
3. User Input
4. User Input
5. User Input, use a value of zero if gravel does not cover entire bottom
6. User Input from Worksheet D.5-1 of BMP Design Manual.
7. Minimum between Line 1 or [Line 2 x (Line 6/12) x 6]
8. Default = 0.40 for Infiltration-Only BMPs
9. Default = 0.40
10. [Line 3 + (Line 4 x Line 8) + (Line 5 x Line 9)]
11. [Line 3 / Line 6]. Must be less than 96 hours for vector control.
12. [Line 10 / Line 6] + 6.0. Must be between 6 and 120 hours.
13. [Line 2 x (Line 10/12) + Line 7]
14. [Line 13/Line 1]. Maximum of 3.00
15. Look up value from Retention Percent Capture Curves and divide by 0.80. Maximum result of 1.00.
16. [Line 1 x Line 15] - Line 1

Worksheet B.4-2: Sizing Bioretention BMPs

Category	#	Description	Value	Units
BMP Inputs	0	Drainage Basin ID or Name		unitless
	1	Design Capture Volume Tributary to BMP		cubic-feet
	2	Provided Bioretention Surface Area		sq-ft
	3	Provided Surface Ponding Depth		inches
	4	Provided Soil Media Thickness		inches
	5	Provided Gravel Storage Thickness		inches
	6	Native Soil Infiltration Rate		in/hr
Retention Calculations	7	Volume Infiltrated Over 6 Hour Storm		cubic-feet
	8	Soil Media Pore Space	0.30	unitless
	9	Gravel Pore Space	0.40	unitless
	10	Effective Depth of Retention Storage		inches
	11	Drawdown Time for Surface Ponding (Post-Storm)		hours
	12	Drawdown Time for Entire Bioretention Basin (Including 6 Hour Storm)		hours
	13	Volume Retained by BMP		cubic-feet
	14	Fraction of DCV Retained		ratio
	15	Percentage of Performance Requirement Satisfied		ratio
Result	16	**Deficit of Effectively Treated Stormwater**		cubic-feet

Worksheet B.4-2 General Notes:

A. Applicants may use this worksheet to size Bioretention BMPs (INF-2) Applicants must provide inputs for yellow shaded cells and calculate appropriate values for unshaded cells. Notes corresponding with each line item are provided below. An automated version of this worksheet is available for download at the County of San Diego Department of Public Works website.

Worksheet B.4-2 Line Item Notes

0. User Input from stormwater plans.
1. Populated per result of Worksheet B.1-1
2. User Input
3. User Input
4. User Input, 18 inches minimum
5. User Input, use a value of zero if gravel does not cover entire bottom
6. User Input from Worksheet D.5-1 of BMP Design Manual.
7. Minimum of Line 1 or [Line 2 x (Line 6/12) x 6]
8. Default = 0.30 for Retention-Only BMPs
9. Default = 0.40
10. [Line 3 + (Line 4 x Line 8) + (Line 5 x Line 9)]
11. [Line 3 / Line 6]. Must be less than 24 hours for plant health.
12. [Line 10 / Line 6] + 6.0. Must be between 6 and 120 hours.
13. [Line 2 x (Line 10/12) + Line 7]
14. [Line 13/Line 1]. Maximum of 3.00
15. Look up value from Retention Percent Capture Curves and divide by 0.80. Maximum result of 1.00.
16. [Line 1 x Line 15] - Line 1

B.4.1 Percent Capture Method

This section describes the recommended method of sizing volume-based BMPs to achieve the 80 percent capture performance criterion. This method has a number of potential applications for sizing BMPs, including:

- Use this method when a BMP can draw down in less than 36 hours and it is desired to demonstrate that 80 percent capture can be achieved using a BMP volume smaller than the DCV.
- Use this method to determine how much volume (greater than the DCV) must be provided to achieve 80 percent capture when the drawdown time of the BMP exceeds 36 hours.
- Use this method to determine how much volume should be provided to achieve 80 percent capture when upstream BMP(s) have achieved some capture, but have not achieved 80 percent capture.

By nature, the percent capture method is an iterative process that requires some initial assumptions about BMP design parameters and subsequent confirmation that these assumptions are valid. For example, sizing calculations depend on the assumed drawdown time, which depends on BMP depth, which may in turn need to be adjusted to provide the required volume within the allowable footprint. In general, the selection of reasonable BMP design parameters in the first iteration will result in minimal required additional iterations. Figure B.4-1 presents the nomograph for use in sizing retention BMPs in San Diego County.

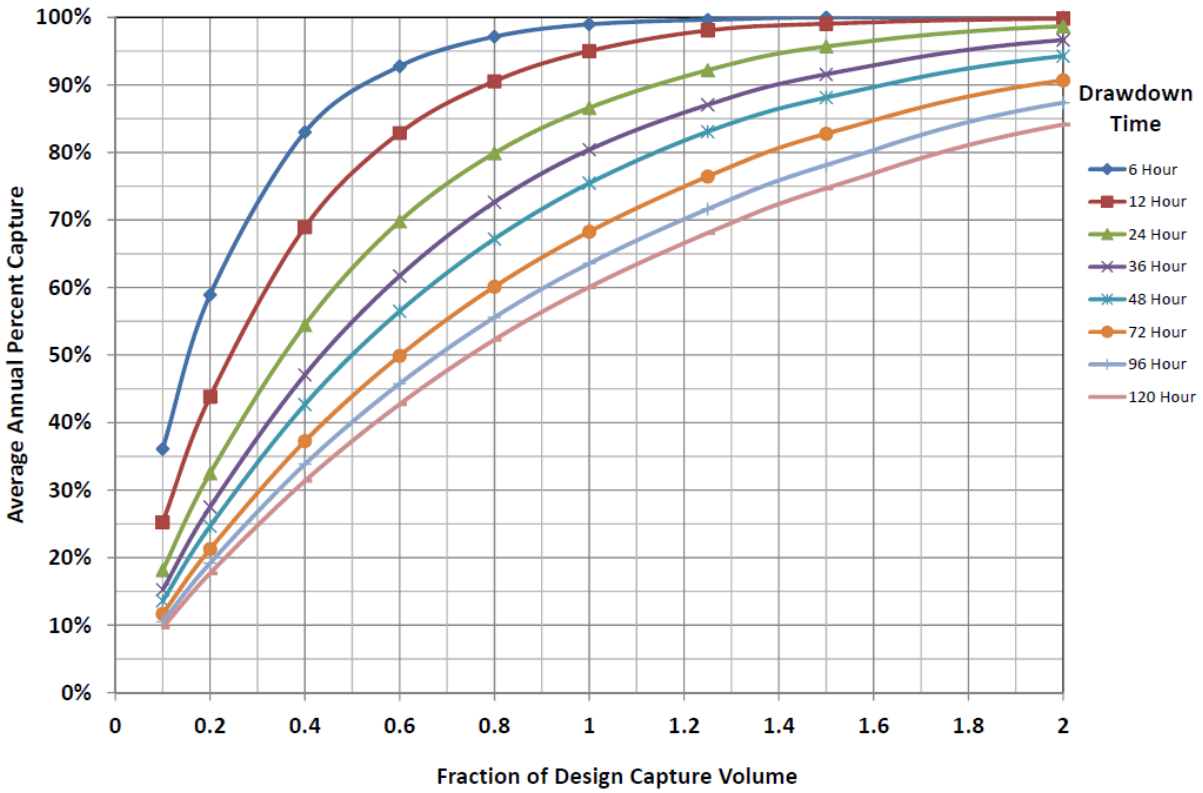


Figure B.4-1: Percent Capture Nomograph

B.4.1.1 Stepwise Instructions for sizing a single BMP:

1. Estimate the drawdown time of the proposed BMP by estimating the design infiltration rate (Worksheet D.5-1) and accounting for BMP dimensions/geometry. See the applicable BMP Fact Sheet for specific guidance on how to convert BMP geometry to estimated drawdown time.
2. Using the estimated drawdown time and the nomograph from Figure B.4-1 locate where the line corresponding to the estimated drawdown time intersects with 80 percent capture. Pivot to the X axis and read the fraction of the DCV that needs to be provided in the BMP to achieve this level of capture.
3. Calculate the DCV using Worksheet B.2-1.
4. Multiply the result of Step 2 by the DCV (Step 3). This is the required BMP design volume.
5. Design the BMP to retain the required volume, and confirm that the drawdown time is no more than 25 percent greater than estimated in Step 1. If the computed drawdown time is greater than 125 percent of the estimated drawdown, then return to Step 1 and revise the initial drawdown time assumption.

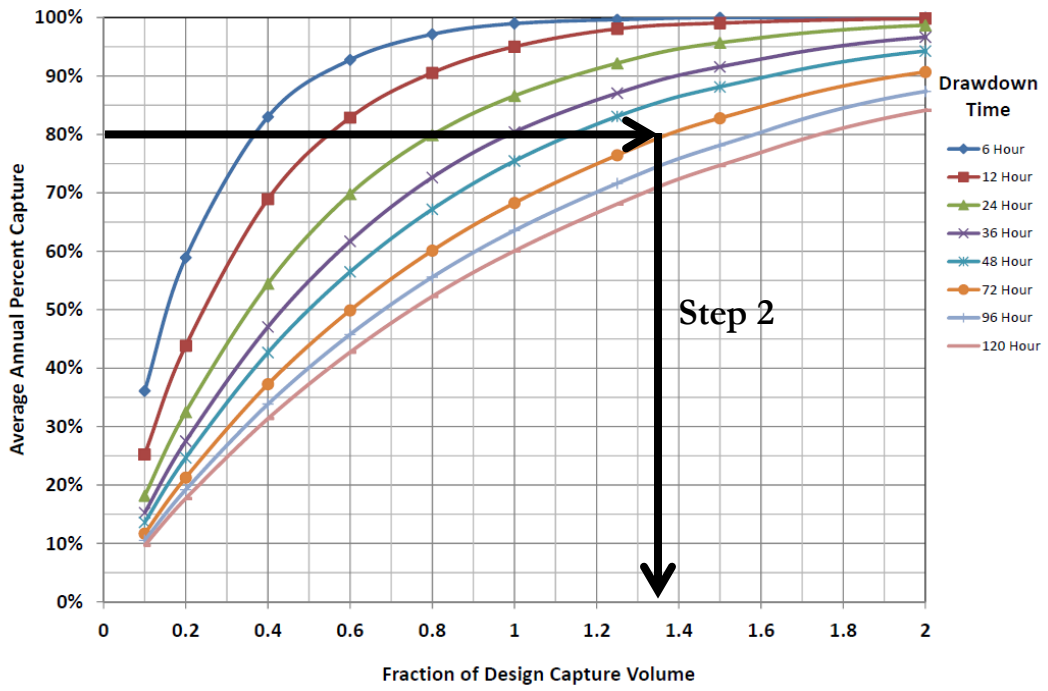
See the respective BMP facts sheets for BMP-specific instructions for the calculation of volume and drawdown time. The above method can also be used to size and/or evaluate the performance of other retention BMPs (evapotranspiration, harvest and use) that have a drawdown rate that can be approximated as constant throughout the year or over the wet season. In order to use this method for other retention BMPs, drawdown time in Step 1 will need to be evaluated using an applicable method for the type of BMP selected. After completing Step 1 continue to Step 2 listed above.

Example B.4.1.1 Percent Capture Method for Sizing a Single BMP:

Given:
• Estimated drawdown time: 72 Hours • DCV: 3000 ft^3
Required:
• Determine the volume required to achieve 80 percent capture.
Solution:
1. Estimated drawdown time = 72 Hours 2. Fraction of DCV required = 1.35 3. DCV = 3000 ft^3 (Given for this example; To be estimated using Worksheet B.2-1) 4. Required BMP volume = 1.35 x 3000 = 4050 ft^3 5. Design BMP and confirm drawdown Time is $\leq$ 90 Hours (72 Hours +25%)

Example B.4.1.1 Continued:

Graphical Operations Supporting Solution:



Percent Capture Nomograph

B.4.1.2 Stepwise Instructions for sizing BMPs in series:

For projects where BMPs in series have to be implemented to meet the performance standard the following stepwise procedure must be used to size the downstream BMP to achieve the 80 percent capture performance criterion:

1. Using the upstream BMP parameters (volume and drawdown time) estimate the average annual capture efficiency achieved by the upstream BMP using the nomograph.
2. Estimate the drawdown time of the proposed downstream BMP by estimating the design infiltration rate (Worksheet D.5-1) and accounting for BMP dimensions/geometry. See the applicable BMP Fact Sheet for specific guidance on how to convert BMP geometry to estimated drawdown time. Use the nomograph and locate where the line corresponding to the estimated drawdown time intersects with 80 percent capture. Pivot to the horizontal axis and read the fraction of the DCV that needs to be provided in the BMP. This is referred to as X_1.
3. Trace a horizontal line on the nomograph using the capture efficiency of the upstream BMP estimated in Step 1. Find where the line traced intersects with the drawdown time of the downstream BMP (Step 2). Pivot and read down to the horizontal axis to yield the fraction of the DCV already provided by the upstream BMP. This is referred to as X_2.

4. Subtract X_2 (Step 3) from X_1 (Step 2) to determine the fraction of the design volume that must be provided in the downstream BMP to achieve 80 percent capture to meet the performance standard.
5. Multiply the result of Step 4 by the DCV. This is the required downstream BMP design volume.
6. Design the BMP to retain the required volume, and confirm that the drawdown time is no more than 25 percent greater than estimated in Step 2. If the computed drawdown time is greater than 125 percent of the estimated drawdown, then return to Step 2 and revise the initial drawdown time assumption.

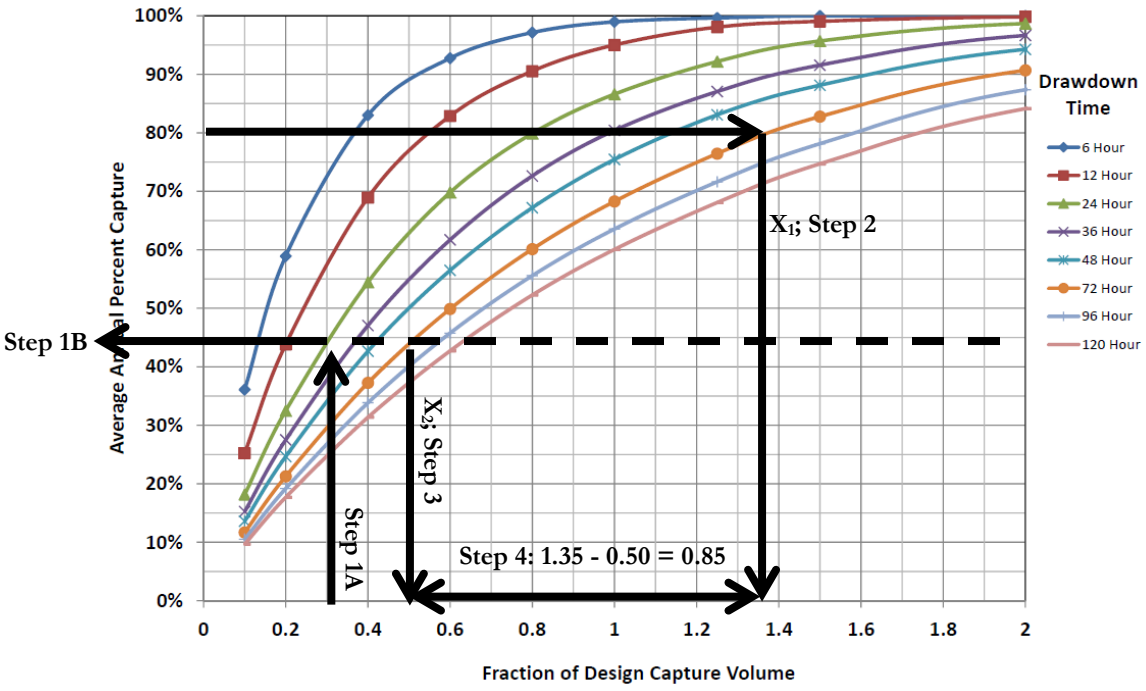
See the respective BMP facts sheets for BMP-specific instructions for the calculation of volume and drawdown time.

Example B.4.1.2 Percent Capture Method for Sizing BMPs in Series:

Given:
• Estimated drawdown time for downstream BMP: 72 Hours • DCV for the area draining to the BMP: 3000 ft^3 • Upstream BMP volume: 900 ft^3 • Upstream BMP drawdown time: 24 Hours
Required:
• Determine the volume required in the downstream BMP to achieve 80 percent capture.
Solution:
1. Step 1A: Upstream BMP Capture Ratio = 900/3000 = 0.3; Step 1B: Average annual capture efficiency achieved by upstream BMP = 44% 2. Downstream BMP drawdown = 72 hours; Fraction of DCV required to achieve 80% capture = 1.35 3. Locate intersection of design capture efficiency and drawdown time for upstream BMP (See Graph); Fraction of DCV already provided (X_2) = 0.50 (See Graph) 4. Fraction of DCV Required by downstream BMP = 1.35-0.50 = 0.85 5. DCV (given) = 3000 ft^3 ; Required downstream BMP volume = 3000 ft^3 x 0.85 = 2,550 ft^3 6. Design BMP and confirm drawdown Time is $\leq$ 90 Hours (72 Hours +25%)

Example B.4.1.2 Continued:

Graphical Operations Supporting Solution:



Percent Capture Nomograph

B.4.2 Technical Basis for Equivalent Sizing Methods

Storm water BMPs can be conceptualized as having a storage volume and a treatment rate, in various proportions. Both are important in the long-term performance of the BMP under a range of actual storm patterns, depths, and inter-event times. Long-term performance is measured by the operation of a BMP over the course of multiple years, and provides a more complete metric than the performance of a BMP during a single event, which does not take into account antecedent conditions, including multiple storms arriving in short timeframes. A BMP that draws down more quickly would be expected to capture a greater fraction of overall runoff (i.e., long-term runoff) than an identically sized BMP that draws down more slowly. This is because storage is made available more quickly, so subsequent storms are more likely to be captured by the BMP. In contrast a BMP with a long drawdown time would stay mostly full, after initial filling, during periods of sequential storms. The volume in the BMP that draws down more quickly is more "valuable" in terms of long term performance than the volume in the one that draws down more slowly. The MS4 permit definition of the DCV does not specify a drawdown time, therefore the definition is not a complete indicator of a BMP's level of performance. An accompanying performance-based expression of the

BMP sizing standard is essential to ensure uniformity of performance across a broad range of BMPs and helps prevents BMP designs from being used that would not be effective.

An evaluation of the relationships between BMP design parameters and expected long term capture efficiency has been conducted to address the needs identified above. Relationships have been developed through a simplified continuous simulation analysis of precipitation, runoff, and routing, that relate BMP design volume and storage recovery rate (i.e., drawdown time) to an estimated long term level of performance using United States Environmental Protection Agency (USEPA) SWMM and parameters listed in Appendix G for Lake Wohlford, Lindbergh, and Oceanside rain gages. Comparison of the relationships developed using the three gages indicated that the differences in relative capture estimates are within the uncertainties in factors used to develop the relationships. For example, the estimated average annual capture for the BMP sized for the DCV and 36 hour drawdown using Lake Wohlford, Lindbergh, and Oceanside are 80%, 76% and 83% respectively. In an effort to reduce the number of curves that are made available, relationships developed using Lake Wohlford are included in this manual for use in the whole San Diego County region.

Figure B.4-1 demonstrated that a BMP sized for the runoff volume from the 85th percentile, 24-hour storm event (i.e., the DCV), which draws down in 36 hours is capable of managing approximately 80 percent of the average annual. There is long precedent for 80 percent capture of average annual runoff as approximately the point at which larger BMPs provide decreasing capture efficiency benefit (also known as the "knee of the curve") for BMP sizing. The characteristic shape of the plot of capture efficiency versus storage volume in Figure B.4-1 illustrates this concept.

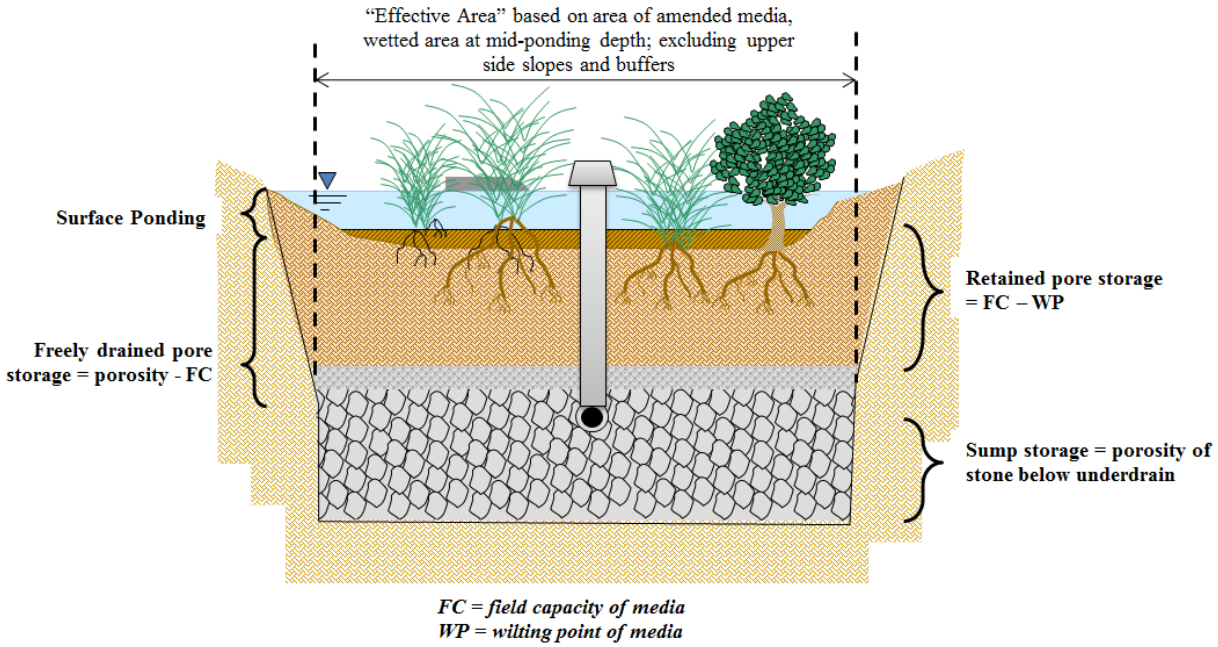
As such, this equivalency (between DCV draw down in 36-hours and 80 percent capture) has been utilized to provide a common currency between volume-based BMPs with a wide range of drawdown rates. This approach allows flexibility in the design of BMPs while ensuring consistent performance.

B.5 Biofiltration BMPs

Biofiltration BMPs must be sized by one of the following sizing methods:

Option 1: Treat 1.5 times the portion of the DCV not reliably retained onsite, OR

Option 2: Treat 1.0 times the portion of the DCV not reliably retained onsite; and additionally check that the system has a total static (i.e., non-routed) storage volume, including pore spaces and pre-filter detention volume, equal to at least 0.75 times the portion of the DCV not reliably retained onsite.



Explanation of Biofiltration Volume Compartments for Sizing Purposes

When using sizing option 1 a routing period of 6 hours is allowed. The routing period was estimated based on 50th percentile storm duration for storms similar to 85th percentile rainfall depth. It was estimated based on inspection of continuous rainfall data from Lake Wohlford, Lindbergh and Oceanside rain gages.

Worksheet B.5-1 on the following page provides a sizing method for biofiltration BMPs that do not incorporate any elements of retention. Alternatively Worksheet B.5-2 provides a sizing method for partial retention BMPs that incorporate elements of both retention and biofiltration. These worksheets require basic inputs for tributary and BMP characteristics and provide standardized calculations to determine associated drawdown times, biofiltration volumes, infiltration volumes, and BMP effectiveness. The result of these worksheets is a "deficit of effectively treated storm water". BMPs that are in compliance with performance standards have a deficit of zero. BMPs with a negative deficit value are not in compliance with performance standards and must be redesigned or augmented with flow-thru treatment and mitigated for through an offsite alternative compliance project.

Worksheet B.5-1: Sizing Biofiltration BMPs

Category	#	Description	Value	Units
BMP Inputs	0	Drainage Basin ID or Name		unitless
	1	Effective Tributary Area		sq-ft
	2	Minimum Biofiltration Footprint Sizing Factor		ratio
	3	Design Capture Volume Tributary to BMP		cubic-feet
	4	Provided Biofiltration Surface Area		sq-ft
	5	Provided Surface Ponding Depth		inches
	6	Provided Soil Media Thickness		inches
	7	Provided Gravel Storage Thickness		inches
	8	Hydromodification Orifice Diameter of Underdrain		inches
Biofiltration Calculations	9	Max Hydromod Flow Rate through Underdrain		CFS
	10	Max Soil Filtration Rate Allowed by Underdrain Orifice		in/hr
	11	Soil Media Filtration Rate	5.00	in/hr
	12	Soil Media Filtration Rate to be used for Sizing		in/hr
	13	Depth Biofiltered Over 6 Hour Storm		inches
	14	Soil Media Pore Space	0.30	unitless
	15	Gravel Pore Space	0.40	unitless
	16	Effective Depth of Biofiltration Storage		inches
	17	Drawdown Time for Surface Ponding		hours
	18	Drawdown Time for Entire Biofiltration Basin		hours
	19	Total Depth Biofiltered		inches
	20	Option 1 - Biofilter 1.50 DCV: Target Volume		cubic-feet
	21	Option 1 - Provided Biofiltration Volume		cubic-feet
	22	Option 2 - Store 0.75 DCV: Target Volume		cubic-feet
	23	Option 2 - Provided Storage Volume		cubic-feet
	24	Percentage of Performance Requirement Satisfied		ratio
Result	25	**Deficit of Effectively Treated Stormwater**		cubic-feet

Worksheet B.5-1 General Notes:

A. Applicants may use this worksheet to size Lined Biofiltration BMPs (BF-1). Applicants must provide inputs for yellow shaded cells and calculate appropriate values for unshaded cells. Notes corresponding with each line item are provided below. An automated version of this worksheet is available for download at the County of San Diego Department of Public Works website.

Worksheet B.5-1 Line Item Notes:

0. User Input from stormwater plans
1. Populated per result of Worksheet B.1-1
2. Populated per result of Worksheet B.5-3 Default is 0.030.
3. Populated per result of Worksheet B.1-1
4. User Input, must satisfy minimum sizing factor specified in Line 2.
5. User Input
6. User Input, 18 inches minimum
7. User Input, use a value of zero if gravel does not cover entire bottom.
8. User Input, Select n/a if no hydromodification flow control is provided
9. If flow controls are provided, calculate per orifice equation: $Q=CA\sqrt{2gh}$
10. If flow controls are provided, calculate as [(Line 9 x 12 x 3600)/Line 4]
11. Default = 5.00
12. Minimum of Line 10 or Line 11
13. [Line 12 x 6 Hours]
14. Default = 0.30 for Biofiltration-Only BMPs
15. Default = 0.40
16. [Line 5 + (Line 6 x Line 14) + (Line 7 x Line 15)]
17. [Line 5 / Line 12]
18. [Line 16 / Line 12]
19. [Line 13 + Line 16]
20. [1.50 x Line 3]
21. [Minimum of Line 20 or [(Line 19/12) x Line 4]]
22. [0.75 x Line 3]
23 [Minimum of Line 22 or [(Line 16/12) x Line 4]]
24. [Maximum of (Line 21/Line 20) or (Line 23/Line 22)]
25. [Line 3 x Line 24] - Line 3

Worksheet B.5-2: Sizing Partial Retention BMPs

Category	#	Description	Value	Units
BMP Inputs	0	Drainage Basin ID or Name		sq-ft
	1	Effective Tributary Area		sq-ft
	2	Minimum Biofiltration Footprint Sizing Factor		ratio
	3	Design Capture Volume Tributary to BMP		cubic-feet
	4	Provided Partial Retention BMP Surface Area		sq-ft
	5	Provided Surface Ponding Depth		inches
	6	Provided Soil Media Thickness		inches
	7	Provided Depth of Gravel Above Underdrain Invert		inches
	8	Hydromodification Orifice Diameter of Underdrain		inches
	9	Provided Depth of Gravel Below the Underdrain		inches
	10	Native Soil Infiltration Rate		in/hr
Retention Calculations	11	Volume Infiltrated Over 6 Hour Storm		cubic-feet
	12	Soil Media Pore Space Available for Retention	0.10	unitless
	13	Gravel Pore Space Available for Retention	0.40	unitless
	14	Effective Retention Depth		inches
	15	Calculated Drawdown for Gravel Below Underdrain (Including 6 Hr Storm)		hours
	16	Volume Retained by BMP		cubic-feet
	17	Fraction of DCV Retained		ratio
	18	Portion of Retention Performance Standard Satisfied		ratio
	19	Equivalent Fraction of DCV Retained with 36-hr Drawdown		ratio
	20	Design Capture Volume Remaining for Biofiltration		cubic-feet
Biofiltration Calculations	21	Max Hydromod Flow Rate through Underdrain		CFS
	22	Max Soil Filtration Rate Allowed by Underdrain Orifice		in/hr
	23	Soil Media Filtration Rate per Specifications	5.00	in/hr
	24	Soil Media Filtration Rate to be used for Sizing		in/hr
	25	Depth Biofiltered Over 6 Hour Storm		inches
	26	Soil Media Pore Space Available for Biofiltration	0.20	unitless
	27	Effective Depth of Biofiltration Storage		inches
	28	Drawdown Time for Surface Ponding		hours
	29	Drawdown Time for Effective Biofiltration Depth		hours
	30	Total Depth Biofiltered		inches
	31	Option 1 - Biofilter 1.50 DCV: Target Volume		cubic-feet
	32	Option 1 - Provided Biofiltration Volume		cubic-feet
	33	Option 2 - Store 0.75 DCV: Target Volume		cubic-feet
	34	Option 2 - Provided Storage Volume		cubic-feet
	35	Portion of Biofiltration Performance Standard Satisfied		ratio
Result	36	Overall Portion of Performance Standard Satisfied		ratio
	37	**Deficit of Effectively Treated Stormwater**		cubic-feet

Worksheet B.5-2 General Notes:

A. Applicants may use this worksheet to size Partial Retention BMPs (PR-1). Applicants must provide inputs for yellow shaded cells and calculate appropriate values for unshaded cells. Notes corresponding with each line item are provided on the following page. An automated version of this worksheet is available for download at the County of San Diego Department of Public Works website.

Worksheet B.5-2 Line Item Notes:

0. User Input from stormwater plans
1. Populated per result of Worksheet B.1-1
2. Populated per result of Worksheet B.5-3. Default is 0.030.
3. Populated per result of Worksheet B.1-1
4. User Input, must satisfy minimum sizing factor specified in Line 2.
5. User Input
6. User Input, 18 inches minimum
7. User Input, use a value of zero if gravel does not cover entire bottom.
8. User Input, select n/a if no hydromodification flow control is provided
9. User Input
10. User Input from Worksheet D.5-1
11. Minimum of Line 3 or [Line 4 x (Line 10/12) x 6.00]
12. Default = 0.10 for Retention Portion of Partial Retention BMP
13. Default = 0.40
14. (Line 6 x Line 12)+ (Line 9 x Line 13)
15. [(Line 9 x Line 13) / Line 10] + 6.0. If this equals 6 (ET only) use 36 hours.
16. [(Line 14/12) x Line 4] + Line 11
17. [Line 16/Line 3]
18. Look up value from Retention Percent Capture Curves, Maximum of 1.00.
19. Look up value from Retention Provided Capture Curves, Maximum of 1.00.
20. [Line 3 x (1.00 - Line 19)]
21. If flow controls are provided, calculate per orifice equation: $Q=CA\sqrt{2gh}$
22. If flow controls are provided, calculate as [(Line 21 x 12 x 3600)/Line 4]
23. Default = 5.00
24. Minimum of Line 22 or Line 23
25. [Line 24 x 6]
26. Default = 0.20 for Biofiltration Portion of Partial Retention BMP
27. [Line 5 + (Line 6 x Line 26) + (Line 7 x Line 13)]
28. Minimum of [Line 5/5.00] or [Line 5/(Line 10+ Line 24)]
29. Minimum of [Line 27/5.00] or [Line 27/(Line 10 + Line 24)]
30. [Line 25 + Line 27]
31. [1.50 x Line 20]
32. [Minimum of Line 31 or [(Line 30/12) x Line 4]]
33. [0.75 x Line 20]
34. [Minimum of Line 33 or [(Line 27/12) x Line 3]]
35. [Maximum of (Line 32/Line 31) or (Line 34/Line 33)]
36. [Line 18 + Line 35]. Maximum of 1.00.
37. [Line 36 x Line 3] - Line 3

B.5.1 Basis for Minimum Sizing Factor for Biofiltration BMPs

B.5.1.1 Introduction

MS4 Permit Provision E.3.c.(1)(a)(i)

The MS4 Permit describes conceptual performance goals for biofiltration BMPs and specifies numeric criteria for sizing biofiltration BMPs (See Section 2.2.1 of this Manual).

However, the MS4 Permit does not define a specific footprint sizing factor or design profile that must be provided for the BMP to be considered "biofiltration." Rather, the MS4 Permit specifies (Footnote 25):

> **As part of the Copermittee's update to its BMP Design Manual, pursuant to Provision E.3.d, the Copermittee must provide guidance for hydraulic loading rates and other biofiltration design criteria necessary to maximize storm water retention and pollutant removal.**

To meet this provision, this manual includes specific criteria for design of biofiltration BMPs. Among other criteria, a minimum footprint sizing factor of 3 percent (BMP footprint area as percent of contributing area times adjusted runoff factor) is specified. The purpose of this section is to provide the technical rationale for this 3 percent minimum sizing factor.

B.5.1.2 Conceptual Need for Minimum Sizing Factor

Under the 2011 Model SUSMP, a sizing factor of 4 percent was used for sizing biofiltration BMPs. This value was derived based on the goal of treating the runoff from a 0.2 inch per hour uniform precipitation intensity at a constant media flow rate of 5 inches per hour. While this method was simple, it was considered to be conservative as it did not account for significant transient storage present in biofiltration BMPs (i.e., volume in surface storage and subsurface storage that would need to fill before overflow occurred). Under this manual, biofiltration BMPs will typically provide subsurface storage to promote infiltration losses; therefore typical BMP profiles will tend to be somewhat deeper than those provided under the 2011 Model SUSMP. A deeper profile will tend to provide more transient storage and allow smaller footprint sizing factors while still providing similar or better treatment capacity and pollutant removal. Therefore a reduction in the minimum sizing factor from the factor used in the 2011 Model SUSMP is supportable. However, as footprint decreases, issues related to potential performance, operations, and/or maintenance can increase for a number of reasons:

1) As the surface area of the media bed decreases, the sediment loading per unit area increases, increasing the risk of clogging. While vigorous plant growth can help maintain permeability

of soil, there is a conceptual limit above which plants may not be able to mitigate for the sediment loading. Scientific knowledge is not conclusive in this area.

2) With smaller surface areas and greater potential for clogging, water may be more likely to bypass the system via overflow before filling up the profile of the BMP.
3) As the footprint of the system decreases, the amount of water that can be infiltrated from subsurface storage layers and evapotranspire from plants and soils tends to decrease.
4) With smaller sizing factors, the hydraulic loading per unit area increases, potentially reducing the average contact time of water in the soil media and diminishing treatment performance.

The MS4 Permit requires that volume and pollutant retention be maximized. Therefore, a minimum sizing factor was determined to be needed. This minimum sizing factor does not replace the need to conduct sizing calculations as described in this manual; rather it establishes a lower limit on required size of biofiltration BMPs as the last step in these calculations. Additionally, it does not apply to alternative biofiltration designs that utilize the checklist in Appendix F (Biofiltration Standard and Checklist). Acceptable alternative designs (such as proprietary systems meeting Appendix F criteria) typically include design features intended to allow acceptable performance with a smaller footprint and have undergone field scale testing to evaluate performance and required O&M frequency.

B.5.1.3 Lines of Evidence to Select Minimum Sizing Factor

Three primary lines of evidence were used to select the minimum sizing factor of 3 percent (BMP footprint area as percent of contributing area times adjusted runoff factor) in this manual:

1. Typical design calculations.
2. Sediment clogging calculations.

These lines of evidence and associated findings are explained below.

Typical Design Calculations

A range of BMP profiles were evaluated for different design rainfall depths and soil conditions. Worksheet B.5-1 was used for each case to compute the required footprint sizing factor. For these calculations, the amount of water filtered during the storm event was determined based on a media filtration rate of 5 inches per hour and a routing time of 6 hours. These input assumptions are considered to be well-supported and consistent with the intent of the MS4 Permit. These calculations generally yielded footprint sizing factors between 1.5 and 4.9 percent. In the interest of establishing a uniform County-wide minimum sizing factor, a 3 percent sizing factor was selected from this range, consistent with other lines of evidence.

Sediment Clogging Calculations

As sediment accumulates in a filter, the permeability of the filter tends to decline. The lifespan of the filter bed can be estimated by determining the rate of sediment loading per unit area of the filter bed. To determine the media bed surface area sizing factor needed to provide a target lifespan, simple sediment loading calculations were conducted based on typical urban conditions. The inputs and

results of this calculation are summarized in Table B.5-1.

Table B.5-1: Inputs and Results of Clogging Calculation

Parameter	Value	Source
Representative TSS Event Mean Concentration, mg/L	100	Approximate average of San Diego Land Use Event Mean Concentrations from San Diego River and San Luis Rey River WQIP
Runoff Coefficient of Impervious Surface	0.90	Table B.1-1
Runoff Coefficient of Pervious Surface	0.10	Table B.1-1 for landscape areas
Imperviousness	40% to 90%	Planning level assumption, covers typical range of single family to commercial land uses
Average Annual Precipitation, inches	11 to 13	Typical range for much of urbanized San Diego County
Load to Initial Maintenance, kg/m^2	10	Pitt, R. and S. Clark, 2010. Evaluation of Biofiltration Media for Engineered Natural Treatment Systems.
Allowable period to initial clogging, yr	10	Planning-level assumption
Estimated BMP Footprint Needed for 10-Year Design Life	2.8 to 3.3%	Calculated

This analysis suggests that a 3 percent sizing factor, coupled with sediment source controls and careful system design, should provide reasonable protection against premature clogging. However, there is substantial uncertainty in sediment loading and the actual load to clog that will be observed under field conditions in the San Diego climate. Additionally this analysis did not account for the effect of plants on maintaining soil permeability. Therefore this line of evidence should be considered provisional, subject to refinement based on field scale experience. As field scale experience is gained about the lifespan of biofiltration BMPs in San Diego and the mitigating effects of plants on long term clogging, it may be possible to justify lower factors of safety and therefore smaller design sizes in some cases. If a longer lifespan is desired and/or greater sediment load is expected, then a larger sizing factor may be justified.

B.5.1.4 Discussion

Generally, the purpose of a minimum sizing factor is to help improve the performance and reliability of standard biofiltration systems and limit the use of sizing methods and assumptions that may lead to designs that are less consistent with the intent of the MS4 Permit.

Ultimately, this factor is a surrogate for a variety of design considerations, including clogging and associated hydraulic capacity, volume reduction potential, and treatment contact time. A prudent design approach should consider each of these factors on a project-specific basis and identify whether site conditions warrant a larger or smaller factor. For example a system treating only rooftop runoff in an area without any allowable infiltration may have negligible clogging risk and negligible volume reduction potential – a smaller sizing factor may not substantially reduce

performance in either of these areas. Alternatively, for a site with high sediment load and limited pre-treatment potential, a larger sizing factor may be warranted to help mitigate potential clogging risks. County staff has discretion to accept alternative sizing factor(s) based on project-specific or jurisdiction-specific considerations. Additionally, the recommended minimum sizing factor may change over time as more experience with biofiltration is obtained.

Worksheet B.5-3 on the following page must be used to support a request for an alternative minimum footprint sizing factor. Based on a review of the submitted worksheet and supporting documentation, the use of a smaller footprint sizing factor may be approved at the discretion of County staff..

This worksheet includes the following general steps to calculate the minimum footprint sizing factor:

- Select a "load to clog" that is representative of the type of BMP proposed
- Select a target life span (i.e., frequency of major maintenance) that is acceptable to County staff. A default value of 10 years is recommended.
- Compile information about the DMA from other parts of the SWQMP development process.
- Determine the event mean concentration (EMC) of TSS that is appropriate for the DMA
- Perform calculations to determine the minimum footprint to provide the target lifespan.

Worksheet B.5-3: Alternate Minimum Biofiltration Footprint Ratio

Category	#	Description	Value	Units
Drainage Basin Inputs (Optional)	0	Drainage Basin ID or Name		unitless
	1	Total Tributary Area		sq-ft
	2	Final Adjusted Runoff Factor		unitless
	3	Average Annual Precipitation		inches
	4	Load to Clog (default =2.0)		lb/sq-ft
	5	Allowable Period to Accumulate Clogging Load (default =10)		years
	6	Pretreatment Measures Included?		yes/no
	7	Commercial: TSS=128 mg/L, C= 0.80		sq-ft
	8	Education: TSS=132 mg/L, C= 0.50		sq-ft
	9	Industrial: TSS=125 mg/L, C= 0.90		sq-ft
	10	Low Traffic Areas: TSS=50 mg/L, C= 0.50		sq-ft
	11	Multi-Family Residential: TSS=40 mg/L, C= 0.60		sq-ft
	12	Roof Areas: TSS=14 mg/L, C= 0.90		sq-ft
	13	Single Family Residential: TSS=123 mg/L, C= 0.40		sq-ft
	14	Transportation: TSS=78 mg/L, C= 0.90		sq-ft
	15	Vacant/Open Space: TSS=216 mg/L, C= 0.10		sq-ft
Minimum Footprint Calculations	16	Effective-Area Based on Specified Land Use Coefficients		sq-ft
	17	Average TSS Concentration for Tributary		mg/L
	18	Effective Tributary Area		sq-ft
	19	Average Annual Runoff		cubic-feet
	20	Average Annual TSS Load		lb/yr
	21	Average Annual TSS Load After Pretreatment Measures		lb/yr
Result	22	Minimum Allowable Biofiltration Footprint Ratio		ratio

Worksheet B.5-3 General Notes:

A. Applicants may use this worksheet to calculate Alternate Minimum Biofiltration Footprint Ratio. Applicants must provide inputs for yellow shaded cells and calculate appropriate values for unshaded cells. Notes corresponding with each line item are provided on the following page. An automated version of this worksheet is available for download at the County of San Diego Department of Public Works website.

Worksheet B.5-3 Line Item Notes

0. User Input from stormwater plans
1. Automatically populated per user input on Worksheet B.1-1
2. Automatically populated per user input on Worksheet B.1-1
3. User Input
4. User Input, Default=2.0. See Table B.5-3 for guidance
5. User Input, Default=10. Provide maintenance justification if alternate value is used.
6. User Input, Default=No
7. User Input
8. User Input
9. User Input
10. User Input
11. User Input
12. User Input
13. User Input
14. User Input
15. User Input
16. ∑Lines 7-15 Area x Runoff Coefficient
17. [(∑Lines 7-15 Area x Runoff Coefficient x TSS Concentration) / Line 16]
18. Line 1 x Line 2
19. [(Line 3/12) x Line 18
20. Line 17 x 0.000062428 x Line 19
21. If Line 6=Yes, then Line 20 x 0.75. Otherwise Line 20
22. [(Line 21 x Line 5) / (Line 4 x Line 28)]. Maximum value of 0.030 is the default footprint ratio.

Table B.5-2 Typical land use total suspended solids (TSS) event mean concentration (EMC) values.

Land Use	TSS EMC[10], mg/L
Single Family Residential	123
Commercial	128
Industrial	125
Education (Municipal)	132
Transportation[11]	78
Multi-family Residential	40
Roof Runoff[12]	14
Low Traffic Areas[13]	50
Open Space	216

Table B.5-3 Guidance for Selecting Load to Clog (L_C)

BMP Configuration	Load to Clog, L_c, lb/sq-ft
Baseline: Approximately 50 percent vegetative cover; typical fine sand and compost blend	2
Baseline + increase vegetative cover to at least 75 percent	3
Baseline + include coarser sand to increase initial permeability to 20 to 30 in/hr; control flowrate with outlet control	3
Baseline + increase vegetative cover and include more permeable media with outlet control, per above	4

References

Charters, F.J., Cochrane, T.A., and O'Sullivan, A.D., (2015). Particle Size Distribution Variance in Untreated Urban Runoff and its implication on treatment selection. Water Research, 85 (2015), pg. 337-345.

[10] EMCs are from SBPAT datasets for SLR and SDR Watersheds – Arithmetic Estimates of the Lognormal Summary Statistics for San Diego, unless otherwise noted.

[11] EMCs are based on Los Angeles region default SBPAT datasets due to lack of available San Diego data.

[12] Value represents the average first flush concentration for roof runoff (Charters et al., 2015).

[13] Davis and McCuen (2005)

Davis, A.P. and McCuen, R.H., (2005). Storm Water Management for Smart Growth. Springer Science & Business Media, pg. 155.

Maniquiz-Redillas, M.C., Geronimo, F.K.F, and Kim, L-H. Investigation on the Effectiveness of Pretreatment in Storm Water Management Technologies. Journal of Environmental Sciences, 26 (2014), pg. 1824-1830.

Pitt, R. and Clark, S.E., (2010). Evaluation of Biofiltration Media for Engineered Natural Treatment Systems. Geosyntec Consultants and The Boeing Company.

B.5.2 Sizing Biofiltration BMPs Downstream of a Storage Unit

B.5.2.1 Introduction

In some cases, incorporation of upstream storage units (e.g. cisterns) may be used to regulate the flows through a downstream biofiltration BMP.

This methodology is **not** applicable when the minimum footprint factor is governed based on the alternative minimum footprint sizing factor calculated using Worksheet B.5-3.

B.5.2.2 Sizing Calculation

Sizing calculations for the biofiltration footprint must demonstrate that one of two equivalent performance standards is met:

1. Use continuous simulation and demonstrate one of the following is met based on the infiltration condition identified in Chapter 5.4.2:
    a. **No infiltration condition**: The BMP or series of BMPs biofilters at least 92 percent of average annual (long term) runoff volume. This can be demonstrated through reporting of output from the San Diego Hydrology Model, or through other continuous simulation modeling meeting the criteria in Appendix G, as acceptable to County staff. The 92 percent of average annual runoff treatment corresponds to the average capture achieved by implementing a BMP with 1.5 times the DCV and a drawdown time of 36 hours.
    b. **Partial infiltration condition**: The BMP or series of BMPs biofilters at least 92 percent of average annual (long term) runoff volume. This can be demonstrated through reporting of output from the San Diego Hydrology Model, or through other continuous simulation modeling meeting the criteria in Appendix G, as acceptable to County staff.
2. Use the simple sizing method in Worksheet B.5-4. This worksheet was developed to satisfy the following two criteria as applicable:
    a. Greater than 92 percent of the average annual runoff volume from the storage unit is routed to the biofiltration BMP through the low flow orifice and the peak flow from the low flow orifice can instantaneously be filtered through the biofiltration media. If the outlet design includes orifices at different elevations and an overflow structure, only flows from the overflow structure should be excluded from the calculation

(both for 92 percent capture and for peak flow to the biofiltration BMP that needs to be instantaneously filtered), unless the flows from other orifices also bypass the biofiltration BMP, in which case flows from the orifices that bypass should also be excluded.

Table B.5-4 Storage required for different drawdown times

Drawdown Time (hours)	Storage requirement (below the overflow elevation, or below outlet elevation that bypass the biofiltration BMP)
12	0.85 DCV
24	1.25 DCV
36	1.50 DCV
48	1.80 DCV
72	2.20 DCV
96	2.60 DCV
120	2.80 DCV

For drawdown times that are outside the range of values presented in Table B.5-4 above the storage unit should be designed to discharge greater than 92% average annual capture to the downstream Biofiltration BMP.

Worksheet B.5-4: Optimized Biofiltration BMP Footprint when Downstream of a Storage Unit

Optimized Biofiltration BMP Footprint when Downstream of a Storage Unit		Worksheet B.5-4	
1	Area draining to the storage unit and biofiltration BMP		sq-ft
2	Adjusted runoff factor for drainage area (Refer to Appendix B.1 and B.2)		
3	Effective impervious area draining to the storage unit and biofiltration BMP [Line 1 x Line 2]		sq-ft
4	Remaining DCV after implementing retention BMPs		cubic-feet
5	Infiltration rate from Worksheet D.5-1 if partial infiltration is feasible		ft/hr.
6	Media Thickness [1.5 feet minimum], also add mulch layer thickness to this line for sizing calculations		ft
7	Media filtration rate to be used for sizing (0.42 ft/hr. with no outlet control; if the filtration rate is controlled by the outlet use the outlet controlled rate)		ft/hr
8	Media retained pore storage	0.1	ft/ft
Storage Unit Requirement			
9	Drawdown time of the storage unit, minimum(from the elevation that bypasses the biofiltration BMP, overflow elevation)		hours
10	Storage required to achieve greater than 92 percent capture (see Table B.5-4)		fraction
11	Storage required in cubic feet (Line 4 x Line 10)		cubic-feet
12	Storage provided in the design, minimum(from the elevation that bypasses the biofiltration BMP, overflow elevation)		cubic-feet
13	Is Line 12 ≥ Line 11. If no increase storage provided until this criteria is met	☐ Yes	☐ No
Criteria 1: BMP Footprint Biofiltration Capacity			
14	Peak flow from the storage unit to the biofiltration BMP (using the elevation used to evaluate the percent capture)		cfs
15	Required biofiltration footprint [(3,600 x Line 14)/Line 7]		sq-ft
Criteria 2: Alternative Minimum Sizing Factor (Clogging)			
16	Alternative Minimum Footprint Sizing Factor [Worksheet B.5-3]		Fraction
17	Required biofiltration footprint [Line 3 x Line 16]		sq-ft
Optimized Biofiltration Footprint			
18	Optimized biofiltration footprint, maximum(Line 15, Line 17)		sq-ft

Note: Biofiltration BMP smaller than the alternative minimum footprint sizing (Line 17) is considered compact biofiltration BMP and may be allowed at the discretion of County staff if the BMP meets the requirements in Appendix F and Option 1 or Option 2 sizing in Worksheet B.5-1.

B.6 Flow-Thru Treatment Control BMPs (for use with Alternative Compliance)

The following methodology must be used for selecting and sizing onsite flow-thru treatment control BMPs. These BMPs are to be used only when the project is participating in an alternative compliance program. This methodology consists of three steps:

1) Determine the PDP most significant pollutants of concern (Appendix B.6.1).
2) Select a flow-thru treatment control BMP that treats the PDP most significant pollutants of concern and meets the pollutant control BMP treatment performance standard (Appendix B.6.2).
3) Size the selected flow-thru treatment control BMP (Appendix B.6.3).

B.6.1 PDP Most Significant Pollutants of Concern

The following steps must be followed to identify the PDP most significant pollutants of concern:

1) Compile the following information for the PDP and receiving water:
    a. Receiving water quality (including pollutants for which receiving waters are listed as impaired under the Clean Water Act section 303(d) List; refer to Section 1.9);
    b. Pollutants, stressors, and/or receiving water conditions that cause or contribute to the highest priority water quality conditions identified in the WQIP (refer to Section 1.9);
    c. Land use type(s) proposed by the PDP and the storm water pollutants associated with the PDP land use(s) (see Table B.6–1).
2) From the list of pollutants identified in Step 1 identify the most significant PDP pollutants of concern. A PDP could have multiple most significant pollutants of concerns and must include the highest priority water quality condition identified in the watershed WQIP and pollutants anticipated to be present onsite/generated from land use.

TABLE B.6–1: Anticipated and Potential Pollutants Generated by Land Use Type

Priority Project Categories	General Pollutant Categories								
	Sediment	Nutrients	Heavy Metals	Organic Compounds	Trash & Debris	Oxygen Demanding Substances	Oil & Grease	Bacteria & Viruses	Pesticides
Detached Residential Development	X	X			X	X	X	X	X
Attached Residential Development	X	X			X	P(1)	P(2)	P	X
Commercial Development >one acre	P(1)	P(1)	X	P(2)	X	P(5)	X	P(3)	P(5)
Heavy Industry	X		X	X	X	X	X		
Automotive Repair Shops			X	X(4)(5)	X		X		
Restaurants					X	X	X	X	P(1)
Hillside Development >5,000 ft2	X	X			X	X	X		X
Parking Lots	P(1)	P(1)	X		X	P(1)	X		P(1)
Retail Gasoline Outlets			X	X	X	X	X		
Streets, Highways & Freeways	X	P(1)	X	X(4)	X	P(5)	X	X	P(1)

X = anticipated
P = potential
(1) A potential pollutant if landscaping exists onsite.
(2) A potential pollutant if the project includes uncovered parking areas.
(3) A potential pollutant if land use involves food or animal waste products.
(4) Including petroleum hydrocarbons.
(5) Including solvents.

B.6.2 Selection of Flow-Thru Treatment Control BMPs

The following steps must be followed to select the appropriate flow-thru treatment control BMPs for the PDP:

1) For each PDP most significant pollutant of concern identify the grouping using Table B.6-2. Table B.6-2 is adopted from the Model SUSMP.

2) Select the flow-thru treatment control BMP based on the grouping of pollutants of concern that are identified to be most significant in Step 1. This section establishes the pollutant control BMP treatment performance standard to be met for each grouping of pollutants in order to meet the standards required by the MS4 permit and how an applicant can select a non-proprietary or a proprietary BMP that meets the established performance standard. The grouping of pollutants of concern are:

    a. Coarse Sediment and Trash (Appendix B.6.2.1)
    b. Pollutants that tend to associate with fine particles during treatment (Appendix B.6.2.2)
    c. Pollutants that tend to be dissolved following treatment (Appendix B.6.2.3)

TABLE B.6–2: Grouping of Potential Pollutants of Concern

Pollutant	Coarse Sediment and Trash	Suspended Sediment and Particulate-bound Pollutants[1]	Soluble-form Dominated Pollutants[2]
Sediment	X	X	
Nutrients		X	X
Heavy Metals		X	
Organic Compounds		X	
Trash & Debris	X		
Oxygen Demanding		X	
Bacteria		X	
Oil & Grease		X	
Pesticides		X	

[1] Pollutants in this category can be addressed to Medium or High effectiveness by effectively removing suspended sediments and associated particulate-bound pollutants. Some soluble forms of these pollutants will exist, however treatment mechanisms to address soluble pollutants are not necessary to remove these pollutants to a Medium or High effectiveness.

[2] Pollutants in this category are not typically addressed to a Medium or High level of effectiveness with particle and particulate-bound pollutant removal alone.

One flow-thru BMP can be used to satisfy the required pollutant control BMP treatment performance standard for the PDP most significant pollutants of concern. In some situations it

might be necessary to implement multiple flow-thru BMPs to satisfy the pollutant control BMP treatment performance standards. For example, a PDP has trash, nutrients and bacteria as the most significant pollutants of concern. If a vegetated filter strip is selected as a flow-thru BMP then it is anticipated to meet the performance standard in Appendix B.6.2.2 and B.6.2.3 but would need a trash removal BMP to meet the pollutant control BMP treatment performance standard in Appendix B.6.2.1 upstream of the vegetated filter strip. This could be achieved by fitting the inlets and/or outlets with racks or screens on to address trash.

B.6.2.1 Coarse Sediment and Trash

If coarse sediment and/or trash and debris are identified as a pollutant of concern for the PDP, then BMPs must be selected to capture and remove these pollutants from runoff. The BMPs described below can be effective in removing coarse sediment and/or trash. These devices must be sized to treat the flow rate estimated using Worksheet B.6-1. Applicant can only select BMPs that have High or Medium effectiveness.

Trash Racks and Screens [Coarse Sediment: Low effectiveness; Trash: Medium to High effectiveness] are simple devices that can prevent large debris and trash from entering storm drain infrastructure and/or ensure that trash and debris are retained with downstream BMPs. Trash racks and screens can be installed at inlets to the storm drain system, at the inflow line to a BMP, and/or on the outflow structure from the BMP. Trash racks and screens are commercially available in many sizes and configurations or can be designed and fabricated to meet specific project needs.

Hydrodynamic Separation Devices [Coarse Sediment: Medium to High effectiveness; Trash: Medium to High effectiveness] are devices that remove coarse sediment, trash, and other debris from incoming flows through a combination of screening, settlement, and centrifugal forces. The design of hydrodynamic devises varies widely, more specific information can be found by contacting individual vendors. A list of hydrodynamic separator products approved by the Washington State Technology Acceptance Protocol-Ecology protocol can be found at:

http://www.ecy.wa.gov/programs/wq/storm water/newtech/technologies.html.

Systems should be rated for "pretreatment" with a General Use Level Designation or provide results of field-scale testing indicating an equivalent level of performance.

Catch Basin Insert Baskets [Coarse Sediment: Low effectiveness; Trash: Medium effectiveness, if appropriately maintained] are manufactured filters, fabrics, or screens that are placed in inlets to remove trash and debris. The shape and configuration of catch basin inserts varies based on inlet type and configuration. Inserts are prone to clogging and bypass if large trash items are accumulated, and therefore require frequent observation and maintenance to remain effective. Systems with screen size small enough to retain coarse sediment will tend to clog rapidly and should be avoided.

Other Manufactured Particle Filtration Devices [Coarse Sediment: Medium to High effectiveness; Trash: Medium to High effectiveness] include a range of products such as cartridge filters, bag filters, and other configurations that address medium to coarse particles. Systems should be rated for "pretreatment" with a General Use Level Designation under the Technology Acceptance Protocol-Ecology program or provide results of field-scale testing indicating an equivalent level of performance.

Note, any BMP that achieves Medium or High performance for suspended solids (See Section B.6.2.2) is also considered to address coarse sediments. However, some BMPs that address suspended solids do not retain trash (for example, swales and detention basins). These types of BMPs could be fitted with racks or screens on inlets or outlets to address trash.

BMP Selection for Pretreatment:

Devices that address both coarse sediment and trash can be used as pretreatment devices for other BMPs, such as infiltration BMPs. However, it is recommended that BMPs that meet the performance standard in Appendix B.6.2.2 be used. A device with a "pretreatment" rating and General Use Level Designation under Technology Acceptance Protocol-Ecology is required for pretreatment upstream of infiltration basins and underground galleries. Pretreatment may also be provided as presettling basins or forebays as part of a pollutant control BMP instead of implementing a specific pretreatment device for systems where maintenance access to the facility surface is possible (to address clogging), expected sediment load is not high, and appropriate factors of safety are included in design.

B.6.2.2 Suspended Sediment and Particulate-Bound Pollutants

Performance Standard

The pollutant treatment performance standard is shown in Table B.6-3. This performance standard is consistent with the Washington State Technology Acceptance Protocol-Ecology Basic Treatment Level, and is also met by technologies receiving Phosphorus Treatment or Enhanced Treatment certification. This standard is based on pollutant removal performance for total suspended solids. Systems that provide effective TSS treatment also typically address trash, debris, and particulate bound pollutants and can serve as pre-treatment for offsite mitigation projects or for onsite infiltration BMPs.

Table B.6-3: Performance Standard for Flow-Thru Treatment Control

Influent Range	Criteria
20 – 100 mg/L TSS	Effluent goal ≤ 20 mg/L TSS
100 – 200 mg/L TSS	≥ 80% TSS removal
>200 mg/L TSS	> 80% TSS removal

Selecting Non-Proprietary BMPs

Table B.6-4 identifies the categories of non-proprietary BMPs that are considered to meet the pollutant treatment performance standard if designed to contemporary design standards[14]. BMP types with an "High" ranking should be considered before those with an "Medium" ranking. Statistical analysis by category from the International Storm Water BMP Database (also presented in Table B.6-4) indicates each of these BMP types (as a categorical group) meets or nearly meets the performance standard. The International Storm Water BMP Database includes historic as well as contemporary BMP studies; contemporary BMP designs in these categories are anticipated to meet or exceed this standard on average.

[14] Contemporary design standards refers to design standards that are reasonably consistent with the current state of practice and are based on desired outcomes that are reasonably consistent with the context of the MS4 Permit and this manual. For example, a detention basin that is designed solely to mitigate peak flow rates would not be considered a contemporary water quality BMP design because it is not consistent with the goal of water quality improvement. Current state of the practice recognizes that a drawdown time of 24 to 72 hours is typically needed to promote settling. For practical purposes, design standards can be considered "contemporary" if they have been published within the last 10 years, preferably in California or Washington State, and are specifically intended for storm water quality management.

Table B.6-4: Flow-Thru Treatment Control BMPs Meeting Performance Standard

List of Acceptable Flow-Thru Treatment Control BMPs	Statistical Analysis of International Storm Water BMP Database				Evaluation of Conformance to Performance Standard		
	Count In/Out	TSS Mean Influent, mg/L	TSS Mean Effluent[1], mg/L	Average Category Volume Reduct.	Volume-Adjusted Effluent Conc[2], mg/L	Volume-Adjusted Removal Efficiency[2]	Level of Attainment of Performance Standard (with rationale)
Vegetated Filter Strip	361/ 282	69	31	38%	19	72%	Medium, effluent < 20 mg/L after volume adjustment
Vegetated Swale	399/ 346	45	33	48%	17	61%	Medium, effluent < 20 mg/L after volume adjustment
Detention Basin	321/ 346	125	42	33%	28	77%	Medium, percent removal near 80% after volume adjustment
Sand Filter/ Media Bed Filter	381/ 358	95	19	NA[3]	19	80%	High, effluent and % removal meet criteria without adjustment
Lined Porous Pavement[4]	356/ 220	229	46	NA[3,4]	46	80%	High, % removal meets criteria without adjustment
Wet Pond	923/ 933	119	31	NA[3]	31	74%	Medium, percent removal near 80%

Source: 2014 BMP Performance Summaries and Statistical Appendices; 2010 Volume Performance Summary; available at: www.bmpdatabase.org

1 - A statistically significant difference between influent and effluent was detected at a p value of 0.05 for all categories.

2 - Estimates were adjusted to account for category-average volume reduction.

3 - Not Applicable as these BMPs are not designed for volume reduction and are anticipated to have very small incidental volume reduction.

4 - The category presented in this table represents a lined system for flow-thru treatment purposes. Porous pavement for retention purposes is an infiltration BMP, not a flow-thru BMP. This table should not be consulted for porous pavement for infiltration.

Selecting Proprietary BMPs

Proprietary BMPs can be used if the BMP meets each of the following conditions:

(1) The proposed BMP meets the performance standard in Appendix B.6.2.2 as certified through third-party, field scale evaluation. An active General Use Level Designation for Basic Treatment, Phosphorus Treatment or Enhanced Treatment under the Washington State Technology Acceptance Protocol-Ecology program is the preferred method of demonstrating that the performance standard is met. The list of certified technologies is updated as new technologies are approved (link below). Technologies with Pilot Use Level Designation and Conditional Use Level Designations are not acceptable. Refer to:

http://www.ecy.wa.gov/programs/wq/stormwater/newtech/technologies.html. Alternatively, other field scale verification of 80 percent TSS capture, such as through Technology Acceptance Reciprocity Partnership or New Jersey Corporation for Advance Testing may be acceptable. A list of field-scale verified technologies under Technology Acceptance Reciprocity Partnership Tier II and New Jersey Corporation for Advance Testing can be accessed at: http://www.njcat.org/verification-process/technology-verification-database.html (refer to field verified technologies only).

(2) The proposed BMP is designed and maintained in a manner consistent with its performance certifications (see explanation below). The applicant must demonstrate conclusively that the proposed application of the BMP is consistent with the basis of its certification/verification. Certifications or verifications issued by the Washington Technology Acceptance Protocol-Ecology program and the Technology Acceptance Reciprocity Partnership or New Jersey Corporation for Advance Testing programs are typically accompanied by a set of guidelines regarding appropriate design and maintenance conditions that would be consistent with the certification/verification. It is common for these approvals to specify the specific model of BMP, design capacity for given unit sizes, type of media that is the basis for approval, and/or other parameters.

(3) The proposed BMP is acceptable at the discretion of the County. The applicant may be required to provide additional studies and/or required to meet additional design criteria beyond the scope of this document in order to demonstrate that these criteria are met. While the County has no obligation to accept the use of any proposed proprietary BMP, applicants will be provided a written explanation describing the rationale for the rejection of any proposed devices.

B.6.2.3 Soluble-form dominated Pollutants (Nutrients)

If nutrients are identified as a most significant pollutant of concern for the PDP, then BMPs must be selected to meet the performance standard described in Appendix B.6.2.2 **and** must be selected to provide medium or high level of effectiveness for nutrient treatment as described in this section. The most common nutrient of concern in the San Diego region is nitrogen, therefore total nitrogen (TN) was used as the primary indicator of nutrient performance in storm water BMPs.

Selection of BMPs to address nutrients consists of two steps:

1) Determine if nutrients can be addressed via source control BMPs as described in Appendix E and Chapter 4. After applying source controls, if there are no remaining source areas for soluble nutrients, then this pollutant can be removed from the list of pollutants of concerns for the purpose of selecting flow-thru treatment control BMPs. Particulate nutrients will be addressed by the performance standard in Appendix B.6.2.2.

2) If soluble nutrients cannot be fully addressed with source controls, then select a flow-thru treatment control BMPs that meets the performance criteria in Table B.6-5 or select from

the nutrient-specific menu of treatment control BMPs in Table B.6-6.

a. The performance standard for nitrogen removal (Table B.6-5) has been developed based on evaluation of the relative performance of available categories of non-proprietary BMPs.

b. For proprietary BMPs, submit third party performance data indicating that the criteria in Table B.6-5 are met. The applicant may be required to provide additional studies and/or required to meet additional design criteria beyond the scope of this document in order to demonstrate that these criteria are met. While the County has no obligation to accept the use of any proposed proprietary flow-thru BMP, applicants will be provided a written explanation describing the rationale for the rejection of any proposed devices.

Table B.6-5: Performance Standard for Flow-Thru Treatment Control BMPs for Nutrient Treatment

Basis	Criteria
Treatment Basis	Comparison of mean influent and effluent indicates significant concentration reduction of TN approximately 40 percent or higher based on studies with representative influent concentrations
Combined Treatment and Volume Reduction Basis	Combination of concentration reduction and volume reduction yields TN mass removal of approximately 40 percent or higher based on studies with representative influent concentrations

Table B.6-6: Flow-Thru Treatment Control BMPs Meeting Nutrient Treatment Performance Standard

List of Acceptable Flow-Thru Treatment Control BMPs for Nutrients	Statistical Analysis of International Storm Water BMP Database				Evaluation of Conformance to Performance Standard		
	Count In/Out	TN Mean Influent, mg/L	TN Mean Effluent[1], mg/L	Average Category Volume Reduct.	Volume-Adjusted Effluent Conc[2], mg/L	Volume-Adjusted Removal Efficiency[2]	Level of Attainment of Performance Standard (with rationale)
Vegetated Filter Strip	138/ 122	1.53	1.37	38%	0.85	44%	Medium, if designed to include volume reduction processes
Detention Basin	90/ 89	2.34	2.01	33%	1.35	42%	Medium, if designed to include volume reduction processes
Wet Pond	397/ 425	2.12	1.33	NA	1.33	37%	Medium, best concentration reduction among BMP categories, but limited volume reduction

Source: 2014 BMP Performance Summaries and Statistical Appendices; 2010 Volume Performance Summary; available at: www.bmpdatabase.org

1 - A statistically significant difference between influent and effluent was detected at a p value of 0.05 for all categories included.

2 - Estimates were adjusted to account for category-average volume reduction.

B.6.3 Sizing Flow-Thru Treatment Control BMPs:

Flow-thru treatment control BMPs must be sized to filter or treat the maximum flow rate of runoff produced from a rainfall intensity of 0.2 inch of rainfall per hour, for each hour of every storm event. The required flow-thru treatment rate should be adjusted for the portion of the DCV already retained or biofiltered onsite as described in Worksheet B.6-1. The following hydrologic method must be used to calculate the flow rate to be filtered or treated:

$$Q = C \times i \times A$$

Where:

Q = Design flow rate in cubic feet per second

C = Runoff factor, area-weighted estimate using Table B.1-1.

i = Rainfall intensity of 0.2 in/hr.

A = Tributary area (acres) which includes the total area draining to the BMP, including any offsite or onsite areas that comingle with project runoff and drain to the BMP. Refer to Section 3.3.3 for additional guidance. Street projects consult Section 1.4.3.

Worksheet B.6-1: Flow-Thru Design Flows

Category	#	Description	Value	Units
Flow-Thru BMP Inputs	0	Drainage Basin ID or Name		unitless
	1	Total Tributary Area		sq-ft
	2	Final Adjusted Runoff Factor		unitless
	3	Design Capture Volume		cubic-feet
	4	Volume Effectively Retained and/or Biofiltered		cubic-feet
	5	Deficit of Effectively Treated Stormwater Requiring Flow-Thru Treatment		cubic-feet
	6	Maximum Rated Water Quality Flow Rate of Proposed BMP		CFS
Flow Rate Calculations	7	Adjustment Factor		unitless
	8	Design Rainfall Intensity for Flow-Thru BMPs	0.20	in/hr
	9	Water Quality Flow Rate Requiring Flow-Thru Treatment		CFS
Result	10	Is Flow-Thru BMP Adequately Sized?		unitless

Worksheet B.6-1 General Notes:

A. Applicants may use this worksheet to size flow-thru BMPs. Applicants must provide inputs for yellow shaded cells and calculate appropriate values for unshaded cells. Note that applicants proposing on-site flow-thru BMPs must also implement an offsite alternative compliance project to offset the deficit of effectively treated stormwater volume. An automated version of this worksheet is available for download at the County of San Diego Department of Public Works website.

Worksheet B.6-1 Line Item Notes:

0. Populated per Worksheet B.1-1.
1. Populated per Worksheet B.1-1.
2. Populated per Worksheet B.1-1.
3. Populated per Worksheet B.2-1.
4. Populated per Retention and/or Biofiltration treatment determined in Worksheets B.3-1 through B.5-3.
5. Line 4 - Line 3
6. User input per manufacturer's specification sheet.
7. -Line 5 / Line 3
8. Default value of 0.20 inches per hour
9. (Line 1/43,560) x Line 2 x Line 7 x Line 8
10. If Line 6 ≥ Line 9 then "Yes". If Line 6 < Line 9 then "No".

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Appendix

C

Geotechnical and Groundwater Investigation Requirements

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Appendix C Geotechnical and Groundwater Investigation Requirements

C.1 Purpose and Phasing

Feasibility of storm water infiltration is dependent on the geotechnical and groundwater conditions at the project site.

This appendix provides guidelines for performing and reporting feasibility analysis for infiltration with respect to geotechnical and groundwater conditions. It provides framework for feasibility analysis at two phases of project development:

- *Planning Phase*: Simpler methods for conducting preliminary screening for feasibility/infeasibility, and
- *Design Phase*: When infiltration is considered potentially feasible, more rigorous analysis is needed to confirm feasibility and to develop design considerations and mitigation measures if required

Planning Phase At this stage of the project, information about the site may be limited, the proposed design features may be conceptual, and there may be an opportunity to adjust project plans to incorporate infiltration into the project layout as it is developed. At this phase, project geotechnical engineers are typically responsible for conducting explorations of geologic conditions, performing preliminary analyses, and identifying particular aspects of design that require more detailed investigation at later phases. As part of this process, the role of a planning- level infiltration feasibility assessment is to help planners reach early tentative conclusions regarding where infiltration is likely feasible, possibly feasible if done carefully, or clearly infeasible. This determination can help guide the design process by influencing project layout, selection of infiltration BMPs, and identifying if more detailed studies are necessary. The goal of the planning and feasibility phase is to identify potential geotechnical and groundwater impacts and to determine which impacts may be considered fatal flaws and which impacts may be possible to mitigate with design features. Determination of acceptable risks and/or mitigation measures may involve discussions with adjacent land owners and/or utility operators, as well as coordination with other projects under planning or design in the project vicinity. Early involvement of potentially impacted parties is critical to avoid late-stage design changes and schedule delays and to reduce potential future liabilities.

Design Phase During this phase, potential geotechnical and groundwater impacts must be fully considered and evaluated and mitigation measures should be incorporated in the BMP design, as appropriate. Mitigation measures refer to design features or assumptions intended to reduce risks

associated with storm water infiltration. While rules of thumb may be useful, if applied carefully, for the planning level phase, the analyses conducted in the detailed design phase require the involvement of a geotechnical professional familiar with the local conditions. One of the first steps in the design phase should be determination if additional field and/or laboratory investigations are required (e.g., borings, test pits, laboratory or field testing) to further assess the geotechnical impacts of storm water infiltration. As the design of infiltration systems are highly dependent on the subsurface conditions, coordination with the storm water design team may be beneficial to limit duplicative efforts and costs.

Worksheet C.4-1 is provided to document infiltration feasibility screening. This worksheet is divided into two parts. Part 1 "Full Infiltration Feasibility Screening Criteria" is used to determine if the full design volume can be infiltrated onsite, whereas Part 2 "Partial Infiltration versus No Infiltration Screening Criteria" is used to determine if any amount of volume can be infiltrated.

Note that it is not necessary to investigate each and every criterion in the worksheet, a single "no" answer in Part 1 and Part 2 controls the feasibility and desirability. If all the answers in Part 1 are "yes" then it is not required to complete Part 2. The same worksheet could be used to document both planning-level categorization and design-level categorization. Note that planning-level categorization, are typically based on initial site assessment results; therefore it is not necessarily conclusive. Categorizations should be confirmed or revised, as necessary, based on more detailed design-level investigation and analysis during BMP design.

C.2 Geotechnical Feasibility Criteria

This section is divided into seven factors that should be considered, as applicable, while assessing the feasibility and desirability of infiltration related to geotechnical conditions. Note that during the planning phase, if one or more of these factors precludes infiltration as an approach, it is not necessary to assess every other factor. However, if proposing infiltration BMPs, then every applicable factor in this section must be addressed.

C.2.1 Soil and Geologic Conditions

Site soils and geologic conditions influence the rate at which water can physically enter the soils. Site assessment approaches for soil and geologic conditions may consist of:

- Review of soil survey maps
- Review of available reports on local geology to identify relevant features, such as depth to bedrock, rock type, lithology, faults, and hydrostratigraphic or confining units
- Review of previous geotechnical investigations of the area
- Site-specific geotechnical and/or geologic investigations (e.g., borings, infiltration tests)

Geologic investigations should also seek to provide an assessment of whether soil infiltration properties are likely to be uniform or variable across the project site. Appendix D provides guidance on determining infiltration rates for planning and design phase.

C.2.2 Settlement and Volume Change

Settlement and volume change limits the amount of infiltration that can be allowed without resulting in adverse impacts that cannot be mitigated. Upon considering the impacts of an infiltration design, the designer must identify areas where soil settlement or heave is likely and whether these conditions would be unfavorable to existing or proposed features. Settlement refers to the condition when soils decrease in volume, and heave refers to expansion of soils or increase in volume.

There are several different mechanisms that can induce volume change due to infiltration that the professional must be aware of and consider while completing the feasibility screening including:

- Hydro collapse and calcareous soils;
- Expansive soils;
- Frost heave;
- Consolidation; and
- Liquefaction.

C.2.3 Slope Stability

Infiltration of water has the potential to result in an increased risk of slope failure of nearby slopes. This should be assessed as part of both the feasibility and design stages of a project. There are many factors that impact the stability of slopes, including, but not limited to, slope inclination, soil and unit weight and seepage forces. Increases in moisture content or rising of the water table in the vicinity of a slope, which may result from storm water infiltration, have the potential to change the soil strength and unit weight and to add seepage forces to the slope, which in turn, may reduce the factor of safety of the stability of the slope. When evaluating the effect of infiltration on the design of a slope, the designer must consider all types of potential slope failures.

The County of San Diego Low Impact Development (LID) Handbook (2014) recommends a 50 foot setback from steep or sensitive slopes for BMPs that infiltrate runoff (available at http://www.sandiegocounty.gov/content/sdc/dpw/watersheds/susmp/lid.html). Slope setbacks should be determined on an individual project basis by a qualified geotechnical engineer.

C.2.4 Utility Considerations

Utilities are either public or private infrastructure components that include underground pipelines and vaults (e.g., potable water, sewer, storm water, gas pipelines), underground wires/conduit (e.g., telephone, cable, electrical) and above ground wiring and associated structures (e.g., electrical distribution and transmission lines). Utility considerations are typically within the purview of a geotechnical site assessment and should be considered in assessing the feasibility of storm water

infiltration. Infiltration has the potential to damage subsurface utilities and/or underground utilities may pose geotechnical hazards in themselves when infiltrated water is introduced. Utility setbacks should be determined on an individual project basis by a qualified professional and the approval of the setbacks is at the discretion of the County staff.

Utilities should be avoided as much as possible when implementing infiltration BMPs. This can require shifting or relocating BMPs to prevent construction over utilities. When utilities are unavoidable, hydraulic restriction layers should be used to direct infiltration away from the utility. If a utility must pass through the BMP, liners should be appropriately sealed to prevent any seepage. Liners can be sealed using a patch that adheres to the utility line and seals directly to the liner. Local plumbing codes should be reviewed for restrictions pertaining to water and sewer utilities.[15]

Locations of future utilities should also be considered when planning a BMP's site layout and configuration. Long, linear BMPs should have periodic breaks to allow for future utility trenches. At least one access point should be placed along any BMP for each parcel.

C.2.5 Groundwater Mounding

Storm water infiltration and recharge to the underlying groundwater table may create a groundwater mound beneath the infiltration facility. The height and shape of the mound depends on the infiltration system design, the recharge rate, and the hydrogeologic conditions at the site, especially the horizontal hydraulic conductivity and the saturated thickness. Elevated groundwater levels can lead to a number of problems, including flooding and damage to structures and utilities through buoyancy and moisture intrusion, increase in inflow and infiltration into municipal sanitary sewer systems, and flow of water through existing utility trenches, including sewers, potentially leading to formation of sinkholes (Gobel et al. 2004). Mounding must be considered by the geotechnical professional while performing the infiltration feasibility screening.

C.2.6 Retaining Walls and Foundations

Development projects may include retaining walls or foundations in close proximity to proposed infiltration BMPs. These structures are designed to withstand the forces of the earth they are retaining and other surface loading conditions such as nearby structures. Foundations include shallow foundations (spread and strip footings, mats) and deep foundations (piles, piers) and are designed to support overburden and design loads. All types of retaining walls and foundations can be impacted by increased water infiltration into the subsurface as a result of potential increases in

[15] This paragraph and the following are adapted from Appendix A.11.7 from the County of San Diego LID Handbook updated in 2014.

lateral pressures and potential reductions in soil strength. The geotechnical professional should consider these factors while performing the infiltration feasibility screening.

C.2.7 Other Factors

While completing the feasibility screening, other factors determined by the geotechnical professional to influence the feasibility and desirability of infiltration related to geotechnical conditions must also be considered.

C.3 Groundwater Quality and Water Balance Feasibility Criteria

This section is divided into eight factors that should be considered, to the extent applicable, while assessing the feasibility and desirability of infiltration related to groundwater quality and water balance. Note that during the planning phase, if one or more of these factors precludes infiltration as an approach, it is not necessary to assess every other factor. However, if proposing infiltration BMPs, then every applicable factor in this section must be addressed.

C.3.1 Soil and Groundwater Contamination

Infiltration must be avoided in areas with:

- Physical and chemical characteristics (e.g., appropriate cation exchange capacity, organic content, clay content and infiltration rate) which are not adequate for proper infiltration durations and treatment of runoff for the protection of groundwater beneficial uses.

- Groundwater contamination and/or soil pollution, if infiltration could contribute to the movement or dispersion of soil or groundwater contamination or adversely affect ongoing clean-up efforts, either onsite or down-gradient of the project.

If infiltration is under consideration for one of the above conditions, a site-specific analysis should be conducted to determine where infiltration-based BMPs can be used without adverse impacts.

C.3.2 Separation to Seasonal High Groundwater

The depth to seasonally high groundwater tables (normal high depth during the wet season) beneath the base of any infiltration BMP must be greater than 10 feet for infiltration BMPs to be allowed. The depth to groundwater requirement can be reduced from 10 feet at the discretion of the approval agency if the underlying groundwater basin does not support beneficial uses and the groundwater quality is maintained at the proposed depth. Depth to seasonally high groundwater levels can be estimated based on well level measurements or redoximorphic methods. For sites with complex

groundwater tables, long term studies may be needed to understand how groundwater levels change in wet and dry years.

C.3.3 Wellhead Protection

Wellheads natural and man-made are water resources that may potentially be adversely impacted by storm water infiltration through the introduction of contaminants or alteration in water supply and levels. It is recommended that the locations of wells and springs be identified early in the design process and site design be developed to avoid infiltration in the vicinity of these resources. Infiltration BMPs must be located a minimum of 100 feet horizontally from any water supply well.

C.3.4 Contamination Risks from Land Use Activities

Concentration of storm water pollutants in runoff is highly dependent on the land uses and activities present in the area tributary to an infiltration BMP. Likewise, the potential for groundwater contamination due to the infiltration BMP is a function of pollutant abundance, concentration of pollutants in soluble forms, and the mobility of the pollutant in the subsurface soils. Hence infiltration BMPs must not be used for areas of industrial or light industrial activity, and other high threat to water quality land uses and activities, unless source control BMPs to prevent exposure of high threat activities are implemented, or runoff from such activities is first treated or filtered to remove pollutants prior to infiltration.

The project applicant has an option to classify other land uses and activities that pose high threat to water quality not suitable for infiltration BMPs if source control BMPs to prevent exposure of high threat activities could not be implemented, or runoff from such activities could not be first treated or filtered to remove pollutants prior to infiltration. Approval of the infeasibility of infiltration due to high threat to water quality is evaluated on a case by case basis and is at the discretion of the County.

C.3.5 Consultation with Applicable Groundwater Agencies

Infiltration activities should be coordinated with the applicable groundwater management agency, such as groundwater providers and/or resource protection agencies, to ensure groundwater quality is protected. It is recommended that coordination be initiated as early as possible during the planning process to determine whether specific site assessment activities apply or whether these agencies have data available that may support the planning and design process.

C.3.6 Water Balance Impacts on Stream Flow

Use of infiltration systems to reduce surface water discharge volumes may result in additional volume of deeper infiltration compared to natural conditions, which may result in impacts to

receiving channels associated with change in dry weather flow regimes. A relatively simple survey of hydrogeologic data (piezometer measurements, boring logs, regional groundwater maps) and downstream receiving water characteristics is generally adequate to determine whether there is potential for impacts and whether a more rigorous assessment is needed.

Where water balance conditions appear to be sensitive to development impacts and there is an elevated risk of impacts, a computational analysis may be warranted to evaluate the feasibility/desirability of infiltration. Such an analysis should account for precipitation, runoff, irrigation inputs, soil moisture retention, evapotranspiration, baseflow, and change in groundwater recharge on a long term basis. Because water balance calculations are sensitive to the timing of precipitation versus evapotranspiration, it is most appropriate to utilize a continuous model simulation rather than basing calculations on average annual or monthly normal conditions.

C.3.7 Downstream Water Rights

While water rights cases are not believed to be common, there may be cases in which infiltration of water from area that was previously allowed to drain freely to downstream water bodies would not be legal from a water rights perspective. Site-specific evaluation of water rights laws should be conducted if this is believed to be a potential issue in the project location.

C.3.8 Other Factors

While completing the feasibility screening, other factors determined by the geotechnical professional to influence the feasibility and desirability of infiltration related to groundwater quality and water balance must also be considered.

C.4 Geotechnical and Groundwater Investigation Report Requirements

The geotechnical and groundwater investigation report(s) addressing onsite storm water infiltration must include the following elements, as applicable. These reports may need to be completed by multiple professional disciplines, depending on the issues that need be addressed for a given site. It may also be necessary to prepare separate report(s) at the planning phase and design phase of a project if the methods and timing of analyses differ.

C.4.1 Site Evaluation

Site evaluation must identify the following:

- Areas of contaminated soil or contaminated groundwater within the site;
- "Brown fields" adjacent to the site;
- Mapped soil type(s);

- Historic high groundwater level;
- Slopes steeper than 25 percent; and
- Location of water supply wells, septic systems (and expansion area), or underground storage tanks, or permitted gray water systems within 100 feet of a proposed infiltration/ percolation BMP.

C.4.2 Field Investigation

Where the site evaluation indicates potential feasibility for onsite storm water infiltration BMPs, the following field investigations will be necessary to demonstrate suitability and to provide design recommendations.

C.4.2.1 Subsurface Exploration

Subsurface exploration and testing for storm water infiltration BMPs must include:

- A minimum of two exploratory excavations must be conducted within 50-feet of each proposed storm water infiltration BMP. The excavations must extend at least 10 feet below the lowest elevation of the base of the proposed infiltration BMP.
- Soils must be logged in detail with emphasis on describing the soil profile.
- Identify low permeability or impermeable materials.
- Indicate any evidence of soil contamination.

C.4.2.2 Material Testing and Infiltration/Percolation Testing

Various material testing and in situ infiltration/percolation testing methods and guidance for appropriate factor of safety are discussed in detail in Appendix D. Infiltration testing methods described in Appendix D include surface and shallow excavation methods and deeper subsurface tests.

C.4.2.3 Evaluation of Depth to Groundwater

An evaluation of the depth to groundwater is required to confirm the feasibility of infiltration. Infiltration BMPs may not be feasible in high groundwater conditions (within 10 feet of the base of infiltration/ percolation BMP) unless an exemption is granted by the approval agency.

C.4.3 Reporting Requirements by Geotechnical Engineer

The geotechnical and groundwater investigation report must address the following key elements, and where appropriate, mitigation recommendations must be provided.

- Identify areas of the project site where infiltration is likely to be feasible and provide justifications for selection of those areas based on soil types, slopes, proximity to existing features, etc. Include completed and signed Worksheet C.4-1.
- Investigate, evaluate and estimate the vertical infiltration rates and capacities in accordance with the guidance provided in Appendix D which describes infiltration testing and appropriate factor of safety to be applied for infiltration testing results. The site may be broken into sub-basins, each of which has different infiltration rates or capacities.
- Describe the infiltration/ percolation test results and correlation with published infiltration/ percolation rates based on soil parameters or classification. Recommend providing design infiltration/percolation rate(s) at the sub-basins. Use Worksheet D.5-1.
- Investigate the subsurface geological conditions and geotechnical conditions that would affect infiltration or migration of water toward structures, slopes, utilities, or other features. Describe the anticipated flow path of infiltrated water. Indicate if the water will flow into pavement sections, utility trench bedding, wall drains, foundation drains, or other permeable improvements.
- Investigate depth to groundwater and the nature of the groundwater. Include an estimate of the high seasonal groundwater elevations.
- Evaluate proposed use of the site (industrial use, residential use, etc.), soil and groundwater data and provide a concluding opinion whether proposed storm water infiltration could cause adverse impacts to groundwater quality and if it does cause impacts whether the impacts could be reasonably mitigated or not.
- Estimate the maximum allowable infiltration rates and volumes that could occur at the site that would avoid damage to existing and proposed structures, utilities, slopes, or other features. In addition the report must indicate if the recommended infiltration rate is appropriate based on the conditions exposed during construction.
- Provide a concluding opinion regarding whether or not the proposed onsite storm water infiltration/percolation BMP will result in soil piping, daylight water seepage, slope instability, or ground settlement.
- Recommend measures to substantially mitigate or avoid any potentially detrimental effects of the storm water infiltration BMPs or associated soil response on existing or proposed improvements or structures, utilities, slopes or other features within and adjacent to the site. For example, minimize soil compaction.
- Provide guidance for the selection and location of infiltration BMPs, including the minimum separations between such infiltration BMPs and structures, streets, utilities, manufactured and existing slopes, engineered fills, utilities or other features. Include guidance for measures that could be used to reduce the minimum separations or to mitigate the potential impacts of infiltration BMPs.

- Provide a concluding opinion whether or not proposed infiltration or partial infiltration BMPs are in conformance with the following design criteria:
  - Runoff will undergo pretreatment such as sedimentation or filtration prior to infiltration;
  - Pollution prevention and source control BMPs are implemented at a level appropriate to protect groundwater quality for areas draining to infiltration BMPs;
  - The vertical distance from the base of the infiltration BMPs to the seasonal high groundwater mark is greater than 10 feet. This vertical distance may be reduced when the groundwater basin does not support beneficial uses and the groundwater quality is maintained;
  - The soil through which infiltration is to occur has physical and chemical characteristics (e.g., appropriate cation exchange capacity, organic content, clay content, and infiltration rate) which are adequate for proper infiltration durations and treatment of runoff for the protection of groundwater beneficial uses;
  - Infiltration BMPs are not used for areas of industrial or light industrial activity, and other high threat to water quality land uses and activities, unless source control BMPs to prevent exposure of high threat activities are implemented, or runoff from such activities is first treated or filtered to remove pollutants prior to infiltration; and
  - Infiltration BMPs are located a minimum of 100 feet horizontally from any water supply wells and 25 feet from any septic system or as prescribed by County of San Diego Department of Environmental Health.

C.4.4 Reporting Requirements by the Project Design Engineer

Project design engineer has the following responsibilities:

- Complete criteria 4 and 8 in Worksheet C.4-1; and
- In the SWQMP provide a concluding opinion whether or not proposed infiltration BMPs will affect seasonality of ephemeral streams.

Worksheet C.4-1: Categorization of Infiltration Feasibility Condition

Categorization of Infiltration Feasibility Condition	Worksheet C.4-1

Part 1 - Full Infiltration Feasibility Screening Criteria

Would infiltration of the full design volume be feasible from a physical perspective without any undesirable consequences that cannot be reasonably mitigated?

Note that it is not necessary to investigate each and every criterion in the worksheet if infiltration is precluded. Instead a letter of justification from a geotechnical professional familiar with the local conditions substantiating any geotechnical issues will be required.

Criteria	Screening Question	Yes	No
1	**Is the estimated reliable infiltration rate below proposed facility locations greater than 0.5 inches per hour?** The response to this Screening Question must be based on a comprehensive evaluation of the factors presented in Appendix C.2 and Appendix D.		

Provide basis:

Summarize findings of studies; provide reference to studies, calculations, maps, data sources, etc. Provide narrative discussion of study/data source applicability.

2	**Can infiltration greater than 0.5 inches per hour be allowed without increasing risk of geotechnical hazards (slope stability, groundwater mounding, utilities, or other factors) that cannot be mitigated to an acceptable level?** The response to this Screening Question must be based on a comprehensive evaluation of the factors presented in Appendix C.2.		

Provide basis:

Summarize findings of studies; provide reference to studies, calculations, maps, data sources, etc. Provide narrative discussion of study/data source applicability.

Worksheet C.4-1 Page 2 of 4			
Criteria	Screening Question	**Yes**	**No**
3	**Can infiltration greater than 0.5 inches per hour be allowed without increasing risk of groundwater contamination (shallow water table, storm water pollutants or other factors) that cannot be mitigated to an acceptable level?** The response to this Screening Question must be based on a comprehensive evaluation of the factors presented in Appendix C.3.		
Provide basis: Summarize findings of studies; provide reference to studies, calculations, maps, data sources, etc. Provide narrative discussion of study/data source applicability.			
4	**Can infiltration greater than 0.5 inches per hour be allowed without causing potential water balance issues such as change of seasonality of ephemeral streams or increased discharge of contaminated groundwater to surface waters?** The response to this Screening Question must be based on a comprehensive evaluation of the factors presented in Appendix C.3.		
Provide basis: Summarize findings of studies; provide reference to studies, calculations, maps, data sources, etc. Provide narrative discussion of study/data source applicability.			
Part 1 Result*	If all answers to rows 1 - 4 are "**Yes**" a full infiltration design is potentially feasible. The feasibility screening category is **Full Infiltration** If any answer from row 1-4 is "**No**", infiltration may be possible to some extent but would not generally be feasible or desirable to achieve a "full infiltration" design. Proceed to Part 2		

*To be completed using gathered site information and best professional judgment considering the definition of MEP in the MS4 Permit. Additional testing and/or studies may be required by County staff to substantiate findings.

Worksheet C.4-1 Page 3 of 4

Part 2 – Partial Infiltration vs. No Infiltration Feasibility Screening Criteria

Would infiltration of water in any appreciable amount be physically feasible without any negative consequences that cannot be reasonably mitigated?

Criteria	Screening Question	Yes	No
5	**Do soil and geologic conditions allow for infiltration in any appreciable rate or volume?** The response to this Screening Question must be based on a comprehensive evaluation of the factors presented in Appendix C.2 and Appendix D.		

Provide basis:

Summarize findings of studies; provide reference to studies, calculations, maps, data sources, etc. Provide narrative discussion of study/data source applicability and why it was not feasible to mitigate low infiltration rates.

6	**Can Infiltration in any appreciable quantity be allowed without increasing risk of geotechnical hazards (slope stability, groundwater mounding, utilities, or other factors) that cannot be mitigated to an acceptable level**? The response to this Screening Question must be based on a comprehensive evaluation of the factors presented in Appendix C.2.		

Provide basis:

Summarize findings of studies; provide reference to studies, calculations, maps, data sources, etc. Provide narrative discussion of study/data source applicability and why it was not feasible to mitigate low infiltration rates.

Worksheet C.4-1 Page 4 of 4			
Criteria	Screening Question	**Yes**	**No**
7	**Can Infiltration in any appreciable quantity be allowed without posing significant risk for groundwater related concerns (shallow water table, storm water pollutants or other factors)?** The response to this Screening Question must be based on a comprehensive evaluation of the factors presented in Appendix C.3.		
Provide basis: Summarize findings of studies; provide reference to studies, calculations, maps, data sources, etc. Provide narrative discussion of study/data source applicability and why it was not feasible to mitigate low infiltration rates.			
8	**Can infiltration be allowed without violating downstream water rights**? The response to this Screening Question must be based on a comprehensive evaluation of the factors presented in Appendix C.3.		
Provide basis: Summarize findings of studies; provide reference to studies, calculations, maps, data sources, etc. Provide narrative discussion of study/data source applicability and why it was not feasible to mitigate low infiltration rates.			
Part 2 Result*	If all answers from row 5-8 are yes then partial infiltration design is potentially feasible. The feasibility screening category is **Partial Infiltration.** If any answer from row 5-8 is no, then infiltration of any volume is considered to be **infeasible** within the drainage area. The feasibility screening category is **No Infiltration.**		

*To be completed using gathered site information and best professional judgment considering the definition of MEP in the MS4 Permit. Additional testing and/or studies may be required by Agency/Jurisdictions to substantiate findings

C.5 Feasibility Screening Exhibits

Table C.5-1 lists the feasibility screening exhibits that were generated using readily available GIS data sets to assist the project applicant to screen the project site for feasibility.

Table C.5-1: Feasibility Screening Exhibits

Figures	Layer	Intent/Rationale	Data Sources
C.1 Soils	Hydrologic Soil Group – A, B, C, D	Hydrologic Soil Group will aid in determining areas of potential infiltration	SanGIS http://www.sangis.org/
	Hydric Soils	Hydric soils will indicate layers of intermittent saturation that may function like a D soil and should be avoided for infiltration	USDA Web Soil Survey. Hydric soils, (ratings of 100) were classified as hydric. http://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm
C.2: Slopes and Geologic Hazards	Slopes >25%	BMPs are hard to construct on slopes >25% and can potentially cause slope instability	SanGIS http://www.sangis.org/
	Liquefaction Potential	BMPs (particularly infiltration BMPs) must not be sited in areas with high potential for liquefaction or landslides to minimize earthquake/landslide risks	SanGIS http://www.sangis.org/
	Landslide Potential		SanGIS Geologic Hazards layer. Subset of polygons with hazard codes related to landslides was selected. This data is limited to the City of San Diego Boundary. http://www.sangis.org/
C.3: Groundwater Table Elevations	Groundwater Depths	Infiltration BMPs will need to be sited in areas with adequate distance (>10 ft) from the groundwater table	GeoTracker. Data downloaded for San Diego county from 2014 and 2013. In cases where there were multiple measurements made at the same well, the average was taken over that year. http://geotracker.waterboards.ca.gov/data_download_by_county.asp
C.4: Contaminated Sites	Contaminated soils and/or groundwater sites	Infiltration must limited in areas of contaminated soil/groundwater	GeoTracker. Data downloaded for San Diego county and limited to active cleanup sites http://geotracker.waterboards.ca.gov/

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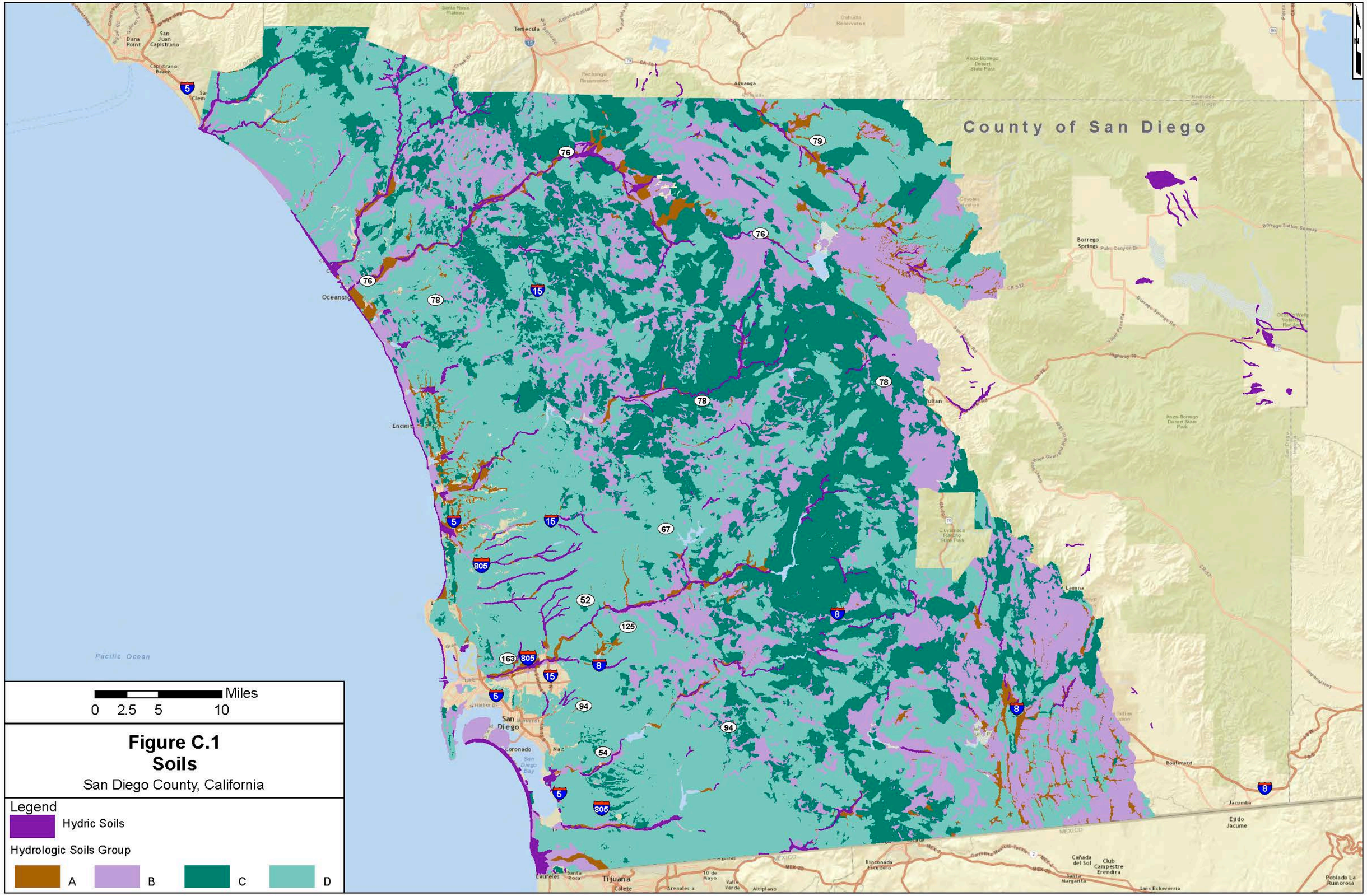
County of San Diego
Pacific Ocean
Miles
0 2.5 5 10
Figure C.1
Soils
San Diego County, California
Legend
Hydric Soils
Hydrologic Soils Group
A
B
C
D

County of San Diego

Miles
0 2.5 5 10

Figure C.2
Slopes and Geologic Hazards
San Diego County, California

Legend

- Landslide Data Extent
- Potential Landslide Areas
- Slopes >25%
- Potential Liquefaction Areas

County of San Diego

Miles
0 2.5 5 10

Figure C.3
Groundwater Table Elevation
San Diego County, California

Legend
Average Depth to Groundwater

- <5 ft
- 5 - 9 ft
- 10 - 14ft
- >15 ft

County of San Diego

Miles
0 2.5 5 10

Figure C.4
Contaminated Sites
San Diego County, California

Legend

- Contaminated Sites

Appendix

D

Approved Infiltration Rate Assessment Methods for Selection of Storm Water BMPs

February 26, 2016

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Appendix D Approved Infiltration Rate Assessment Methods for Selection and Design of Storm Water BMPs

D.1 Introduction

Characterization of potential infiltration rates is a critical step in evaluating the degree to which infiltration can be used to reduce storm water runoff volume. This appendix is intended to provide guidance to help answer the following questions:

1. *How and where does infiltration testing fit into the project development process?*

   Section D.2 discusses the role of infiltration testing in different stage of project development and how to plan a phased investigation approach.

2. *What infiltration rate assessment methods are acceptable?*

   Section D.3 describes the infiltration rate assessment methods that are acceptable.

3. *What factors should be considered in selecting the most appropriate testing method for a project?*

   Section D.4 provides guidance on site-specific considerations that influence which assessment methods are most appropriate.

4. *How should factors of safety be selected and applied to, for BMP selection and design?*

   Section D.5 provides guidance for selecting a safety factor.

Note, that this appendix does not consider other feasibility criteria that may make infiltration infeasible, such as groundwater contamination and geotechnical considerations (these are covered in Appendix C). In general, infiltration testing should only be conducted after other feasibility criteria specified in this manual have been evaluated and cleared.

D.2 Role of Infiltration Testing in Different Stages of Project Development

In the process of planning and designing infiltration facilities, there are a number of ways that infiltration testing or estimation factors into project development, as summarized in Table D.2-1. As part of selecting infiltration testing methods, the geotechnical engineer must select methods that are applicable to the phase of the project and the associated burden of proof.

Table D.2-1: Role of Infiltration Testing

Project Phase	Key Questions/Burden of Proof	General Assessment Strategies
Site Planning Phase	• Where within the project area is infiltration potentially feasible? • What volume reduction approaches are potentially suitable for my project?	• Use existing data and maps to the extent possible • Use less expensive methods to allow a broader area to be investigated more rapidly • Reach tentative conclusions that are subject to confirmation/refinement at the design phase
BMP Design Phase	• What infiltration rates should be used to design infiltration and biofiltration facilities? • What factor of safety should be applied?	• Use more rigorous testing methods at specific BMP locations • Support or modify preliminary feasibility findings • Estimate design infiltration rates with appropriate factors of safety

D.3 Guidance for Selecting Infiltration Testing Methods

The geotechnical engineer must select appropriate testing methods for the site conditions, subject to the engineer's discretion and approval of the County, that are adequate to meet the burden of proof that is applicable at each phase of the project design (See Table D.3-1):

- At the planning phase, testing/evaluation method must be selected to provide a reliable estimate of the locations where infiltration is feasible and allow a reasonably confident determination of infiltration feasibilility to support the selection between full infiltration, partial infiltration, and no infiltration BMPs.

- At the design phase, the testing method must be selected to provide a reliable infiltration rate to be used in design. The degree of certainty provided by the selected test should be considered

Table D.3-1 provides a matrix comparison of these methods. Sections D.3.1 to D.3.3 provide a summary of each method. This appendix is not intended to be an exhaustive reference on infiltration testing at this time. It does not attempt to discuss every method for testing, nor is it intended to provide step-by-step procedures for each method. The user is directed to supplemental resources (referenced in this appendix) or other appropriate references for more specific

information. **Alternative testing methods are allowed with appropriate rationales, subject to the discretion of the County.**

In order to select an infiltration testing method, it is important to understand how each test is applied and what specific physical properties the test is designed to measure. Infiltration testing methods vary considerably in these regards. For example, a borehole percolation test is conducted by drilling a borehole, filling a portion of the hole with water, and monitoring the rate of fall of the water. This test directly measures the three dimensional flux of water into the walls and bottom of the borehole. An approximate correction is applied to indirectly estimate the vertical hydraulic conductivity from the results of the borehole test. In contrast, a double-ring infiltrometer test is conducted from the ground surface and is intended to provide a direct estimate of vertical (one-dimensional) infiltration rate at this point. Both of these methods are applicable under different conditions.

Table D.3-1: Comparision of Infiltration Rate Estimation and Testing Methods

Test	Suitability at Planning Level Screening Phase	Suitability at BMP Design Phase
NRCS Soil Survey Maps	Yes, but mapped soil types must be confirmed with site observations. Regional soil maps are known to contain inaccuracies at the scale of typical development sites.	No, unless a strong correlation is developed between soil types and infiltration rates in the direct vicinity of the site and an elevated factor of safety is used.
Grain Size Analysis	Not preferred. Should only be used if a strong correlation has been developed between grain size analysis and measured infiltration rates testing results of site soils.	No
Cone Penetrometer Testing	Not preferred. Should only be used if a strong correlation has been developed between CPT results and measured infiltration rates testing results of site soils.	No
Simple Open Pit Test	Yes	Yes, with appropriate correction for infiltration into side walls and elevated factor of safety.
Open Pit Falling Head Test	Yes	Yes, with appropriate correction for infiltration into side walls and elevated factor of safety.
Double Ring Infiltrometer Test (ASTM 3385)	Yes	Yes

Test	Suitability at Planning Level Screening Phase	Suitability at BMP Design Phase
Single Ring Infiltrometer Test	Yes	Yes
Large-scale Pilot Infiltration Test	Yes, but generally cost prohibitive and too water-intensive for preliminary screening of a large area.	Yes, but should consider relatively large water demand associated with this test.
Smaller-scale Pilot Infiltration Test	Yes	Yes
Well Permeameter Method (USBR 7300-89)	Yes; reliability of this test can be improved by obtaining a continuous core where tests are conducted.	Yes in areas of proposed cut where other tests are not possible; a continuous boring log should be recorded and used to interpret test; should be confirmed with a more direct measurement following excavation.
Borehole Percolation Tests (various methods)	Yes; reliability of this test can be improved by obtaining a continuous core where tests are conducted.	Yes in areas of proposed cut where other tests are not possible; a continuous boring log should be recorded and used to interpret test; should be confirmed with a more direct measurement following excavation.
Laboratory Permeability Tests (e.g., ASTM D2434)	Yes, only suitable for evaluating potential infiltration rates in proposed fill areas. For sites with proposed cut, it is preferred to do a borehole percolation test at the proposed grade instead of analyzing samples in the lab. A combination of both tests may improve reliability.	No. However, may be part of a line of evidence for estimating the design infiltration of partial infiltration BMPs constructed in future compacted fill.

D.3.1 Desktop Approaches and Data Correlation Methods

This section reviews common methods used to evaluate infiltration characteristics based on desktop-available information, such as GIS data. This section also introduces methods for estimating infiltration properties via correlations with other measurements.

D.3.1.1 NRCS Soil Survey Maps

NRCS Soil Survey maps (http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm) can be used to estimate preliminary feasibility conditions, specifically by mapping hydrologic soil groups, soil texture classes, and presence of hydric soils relative to the site layout. For feasibility determinations, mapped conditions must be supplemented with available data from the site (e.g., soil borings, observed soil textures, biological indicators). The presence of D soils, if confirmed by available data, provides a reasonable basis to determine that full infiltration is not feasible for a given DMA.

D.3.1.2 Grain Size Analysis Testing and Correlations to Infiltration Rate

Hydraulic conductivity can be estimated indirectly from correlations with soil grain-size distributions. While this method is approximate, correlations have been relatively well established for some soil conditions. One of the most commonly used correlations between grain size parameters and hydraulic conductivity is the Hazen (1892, 1911) empirical formula (Philips and Kitch, 2011), but a variety of others have been developed. Correlations must be developed based on testing of site-specific soils.

D.3.1.3 Cone Penetrometer Testing and Correlations to Infiltration Rate

Hydraulic conductivity can also be estimated indirectly from cone penetrometer testing (CPT). A cone penetrometer test involves advancing a small probe into the soil and measuring the relative resistance encountered by the probe as it is advanced. The signal returned from this test can be interpreted to yield estimated soil types and the location of key transitions between soil layers. If this method is used, correlations must be developed based on testing of site-specific soils.

D.3.2 Surface and Shallow Excavation Methods

This section describes tests that are conducted at the ground surface or within shallow excavations close to the ground surface. These tests are generally applicable for cases where the bottom of the infiltration system will be near the existing ground surface. They can also be conducted to confirm the results of borehole methods after excavation/site grading has been completed.

D.3.2.1 Simple Open Pit Test

The Simple Open Pit Test is most appropriate for planning level screening of infiltration feasibility. Although it is similar to Open Pit Falling Head tests used for establishing a design infiltration rate (see below), the Simple Open Pit Test is less rigorous and is generally conducted to a lower standard of care. This test can be conducted by a nonprofessional as part of planning level screening phase.

The Simple Open Pit Test is a falling head test in which a hole at least two feet in diameter is filled with water to a level of 6" above the bottom. Water level is checked and recorded regularly until either an hour has passed or the entire volume has infiltrated. The test is repeated two more times in succession and the rate at which the water level falls in the third test is used as the infiltration rate.

This test has the advantage of being inexpensive to conduct. Yet it is believed to be fairly reliable for screening as the dimensions of the test are similar, proportionally, to the dimensions of a typical BMP. The key limitations of this test are that it measures a relatively small area, does not necessarily result in a precise measurement, and may not be uniformly implemented.

Source: City of Portland, 2008. Storm Water Management Manual

D.3.2.2 Open Pit Falling Head Test

This test is similar to the Simple Open Pit Test, but covers a larger footprint, includes more specific instructions, returns more precise measurements, and generally should be overseen by a geotechnical professional. Nonetheless, it remains a relatively simple test.

To perform this test, a hole is excavated at least 2 feet wide by 4 feet long (larger is preferred) and to a depth of at least 12 inches. The bottom of the hole should be approximately at the depth of the proposed infiltrating surface of the BMP. The hole is pre-soaked by filling it with water at least a foot above the soil to be tested and leaving it at least 4 hours (or overnight if clays are present). After pre-soaking, the hole is refilled to a depth of 12 inches and allow it to drain for one hour (2 hours for slower soils), measuring the rate at which the water level drops. The test is then repeated until successive trials yield a result with less than 10 percent change.

In comparison to a double-ring infiltrometer, this test has the advantage of measuring infiltration over a larger area and better resembles the dimensionality of a typical small scale BMP. Because it includes both vertical and lateral infiltration, it should be adjusted to estimate design rates for larger scale BMPs.

D.3.2.3 Double Ring Infiltrometer Test (ASTM 3385)

The Double Ring Infiltrometer was originally developed to estimate the saturated hydraulic conductivity of low permeability materials, such as clay liners for ponds, but has seen significant use in storm water applications. The most recent revision of this method from 2009 is known as ASTM 3385-09. The testing apparatus is designed with concentric rings that form an inner ring and an annulus between the inner and outer rings. Infiltration from the annulus between the two rings is intended to saturate the soil outside of the inner ring such that infiltration from the inner ring is restricted primarily to the vertical direction.

To conduct this test, both the center ring and annulus between the rings are filled with water. There is no pre-wetting of the soil in this test. However, a constant head of 1 to 6 inches is maintained for 6 hours, or until a constant flow rate is established. Both the inner flow rate and annular flow rate are recorded, but if they are different, the inner flow rate should be used. There are a variety of approaches that are used to maintain a constant head on the system, including use of a Mariotte tube, constant level float valves, or manual observation and filling. This test must be conducted at the elevation of the proposed infiltrating surface; therefore application of this test is limited in cases where the infiltration surface is a significant distance below existing grade at the time of testing.

This test is generally considered to provide a direct estimate of vertical infiltration rate for the specific point tested and is highly replicable. However, given the small diameter of the inner ring (standard diameter is 12 inches, but it can be larger), this test only measures infiltration rate in a small area. Additionally, given the small quantity of water used in this test compared to larger scale

tests, this test may be biased high in cases where the long term infiltration rate is governed by groundwater mounding and the rate at which mounding dissipates (i.e., the capacity of the infiltration receptor). Finally, the added effort and cost of isolating vertical infiltration rate may not necessarily be warranted considering that BMPs typically have a lateral component of infiltration as well. Therefore, while this method has the advantages of being technical rigorous and well standardized, it should not necessarily be assumed to be the most representative test for estimating full-scale infiltration rates. Source: American Society for Testing and Materials (ASTM) International (2009)

D.3.2.4 Single Ring Infiltrometer Test

The single ring infiltrometer test is not a standardized ASTM test, however it is a relatively well-controlled test and shares many similarities with the ASTM standard double ring infiltrometer test (ASTM 3385-09). This test is a constant head test using a large ring (preferably greater than 40 inches in diameter) usually driven 12 inches into the soil. Water is ponded above the surface. The rate of water addition is recorded and infiltration rate is determined after the flow rate has stabilized. Water can be added either manually or automatically.

The single ring used in this test tends to be larger than the inner ring used in the double ring test. Driving the ring into the ground limits lateral infiltration; however some lateral infiltration is generally considered to occur. Experience in Riverside County (CA) has shown that this test gives results that are close to full-scale infiltration facilities. The primary advantages of this test are that it is relatively simple to conduct and has a larger footprint (compared to the double-ring method) and restricts horizontal infiltration and is more standardized (compared to open pit methods). However, it is still a relatively small scale test and can only be reasonably conducted near the existing ground surface.

D.3.2.5 Large-scale Pilot Infiltration Test

As its name implies, this test is closer in scale to a full-scale infiltration facility. This test was developed by Washington State Department of Ecology specifically for storm water applications.

To perform this test, a test pit is excavated with a horizontal surface area of roughly 100 square feet to a depth that allows 3 to 4 feet of ponding above the expected bottom of the infiltration facility. Water is continually pumped into the system to maintain a constant water level (between 3 and 4 feet about the bottom of the pit, but not more than the estimated water depth in the proposed facility) and the flow rate is recorded. The test is continued until the flow rate stabilizes. Infiltration rate is calculated by dividing the flow rate by the surface area of the pit. Similar to other open pit test, this test is known to result in a slight bias high because infiltration also moves laterally through the walls of the pit during the test. Washington State Department of Ecology requires a correction factor of 0.75 (factor of safety of 1.33) be applied to results.

This test has the advantage of being more resistant to bias from localized soil variability and being more similar to the dimensionality and scale of full scale BMPs. It is also more likely to detect long term decline in infiltration rates associated with groundwater mounding. As such, it remains the preferred test for establishing design infiltration rates in Western Washington (Washington State Department of Ecology, 2012). In a comparative evaluation of test methods, this method was found to provide a more reliable estimate of full-scale infiltration rate than double ring infiltrometer and borehole percolation tests (Philips and Kitch 2011).

The difficulty encountered in this method is that it requires a larger area be excavated than the other methods, and this in turn requires larger equipment for excavation and a greater supply of water. However, this method should be strongly considered when less information is known about spatial variability of soils and/or a higher degree of certainty in estimated infiltration rates is desired.

Source: Washington State Department of Ecology, 2012.

D.3.2.6 Smaller-scale Pilot Infiltration Test

The smaller-scale PIT is conducted similarly to the large-scale PIT but involves a smaller excavation, ranging from 20 to 32 square feet instead of 100 square feet for the large-scale PIT, with similar depths. The primary advantage of this test compared to the full-scale PIT is that it requires less excavation volume and less water. It may be more suitable for small-scale distributed infiltration controls where the need to conduct a greater number of tests outweighs the accuracy that must be obtained in each test, and where groundwater mounding is not as likely to be an issue. Washington State Department of Ecology establishes a correction factor of 0.5 (factor of safety of 2.0) for this test in comparison to 0.75 (factor of safety of 1.33) for the large-scale PIT to account for a greater fraction of water infiltrating through the walls of the excavation and lower degree of certainty related to spatial variability of soils.

D.3.3 Deeper Subsurface Tests

D.3.3.1 Well Permeameter Method (USBR 7300-89)

Well permeameter methods were originally developed for purposes of assessing aquifer permeability and associated yield of drinking water wells. This family of tests is most applicable in situations in which infiltration facilities will be placed substantially below existing grade, which limits the use of surface testing methods.

In general, this test involves drilling a 6 inch to 8 inch test well to the depth of interest and maintaining a constant head until a constant flow rate has been achieved. Water level is maintained with down-hole floats. The Porchet method or the nomographs provided in the USBR Drainage Manual (United States Department of the Interior, Bureau of Reclamation, 1993) are used to convert the measured rate of percolation to an estimate of vertical hydraulic conductivity. A smaller diameter

boring may be adequate, however this then requires a different correction factor to account for the increased variability expected.

While these tests have applicability in screening level analysis, considerable uncertainty is introduced in the step of converting direct percolation measurements to estimates of vertical infiltration. Additionally, this testing method is prone to yielding erroneous results cases where the vertical horizon of the test intersects with minor lenses of sandy soils that allow water to dissipate laterally at a much greater rate than would be expected in a full-scale facility. To improve the interpretation of this test method, a continuous bore log should be inspected to determine whether thin lenses of material may be biasing results at the strata where testing is conducted. Consult USBR procedure 7300-89 for more details.

Source: (United States Department of the Interior, Bureau of Reclamation, 1990, 1993)

D.3.3.2 Borehole Percolation Tests (various methods)

Borehole percolation tests were originally developed as empirical tests to estimate the capacity of onsite sewage disposal systems (septic system leach fields), but have more recently been adopted into use for evaluating storm water infiltration. Similar to the well permeameter method, borehole percolation methods primarily measure lateral infiltration into the walls of the boring and are designed for situations in which infiltration facilities will be placed well below current grade. The percolation rate obtained in this test should be converted to an infiltration rate using a technique such as the Porchet method.

This test is generally implemented similarly to the USBR Well Permeameter Method. Per the Riverside County Borehole Percolation method, a hole is bored to a depth at least 5 times the borehole radius. The hole is presoaked for 24 hours (or at least 2 hours if sandy soils with no clay). The hole is filled to approximately the anticipated top of the proposed infiltration basin. Rates of fall are measured for six hours, refilling each half hour (or 10 minutes for sand). Tests are generally repeated until consistent results are obtained.

The same limitations described for the well permeameter method apply to borehole percolation tests, and their applicability is generally limited to initial screening. To improve the interpretation of this test method, a continuous soil core can be extracted from the hole and below the test depth, following testing, to determine whether thin lenses of material may be biasing results at the strata where testing is conducted.

Sources: Riverside County Percolation Test (2011), California Test 750 (Caltrans, 1986), San Bernardino County Percolation Test (1992); USEPA Falling Head Test (USEPA, 1980).

D.4 Specific Considerations for Infiltration Testing

The following subsections are intended to address specific topics that commonly arise in characterizing infiltration rates.

D.4.1 Hydraulic Conductivity versus Infiltration Rate versus Percolation Rate

A common misunderstanding is that the "percolation rate" obtained from a percolation test is equivalent to the "infiltration rate" obtained from tests such as a single or double ring infiltrometer test which is equivalent to the "saturated hydraulic conductivity". In fact, these terms have different meanings. Saturated hydraulic conductivity is an intrinsic property of a specific soil sample under a given degree of compaction. It is a coefficient in Darcy's equation (Darcy 1856) that characterizes the flux of water that will occur under a given gradient. The measurement of saturated hydraulic conductivity in a laboratory test is typically referred to as "permeability", which is a function of the density, structure, stratification, fines, and discontinuities of a given sample under given controlled conditions. In contrast, infiltration rate is an empirical observation of the rate of flux of water into a given soil structure under long term ponding conditions. Similarly to permeability, infiltration rate can be limited by a number of factors including the layering of soil, density, discontinuities, and initial moisture content. These factors control how quickly water can move through a soil. However, infiltration rate can also be influenced by mounding of groundwater, and the rate at which water dissipates horizontally below a BMP – both of which describe the "capacity" of the "infiltration receptor" to accept this water over an extended period. For this reason, an infiltration test should ideally be conducted for a relatively long duration resembling a series of storm events so that the capacity of the infiltration receptor is evaluated as well as the rate at which water can enter the system. Infiltration rates are generally tested with larger diameter holes, pits, or apparatuses intended to enforce a primarily vertical direction of flux.

In contrast, percolation is tested with small diameter holes, and it is mostly a lateral phenomenon. The direct measurement yielded by a percolation test tends to overestimate the infiltration rate, except perhaps in cases in which a BMP has similar dimensionality to the borehole, such as a dry well. Adjustment of percolation rates may be made to an infiltration rate using a technique such as the Porchet Method.

D.4.2 Cut and Fill Conditions

Cut Conditions: Where the proposed infiltration BMP is to be located in a cut condition, the infiltration surface level at the bottom of the BMP might be far below the existing grade. For example, if the infiltration surface of a proposed BMP is to be located at an elevation that is currently beneath 15 feet of planned cut, *how can the proposed infiltration surface be tested to establish a design infiltration rate prior to beginning excavation?* The question can be addressed in two ways: First, one of

the deeper subsurface tests described above can be used to provide a planning level screening of potential rates at the elevation of the proposed infiltrating surface. These tests can be conducted at depths exceeding 100 feet, therefore are applicable in most cut conditions. Second, the project can commit to further testing using more reliable methods following bulk excavation to refine or adjust infiltration rates, and/or apply higher factors of safety to borehole methods to account for the inherent uncertainty in these measurements and conversions.

Fill Conditions: There are two types of fills – those that are engineered or documented, and those that are undocumented. Undocumented fills are fills placed without engineering controls or construction quality assurance and are subject to great uncertainty. Engineered fills are generally placed using construction quality assurance procedures and may have criteria for grain-size and fines content, and the properties can be very well understood. However, for engineered fills, infiltration rates may still be quite uncertain due to layering and heterogeneities introduced as part of construction that cannot be precisely controlled.

If the bottom of a BMP (infiltration surface) is proposed to be located in a fill location, the infiltration surface may not exist prior to grading. How then can the infiltration rate be determined? For example, if a proposed infiltration BMP is to be located with its bottom elevation in 10 feet of fill, how could one reasonably establish an infiltration rate prior to the fill being placed?

Where possible, infiltration BMPs on fill material should be designed such that their infiltrating surface extends into native soils. Additionally, for shallow fill depths, fill material can be selectively graded (i.e., high permeability granular material placed below proposed BMPs) to provide reliable infiltration properties until the infiltrating water reaches native soils. In some cases, due to considerable fill depth, the extension of the BMP down to natural soil and/or selective grading of fill material may prove infeasible. In addition, fill material will result in some compaction of now buried native soils potentially reducing their ability to infiltrate. In these cases, because of the uncertainty of fill parameters as described above as well as potential compaction of the native soils, an infiltration BMP may not be feasible.

If the source of fill material is defined and this material is known to be of a granular nature and that the native soils below is permeable and will not be highly compacted, infiltration through compacted fill materials may still be feasible. In this case, a project phasing approach could be used including the following general steps, (1) collect samples from areas expected to be used as borrow sites for fill activities, (2) remold samples to approximately the proposed degree of compaction and measure the saturated hydraulic conductivity of remolded samples using laboratory methods, (3) if infiltration rates appear adequate for infiltration, then apply an appropriate factor of safety and use the initial rates for preliminary design, (4) following placement of fill, conduct in-situ testing to refine design infiltration rates and adjust the design as needed; the infiltration rate of native soil below the fill should also be tested at this time to determine if compaction as a result of fill placement has significantly reduced its infiltration rate. The project geotechnical engineer should be involved in

decision making whenever infiltration is proposed in the vicinity of engineered fill structures so that potential impacts of infiltration on the strength and stability of fills and pavement structures can be evaluated.

D.4.3 Effects of Direct and Incidental Compaction

It is widely recognized that compaction of soil has a major influence on infiltration rates (Pitt et al. 2008). However, direct (intentional) compaction is an essential aspect of project construction and indirect compaction (such as by movement of machinery, placement of fill, stockpiling of materials, and foot traffic) can be difficult to avoid in some parts of the project site. Infiltration testing strategies should attempt to measure soils at a degree of compaction that resembles anticipated post-construction conditions.

Ideally, infiltration systems should be located outside of areas where direct compaction will be required and should be staked off to minimize incidental compaction from vehicles and stockpiling. For these conditions, no adjustment of test results is needed.

However, in some cases, infiltration BMPs will be constructed in areas to be compacted. For these areas, it may be appropriate to include field compaction tests or prepare laboratory samples and conducting infiltration testing to approximate the degree of compaction that will occur in post-construction conditions. Alternatively, testing could be conducted on undisturbed soil, and an additional factor of safety could be applied to account for anticipated infiltration after compaction. To develop a factor of safety associated with incidental compaction, samples could compacted to various degrees of compaction, their hydraulic conductivity measured, and a "response curve" developed to relate the degree of compaction to the hydraulic conductivity of the material.

D.4.4 Temperature Effects on Infiltration Rate

The rate of infiltration through soil is affected by the viscosity of water, which in turn is affected by the temperature of water. As such, infiltration rate is strongly dependent on the temperature of the infiltrating water (Cedergren, 1997). For example, Emerson (2008) found that wintertime infiltration rates below a BMP in Pennsylvania were approximately half their peak summertime rates. As such, it is important to consider the effects of temperature when planning tests and interpreting results.

If possible, testing should be conducted at a temperature that approximates the typical runoff temperatures for the site during the times when rainfall occurs. If this is not possible, then the results of infiltration tests should be adjusted to account for the difference between the temperature at the time of testing and the typical temperature of runoff when rainfall occurs. The measured infiltration can be adjusted by the ratio of the viscosity at the test temperature versus the typical temperature when rainfall occurs (Cedergren, 1997), per the following formula:

$$K_{Typical} = K_{Test} \times \left(\frac{\mu_{Test}}{\mu_{Typical}} \right)$$

Where:

$K_{Typical}$ = the typical infiltration rate expected at typical temperatures when rainfall occurs

K_{Test} = the infiltration rate measured or estimated under the conditions of the test

$\mu_{Typical}$ = the viscosity of water at the typical temperature expected when rainfall occurs

μ_{Test} = the viscosity of water at the temperature at which the test was conducted

D.4.5 Number of Infiltration Tests Needed

The heterogeneity inherent in soils implies that all but the smallest proposed infiltration facilities would benefit from infiltration tests in multiple locations. The following requirements apply for in situ infiltration/percolation testing:

- In situ infiltration/ percolation testing must be conducted at a minimum of two locations within 50-feet of each proposed storm water infiltration/ percolation BMP.
- In situ infiltration/percolation testing must be conducted using an approved method listed in Table D.3-1
- Testing must be conducted at approximately the same depth and in the same material as the base of the proposed storm water BMP.

D.5 Selecting a Safety Factor

Should I use a factor of safety for design infiltration rate?

Monitoring of actual facility performance has shown that the full-scale infiltration rate can be much lower than the rate measured by small-scale testing (King County Department of Natural Resources and Parks, 2009). Factors such as soil variability and groundwater mounding may be responsible for much of this difference. Additionally, the infiltration rate of BMPs naturally declines between maintenance cycles as the BMP surface becomes occluded and particulates accumulate in the infiltrative layer.

In the past, infiltration structures have been shown to have a relatively short lifespan. Over 50 percent of infiltration systems either partially or completely failed within the first 5 years of operation (United States EPA. 1999). In a Maryland study on infiltration trenches (Lindsey et al. 1991), 53 percent were not operating as designed, 36 percent were clogged, and 22 percent showed reduced filtration. In a study of 12 infiltration basins (Galli 1992), none of which had built-in pretreatment systems, all had failed within the first two years of operation.

Given the known potential for infiltration BMPs to degrade or fail over time, an appropriate factor of safety applied to infiltration testing results is strongly recommended. This section presents a recommended thought process for selecting a safety factor. This method considers factor of safety

to be a function of:

- Site suitability considerations, and
- Design-related considerations.

These factors and the method for using them to compute a safety factor are discussed below. Importantly, this method encourages rigorous site investigation, good pretreatment, and commitments to routine maintenance to provide technically-sound justification for using a lower factor of safety.

D.5.1 Determining Factor of Safety

Worksheet D.5-1, at the end of this section can be used in conjunction with Tables D.5-1 and D.5-2 to determine an appropriate safety factor. Tables D.5-1 and D.5-2 assign point values to design considerations; the values are entered into Worksheet D.5-1, which assign a weighting factor for each design consideration.

The following procedure can be used to estimate an appropriate factor of safety to be applied to the infiltration testing results. When assigning a factor of safety, care should be taken to understand what other factors of safety are implicit in other aspects of the design to avoid incorporating compounding factors of safety that may result in significant over-design.

1. For each consideration shown above, determine whether the consideration is a high, medium, or low concern.
2. For all high concerns in Table D.5-1, assign a factor value of 3, for medium concerns, assign a factor value of 2, and for low concerns assign a factor value of 1.
3. Multiply each of the factors in Table D.5-1 by 0.25 and then add them together. This should yield a number between 1 and 3.
4. For all high concerns in Table D.5-2, assign a factor value of 3, for medium concerns, assign a factor value of 2, and for low concerns assign a factor value of 1.
5. Multiply each of the factors in Table D.5-2 by 0.5 and then add them together. This should yield a number between 1 and 3.
6. Multiply the two safety factors together to get the final combined safety factor. If the combined safety factor is less than 2, then 2 should be used as the safety factor.
7. Divide the tested infiltration rate by the combined safety factor to obtain the adjusted design infiltration rate for use in sizing the infiltration facility.

Note: The minimum combined adjustment factor should not be less than 2.0 and the maximum combined adjustment factor should not exceed 9.0.

D.5.2 Site Suitability Considerations for Selection of an Infiltration Factor of Safety

Considerations related to site suitability include:

- Soil assessment methods – the site assessment extent (e.g., number of borings, test pits, etc.) and the measurement method used to estimate the short-term infiltration rate.
- Predominant soil texture/percent fines – soil texture and the percent of fines can influence the potential for clogging. Finer grained soils may be more susceptible to clogging.
- Site soil variability – site with spatially heterogeneous soils (vertically or horizontally) as determined from site investigations are more difficult to estimate average properties for resulting in a higher level of uncertainty associated with initial estimates.
- Depth to seasonal high groundwater/impervious layer – groundwater mounding may become an issue during excessively wet conditions where shallow aquifers or shallow clay lenses are present.

These considerations are summarized in Table D.5-1 below, in addition to presenting classification of concern.

Table D.5-1: Suitability Assessment Related Considerations for Infiltration Facility Safety Factors

Consideration	High Concern – 3 points	Medium Concern – 2 points	Low Concern – 1 point
Assessment methods (see explanation below)	Use of soil survey maps or simple texture analysis to estimate short-term infiltration rates Use of well permeameter or borehole methods without accompanying continuous boring log Relatively sparse testing with direct infiltration methods	Use of well permeameter or borehole methods with accompanying continuous boring log Direct measurement of infiltration area with localized infiltration measurement methods (e.g., infiltrometer) Moderate spatial resolution	Direct measurement with localized (i.e., small-scale) infiltration testing methods at relatively high resolution[1] or Use of extensive test pit infiltration measurement methods[2]
Texture Class	Silty and clayey soils with significant fines	Loamy soils	Granular to slightly loamy soils
Site soil variability	Highly variable soils indicated from site assessment, or Unknown variability	Soil borings/test pits indicate moderately homogeneous soils	Soil borings/test pits indicate relatively homogeneous soils
Depth to groundwater/ impervious layer	<5 ft below facility bottom	5-15 ft below facility bottom	>15 below facility bottom

1 - Localized (i.e., small scale) testing refers to methods such as the double-ring infiltrometer and borehole tests)

2 - Extensive infiltration testing refers to methods that include excavating a significant portion of the proposed infiltration area, filling the excavation with water, and monitoring drawdown. The excavation should be to the depth of the proposed infiltration surface and ideally be at least 30 to 100 square feet.

D.5.3 Design Related Considerations for Selection of an Infiltration Factor of Safety

Design related considerations include:

- Level of pretreatment and expected influent sediment loads – credit should be given for good pretreatment to account for the reduced probability of clogging from high sediment loading. Appendix B.6 describes performance criteria for "flow-thru treatment" based 80 percent capture of total suspended solids, which provides excellent levels of pretreatment. Additionally, the Washington State Technology Acceptance Protocol-Ecology provides a certification for "pre-treatment" based on 50 percent removal of TSS, which provides moderate levels of treatment. Current approved technologies are listed at: http://www.ecy.wa.gov/programs/wq/storm_water/newtech/technologies.html. Use of certified technologies can allow a lower factor of safety. Also, facilities designed to capture runoff from relatively clean surfaces such as rooftops are likely to see low sediment loads and

therefore may be designed with lower safety factors. Finally, the amount of landscaped area and its vegetation coverage characteristics should be considered. For example in arid areas with more soils exposed, open areas draining to infiltration systems may contribute excessive sediments.

- Compaction during construction – proper construction oversight is needed during construction to ensure that the bottoms of infiltration facility are not impacted by significant incidental compaction. Facilities that use proper construction practices and oversight need less restrictive safety factors.

Table D.5-2: Design Related Considerations for Infiltration Facility Safety Factors

Consideration	High Concern – 3 points	Medium Concern – 2 points	Low Concern – 1 point
Level of pretreatment/ expected influent sediment loads	Limited pretreatment using gross solids removal devices only, such as hydrodynamic separators, racks and screens AND tributary area includes landscaped areas, steep slopes, high traffic areas, road sanding, or any other areas expected to produce high sediment, trash, or debris loads.	Good pretreatment with BMPs that mitigate coarse sediments such as vegetated swales AND influent sediment loads from the tributary area are expected to be moderate (e.g., low traffic, mild slopes, stabilized pervious areas, etc.). Performance of pretreatment consistent with "pretreatment BMP performance criteria" (50% TSS removal) in Appendix B.6	Excellent pretreatment with BMPs that mitigate fine sediments such as bioretention or media filtration OR sedimentation or facility only treats runoff from relatively clean surfaces, such as rooftops/non-sanded road surfaces. Performance of pretreatment consistent with "flow-thru treatment control BMP performance criteria" (i.e., 80% TSS removal) in Appendix B.6
Redundancy/ resiliency	No "backup" system is provided; the system design does not allow infiltration rates to be restored relatively easily with maintenance	The system has a backup pathway for treated water to discharge if clogging occurs or infiltration rates can be restored via maintenance.	The system has a backup pathway for treated water to discharge if clogging occurs and infiltration rates can be relatively easily restored via maintenance.
Compaction during construction	Construction of facility on a compacted site or increased probability of unintended/ indirect compaction.	Medium probability of unintended/ indirect compaction.	Equipment traffic is effectively restricted from infiltration areas during construction and there is low probability of unintended/ indirect compaction.

D.5.4 Implications of a Factor of Safety in BMP Feasibility and Design

The above method will provide safety factors in the range of 2 to 9. From a simplified practical perspective, this means that the size of the facility will need to increase in area from 2 to 9 times relative to that which might be used without a safety factor. Clearly, numbers toward the upper end of this range will make all but the best locations prohibitive in land area and cost.

In order to make BMPs more feasible and cost effective, steps should be taken to plan and execute the implementation of infiltration BMPs in a way that will reduce the safety factors needed for those projects. A commitment to effective site design and source control thorough site investigation, use of effective pretreatment controls, good construction practices, and restoration of the infiltration rates of soils that are damaged by prior compaction should lower the safety factor that should be applied, to help improve the long term reliability of the system and reduce BMP construction cost. While these practices decrease the recommended safety factor, they do not totally mitigate the need to apply a factor of safety. The minimum recommended safety factor of 2.0 is intended to account for the remaining uncertainty and long-term deterioration that cannot be technically mitigated.

Because there is potential for an applicant to "exaggerate" factor of safety to artificially prove infeasibility, an upper cap on the factor of safety is proposed for feasibility screening. A maximum factor of safety of 2.0 is recommended for infiltration feasibility screening such that an artificially high factor of safety cannot be used to inappropriately rule out infiltration, unless justified. If the site passes the feasibility analysis at a factor of safety of 2.0, then infiltration must investigated, but a higher factor of safety may be selected at the discretion of the design engineer.

Worksheet D.5-1: Factor of Safety and Design Infiltration Rate Worksheet

Factor of Safety and Design Infiltration Rate Worksheet			Worksheet D.5-1		
Factor Category		Factor Description	Assigned Weight (w)	Factor Value (v)	Product (p) p = w x v
A	Suitability Assessment	Soil assessment methods	0.25		
		Predominant soil texture	0.25		
		Site soil variability	0.25		
		Depth to groundwater / impervious layer	0.25		
		Suitability Assessment Safety Factor, $S_A = \Sigma p$			
B	Design	Level of pretreatment/ expected sediment loads	0.5		
		Redundancy/resiliency	0.25		
		Compaction during construction	0.25		
		Design Safety Factor, $S_B = \Sigma p$			
Combined Safety Factor, $S_{total} = S_A \times S_B$					
Observed Infiltration Rate, inch/hr, $K_{observed}$ (corrected for test-specific bias)					
Design Infiltration Rate, in/hr, $K_{design} = K_{observed} / S_{total}$					
Supporting Data					
Briefly describe infiltration test and provide reference to test forms:					

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Appendix

E

BMP Design Fact Sheets

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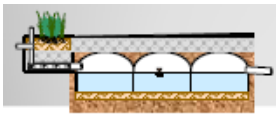
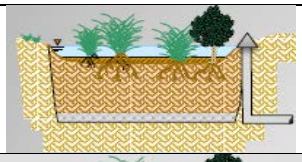
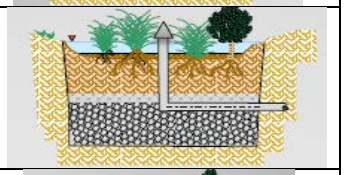
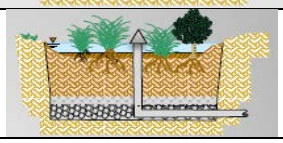
Appendix E BMP Design Fact Sheets

The following fact sheets were developed to assist the project applicants with designing BMPs to meet the storm water obligations:

MS4 Category	Manual Category	Design Fact Sheet	Typical Design
Source Control	Source Control	SC: Source Control BMP Requirements SC-6A: Large Trash Generating Facilities SC-6B: Animal Facilities SC-6C: Plant Nurseries and Garden Centers SC-6D: Automotive-related Uses	
Site Design	Site Design	SD-A Tree Wells SD-B: Impervious Area Dispersion SD-C: Green Roofs SD-D: Permeable Pavement (Site Design BMP) SD-E: Rain Barrels SD-F: Amended Soil	
Retention	Harvest and Use	HU-1: Cistern	
	Infiltration	INF-1: Infiltration Basins INF-2: Bioretention INF-3: Permeable Pavement (Pollutant Control)	
	Partial Retention	PR-1: Biofiltration with Partial Retention	
Biofiltration	Biofiltration	BF-1: Biofiltration BF-2: Nutrient Sensitive Media Design BF-3: Proprietary Biofiltration	
Flow-thru Treatment Control	Flow-thru Treatment Control with Alternative Compliance	FT-1: Vegetated Swales FT-2: Media Filters FT-3: Sand Filters FT-4: Dry Extended Detention Basin FT-5: Proprietary Flow-thru Treatment Control	
		PL: Plant List for Bioretention Facilities	

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E.1 Source Control BMP Requirements

Worksheet E.1-1: Source Control BMP Requirements

How to comply: Projects must comply with this requirement by implementing all source control BMPs listed in this section that are applicable and feasible for their project. Applicability must be determined through consideration of the development project's features and anticipated pollutant sources. Appendix E.1 provides guidance for identifying source control BMPs applicable to a project. The Standard and PDP SWQMP templates include sections that must be used to document compliance with source control BMP requirements.

How to use this worksheet:

1. Review Column 1 and identify which of these potential sources of storm water pollutants apply to your site. Check each box that applies.
2. Review Column 2 and incorporate all of the corresponding applicable BMPs in your project site plan.
3. Review Columns 3 and 4 and incorporate all of the corresponding applicable permanent controls and operational BMPs in a table in your project-specific storm water management report. Describe your specific BMPs in an accompanying narrative, and explain any special conditions or situations that required omitting BMPs or substituting alternatives.

If These Sources Will Be on the Project Site …	… Then Your SWQMP Must Consider These Source Control BMPs		
1 **Potential Sources of Runoff Pollutants**	**2** **Permanent Controls—Show on Drawings**	**3** **Permanent Controls—List in Table and Narrative**	**4** **Operational BMPs—Include in Table and Narrative**
❑ **A.** Onsite storm drain inlets ❑ Not Applicable	❑ Locations of inlets.	❑ Mark all inlets with the words "No Dumping! Flows to Bay" or similar. See stencil template provided in Appendix I-4	❑ Maintain and periodically repaint or replace inlet markings. ❑ Provide storm water pollution prevention information to new site owners, lessees, or operators. ❑ See applicable operational BMPs in Fact Sheet SC-44, "Drainage System Maintenance," in the CASQA Storm Water Quality Handbooks at www.casqa.org/resources/bmp-handbooks/municipal-bmp-handbook. ❑ Include the following in lease agreements: "Tenant shall not allow anyone to discharge anything to storm drains or to store or deposit materials so as to create a potential discharge to storm drains."

If These Sources Will Be on the Project Site …	… Then Your SWQMP must consider These Source Control BMPs		
1 **Potential Sources of Runoff Pollutants**	**2** **Permanent Controls—Show on Drawings**	**3** **Permanent Controls—List in Table and Narrative**	**4** **Operational BMPs—Include in Table and Narrative**
❑ **B.** Interior floor drains and elevator shaft sump pumps ❑ Not Applicable		❑ State that interior floor drains and elevator shaft sump pumps will be plumbed to sanitary sewer.	❑ Inspect and maintain drains to prevent blockages and overflow.
❑ **C.** Interior parking garages ❑ Not Applicable		❑ State that parking garage floor drains will be plumbed to the sanitary sewer.	❑ Inspect and maintain drains to prevent blockages and overflow.
❑ **D1.** Need for future indoor & structural pest control ❑ Not Applicable		❑ Note building design features that discourage entry of pests.	❑ Provide Integrated Pest Management information to owners, lessees, and operators.

If These Sources Will Be on the Project Site …	… Then Your SWQMP must consider These Source Control BMPs		
1 **Potential Sources of Runoff Pollutants**	**2** **Permanent Controls—Show on Drawings**	**3** **Permanent Controls—List in Table and Narrative**	**4** **Operational BMPs—Include in Table and Narrative**
❑ **D2.** Landscape/ Outdoor Pesticide Use ❑ Not Applicable	❑ Show locations of existing trees or areas of shrubs and ground cover to be undisturbed and retained. ❑ Show self-retaining landscape areas, if any. ❑ Show storm water treatment facilities.	State that final landscape plans will accomplish all of the following. ❑ Preserve existing drought tolerant trees, shrubs, and ground cover to the maximum extent possible. ❑ Design landscaping to minimize irrigation and runoff, to promote surface infiltration where appropriate, and to minimize the use of fertilizers and pesticides that can contribute to storm water pollution. ❑ Where landscaped areas are used to retain or detain storm water, specify plants that are tolerant of periodic saturated soil conditions. ❑ Consider using pest-resistant plants, especially adjacent to hardscape. ❑ To ensure successful establishment, select plants appropriate to site soils, slopes, climate, sun, wind, rain, land use, air movement, ecological consistency, and plant interactions.	❑ Maintain landscaping using minimum or no pesticides. ❑ See applicable operational BMPs in Fact Sheet SC-41, "Building and Grounds Maintenance," in the CASQA Storm Water Quality Handbooks at www.casqa.org/resources/bmp-handbooks/municipal-bmp-handbook. ❑ Provide IPM information to new owners, lessees and operators.

If These Sources Will Be on the Project Site …	… Then Your SWQMP must consider These Source Control BMPs		
1 **Potential Sources of Runoff Pollutants**	**2** **Permanent Controls—Show on Drawings**	**3** **Permanent Controls—List in Table and Narrative**	**4** **Operational BMPs—Include in Table and Narrative**
❑ **E.** Pools, spas, ponds, decorative fountains, and other water features. ❑ Not Applicable	❑ Show location of water feature and a sanitary sewer cleanout in an accessible area within 10 feet.	❑ If the local municipality requires pools to be plumbed to the sanitary sewer, place a note on the plans and state in the narrative that this connection will be made according to local requirements.	❑ See applicable operational BMPs in Fact Sheet SC-72, "Fountain and Pool Maintenance," in the CASQA Storm Water Quality Handbooks at www.casqa.org/resources/bmp-handbooks/municipal-bmp-handbook.
❑ **F.** Food service ❑ Not Applicable	❑ For restaurants, grocery stores, and other food service operations, show location (indoors or in a covered area outdoors) of a floor sink or other area for cleaning floor mats, containers, and equipment. ❑ On the drawing, show a note that this drain will be connected to a grease interceptor before discharging to the sanitary sewer.	❑ Describe the location and features of the designated cleaning area. ❑ Describe the items to be cleaned in this facility and how it has been sized to ensure that the largest items can be accommodated.	

If These Sources Will Be on the Project Site …	… Then Your SWQMP must consider These Source Control BMPs		
1 **Potential Sources of**	2 **Permanent Controls—Show on Drawings**	3 **Permanent Controls—List in Table and Narrative**	4 **Operational BMPs—Include in Table and Narrative**
❑ **G.** Refuse areas ❑ Not Applicable	❑ Show where site refuse and recycled materials will be handled and stored for pickup. See local municipal requirements for sizes and other details of refuse areas. ❑ If dumpsters or other receptacles are outdoors, show how the designated area will be covered, graded, and paved to prevent run-on and show locations of berms to prevent runoff from the area. Also show how the designated area will be protected from wind dispersal. ❑ Any drains from dumpsters, compactors, and tallow bin areas must be connected to a grease removal device before discharge to sanitary sewer.	❑ State how site refuse will be handled and provide supporting detail to what is shown on plans. ❑ State that signs will be posted on or near dumpsters with the words "Do not dump hazardous materials here" or similar.	❑ State how the following will be implemented: Provide adequate number of receptacles. Inspect receptacles regularly; repair or replace leaky receptacles. Keep receptacles covered. Prohibit/prevent dumping of liquid or hazardous wastes. Post "no hazardous materials" signs. Inspect and pick up litter daily and clean up spills immediately. Keep spill control materials available on- site. See Fact Sheet SC-34, "Waste Handling and Disposal" in the CASQA Storm Water Quality Handbooks at www.casqa.org/resources/bmp-handbooks/municipal-bmp-handbook.

If These Sources Will Be on the Project Site …	… Then Your SWQMP must consider These Source Control BMPs		
1 **Potential Sources of Runoff Pollutants**	**2** **Permanent Controls—Show on Drawings**	**3** **Permanent Controls—List in Table and Narrative**	**4** **Operational BMPs—Include in Table and Narrative** **Table and Narrative**
❑ **H.** Industrial processes. ❑ Not Applicable	❑ Show process area.	❑ If industrial processes are to be located onsite, state: "All process activities to be performed indoors. No processes to drain to exterior or to storm drain system."	❑ See Fact Sheet SC-10, "Non-Storm Water Discharges" in the CASQA Storm Water Quality Handbooks at https://www.casqa.org/resources/bmp-handbooks.
❑ **I.** Outdoor storage of equipment or materials. (See rows J and K for source control measures for vehicle cleaning, repair, and maintenance.) ❑ Not Applicable	❑ Show any outdoor storage areas, including how materials will be covered. Show how areas will be graded and bermed to prevent run-on or runoff from area and protected from wind dispersal. ❑ Storage of non-hazardous liquids must be covered by a roof and/or drain to the sanitary sewer system, and be contained by berms, dikes, liners, or vaults. ❑ Storage of hazardous materials and wastes must be in compliance with the local hazardous materials ordinance and a Hazardous Materials Management Plan for the site.	❑ Include a detailed description of materials to be stored, storage areas, and structural features to prevent pollutants from entering storm drains. Where appropriate, reference documentation of compliance with the requirements of local Hazardous Materials Programs for: ▪ Hazardous Waste Generation ▪ Hazardous Materials Release Response and Inventory ▪ California Accidental Release Prevention Program ▪ Aboveground Storage Tank ▪ Uniform Fire Code Article 80 Section 103(b) & (c) 1991 ▪ Underground Storage Tank	❑ See the Fact Sheets SC-31, "Outdoor Liquid Container Storage" and SC-33, "Outdoor Storage of Raw Materials" in the CASQA Storm Water Quality Handbooks at www.casqa.org/resources/bmp-handbooks/municipal-bmp-handbook.

If These Sources Will Be on the Project Site …	… Then Your SWQMP must consider These Source Control BMPs		
1 **Potential Sources of Runoff Pollutants**	**2** **Permanent Controls—Show on Drawings**	**3** **Permanent Controls—List in Table and Narrative**	**4** **Operational BMPs—Include in Table and Narrative**
❑ **J.** Vehicle and Equipment Cleaning ❑ Not Applicable	❑ Show on drawings as appropriate: (1) Commercial/industrial facilities having vehicle /equipment cleaning needs must either provide a covered, bermed area for washing activities or discourage vehicle/equipment washing by removing hose bibs and installing signs prohibiting such uses. (2) Multi-dwelling complexes must have a paved, bermed, and covered car wash area (unless car washing is prohibited onsite and hoses are provided with an automatic shut-off to discourage such use). (3) Washing areas for cars, vehicles, and equipment must be paved, designed to prevent run-on to or runoff from the area, and plumbed to drain to the sanitary sewer. (4) Commercial car wash facilities must be designed such that no runoff from the facility is discharged to the storm drain system. Wastewater from the facility must discharge to the sanitary sewer, or a wastewater reclamation system must be installed.	❑ If a car wash area is not provided, describe measures taken to discourage onsite car washing and explain how these will be enforced.	Describe operational measures to implement the following (if applicable): ❑ Washwater from vehicle and equipment washing operations must not be discharged to the storm drain system. ❑ Car dealerships and similar may rinse cars with water only. ❑ See Fact Sheet SC-21, "Vehicle and Equipment Cleaning," in the CASQA Storm Water Quality Handbooks at www.casqa.org/resources/bmp-handbooks/municipal-bmp-handbook.

If These Sources Will Be on the Project Site …	… Then Your SWQMP must consider These Source Control BMPs		
1 **Potential Sources of Runoff Pollutants**	**2** **Permanent Controls—Show on Drawings**	**3** **Permanent Controls—List in Table and Narrative**	**4** **Operational BMPs—Include in Table and Narrative**
❑ **K.** Vehicle/Equipment Repair and Maintenance ❑ Not Applicable	❑ Accommodate all vehicle equipment repair and maintenance indoors. Or designate an outdoor work area and design the area to protect from rainfall, run-on runoff, and wind dispersal. ❑ Show secondary containment for exterior work areas where motor oil, brake fluid, gasoline, diesel fuel, radiator fluid, acid-containing batteries or other hazardous materials or hazardous wastes are used or stored. Drains must not be installed within the secondary containment areas. ❑ Add a note on the plans that states either (1) there are no floor drains, or (2) floor drains are connected to wastewater pretreatment systems prior to discharge to the sanitary sewer and an industrial waste discharge permit will be obtained.	❑ State that no vehicle repair or maintenance will be done outdoors, or else describe the required features of the outdoor work area. ❑ State that there are no floor drains or if there are floor drains, note the agency from which an industrial waste discharge permit will be obtained and that the design meets that agency's requirements. ❑ State that there are no tanks, containers or sinks to be used for parts cleaning or rinsing or, if there are, note the agency from which an industrial waste discharge permit will be obtained and that the design meets that agency's requirements.	In the report, note that all of the following restrictions apply to use the site: ❑ No person must dispose of, nor permit the disposal, directly or indirectly of vehicle fluids, hazardous materials, or rinsewater from parts cleaning into storm drains. ❑ No vehicle fluid removal must be performed outside a building, nor on asphalt or ground surfaces, whether inside or outside a building, except in such a manner as to ensure that any spilled fluid will be in an area of secondary containment. Leaking vehicle fluids must be contained or drained from the vehicle immediately. ❑ No person must leave unattended drip parts or other open containers containing vehicle fluid, unless such containers are in use or in an area of secondary containment.

If These Sources Will Be on the Project Site …	… Then Your SWQMP must consider These Source Control BMPs		
1 **Potential Sources of Runoff Pollutants**	2 **Permanent Controls—Show on Drawings**	3 **Permanent Controls—List in Table and Narrative**	4 **Operational BMPs—Include in Table and Narrative**
❑ **L.** Fuel Dispensing Areas ❑ Not Applicable	❑ Fueling areas[16] must have impermeable floors (i.e., portland cement concrete or equivalent smooth impervious surface) that are (1) graded at the minimum slope necessary to prevent ponding; and (2) separated from the rest of the site by a grade break that prevents run-on of storm water to the MEP. ❑ Fueling areas must be covered by a canopy that extends a minimum of ten feet in each direction from each pump. [Alternative: The fueling area must be covered and the cover's minimum dimensions must be equal to or greater than the area within the grade break or fuel dispensing area1.] The canopy [or cover] must not drain onto the fueling area.		❑ The property owner must dry sweep the fueling area routinely. ❑ See the Business Guide Sheet, "Automotive Service—Service Stations" in the CASQA Storm Water Quality Handbooks at https://www.casqa.org/resources/bmp-handbooks.

[16] The fueling area must be defined as the area extending a minimum of 6.5 feet from the corner of each fuel dispenser or the length at which the hose and nozzle assembly may be operated plus a minimum of one foot, whichever is greater.

If These Sources Will Be on the Project Site …	… Then Your SWQMP must consider These Source Control BMPs		
1 **Potential Sources of Runoff Pollutants**	**2** **Permanent Controls—Show on Drawings**	**3** **Permanent Controls—List in**	**4** **Operational BMPs—Include in Table and Narrative**
M. Loading Docks ❑ Not Applicable	❑ Show a preliminary design for the loading dock area, including roofing and drainage. Loading docks must be covered and/or graded to minimize run-on to and runoff from the loading area. Roof downspouts must be positioned to direct storm water away from the loading area. Water from loading dock areas should be drained to the sanitary sewer where feasible. Direct connections to storm drains from depressed loading docks are prohibited. ❑ Loading dock areas draining directly to the sanitary sewer must be equipped with a spill control valve or equivalent device, which must be kept closed during periods of operation. ❑ Provide a roof overhang over the loading area or install door skirts (cowling) at each bay that enclose the end of the trailer.		❑ Move loaded and unloaded items indoors as soon as possible. ❑ See Fact Sheet SC-30, "Outdoor Loading and Unloading," in the CASQA Storm Water Quality Handbooks at www.casqa.org/resources/bmp-handbooks/municipal-bmp-handbook.

If These Sources Will Be on the Project Site …	… Then Your SWQMP must consider These Source Control BMPs		
1 **Potential Sources of Runoff Pollutants**	2 **Permanent Controls—Show on Drawings**	3 **Permanent Controls—List in Table and Narrative**	4 **Operational BMPs—Include in Table and Narrative**
❑ **N.** Fire Sprinkler Test Water ❑ Not Applicable		❑ Provide a means to drain fire sprinkler test water to the sanitary sewer.	❑ See the note in Fact Sheet SC-41, "Building and Grounds Maintenance," in the CASQA Storm Water Quality Handbooks at www.casqa.org/resources/bmp-handbooks/municipal-bmp-handbook
O. Miscellaneous Drain or Wash Water ❑ Boiler drain lines ❑ Condensate drain lines ❑ Rooftop equipment ❑ Drainage sumps ❑ Roofing, gutters, and trim ❑ Not Applicable		❑ Boiler drain lines must be directly or indirectly connected to the sanitary sewer system and may not discharge to the storm drain system. ❑ Condensate drain lines may discharge to landscaped areas if the flow is small enough that runoff will not occur. Condensate drain lines may not discharge to the storm drain system. ❑ Rooftop mounted equipment with potential to produce pollutants must be roofed and/or have secondary containment. ❑ Any drainage sumps onsite must feature a sediment sump to reduce the quantity of sediment in pumped water. ❑ Avoid roofing, gutters, and trim made of copper or other unprotected metals that may leach into runoff.	

If These Sources Will Be on the Project Site …	… Then Your SWQMP must consider These Source Control BMPs		
1 **Potential Sources of Runoff Pollutants**	2 **Permanent Controls—Show on Drawings**	3 **Permanent Controls—List in Table and Narrative**	4 **Operational BMPs—Include in Table and Narrative**
❑ **P.** Plazas, sidewalks, and parking lots. ❑ Not Applicable			❑ Plazas, sidewalks, and parking lots must be swept regularly to prevent the accumulation of litter and debris. Debris from pressure washing must be collected to prevent entry into the storm drain system. Washwater containing any cleaning agent or degreaser must be collected and discharged to the sanitary sewer and not discharged to a storm drain.

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E.2 SC-6A Large Trash Generating Facilities[17]



MS4 Permit Category

Source Control

Manual Category

Source Control

Applicable Performance Standard

Source Control

Primary Benefits

Source Control

Description

Storm water runoff from areas where trash is stored or disposed of can be polluted. In addition, loose trash and debris can be easily transported by water or wind to nearby storm drain inlets, channels, and/or creeks. Trash generating facilities that generate large amounts of trash require special attention to protect trash storage areas from rainfall, run-on, runoff, and wind dispersal. Large trash generating, or trash build-up areas, include but are not limited to restaurants, supermarkets, "big box" retail stores serving food, and pet stores. The County Engineer may designate additional facilities if they are likely to generate or accumulate large quantities of trash.

Design Adaptations for Project Goals

Source control BMPs reduce the amount of pollutants that are generated. This fact sheet contains details on the additional measures required to prevent or reduce pollutants in storm water runoff associated with trash storage and handling for large trash generating facilities. The requirements presented here are in addition to the requirements of SC-5 which requires all development projects to protect trash storage areas from rainfall, run-on, runoff, and

[17] Source: City of San Diego Storm Water Standards

wind dispersal:

- Areas where trash containers are stored must be enclosed on four sides to prevent off-site transport of trash. Four-sided trash enclosures typically consist of three walled sides and one gated side. Trash enclosures limit the potential for trash to pollute storm water runoff by limiting mobilization mechanisms (runoff, run-on, and wind dispersal).

  - Trash enclosures must be covered to minimize direct precipitation and prevent rainfall from entering enclosures. Structural overhead covers are required as container lids are often left open.

  - Enclosures must be hydraulically isolated from surrounding areas. Slabs shall be sloped such that any leaked materials will be contained within the enclosure. Drains must be provided that capture and direct potential leaks to the sanitary sewer or appropriate BMPs.

  - Divert runoff from surrounding areas away from the enclosure to prevent contamination and dispersion of collected materials.

  - Owner must provide BMP storm water training to employees. Employee participation is required to ensure that enclosures are properly maintained and kept clean.

Design Criteria and Considerations

All trash shall be stored in weather-protected receptacles/bins and recyclable materials shall be protected against adverse weather conditions, which might render the collected materials unmarketable. Trash enclosure dimensions will vary based on projected usage and the following information is offered as an aid in planning new projects. Businesses that use dumpsters must design the enclosure to accommodate three-yard containers at a minimum. The tenants may use any dumpster size that is appropriate for their needs, but the enclosure must be able to accommodate different tenants with varying waste production, including any recycling requirements. The design of the enclosure must be signed and sealed by a California licensed engineer. Substantiating structural calculations may be required. The location and design of the enclosure will require review and approval by the County Engineer. Building permits may be required.

The following recommendations for typical bin sizes are adopted from the City of Escondido trash enclosure guidelines. The following bin/container measurements are approximate (add 8" to width for side pockets):

Typical Trash Bin Sizes

Size	Width	Depth	Height (front)	Height (back)
3 cubic yard	72" bin, 81" plus lid	43"	42"	70"
4 cubic yard	72" bin, 81" plus lid	56"	72"	72"

1. Enclosures shall be structurally strong and constructed of reinforced masonry block or wood panels/boards. Refer to County staff for specific guidelines.

2. The enclosure should be constructed to the following minimum inside dimensions to accommodate three cubic-yard dumpsters (larger enclosures may be necessary to accommodate additional trash bins, recycling bins, and accessibility)

No. of Bins	Loading	Width	Depth	Height
One	Front	6'	6'	6'
One	Side	8'	8'	6'
Two	Front	16'	6'	6'
Two	Side	8'	16'	6'

3. The enclosure slab should be designed to keep storm water drainage out of the enclosure area, typically sloped at 0.5%. Slab construction specifications will vary according to methods of construction, but should be at least 4 inches of reinforced concrete.

4. Sturdy gates/doors shall be installed on all enclosures. Gates should not be mounted directly onto the block wall or inside of enclosure. The enclosure should include hardware to secure the gate's doors both open and closed (i.e., cane bolt w/sleeve and latch between doors and sleeve in pavement).

5. To prevent trash enclosures from contributing to storm water runoff pollution, all enclosures must be fitted with a roof deigned to drain into on-site landscape areas (where necessary) and/or to appropriate BMPs. The roof must provide sufficient clearance to allow the dumpster lid to open to the 90 degree position.

6. Enclosure roofs not conforming to County specifications for Patio Covers may require a building permit. Generally roofs not more than 12 feet in height above grade and constructed with conventional light-frame wood construction are considered acceptable. The use of metal roofs is not recommended as they can act as a source of pollutants.

7. Dumpsters associated with food establishments shall be sized per County Health Department requirements for wash down. Drains shall be connected to the business grease interceptor.

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E.3 SC-6B Animal Facilities[18]



MS4 Permit Category

Source Control

Manual Category

Source Control

Applicable Performance Standard

Source Control

Primary Benefits

Source Control

Description

Animal facilities have an elevated potential for bacterial loading. If animal fecal material comes into contact with storm water, the storm water can become polluted. Animal facilities include but are not limited to animal shelters, dog daycare centers, veterinary clinics, groomers, pet care stores, and breeding, boarding, and training facilities. The County Engineer may designate additional facilities where animal fecal material is likely to be found.

Design Adaptations for Project Goals

Source control BMPs reduce the amount of pollutants that are generated. This fact sheet contains details on the additional measures required to prevent or reduce pollutants in storm water runoff associated with animal facilities. The requirements presented here are in addition to the source control requirements for all projects:

- Dry weather runoff must be controlled. Dry weather runoff from hosed off areas as part of animal facility operations must not drain to the MS4. Dry weather flows should be retained on-site through implementation of BMPs or collected and discharged to the sanitary sewer.

- Outdoor activity areas must be identified on site plans. Plan reviewers must be able to ensure that runoff from these areas is either diverted to the sanitary sewer or directed to appropriate treatment BMPs. On-site inspection of facilities, grading, and drainage may be required.

[18] Source: City of San Diego Storm Water Standards

- Trash enclosures within animal facilities must be covered to minimize direct precipitation and prevent rainfall from entering enclosures. Structural overhead covers are required as container lids are often left open.

E.4 SC-6C Plant Nurseries and Garden Centers[19]



MS4 Permit Category
Source Control
Manual Category
Source Control
Applicable Performance Standard
Source Control
Primary Benefits
Source Control

Description

Storm water runoff from plant nurseries and garden centers has an elevated risk of being polluted by organics, nutrients, and/or pesticides. Nurseries and garden centers require special attention to protect against these elevated risks. Plant nurseries and garden centers include but are not limited to commercial facilities that grow, distribute, sell, or store plants and plant material. The County Engineer may designate additional facilities if they are likely to be a source of organics, nutrients or pesticides.

Design Adaptations for Project Goals

Source control BMPs reduce the amount of pollutants that are generated. This fact sheet contains details on the additional measures required to prevent or reduce pollutants in storm water runoff associated with plant nurseries or garden center facilities. The requirements presented here are in addition to the requirements of SC-1 through SC-5 which require all development projects to avoid and reduce pollutants in storm water runoff:

- Owner must provide BMP stormwater training to appropriate employees. Employee participation is required to ensure that source controls are properly maintained and behavioral BMPs are followed.

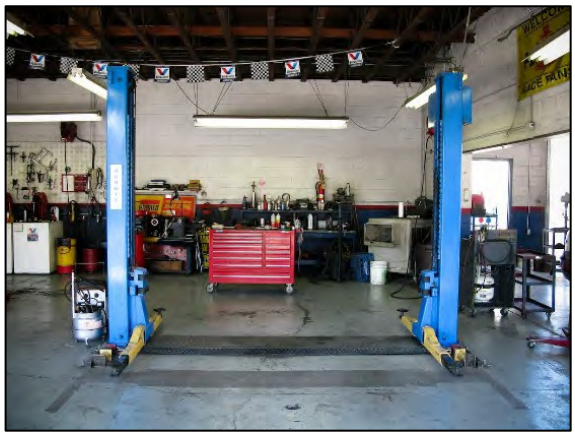
- Eliminate overwatering and overspraying of plants. Overwatering and overspraying of plants increases dry weather flows and pollutant loading, and wastes water. Delivery

[19] Source: City of San Diego Storm Water Standards

systems and schedules should account for different plant types and containers.

- Discharges from outdoor watering areas must be controlled. Regular runoff from outdoor watering can contribute un-authorized dry weather flows to the MS4 (e.g., runoff from watering the plants at garden centers). Runoff water is also likely to be polluted by potting soil mixes and plants that contain fertilizers and/or pesticides. So, regular runoff should be treated and/or retained on-site through BMPs or discharged to the sanitary sewer.

E.5 SC-6D Automotive Facilities[20]



MS4 Permit Category
Source Control
Manual Category
Source Control
Applicable Performance Standard
Source Control
Primary Benefits
Source Control

Description

Storm water runoff from automotive facilities can pollute storm water runoff with oils and grease, metals, and other pollutants. Pollutants sources can include maintenance and repair activities, outside storage areas, liquid material storage, and others. Automotive facilities require additional measures because of the potential impact of pollutants. Automotive facilities include but are not limited to facilities that perform maintenance or repair of vehicles, vehicle washing facilities, and retail gasoline outlets. County staff may designate additional facilities if they are likely sources of storm water pollutants.

Design Adaptations for Project Goals

Source control BMPs reduce the amount of pollutants that are generated. This fact sheet contains details on the additional measures required to prevent or reduce pollutants in storm water runoff associated with automotive facilities. The requirements presented here are in addition to the requirements of Sections 4.2.1 through 4.2.6, which require all development projects avoid and reduce pollutants in storm water runoff:

- **Auto repair, maintenance activities, fueling, and vehicle washing must be conducted in covered areas**. Activity areas must be protected from precipitation by permanent canopy or roof structures. Covers 10 feet high or less should have a minimum overhang of 3 feet on each side, covers higher than 10 feet should have a minimum overhang of 5 feet on each side. Overhang should be measured from the perimeter of the hydraulically isolated activity area.

[20] Source: City of San Diego Storm Water Standards

- **Hydraulically isolate activity areas**. Activity areas should be protected from run-on that can mobilize pollutants and pollute uncontaminated storm water through the use of grading, berms, or drains. Direct drainage from the hydraulically isolated area to an approved sanitary sewer or a BMP.

- **Pave activity areas with hydraulic concrete or appropriately sealed asphalt cement**.
  Unpaved activity areas could contaminate ground water. So all activity area, including area for fueling vehicles or equipment shall be paved with hydraulic concrete. If the area is already paved with asphalt, apply an asphalt sealant to the pavement surface. Maintain the paved surface to prevent gaps and cracks.

- **Provide sedimentation manhole with outlet**. Automotive facilities discharging to the sanitary sewer must follow County standards for wastewater discharge.

- **Provide appropriate oil controls**. All equipment and vehicle washing activity areas should include oil controls. On-site wash recycling systems may be used for oil control if they meet applicable effluent discharge limits for the sanitary sewer.

- **Identify auto-related usage areas on site plans and describe activities and drainage**.
  Plan checkers must be satisfied that grading and drainage will prevent contact between pollutants and storm water. Drains within the facilities must be connected to the sanitary sewer or a BMP. Verification may be required.

- **Owner must provide BMP storm water training to employees**. Employee participation is required to ensure that activity areas are properly maintained and kept clean.

E.6 SD-A Tree Wells



MS4 Permit Category
Site Design
Manual Category
Site Design
Applicable Performance Standard
Site Design
Primary Benefits
Volume Reduction

Tree Wells (Source: County of San Diego LID Manual – EOA, Inc.)

Description

Trees planted to intercept rainfall and runoff can be used as storm water management measures that provide additional benefits beyond those typically associated with trees, including energy conservation, air quality improvement, and aesthetic enhancement. Typical storm water management benefits associated with trees include:

- **Interception of rainfall** – tree surfaces (roots, foliage, bark, and branches) intercept, evaporate, store, or convey precipitation to the soil before it reaches surrounding impervious surfaces
- **Reduced erosion** – trees protect denuded area by intercepting or reducing the velocity of rain drops as they fall through the tree canopy
- **Increased infiltration** – soil conditions created by roots and fallen leaves promote infiltration
- **Treatment of storm water** – trees provide treatment through uptake of nutrients and other storm water pollutants (phytoremediation) and support of other biological processes that break down pollutants

Typical tree well system components include:

- Trees of the appropriate species for site conditions and constraints
- Available soil media reservoir volume based on mature tree size, soil type, water availability, surrounding land uses, and project goals

- Optional suspended pavement design to provide structural support for adjacent pavement without requiring compaction of underlying layers
- Optional root barrier devices as needed; a root barrier is a device installed in the ground, between a tree and the sidewalk, intended to guide roots down and away from the sidewalk in order to prevent sidewalk lifting from tree roots.
- Optional tree grates; to be considered to maximize available space for pedestrian circulation and to protect tree roots from compaction related to pedestrian circulation; tree grates are typically made up of porous material that will allow the runoff to soak through.
- Optional shallow surface depression for ponding of excess runoff
- Optional planter box drain

Design Adaptations for Project Goals

Site design BMP to provide incidental treatment. Tree wells primarily function as site design BMPs for incidental treatment. Benefits from tree wells are accounted for by adjustment factors presented in Appendix B.2. This credit can apply to non-tree wells also (that meet the same criteria).

Design Criteria and Considerations

Tree wells must meet the following design criteria and considerations. Deviations from the below criteria may be approved at the discretion of the County staff if it is determined to be appropriate:

	Siting and Design	*Intent/Rationale*
☐	**Tree species** is appropriately chosen for the development (private or public). For public rights-of-ways, local planning guidelines and zoning provisions for the permissible species and placement of trees are consulted. A list of trees appropriate for site design that can be used by all county municipalities are provided in Appendix E.25	Proper tree placement and species selection minimizes problems such as pavement damage by surface roots and poor growth.
☐	**Tree well placement:** ensure area is graded; and the well is located so that full amount of DCV reduction drains to the well.	Minimizes short-circuiting of run off and assures DCV reductions are retained onsite.

Siting and Design		*Intent/Rationale*
☐	**Location of trees planted along public streets** follows guidance on green infrastructure (Appendix K). Vehicle and pedestrian line of sight and clear recovery zones are considered in tree selection and placement. Unless exemption is granted by County staff the following minimum tree separation distance is followed <table><tr><th>Improvement</th><th>Minimum distance to tree well</th></tr><tr><td>Traffic Signal, Stop sign</td><td>20 feet</td></tr><tr><td>Underground Utility lines (except sewer)</td><td>5 feet</td></tr><tr><td>Sewer Lines</td><td>10 feet</td></tr><tr><td>Above ground utility structures (Transformers, Hydrants, Utility poles, etc.)</td><td>10 feet</td></tr><tr><td>Driveways</td><td>10 feet</td></tr><tr><td>Intersections (intersecting curb lines of two streets)</td><td>25 feet</td></tr></table>	Roadway safety for both vehicular and pedestrian traffic is a key consideration for placement along public streets.
☐	**Underground utilities and overhead wires** are considered in the design and avoided or circumvented. Underground utilities are routed around or through the planter in suspended pavement applications. All underground utilities are protected from water and root penetration.	Tree growth can damage utilities and overhead wires resulting in service interruptions. Protecting utilities routed through the planter prevents damage and service interruptions. Refer to Section 6.6 of the Green Streets Design Criteria in Appendix K for guidelines regarding utility placement and potential conflict with BMP facilities.

Siting and Design		*Intent/Rationale*
☐	**Suspended pavement** design was developed where appropriate to minimize soil compaction and improve infiltration and filtration capabilities. Suspended pavement was constructed with an approved structural cell.	Suspended pavement designs provide structural support without compaction of the underlying layers, thereby promoting tree growth. Recommended structural cells include poured in place concrete columns, Silva Cells manufactured by Deeproot Green Infrastructures and Stratacell and Stratavault systems manufactured by Citygreen Systems.
☐	A minimum soil volume of 2 cubic feet per square foot of canopy projection area is provided for each tree. Canopy projection area is the ground area beneath the tree, measured at the drip line.	The minimum soil volume ensures that there is adequate storage volume to allow for unrestricted evapotranspiration and infiltration. A lower amount of soil volume may be allowed at the discretion of County staff if certified by a landscape architect or agronomist. The retention credit from the tree is directly proportional to the soil volume provided for the tree.
☐	DCV from the tributary area draining to the tree is equal to or greater than the tree credit volume	The minimum tributary area ensures that the tree receives enough runoff to fully utilize the infiltration and evapotranspiration potential provided. In cases where the minimum tributary area is not provided, the tree credit volume must be reduced proportionately to the actual tributary area.

Siting and Design		*Intent/Rationale*
	Inlet opening to the tree that is at least 18 inches wide.	Design requirement to ensure that the runoff from the tributary area does not bypass the BMP.
☐	A minimum 2 inch drop in grade from the inlet to the finish grade of the tree.	Different inlet openings and drops in grade may be allowed at the discretion of County staff if calculations are shown that the diversion flow rate (Appendix B.1.2) from the tributary area can be conveyed to the tree. In cases where the inlet capacity is limiting the amount of runoff draining to the tree, the tree credit volume must be reduced proportionately.
	Grated inlets are allowed for pedestrian circulation. Grates need to be ADA compliant and have sufficient slip resistance.	

Conceptual Design and Sizing Approach for Site Design

1. Determine the areas where tree wells can be used in the site design to achieve incidental treatment. Tree wells reduce runoff volumes from the site. Refer to Appendix B.2. Document the proposed tree locations in the SWQMP.

2. When trees are proposed as a storm water pollutant control BMP, applicant must complete feasibility analysis in Appendix C and D and submit detailed calculations for the DCV treated by trees. Document the proposed tree locations, feasibility analysis and sizing calculations in the SWQMP. The following calculations should be performed and the smallest of the three should be used as the volume treated by trees:

    a. Delineate the DMA (tributary area) to the tree and calculate the associated DCV.

    b. Calculate the required diversion flow rate using Appendix B.1.2 and size the inlet required to covey this flow rate to the tree. If the proposed inlet cannot convey the diversion flow rate for the entire tributary area, then the DCV that enters the tree should be proportionally reduced.

        i. For example, 0.5 acre drains to the tree and the associated DCV is 820 ft^3. The required diversion flow rate is 0.10 ft^3/s, but only an inlet that can divert 0.05 ft^3/s could be installed.

        ii. Then the effective DCV draining to the tree = 820 ft^3 * (0.05/0.10) = 420 ft^3

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E.7 SD-B Impervious Area Dispersion



MS4 Permit Category
Site Design

Manual Category
Site Design

Applicable Performance Criteria
Site Design

Primary Benefits
Volume Reduction
Peak Flow Attenuation

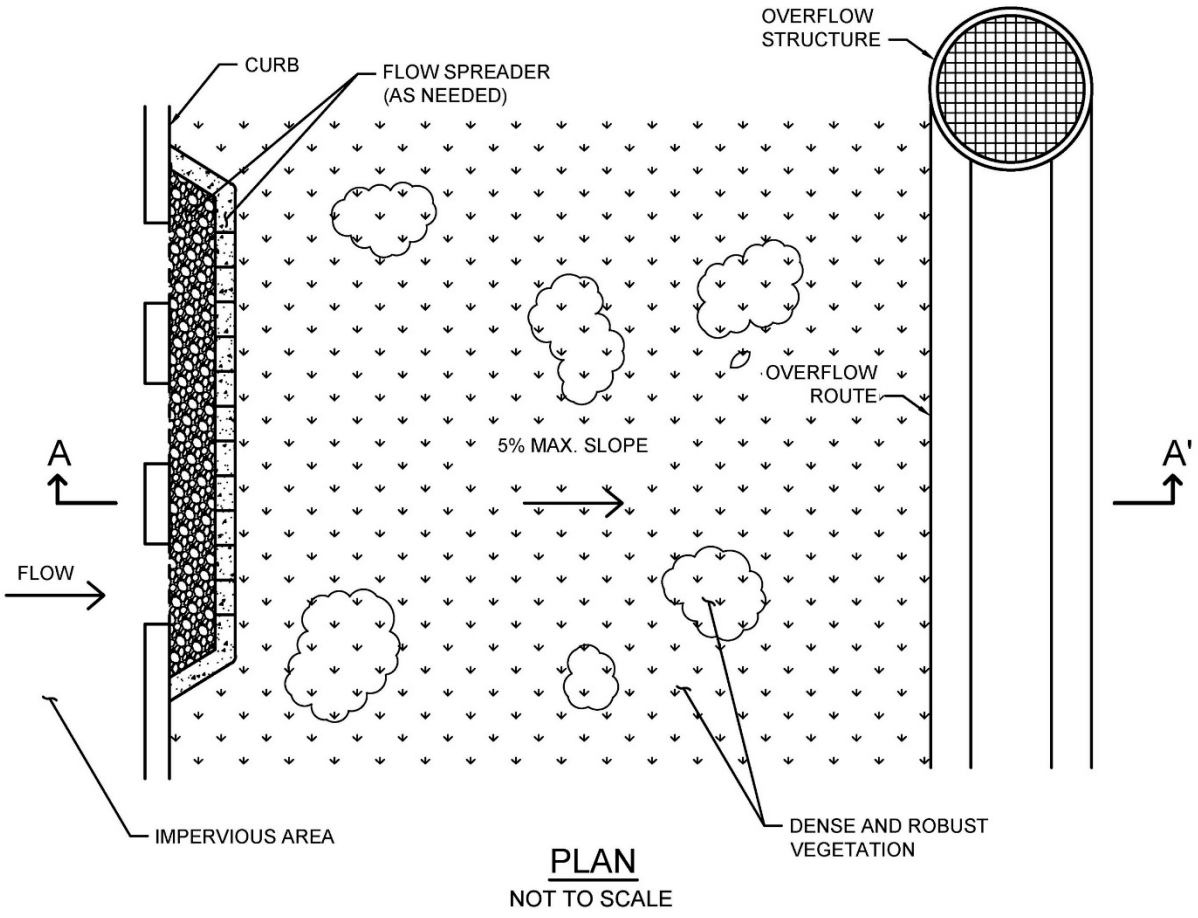
Photo Credit: Orange County Technical Guidance Document

Description

Impervious area dispersion (dispersion) refers to the practice of effectively disconnecting impervious areas from directly draining to the storm drain system by routing runoff from impervious areas such as rooftops (through downspout disconnection), walkways, and driveways onto the surface of adjacent pervious areas. The intent is to slow runoff discharges, and reduce volumes. Dispersion with partial or full infiltration results in significant volume reduction by means of infiltration and evapotranspiration.

Typical dispersion components include:

- An impervious surface from which runoff flows will be routed with minimal piping to limit concentrated inflows
- Splash blocks, flow spreaders, or other means of dispersing concentrated flows and providing energy dissipation as needed
- Dedicated pervious area, typically vegetated, with in-situ soil infiltration capacity for partial or full infiltration
- Optional soil amendments to improve vegetation support, maintain infiltration rates and enhance treatment of routed flows
- Overflow route for excess flows to be conveyed from dispersion area to the storm drain system or discharge point



Typical plan and section view of an Impervious Area Dispersion BMP

Design Adaptations for Project Goals

Site design BMP to reduce impervious area and DCV. Impervious area dispersion primarily functions as a site design BMP for reducing the effective imperviousness of a site by providing partial or full infiltration of the flows that are routed to pervious dispersion areas and otherwise slowing down excess flows that eventually reach the storm drain system. This can significantly reduce the DCV for the site.

Design Criteria and Considerations

Dispersion must meet the following design criteria. Deviations from the below criteria may be approved at the discretion of County Staff if it is determined to be appropriate:

Siting and Design		*Intent/Rationale*
☐	**Impervious area dispersion Placement:** ensure area is graded; and located so that full DCV water drains to the area of dispersion	Minimizes short-circuiting of run off
☐	Dispersion is over areas with soil types capable of supporting or being amended (e.g., with sand or compost) to support vegetation. Media amendments must be tested to verify that they are not a source of pollutants.	Soil must have long-term infiltration capacity for partial or full infiltration and be able to support vegetation to provide runoff treatment. Amendments to improve plant growth must not have negative impact on water quality.
☐	Dispersion has vegetated sheet flow over a relatively large distance (minimum 10 feet) from inflow to overflow route.	Full or partial infiltration requires relatively large areas to be effective depending on the permeability of the underlying soils.
☐	Pervious areas should be flat (with less than 5% slopes) and vegetated.	Flat slopes facilitate sheet flows and minimize velocities, thereby improving treatment and reducing the likelihood of erosion.
Inflow velocities		
☐	Inflow velocities are limited to 3 ft/s or less or use energy dissipation methods (e.g., riprap, level spreader) for concentrated inflows.	High inflow velocities can cause erosion, scour and/or channeling.
Dedication		

Siting and Design		*Intent/Rationale*
☐	Dispersion areas must be owned by the project owner and be dedicated for the purposes of dispersion to the exclusion of other future uses that might reduce the effectiveness of the dispersion area.	Dedicated dispersion areas prevent future conversion to alternate uses and facilitate continued full and partial infiltration benefits.

Vegetation

☐	Dispersion typically requires dense and robust vegetation for proper function. Drought tolerant species should be selected to minimize irrigation needs. A plant list to aid in selection can be found in Appendix E.25.	Vegetation improves resistance to erosion and aids in runoff treatment.

Conceptual Design and Sizing Approach for Site Design

1. Determine the areas where dispersion can be used in the site design to reduce the DCV for pollutant control sizing.
2. Calculate the DCV for storm water pollutant control per Appendix B.2, taking into account reduced runoff from dispersion.
3. Determine if a DMA is considered "Self-retaining" if the impervious to pervious ratio is:
    a. 2:1 when the pervious area is composed of Hydrologic Soil Group A
    b. 1:1 when the pervious area is composed of Hydrologic Soil Group B

E.8 SD-C: Green Roofs



MS4 Permit Category
Site Design

Manual Category
Site Design

Applicable Performance Standard
Site Design

Primary Benefits
Volume Reduction
Peak Flow Attenuation

Location: County of San Diego Operations Center, San Diego, California

Description

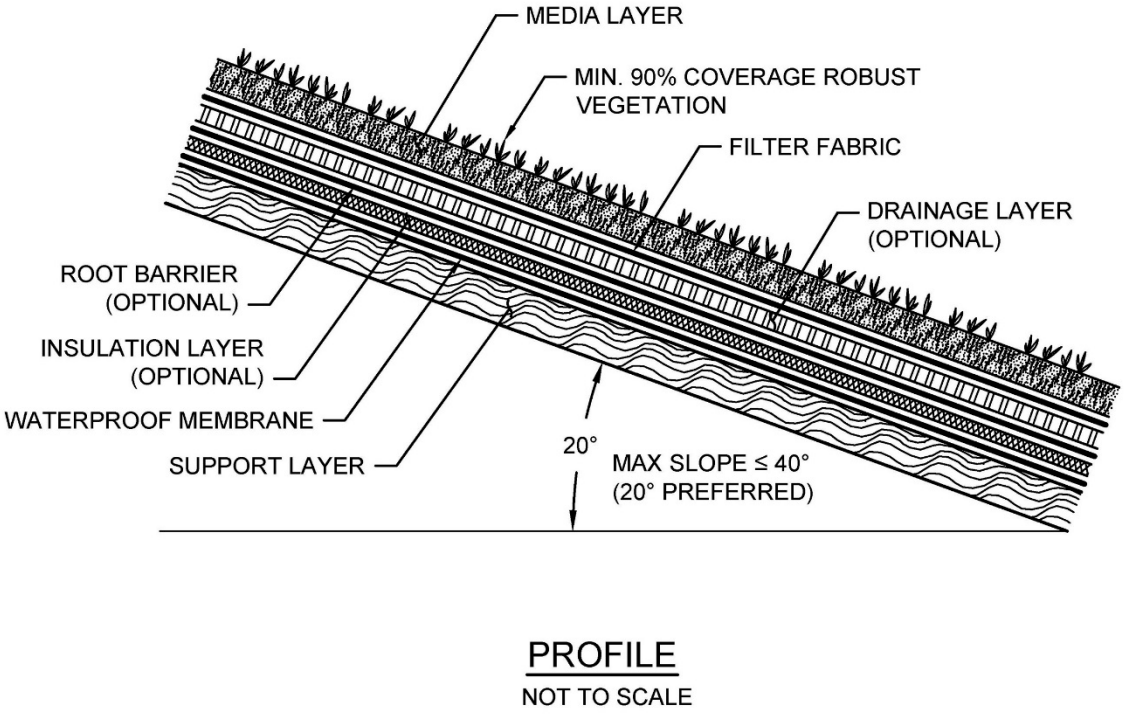
Green roofs are vegetated rooftop systems that reduce runoff volumes and rates, treat storm water pollutants through filtration and plant uptake, provide additional landscape amenity, and create wildlife habitat. Additionally, green roofs reduce the heat island effect and provide acoustical control, air filtration and oxygen production. In terms of building design, they can protect against ultraviolet rays and extend the roof lifetime, as well as increase the building insulation, thereby decreasing heating and cooling costs. There are two primary types of green roofs:

- **Extensive** – lightweight, low maintenance system with low-profile, drought tolerant type groundcover in shallow growing medium (6 inches or less)
- **Intensive** – heavyweight, high maintenance system with a more garden-like configuration and diverse plantings that may include shrubs or trees in a thicker growing medium (greater than 6 inches)

Typical green roof components include, from top to bottom:

- Vegetation that is appropriate to the type of green roof system, climate, and watering conditions
- Media layer (planting mix or engineered media) capable of supporting vegetation growth

- Filter fabric to prevent migration of fines (soils) into the drainage layer
- Optional drainage layer to convey excess runoff
- Optional root barrier
- Optional insulation layer
- Waterproof membrane
- Structural roof support capable of withstanding the additional weight of a green roof



Typical profile of a Green Roof BMP

Design Adaptations for Project Goals

Site design BMP to provide incidental treatment. Green roofs can be used as a site design feature to reduce the impervious area of the site through replacing conventional roofing. This can reduce the DCV and flow control requirements for the site.

Design Criteria and Considerations

Green roofs must meet the following design criteria. Deviations from the below criteria may be approved at the discretion of County staff if it is determined to be appropriate:

Siting and Design		*Intent/Rationale*
☐	Roof slope is ≤ 40% (Roofs that are ≤ 20% are preferred).	Steep roof slopes increases project complexity and requires supplemental anchoring.
☐	Structural roof capacity design supports the calculated additional load (lbs/sq. ft) of the vegetation growing medium and additional drainage and barrier layers.	Inadequate structural capacity increases the risk for roof failure and harm to the building and occupants.
☐	Design and construction is planned to be completed by an experienced green roof specialist.	A green roof specialist will minimize complications in implementation and potential structural issues that are critical to green roof success.
☐	Green roof location and extent must meet fire safety provisions.	Green roof design must not negatively impact fire safety.
☐	Maintenance access is included in the green roof design.	Maintenance will facilitate proper functioning of drainage and irrigation components and allow for removal of undesirable vegetation and soil testing, as needed.
Vegetation		
☐	Vegetation is suitable for the green roof type, climate and expected watering conditions. Perennial, self-sowing plants that are drought-tolerant (e.g., sedums, succulents) and require little to no fertilizer, pesticides or herbicides are recommended. Vegetation pre-grown at grade may allow plants to establish prior to facing harsh roof conditions.	Plants suited to the design and expected growing environment are more likely to survive.
☐	Vegetation is capable of covering ≥ 90% the roof surface.	Benefits of green roofs are greater with more surface vegetation.
☐	Vegetation is robust and erosion-resistant in order to withstand the anticipated rooftop environment (e.g., heat, cold, high winds).	Weak plants will not survive in extreme rooftop environments.
☐	Vegetation is fire resistant.	Vegetation that will not burn easily decreases the chance for fire and harm to the building and occupants.
☐	Vegetation considers roof sun exposure and shaded areas based on roof slope and	The amount of sunlight the vegetation receives can inhibit growth therefore the beneficial

Siting and Design		*Intent/Rationale*
	location.	effects of a vegetated roof.
☐	An irrigation system (e.g., drip irrigation system) is included as necessary to maintain vegetation.	Proper watering will increase plant survival, especially for new plantings.
☐	Media is well-drained and is the appropriate depth required for the green roof type and vegetation supported.	Unnecessary water retention increases structural loading. An adequate media depth increases plant survival.
☐	A filter fabric is used to prevent migration of media fines through the system.	Migration of media can cause clogging of the drainage layer.
☐	A drainage layer is provided if needed to convey runoff safely from the roof. The drainage layer can be comprised of gravel, perforated sheeting, or other drainage materials.	Inadequate drainage increases structural loading and the risk of harm to the building and occupants.
☐	A root barrier comprised of dense material to inhibit root penetration is used if the waterproof membrane will not provide root penetration protection.	Root penetration can decrease the integrity of the underlying structural roof components and increase the risk of harm to the building and occupants.
☐	An insulation layer is included as needed to protect against the water in the drainage layer from extracting building heat in the winter and cool air in the summer.	Regulating thermal impacts of green roofs will aid in controlling building heating and cooling costs.
☐	A waterproof membrane is used to prevent the roof runoff from vertically migrating and damaging the roofing material. A root barrier may be required to prevent roots from compromising the integrity of the membrane.	Water-damaged roof materials increase the risk of harm to the building and occupants.

Conceptual Design and Sizing Approach for Site Design

1. Determine the areas where green roofs can be used in the site design to replace conventional roofing to reduce the DCV. These green roof areas can be credited toward reducing runoff generated through representation in storm water calculations as pervious, not impervious, areas but are not credited for storm water pollutant control.
2. Calculate the DCV per Appendix B.2.

E.9 SD-D Permeable Pavement (Site Design BMP)



Photo Credit: San Diego Low Impact Development Design Manual

Description

Permeable pavement is pavement that allows for percolation through void spaces in the pavement surface into subsurface layers. Permeable pavements reduce runoff volumes and rates and can provide pollutant control via infiltration, filtration, sorption, sedimentation, and biodegradation processes. When used as a site design BMP, the subsurface layers are designed to provide storage of storm water runoff so that outflow rates can be controlled via infiltration into subgrade soils. Varying levels of storm water treatment and flow control can be provided depending on the size of the permeable pavement system relative to its drainage area and the underlying infiltration rates. As a site design BMP permeable pavement areas are designed to be self-retaining and are designed primarily for direct rainfall. Self-retaining permeable pavement areas have a ratio of total drainage area (including permeable pavement) to area of permeable pavement of 1.5:1 or less. Permeable pavement surfaces can be constructed from modular paver units or paver blocks, pervious concrete, porous asphalt, and turf pavers. Sites designed with permeable pavements can significantly reduce the impervious area of the project. Reduction in impervious surfaces decreases the DCV and can reduce the footprint of treatment control and flow control BMPs.

Design Adaptations for Project Goals

Site design BMP to reduce impervious area and DCV. Permeable pavement without an underdrain can be used as a site design feature to reduce the impervious area of the site by replacing traditional pavements, including roadways, parking lots, emergency access lanes, sidewalks, trails and driveways.

Typical Permeable Pavement Components (Top to Bottom)
Permeable surface layer
Bedding layer for permeable surface
Aggregate storage layer with optional underdrain(s)
Optional final filter course layer over uncompacted existing subgrade

Conceptual Design and Sizing Approach for Site Design

1. Determine the areas where permeable pavements can be used in the site design to replace conventional pavements to reduce the DCV. These areas can be credited toward reducing runoff generated through representation in storm water calculations as pervious, not impervious, areas but are not credited for storm water pollutant control.
2. Calculate the DCV per Appendix B.2, taking into account reduced runoff from permeable pavement areas.

E.10 SD-E Rain Barrels



Photo Credit: San Diego Low Impact Development Design Manual

Description

Rain barrels are containers that can capture rooftop runoff and store it for future use. With controlled timing and volume release, the captured rainwater can be used for irrigation or alternative grey water between storm events, thereby reducing runoff volumes and associated pollutants to downstream waterbodies. Rain barrels tend to be smaller systems, less than 100 gallons. Treatment can be achieved when rain barrels are used as part of a treatment train along with other BMPs that use captured flows in applications that do not result in discharges into the storm drain system. Rooftops are the ideal tributary areas for rain barrels.

Design Adaptations for Project Goals

Site design BMP to reduce effective impervious area and DCV. Barrels can be used as a site design feature to reduce the effective impervious area of the site by removing roof runoff from the site discharge. This can reduce the DCV and flow control requirements for the site.

Typical Rain Barrel Components
Storage container, barrel or tank for holding captured flows
Inlet and associated valves and piping
Outlet and associated valves and piping
Overflow outlet
Optional pump
Optional first flush diverters
Optional roof, supports, foundation, level indicator, and other accessories

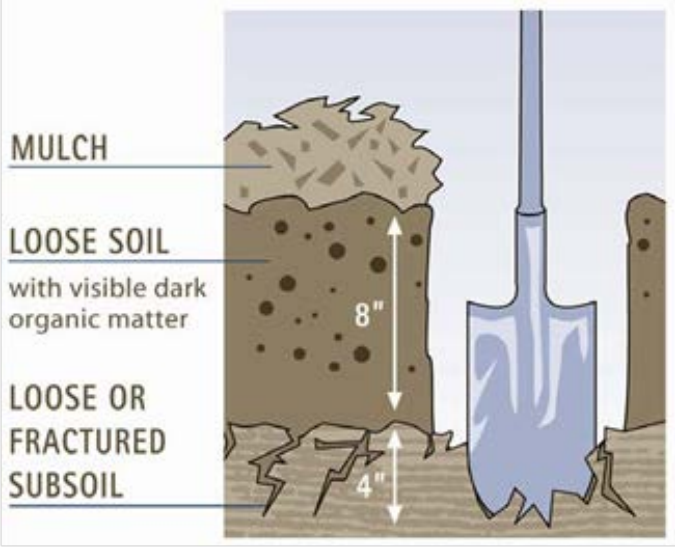
Important Considerations

Maintenance: Rain barrels require regular monitoring and cleaning to ensure that they do not become clogged with leaves or other debris.
Economics: Rain barrels have low installation costs.
Limitations: Due to San Diego's arid climate, some rain barrels may fill only a few times each year.

Conceptual Design and Sizing Approach for Site Design

1. Determine the areas where rain barrels can be used in the site design to capture roof runoff to reduce the DCV. Rain barrels reduce the effective impervious area of the site by removing roof runoff from the site discharge.
2. Calculate the DCV per Appendix B.2, taking into account reduced runoff from permeable pavement areas. Credit can be taken for the full rain barrel volume when each barrel volume is smaller than 100 gallons, and meet the following criteria: total rain barrel volume is less than 0.25 DCV and landscape areas are greater than 30 percent of the project footprint. Credit for harvest and use systems that do not meet the above criteria must be based on the criteria in Appendix B.3 and HU-1 fact sheet.

E.11 SD-F Amended Soil[21]



Planting bed Cross-Section

Description

Naturally occurring (undisturbed) topsoil and vegetation provide important storm water functions including: water infiltration; nutrient, sediment, and pollutant adsorption; sediment and pollutant biofiltration; water interflow storage and transmission; and pollutant decomposition.

Natural functions are largely lost when development strips away native topsoil and vegetation and replaces it with minimal topsoil and sod. Not only are these important storm water functions lost, but such landscapes themselves become pollution generating pervious surfaces due to increased use of pesticides, fertilizers and other landscaping and household/industrial chemicals, the concentration of pet wastes, and pollutants that accompany roadside litter.

Amended soil attains greater storm water functions in the post development landscape, provides increased treatment of pollutants and sediments that result from development and habitation, and minimizes the need for some landscaping chemicals, thus reducing pollution through prevention.

Design Adaptations for Project Goals

Amended soil primarily functions as a site design BMP for reducing the effective imperviousness of a site by providing partial or full infiltration of the flows that are routed to amended soil areas and otherwise slowing down excess flows that eventually reach the storm drain system.

Applications and Limitations

Amending soil per these guidelines is not the same as preservation of naturally occurring topsoil and vegetation. However, amending soil will improve on-site management of storm water flow and

[21] Reprinted from Guidelines and Resources for Implementing Amended Soil BMP T5.13 in WDOE Storm Water Management Manual for Western Washington, 2010, Washington Organic Recycling Council.

water quality.

Soil organic matter can be attained through numerous materials such as compost, composted woody material, and biosolids. It is important that the materials used to meet this Amended Soil Fact Sheet be appropriate and beneficial to the plant cover to be established. Likewise, it is important that imported topsoils improve soil conditions and do not have an excessive percent of clay fines.

The amended soil layer shall have a minimum depth of eight inches except where tree roots limit the depth of incorporation of amendments needed to meet the criteria. Subsoils below the topsoil layer should be scarified at least 4 inches with some incorporation of the upper material to avoid stratified layers, where feasible.

The amended soil layer for trees shall be a minimum of three feet deep and extend at least twelve inches in all directions of the root ball when planted; the amended soil layer for shrubs shall be a minimum of two feet deep and extend at least twelve inches in all directions of the root ball when planted; the length and width must ensure the appropriate volume for the species and site.

Amended Soils can be considered infeasible on slopes greater than 25 percent. Only amended planting holes for trees and shrubs need meet these requirements. Mulching requirements still apply to slopes over 25 percent.

Design Criteria and Considerations

Soil Retention

☐	Retain, in an undisturbed state, the mulch and native topsoil to the maximum extent practicable. In any areas requiring grading remove and stockpile the mulch and topsoil on site in a designated, controlled area, not adjacent to public resources and critical areas, to be reapplied to other portions of the site where feasible.	Relocated soil can be utilized to create berms or high points within the landscaping. They help contain and move water increasing the holding capacity of swales. Berms also become homes for plants that like fast drainage.

Soil Quality

All areas subject to clearing and grading that have not been covered by impervious surface, incorporated into a drainage facility or engineered as structural fill or slope shall, at project completion, demonstrate the following:

☐	Amended soil Shall have a minimum organic matter content of 10% dry weight in planting beds, and 5% organic matter content in turf areas, and a pH from 6.0 to 8.0 or matching the pH of the undisturbed topsoil.	Organic matter, such as leaves and twigs, feed the microbes in the soil. Microbes form part of the soil structure and act like sponges, helping the soil absorb water.
☐	Use compost and other materials that meet organic content requirements: a) The organic content for "pre-approved" amendment rates can be met only using compost that meets the definition of "composted materials" in WAC 173-350-100. This code is available online at: http://apps.leg.wa.gov/wac/default.aspx?cite=173-350 b) The compost must also have an organic matter content of 40% to 65%, and a carbon to nitrogen ratio below 25:1. c) Calculated amendment rates may be met through use of composted materials meeting a) and b) above; or other organic materials amended to meet the carbon to nitrogen ratio requirements, and meeting the contaminant standards of Grade A Compost. The resulting soil should be conducive to the type of vegetation to be established.	Compost contains particles that improve the overall soil structure. As compost decomposes, it encourages the formation of macroaggregate that create a more stable soil structure.

Soil Quality

	A minimum three inch layer of mulch shall be applied on all exposed soil surfaces in each landscaped area except in turf areas, creeping or rooting ground covers or direct seeding applications where mulch is contraindicated.	Mulch creates a blanket protecting the soil and plant roots from temperature change, keeps moisture in by slowing down evaporation and keeps weeds from sprouting by reducing sunlight penetration.
☐	Organic mulch materials made from recycled or post-consumer products/materials shall take precedence over inorganic materials or virgin forest products unless the recycled post-consumer organic products are not locally available. Organic mulches are not required where prohibited by County Fire Code.	
	Highly flammable mulch material, such as straw or small, mini size wood chips, shall not be used in a "Hazardous Fire Area," as that term is defined in the County Fire Code.	

Implementation Options

The soil quality design guidelines listed above can be met by using one of the methods listed below:

1) Leave undisturbed native vegetation and soil, and protect from compaction during construction.
2) Amend existing site topsoil or subsoil either at default "pre-approved" rates, or at custom calculated rates based on tests of the soil and amendment to achieve the organic matter content required..
3) Stockpile existing topsoil during grading, and replace it prior to planting. Stockpiled topsoil must also be amended if needed to meet the organic matter or depth requirements, either at a default "pre-approved" rate or at a custom calculated rate.
4) Import topsoil mix of sufficient organic matter content and depth to meet the requirements.

More than one method may be used on different portions of the same site. Soil that already meets the depth and organic matter quality standards, and is not compacted, does not need to be amended.

Planning/Permitting/Inspection/Verification Guidelines & Procedures

Sitting and Design		*Intent/Rationale*
☐	Establish Amended Soil toward the end of construction and once established, protect from compaction, such as from large machinery use, and from erosion.	Compaction, augmenting or tilling the soil destroys the overall structure of the soil. Healthy soil has lots of tiny little pockets of air, when soils are eroded, graded or disturbed, their structure becomes compacted. Compaction is caused when the tiny air and water bubbles are squeezed out of the soil and microbes are killed.
☐	Plant vegetation and mulch the amended soil area after installation.	Mulch stays on top of the soil and is never worked in. Keep mulch 1 to 6 inches away from stems of plants.
☐	Leave plant debris or its equivalent on the soil surface to replenish organic matter.	Bits of leaves and twigs function as food for microbes living in the soil. Once established, the plants will eventually feed themselves off their own leaf litter.
☐	Use appropriate irrigation.	Knowing your climate zones and the water needs of your landscape will help establish watering zones and watering schedules for your landscape. Rainwater is best for both plants and microbes; provide this as much as possible when it is available. Adjust spray irrigation so that there is no overspray on to hard surfaces. When possible, convert spray systems to drip irrigation. This will reduce runoff and allow water to infiltrate the soil.
☐	Reduce and adjust, where possible, the use of irrigation, fertilizers, herbicides and pesticides, rather than continuing to implement formerly established practices.	Chemical fertilizers, herbicides and pesticides; including organic ones; kill soil microbes.

Runoff Model Representation

Flow reduction credits can be taken in runoff modeling when *SD-F Amended Soil* is used as part of a dispersion design under the conditions described in *SD-B Impervious Area Dispersion.*

Areas meeting the design guidelines may be entered into approved runoff models by adjusting depression storage parameters.

Data Sources

San Diego Sustainable Landscapes Guidelines
San Diego County Water Authority 2015

BMP T5.13 "Post Construction Soil Quality and Depth"
Storm Water Management Manual for Western Washington, August 2012

E.12 HU-1 Cistern



MS4 Permit Category

Retention

Manual Category

Harvest and Use

Applicable Performance Standards

Pollutant Control

Flow Control

Primary Benefits

Volume Reduction

Peak Flow Attenuation

Photo Credit: Water Environment Research Foundation: WERF.org

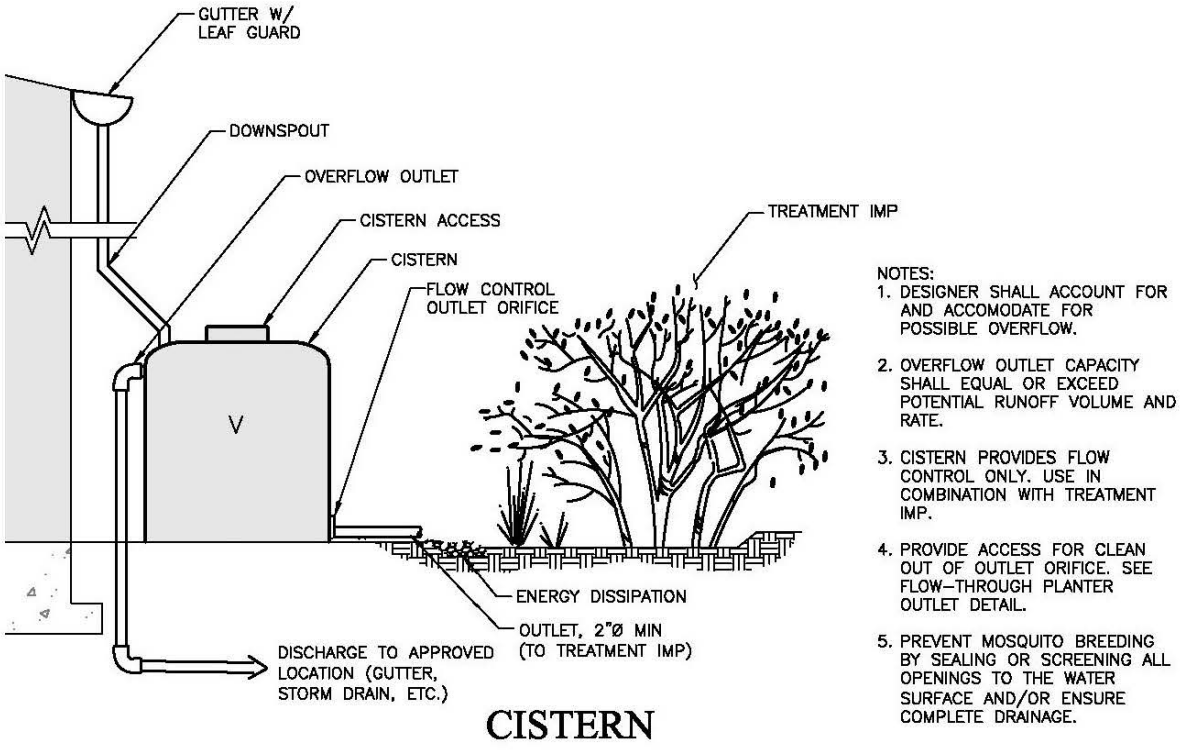
Description

Cisterns are containers that can capture rooftop runoff and store it for future use. With controlled timing and volume release, the captured rainwater can be used for irrigation or alternative grey water between storm events, thereby reducing runoff volumes and associated pollutants to downstream water bodies. Cisterns are larger systems (generally>100 gallons) that can be self-contained aboveground or below ground systems. Treatment can be achieved when cisterns are used as part of a treatment train along with other BMPs that use captured flows in applications that do not result in discharges into the storm drain system. Rooftops are the ideal tributary areas for cisterns.

Typical cistern components include:

- Storage container, barrel or tank for holding captured flows
- Inlet and associated valves and piping
- Outlet and associated valves and piping
- Overflow outlet
- Optional pump

- Optional first flush diverters
- Optional roof, supports, foundation, level indicator, and other accessories



Source: City of San Diego Storm Water Standards

Design Adaptations for Project Goals

Site design BMP to reduce effective impervious area and DCV. Cisterns can be used as a site design feature to reduce the effective impervious area of the site by removing roof runoff from the site discharge. This can reduce the DCV and flow control requirements for the site.

Harvest and use for storm water pollutant control. Typical uses for captured flows include irrigation, toilet flushing, cooling system makeup, and vehicle and equipment washing.

Integrated storm water flow control and pollutant control configuration. Cisterns provide flow control in the form of volume reduction and/or peak flow attenuation and storm water treatment through elimination of discharges of pollutants. Additional flow control can be achieved by sizing the cistern to include additional detention storage and/or real-time automated flow release controls.

Design Criteria and Considerations

Cisterns must meet the following design criteria. Deviations from the below criteria may be approved at the discretion of County staff if it is determined to be appropriate:

Siting and Design		*Intent/Rationale*
☐	Cisterns are sized to detain the full DCV of contributing area and empty within 36 hours.	Draining the cistern makes the storage volume available to capture the next storm. The applicant has an option to use a different drawdown time up to 120 hours if the volume of the facility is adjusted using the percent capture method in Appendix B.4.1.
☐	Cisterns are fitted with a flow control device such as an orifice or a valve to limit outflow in accordance with drawdown time requirements.	Flow control provides flow attenuation benefits and limits cistern discharge to downstream facilities during storm events.
☐	Cisterns are designed to drain completely, leaving no standing water, and all entry points are fitted with traps or screens, or sealed.	Complete drainage and restricted entry prevents mosquito habitat.
☐	Leaf guards and/or screens are provided to prevent debris from accumulating in the cistern.	Leaves and organic debris can clog the outlet of the cistern.
☐	Access is provided for maintenance and the cistern outlets are accessible and designed to allow easy cleaning.	Properly functioning outlets are needed to maintain proper flow control in accordance with drawdown time requirements.
☐	Cisterns must be designed and sited such that overflow will be conveyed safely overland to the storm drain system or discharge point.	Safe overflow conveyance prevents flooding and damage of property.

Conceptual Design and Sizing Approach for Site Design and Storm Water Pollutant Control

1. Calculate the DCV for site design per Appendix B.
2. Determine the locations on the site where cisterns can be located to capture and detain the DCV from roof areas without subsequent discharge to the storm drain system. Cisterns are best located in close proximity to building and other roofed structures to minimize piping. Cisterns can also be used as part of a treatment train upstream by increasing pollutant control through delayed runoff to infiltration BMPs such as bioretention without underdrain facilities.

3. Use the sizing worksheet in Appendix B.3 to determine if full or partial capture of the DCV is achievable.
4. The remaining DCV to be treated should be calculated for use in sizing downstream BMP(s).

Conceptual Design and Sizing Approach when Storm Water Flow Control is Applicable

Control of flow rates and/or duration will typically require significant cistern volumes, and therefore the following steps should be taken prior to determination of site design and storm water pollutant control. Pre-development and allowable post-project flow rates and durations should be determined as discussed in Chapter 6 of the manual.

1. Verify that cistern siting and design criteria have been met. Design for flow control can be achieved using various design configurations, shapes, and quantities of cisterns.
2. Iteratively determine the cistern storage volume required to provide detention storage to reduce flow rates and durations to allowable limits. Flow rates and durations can be controlled from detention storage by altering outlet structure orifice size(s) and/or water control valve operation.
3. Verify that the cistern is drawdown within 36 hours. The drawdown time can be estimated by dividing the storage volume by the rate of use of harvested water.
4. If the cistern cannot fully provide the flow rate and duration control required by this manual, a downstream structure with additional storage volume or infiltration capacity such as a biofiltration can be used to provide remaining flow control.

E.13 INF-1 Infiltration Basin



MS4 Permit Category
Retention

Manual Category
Infiltration

Applicable Performance Standard
Pollutant Control
Flow Control

Primary Benefits
Volume Reduction
Peak Flow Attenuation

Photo Credit: http://www.storm waterpartners.com/facilities/basin.html

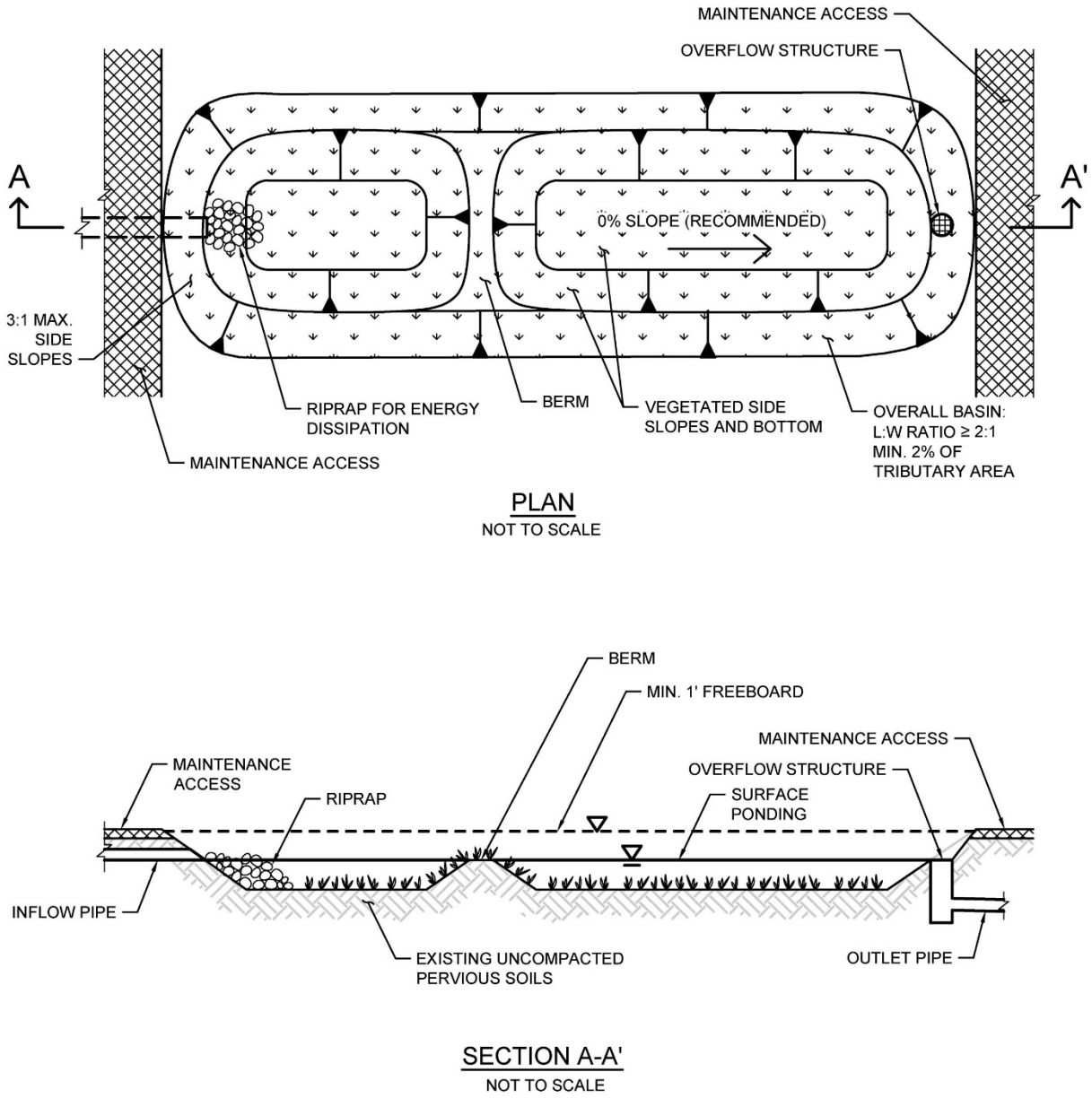
Description

An infiltration basin typically consists of an earthen basin with a flat bottom constructed in naturally pervious soils. An infiltration basin retains storm water and allows it to evaporate and/or percolate into the underlying soils. The bottom of an infiltration basin is typically vegetated with native grasses or turf grass; however other types of vegetation can be used if they can survive periodic inundation and long inter-event dry periods. Treatment is achieved primarily through infiltration, filtration, sedimentation, biochemical processes and plant uptake. Infiltration basins can be constructed as linear **trenches** or as **underground infiltration galleries**.

Typical infiltration basin components include:

- Inflow distribution mechanisms (e.g., perimeter flow spreader or filter strips)
- Energy dissipation mechanism for concentrated inflows (e.g., splash blocks or riprap)
- Forebay to provide pretreatment surface ponding for captured flows
- Vegetation selected based on basin use, climate, and ponding depth
- Uncompacted native soils at the bottom of the facility

- Overflow structure



Typical plan and section view of an Infiltration BMP

Design Adaptations for Project Goals

Full infiltration BMP for storm water pollutant control. Infiltration basins can be used as a pollutant control BMP, designed to infiltrate runoff from direct rainfall as well as runoff from adjacent areas that are tributary to the BMP. Infiltration basins must be designed with an infiltration storage volume (a function of the surface ponding volume) equal to the full DCV and able to meet drawdown time limitations.

Integrated storm water flow control and pollutant control configuration. Infiltration basins can also be designed for flow rate and duration control by providing additional infiltration storage through increasing the surface ponding volume.

Design Criteria and Considerations

Infiltration basins must meet the following design criteria. Deviations from the below criteria may be approved at the discretion of County staff if it is determined to be appropriate:

	Siting and Design	*Intent/Rationale*
☐	Placement observes geotechnical recommendations regarding potential hazards (e.g., slope stability, landslides, liquefaction zones) and setbacks (e.g., slopes, foundations, utilities).	Must not negatively impact existing site geotechnical concerns.
☐	Selection and design of basin is based on infiltration feasibility criteria and appropriate design infiltration rate (See Appendix C and D).	Must operate as a full infiltration design and must be supported by drainage area and in-situ infiltration rate feasibility findings.
☐	Finish grade of the facility is ≤ 2% (0% recommended).	Flatter surfaces reduce erosion and channelization with the facility.
☐	Settling forebay has a volume ≥ 25% of facility volume below the forebay overflow.	A forebay to trap sediment can decrease frequency of required maintenance.
☐	Infiltration of surface ponding is limited to a 36-hour drawdown time.	Prolonged surface ponding reduces volume available to capture subsequent storms. The applicant has an option to use a surface drawdown time of up to 96 hours if the volume of the facility is adjusted using the percent capture method in Appendix B.4.1.
☐	Minimum freeboard provided is ≥1 foot.	Freeboard minimizes risk of uncontrolled surface discharge.
☐	Side slopes are = 3H:1V or shallower.	Gentler side slopes are safer, less prone to erosion, able to establish vegetation more quickly and easier to maintain.

Inflow and Overflow Structures		
☐	Inflow and outflow structures are accessible by required equipment (e.g., vactor truck) for inspection and maintenance.	Maintenance will prevent clogging and ensure proper operation of the flow control structures.
☐	Inflow velocities are limited to 3 ft/s or less or use energy dissipation methods (e.g., riprap, level spreader) for concentrated inflows.	High inflow velocities can cause erosion, scour and/or channeling.
☐	Overflow is safely conveyed to a downstream storm drain system or discharge point. Size overflow structure to pass 100-year peak flow for on-line basins and water quality peak flow for off-line basins.	Planning for overflow lessens the risk of property damage due to flooding.

Conceptual Design and Sizing Approach for Storm Water Pollutant Control

To design infiltration basins for storm water pollutant control only (no flow control required), the following steps should be taken:

1. Verify that siting and design criteria have been met, including placement and basin area requirements, forebay volume, and maximum slopes for basin sides and bottom.
2. Calculate the DCV per Appendix B based on expected site design runoff for tributary areas.
3. Use the sizing worksheet (Appendix B.4) to determine if full infiltration of the DCV is achievable based on the infiltration storage volume calculated from the surface ponding area and depth for a maximum 36-hour drawdown time. The drawdown time can be estimated by dividing the average depth of the basin by the design infiltration rate. Appendix D provides guidance on evaluating a site's infiltration rate.

Conceptual Design and Sizing Approach for Storm Water Pollutant Treatment and Flow Control

Control of flow rates and/or durations will typically require significant surface ponding volume, and therefore the following steps should be taken prior to determination of storm water pollutant control design. Pre-development and allowable post-project flow rates and durations should be determined as discussed in Chapter 6 of the manual.

1. Verify that siting and design criteria have been met, including placement and basin area requirements, forebay volume, and maximum slopes for basin sides and bottom.

2. Iteratively determine the surface ponding required to provide infiltration storage to reduce flow rates and durations to allowable limits while adhering to the maximum 36-hour drawdown time. Flow rates and durations can be controlled using flow splitters that route the appropriate inflow amounts to the infiltration basin and bypass excess flows to the downstream storm drain system or discharge point.
3. If an infiltration basin cannot fully provide the flow rate and duration control required by this manual, an upstream or downstream structure with appropriate storage volume such as an underground vault can be used to provide additional control.
4. After the infiltration basin has been designed to meet flow control requirements, calculations must be completed to verify if storm water pollutant control requirements to treat the DCV have been met.

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E.14 INF-2 Bioretention



MS4 Permit Category
Retention

Manual Category
Infiltration

Applicable Performance Standard
Pollutant Control
Flow Control

Primary Benefits
Volume Reduction
Treatment
Peak Flow Attenuation

Photo Credit: Ventura County Technical Guidance Document

Description

Bioretention (bioretention without underdrain) facilities are vegetated surface water systems that filter water through vegetation and soil, or engineered media prior to infiltrating into native soils. These facilities are designed to infiltrate the full DCV. Bioretention facilities are commonly incorporated into the site within parking lot landscaping, along roadsides, and in open spaces. They can be constructed inground or partially aboveground, such as planter boxes with open bottoms (no impermeable liner at the bottom) to allow infiltration. Treatment is achieved through filtration, sedimentation, sorption, infiltration, biochemical processes and plant uptake.

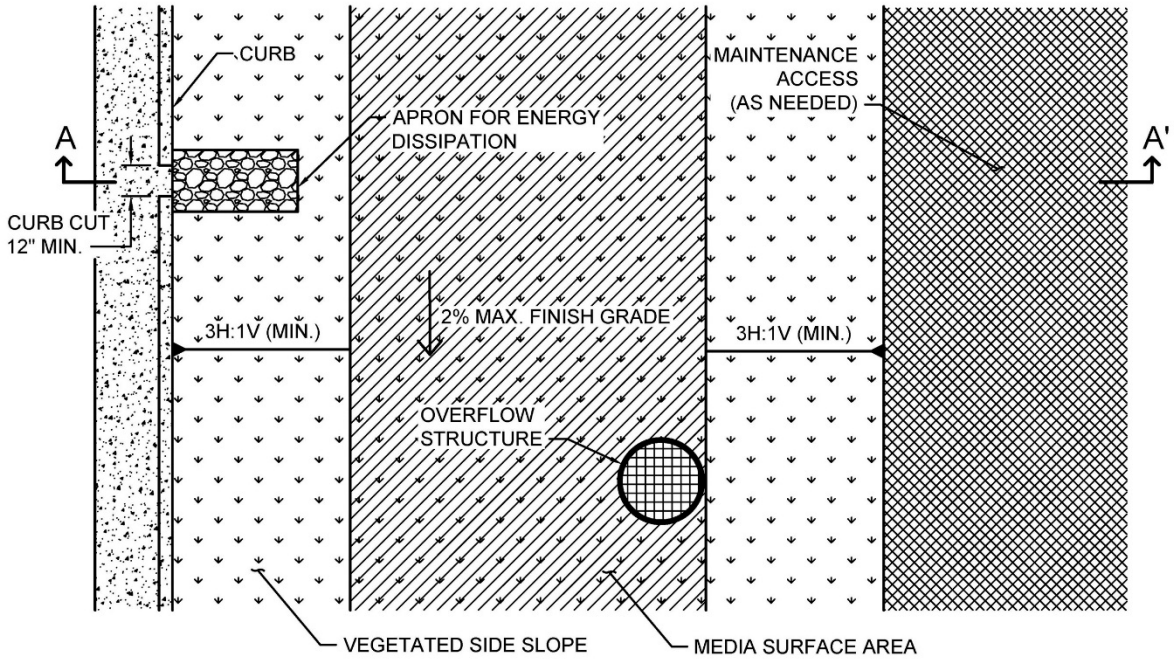
Typical bioretention without underdrain components include:

- Inflow distribution mechanisms (e.g, perimeter flow spreader or filter strips)
- Energy dissipation mechanism for concentrated inflows (e.g., splash blocks or riprap)
- Shallow surface ponding for captured flows
- Side slope and basin bottom vegetation selected based on expected climate and ponding depth
- Non-floating mulch layer (optional)

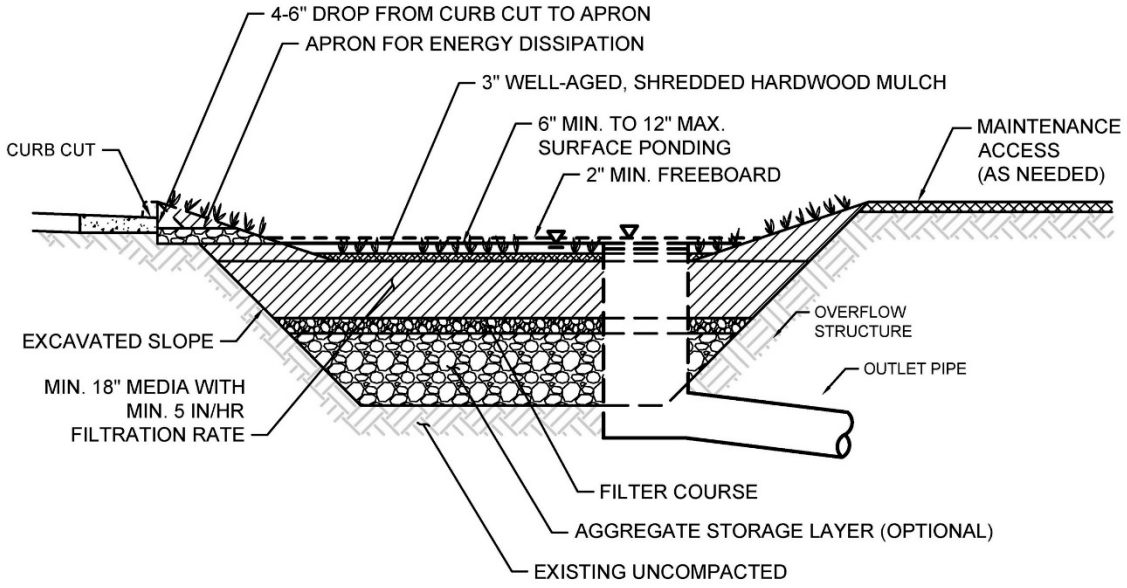
- Media layer (planting mix or engineered media) capable of supporting vegetation growth
- Filter course layer consisting of aggregate to prevent the migration of fines into uncompacted native soils or the optional aggregate storage layer
- Optional aggregate storage layer for additional infiltration storage
- Uncompacted native soils at the bottom of the facility
- Overflow structure

Design Adaptations for Project Goals

- **Full infiltration BMP for storm water pollutant control.** Bioretention can be used as a pollutant control BMP designed to infiltrate runoff from direct rainfall as well as runoff from adjacent tributary areas. Bioretention facilities must be designed with an infiltration storage volume (a function of the ponding, media and aggregate storage volumes) equal to the full DCV and able to meet drawdown time limitations.
- **Integrated storm water flow control and pollutant control configuration.** Bioretention facilities can be designed to provide flow rate and duration control. This may be accomplished by providing greater infiltration storage with increased surface ponding and/or aggregate storage volume for storm water flow control.



PLAN
NOT TO SCALE



SECTION A-A'
NOT TO SCALE

Typical plan and section view of a Bioretention BMP

Design Criteria and Considerations

Bioretention must meet the following design criteria. Deviations from the below criteria may be approved at the discretion of County staff if it is determined to be appropriate:

	Siting and Design	*Intent/Rationale*
☐	Placement observes geotechnical recommendations regarding potential hazards (e.g., slope stability, landslides, liquefaction zones) and setbacks (e.g., slopes, foundations, utilities).	Must not negatively impact existing site geotechnical concerns.
☐	Selection and design of BMP is based on infiltration feasibility criteria and appropriate design infiltration rate presented in Appendix C and D.	Must operate as a full infiltration design and must be supported by drainage area and in-situ infiltration rate feasibility findings.
☐	Contributing tributary area is ≤ 5 acres (≤ 1 acre preferred).	Bigger BMPs require additional design features for proper performance. Contributing tributary area greater than 5 acres may be allowed at the discretion of County staff if the following conditions are met: 1) incorporate design features (e.g. flow spreaders) to minimize short circuiting of flows in the BMP and 2) incorporate additional design features requested by County staff for proper performance of the regional BMP.
☐	Finish grade of the facility is ≤ 2%. In long bioretention facilities where the potential for internal erosion and channelization exists, the use of check dams is required.	Flatter surfaces reduce erosion and channelization within the facility. Internal check dams reduce velocity and dissipate energy.
	Surface Ponding	
☐	Surface ponding is limited to a 24-hour drawdown time.	24-hour drawdown time is recommended for plant health. Surface ponding drawdown time greater than 24-hours but less than 96 hours may be allowed at the discretion of County staff if certified by a landscape architect or agronomist.

Surface Ponding		
☐	Surface ponding depth is ≥ 6 and ≤ 12 inches.	Surface ponding capacity lowers subsurface storage requirements. Deep surface ponding raises safety concerns. Surface ponding depth greater than 12 inches (for additional pollutant control or surface outlet structures or flow-control orifices) may be allowed at the discretion of County staff if the following conditions are met: 1) surface ponding depth drawdown time is less than 24 hours; and 2) safety issues and fencing requirements are considered (typically ponding greater than 18" will require a fence and/or flatter side slopes) and 3) potential for elevated clogging risk is considered.
☐	A minimum of 2 inches of freeboard is provided.	Freeboard provides room for head over overflow structures and minimizes risk of uncontrolled surface discharge.
☐	Side slopes are stabilized with vegetation and are ≥ 3H: 1V.	Gentler side slopes are safer, less prone to erosion, able to establish vegetation more quickly and easier to maintain.
Vegetation		
☐	Plantings are suitable for the climate and expected ponding depth. A plant list to aid in selection can be found in Appendix E.20.	Plants suited to the climate and ponding depth are more likely to survive.
☐	An irrigation system with a connection to water supply is provided as needed.	Seasonal irrigation might be needed to keep plants healthy.
Mulch (Mandatory)		
☐	A minimum of 3 inches of well-aged, shredded hardwood mulch that has been stockpiled or stored for at least 12 months is provided. Mulch must be non-floating to avoid clogging of overflow structure.	Mulch will suppress weeds and maintain moisture for plant growth. Aging mulch kills pathogens and weed seeds and allows beneficial microbes to multiply.

Media Layer		
☐	Media maintains a minimum filtration rate of 5 in/hr over lifetime of facility. A minimum initial filtration rate of 10 in/hr is recommended.	A high filtration rate through the soil mix minimizes clogging potential and allows flows to quickly enter the aggregate storage layer, thereby minimizing bypass.
☐	Media is a minimum 18 inches deep, meeting either of these two media specifications: City of San Diego Low Impact Development Design Manual (page B-18) (July 2011, unless superseded by more recent edition) **or** County of San Diego Low Impact Development Handbook: Appendix G -Bioretention Soil Specification (June 2014, unless superseded by more recent edition).	A deep media layer provides additional filtration and supports plants with deeper roots. Standard specifications must be followed.
☐	Alternatively, for proprietary designs and custom media mixes not meeting the media specifications contained in the City or County LID Manual, the media meets the pollutant treatment performance criteria in Section F.1.	For non-standard or proprietary designs, compliance with F.1 ensures that adequate treatment performance will be provided.
☐	Media surface area is 3% of contributing area times adjusted runoff factor or greater.	Greater surface area to tributary area ratios decrease loading rates per square foot and therefore increase longevity. Adjusted runoff factor is to account for site design BMPs implemented upstream of the BMP (such as rain barrels, impervious area dispersion, etc.). Refer to Appendix B.2 guidance. Use Worksheet B.5-1 Line 26 to estimate the minimum surface area required per this criteria.
Filter Course Layer (Optional)		
☐	A filter course is used to prevent migration of fines through layers of the facility. Filter fabric is not used.	Migration of media can cause clogging of the aggregate storage layer void spaces or subgrade. Filter fabric is more likely to clog.
☐	Filter course is washed and free of fines.	Washing aggregate will help eliminate fines that could clog the facility and impede infiltration.

Filter Course Layer (Optional)		
☐	Filter course calculations assessing suitability for particle migration prevention have been completed.	Gradation relationship between layers can evaluate factors (e.g., bridging, permeability, and uniformity) to determine if particle sizing is appropriate or if an intermediate layer is needed.
Aggregate Storage Layer (Optional)		
☐	Class 2 Permeable per Caltrans specification 68-1.025 is recommended for the storage layer. Washed, open-graded crushed rock may be used, however a 4-6 inch washed pea gravel filter course layer at the top of the crushed rock is required.	Washing aggregate will help eliminate fines that could clog the aggregate storage layer void spaces or subgrade.
☐	Maximum aggregate storage layer depth is determined based on the infiltration storage volume that will infiltrate within a 36-hour drawdown time.	A maximum drawdown time to facilitate provision of adequate storm water storage for the next storm event. The applicant has an option to use a different drawdown time of up to 120 hours if the volume of the facility is adjusted using the percent capture method in Appendix B.4.1.
Inflow and Overflow Structures		
☐	Inflow and overflow structures are accessible for inspection and maintenance. Overflow structures must be connected to downstream storm drain system or appropriate discharge point.	Maintenance will prevent clogging and ensure proper operation of the flow control structures.
☐	Inflow velocities are limited to 3 ft/s or less or use energy dissipation methods (e.g., riprap, level spreader) for concentrated inflows.	High inflow velocities can cause erosion, scour and/or channeling.
☐	Curb cut inlets are at least 12 inches wide, have a 4-6 inch reveal (drop) and an apron and energy dissipation as needed.	Inlets must not restrict flow and apron prevents blockage from vegetation as it grows in. Energy dissipation prevents erosion.

☐	Overflow is safely conveyed to a downstream storm drain system or discharge point. Size overflow structure to pass 100-year peak flow for on-line basins and water quality peak flow for off-line basins.	Planning for overflow lessens the risk of property damage due to flooding.

Conceptual Design and Sizing Approach for Storm Water Pollutant Control Only

To design bioretention for storm water pollutant control only (no flow control required), the following steps should be taken:

1. Verify that siting and design criteria have been met, including placement and basin area requirements, maximum side and finish grade slope, and the recommended media surface area tributary ratio.
2. Calculate the DCV per Appendix B based on expected site design runoff for tributary areas.
3. Use the sizing worksheet to determine if full infiltration of the DCV is achievable based on the available infiltration storage volume calculated from the bioretention without underdrain footprint area, effective depths for surface ponding, media and aggregate storage layers, and in-situ soil design infiltration rate for a maximum 36-hour drawdown time for the aggregate storage layer (unless percent capture method is used), with surface ponding no greater than a maximum 24-hour drawdown. The drawdown time can be estimated by dividing the average depth of the basin by the design infiltration rate of the underlying soil. Appendix D provides guidance on evaluating a site's infiltration rate. A generic sizing worksheet is provided in Appendix B.4.
4. Where the DCV cannot be fully infiltrated based on the site or bioretention constraints, an underdrain can be added to the design (use biofiltration with partial retention factsheet).

Conceptual Design and Sizing Approach when Storm Water Flow Control is Applicable

Control of flow rates and/or durations will typically require significant surface ponding and/or aggregate storage volumes, and therefore the following steps should be taken prior to determination of storm water pollutant control design. Pre-development and allowable post-project flow rates and durations must be determined as discussed in Chapter 6 of the manual.

1. Verify that siting and design criteria have been met, including placement requirements, maximum side and finish grade slopes, and the recommended media surface area tributary area ratio. Design for flow control can be achieved using various design configurations.
2. Iteratively determine the facility footprint area, surface ponding and/or aggregate storage layer depth required to provide infiltration storage to reduce flow rates and durations to allowable limits while adhering to the maximum drawdown times for surface ponding and aggregate storage. Flow rates and durations can be controlled using flow splitters that route the appropriate inflow amounts to the bioretention facility and bypass excess flows to the

downstream storm drain system or discharge point.

3. If bioretention without underdrain facility cannot fully provide the flow rate and duration control required by the MS4 permit, an upstream or downstream structure with appropriate storage volume such as an underground vault can be used to provide additional control.
4. After bioretention without underdrain BMPs have been designed to meet flow control requirements, calculations must be completed to verify if storm water pollutant control requirements to treat the DCV have been met.

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E.15 INF-3 Permeable Pavement (Pollutant Control)



Location: Kellogg Park, San Diego, California

MS4 Permit Category

Retention
Flow-thru Treatment Control

Manual Category

Infiltration
Flow-thru Treatment Control

Applicable Performance Standard

Pollutant Control
Flow Control

Primary Benefits

Volume Reduction
Peak Flow Attenuation

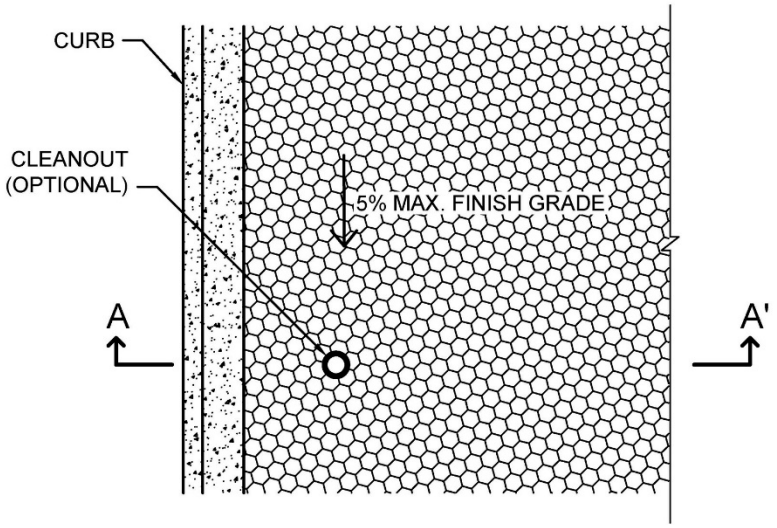
Description

Permeable pavement is pavement that allows for percolation through void spaces in the pavement surface into subsurface layers. The subsurface layers are designed to provide storage of storm water runoff so that outflows, primarily via infiltration into subgrade soils or release to the downstream conveyance system, can be at controlled rates. Varying levels of storm water treatment and flow control can be provided depending on the size of the permeable pavement system relative to its drainage area, the underlying infiltration rates, and the configuration of outflow controls. Pollutant control permeable pavement is designed to receive runoff from a larger tributary area than site design permeable pavement (see SD-D). Pollutant control is provided via infiltration, filtration, sorption, sedimentation, and biodegradation processes. **Permeable pavements proposed as a retention or partial retention BMP should not have an impermeable liner**.

Typical permeable pavement components include, from top to bottom:

- Permeable surface layer
- Bedding layer for permeable surface
- Aggregate storage layer with optional underdrain(s)

- Optional final filter course layer over uncompacted existing subgrade



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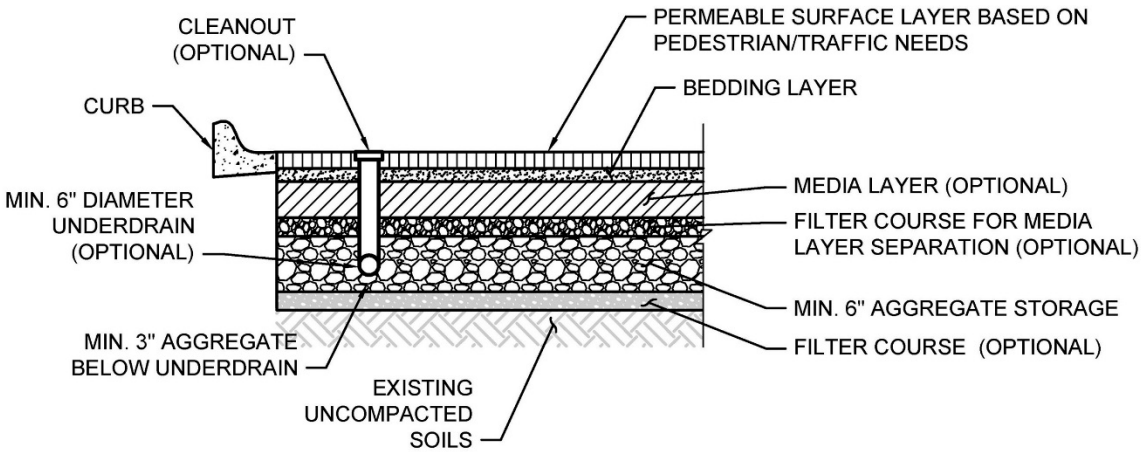

SECTION A-A'
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Typical plan and Section view of a Permeable Pavement BMP

Subcategories of permeable pavement include modular paver units or paver blocks, pervious concrete, porous asphalt, and turf pavers. These subcategory variations differ in the material used for the permeable surface layer but have similar functions and characteristics below this layer.

Design Adaptations for Project Goals

Site design BMP to reduce impervious area and DCV. See site design option SD-D.

Full infiltration BMP for storm water pollutant control. Permeable pavement without an underdrain and without impermeable liners can be used as a pollutant control BMP, designed to infiltrate runoff from direct rainfall as well as runoff from adjacent areas that are tributary to the pavement. The system must be designed with an infiltration storage volume (a function of the aggregate storage volume) equal to the full DCV and able to meet drawdown time limitations.

Partial infiltration BMP with flow-thru treatment for storm water pollutant control. Permeable pavement can be designed so that a portion of the DCV is infiltrated by providing an underdrain with infiltration storage below the underdrain invert. The infiltration storage depth should be determined by the volume that can be reliably infiltrated within drawdown time limitations. Water discharged through the underdrain is considered flow-thru treatment and is not considered biofiltration treatment. Storage provided above the underdrain invert is included in the flow-thru treatment volume.

Flow-thru treatment BMP for storm water pollutant control. The system may be lined and/or installed over impermeable native soils with an underdrain provided at the bottom to carry away filtered runoff. Water quality treatment is provided via unit treatment processes other than infiltration. This configuration is considered to provide flow-thru treatment, not biofiltration treatment. Significant aggregate storage provided above the underdrain invert can provide detention storage, which can be controlled via inclusion of an orifice in an outlet structure at the downstream end of the underdrain. **PDPs have the option to add saturated storage to the flow-thru configuration in order to reduce the DCV that the BMP is required to treat.** Saturated storage can be added to this design by including an upturned elbow installed at the downstream end of the underdrain or via an internal weir structure designed to maintain a specific water level elevation. The DCV can be reduced by the amount of saturated storage provided.

Integrated storm water flow control and pollutant control configuration. With any of the above configurations, the system can be designed to provide flow rate and duration control. This may include having a deeper aggregate storage layer that allows for significant detention storage above the underdrain, which can be further controlled via inclusion of an outlet structure at the downstream end of the underdrain.

Design Criteria and Considerations

Permeable pavements must meet the following design criteria. Deviations from the below criteria may be approved at the discretion of County staff if it is determined to be appropriate:

Siting and Design		*Intent/Rationale*
☐	Placement observes geotechnical recommendations regarding potential hazards (e.g., slope stability, landslides, liquefaction zones) and setbacks (e.g., slopes, foundations, utilities).	Must not negatively impact existing site geotechnical concerns.
☐	Selection must be based on infiltration feasibility criteria.	Full or partial infiltration designs must be supported by drainage area feasibility findings.
☐	An impermeable liner or other hydraulic restriction layer is included if site constraints indicate that infiltration should not be allowed.	Lining prevents storm water from impacting groundwater and/or sensitive environmental or geotechnical features. Incidental infiltration, when allowable, can aid in pollutant removal and groundwater recharge.
☐	Permeable pavement is not placed in an area with significant overhanging trees or other vegetation.	Leaves and organic debris can clog the pavement surface.
☐	For pollutant control permeable pavement, the ratio of the total drainage area (including the permeable pavement) to the permeable pavement should not exceed 4:1.	Higher ratios increase the potential for clogging but may be acceptable for relatively clean tributary areas.
☐	Finish grade of the permeable pavement has a slope ≤ 5%.	Flatter surfaces facilitate increased runoff capture.
☐	Minimum depth to groundwater and bedrock ≥ 10 ft.	A minimum separation facilitates infiltration and lessens the risk of negative groundwater impacts.
☐	Contributing tributary area includes effective sediment source control and/or pretreatment measures such as raised curbed or grass filter strips.	Sediment can clog the pavement surface.

Siting and Design		*Intent/Rationale*
☐	Direct discharges to permeable pavement are only from downspouts carrying "clean" roof runoff that are equipped with filters to remove gross solids.	Roof runoff typically carries less sediment than runoff from other impervious surfaces and is less likely to clog the pavement surface.
Permeable Surface Layer		
☐	Permeable surface layer type is appropriately chosen based on pavement use and expected vehicular loading.	Pavement may wear more quickly if not durable for expected loads or frequencies.
☐	Permeable surface layer type is appropriate for expected pedestrian traffic.	Expected demographic and accessibility needs (e.g., adults, children, seniors, runners, high-heeled shoes, wheelchairs, strollers, bikes) requires selection of appropriate surface layer type that will not impede pedestrian needs.

Bedding Layer for Permeable Surface		
☐	Bedding thickness and material is appropriate for the chosen permeable surface layer type.	Porous asphalt requires a 2- to 4-inch layer of asphalt and a 1- to 2-inch layer of choker course (single-sized crushed aggregate, one-half inch) to stabilize the surface. Pervious concrete also requires an aggregate course of clean gravel or crushed stone with a minimum amount of fines. Permeable Interlocking Concrete Paver requires 1 or 2 inches of sand or No. 8 aggregate to allow for leveling of the paver blocks. Similar to Permeable Interlocking Concrete Paver, plastic grid systems also require a 1- to 2-inch bedding course of either gravel or sand. For Permeable Interlocking Concrete Paver and plastic grid systems, if sand is used, a geotextile should be used between the sand course and the reservoir media to prevent the sand from migrating into the stone media.
☐	Aggregate used for bedding layer is washed prior to placement.	Washing aggregate will help eliminate fines that could clog the permeable pavement system aggregate storage layer void spaces or underdrain.
Media Layer (Optional) –used between bedding layer and aggregate storage layer to provide pollutant treatment control		
☐	The pollutant removal performance of the media layer is documented by the applicant.	Media used for BMP design should be shown via research or testing to be appropriate for expected pollutants of concern and flow rates.
☐	A filter course is provided to separate the media layer from the aggregate storage layer.	Migration of media can cause clogging of the aggregate storage layer void spaces or underdrain.

Media Layer (Optional) –used between bedding layer and aggregate storage layer to provide pollutant treatment control		
☐	If a filter course is used, calculations assessing suitability for particle migration prevention have been completed.	Gradation relationship between layers can evaluate factors (e.g., bridging, permeability, and uniformity) to determine if particle sizing is appropriate or if an intermediate layer is needed.
☐	Consult permeable pavement manufacturer to verify that media layer provides required structural support.	Media must not compromise the structural integrity or intended uses of the permeable pavement surface.
Aggregate Storage Layer		
☐	Aggregate used for the aggregate storage layer is washed and free of fines.	Washing aggregate will help eliminate fines that could clog aggregate storage layer void spaces or underdrain.
☐	Minimum layer depth is 6 inches and for infiltration designs, the maximum depth is determined based on the infiltration storage volume that will infiltrate within a 36-hour drawdown time.	A minimum depth of aggregate provides structural stability for expected pavement loads. The applicant has an option to use a different drawdown time of up to 120 hours if the volume of the facility is adjusted using the percent capture method in Appendix B.4.1
Underdrain and Outflow Structures		
☐	Underdrains and outflow structures, if used, are accessible for inspection and maintenance.	Maintenance will improve the performance and extend the life of the permeable pavement system.
☐	Underdrain outlet elevation should be a minimum of 3 inches above the bottom elevation of the aggregate storage layer.	A minimal separation from subgrade or the liner lessens the risk of fines entering the underdrain and can improve hydraulic performance by allowing perforations to remain unblocked.
☐	Minimum underdrain diameter is 6 inches.	Smaller diameter underdrains are prone to clogging.
☐	Underdrains are made of slotted, PVC pipe conforming to ASTM D 3034 or equivalent or corrugated, HDPE pipe conforming to AASHTO 252M or equivalent.	Slotted underdrains provide greater intake capacity, clog resistant drainage, and reduced entrance velocity into the pipe, thereby reducing the chances of solids migration.

Filter Course (Optional)		
☐	Filter course is washed and free of fines.	Washing aggregate will help eliminate fines that could clog subgrade and impede infiltration.

Conceptual Design and Sizing Approach for Site Design

1. Determine the areas where permeable pavement can be used in the site design to replace traditional pavement to reduce the impervious area and DCV. These permeable pavement areas can be credited toward reducing runoff generated through representation in storm water calculations as pervious, not impervious, areas but are not credited for storm water pollutant control. These permeable pavement areas should be designed as self-retaining with the appropriate tributary area ratio identified in the design criteria.
2. Calculate the DCV per Appendix B, taking into account reduced runoff from self-retaining permeable pavement areas.

Conceptual Design and Sizing Approach for Storm Water Pollutant Control Only

To design permeable pavement for storm water pollutant control only (no flow control required), the following steps should be taken:

1. Verify that siting and design criteria have been met, including placement requirements, maximum finish grade slope, and the recommended tributary area ratio for non-self-retaining permeable pavement. If infiltration is infeasible, the permeable pavement can be designed as flow-thru treatment per the sizing worksheet. If infiltration is feasible, calculations should follow the remaining design steps.
2. Calculate the DCV per Appendix B based on expected site design runoff for tributary areas.
3. Use the sizing worksheet to determine if full or partial infiltration of the DCV is achievable based on the available infiltration storage volume calculated from the permeable pavement footprint, aggregate storage layer depth, and in-situ soil design infiltration rate for a maximum 36-hour drawdown time. The applicant has an option to use a different drawdown time up to 120 hours if the volume of the facility is adjusted using the percent capture method in Appendix B.4.1.
4. Where the DCV cannot be fully infiltrated based on the site or permeable pavement constraints, an underdrain must be incorporated above the infiltration storage to carry away runoff that exceeds the infiltration storage capacity.
5. The remaining DCV to be treated should be calculated for use in sizing downstream BMP(s).

Conceptual Design and Sizing Approach when Storm Water Flow Control is Applicable

Control of flow rates and/or durations will typically require significant aggregate storage volumes, and therefore the following steps should be taken prior to determination of storm water pollutant control design. Pre-development and allowable post-project flow rates and durations should be determined as discussed in Chapter 6 of the manual.

1. Verify that siting and design criteria have been met, including placement requirements, maximum finish grade slope, and the recommended tributary area ratio for non-self-retaining permeable pavement. Design for flow control can be achieving using various design configurations, but a flow-thru treatment design will typically require a greater aggregate storage layer volume than designs which allow for full or partial infiltration of the DCV.
2. Iteratively determine the area and aggregate storage layer depth required to provide infiltration and/or detention storage to reduce flow rates and durations to allowable limits. Flow rates and durations can be controlled from detention storage by altering outlet structure orifice size(s) and/or water control levels. Multi-level orifices can be used within an outlet structure to control the full range of flows.
3. If the permeable pavement system cannot fully provide the flow rate and duration control required by this manual, a downstream structure with sufficient storage volume such as an underground vault can be used to provide remaining controls.
4. After permeable pavement has been designed to meet flow control requirements, calculations must be completed to verify if storm water pollutant control requirements to treat the DCV have been met.

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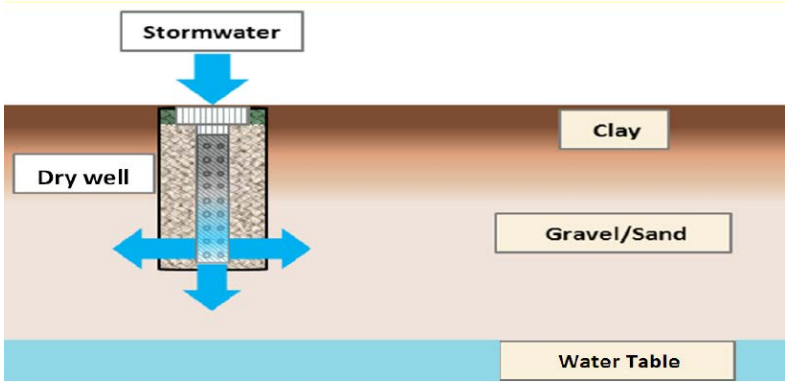
E.16 INF-4 Dry Wells



Source: Cal/EPA Fact Sheet on Dry Wells

MS4 Permit Category
Retention

Manual Category
Infiltration

Applicable Performance Standard
Pollutant Control
Flow Control

Primary Benefits
Volume Reduction

Description

Dry wells are typically designed as gravity-fed pits lined with perforated casing and often backfilled with gravel or stone. Dry wells are intended to penetrate layers of poorly infiltrating soils, such as clays, allowing infiltration into deeper permeable layers. Dry wells can reduce storm water runoff while increasing groundwater recharge. It is recommended that dry wells be used in conjunction with low impact development (LID) practices (or pretreatment) to help reduce potential contaminants to groundwater and aquatic ecosystem. Pretreatment effectiveness is contingent upon proper maintenance. With proper design and maintenance, dry wells not only aid in stormwater runoff reduction, but they can also increase groundwater recharge.

Design Adaptations for Project Goals

Full infiltration BMP for storm water pollutant control. Dry wells can be used as a pollutant control BMP, designed to infiltrate runoff from direct rainfall as well as runoff from adjacent areas that are tributary to the pavement. Dry wells must be designed with an infiltration storage volume equal to the full DCV and able to meet drawdown time limitations.

Integrated storm water flow control and pollutant control configuration. Dry wells can be designed to provide flow rate and duration control. This may be accomplished by providing greater infiltration storage

Criteria and Considerations for Use of a Dry Wells as Infiltration BMP

In general, a careful site evaluation conducted by a registered civil engineer and a geologist/geotechnical engineer should be made to determine if the use of a dry well is suitable at any particular location

A dry well may be acceptable as an "infiltration BMP" if it meets **ALL** the following criteria:

- The BMP meets the minimum geotechnical and groundwater investigation requirements listed in Appendix C; and
- The BMP is evaluated by approved infiltration rate assessment methods presented in Appendix D; and
- Implements an appropriate Low Impact Development (LID) practice / pretreatment BMP (refer to Appendix B.6.2 for selection); and
- Dry wells serving lots other than single-family homes are registered with the US EPA.

In designing a dry well, the following items should be considered:

- Depth of dry well – The EPA currently encourages that the well "should not be constructed deeper than the seasonal high water table". As water begins to percolate into an aquifer, it requires a certain holding time in order to filter out contaminants before reaching the water table. This would need to be addressed by a professional geologist/geotechnical engineer.
- Geology – Theoretically the well would be dug through an area of low permeability and into an area that would allow the movement of water into the aquifer. Also, the type of geology and its ability to act as a conduit to the aquifer system would need to be addressed. This assessment would need to be made by a professional geologist/geotechnical engineer (Note: While some areas are conducive to this, vast areas of the County of San Diego have geological conditions not conducive for dry wells).
- Grading – The use of a dry well without the proper grading and back up storm drain system might pose a problem with the ponding of runoff due to the dry well's limited storage capacity and the time it would take to discharge water into the aquifer system. This assessment would need to be made by a professional civil engineer.
- Routine maintenance – Pretreatment effectiveness is contingent upon proper maintenance. Routine maintenance should be provided in order to keep a dry well free of trash/debris, sediments, oil and grease, etc.
- Potential contamination – It is recommended that dry wells be used in conjunction with low impact development (LID) practices (or pretreatment BMPs) to help reduce potential contaminants to groundwater and aquatic ecosystem. Note: The County of San Diego Department of Environmental Health may be able to provide further input.

Note: As indicated on the Cal/EPA Fact Sheet on Dry Wells, there are currently no uniform state regulations or guidelines on dry wells in California. The purpose of this fact sheet is to help explain the role of dry wells in meeting infiltration requirements. Therefore, this fact sheet does not describe specific design criteria like the other fact sheets in this manual. The County of San Diego may develop specific design criteria and include in this fact sheet at a future time.

E.17 PR-1 Biofiltration with Partial Retention



Location: 805 and Bonita Road, Chula vista, CA.

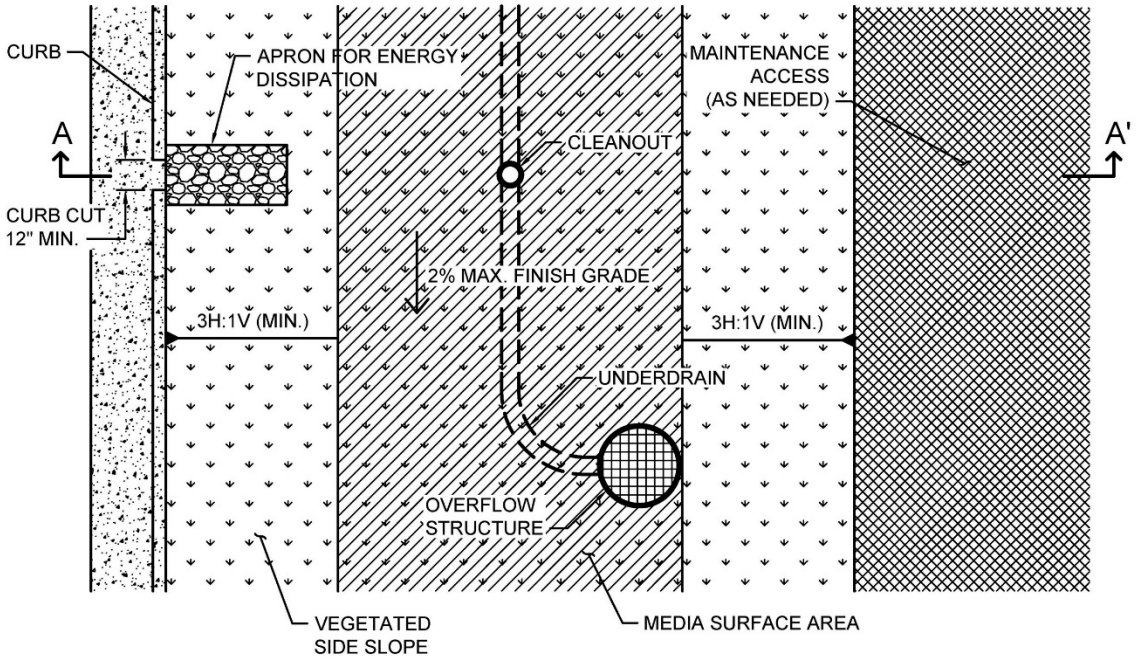
MS4 Permit Category
NA
Manual Category
Partial Retention
Applicable Performance Standard
Pollutant Control Flow Control
Primary Benefits
Volume Reduction Treatment Peak Flow Attenuation

Description

Biofiltration with partial retention (partial infiltration and biofiltration) facilities are vegetated surface water systems that filter water through vegetation, and soil or engineered media prior to infiltrating into native soils, discharge via underdrain, or overflow to the downstream conveyance system. Where feasible, these BMPs have an elevated underdrain discharge point that creates storage capacity in the aggregate storage layer. Biofiltration with partial retention facilities are commonly incorporated into the site within parking lot landscaping, along roadsides, and in open spaces. They can be constructed in ground or partially aboveground, such as planter boxes with open bottoms to allow infiltration. Treatment is achieved through filtration, sedimentation, sorption, infiltration, biochemical processes and plant uptake.

Typical biofiltration with partial retention components include:

- Inflow distribution mechanisms (e.g, perimeter flow spreader or filter strips)
- Energy dissipation mechanism for concentrated inflows (e.g., splash blocks or riprap)
- Shallow surface ponding for captured flows
- Side Slope and basin bottom vegetation selected based on climate and ponding depth
- Non-floating mulch layer
- Media layer (planting mix or engineered media) capable of supporting vegetation growth
- Filter course layer consisting of aggregate to prevent the migration of fines into uncompacted native soils or the optional aggregate storage layer
- Aggregate storage layer with underdrain(s)
- Uncompacted native soils at the bottom of the facility
- Overflow structure



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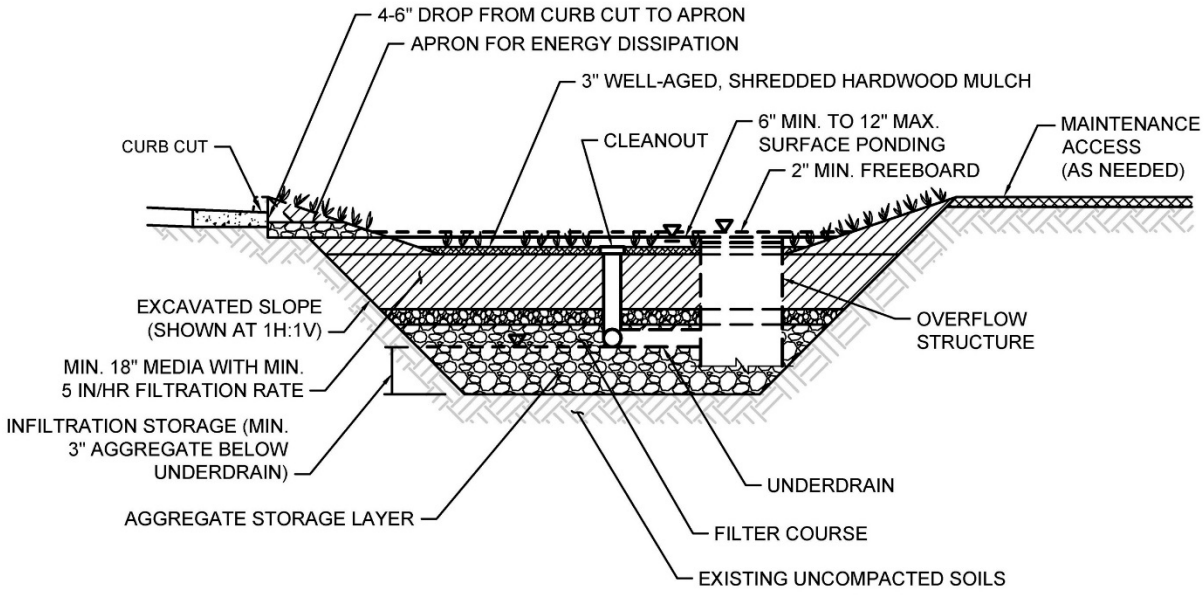

SECTION A-A'
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Typical plan and Section view of a Biofiltration with Partial Retention BMP

Design Adaptations for Project Goals

Partial infiltration BMP with biofiltration treatment for storm water pollutant control. Biofiltration with partial retention can be designed so that a portion of the DCV is infiltrated by providing infiltration storage below the underdrain invert. The infiltration storage depth should be determined by the volume that can be reliably infiltrated within drawdown time limitations. Water discharged through the underdrain is considered biofiltration treatment. Storage provided above the underdrain within surface ponding, media, and aggregate storage is included in the biofiltration treatment volume.

Integrated storm water flow control and pollutant control configuration. The system can be designed to provide flow rate and duration control by primarily providing increased surface ponding and/or having a deeper aggregate storage layer. This will allow for significant detention storage, which can be controlled via inclusion of an orifice in an outlet structure at the downstream end of the underdrain.

Design Criteria and Considerations

Biofiltration with partial retention must meet the following design criteria and considerations. Deviations from the below criteria may be approved at the discretion of County staff if it is determined to be appropriate:

	Siting and Design	*Intent/Rationale*
☐	Placement observes geotechnical recommendations regarding potential hazards (e.g., slope stability, landslides, liquefaction zones) and setbacks (e.g., slopes, foundations, utilities).	Must not negatively impact existing site geotechnical concerns.
☐	Selection and design of basin is based on infiltration feasibility criteria and appropriate design infiltration rate (See Appendix C and D).	Must operate as a partial infiltration design and must be supported by drainage area and in-situ infiltration rate feasibility findings.

Siting and Design		*Intent/Rationale*
☐	Contributing tributary area must be ≤ 5 acres (≤ 1 acre preferred).	Bigger BMPs require additional design features for proper performance. Contributing tributary area greater than 5 acres may be allowed at the discretion of County staff if the following conditions are met: 1) incorporate design features (e.g. flow spreaders) to minimize short circuiting of flows in the BMP and 2) incorporate additional design features requested by County staff for proper performance of the regional BMP.
☐	Finish grade of the facility is ≤ 2%.	Flatter surfaces reduce erosion and channelization within the facility.
Surface Ponding		
☐	Surface ponding is limited to a 24-hour drawdown time.	Surface ponding limited to 24 hours for plant health.
☐	Surface ponding depth is ≥ 6 and ≤ 12 inches.	Surface ponding capacity lowers subsurface storage requirements. Deep surface ponding raises safety concerns. Surface ponding depth greater than 12 inches (for additional pollutant control or surface outlet structures or flow-control orifices) may be allowed at the discretion of County staff if the following conditions are met: 1) surface ponding depth drawdown time is less than 24 hours; and 2) safety issues and fencing requirements are considered (typically ponding greater than 18" will require a fence and/or flatter side slopes) and 3) potential for elevated clogging risk is considered.
☐	A minimum of 2 inches of freeboard is provided.	Freeboard provides room for head over overflow structures and minimizes risk of uncontrolled surface discharge.
☐	Side slopes are stabilized with vegetation and are = 3H:1V or shallower.	Gentler side slopes are safer, less prone to erosion, able to establish vegetation more quickly and easier to maintain.

Vegetation		
☐	Plantings are suitable for the climate and expected ponding depth. A plant list to aid in selection can be found in Appendix E.20	Plants suited to the climate and ponding depth are more likely to survive.
☐	An irrigation system with a connection to water supply should be provided as needed.	Seasonal irrigation might be needed to keep plants healthy.
Mulch (Mandatory)		
☐	A minimum of 3 inches of well-aged, shredded hardwood mulch that has been stockpiled or stored for at least 12 months is provided. Mulch must be non-floating to avoid clogging of overflow structure.	Mulch will suppress weeds and maintain moisture for plant growth. Aging mulch kills pathogens and weed seeds and allows the beneficial microbes to multiply.
Media Layer		
☐	Media maintains a minimum filtration rate of 5 in/hr over lifetime of facility. An initial filtration rate of 8 to 12 in/hr is recommended to allow for clogging over time; the initial filtration rate should not exceed 12 inches per hour.	A filtration rate of at least 5 inches per hour allows soil to drain between events, and allows flows to relatively quickly enter the aggregate storage layer, thereby minimizing bypass. The initial rate should be higher than long term target rate to account for clogging over time. However an excessively high initial rate can have a negative impact on treatment performance, therefore an upper limit is needed.

Media Layer		
☐	Media is a minimum 18 inches deep, meeting either of these two media specifications: City of San Diego Storm Water Standards Appendix F (February 2016, unless superseded by more recent edition) **or** County of San Diego Low Impact Development Handbook: Appendix G -Bioretention Soil Specification (June 2014, unless superseded by more recent edition).	A deep media layer provides additional filtration and supports plants with deeper roots. Standard specifications must be followed.
	Alternatively, for proprietary designs and custom media mixes not meeting the media specifications contained in the 2016 City Storm Water Standards or County LID Manual, the media meets the pollutant treatment performance criteria in Section F.1.	For non-standard or proprietary designs, compliance with Appendix F.1 ensures that adequate treatment performance will be provided.
☐	Media surface area is 3% of contributing area times adjusted runoff factor or greater. Unless demonstrated that the BMP surface area can be smaller than 3%.	Greater surface area to tributary area ratios: a) maximizes volume retention as required by the MS4 Permit and b) decrease loading rates per square foot and therefore increase longevity. Adjusted runoff factor is to account for site design BMPs implemented upstream of the BMP (such as rain barrels, impervious area dispersion, etc.). Refer to Appendix B.2 guidance. Use Worksheet B.5-1 Line 26 to estimate the minimum surface area required per this criteria.
☐	Where receiving waters are impaired or have a TMDL for nutrients, the system is designed with nutrient sensitive media design (see fact sheet BF-2).	Potential for pollutant export is partly a function of media composition; media design must minimize potential for export of nutrients, particularly where receiving waters are impaired for nutrients.

Filter Course Layer		
☐	A filter course is used to prevent migration of fines through layers of the facility. Filter fabric is not used.	Migration of media can cause clogging of the aggregate storage layer void spaces or subgrade. Filter fabric is more likely to clog.
☐	Filter course is washed and free of fines.	Washing aggregate will help eliminate fines that could clog the facility
☐	Filter course calculations assessing suitability for particle migration prevention have been completed.	Gradation relationship between layers can evaluate factors (e.g., bridging, permeability, and uniformity) to determine if particle sizing is appropriate or if an intermediate layer is needed.
Aggregate Storage Layer		
☐	Class 2 Permeable per Caltrans specification 68-1.025 is recommended for the storage layer. Washed, open-graded crushed rock may be used, however a 4-6 inch washed pea gravel filter course layer at the top of the crushed rock is required.	Washing aggregate will help eliminate fines that could clog the aggregate storage layer void spaces or subgrade.
☐	Maximum aggregate storage layer depth below the underdrain invert is determined based on the infiltration storage volume that will infiltrate within a 48-hour drawdown time.	A maximum drawdown time is needed for vector control and to facilitate providing storm water storage for the next storm event.
Inflow, Underdrain, and Outflow Structures		
☐	Inflow, underdrains and outflow structures are accessible for inspection and maintenance.	Maintenance will prevent clogging and ensure proper operation of the flow control structures.
☐	Inflow velocities are limited to 3 ft/s or less or use energy dissipation methods. (e.g., riprap, level spreader) for concentrated inflows.	High inflow velocities can cause erosion, scour and/or channeling.
☐	Curb cut inlets are at least 12 inches wide, have a 4-6 inch reveal (drop) and an apron and energy dissipation as needed.	Inlets must not restrict flow and apron prevents blockage from vegetation as it grows in. Energy dissipation prevents erosion.

Inflow, Underdrain, and Outflow Structures		
☐	Underdrain outlet elevation should be a minimum of 3 inches above the bottom elevation of the aggregate storage layer.	A minimal separation from subgrade or the liner lessens the risk of fines entering the underdrain and can improve hydraulic performance by allowing perforations to remain unblocked.
☐	Minimum underdrain diameter is 6 inches.	Smaller diameter underdrains are prone to clogging.
☐	Underdrains are made of slotted, PVC pipe conforming to ASTM D 3034 or equivalent or corrugated, HDPE pipe conforming to AASHTO 252M or equivalent.	Slotted underdrains provide greater intake capacity, clog resistant drainage, and reduced entrance velocity into the pipe, thereby reducing the chances of solids migration.
☐	An underdrain cleanout with a minimum 6-inch diameter and lockable cap is placed every 250 to 300 feet as required based on underdrain length.	Properly spaced cleanouts will facilitate underdrain maintenance.
☐	Overflow is safely conveyed to a downstream storm drain system or discharge point. Size overflow structure to pass 100-year peak flow for on-line infiltration basins and water quality peak flow for off-line basins.	Planning for overflow lessens the risk of property damage due to flooding.

Nutrient Sensitive Media Design

To design biofiltration with partial retention with underdrain for storm water pollutant control only (no flow control required), the following steps should be taken:

Conceptual Design and Sizing Approach for Storm Water Pollutant Control Only

To design biofiltration with partial retention and an underdrain for storm water pollutant control only (no flow control required), the following steps should be taken:

1. Verify that siting and design criteria have been met, including placement requirements, contributing tributary area, maximum side and finish grade slopes, and the recommended media surface area tributary ratio.
2. Calculate the DCV per Appendix B based on expected site design runoff for tributary areas.
3. Generalized sizing procedure is presented in Appendix B.5. The surface ponding should be verified to have a maximum 24-hour drawdown time.

Conceptual Design and Sizing Approach when Storm Water Flow Control is Applicable

Control of flow rates and/or durations will typically require significant surface ponding and/or aggregate storage volumes, and therefore the following steps should be taken prior to determination of storm water pollutant control design. Pre-development and allowable post-project flow rates and durations should be determined as discussed in Chapter 6 of the manual.

1. Verify that siting and design criteria have been met, including placement requirements, contributing tributary area, maximum side and finish grade slopes, and the recommended media surface area tributary ratio.
2. Iteratively determine the facility footprint area, surface ponding and/or aggregate storage layer depth required to provide detention and/or infiltration storage to reduce flow rates and durations to allowable limits. Flow rates and durations can be controlled from detention storage by altering outlet structure orifice size(s) and/or water control levels. Multi-level orifices can be used within an outlet structure to control the full range of flows.
3. If biofiltration with partial retention cannot fully provide the flow rate and duration control required by this manual, an upstream or downstream structure with significant storage volume such as an underground vault can be used to provide remaining controls.
4. After biofiltration with partial retention has been designed to meet flow control requirements, calculations must be completed to verify if storm water pollutant control requirements to treat the DCV have been met.

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E.18 BF-1 Biofiltration



Location: 43rd Street and Logan Avenue, San Diego, California

MS4 Permit Category
Biofiltration

Manual Category
Biofiltration

Applicable Performance Standard
Pollutant Control
Flow Control

Primary Benefits
Treatment
Volume Reduction (Incidental)
Peak Flow Attenuation (Optional)

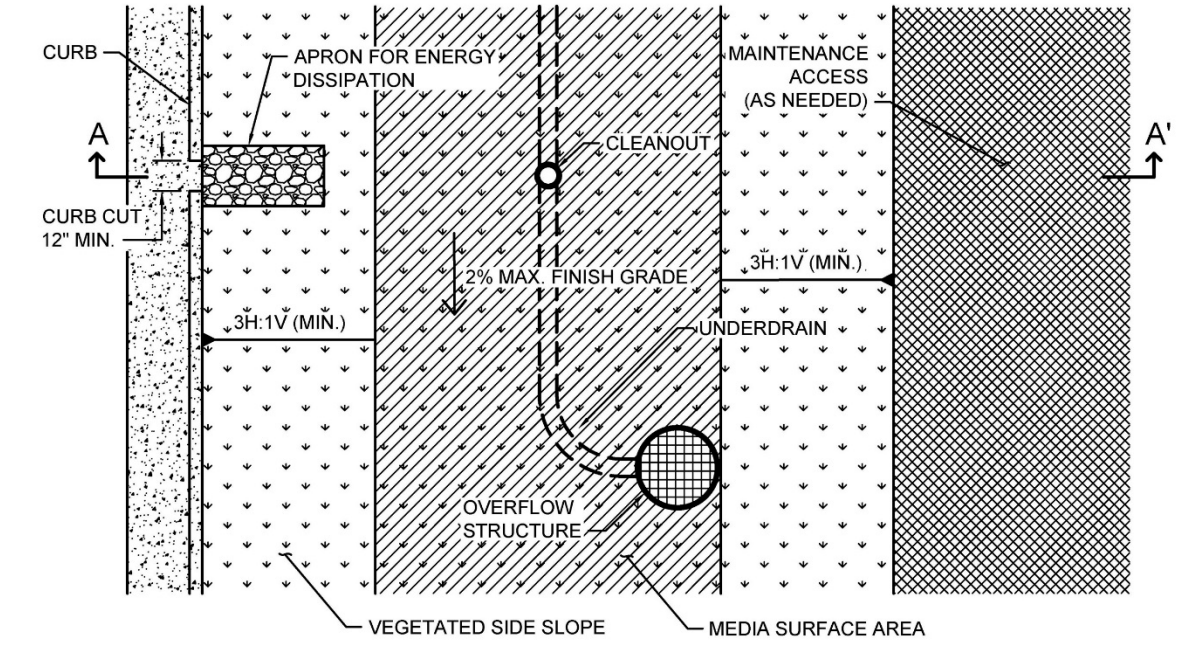
Description

Biofiltration (Bioretention with underdrain) facilities are vegetated surface water systems that filter water through vegetation, and soil or engineered media prior to discharge via underdrain or overflow to the downstream conveyance system. Bioretention with underdrain facilities are commonly incorporated into the site within parking lot landscaping, along roadsides, and in open spaces. Because these types of facilities have limited or no infiltration, they are typically designed to provide enough hydraulic head to move flows through the underdrain connection to the storm drain system. Treatment is achieved through filtration, sedimentation, sorption, biochemical processes and plant uptake.

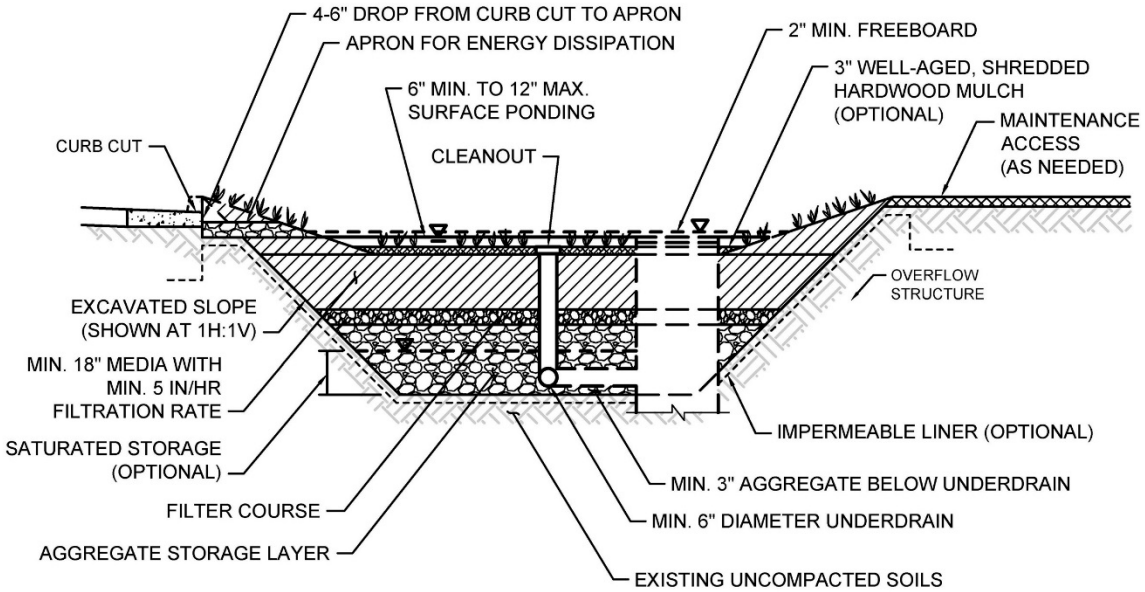
Typical bioretention with underdrain components include:

- Inflow distribution mechanisms (e.g, perimeter flow spreader or filter strips)
- Energy dissipation mechanism for concentrated inflows (e.g., splash blocks or riprap)
- Shallow surface ponding for captured flows
- Side slope and basin bottom vegetation selected based on expected climate and ponding depth
- Non-floating mulch layer (Optional)
- Media layer (planting mix or engineered media) capable of supporting vegetation growth
- Filter course layer consisting of aggregate to prevent the migration of fines into uncompacted native soils or the aggregate storage layer
- Aggregate storage layer with underdrain(s)

- Impermeable liner or uncompacted native soils at the bottom of the facility
- Overflow structure



PLAN
NOT TO SCALE



SECTION A-A'
NOT TO SCALE

Typical plan and Section view of a Biofiltration BMP

Design Adaptations for Project Goals

Biofiltration Treatment BMP for storm water pollutant control. The system is lined or un-lined to provide incidental infiltration, and an underdrain is provided at the bottom to carry away filtered runoff. This configuration is considered to provide biofiltration treatment via flow through the media layer. Storage provided above the underdrain within surface ponding, media, and aggregate storage is considered included in the biofiltration treatment volume. Saturated storage within the aggregate storage layer can be added to this design by raising the underdrain above the bottom of the aggregate storage layer or via an internal weir structure designed to maintain a specific water level elevation.

Integrated storm water flow control and pollutant control configuration. The system can be designed to provide flow rate and duration control by primarily providing increased surface ponding and/or having a deeper aggregate storage layer above the underdrain. This will allow for significant detention storage, which can be controlled via inclusion of an outlet structure at the downstream end of the underdrain.

Design Criteria and Considerations

Bioretention with underdrain must meet the following design criteria. Deviations from the below criteria may be approved at the discretion of County staff if it is determined to be appropriate:

	Siting and Design	*Intent/Rationale*
☐	Placement observes geotechnical recommendations regarding potential hazards (e.g., slope stability, landslides, liquefaction zones) and setbacks (e.g., slopes, foundations, utilities).	Must not negatively impact existing site geotechnical concerns.
☐	An impermeable liner or other hydraulic restriction layer is included if site constraints indicate that infiltration or lateral flows should not be allowed.	Lining prevents storm water from impacting groundwater and/or sensitive environmental or geotechnical features. Incidental infiltration, when allowable, can aid in pollutant removal and groundwater recharge.

Siting and Design		*Intent/Rationale*
☐	Contributing tributary area must be ≤ 5 acres (≤ 1 acre preferred).	Bigger BMPs require additional design features for proper performance. Contributing tributary area greater than 5 acres may be allowed at the discretion of County staff if the following conditions are met: 1) incorporate design features (e.g. flow spreaders) to minimize short circuiting of flows in the BMP and 2) incorporate additional design features requested by County staff for proper performance of the regional BMP.
☐	Finish grade of the facility is ≤ 2%.	Flatter surfaces reduce erosion and channelization within the facility.
Surface Ponding		
☐	Surface ponding is limited to a 24-hour drawdown time.	Surface ponding limited to 24 hour for plant health. Surface ponding drawdown time greater than 24-hours but less than 96 hours may be allowed at the discretion of County staff if certified by a landscape architect or agronomist.
☐	Surface ponding depth is ≥ 6 and ≤ 12 inches.	Surface ponding capacity lowers subsurface storage requirements. Deep surface ponding raises safety concerns. Surface ponding depth greater than 12 inches (for additional pollutant control or surface outlet structures or flow-control orifices) may be allowed at the discretion of County staff if the following conditions are met: 1) surface ponding depth drawdown time is less than 24 hours; and 2) safety issues and fencing requirements are considered (typically ponding greater than 18" will require a fence and/or flatter side slopes) and 3) potential for elevated clogging risk is considered.
☐	A minimum of 2 inches of freeboard is provided.	Freeboard provides room for head over overflow structures and minimizes risk of uncontrolled surface discharge.

Surface Ponding		
☐	Side slopes are stabilized with vegetation and are = 3H:1V or shallower.	Gentler side slopes are safer, less prone to erosion, able to establish vegetation more quickly and easier to maintain.
Vegetation		
☐	Plantings are suitable for the climate and expected ponding depth. A plant list to aid in selection can be found in Appendix E.20.	Plants suited to the climate and ponding depth are more likely to survive.
☐	An irrigation system with a connection to water supply should be provided as needed.	Seasonal irrigation might be needed to keep plants healthy.
Mulch (Mandatory)		
☐	A minimum of 3 inches of well-aged, shredded hardwood mulch that has been stockpiled or stored for at least 12 months is provided.	Mulch will suppress weeds and maintain moisture for plant growth. Aging mulch kills pathogens and weed seeds and allows the beneficial microbes to multiply.
Media Layer		
☐	Media maintains a minimum filtration rate of 5 in/hr over lifetime of facility. An initial filtration rate of 8 to 12 in/hr is recommended to allow for clogging over time; the initial filtration rate should not exceed 12 inches per hour.	A filtration rate of at least 5 inches per hour allows soil to drain between events. The initial rate should be higher than long term target rate to account for clogging over time. However an excessively high initial rate can have a negative impact on treatment performance, therefore an upper limit is needed.

Media Layer		
☐	Media is a minimum 18 inches deep, meeting either of these two media specifications: City of San Diego Storm Water Standards Appendix F (February 2016, unless superseded by more recent edition) **or** County of San Diego Low Impact Development Handbook: Appendix G -Bioretention Soil Specification (June 2014, unless superseded by more recent edition). Alternatively, for proprietary designs and custom media mixes not meeting the media specifications contained in the 2016 City Storm Water Standards or County LID Manual, the media meets the pollutant treatment performance criteria in Section F.1.	A deep media layer provides additional filtration and supports plants with deeper roots. Standard specifications must be followed. For non-standard or proprietary designs, compliance with F.1 ensures that adequate treatment performance will be provided.
☐	Media surface area is 3% of contributing area times adjusted runoff factor or greater. Unless demonstrated that the BMP surface area can be smaller than 3%.	Greater surface area to tributary area ratios: a) maximizes volume retention as required by the MS4 Permit and b) decrease loading rates per square foot and therefore increase longevity. Adjusted runoff factor is to account for site design BMPs implemented upstream of the BMP (such as rain barrels, impervious area dispersion, etc.). Refer to Appendix B.2 guidance. Use Worksheet B.5-1 Line 26 to estimate the minimum surface area required per this criteria.
☐	Where receiving waters are impaired or have a TMDL for nutrients, the system is designed with nutrient sensitive media design (see fact sheet BF-2).	Potential for pollutant export is partly a function of media composition; media design must minimize potential for export of nutrients, particularly where receiving waters are impaired for nutrients.
Filter Course Layer		
☐	A filter course is used to prevent migration of fines through layers of the facility. Filter fabric is not used.	Migration of media can cause clogging of the aggregate storage layer void spaces or subgrade. Filter fabric is more likely to clog.

Filter Course Layer		
☐	Filter course is washed and free of fines.	Washing aggregate will help eliminate fines that could clog the facility and impede infiltration.
☐	Filter course calculations assessing suitability for particle migration prevention have been completed.	Gradation relationship between layers can evaluate factors (e.g., bridging, permeability, and uniformity) to determine if particle sizing is appropriate or if an intermediate layer is needed.
Aggregate Storage Layer		
☐	Class 2 Permeable per Caltrans specification 68-1.025 is recommended for the storage layer. Washed, open-graded crushed rock may be used, however a 4-6 inch washed pea gravel filter course layer at the top of the crushed rock is required.	Washing aggregate will help eliminate fines that could clog the aggregate storage layer void spaces or subgrade.
☐	The depth of aggregate provided (12-inch typical) and storage layer configuration is adequate for providing conveyance for underdrain flows to the outlet structure.	Proper storage layer configuration and underdrain placement will minimize facility drawdown time.
Inflow, Underdrain, and Outflow Structures		
☐	Inflow, underdrains and outflow structures are accessible for inspection and maintenance.	Maintenance will prevent clogging and ensure proper operation of the flow control structures.
☐	Inflow velocities are limited to 3 ft/s or less or use energy dissipation methods. (e.g., riprap, level spreader) for concentrated inflows.	High inflow velocities can cause erosion, scour and/or channeling.
☐	Curb cut inlets are at least 12 inches wide, have a 4-6 inch reveal (drop) and an apron and energy dissipation as needed.	Inlets must not restrict flow and apron prevents blockage from vegetation as it grows in. Energy dissipation prevents erosion.
☐	Underdrain outlet elevation should be a minimum of 3 inches above the bottom elevation of the aggregate storage layer.	A minimal separation from subgrade or the liner lessens the risk of fines entering the underdrain and can improve hydraulic performance by allowing perforations to remain unblocked.
☐	Minimum underdrain diameter is 6 inches.	Smaller diameter underdrains are prone to clogging.

Inflow, Underdrain, and Outflow Structures		
☐	Underdrains are made of slotted, PVC pipe conforming to ASTM D 3034 or equivalent or corrugated, HDPE pipe conforming to AASHTO 252M or equivalent.	Slotted underdrains provide greater intake capacity, clog resistant drainage, and reduced entrance velocity into the pipe, thereby reducing the chances of solids migration.
☐	An underdrain cleanout with a minimum 6-inch diameter and lockable cap is placed every 250 to 300 feet as required based on underdrain length.	Properly spaced cleanouts will facilitate underdrain maintenance.
☐	Overflow is safely conveyed to a downstream storm drain system or discharge point Size overflow structure to pass 100-year peak flow for on-line infiltration basins and water quality peak flow for off-line basins.	Planning for overflow lessens the risk of property damage due to flooding.

Conceptual Design and Sizing Approach for Storm Water Pollutant Control Only

To design bioretention with underdrain for storm water pollutant control only (no flow control required), the following steps should be taken:

1. Verify that siting and design criteria have been met, including placement requirements, contributing tributary area, maximum side and finish grade slopes, and the recommended media surface area tributary ratio.
2. Calculate the DCV per Appendix B based on expected site design runoff for tributary areas.
3. Use the sizing worksheet presented in Appendix B.5 to size biofiltration BMPs.

Conceptual Design and Sizing Approach when Storm Water Flow Control is Applicable

Control of flow rates and/or durations will typically require significant surface ponding and/or aggregate storage volumes, and therefore the following steps should be taken prior to determination of storm water pollutant control design. Pre-development and allowable post-project flow rates and durations should be determined as discussed in Chapter 6 of the manual.

1. Verify that siting and design criteria have been met, including placement requirements, contributing tributary area, maximum side and finish grade slopes, and the recommended media surface area tributary ratio.
2. Iteratively determine the facility footprint area, surface ponding and/or aggregate storage layer depth required to provide detention storage to reduce flow rates and durations to allowable limits. Flow rates and durations can be controlled from detention storage by altering outlet structure orifice size(s) and/or water control levels. Multi-level orifices can be

used within an outlet structure to control the full range of flows.

3. If bioretention with underdrain cannot fully provide the flow rate and duration control required by this manual, an upstream or downstream structure with significant storage volume such as an underground vault can be used to provide remaining controls.
4. After bioretention with underdrain has been designed to meet flow control requirements, calculations must be completed to verify if storm water pollutant control requirements to treat the DCV have been met.

E.19 BF-2 Nutrient Sensitive Media Design

Some studies of bioretention with underdrains have observed export of nutrients, particularly inorganic nitrogen (nitrate and nitrite) and dissolved phosphorus. This has been observed to be a short-lived phenomenon in some studies or a long term issue in some studies. The composition of the soil media, including the chemistry of individual elements is believed to be an important factor in the potential for nutrient export. Organic amendments, often compost, have been identified as the most likely source of nutrient export. The quality and stability of organic amendments can vary widely.

The biofiltration media specifications contained in the County of San Diego Low Impact Development Handbook: Appendix G -Bioretention Soil Specification (June 2014, unless superseded by more recent edition) and the City of San Diego Low Impact Development Design Manual (page B-18) (July 2011, unless superseded by more recent edition) were developed with consideration of the potential for nutrient export. These specifications include criteria for individual component characteristics and quality in order to control the overall quality of the blended mixes. As of the publication of this manual, the June 2014 County of San Diego specifications provide more detail regarding mix design and quality control.

The City and County specifications noted above were developed for general purposes to meet permeability and treatment goals. In cases where the BMP discharges to receiving waters with nutrient impairments or nutrient TMDLs, the biofiltration media should be designed with the specific goal of minimizing the potential for export of nutrients from the media. Therefore, in addition to adhering to the City or County media specifications, the following guidelines should be followed:

1. Select plant palette to minimize plant nutrient needs

A landscape architect or agronomist should be consulted to select a plant palette that minimizes nutrient needs. Utilizing plants with low nutrient needs results in less need to enrich the biofiltration soil mix. If nutrient quantity is then tailored to plants with lower nutrient needs, these plants will generally have less competition from weeds, which typically need higher nutrient content. The following practices are recommended to minimize nutrient needs of the plant palette:

- **Utilize native, drought-tolerant plants and grasses where possible.** Native plants generally have a broader tolerance for nutrient content, and can be longer lived in leaner/lower nutrient soils.

- **Start plants from smaller starts or seed.** Younger plants are generally more tolerant of lower nutrient levels and tend to help develop soil structure as they grow. Given the lower cost of smaller plants, the project should be able to accept a plant mortality rate that is somewhat higher than starting from larger plants and providing high organic content.

2. Minimize excess nutrients in media mix

Once the low-nutrient plant palette is established (item 1), the landscape architect and/or agronomist should be consulted to assist in the design of a biofiltration media to balance the interests of plant establishment, water retention capacity (irrigation demand), and the potential for nutrient export. The following guidelines should be followed:

- **The mix should not exceed the nutrient needs of plants.** In conventional landscape design, the nutrient needs of plants are often exceeded intentionally in order to provide a factor of safety for plant survival. This practice must be avoided in biofiltration media as excess nutrients will increase the chance of export. The mix designer should keep in mind that nutrients can be added later (through mulching, tilling of amendments into the surface), but it is not possible to remove nutrients, once added.

- **The actual nutrient content and organic content of the selected organic amendment source should be determined when specifying mix proportions.** Nutrient content (i.e., C:N ratio; plant extractable nutrients) and organic content (i.e, % organic material) are relatively inexpensive to measure via standard agronomic methods and can provide important information about mix design. If mix design relies on approximate assumption about nutrient/organic content and this is not confirmed with testing (or the results of prior representative testing), it is possible that the mix could contain much more nutrient than intended.

- **Nutrients are better retained in soils with higher cation exchange capacity.** Cation exchange capacity can be increased through selection of organic material with naturally high cation exchange capacity, such as peat or coconut coir pith, and/or selection of inorganic material with high cation exchange capacity such as some sands or engineered minerals (e.g., low P-index sands, zeolites, rhyolites, etc). Including higher cation exchange capacity materials would tend to reduce the net export of nutrients. Natural silty materials also provide cation exchange capacity; however potential impacts to permeability need to be considered.

- **Focus on soil structure as well as nutrient content.** Soil structure is loosely defined as the ability of the soil to conduct and store water and nutrients as well as the degree of aeration of the soil. Soil structure can be more important than nutrient content in plant survival and biologic health of the system. If a good soil structure can be created with very low amounts of organic amendment, plants survivability should still be provided. While soil structure generally develops with time, biofiltration media can be designed to promote earlier development of soil structure. Soil structure is enhanced by the use of amendments with high humus content (as found in well-aged organic material). In addition, soil structure can be enhanced through the use of organic material with a distribution of particle sizes (i.e., a more heterogeneous mix).

- **Consider alternatives to compost.** Compost, by nature, is a material that is continually evolving and decaying. It can be challenging to determine whether tests previously done on a given compost stock are still representative. It can also be challenging to determine how the

properties of the compost will change once placed in the media bed. More stable materials such as aged coco coir pith, peat, biochar, shredded bark, and/or other amendments should be considered.

With these considerations, it is anticipated that less than 10 percent organic amendment by volume could be used, while still balancing plant survivability and water retention. If compost is used, designers should strongly consider utilizing less than 10 percent by volume.

3. Design with partial retention and/or internal water storage

An internal water storage zone, as described in Fact Sheet PR-1 is believed to improve retention of nutrients. For lined systems, an internal water storage zone worked by providing a zone that fluctuates between aerobic and anaerobic conditions, resulting in nitrification/denitrification. In soils that will allow infiltration, a partial retention design (PR-1) allows significant volume reduction and can also promote nitrification/denitrification.

Acknowledgment: This fact sheet has been adapted from the Orange County Technical Guidance Document (May 2011). It was originally developed based on input from: Deborah Deets, City of Los Angeles Bureau of Sanitation, Drew Ready, Center for Watershed Health, Rick Fisher, ASLA, City of Los Angeles Bureau of Engineering, Dr. Garn Wallace, Wallace Laboratories, Glen Dake, GDML, and Jason Schmidt, Tree People. The guidance provided herein does not reflect the individual opinions of any individual listed above and should not be cited or otherwise attributed to those listed.

E.20 BF-3 Proprietary Biofiltration Systems

The purpose of this fact sheet is to help explain the potential role of proprietary BMPs in meeting biofiltration requirements, when full retention of the DCV is not feasible. The fact sheet does not describe design criteria like the other fact sheets in this appendix because this information varies by BMP product model.

Criteria for Use of a Proprietary BMP as a Biofiltration BMP

A proprietary BMP may be acceptable as a "biofiltration BMP" under the following conditions:

(1) The BMP meets the minimum design criteria listed in Appendix F, including the selection criteria (i.e. only allowed in No Infiltration Condition and where site-specific documentation demonstrates that the use of larger footprint biofiltration BMPs (i.e. 3 %) would be infeasible) and the pollutant treatment performance standard in Appendix F.1;

(2) The BMP is designed and maintained in a manner consistent with its performance certifications (See explanation in Appendix F.2); and

(3) The BMP is acceptable at the discretion of County staff. While the County has no obligation to accept the use of any proposed proprietary flow-thru BMP, applicants will be provided a written explanation describing the rationale for the rejection of any proposed devices.

Guidance for Sizing a Proprietary BMP as a Biofiltration BMP

Proprietary biofiltration BMPs must meet the same sizing guidance as non-proprietary BMPs. Sizing is typically based on capturing and treating 1.50 times the DCV not reliably retained. Guidance for sizing biofiltration BMPs to comply with requirements of this manual is provided in Appendix F.2.

E.21 FT-1 Vegetated Swales



MS4 Permit Category
Flow-thru Treatment Control

Manual Category
Flow-thru Treatment Control

Applicable Performance Standard
Pollutant Control

Primary Benefits
Treatment
Volume Reduction (Incidental)
Peak Flow Attenuation

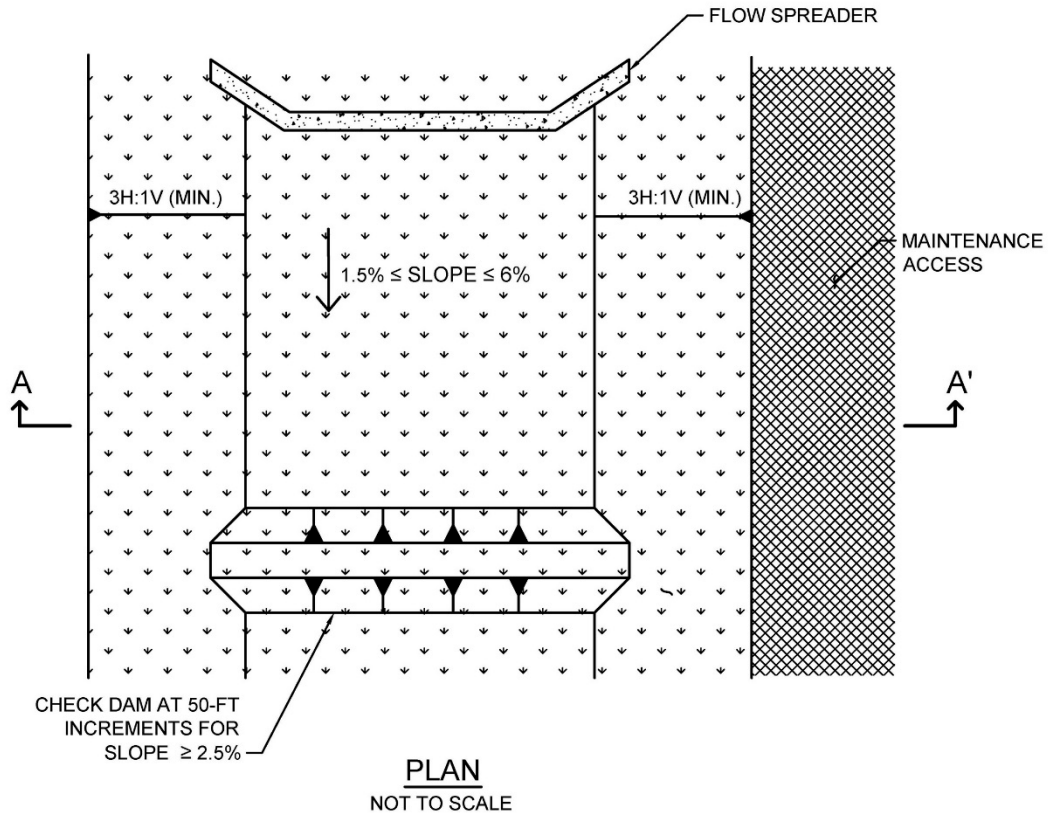
Location: Eastlake Business Center, Chula Vista, California; Photo Credit: Eric Mosolgo

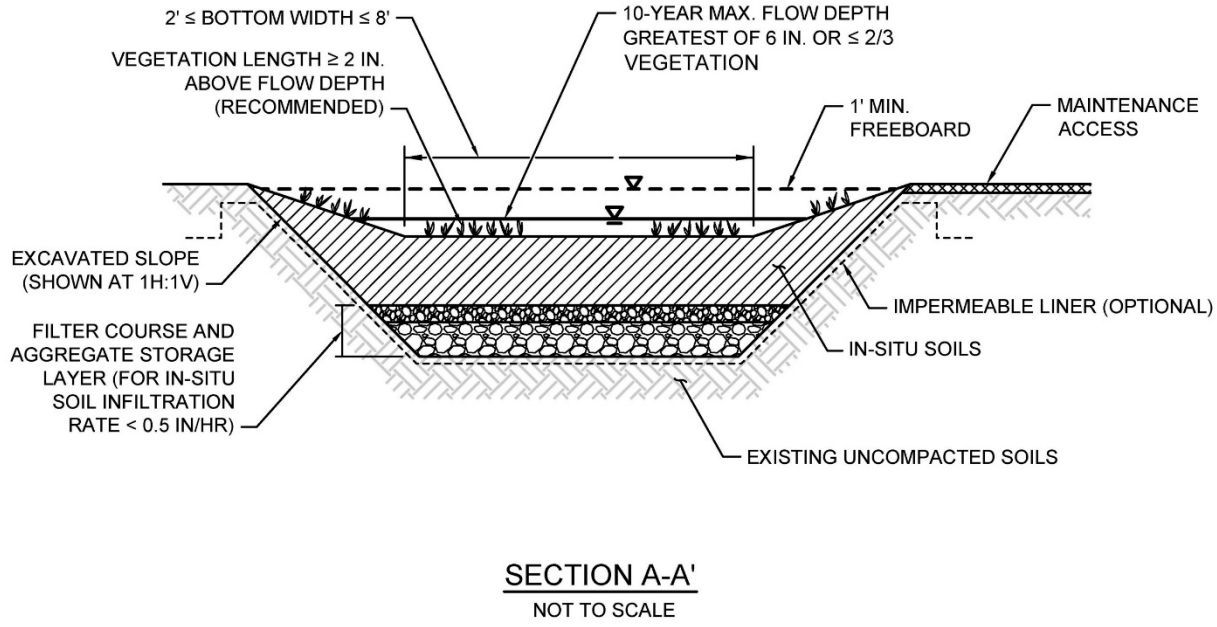
Description

Vegetated swales are shallow, open channels that are designed to remove storm water pollutants by physically straining/filtering runoff through vegetation in the channel. Swales can be used in place of traditional curbs and gutters and are well-suited for use in linear transportation corridors to provide both conveyance and treatment via filtration. An effectively designed vegetated swale achieves uniform sheet flow through densely vegetated areas. When soil conditions allow, infiltration and volume reduction are enhanced by adding a gravel drainage layer underneath the swale. Vegetated swales with a subsurface media layer can provide enhanced infiltration, water retention, and pollutant-removal capabilities. Pollutant removal effectiveness can also be maximized by increasing the hydraulic residence time of water in swale using weirs or check dams.

Typical vegetated swale components include:

- Inflow distribution mechanisms (e.g., flow spreader)
- Surface flow
- Vegetated surface layer
- Check dams (if required)
- Optional aggregate storage layer with underdrain(s)





Typical plan and Section view of a Vegetated Swale BMP

Design Adaptations for Project Goals

Site design BMP to reduce runoff volumes and storm peaks. Swales without underdrains are an alternative to lined channels and pipes and can provide volume reduction through infiltration. Swales can also reduce the peak runoff discharge rate by increasing the time of concentration of the site and decreasing runoff volumes and velocities.

Flow-thru treatment BMP for storm water pollutant control. The system is lined or un-lined to provide incidental infiltration with an underdrain and designed to provide pollutant removal through settling and filtration in the channel vegetation (usually grasses). This configuration is considered to provide flow-thru treatment via horizontal surface flow through the swale. Sizing for flow-thru treatment control is based on the surface flow rate through the swale that meets water quality treatment performance objectives.

Design Criteria and Considerations

Vegetated swales must meet the following design criteria. Deviations from the below criteria may be approved at the discretion of County staff if it is determined to be appropriate:

	Siting and Design	*Intent/Rationale*
☐	Placement observes geotechnical recommendations regarding potential hazards (e.g., slope stability, landslides, and liquefaction zones) and setbacks (e.g., slopes, foundations, utilities).	Must not negatively impact existing site geotechnical concerns.
☐	An impermeable liner or other hydraulic restriction layer is included if site constraints indicate that infiltration or lateral flows should not be allowed.	Lining prevents storm water from impacting groundwater and/or sensitive environmental or geotechnical features. Incidental infiltration, when allowable, can aid in pollutant removal and groundwater recharge.
☐	Contributing tributary area ≤ 2 acres.	Higher ratios increase the potential for clogging but may be acceptable for relatively clean tributary areas.
☐	Longitudinal slope is ≥ 1.5% and ≤ 6%.	Flatter swales facilitate increased water quality treatment while minimum slopes prevent ponding.
☐	For site design goal, in-situ soil infiltration rate ≥ 0.5 in/hr (if < 0.5 in/hr, an underdrain is required and design goal is for pollutant control only).	Well-drained soils provide volume reduction and treatment. An underdrain should only be provided when soil infiltration rates are low or per geotechnical or groundwater concerns.

Surface Flow		
☐	Maximum flow depth is ≤ 6 inches or ≤ $^2/_3$ the vegetation length, whichever is greater. Ideally, flow depth will be ≥ 2 inches below shortest plant species.	Flow depth must fall within the height range of the vegetation for effective water quality treatment via filtering.
	A minimum of 1 foot of freeboard is provided.	Freeboard minimizes risk of uncontrolled surface discharge.
☐	Cross sectional shape is trapezoidal or parabolic with side slopes ≥ 3H:1V.	Gentler side slopes are safer, less prone to erosion, able to establish vegetation more quickly and easier to maintain.
☐	Bottom width is ≥ 2 feet and ≤ 8 feet.	A minimum of 2 feet minimizes erosion. A maximum of 8 feet prevents channel braiding.
☐	Minimum hydraulic residence time ≥ 10 minutes.	Longer hydraulic residence time increases pollutant removal.
☐	Swale is designed to safely convey the 10-yr storm event unless a flow splitter is included to allow only the water quality event.	Planning for larger storm events lessens the risk of property damage due to flooding.
☐	Flow velocity is ≤ 1 ft/s for water quality event. Flow velocity for 10-yr storm event is ≤ 3 ft/s.	Lower flow velocities provide increased pollutant removal via filtration and minimize erosion.
Vegetated Surface Layer (amendment with media is Optional)		
☐	Soil is amended with 2 inches of media mixed into the top 6 inches of in-situ soils, as needed, to promote plant growth (optional). For enhanced pollutant control, 2 feet of media can be used in place of in-situ soils. Media meets either of these two media specifications: City of San Diego Storm Water Standards Appendix F, February 2016; Or County of San Diego Low Impact Development Handbook, June 2014: Appendix G -Bioretention Soil Specification.	Amended soils aid in plant establishment and growth. Media replacement for in-situ soils can improve water quality treatment and site design volume reduction.

Vegetated Surface Layer (amendment with media is Optional)		
☐	Vegetation is appropriately selected low-growing, erosion-resistant plant species that effectively bind the soil, thrive under site-specific climatic conditions and require little or no irrigation.	Plants suited to the climate and expected flow conditions are more likely to survive.
Check Dams		
☐	Check dams are provided at 50-foot increments for slopes ≥ 2.5%.	Check dams prevent erosion and increase the hydraulic residence time by lowering flow velocities and providing ponding opportunities.
Filter Course Layer (For Underdrain Design)		
☐	A filter course is used to prevent migration of fines through layers of the facility. Filter fabric is not used.	Migration of media can cause clogging of the aggregate storage layer void spaces or subgrade. Filter fabric is more likely to clog.
☐	Filter course is washed and free of fines.	Washing aggregate will help eliminate fines that could clog the facility and impede infiltration.
☐	Filter course calculations assessing suitability for particle migration prevention have been completed.	Gradation relationship between layers can evaluate factors (e.g., bridging, permeability, and uniformity) to determine if particle sizing is appropriate or if an intermediate layer is needed.
Aggregate Storage Layer (For Underdrain Design)		
☐	The depth of aggregate provided (12-inch typical) and storage layer configuration is adequate for providing conveyance for underdrain flows to the outlet structure.	Proper storage layer configuration and underdrain placement will minimize facility drawdown time.
☐	Aggregate used for the aggregate storage layer is washed and free of fines.	Washing aggregate will help eliminate fines that could clog aggregate storage layer void spaces or underdrain.
Inflow and Underdrain Structures		
☐	Inflow and underdrains are accessible for inspection and maintenance.	Maintenance will prevent clogging and ensure proper operation of the flow control structures.
Inflow and Underdrain Structures		

☐	Underdrain outlet elevation should be a minimum of 3 inches above the bottom elevation of the aggregate storage layer.	A minimal separation from subgrade or the liner lessens the risk of fines entering the underdrain and can improve hydraulic performance by allowing perforations to remain unblocked.
☐	Minimum underdrain diameter is 6 inches.	Smaller diameter underdrains are prone to clogging.
☐	Underdrains are made of slotted, PVC pipe conforming to ASTM D 3034 or equivalent or corrugated, HDPE pipe conforming to AASHTO 252M or equivalent.	Slotted underdrains provide greater intake capacity, clog resistant drainage, and reduced entrance velocity into the pipe, thereby reducing the chances of solids migration.
☐	An underdrain cleanout with a minimum 6-inch diameter and lockable cap is placed every 250 to 300 feet as required based on underdrain length.	Properly spaced cleanouts will facilitate underdrain maintenance.

Conceptual Design and Sizing Approach for Site Design

1. Determine the areas where vegetated swales can be used in the site design to replace traditional curb and gutter facilities and provide volume reduction through infiltration.

Conceptual Design and Sizing Approach for Storm Water Pollutant Control Only

To design vegetated swales for storm water pollutant control only, the following steps should be taken:

1. Verify that siting and design criteria have been met, including bottom width and longitudinal and side slope requirements.
2. Calculate the design flow rate per Appendix B based on expected site design runoff for tributary areas.
3. Use the sizing worksheet to determine flow-thru treatment sizing of the vegetated swale and if flow velocity, flow depth, and hydraulic residence time meet required criteria. Swale configuration should be adjusted as necessary to meet design requirements.

E.22 FT-2 Media Filters



MS4 Permit Category
Flow-thru Treatment Control

Manual Category
Flow-thru Treatment Control

Applicable Performance Standard
Pollutant Control
Flow Control

Primary Benefits
Treatment
Peak Flow Attenuation (Optional)

Photo Credit: Contech Storm Water Solutions

Description

Media filters are manufactured devices that consist of a series of modular filters packed with engineered media that can be contained in a catch basin, manhole, or vault that provide treatment through filtration and sedimentation. The manhole or vault may be divided into multiple chambers where the first chamber acts as a presettling basin for removal of coarse sediment while the next chamber acts as the filter bay and houses the filter cartridges. A variety of media types are available from various manufacturers that can target pollutants of concern via primarily filtration, sorption, ion exchange, and precipitation. **Specific products must be selected to meet the flow-thru BMP selection requirements described in Appendix B.6**. Treatment effectiveness is contingent upon proper maintenance of filter units.

Typical media filter components include:

- Vault for flow storage and media housing
- Inlet and outlet
- Media filters

Design Adaptations for Project Goals

Flow-thru treatment BMP for storm water pollutant control. Water quality treatment is provided through filtration. This configuration is considered to provide flow-thru treatment, not biofiltration treatment. Storage provided within the vault restricted by an outlet is considered detention storage and is included in calculations for the flow-thru treatment volume.

Integrated storm water flow control and pollutant control configuration. Media filters can also be designed for flow rate and duration control via additional detention storage. The vault storage can be designed to accommodate higher volumes than the storm water pollutant control volume and can utilize multi-stage outlets to mitigate both the duration and rate of flows within a prescribed range.

Design Criteria and Considerations

Media filters must meet the following design criteria. Deviations from the below criteria may be approved at the discretion of County staff if it is determined to be appropriate:

Siting and Design		*Intent/Rationale*
☐	Placement observes geotechnical recommendations regarding potential hazards (e.g., slope stability, landslides, and liquefaction zones) and setbacks (e.g., slopes, foundations, utilities).	Must not negatively impact existing site geotechnical concerns.
☐	Recommended for tributary areas with limited available surface area or where surface BMPs would restrict uses.	Maintenance needs may be more labor intensive for media filters than surface BMPs. Lack of surface visibility creates additional risk that maintenance needs may not be completed in a timely manner.
☐	Vault storage drawdown time ≤96 hours.	Provides vector control.
☐	Vault storage drawdown time ≤36 hours if the vault is used for equalization of flows for pollutant treatment.	Provides required capacity to treat back to back storms. Exception to the 36 hour drawdown criteria is allowed if additional vault storage is provided using the curves in Appendix B.4.1.
Inflow and Outflow Structures		
☐	Inflow and outflow structures are accessible by required equipment (e.g., vactor truck) for inspection and maintenance.	Maintenance will prevent clogging and ensure proper operation of the flow control structures.

Conceptual Design and Sizing Approach for Storm Water Pollutant Control Only

To design a media filter for storm water pollutant control only (no flow control required), the following steps should be taken

1. Verify that the selected BMP complies with BMP selection requirements in Appendix B.6.
2. Verify that placement and tributary area requirements have been met.
3. Calculate the required DCV and/or flow rate per Appendix B.6.3 based on expected site design runoff for tributary areas.
4. Media filter can be designed either for DCV or flow rate. To estimate the drawdown time, divide the vault storage by the treatment rate of media filters.

Conceptual Design and Sizing Approach when Storm Water Flow Control is Applicable

Control of flow rates and/or durations will typically require significant vault storage volume, and therefore the following steps should be taken prior to determination of storm water pollutant control design. Pre-development and allowable post-project flow rates and durations should be determined as discussed in Chapter 6 of the manual.

1. Verify that placement and tributary area requirements have been met.
2. Iteratively determine the vault storage volume required to provide detention storage to reduce flow rates and durations to allowable limits. Flow rates and durations can be controlled from detention storage by altering outlet structure orifice size(s) and/or water control levels. Multi-level orifices can be used within an outlet structure to control the full range of flows to MS4.
3. If a media filter cannot fully provide the flow rate and duration control required by this manual, an upstream or downstream structure with appropriate storage volume such as an underground vault can be used to provide remaining controls.
4. After the media filter has been designed to meet flow control requirements, calculations must be completed to verify if storm water pollutant control requirements to treat the DCV have been met.
5. Verify that the vault drawdown time is 96 hours or less. To estimate the drawdown time:
    a. Divide the vault volume by the filter surface area.
    b. Divide the result (a) by the design filter rate.

E.23 FT-3 Sand Filters



MS4 Permit Category
Flow-thru Treatment Control
Manual Category
Flow-thru Treatment Control
Applicable Performance Standard
Pollutant Control Flow Control
Primary Benefits
Treatment Volume Reduction (Incidental) Peak Flow Attenuation (Optional)

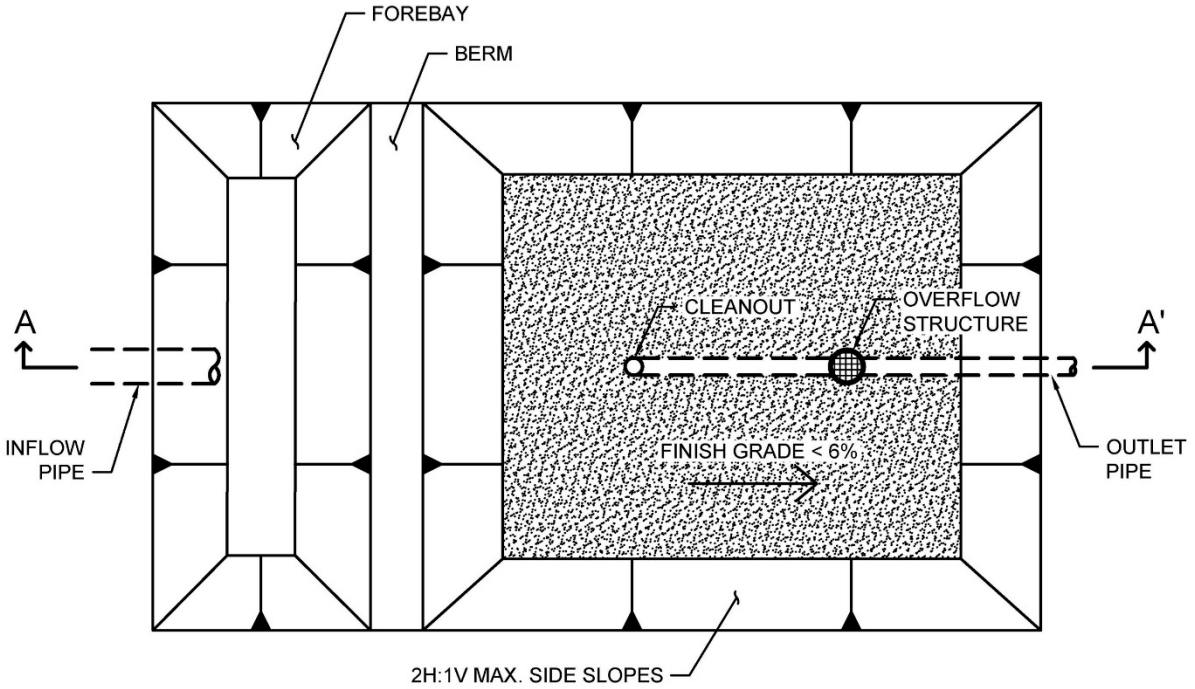
Photo Credit: City of San Diego LID Manual

Description

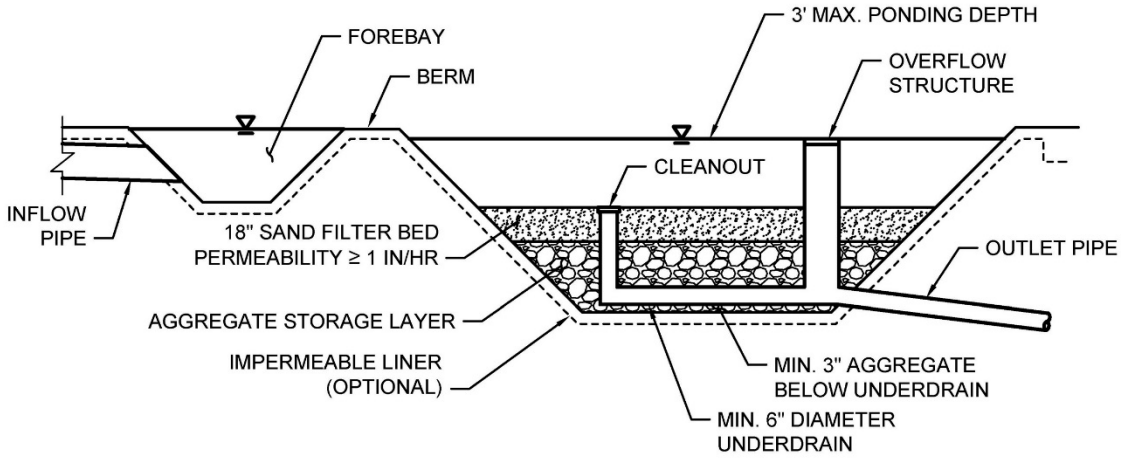
Sand filters operate by filtering storm water through a constructed sand bed with an underdrain system. Runoff enters the filter and spreads over the surface. Sand filter beds can be enclosed within concrete structures or within earthen containment. As flows increase, water backs up on the surface of the filter where it is held until it can percolate through the sand. The treatment pathway is downward (vertical) through the media to an underdrain system that is connected to the downstream storm drain system. As storm water passes through the sand, pollutants are trapped on the surface of the filter, in the small pore spaces between sand grains or are adsorbed to the sand surface. The high filtration rates of sand filters, which allow a large runoff volume to pass through the media in a short amount of time, can provide efficient treatment for storm water runoff.

Typical sand filter components include:

- Forebay for pretreatment/energy dissipation
- Surface ponding for captured flows
- Sand filter bed
- Aggregate storage layer with underdrain(s)
- Overflow structure



PLAN
NOT TO SCALE



SECTION A-A'
NOT TO SCALE

Typical plan and Section view of a Sand Filter BMP

Design Adaptations for Project Goals

Flow-thru treatment BMP for storm water pollutant control. The system is lined or un-lined to provide incidental infiltration, and an underdrain is provided at the bottom to carry away filtered runoff. This configuration is considered to provide flow-thru treatment via vertical flow through the sand filter bed. Storage provided above the underdrain within surface ponding, the sand filter bed, and aggregate storage is considered included in the flow-thru treatment volume. Saturated storage within the aggregate storage layer can be added to this design by including an upturned elbow installed at the downstream end of the underdrain or via an internal weir structure designed to maintain a specific water level elevation.

Integrated storm water flow control and pollutant control configuration. The system can be designed to provide flow rate and duration control by primarily providing increased surface ponding and/or having a deeper aggregate storage layer above the underdrain. This will allow for significant detention storage, which can be controlled via inclusion of an outlet structure at the downstream end of the underdrain.

Design Criteria and Considerations

Sand filters must meet the following design criteria. Deviations from the below criteria may be approved at the discretion of County staff if it is determined to be appropriate:

Siting and Design		*Intent/Rationale*
☐	Placement observes geotechnical recommendations regarding potential hazards (e.g., slope stability, landslides, and liquefaction zones) and setbacks (e.g., slopes, foundations, utilities).	Must not negatively impact existing site geotechnical concerns.
☐	An impermeable liner or other hydraulic restriction layer is included if site constraints indicate that infiltration or lateral flows should not be allowed.	Lining prevents storm water from impacting groundwater and/or sensitive environmental or geotechnical features. Incidental infiltration, when allowable, can aid in pollutant removal and groundwater recharge.
☐	Contributing tributary area (≤ 5 acres).	Bigger BMPs require additional design features for proper performance. Contributing tributary area greater than 5 acres may be allowed at the discretion of County staff if the following conditions are met: 1) incorporate design features (e.g. flow spreaders) to minimize short circuiting of flows in the BMP and 2) incorporate additional design features requested by

Siting and Design	*Intent/Rationale*
	County staff for proper performance of the regional BMP.
☐ Finish grade of facility is < 6%.	Flatter surfaces reduce erosion and channelization within the facility.
☐ Earthen side slopes are ≥ 3H:1V.	Gentler side slopes are safer, less prone to erosion, able to establish vegetation more quickly and easier to maintain.
☐ Surface ponding is limited to a 36-hour drawdown time.	Provides required capacity to treat back to back storms. A surface ponding drawdown of up to 96 hours may be permitted if additional surface storage is provided using the curves in Appendix B.4.1.
☐ Surface ponding is limited to a 96-hour drawdown time.	Prolonged surface ponding can create a vector hazard.
☐ Maximum ponding depth does not exceed 3 feet.	Surface ponding capacity lowers subsurface storage requirements and results in lower cost facilities. Deep surface ponding raises safety concerns.
☐ Sand filter bed consists of clean washed concrete or masonry sand (passing ¼ inch sieve) or sand similar to the ASTM C33 gradation.	Washing sand will help eliminate fines that could clog the void spaces of the aggregate storage layer.
☐ Sand filter bed permeability is at least 1 in/hr.	A high filtration rate through the media allows flows to quickly enter the aggregate storage layer, thereby minimizing bypass.
☐ Sand filter bed depth is at least 18 inches deep.	Different pollutants are removed in various zones of the media using several mechanisms. Some pollutants bound to sediment, such as metals, are typically removed within 18 inches of the media.
☐ Aggregate storage should be washed, bank-run gravel.	Washing aggregate will help eliminate fines that could clog the aggregate storage layer void spaces or subgrade.
☐ The depth of aggregate provided (12-inch typical) and storage layer configuration is adequate for providing conveyance for underdrain flows to the outlet structure.	Proper storage layer configuration and underdrain placement will minimize facility drawdown time.

Siting and Design		*Intent/Rationale*
☐	Inflow, underdrains and outflow structures are accessible for inspection and maintenance.	Maintenance will prevent clogging and ensure proper operation of the flow control structures.
☐	Inflow must be non-erosive sheet flow (≤ 3 ft/s) unless an energy-dissipation device, flow diversion/splitter or forebay is installed.	Concentrated flow and/or excessive volumes can cause erosion in a sand filter and can be detrimental to the treatment capacity of the system.
☐	Underdrain outlet elevation should be a minimum of 3 inches above the bottom elevation of the aggregate storage layer.	A minimal separation from subgrade or the liner lessens the risk of fines entering the underdrain and can improve hydraulic performance by allowing perforations to remain unblocked.
☐	Minimum underdrain diameter is 6 inches.	Smaller diameter underdrains are prone to clogging.
☐	Underdrains should be made of slotted, PVC pipe conforming to ASTM D 3034 or equivalent or corrugated, HDPE pipe conforming to AASHTO 252M or equivalent.	Slotted underdrains provide greater intake capacity, clog resistant drainage, and reduced entrance velocity into the pipe, thereby reducing the chances of solids migration.
☐	Overflow is safely conveyed to a downstream storm drain system or discharge point.	Planning for overflow lessens the risk of property damage due to flooding.

Conceptual Design and Sizing Approach for Storm Water Pollutant Control Only

To design a sand filter for storm water pollutant control only (no flow control required), the following steps should be taken:

1. Verify that siting and design criteria have been met, including placement requirements, contributing tributary area, and maximum finish grade slope.
2. Calculate the required DCV and/or flow rate per Appendix B.6.3 based on expected site design runoff for tributary areas.
3. Sand filter can be designed either for DCV or flow rate. To estimate the drawdown time, divide the average ponding depth by the permeability of the filter sand.

Conceptual Design and Sizing Approach when Storm Water Flow Control is Applicable

Control of flow rates and/or durations will typically require significant surface ponding and/or

aggregate storage volumes, and therefore the following steps should be taken prior to determination of storm water pollutant control design. Pre-development and allowable post-project flow rates and durations should be determined as discussed in Chapter 6 of the Manual.

1. Verify that siting and design criteria have been met, including placement requirements, contributing tributary area, and maximum finish grade slope.
2. Iteratively determine the facility footprint area, surface ponding and/or aggregate storage layer depth required to provide detention storage to reduce flow rates and durations to allowable limits. Flow rates and durations can be controlled from detention storage by altering outlet structure orifice size(s) and/or water control levels. Multi-level orifices can be used within an outlet structure to control the full range of flows.
3. If a sand filter cannot fully provide the flow rate and duration control required by the MS4 permit, an upstream or downstream structure with appropriate storage volume such as an underground vault can be used to provide remaining controls.
4. After the sand filter has been designed to meet flow control requirements, calculations must be completed to verify if storm water pollutant control requirements to treat the DCV have been met.

E.24 FT-4 Dry Extended Detention Basin



MS4 Permit Category
Flow-thru Treatment Control

Manual Category
Flow-thru Treatment Control

Applicable Performance Standard
Pollutant Control
Flow Control

Primary Benefits
Treatment
Volume Reduction (Incidental)
Peak Flow Attenuation

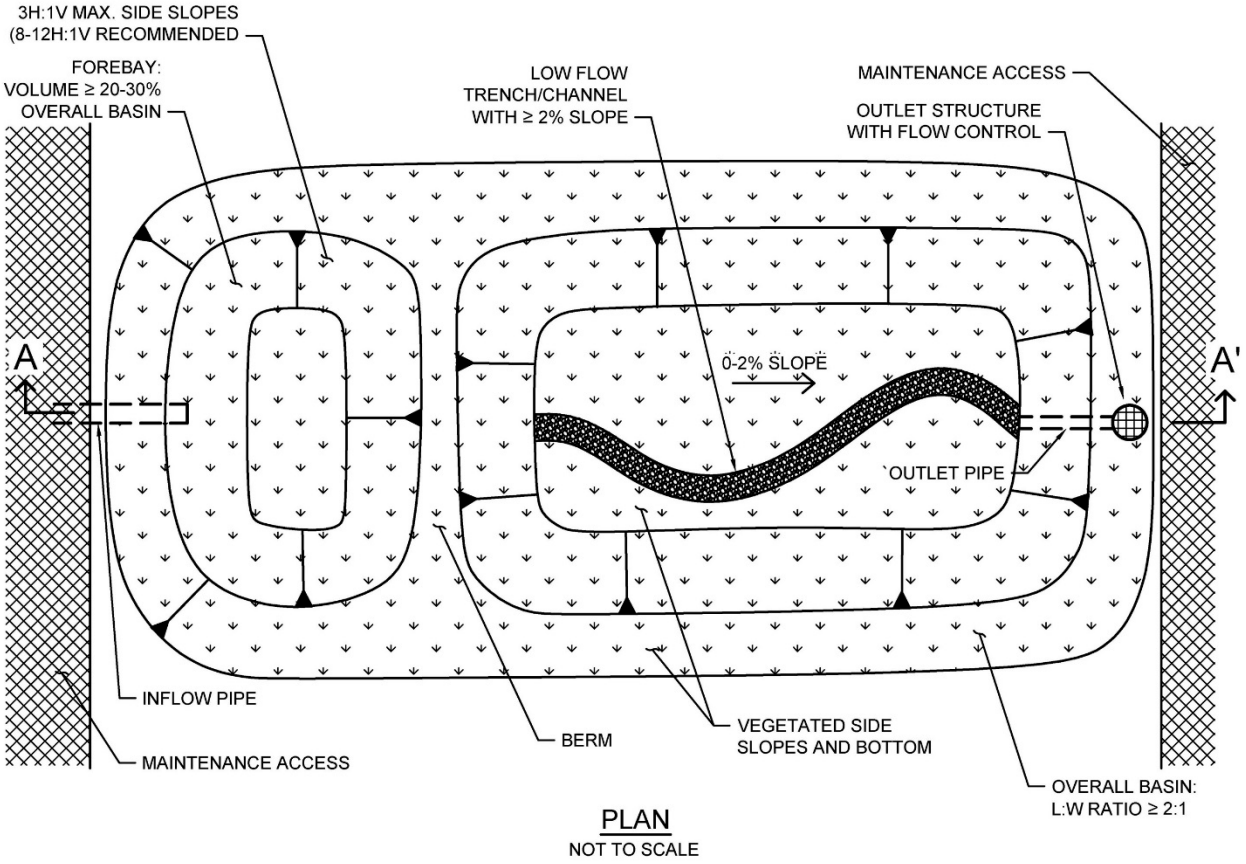
Location: Rolling Hills Ranch, Chula Vista, California; Photo Credit: Eric Mosolgo

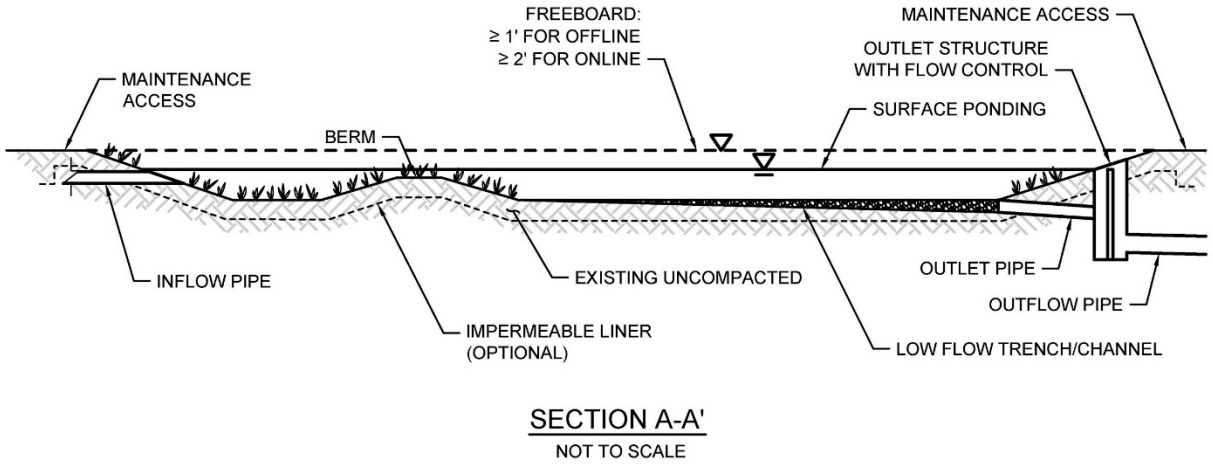
Description

Dry extended detention basins are basins that have been designed to detain storm water for an extended period to allow sedimentation and typically drain completely between storm events. A portion of the dissolved pollutant load may also be removed by filtration, uptake by vegetation, and/or through infiltration. The slopes, bottom, and forebay of dry extended detention basins are typically vegetated. Considerable storm water volume reduction can occur in dry extended detention basins when they are located in permeable soils and are not lined with an impermeable barrier. dry extended detention basins are generally appropriate for developments of ten acres or larger, and have the potential for multiple uses including parks, playing fields, tennis courts, open space, and overflow parking lots. They can also be used to provide flow control by modifying the outlet control structure and providing additional detention storage.

Typical dry extended detention basins components include:

- Forebay for pretreatment
- Surface ponding for captured flows
- Vegetation selected based on basin use, climate, and ponding depth
- Low flow channel, outlet, and overflow device
- Impermeable liner or uncompacted native soils at the bottom of the facility





Typical plan and Section view of a Dry Extended Detention Basin BMP

Design Adaptations for Project Goals

Flow-thru treatment BMP for storm water pollutant control. The system is lined or un-lined to provide incidental infiltration and designed to detain storm water to allow particulates and associated pollutants to settle out. This configuration is considered to provide flow-thru treatment, not biofiltration treatment. Storage provided as surface ponding above a restricted outlet invert is considered detention storage and is included in calculations for the flow-thru treatment volume.

Integrated storm water flow control and pollutant control configuration. Dry extended detention basins can also be designed for flow control. The surface ponding can be designed to accommodate higher volumes than the storm water pollutant control volume and can utilize multi-stage outlets to mitigate both the duration and rate of flows within a prescribed range.

Design Criteria and Considerations

Dry extended detention basins must meet the following design criteria. Deviations from the below criteria may be approved at the discretion of County staff if it is determined to be appropriate:

Siting and Design		*Intent/Rationale*
☐	Placement observes geotechnical recommendations regarding potential hazards (e.g., slope stability, landslides, and liquefaction zones) and setbacks (e.g., slopes, foundations, utilities).	Must not negatively impact existing site geotechnical concerns.
☐	An impermeable liner or other hydraulic restriction layer is included if site constraints indicate that infiltration or lateral flows should not be allowed.	Lining prevents storm water from impacting groundwater and/or sensitive environmental or geotechnical features. Incidental infiltration, when allowable, can aid in pollutant removal and groundwater recharge.
☐	Contributing tributary area is large (typically ≥ 10 acres).	Dry extended detention basins require significant space and are more cost-effective for treating larger drainage areas.
☐	Longitudinal basin bottom slope is 0 - 2%.	Flatter slopes promote ponding and settling of particles.
☐	Basin length to width ratio is ≥ 2:1 (L:W).	A larger length to width ratio provides a longer flow path to promote settling.
☐	Forebay is included that encompasses 20 - 30% of the basin volume.	A forebay to trap sediment can decrease frequency of required maintenance.
☐	Side slopes are ≥ 3H:1V.	Gentler side slopes are safer, less prone to erosion, able to establish vegetation more

Siting and Design		*Intent/Rationale*
		quickly and easier to maintain.
☐	Surface ponding drawdown time is between 24 and 96 hours.	Minimum drawdown time of 24 hours allows for adequate settling time and maximizes pollutant removal. Maximum drawdown time of 96 hours provides vector control.
☐	Minimum freeboard provided is ≥1 foot for offline facilities and ≥2 feet for online facilities.	Freeboard provides room for head over overflow structures and minimizes risk of uncontrolled surface discharge.
☐	Inflow and outflow structures are accessible by required equipment (e.g., vactor truck) for inspection and maintenance.	Maintenance will prevent clogging and ensure proper operation of the flow control structures.
☐	A low flow channel or trench with a ≥ 2% slope is provided. A gravel infiltration trench is provided where infiltration is allowable.	Aids in draining or infiltrating dry weather flows.
☐	Overflow is safely conveyed to a downstream storm drain system or discharge point. Size overflow structure to pass 100-year peak flow.	Planning for overflow lessens the risk of property damage due to flooding.
☐	The maximum rate at which runoff is discharged is set below the erosive threshold for the site.	Extended low flows can have erosive effects.

Conceptual Design and Sizing Approach for Storm Water Pollutant Control Only

To design dry extended detention basins for storm water pollutant control only (no flow control required), the following steps should be taken:

1. Verify that siting and criteria have been met, including placement requirements, contributing tributary area, forebay volume, and maximum slopes for basin sides and bottom.
2. Calculate the DCV per Appendix B based on expected site design runoff for tributary areas.
3. Use the sizing worksheet to determine flow-thru treatment sizing of the surface ponding of the dry extended detention basin, which includes calculations for a maximum 96-hour drawdown time.

Conceptual Design and Sizing Approach when Storm Water Flow Control is Applicable

Control of flow rates and/or durations will typically require significant surface ponding volume, and therefore the following steps should be taken prior to determination of storm water pollutant control design. Pre-development and allowable post-project flow rates and durations should be determined as discussed in Chapter 6 of the manual.

1. Verify that siting and criteria have been met, including placement requirements, tributary area, and maximum slopes for basin sides and bottom.
2. Iteratively determine the surface ponding required to provide detention storage to reduce flow rates and durations to allowable limits. Flow rates and durations can be controlled from detention storage by altering outlet structure orifice size(s) and/or water control levels. Multi-level orifices can be used within an outlet structure to control the full range of flows.
3. If a dry extended detention basin cannot fully provide the flow rate and duration control required by this manual, an upstream or downstream structure with appropriate storage volume such as an additional basin or underground vault can be used to provide remaining controls.
4. After the dry extended detention basin has been designed to meet flow control requirements, calculations must be completed to verify if storm water pollutant control requirements to treat the DCV have been met.

E.25 FT-5 Proprietary Flow-Thru Treatment Control BMPs

The purpose of this fact sheet is to help explain the potential role of proprietary BMPs in meeting flow thru treatment control BMP requirements. The fact sheet does not describe design criteria like the other fact sheets in this appendix because this information varies by BMP product model.

Criteria for Use of a Proprietary BMP as a Flow-Thru Treatment Control BMP

A proprietary BMP may be acceptable as a "flow-thru treatment control BMP" under the following conditions:

(1) The BMP is selected and sized consistent with the method and criteria described in Appendix B.6;

(2) The BMP is designed and maintained in a manner consistent with its performance certifications (See explanation in Appendix B.6); and

(3) The BMP is acceptable at the discretion of County staff. While the County has no obligation to accept the use of any proposed proprietary flow-thru BMP, applicants will be provided a written explanation describing the rationale for the rejection of any proposed devices.

Guidance for Sizing Proprietary BMPs

Proprietary flow-thru BMPs must meet the same sizing guidance as other flow-thru treatment control BMPs. Guidance for sizing flow-thru BMPs to comply with requirements of this manual is provided in Appendix B.6.

E.26 PL Plant List for Bioretention Facilities

Plant Name		Irrigation Requirements		Preferred Location in Basin		Applicable Bioretention Sections (Un-Lined Facilities)				Applicability to Flow-Through Planter? (Lined Facility)	
Latin Name	Common Name	Temporary Irrigation during Plant Establishment Period	Permanent Irrigation (Drip / Spray)[1]	Basin Bottom	Basin Side Slopes	Section A Treatment-Only Bioretention in Hydrologic Soil Group A or B Soils	Section B Treatment-Only Bioretention in Hydrologic Soil Group C or D soils	Section C Treatment Plus Flow Control Bioretention in Hydrologic Soil Group A or B Soils	Section D Treatment Plus Flow Control Bioretention in Hydrologic Soil Group C or D Soils	**NO** Applicable to Un-lined Facilities Only (Bioretention Only)	**YES** Can Use in Lined or Un-Lined Facility (Flow-Through Planter OR Bioretention)
TREES[2]											
Alnus rhombifolia	White Alder	X		X	X	X	X	X	X	X	
Platanus racemosa	California Sycamore	X		X	X	X	X	X	X	X	
Salix lasiolepsis	Arroyo Willow	X			X	X	X	X	X	X	
Salix lucida	Lance-Leaf Willow	X			X	X	X	X	X	X	
Sambucus mexicana	Blue Elderberry	X			X	X	X	X	X	X	
SHRUBS / GROUNDCOVER											
Achillea millefolium	Yarrow	X			X	X	X				X
Agrostis palens	Thingrass	X			X	X	X	X	X		X
Anemopsis californica	Yerba Manza	X			X	X	X	X	X		X
Baccharis douglasii	Marsh Baccahris	X	X	X		X	X	X	X		X
Carex praegracillis	California Field Sedge	X	X	X		X	X	X	X		X
Carex spissa	San Diego Sedge	X	X	X		X	X	X	X		X
Carex subfusca	Rusty Sedge	X	X	X	X	X	X	X	X		X
Distichlis spicata	Salt Grass	X	X	X		X	X	X	X		X
Eleocharis macrostachya	Pale Spike Rush	X	X	X		X	X	X	X		X
Festuca rubra	Red Fescue	X	X	X	X	X	X				X
Festuca californica	California Fescue	X	X		X	X	X				X
Iva hayesiana	Hayes Iva	X			X	X	X				X
Juncus Mexicana	Mexican Rush	X	X	X	X	X	X	X	X		X
Jucus patens	California Gray Rush	X	X	X	X	X	X	X	X		X
Leymus condensatus ‘Canyon Prince’	Canyon Prince Wild Rye	X	X	X	X	X	X	X	X		X
Mahonia nevinii	Nevin’s Barberry	X			X	X	X	X	X		X
Muhlenburgia rigens	Deergrass	X	X	X	X	X	X	X	X		X
Mimulus cardinalis	Scarlet Monkeyflower	X		X	X	X	X				X
Ribes speciosum	Fushia Flowering Goose.	X			X	X	X				X
Rosa californica	California Wild Rose	X	X		X	X	X				X
Scirpus cenuus	Low Bullrush	X	X	X		X	X	X	X		X
Sisyrinchium bellum	Blue-eyed Grass	X			X	X	X				X

1. All plants will benefit from some supplemental irrigation during hot dry summer months, particularly those on basin side slopes and further inland.
2. All trees should be planted a min. of 10’ away from any drain pipes or structures.

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Appendix

F

Biofiltration Standard and Checklist

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Appendix F Biofiltration Standard and Checklist

Introduction

The MS4 Permit and this manual define a specific category of storm water pollutant treatment BMPs called "biofiltration BMPs." The MS4 Permit (Section E.3.c.1) states:

Biofiltration BMPs must be designed to have an appropriate hydraulic loading rate to maximize storm water retention and pollutant removal, as well as to prevent erosion, scour, and channeling within the BMP, and must be sized to:

a) **Treat 1.5 times the DCV not reliably retained onsite, OR**

b) **Treat the DCV not reliably retained onsite with a flow-thru design that has a total volume, including pore spaces and pre-filter detention volume, sized to hold at least 0.75 times the portion of the DCV not reliably retained onsite.**

A project applicant must be able to affirmatively demonstrate that a given BMP is designed and sized in a manner consistent with this definition to be considered as a "biofiltration BMP" as part of a compliant storm water quality management plan. Retention is defined in the MS4 Permit as evapotranspiration, infiltration, and harvest and use of storm water vs. discharge to a surface water system.

Contents and Intended Uses

This appendix contains a checklist of the key underlying criteria that must be met for a BMP to be considered a biofiltration BMP. The purpose of this checklist is to facilitate consistent review and approval of biofiltration BMPs that meet the "biofiltration standard" defined by the MS4 Permit.

This checklist includes specific design criteria that are essential to defining a system as a biofiltration BMP; however it does not present a complete design basis. This checklist was used to develop BMP Fact Sheets for PR-1 biofiltration with partial retention and BF-1 biofiltration, which do present a complete design basis. Therefore, biofiltration BMPs that substantially meet all aspects of the Fact sheets PR-1 or BF-1 should be able to complete this checklist without additional documentation beyond what would already be required for a project submittal.

Other biofiltration BMP designs[22] (including both non-proprietary and proprietary designs) may also meet the underlying MS4 Permit requirements to be considered biofiltration BMPs. These BMPs may be classified as biofiltration BMPs if they (1) meet the minimum design criteria listed in this appendix, including the pollutant treatment performance standard in Appendix F.1, (2) are designed and maintained in a manner consistent with their performance certifications (See explanation in Appendix F.2), if applicable, and (3) are acceptable at the discretion of County staff. The applicant may be required to provide additional studies and/or required to meet additional design criteria beyond the scope of this document in order to demonstrate that these criteria are met.

Organization

The checklist in this appendix is organized into the seven (7) main objectives associated with biofiltration BMP design. It describes the associated minimum criteria that must be met in order to qualify a biofiltration BMP as meeting the biofiltration standard. The seven main objectives are listed below. Specific design criteria and associated manual references associated with each of these objectives is provided in the checklist in the following section.

1. Biofiltration BMPs must be allowed only as described in the BMP selection process in this manual (i.e., retention feasibility hierarchy).

2. Biofiltration BMPs must be sized using acceptable sizing methods described in this manual.

3. Biofiltration BMPs must be sited and designed to achieve maximum feasible infiltration and evapotranspiration.

4. Biofiltration BMPs must be designed with a hydraulic loading rate to maximize pollutant retention, preserve pollutant control/sequestration processes, and minimize potential for pollutant washout.

5. Biofiltration BMPs must be designed to promote appropriate biological activity to support and maintain treatment processes.

6. Biofiltration BMPs must be designed to prevent erosion, scour, and channeling within the BMP.

[22] Defined as biofiltration designs that do not conform to the specific design criteria described in Fact Sheets PR-1 or BF-1. This category includes proprietary BMPs that are sold by a vendor as well as non-proprietary BMPs that are designed and constructed of primarily of more elementary construction materials.

7. Biofiltration BMP must include operations and maintenance design features and planning considerations to provide for continued effectiveness of pollutant and flow control functions.

Biofiltration Criteria Checklist

The applicant must provide documentation of compliance with each criterion in this checklist as part of the project submittal. The right column of this checklist identifies the submittal information that is recommended to document compliance with each criterion. Biofiltration BMPs that substantially meet all aspects of Fact Sheets PR-1 or BF-1 should still use this checklist; however additional documentation (beyond what is already required for project submittal) should not be required.

1. Biofiltration BMPs must be allowed to be used only as described in the BMP selection process based on a documented feasibility analysis.

Intent: This manual defines a specific prioritization of pollutant treatment BMPs, where BMPs that retain water (retained includes evapotranspired, infiltrated, and/or harvested and used) must be used before considering BMPs that have a biofiltered discharge to the MS4 or surface waters. Use of a biofiltration BMP in a manner in conflict with this prioritization (i.e., without a feasibility analysis justifying its use) is not permitted, regardless of the adequacy of the sizing and design of the system.

☐	The project applicant has demonstrated that it is not technically feasible to retain the full DCV onsite.	Document feasibility analysis and findings in the SWQMP per Appendix C.

2. Biofiltration BMPs must be sized using acceptable sizing methods.

Intent: The MS4 Permit and this manual defines specific sizing methods that must be used to size biofiltration BMPs. Sizing of biofiltration BMPs is a fundamental factor in the amount of storm water that can be treated and also influences volume and pollutant retention processes.

☐	The project applicant has demonstrated that biofiltration BMPs are sized to meet one of the biofiltration sizing options available (Appendix B).	Submit sizing worksheets (Appendix B) or other equivalent documentation with the SWQMP.

3. Biofiltration BMPs must be sited and designed to achieve maximum feasible infiltration and evapotranspiration.

Intent: Various decisions about BMP placement and design influence how much water is retained via infiltration and evapotranspiration. The MS4 Permit requires that biofiltration BMPs achieve maximum feasible retention (evapotranspiration and infiltration) of storm water volume.

☐	The biofiltration BMP is sited to allow for maximum infiltration of runoff volume based on the feasibility factors considered in site planning efforts. It is also designed to maximize evapotranspiration through the use of amended media and plants (biofiltration designs without amended media and plants may be permissible; see Item 5).	Document site planning and feasibility analyses in the SWQMP per Section 5.4.
☐	For biofiltration BMPs categorized as "Partial Infiltration Condition," the infiltration storage depth in the biofiltration design has been selected to drain in 36 hours or an alternative value shown to maximize infiltration on the site.	Included documentation of estimated infiltration rate per Appendix D; provide calculations using Appendix B.4 and B.5 to show that the infiltration storage depth meets this criterion. Note, depths that are too shallow or too deep may not be acceptable.
☐	For biofiltration BMP locations categorized as "Partial Infiltration Condition," the infiltration storage is over the entire bottom of the biofiltration BMP footprint.	Document on plans that the infiltration storage covers the entire bottom of the BMP (i.e., not just underdrain trenches); or an equivalent footprint elsewhere on the site.
☐	For biofiltration BMP locations categorized as "Partial Infiltration Condition," the sizing factor used for the infiltration storage area is not less than the minimum biofiltration BMP sizing factors calculated using Worksheet B.5.3.	Provide a table that compares the minimum sizing factor from Appendix B.5 to the provided sizing factor. Note: The infiltration storage area could be a separate storage feature located downstream of the biofiltration BMP, not necessarily within the same footprint.
☐	An impermeable liner or other hydraulic restriction layer is only used when needed to avoid geotechnical and/or subsurface contamination issues in locations identified as "No Infiltration Condition."	If using an impermeable liner or hydraulic restriction layer, provide documentation of feasibility findings per Appendix C that recommend the use of this feature.
☐	The use of "compact" biofiltration BMP design is permitted only in conditions identified as "No Infiltration Condition" and where site-specific documentation demonstrates that the use of larger footprint biofiltration BMPs would be infeasible.	Provide documentation of feasibility findings that recommend no infiltration is feasible. Provide site-specific information to demonstrate that a larger footprint biofiltration BMP would not be feasible.

4. Biofiltration BMPs must be designed with a hydraulic loading rate to maximize pollutant retention, preserve pollutant control processes, and minimize potential for pollutant washout.

Intent: Various decisions about biofiltration BMP design influence the degree to which pollutants are retained. The MS4 Permit requires that biofiltration BMPs achieve maximum feasible retention of storm water pollutants.

☐	Media selected for the biofiltration BMP meets minimum quality and material specifications per 2016 City Storm Water Standards or County LID Manual, including the maximum allowable design filtration rate and minimum thickness of media. **OR**	Provide documentation that media meets the specifications in 2016 City Storm Water Standards or County LID Manual.
☐	Alternatively, for proprietary designs and custom media mixes not meeting the media specifications contained in the 2016 City Storm Water Standards or County LID Manual, field scale testing data are provided to demonstrate that proposed media meets the pollutant treatment performance criteria in Section F.1 below.	Provide documentation of performance information as described in Section F.1.
☐	To the extent practicable, filtration rates are outlet controlled (e.g., via an underdrain and orifice/weir) instead of controlled by the infiltration rate of the media.	Include outlet control in designs or provide documentation of why outlet control is not practicable.
☐	The water surface drains to at least 12 inches below the media surface within 24 hours from the end of storm event flow to preserve plant health and promote healthy soil structure.	Include calculations to demonstrate that drawdown rate is adequate. Surface ponding drawdown time greater than 24-hours but less than 96 hours may be allowed at the discretion of County staff if certified by a landscape architect or agronomist.
☐	If nutrients are a pollutant of concern, design of the biofiltration BMP follows nutrient-sensitive design criteria.	Follow specifications for nutrient sensitive design in Fact Sheet BF-2. Or provide alternative documentation that nutrient treatment is addressed and potential for nutrient release is minimized.
☐	Media gradation calculations or geotextile selection calculations demonstrate that migration of media between layers will be prevented and permeability will be preserved.	Follow specification for choking layer or geotextile in Fact Sheet PR-1 or BF-1. Or include calculations to demonstrate that choking layer is appropriately specified.

5. Biofiltration BMPs must be designed to promote appropriate biological activity to support and maintain treatment processes.

Intent: Biological processes are an important element of biofiltration performance and longevity.

☐	Plants have been selected to be tolerant of project climate, design ponding depths and the treatment media composition.	Provide documentation justifying plant selection. Refer to the plant list in Appendix E.20.
☐	Plants have been selected to minimize irrigation requirements.	Provide documentation describing irrigation requirements for establishment and long term operation.
☐	Plant location and growth will not impede expected long-term media filtration rates and will enhance long term infiltration rates to the extent possible.	Provide documentation justifying plant selection. Refer to the plant list in Appendix E.20.
☐	If plants are not part of the biofiltration design, other biological processes are supported as needed to sustain treatment processes (e.g., biofilm in a subsurface flow wetland).	For biofiltration designs without plants, describe the biological processes that will support effective treatment and how they will be sustained.

6. Biofiltration BMPs must be designed with a hydraulic loading rate to prevent erosion, scour, and channeling within the BMP.

Intent: Erosion, scour, and/or channeling can disrupt treatment processes and reduce biofiltration effectiveness.

☐	Scour protection has been provided for both sheet flow and pipe inflows to the BMP, where needed.	Provide documentation of scour protection as described in Fact Sheets PR-1 or BF-1 or approved equivalent.
☐	Where scour protection has not been provided, flows into and within the BMP are kept to non-erosive velocities.	Provide documentation of design checks for erosive velocities as described in Fact Sheets PR-1 or BF-1 or approved equivalent.
☐	For proprietary BMPs, the BMP is used in a manner consistent with manufacturer guidelines and conditions of its third-party certification[23] (i.e., maximum tributary area, maximum inflow velocities, etc., as applicable).	Provide copy of manufacturer recommendations and conditions of third-party certification.

[23] Certifications or verifications issued by the Washington Technology Acceptance Protocol-Ecology program and the New Jersey Corporation for Advanced Technology programs are typically accompanied by a set of guidelines regarding appropriate design and maintenance conditions that would be consistent with the certification/verification

7. Biofiltration BMP must include operations and maintenance design features and planning considerations for continued effectiveness of pollutant and flow control functions.

Intent: Biofiltration BMPs require regular maintenance in order provide ongoing function as intended. Additionally, it is not possible to foresee and avoid potential issues as part of design; therefore plans must be in place to correct issues if they arise.

☐	The biofiltration BMP maintenance plan describes specific inspection activities, regular/periodic maintenance activities and specific corrective actions relating to scour, erosion, channeling, media clogging, vegetation health, and inflow and outflow structures.	Include maintenance plan with the SWQMP as described in Chapter 7.
☐	Adequate site area and features have been provided for BMP inspection and maintenance access.	Illustrate maintenance access routes, setbacks, maintenance features as needed on project water quality plans.
☐	For proprietary biofiltration BMPs, the BMP maintenance plan is consistent with manufacturer guidelines and conditions of its third-party certification (i.e., maintenance activities, frequencies).	Provide copy of manufacturer recommendations and conditions of third-party certification.

F.1 Pollutant Treatment Performance Standard

Standard biofiltration BMPs that are designed following the criteria in Fact Sheets PR-1 and BF-1 are presumed to the meet the pollutant treatment performance standard associated with biofiltration BMPs. This presumption is based on the MS4 Permit Fact Sheet which cites analyses of standard biofiltration BMPs conducted in the Ventura County Technical Guidance Manual (July 2011).

For BMPs that do not meet the biofiltration media specification and/or the range of acceptable media filtration rates described in Fact Sheet, PR-1 and BF-1, additional documentation must be provided to demonstrate that adequate pollutant treatment performance is provided to be considered a biofiltration BMP. Project applicants have three options for documenting compliance:

1) Project applicants may provide documentation to substantiate that the minor modifications to the design is expected to provide equal or better pollutant removal performance for the project pollutants of concern than would be provided by a biofiltration design that complies with the criteria in Fact Sheets PR-1 and BF-1. Minor modifications are design elements that deviate only slightly from standard design criteria and are expected to either not impact performance or to improve performance compared to standard biofiltration designs. The reviewing agency has the discretion to accept or reject this documentation and/or request additional documentation to substantiate equivalent or better performance to BF-1 or PR-1, as applicable. Examples of minor deviations include:

    - Different particle size distribution of aggregate, with documentation that system filtration rate will meet specifications.
    - Alternative source of organic components, with documentation of material suitability and stability from appropriate testing agency.
    - Specialized amendments to provide additional treatment mechanisms, and which have negligible potential to upset other treatment mechanisms or otherwise deteriorate performances.

2) For proprietary BMPs, project applicants may provide evidence that the BMP has been certified for use as part of the Washington State Technology Assessment Protocol-Ecology certification program and meets each of the following requirements:

    a. The applicant must demonstrate (using the checklist in this Appendix) that the BMP meets all other conditions to be considered as a biofiltration BMP. For example, a cartridge media filter or hydrodynamic separator would not meet biofiltration BMP design criteria regardless of Technology Acceptance Protocol-Ecology certification because they do not support effective biological processes.

b. The applicant must select BMPs that have an active Technology Acceptance Protocol-Ecology certification, with General Use Level Designation for the appropriate project pollutants of concern as identified in Table F.1-1. The list of certified technologies is updated as new technologies are approved (link below). Technologies with Pilot Use Level Designation and Conditional Use Level Designations are not acceptable. Refer to: http://www.ecy.wa.gov/programs/wq/stormwater/newtech/technologies.html.

c. The applicant must demonstrate that BMP is being used in a manner consistent with all conditions of the Technology Acceptance Protocol-Ecology certification while meeting the flow rate or volume design criteria that is required for biofiltration BMPs under this manual. Conditions of Technology Acceptance Protocol-Ecology certification are available by clicking on the technology name at the website listed in bullet b. Additional discussion about sizing of proprietary biofiltration BMPs to comply with applicable sizing standards is provided below in Section F.2.

3) For BMPs that do not fall into options 1 or 2 above, County staff may allow the applicant to submit alternative third-party documentation that the pollutant treatment performance of the system is consistent with the performance levels associated with the necessary Technology Acceptance Protocol-Ecology certifications. Table F.1-1 describes the required levels of certification and Table F.l-2 describes the pollutant treatment performance levels associated with each level of certification. Acceptance of this approach is at the sole discretion of County staff. While the County has no obligation to accept the use of any proposed proprietary flow-thru BMP, applicants will be provided a written explanation describing the rationale for the rejection of any proposed devices. If Technology Acceptance Protocol-Ecology certifications are not available, preference would be given to:

a. Verified third-party, field-scale testing performance under the Technology Acceptance Reciprocity Partnership Tier II Protocol. This protocol is no longer operated, however this is considered to be a valid protocol and historic verifications are considered to be representative provided that product models being proposed are consistent with those that were tested. Technology Acceptance Reciprocity Partnership verifications were conducted under New Jersey Corporation for Advance Testing and are archived at the website linked below. Note that Technology Acceptance Reciprocity Partnership verifications must be matched to pollutant treatment standards in Table F.1-2 then matched to an equivalent Technology Acceptance Protocol-Ecology certification in Table F.1-1.

b. Verified third-party, field-scale testing performance under the New Jersey Corporation for Advance Testing protocol. Note that New Jersey Corporation for

Advance Testing verifications must be matched to pollutant treatment standards in Table F.1-2 then matched to an equivalent Technology Acceptance Protocol-Ecology certification in Table F.1-1.

A list of field-scale verified technologies under Technology Acceptance Reciprocity Partnership Tier II and New Jersey Corporation for Advance Testing can be accessed at: http://www.njcat.org/verification-process/technology-verification-database.html (refer to field verified technologies only).

Table F.1-1: Required Technology Acceptance Protocol-Ecology Certifications for Polltuants of Concern for Biofiltration Performance Standard

Project Pollutant of Concern	Required Technology Acceptance Protocol-Ecology Certification for Biofiltration Performance Standard
Trash	Basic Treatment OR Phosphorus Treatment OR Enhanced Treatment
Sediments	Basic Treatment OR Phosphorus Treatment OR Enhanced Treatment
Oil and Grease	Basic Treatment OR Phosphorus Treatment OR Enhanced Treatment
Nutrients	Phosphorus Treatment[1]
Metals	Enhanced Treatment
Pesticides	Basic Treatment (including filtration)[2] OR Phosphorus Treatment OR Enhanced Treatment
Organics	Basic Treatment (including filtration)[2] OR Phosphorus Treatment OR Enhanced Treatment
Bacteria and Viruses	Basic Treatment (including bacteria removal processes)[3] OR Phosphorus Treatment OR Enhanced Treatment

1 – There is no Technology Acceptance Protocol-Ecology equivalent for nitrogen compounds; however systems that are designed to retain phosphorus (as well as meet basic treatment designation), generally also provide treatment of nitrogen compounds. Where nitrogen is a pollutant of concern, relative performance of available certified systems for nitrogen removal should be considered in BMP selection.

2 – Pesticides, organics, and oxygen demanding substances are typically addressed by particle filtration consistent with the level of treatment required to achieve Basic treatment certification; if a system with Basic treatment certification does not provide filtration, it is not acceptable for pesticides, organics or oxygen demanding substances.

3 – There is no Technology Acceptance Protocol-Ecology equivalent for pathogens (viruses and bacteria), and testing data are limited because of typical sample hold times. Systems with Technology Acceptance Protocol-Ecology Basic Treatment must be include one or more significant bacteria removal process such as media filtration, physical sorption, predation, reduced redox conditions, and/or solar inactivation. Where design options are available to enhance pathogen removal (i.e., pathogen-specific media mix offered by vendor), this design variation should be used.

Table F.1-2: Performance Standards for Technology Acceptance Protocol-Ecology Certification

Performance Goal	Influent Range	Criteria
Basic Treatment	20 – 100 mg/L TSS	Effluent goal ≤ 20 mg/L TSS
	100 – 200 mg/L TSS	≥ 80% TSS removal
	>200 mg/L TSS	> 80% TSS removal
Enhanced (Dissolved Metals) Treatment	Dissolved copper 0.005 – 0.02 mg/L	Must meet basic treatment goal and better than basic treatment currently defined as >30% dissolved copper removal
	Dissolved zinc 0.02 – 0.3 mg/L	Must meet basic treatment goal and better than basic treatment currently defined as >60% dissolved zinc removal
Phosphorous Treatment	Total phosphorous 0.1 – 0.5 mg/L	Must meet basic treatment goal and exhibit ≥50% total phosphorous removal
Oil Treatment	Total petroleum hydrocarbon > 10 mg/L	No ongoing or recurring visible sheen in effluent Daily average effluent Total petroleum hydrocarbon concentration < 10 mg/L Maximum effluent Total petroleum hydrocarbon concentration for a 15 mg/L for a discrete (grab) sample
Pretreatment	50 – 100 mg/L TSS	≤ 50 mg/L TSS
	≥ 200 mg/L TSS	≥ 50% TSS removal

F.2 Guidance on Sizing and Design of Non-Standard Biofiltration BMPs

This section explains the general process for design and sizing of non-standard biofiltration BMPs. This section assumes that the BMPs have been selected based on the criteria in Section F.1.

F.2.1 Guidance on Design per Conditions of Certification/Verification

The biofiltration standard and checklist in this appendix requires that "the BMP is used in a manner consistent with manufacturer guidelines and conditions of its third-party certification." Practically, what this means is that the BMP is used in the same way in which it was tested and certified. For example, it is not acceptable for a BMP of a given size to be certified/verified with a 100 gallon per minute treatment rate and be applied at a 150 gallon per minute treatment rate in a design.

Certifications or verifications issued by the Washington Technology Acceptance Protocol-Ecology program and the Technology Acceptance Reciprocity Partnership or New Jersey Corporation for Advance Testing programs are typically accompanied by a set of guidelines regarding appropriate design and maintenance conditions that would be consistent with the certification/verification. It is common for these approvals to specify the specific model of BMP, design capacity for given unit sizes, type of media that is the basis for approval, and/or other parameter. The applicant must demonstrate conclusively that the proposed application of the BMP is consistent with these criteria.

For alternate non-proprietary systems that do not have a Technology Acceptance Protocol-Ecology / Technology Acceptance Reciprocity Partnership / New Jersey Corporation for Advance Testing certification (but which still must provide quantitative data per Appendix F.1), it must be demonstrate that the configuration and design proposed for the project is reasonably consistent with the configuration and design under which the BMP was tested to demonstrate compliance with Appendix F.1.

F.2.2 Sizing of Flow-Based Biofiltration BMP

This sizing method is only available when the BMP meets the pollutant treatment performance standard in Appendix F.1.

Proprietary biofiltration BMPs are typically designed as a flow-based BMPs (i.e., a constant treatment capacity with negligible storage volume). Additionally, proprietary biofiltration is only acceptable if no infiltration is feasible and where site-specific documentation demonstrates that the use of larger footprint biofiltration BMPs would be infeasible or if the proprietary biofiltration BMP is supplemented with a downstream retention BMP that achieves volume reduction equivalent to a non-proprietary BMP sized in accordance with Worksheet B.5-1. The applicable sizing method for biofiltration is therefore reduced to: Treat 1.5 times the DCV.

The following steps should be followed to demonstrate that the system is sized to treat 1.5 times the DCV.

1. Calculate the flow rate required to meet the pollutant treatment performance standard without scaling for the 1.5 factor. Options include either:
   - Calculate the runoff flow rate from a 0.2 inch per hour uniform intensity precipitation event (See methodology Appendix B.6.3), or
   - Conduct a continuous simulation analysis to compute the size required to capture and treat 80 percent of average annual runoff; for small catchments, 5-minute precipitation data should be used to account for short time of concentration. Nearest rain gage with 5-minute precipitation data is allowed for this analysis.
2. Multiply the flow rate from Step 1 by 1.5 to compute the design flow rate for the biofiltration system.
3. Based on the conditions of certification/verification (discussed above), establish the design

capacity, as a flow rate, of a given sized unit.

4. Demonstrates that an appropriate unit size and number of units is provided to provide a flow rate that meets the required flow rate from Step 2.

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Appendix

G

Guidance for Continuous Simulation and Hydromodification Management Sizing Factors

February 26, 2016

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Appendix G Guidance for Continuous Simulation and Hydromodification Management Sizing Factors

G.1 Guidance for Continuous Simulation Hydrologic Modeling for Hydromodification Management Studies in San Diego County Region 9

G.1.1 Introduction

Continuous simulation hydrologic modeling is used to demonstrate compliance with the performance standards for hydromodification management in San Diego. There are several available hydrologic models that can perform continuous simulation analyses. Each has different methods and parameters for determining the amount of rainfall that becomes runoff, and for representing the hydraulic operations of certain structural BMPs such as biofiltration with partial retention or biofiltration. This Appendix is intended to:

- Identify acceptable models for continuous simulation hydrologic analyses for hydromodification management;
- Provide guidance for selecting climatology input to the models;
- Provide standards for rainfall loss parameters to be used in the models;
- Provide standards for defining physical characteristics of LID components; and
- Provide guidance for demonstrating compliance with performance standards for hydromodification management.

This Appendix is not a user's manual for any of the acceptable models, nor a comprehensive manual for preparing a hydrologic model. This Appendix provides guidance for selecting model input parameters for the specific purpose of hydromodification management studies. The model preparer must be familiar with the user's manual for the selected software to determine how the parameters are entered to the model.

G.1.2 Software for Continuous Simulation Hydrologic Modeling

The following software models may be used for hydromodification management studies in San

Diego:

- HSPF – Hydrologic Simulation Program-FORTRAN, distributed by USEPA, public domain.
- SDHM – San Diego Hydrology Model, distributed by Clear Creek Solutions, Inc. This is an HSPF-based model with a proprietary interface that has been customized for use in San Diego for hydromodification management studies.
- SWMM – Storm Water Management Model, distributed by USEPA, public domain.

Third-party and proprietary software, such as XPSWMM, InfoSWMM, or PCSWMM, may be used for hydromodification management studies in San Diego, provided that:

- Input and output data from the software can interface with public domain software such as SWMM. In other words, input files from the third party software should have sufficient functionality to allow export to public domain software for independent validation.
- The software's hydromodification control processes are substantiated.

G.1.3 Climatology Parameters

G.1.3.1 Rainfall

In all software applications for preparation of hydromodification management studies in San Diego, rainfall data must be selected from approved data sets that have been prepared for this purpose. As part of the development of the March 2011 Final HMP, long-term hourly rainfall records were prepared for public use. The rainfall record files are provided on the Project Clean Water website. The rainfall station map is provided in the March 2011 Final HMP and is included in this Appendix as Figure G.1-1.

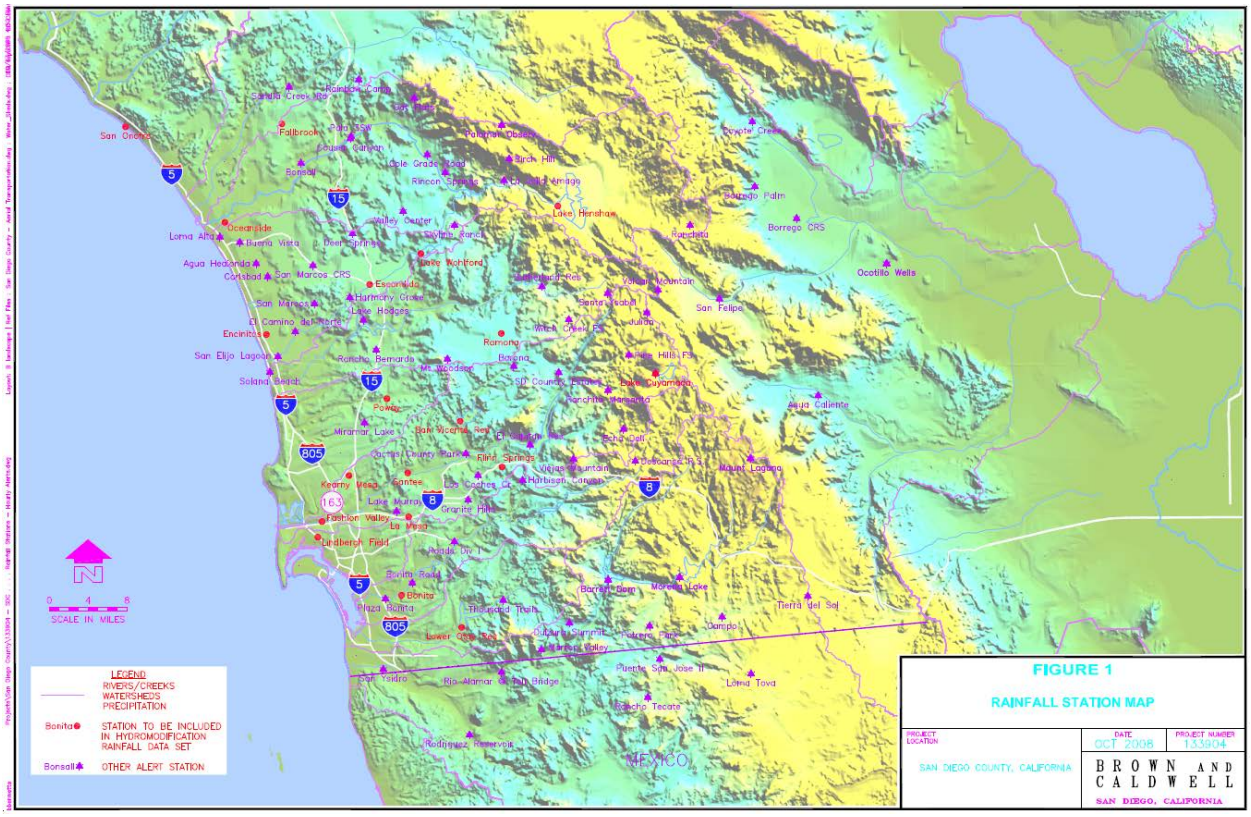


Figure G.1-1: Rainfall Station Map

Project applicants preparing continuous simulation models must select the most appropriate rainfall data set from the rainfall record files provided on the Project Clean Water website. For a given project location, the following factors should be considered in the selection of the appropriate rainfall data set:

- In most cases, the rainfall data set in closest proximity to the project site will be the appropriate choice (refer to the rainfall station map).
- In some cases, the rainfall data set in closest proximity to the project site may not be the most applicable data set. Such a scenario could involve a data set with an elevation significantly different from the project site. In addition to a simple elevation comparison, the project proponent may also consult with the San Diego County's average annual precipitation isopluvial map, which is provided in the San Diego County Hydrology Manual (2003). Review of this map could provide an initial estimate as to whether the project site is in a similar rainfall zone as compared to the rainfall stations. Generally, precipitation totals in San Diego County increase with increasing elevation.
- Where possible, rainfall data sets should be chosen so that the data set and the project location are both located in the same topographic zone (coastal, foothill, mountain) and

major watershed unit (Upper San Luis Rey, Lower San Luis Rey, Upper San Diego River, Lower San Diego River, etc.).

For SDHM users, the approved rainfall data sets are pre-loaded into the software package. SDHM users may select the appropriate rainfall gage within the SDHM program. HSPF or SWMM users must download the appropriate rainfall record from the Project Clean Water website and load it into the software program.

Both the pre-development and post-project model simulation period must encompass the entire rainfall record provided in the approved rainfall data set. Scaling the rainfall data is not permitted.

Hydrologic water balance can be used to compare pre-development and post-project conditions, which can be defined by the following equation:

Precipitation = Evapotranspiration + Infiltration + Surface Storage+ Surface Runoff

Rainfall comprises the left side of the equation, however in some cases additional inputs from irrigation, groundwater discharge, or snowmelt may need to be considered. Each term on the right side of the equation is commonly referred to as a "rainfall loss" and is referenced as such in the Final HMP and throughout this document. Despite their name, these rainfall losses include dry weather processes that can significantly impact model results for long-term continuous simulation. Hydrologic losses can occur from standing water on subcatchment surfaces and from soil moisture beneath the ground surface. In SWMM, losses can also be simulated in the hydraulic model, from water traveling through open channels and from water held in surface storage units.

It is also worth noting that the "Surface Runoff" term in the equation includes the disposal of excess runoff generated from a subcatchment into the storm drain, receiving watercourse, or waterbody. Structural BMP designs that include consumptive use (e.g., rainwater harvesting systems) can capture a portion of the surface runoff volume and use it to meet non-potable water demands that don't require a high level of treatment.

G.1.3.2 Potential Evapotranspiration

The Evapotranspiration term in the water balance equation includes evaporation of surface waters and transpiration of soil moisture through vegetation. Climatology parameters characterize rates, as the actual amount of water evaporated or transpired depends on the amount of available water (i.e., either held in surface depressions or soil pores), temperature, wind velocity, relative humidity, and solar radiation. It is important to understand the source of measurements. Pan evaporation data are derived from measurements in stainless steel pans and therefore need to be adjusted to reflect actual site conditions by applying the appropriate set of pan coefficients. Likewise, evapotranspiration data may be derived from a specific crop or vegetation type and may need to be translated to the appropriate reference evapotranspiration (ETo). Pan coefficients can also be adjusted to reflect

seasonal variations to distinguish growing/dormant periods or to account for excessive transpiration from heavy canopy/root systems.

Project applicants preparing continuous simulation models must select a data set from the sources described below to represent potential evapotranspiration.

For HSPF users, this parameter may be entered as an hourly time series. The hourly time series that was used to develop the BMP Sizing Calculator parameters is provided on the project clean water website and may be used for hydromodification management studies in San Diego. For SDHM users, the hourly evaporation data set is pre-loaded into the program. HSPF users may download the evaporation record from the Project Clean Water website and load it into the software program.

For HSPF or SWMM users, this parameter may be entered as monthly values in inches per month or inches per day. Monthly values may be obtained from the California Irrigation Management Information System "Reference Evapotranspiration Zones" brochure and map (herein "CIMIS ETo Zone Map"), prepared by California Department of Water Resources, dated January 2012. The CIMIS ETo Zone Map is available from www.cimis.gov, and is provided in this Appendix as Figure G.1-2. Determine the appropriate reference evapotranspiration zone for the project from the CIMIS ETo Zone Map. The monthly average reference evapotranspiration values are provided below in Table G.1-1.

In SWMM, there are a number of options available for characterizing potential evaporation rates, including:

- Constant Value: This is not acceptable for hydromodification management studies
- Time Series: A user-defined set of values can be supplied with either a fixed recording interval (e.g., 15-minute or hourly) or variable recording interval
- Climate File: Daily evaporation rates can be read from an external climate file, and monthly pan coefficients can be specified
- Monthly Averages: A set of monthly average values is input by the user
- Temperatures: Daily evaporation rates can be computed based on daily air temperature time series data using the Hargreaves method

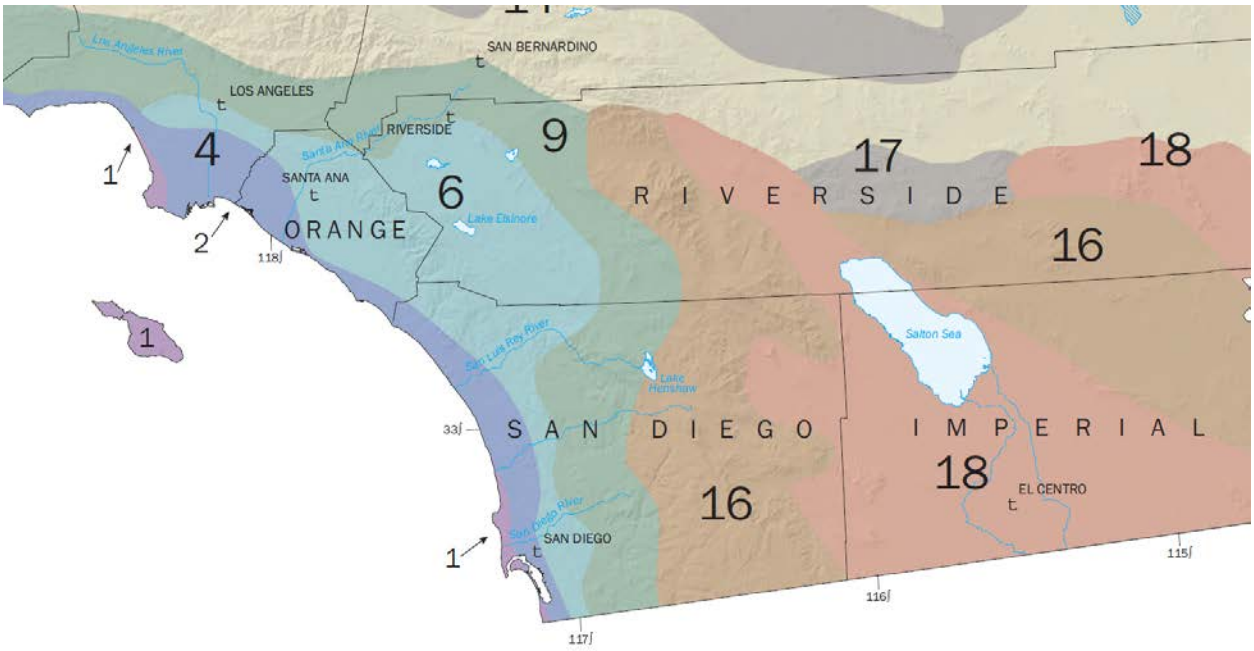


Figure G.1-2: California Irrigation Management Information System "Reference Evapotranspiration Zones"

Table G.1-1: Monthly Average Reference Evapotranspiration by ETo Zone (inches/month and inches/day) for use in SWMM Models for Hydromodification Management Studies in San Diego County CIMIS Zones 1, 4, 6, 9, and 16 (See CIMIS ETo Zone Map)

	January	February	March	April	May	June	July	August	September	October	November	December
Zone	in/month	in/month	in/month	in/month	in/month	in/month	in/month	in/month	in/month	in/month	in/month	in/month
1	0.93	1.4	2.48	3.3	4.03	4.5	4.65	4.03	3.3	2.48	1.2	0.62
4	1.86	2.24	3.41	4.5	5.27	5.7	5.89	5.58	4.5	3.41	2.4	1.86
6	1.86	2.24	3.41	4.8	5.58	6.3	6.51	6.2	4.8	3.72	2.4	1.86
9	2.17	2.8	4.03	5.1	5.89	6.6	7.44	6.82	5.7	4.03	2.7	1.86
16	1.55	2.52	4.03	5.7	7.75	8.7	9.3	8.37	6.3	4.34	2.4	1.55
	January	February	March	April	May	June	July	August	September	October	November	December
Days	31	28	31	30	31	30	31	31	30	31	30	31
Zone	in/day	in/day	in/day	in/day	in/day	in/day	in/day	in/day	in/day	in/day	in/day	in/day
1	0.030	0.050	0.080	0.110	0.130	0.150	0.150	0.130	0.110	0.080	0.040	0.020
4	0.060	0.080	0.110	0.150	0.170	0.190	0.190	0.180	0.150	0.110	0.080	0.060
6	0.060	0.080	0.110	0.160	0.180	0.210	0.210	0.200	0.160	0.120	0.080	0.060
9	0.070	0.100	0.130	0.170	0.190	0.220	0.240	0.220	0.190	0.130	0.090	0.060
16	0.050	0.090	0.130	0.190	0.250	0.290	0.300	0.270	0.210	0.140	0.080	0.050

G.1.4 Land Characteristics and Loss Parameters

In all software applications for preparation of hydromodification management studies in San Diego, rainfall loss parameters must be consistent with this Appendix unless the preparer can provide documentation to substantiate use of other parameters, subject to County approval. HSPF and SWMM use different processes and different sets of parameters. SDHM is based on HSPF, therefore parameters for SDHM and HSPF are presented together in Section G.1.4.1. Parameters that have been pre-loaded into SDHM may be used for other HSPF hydromodification management studies outside of SDHM. Parameters for SWMM are presented separately in Section G.1.4.2.

G.1.4.1 Rainfall Loss Parameters for HSPF and SDHM

Rainfall losses in HSPF are characterized by PERLND/PWATER parameters and IMPLND parameters, which describe processes occurring when rainfall lands on pervious lands and impervious lands, respectively. "BASINS Technical Notice 6, Estimating Hydrology and Hydraulic Parameters for HSPF," prepared by the USEPA, dated July 2000, provides details regarding these parameters and summary tables of possible ranges of these parameters. Table G.1-2, excerpted from the above-mentioned document, presents the ranges of these parameters.

For HSPF studies for hydromodification management in San Diego, PERLND/PWATER parameters and IMPLND parameters must fall within the "possible" range provided in EPA Technical Note 6. To select specific parameters, HSPF users may use the parameters established for development of the San Diego BMP Sizing Calculator, and/or the parameters that have been established for SDHM. Parameters for the San Diego BMP Sizing Calculator and SDHM are based on research conducted specifically for HSPF modeling in San Diego.

Documentation of parameters selected for the San Diego BMP Sizing Calculator is presented in the document titled, San Diego BMP Sizing Calculator Methodology, prepared by Brown and Caldwell, dated January 2012 (herein "BMP Sizing Calculator Methodology"). The PERLND/PWATER parameters selected for development of the San Diego BMP Sizing Calculator represent a single composite pervious land cover that is representative of most pre-development conditions for sites that would commonly be managed by the BMP Sizing Calculator. The parameters shown below in Table G.1-3 are excerpted from the BMP Sizing Calculator Methodology.

Table G.1-2: HSPF PERLND/PWATER and IMPLND Parameters from EPA Technical Note 6

			Range of Values					
Name	**Definition**	**Units**	**Typical**		**Possible**		**Function of ...**	**Comment**
			Min	**Max**	**Min**	**Max**		
PWAT – PARM2								
FOREST	Fraction forest cover	none	0.0	0.50	0.0	0.95	Forest cover	Only impact when SNOW is active
LZSN	Lower Zone Nominal Soil Moisture Storage	inches	3.0	8.0	2.0	15.0	Soils, climate	**Calibration**
INFILT	Index to Infiltration Capacity	in/hr	0.01	0.25	0.001	0.50	Soils, land use	**Calibration**, divides surface and subsurface flow
LSUR	Length of overland flow	feet	200	500	100	700	Topography	Estimate from high resolution topo maps or GIS
SLSUR	Slope of overland flow plane	ft/ft	0.01	0.15	0.001	0.30	Topography	Estimate from high resolution topo maps or GIS
KVARY	Variable groundwater recession	1/inches	0.0	3.0	0.0	5.0	Baseflow recession variation	Used when recession rate varies with GW levels
AGWRC	Base groundwater recession	none	0.92	0.99	0.85	0.999	Baseflow recession	**Calibration**
PWAT – PARM3								
PETMAX	Temp below which ET is reduced	deg. F	35.0	45.0	32.0	48.0	Climate, vegetation	Reduces ET near freezing, when SNOW is active
PETMIN	Temp below which ET is set to zero	deg. F	30.0	35.0	30.0	40.0	Climate, vegetation	Reduces ET near freezing, when SNOW is active
INFEXP	Exponent in infiltration equation	none	2.0	2.0	1.0	3.0	Soils variability	Usually default to 2.0
INFILD	Ratio of max/mean infiltration capacities	none	2.0	2.0	1.0	3.0	Soils variability	Usually default to 2.0
DEEPFR	Fraction of GW inflow to deep recharge	none	0.0	0.20	0.0	0.50	Geology, GW recharge	Accounts for subsurface losses
BASETP	Fraction of remaining ET from baseflow	none	0.0	0.05	0.0	0.20	Riparian vegetation	Direct ET from riparian vegetation
AGWETP	Fraction of remaining ET from active GW	none	0.0	0.05	0.0	0.20	Marsh/wetlands extent	Direct ET from shallow GW
PWAT – PARM4								
CEPSC	Interception storage capacity	inches	0.03	0.20	0.01	0.40	Vegetation type/density, land use	Monthly values usually used
UZSN	Upper zone nominal soil moisture storage	inches	0.10	1.0	0.05	2.0	Surface soil conditions, land use	Accounts for near surface retention
NSUR	Manning's n (roughness) for overland flow	none	0.15	0.35	0.05	0.50	Surface conditions, residue, etc.	Monthly values often used for croplands
INTFW	Interflow inflow parameter	none	1.0	3.0	1.0	10.0	Soils, topography, land use	**Calibration**, based on hydrograph separation
IRC	Interflow recession parameter	none	0.5	0.70	0.30	0.85	Soils, topography, land use	Often start with a value of 0.7, and then adjust
LZETP	Lower zone ET parameter	none	0.2	0.70	0.1	0.9	Vegetation type/density, root depth	**Calibration**
IWAT – PARM2								
LSUR	Length of overland flow	feet	50	150	50	250	Topography, drainage system	Estimate from maps, GIS, or field survey
SLSUR	Slope of overland flow plane	ft/ft	0.01	0.05	0.001	0.15	Topography, drainage	Estimate from maps, GIS, or field survey
NSUR	Manning's n (roughness) for overland flow	none	0.03	0.10	0.01	0.15	Impervious surface conditions	Typical range is 0.05 to 0.10 for roads/parking lots
RETSC	Retention storage capacity	inches	0.03	0.10	0.01	0.30	Impervious surface conditions	Typical range is 0.03 to 0.10 for roads/parking lots
IWAT – PARM3 (PETMAX and PETMIN, same values as shown for PWAT – PARM3)								

Table G.1-3: HSPF PERLND/PWATER Parameters from BMP Sizing Calculator Methodology

		Hydrologic Soil Group A			Hydrologic Soil Group B			Hydrologic Soil Group C			Hydrologic Soil Group D		
	Slope	<5%	5-15%	=>15%	<5%	5-15%	=>15%	<5%	5-15%	=>15%	<5%	5-15%	=>15%
PWAT_PARM2	Units												
FOREST	None	0	0	0	0	0	0	0	0	0	0	0	0
LZSN	inches	5.2	4.8	4.5	5.0	4.7	4.4	4.8	4.5	4.2	4.8	4.5	4.2
INFILT	in/hr	0.090	0.070	0.045	0.070	0.055	0.040	0.050	0.040	0.032	0.040	0.030	0.020
LSUR	Feet	200	200	200	200	200	200	200	200	200	200	200	200
SLSUR	ft/ft	0.05	0.1	0.15	0.05	0.1	0.15	0.05	0.1	0.15	0.05	0.1	0.15
KVARY	1/inches	3	3	3	3	3	3	3	3	3	3	3	3
AGWRC	None	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
PWAT_PARM3													
PETMAX (F)	F	35	35	35	35	35	35	35	35	35	35	35	35
PETMIN (F)	F	30	30	30	30	30	30	30	30	30	30	30	30
INFEXP	None	2	2	2	2	2	2	2	2	2	2	2	2
INFILD	None	2	2	2	2	2	2	2	2	2	2	2	2
DEEPFR	None	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
BASETP	None	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
AGEWTP	None	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
PWAT_PARM4													
CEPSC	inches	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
UZSN	inches	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
NSUR	None	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
INTFW	None	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
IRC	None	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
LZETP	None	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5

Parameters within SDHM are documented in "San Diego Hydrology Model User Manual," prepared by Clear Creek Solutions, Inc. (as of the development of the Manual, the current version of the SDHM User Manual is dated January 2012). Parameters established for SDHM represent "grass" (non-turf grasslands), "dirt," "gravel," and "urban" cover. The documented PERLND and IMPLND parameters for the various land covers and soil types have been pre-loaded into SDHM. SDHM users must use the parameters that have been pre-loaded into the program without modification unless the preparer can provide documentation to substantiate use of other parameters.

G.1.4.2 Rainfall Loss Parameters for SWMM

In SWMM, rainfall loss parameters (parameters that describe processes occurring when rainfall lands on pervious lands and impervious lands) are entered in the "subcatchment" module. In addition to specifying parameters, the SWMM user must also select an infiltration model and the LID manual where applicable. The latest version is available for download, along with detailed documentation and supporting information, at

http://www.epa.gov/nrmrl/wswrd/wq/models/swmm/

The SWMM Manual provides details regarding the hydrologic input parameters and summary tables of possible ranges of these parameters. For SWMM studies for hydromodification management in San Diego, hydrology parameters must fall within the range provided in the SWMM Manual. The program help file is another source of information for typical values and additional guidance. Further, users should confirm that values are consistent within the acceptable range stated in the BMP Design Manual. Some of the parameters depend on the selection of the infiltration model. For consistency across the San Diego region, SWMM users must use the Green-Ampt infiltration model for hydromodification management studies. Table G.1-4 presents SWMM subcatchment and infiltration parameters for use in hydromodification management studies in the San Diego region. The LID module requires an additional set of parameters and these are described below.

Table G.1-4: Subcatchment Parameters for SWMM Studies for Hydromodification Management in San Diego

SWMM Parameter Name	Unit	Range	Use in San Diego
Name X-Coordinate Y-Coordinate Description Tag Rain Gage Outlet	N/A	N/A – project-specific	Project-specific
Area	acres (ac)	Project-specific	Project-specific
Width	feet (ft)	Project-specific	Project-specific
% Slope	percent (%)	Project-specific	Project-specific
% Imperv	percent (%)	Project-specific	Project-specific
N-imperv	--	0.011 – 0.024 presented in Table A.6 of SWMM Manual	default use 0.012 for smooth concrete, otherwise provide documentation of other surface consistent with Table A.6 of SWMM Manual
N-Perv	--	0.05 – 0.80 presented in Table A.6 of SWMM Manual	default use 0.10 for undisturbed vegetated areas within the unincorporated areas of the County, otherwise provide documentation of other surface consistent with Table A.6 of SWMM Manual
Dstore-Imperv	inches	0.05 – 0.10 inches presented in Table A.5 of SWMM Manual	0.05
Dstore-Perv	inches	0.10 – 0.30 inches presented in Table A.5 of SWMM Manual	0.10
%ZeroImperv	percent (%)	0% – 100%	25%
Subarea routing	--	OUTLET IMPERVIOUS PERVIOUS	Project-specific, typically OUTLET
Percent Routed	%	0% – 100%	Project-specific, typically 100%

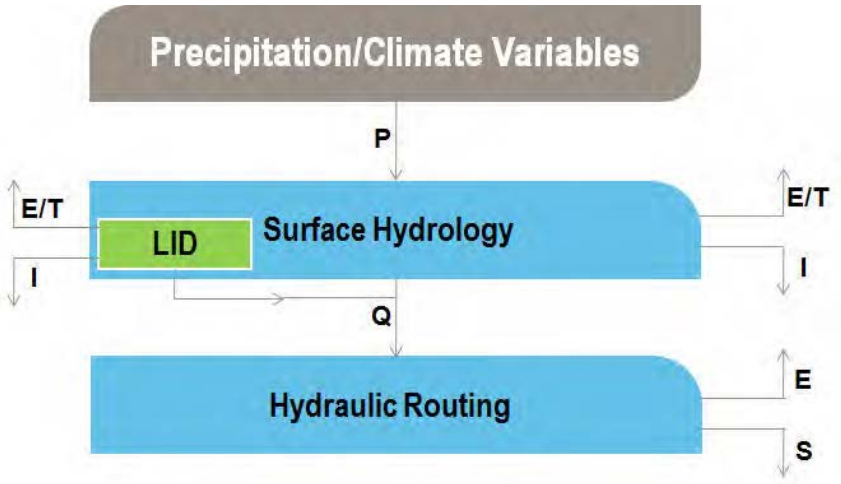
SWMM Parameter Name	Unit	Range	Use in San Diego
Infiltration	Method	HORTON GREEN_AMPT CURVE_NUMBER	GREEN_AMPT
Suction Head (Green-Ampt)	Inches	1.93 – 12.60 presented in Table A.2 of SWMM Manual	Hydrologic Soil Group A: 1.5 Hydrologic Soil Group B: 3.0 Hydrologic Soil Group C: 6.0 Hydrologic Soil Group D: 9.0
Conductivity (Green-Ampt)	Inches per hour	0.01 – 4.74 presented in Table A.2 of SWMM Manual by soil texture class 0.00 – ≥0.45 presented in Table A.3 of SWMM Manual by hydrologic soil group	Hydrologic Soil Group A: 0.3 Hydrologic Soil Group B: 0.2 Hydrologic Soil Group C: 0.1 Hydrologic Soil Group D: 0.025 Note: reduce conductivity by 25% in the post-project condition when native soils will be compacted. For fill soils in post-project condition, see Section G.1.4.3.
Initial Deficit (Green-Ampt)		The difference between soil porosity and initial moisture content. Based on the values provided in Table A.2 of SWMM Manual, the range for completely dry soil would be 0.097 to 0.375	Hydrologic Soil Group A: 0.30 Hydrologic Soil Group B: 0.31 Hydrologic Soil Group C: 0.32 Hydrologic Soil Group D: 0.33 Note: in long-term continuous simulation, this value is not important as the soil will reach equilibrium after a few storm events regardless of the initial moisture content specified.
Groundwater	yes/no	yes/no	NO
LID Controls			Project Specific
Snow Pack Land Uses Initial Buildup Curb Length			Not applicable to hydromodification management studies

A schematic of the basic SWMM setup for hydromodification management studies is shown below, with the LID module is shown as a feature within the hydrology computational block. Surface water

hydrology is distinguished from groundwater, however the groundwater module is not typically used in hydromodification management studies.

The rainfall and climatology input time series data are used to generate surface runoff which in turn is hydraulically routed through the collection system and storage/treatment facilities. The figure includes the following terms in the water balance equation:

- P = Precipitation
- E/T = Evaporation / Transpiration
- I/S = Infiltration / Seepage
- Q = Runoff



Evapotranspiration was previously addressed above; the remainder of this section discusses the other hydrologic losses and parameters.

Soil and Infiltration Parameters

Of the infiltration options available in SWMM, the Green-Ampt equation can best handle variable water content conditions in the shallow soil layers beneath the ground surface, which is critical for long-term continuous simulation of surface water hydrology. The Green-Ampt parameters suggested in Table G.1-4 are referenced according to hydrologic soil group. Green-Ampt parameters can also be determined by relating infiltration parameters to soil texture properties, as identified by in-situ geotechnical analysis results or published County soil survey information. Infiltration parameters include:

- Capillary Tension (Suction Head): a measure of how tightly water is held within the soil pore space;

- Saturated Hydraulic Conductivity: a measure of how quickly the water can be drained vertically; and
- Initial Moisture Deficit: a measure of the initial soilwater deficit, also known as porosity (i.e., the volumetric fraction of water within the soil pore space under initially dry conditions).

Note that when SWMM is used without the Groundwater module, there is no distinction between the upper and lower zone soil moisture storage as in HSPF/SDHM. The LID module does however distinguish several layers/zones within each facility, and these are described below.

Overland Flow Parameters

Overland flow parameters describe the slope and length characteristics of shallow surface runoff. These are determined by identifying representative overland flow paths for each subcatchment using available digital topographic data for pre-development conditions and the proposed grading plan for post-project conditions. Overland flow path lengths and slopes are measured directly from the available information. Generally, overland flow paths should be less than 1,000 feet in length, otherwise channelized flow is likely present and should be modeled hydraulically. Overland flow path widths are determined based on the subcatchment area divided by the corresponding flow path length for each subcatchment.

Although Surface Storage is not depicted in SWMM schematic, it is a component of the water balance equation and includes excess runoff that is held in both hydrologic depression storage and hydraulic storage units.

LID Module

Details on the use and application of LID controls are provided in the SWMM Manual and program help file. Suggested parameter values for use with hydromodification management studies in the San Diego region are provided in Section G.1.5.

G.1.4.3 Pervious Area Rainfall Loss Parameters in Post-Project Condition (HSPF, SDHM, and SWMM)

The following guidance applies to HSPF, SDHM, and SWMM. When modeling pervious areas in the post-project condition, fill soils must be modeled as hydrologic soil group Type D soils, or the project applicant may provide an actual expected infiltration rate for the fill soil based on testing (must be approved by the County for use in the model). Where landscaped areas on fill soils will be re-tilled and/or amended in the post-project condition, the landscaped areas may be modeled as Type C soils. Areas to be re-tilled and/or amended in the post-project condition must be shown on the project plans. For undisturbed pervious areas (i.e., native soils, no fill), use the actual hydrologic soil group, the same as in the pre-development condition.

G.1.5 Modeling Structural BMPs (Ponds and Lid Features)

There are many ways to model structural BMPs. There are standard modules for several pond or LID elements included in SDHM and SWMM. Users may also set up project-specific stage-storage-discharge relationships representing structural BMPs. Regardless of the modeling method, certain characteristics of the structural BMP, including infiltration of water from the bottom of the structural BMP into native soils, porosity of bioretention soils and/or gravel sublayers, and other program-specific parameters must be consistent with those presented below, unless the preparer can provide documentation to substantiate use of other parameters, subject to County approval. The geometry of structural BMPs is project-specific and must match the project plans.

G.1.5.1 Infiltration into Native Soils Below Structural BMPs

Infiltration into native soils below structural BMPs may be modeled as a constant outflow rate equal to the project site-specific design infiltration rate (Worksheet D.5-1) multiplied by the area of the infiltrating surface (and converted to cubic feet per second). This infiltration rate is not the same as an infiltration parameter used in the calculation of rainfall losses, such as the HSPF INFILT parameter or the Green-Ampt conductivity parameter in the SWMM subcatchment module. It must be site-specific and must be determined based on the methods presented in Appendix D of this manual.

For preliminary analysis when site-specific geotechnical investigation has not been completed, project applicants proposing infiltration into native soils as part of the structural BMP design must prepare a sensitivity analysis to determine a potential range for the structural BMP size based on a range of potential infiltration rates. As shown in Appendices C and D of this manual, many factors influence the ability to infiltrate storm water. Therefore even when soils types A and B are present, which are generally expected to infiltrate storm water, the possibility that a very low infiltration rate could be determined at design level must be considered. The range of potential infiltration rates for preliminary analysis is shown below in Table G.1-5.

Table G.1-5: Range of Potential Infiltration Rates to be Studied for Sensitivity Analysis when Native Infiltration is Proposed but Site-Specific Geotechnical Investigation has not been Completed

Hydrologic Soil Group at Location of Proposed Structural BMP	Low Infiltration Rate for Preliminary Study (inches/hour)	High Infiltration Rate for Preliminary Study (inches/hour)
A	0.02	2.4
B	0.02	0.52
C	0	0.08
D	0	0.02

The infiltration rates shown above are for preliminary investigation only. Final design of a structural BMP must be based on the project site-specific design infiltration rate (Worksheet D.5-1).

G.1.5.2 Structural BMPs That Do Not Include Sub-Layers (Ponds)

To model a pond, basin, or other depressed area that does not include processing runoff through sublayers of amended soil and/or gravel, create a stage storage discharge relationship for the pond, and supply the information to the model according to the program requirements. For HSPF users, the stage-storage-discharge relationship is provided in FTABLES. SDHM users may use the TRAPEZOIDAL POND element for a trapezoidal pond or IRREGULAR POND element to request the program to create the stage-storage-discharge relationship, use the SSD TABLE element to supply a user-created stage-storage-discharge relationship, or use other available modules such as TANK or VAULT. For SWMM users, the stage-storage relationship is supplied in the storage unit module, and the stage-discharge relationship may be simulated by including the various control structures such as the orifice, weir, gate, pump or other device directly in the hydraulic model. Stage-storage and stage-discharge curves for structural BMPs must be fully documented in the project-specific HMP report and must be consistent with the structural BMP(s) shown on project plans.

For user-created stage-discharge relationships, refer to County drainage manual criteria for equations representing hydraulic behavior of outlet structures. Users relying on the software to develop the stage-discharge relationship may use the equations built into the program. This manual does not recommend that all program modules calculating stage-discharge relationships must be uniform because the flows to be controlled for hydromodification management are low flows, calculated differently from the single-storm event peak flows studied for flood control purposes, and hydromodification management performance standards do not represent any performance standard for flood control drainage design. Note that for design of emergency outlet structures, and any calculations related to single-storm event routing for flood control drainage design, stage-discharge calculations must be consistent with the County drainage design requirements. This may require separate calculations for stage-discharge relationship pursuant to County manuals. The HMP flow rates must not be used for flood control calculations.

G.1.5.3 Structural BMPs That Include Sub-Layers (Bioretention and Other LID)

G.1.5.3.1 Characteristics of Engineered Soil Media

The engineered soil media used in bioretention, biofiltration with partial retention, and biofiltration structural BMPs is a sandy loam. The following parameters presented in Table G.1-6 are characteristics of a sandy loam for use in continuous simulation models.

Table G.1-6: Characteristics of Sandy Loam to Represent Engineered Soil Media in Continuous Simulation for Hydromodification Management Studies in San Diego

Soil Texture	Porosity	Field Capacity	Wilting Point	Conductivity	Suction Head
Sandy Loam	0.4	0.2	0.1	5 inches/hour	1.5 inches

- Porosity is the volume of pore space (voids) relative to the total volume of soil (as a fraction).
- Field Capacity is the volume of pore water relative to total volume after the soil has been allowed to drain fully (as a fraction). Below this level, vertical drainage of water through the soil layer does not occur.
- Wilting point is the volume of pore water relative to total volume for a well dried soil where only bound water remains (as a fraction). The moisture content of the soil cannot fall below this limit.
- Conductivity is the hydraulic conductivity for the fully saturated soil (in/hr or mm/hr).
- Suction head is the average value of soil capillary suction along the wetting front (inches or mm).

Figures G.1-3 and G.1-4, from http://www.stevenswater.com/articles/irrigationscheduling.aspx, illustrate unsaturated soil and soil saturation, field capacity, and wilting point.

Unsaturated soil is composed of solid particles, organic material and pores. The pore space will contain air and water.

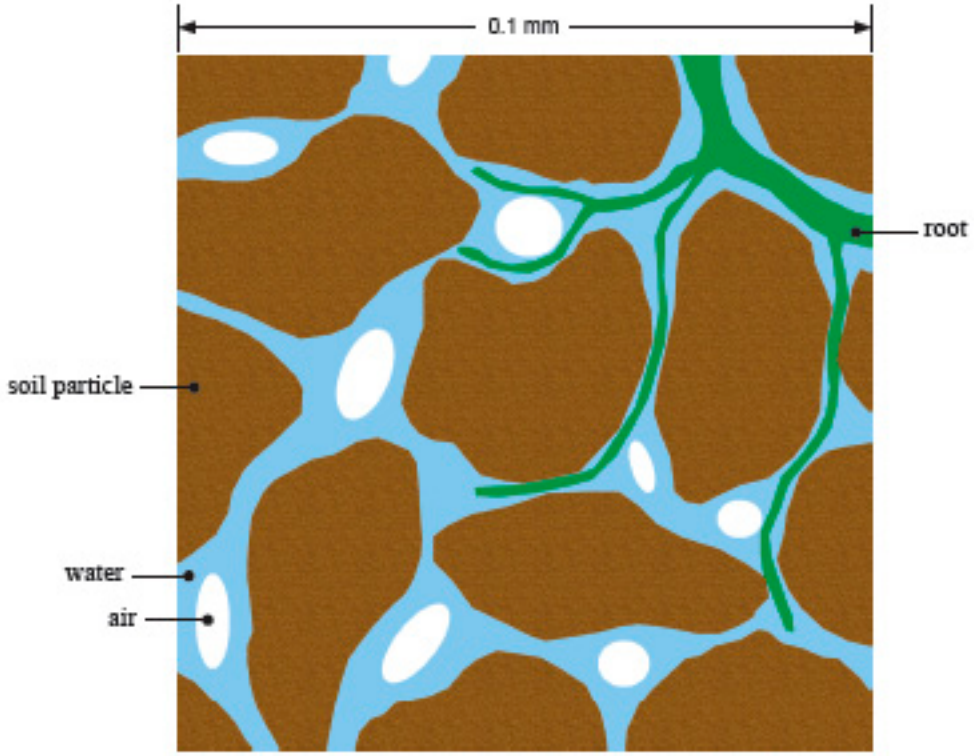


Figure G.1-3: Unsaturated Soil Composition

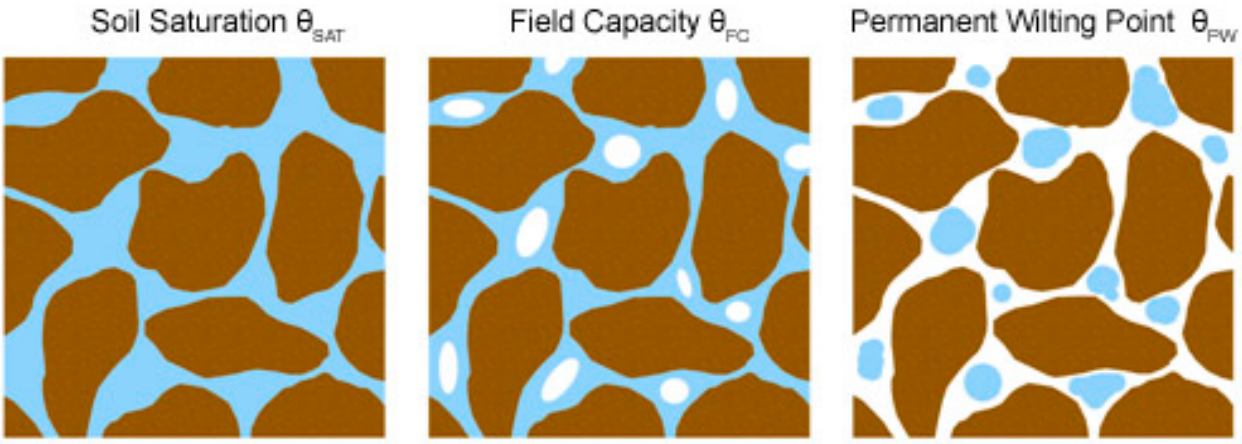


Figure G.1-4: Soil saturation, field capacity, and wilting point

G.1.5.3.2 Characteristics of Gravel

For the purpose of hydromodification management studies, it may be assumed that water moves freely through gravel, not limited by hydraulic properties of the gravel. For the purpose of calculating available volume, use porosity of 0.4, or void ratio of 0.67. Porosity is equal to void ratio divided by (1 + void ratio).

G.1.5.3.3 Additional Guidance for SDHM Users

The module titled "bioretention/rain garden element" may be used to represent bioretention or biofiltration BMPs. SDHM users using the available "bioretention/rain garden element" must customize the soil media characteristics to use the parameters from Table G.1-6 above, and select "gravel" for gravel sublayers. All other input variables are project-specific. "Native infiltration" refers to infiltration from the bottom of the structural BMP into the native soil. This variable is project-specific, see Section G.1.5.1.

G.1.5.3.4 Additional Guidance for SWMM Users

The latest version of SWMM includes the following eight types of LID controls:

- Bio-Retention Cell: surface storage facility with vegetation in an engineered soil mixture placed above a gravel drainage bed.
- Rain Garden: same setup as bio-retention cell, but without an underlying gravel bed.
- Green Roof: bio-retention cell with shallow surface storage and soil layers, underlain by a drainage mat that conveys excess percolated rainfall to the regular roof drainage system.
- Infiltration Trench: drainage swale or narrow storage basin filled with gravel or other porous media designed to capture and infiltrate runoff to the native soil below.
- Permeable Pavement: continuous pavement systems with porous concrete, asphalt mix, or paver blocks above a sand or gravel drainage bed with gravel storage layer below.
- Rain Barrel: container (cistern) to collect roof runoff for later use (e.g., landscape irrigation) or release.
- Rooftop Disconnection: to simulate redirection of downspout discharge onto pervious landscaped areas and lawns instead of directly into storm drains.
- Vegetative Swale: grassed conveyance channel (drainage ditch or swale) with vegetation designed to slow down runoff to allow more time for infiltration into the native soil below.

The "bio-retention cell" LID control may be used to represent bioretention or biofiltration BMPs. For bio-retention cells, a number of LID process layers have been defined in SWMM and these are described below. Table G.1-7 provides parameters required for the standard "bio-retention cell" available in SWMM. The parameters are entered in the LID Control Editor.

Table G.1-7: Parameters for SWMM "Bio-Retention Cell" LID Control for Hydromodification Management Studies in San Diego

SWMM Parameter Name	Unit	Use in San Diego
Surface		
Berm Height also known as Storage Depth	inches	Project-specific
Vegetative Volume Fraction also known as Vegetative Cover Fraction	---	0
Surface Roughness	---	0 (this parameter is not applicable to bio-retention cell)
Surface Slope	---	0 (this parameter is not applicable to bio-retention cell)
Soil		
Thickness	inches	project-specific
Porosity	---	0.40
Field Capacity	---	0.2
Wilting Point	---	0.1
Conductivity	Inches/hour	5
Conductivity Slope	---	5
Suction Head	inches	1.5
Storage		
Thickness also known as Height	inches	Project-specific
Void Ratio	---	0.67
Seepage Rate also known as Conductivity	Inches/hour	Conductivity from the storage layer refers to infiltration from the bottom of the structural BMP into the native soil. This variable is project-specific, see Section G.5.1. Use 0 if the bio-retention cell includes an impermeable liner
Clogging Factor	---	0
Underdrain		
Flow Coefficient Also known as Drain Coefficient	---	Project-specific
Flow Exponent Also known as Drain Exponent	---	Project-specific, typically 0.5
Offset Height Also known as Drain Offset Height	Inches	Project-specific

Surface Layer

This process layer receives direct rainfall (and run-on from upstream subcatchments) and the resultant storm water is available for ponding, infiltration, evapotranspiration, or overflow to the outlet. The following parameters are used:

- Berm Height: This value is the maximum depth that water can pond above the ground surface before overflow occurs. In some cases, this volume may overlap with the hydraulic representation of existing surface storage or another proposed BMP facility. In any case, the user must avoid double-counting the physical storage volume.
- Vegetation Volume Fraction: This represents the surface storage volume that is occupied by the stems and leaves of vegetation within the bio-retention cell.

Soil Layer

This process layer is typically composed of an amended soil or compost mix. Water that infiltrates into this component is stored in the soil void space and is available for evapotranspiration via plant roots or can percolate into the storage layer below. The following parameters are used:

- Thickness: This parameter represents the depth of the amended soil layer.
- Porosity: Ratio of pore space volume to soil volume.
- Field Capacity: Pore water volume ratio after the soil has been drained.
- Wilting Point: Pore water volume ratio after the soil has been dried.
- Conductivity: This represents the saturated hydraulic conductivity.
- Conductivity Slope: Rate at which conductivity decreases with decreasing soil moisture content.
- Suction Head: This represents the capillary tension of water in the soil.

Porosity, conductivity and suction head values as a function of soil texture were included in Table G.1-5. The flow of water through partially saturated soil is less than under fully saturated conditions. The SWMM program accounts for this reduced hydraulic conductivity to predict the rate at which infiltrated water moves through a layer of unsaturated soil when modeling groundwater or LID controls. The conductivity slope is a dimensionless curve-fitting parameter that relates the partially saturated hydraulic conductivity to the soil moisture content.

Storage Layer

This process layer is typically composed of porous granular media such as crushed stone or gravel. Water that percolates into this component is stored in the void space and is available for infiltration into the native soil, or collected by an underdrain and discharged to the outlet. The following parameters are used:

- Thickness: This parameter represents the depth of the stone base.
- Void Ratio: Volume of void space relative to volume of solids. Note, by definition, Porosity = Void Ratio ÷ (1 + Void Ratio).
- Seepage Rate: Filtration rate from the granular media into the native soil below. A value of zero should be used if the facility has an impermeable bottom (e.g., concrete) or is underlain by an impermeable liner.
- Clogging Factor: This value is determined by the total volume of treated runoff to completely clog the bottom of the layer divided by the void volume of the layer.

Drain Layer

This process layer is used to characterize the discharge rate of an underdrain system to the outlet. The following parameters are used:

- Flow Coefficient: This value (coupled with the flow exponent described below) characterizes the rate of discharge to the outlet as a function of the height of water stored in the bio-retention cell. The coefficient can be determined by the following equation:

$$C = Cg\left(\frac{605}{Alid}\right)\left(\frac{\pi D^2}{8}\right)\sqrt{\frac{g}{6}}$$

where,

Cg is the orifice discharge coefficient, typically 0.60-0.65 for thin walled plates and higher for thicker walls;

Alid is the cumulative footprint area (ft2) of all LID controls;

D is the underdrain orifice diameter (in); and

g is the gravitational constant (32.2 ft/s2).

- Flow Exponent: A value of 0.5 should be used to represent flow through an orifice.
- Offset Height: This represents the height of the underdrain above the bottom of the storage layer in the bio-retention cell.

G.1.6 Flow Frequency and Duration

The continuous simulation model will generate a flow record corresponding to the frequency of the rainfall data input as its output. This flow record must then be processed to determine pre-development and post-project flow rates and durations. Compliance with hydromodification management requirements of this manual is achieved when results for flow frequency and duration meet the performance standards. The performance standard is as follows (also presented in Chapter 6 of this manual):

1. For flow rates ranging from 10 percent, 30 percent or 50 percent of the pre-development 2-year runoff event ($0.1Q_2$, $0.3Q_2$, or $0.5Q_2$) to the pre-development 10-year runoff event (Q_{10}), the post-project discharge rates and durations must not exceed the pre-development rates and durations by more than 10 percent.. The specific lower flow threshold will depend on the erosion susceptibility of the receiving stream for the project site (see Section 6.3.4).

To demonstrate that a flow control facility meets the hydromodification management performance standard a flow duration summary must be generated and compared for pre-development and post-project conditions. The following guidelines must be used for determining flow rates and durations.

G.1.6.1 Determining Flow Rates from Continuous Hourly Flow Output

Flow rates for hydromodification management studies in San Diego must be based on partial duration series analysis of the continuous hourly flow output. Partial duration series frequency calculations consider multiple storm events in a given year. To construct the partial duration series:

1. Parse the continuous hourly flow data into discrete runoff events. The following separation criteria may be used for separation of flow events: a new discrete event is designated when the flow falls below an artificially low flow value based on a fraction of the contributing watershed area (e.g., 0.002 to 0.005 cfs/acre) for a time period of 24 hours. Project applicants may consider other separation criteria provided the separation interval is not more than 24 hours and the criteria is clearly described in the submittal document.
2. Rank the peak flows from each discrete flow event, and compute the return interval or plotting position for each event.

Readers who are unfamiliar with how to compute the partial-duration series should consult reference books or online resources for additional information. For example, Hydrology for Engineers, by Linsley et all, 1982, discusses partial-duration series on pages 373-374 and computing recurrence intervals or plotting positions on page 359. Handbook of Applied Hydrology, by Chow, 1964, contains a detailed discussion of flow frequency analysis, including Annual Exceedance, Partial-Duration and Extreme Value series methods, in Chapter 8. The US Geological Survey (USGS) has several hydrologic study reports available online that use partial duration series statistics (see http://water.usgs.gov/ and http://water.usgs.gov/osw/bulletin17b/AGU_Langbein_1949.pdf).

Pre-development Q_2 and Q_{10} must be determined from the partial duration analysis for the pre-development hourly flow record. Pre-development Q_{10} is the upper threshold of flow rates to be controlled in the post-project condition. The lower flow threshold is a fraction of the pre-development Q_2 determined based on the erosion susceptibility of the receiving stream. Simply multiply the pre-development Q_2 by the appropriate fraction (e.g., $0.1Q_2$) to determine the lower flow threshold.

G.1.6.2 Determining Flow Durations from Continuous Hourly Flow Output

Flow durations must be summarized within the range of flows to control. Flow duration statistics provide a simple summary of how often a particular flow rate is exceeded. To prepare this summary:

1. Rank the entire hourly runoff time series output.
2. Extract the portion of the ranked hourly time series output from the lower flow threshold to the upper flow threshold – this is the portion of the record to be summarized.
3. Divide the applicable portion of the record into 100 equal flow bins (compute the difference between the upper flow threshold (cfs) and lower flow threshold (cfs) and divide this value by 99 to establish the flow bin size).
4. Count the number of hours of flow that fall into each flow bin.

Both pre-development and post-project flow duration summary must be based on the entire length of the flow record. Compare the post-project flow duration summary to the pre-development flow duration summary to determine if it meets performance criteria for post-project flow rates and durations (criteria presented under Section G.1.6).

G.2 Sizing Factors for Hydromodification Management BMPs

This section presents sizing factors for design of flow control structural BMPs based on the sizing factor method identified in Chapter 6.3.5.1. The sizing factors are re-printed from the "San Diego BMP Sizing Calculator Methodology," dated January 2012, prepared by Brown and Caldwell (herein "BMP Sizing Calculator Methodology"). The sizing factors are linked to the specific details and descriptions that were presented in the BMP Sizing Calculator Methodology, with limited options for modifications. The sizing factors were developed based on the 2007 MS4 Permit. Although the sizing factors were developed under the 2007 MS4 Permit, the unit runoff ratios and some sizing factors developed for flow control facility sizing may still be applied at the discretion of County staff. Some of the original sizing factors developed based on the 2007 MS4 Permit and presented in the BMP Sizing Calculator Methodology are not compatible with new requirements of the 2013 MS4 Permit, and therefore are not included in this manual. The sizing factor method is intended for simple studies that do not include diversion, do not include significant offsite area draining through the project from upstream, and do not include offsite area downstream of the project area. Use of the sizing factors is limited to the specific structural BMPs described in this Appendix. Sizing factors are available for the following specific structural BMPs:

- Full infiltration condition:
  - **Infiltration**: sizing factors available for A and B soils represent a below-ground structure (dry well)
  - **Bioretention**: sizing factors available for A and B soils represent a bioretention area with engineered soil media and gravel storage layer, with no underdrain and no impermeable liner
- Partial infiltration condition:
  - **Biofiltration with partial retention**: sizing factors available for C and D soils represent a bioretention area with engineered soil media and gravel storage layer, with an underdrain, with gravel storage below the underdrain, with no impermeable liner
- No infiltration condition:
  - **Biofiltration**: sizing factors available for C and D soils represent a bioretention area with engineered soil media and gravel storage layer, with an underdrain, without gravel storage below the underdrain, with no impermeable liner
  - **Biofiltration (formerly known as "flow-through planter") with impermeable liner**: sizing factors available for C and D soils represent a biofiltration system with engineered soil media and gravel storage layer, with an underdrain, with or without gravel storage

below the underdrain, with an impermeable liner

- Other:
  - **Cistern**: sizing factors available for A, B, C, or D soils represent a vessel with a low flow orifice outlet to meet the hydromodification management performance standard.

Sizing factors were created based on three rainfall basins: Lindbergh Field, Oceanside, and Lake Wohlford.

The following information is needed to use the sizing factors:

- Determine the appropriate rainfall basin for the project site from Figure G.2-1, Rainfall Basin Map
- Hydrologic soil group at the project site (use available information pertaining to existing underlying soil type such as soil maps published by the Natural Resources Conservation Service)
- Pre-development and post-project slope categories (low = 0% – 5%, moderate = 5% – 15%, steep = >15%)
- Area tributary to the structural BMP
- Area weighted runoff factor (C) for the area draining to the BMP from Table G.2-1. Note: runoff coefficients and adjustments presented in Appendices B.1 and B.2 are for pollutant control only and are not applicable for hydromodification management studies
- Fraction of Q2 to control (see Chapter 6.3.4)

When using the sizing factor method, Worksheet G.2-1 may be used to present the calculations of the required minimum areas and/or volumes of BMPs as applicable.

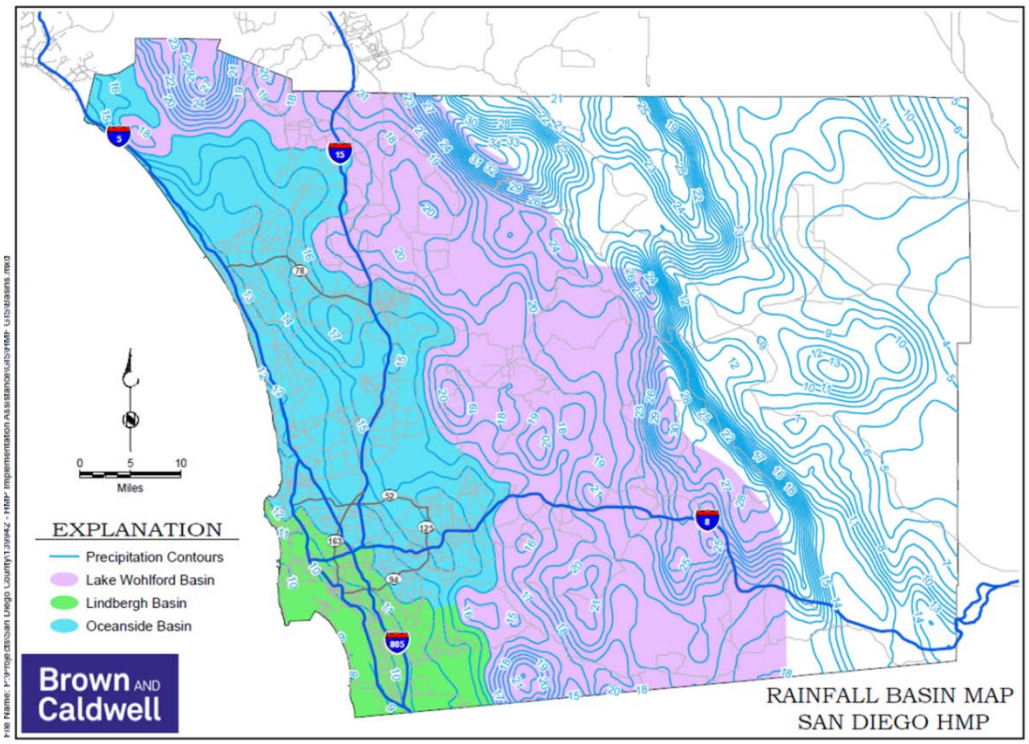


Figure G.2-1: Appropriate Rain Gauge for Project Sites

Table G.2-1: Runoff factors for surfaces draining to BMPs for Hydromodification Sizing Factor Method

Surface	Runoff Factor
Roofs	1.0
Concrete	1.0
Pervious Concrete	0.10
Porous Asphalt	0.10
Grouted Unit Pavers	1.0
Solid Unit Pavers on granular base, min. 3/16 inch joint space	0.20
Crushed Aggregate	0.10
Turf block	0.10
Amended, mulched soils	0.10
Landscape	0.10

Worksheet G.2-1: Sizing Factor Worksheet

Site Information			
Project Name:		Hydrologic Unit	
Project Applicant:		Rain: Gauge:	
Jurisdiction:		Total Project Area:	
Assessor's Parcel Number :		Low Flow Threshold:	
BMP Name:		BMP Type:	

Areas Draining to BMP						Sizing Factors			Minimum BMP Size		
DMA Name	Area (sf)	Soil Type	Pre-Project Slope	Post Project Surface Type	Runoff Factor (From Table G.2-1)	Surface Area	Surface Volume	Subsurface Volume	Surface Area (sf)	Surface Volume (cf)	Subsurface Volume (cf)
Total DMA Area								Minimum BMP Size*			
								Proposed BMP Size*			

*Minimum BMP Size = Total of rows above.

*Proposed BMP Size ≥ Minimum BMP size.

G.2.1 Unit Runoff Ratios

Table G.2-2 presents unit runoff ratios for calculating pre-development Q_2, to be used when applicable to determine the lower flow threshold for low flow orifice sizing for biofiltration with partial retention, biofiltration, biofiltration with impermeable liner, or cistern BMPs. There is no low flow orifice in the infiltration BMP or bioretention BMP. The unit runoff ratios are re-printed from the BMP Sizing Calculator methodology. Unit runoff ratios for "urban" and "impervious" cover categories were not transferred to this manual due to the requirement to control runoff to pre-development condition (see Chapter 6.3.3).

How to use the unit runoff ratios:

Obtain unit runoff ratio from Table G.2-2 based on the project's rainfall basin, hydrologic soil group, and pre-development slope (for redevelopment projects, pre-development slope may be considered if historic topographic information is available, otherwise use pre-project slope). Multiply the area tributary to the structural BMP (A, acres) by the unit runoff ratio (Q2, cfs/acre) to determine the pre-development Q2 to determine the lower flow threshold, to use for low flow orifice sizing.

Table G.2-2: Unit Runoff Ratios for Sizing Factor Method

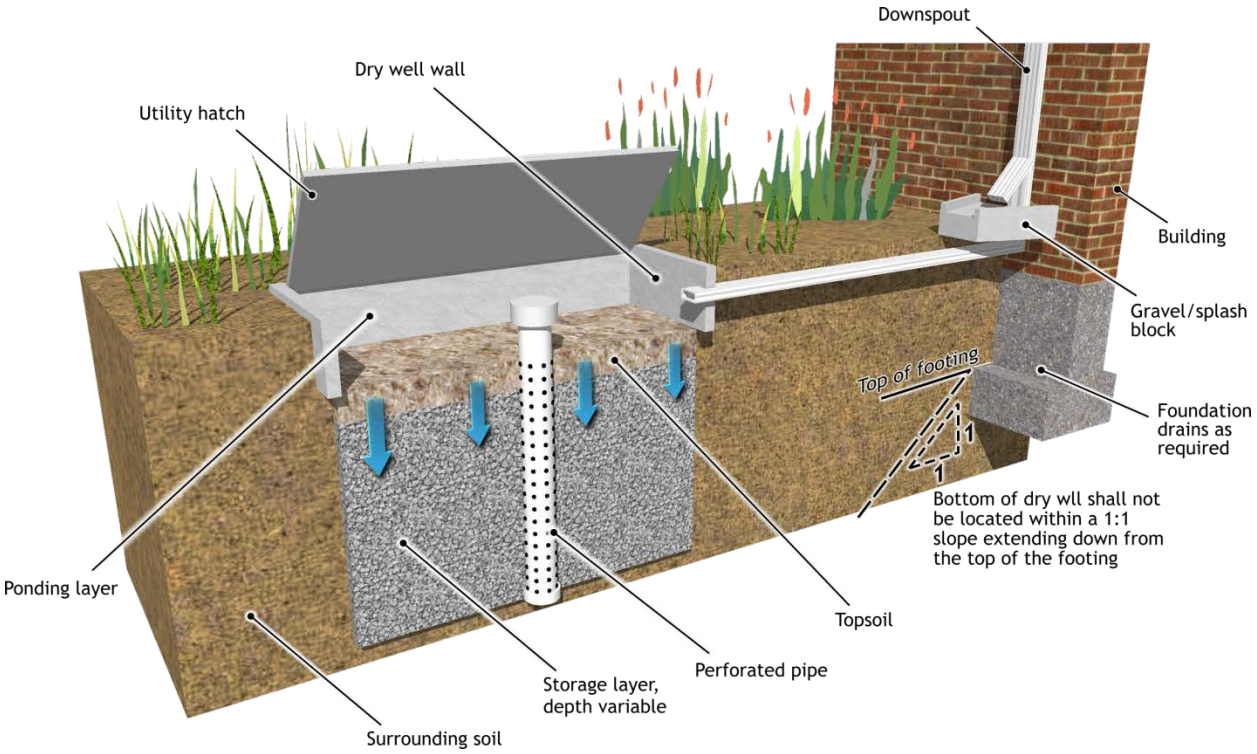
Unit Runoff Ratios for Sizing Factor Method					
Rain Gauge	**Soil**	**Cover**	**Slope**	**Q_2 (cfs/acre)**	**Q_{10} (cfs/ac)**
Lake Wohlford	A	Scrub	Low	0.136	0.369
Lake Wohlford	A	Scrub	Moderate	0.207	0.416
Lake Wohlford	A	Scrub	Steep	0.244	0.47
Lake Wohlford	B	Scrub	Low	0.208	0.414
Lake Wohlford	B	Scrub	Moderate	0.227	0.448
Lake Wohlford	B	Scrub	Steep	0.253	0.482
Lake Wohlford	C	Scrub	Low	0.245	0.458
Lake Wohlford	C	Scrub	Moderate	0.253	0.481
Lake Wohlford	C	Scrub	Steep	0.302	0.517
Lake Wohlford	D	Scrub	Low	0.253	0.48
Lake Wohlford	D	Scrub	Moderate	0.292	0.516

Unit Runoff Ratios for Sizing Factor Method					
Rain Gauge	Soil	Cover	Slope	Q_2 (cfs/acre)	Q_{10} (cfs/ac)
Lake Wohlford	D	Scrub	Steep	0.351	0.538
Oceanside	A	Scrub	Low	0.035	0.32
Oceanside	A	Scrub	Moderate	0.093	0.367
Oceanside	A	Scrub	Steep	0.163	0.42
Oceanside	B	Scrub	Low	0.08	0.365
Oceanside	B	Scrub	Moderate	0.134	0.4
Oceanside	B	Scrub	Steep	0.181	0.433
Oceanside	C	Scrub	Low	0.146	0.411
Oceanside	C	Scrub	Moderate	0.185	0.433
Oceanside	C	Scrub	Steep	0.217	0.458
Oceanside	D	Scrub	Low	0.175	0.434
Oceanside	D	Scrub	Moderate	0.212	0.455
Oceanside	D	Scrub	Steep	0.244	0.571
Lindbergh	A	Scrub	Low	0.003	0.081
Lindbergh	A	Scrub	Moderate	0.018	0.137
Lindbergh	A	Scrub	Steep	0.061	0.211
Lindbergh	B	Scrub	Low	0.011	0.134
Lindbergh	B	Scrub	Moderate	0.033	0.174
Lindbergh	B	Scrub	Steep	0.077	0.23
Lindbergh	C	Scrub	Low	0.028	0.19
Lindbergh	C	Scrub	Moderate	0.075	0.232
Lindbergh	C	Scrub	Steep	0.108	0.274
Lindbergh	D	Scrub	Low	0.05	0.228
Lindbergh	D	Scrub	Moderate	0.104	0.266
Lindbergh	D	Scrub	Steep	0.143	0.319

G.2.2 Sizing Factors for "Infiltration" BMP

Table G.2-3 presents sizing factors for calculating the required surface area (A) and volume (V1) for an infiltration BMP. There is no underdrain and therefore no low flow orifice in the infiltration BMP. Sizing factors were developed for hydrologic soil groups A and B only. This BMP is not applicable in hydrologic soil groups C and D. The infiltration BMP is a below-ground structure (dry well) that consists of three layers:

- Ponding layer: a nominal 6-inch ponding layer should be included below the access hatch to allow for water spreading and infiltration during intense storms.
- Soil layer [topsoil layer]: 12 inches of soil should be included to remove pollutants.
- Free draining layer [storage layer]: The drywell is sized assuming a 6-foot deep free draining layer. However, designers could use shallower facility depths [provided the minimum volume and surface area are met].



Infiltration Facility BMP Example Illustration

Reference: "San Diego BMP Sizing Calculator Methodology," prepared by Brown and Caldwell, dated January 2012

How to use the sizing factors for flow control BMP Sizing:

Obtain sizing factors from Table G.2-3 based on the project's lower flow threshold fraction of Q2, hydrologic soil group, pre-development slope, and rain gauge (rainfall basin). Multiply the area

tributary to the structural BMP (A, square feet) by the area weighted runoff factor (C, unitless) (see Table G.2-1) by the sizing factors to determine the required surface area (A, square feet) and volume (V1, cubic feet) for the infiltration BMP. The civil engineer must provide the necessary volume and surface area of the BMP on the plans.

Additional steps to use this BMP as a combined pollutant control and flow control BMP:

To use this BMP as a combined pollutant control and flow control BMP, determine the size of the BMP using the sizing factors, then refer to Appendix B.4 to check whether the BMP meets performance standards for infiltration for pollutant control. If necessary, increase the surface area to meet the drawdown requirement for pollutant control.

Table G.2-3: Sizing Factors for Hydromodification Flow Control Infiltration BMPs Designed Using Sizing Factor Method

Sizing Factors for Hydromodification Flow Control Infiltration BMPs Designed Using Sizing Factor Method						
Lower Flow Threshold	Soil Group	Slope	Rain Gauge	A	V_1	V_2
$0.5Q_2$	A	Flat	Lindbergh	0.040	0.1040	N/A
$0.5Q_2$	A	Moderate	Lindbergh	0.040	0.1040	N/A
$0.5Q_2$	A	Steep	Lindbergh	0.035	0.0910	N/A
$0.5Q_2$	B	Flat	Lindbergh	0.058	0.1495	N/A
$0.5Q_2$	B	Moderate	Lindbergh	0.055	0.1430	N/A
$0.5Q_2$	B	Steep	Lindbergh	0.050	0.1300	N/A
$0.5Q_2$	C	Flat	Lindbergh	N/A	N/A	N/A
$0.5Q_2$	C	Moderate	Lindbergh	N/A	N/A	N/A
$0.5Q_2$	C	Steep	Lindbergh	N/A	N/A	N/A
$0.5Q_2$	D	Flat	Lindbergh	N/A	N/A	N/A
$0.5Q_2$	D	Moderate	Lindbergh	N/A	N/A	N/A
$0.5Q_2$	D	Steep	Lindbergh	N/A	N/A	N/A
$0.5Q_2$	A	Flat	Oceanside	0.045	0.1170	N/A
$0.5Q_2$	A	Moderate	Oceanside	0.045	0.1170	N/A
$0.5Q_2$	A	Steep	Oceanside	0.040	0.1040	N/A
$0.5Q_2$	B	Flat	Oceanside	0.065	0.1690	N/A
$0.5Q_2$	B	Moderate	Oceanside	0.065	0.1690	N/A
$0.5Q_2$	B	Steep	Oceanside	0.060	0.1560	N/A
$0.5Q_2$	C	Flat	Oceanside	N/A	N/A	N/A
$0.5Q_2$	C	Moderate	Oceanside	N/A	N/A	N/A
$0.5Q_2$	C	Steep	Oceanside	N/A	N/A	N/A
$0.5Q_2$	D	Flat	Oceanside	N/A	N/A	N/A

Sizing Factors for Hydromodification Flow Control Infiltration BMPs Designed Using Sizing Factor Method						
Lower Flow Threshold	Soil Group	Slope	Rain Gauge	A	V_1	V_2
$0.5Q_2$	D	Moderate	Oceanside	N/A	N/A	N/A
$0.5Q_2$	D	Steep	Oceanside	N/A	N/A	N/A
$0.5Q_2$	A	Flat	L Wohlford	0.050	0.1300	N/A
$0.5Q_2$	A	Moderate	L Wohlford	0.050	0.1300	N/A
$0.5Q_2$	A	Steep	L Wohlford	0.040	0.1040	N/A
$0.5Q_2$	B	Flat	L Wohlford	0.078	0.2015	N/A
$0.5Q_2$	B	Moderate	L Wohlford	0.075	0.1950	N/A
$0.5Q_2$	B	Steep	L Wohlford	0.065	0.1690	N/A
$0.5Q_2$	C	Flat	L Wohlford	N/A	N/A	N/A
$0.5Q_2$	C	Moderate	L Wohlford	N/A	N/A	N/A
$0.5Q_2$	C	Steep	L Wohlford	N/A	N/A	N/A
$0.5Q_2$	D	Flat	L Wohlford	N/A	N/A	N/A
$0.5Q_2$	D	Moderate	L Wohlford	N/A	N/A	N/A
$0.5Q_2$	D	Steep	L Wohlford	N/A	N/A	N/A
$0.3Q_2$	A	Flat	Lindbergh	0.040	0.1040	N/A
$0.3Q_2$	A	Moderate	Lindbergh	0.040	0.1040	N/A
$0.3Q_2$	A	Steep	Lindbergh	0.035	0.0910	N/A
$0.3Q_2$	B	Flat	Lindbergh	0.058	0.1495	N/A
$0.3Q_2$	B	Moderate	Lindbergh	0.055	0.1430	N/A
$0.3Q_2$	B	Steep	Lindbergh	0.050	0.1300	N/A
$0.3Q_2$	C	Flat	Lindbergh	N/A	N/A	N/A
$0.3Q_2$	C	Moderate	Lindbergh	N/A	N/A	N/A
$0.3Q_2$	C	Steep	Lindbergh	N/A	N/A	N/A
$0.3Q_2$	D	Flat	Lindbergh	N/A	N/A	N/A
$0.3Q_2$	D	Moderate	Lindbergh	N/A	N/A	N/A
$0.3Q_2$	D	Steep	Lindbergh	N/A	N/A	N/A
$0.3Q_2$	A	Flat	Oceanside	0.045	0.1170	N/A
$0.3Q_2$	A	Moderate	Oceanside	0.045	0.1170	N/A
$0.3Q_2$	A	Steep	Oceanside	0.040	0.1040	N/A
$0.3Q_2$	B	Flat	Oceanside	0.065	0.1690	N/A
$0.3Q_2$	B	Moderate	Oceanside	0.065	0.1690	N/A
$0.3Q_2$	B	Steep	Oceanside	0.060	0.1560	N/A
$0.3Q_2$	C	Flat	Oceanside	N/A	N/A	N/A
$0.3Q_2$	C	Moderate	Oceanside	N/A	N/A	N/A

Sizing Factors for Hydromodification Flow Control Infiltration BMPs Designed Using Sizing Factor Method						
Lower Flow Threshold	Soil Group	Slope	Rain Gauge	A	V_1	V_2
$0.3Q_2$	C	Steep	Oceanside	N/A	N/A	N/A
$0.3Q_2$	D	Flat	Oceanside	N/A	N/A	N/A
$0.3Q_2$	D	Moderate	Oceanside	N/A	N/A	N/A
$0.3Q_2$	D	Steep	Oceanside	N/A	N/A	N/A
$0.3Q_2$	A	Flat	L Wohlford	0.050	0.1300	N/A
$0.3Q_2$	A	Moderate	L Wohlford	0.050	0.1300	N/A
$0.3Q_2$	A	Steep	L Wohlford	0.040	0.1040	N/A
$0.3Q_2$	B	Flat	L Wohlford	0.078	0.2015	N/A
$0.3Q_2$	B	Moderate	L Wohlford	0.075	0.1950	N/A
$0.3Q_2$	B	Steep	L Wohlford	0.065	0.1690	N/A
$0.3Q_2$	C	Flat	L Wohlford	N/A	N/A	N/A
$0.3Q_2$	C	Moderate	L Wohlford	N/A	N/A	N/A
$0.3Q_2$	C	Steep	L Wohlford	N/A	N/A	N/A
$0.3Q_2$	D	Flat	L Wohlford	N/A	N/A	N/A
$0.3Q_2$	D	Moderate	L Wohlford	N/A	N/A	N/A
$0.3Q_2$	D	Steep	L Wohlford	N/A	N/A	N/A
$0.1Q_2$	A	Flat	Lindbergh	0.040	0.1040	N/A
$0.1Q_2$	A	Moderate	Lindbergh	0.040	0.1040	N/A
$0.1Q_2$	A	Steep	Lindbergh	0.035	0.0910	N/A
$0.1Q_2$	B	Flat	Lindbergh	0.058	0.1495	N/A
$0.1Q_2$	B	Moderate	Lindbergh	0.055	0.1430	N/A
$0.1Q_2$	B	Steep	Lindbergh	0.050	0.1300	N/A
$0.1Q_2$	C	Flat	Lindbergh	N/A	N/A	N/A
$0.1Q_2$	C	Moderate	Lindbergh	N/A	N/A	N/A
$0.1Q_2$	C	Steep	Lindbergh	N/A	N/A	N/A
$0.1Q_2$	D	Flat	Lindbergh	N/A	N/A	N/A
$0.1Q_2$	D	Moderate	Lindbergh	N/A	N/A	N/A
$0.1Q_2$	D	Steep	Lindbergh	N/A	N/A	N/A
$0.1Q_2$	A	Flat	Oceanside	0.045	0.1170	N/A
$0.1Q_2$	A	Moderate	Oceanside	0.045	0.1170	N/A
$0.1Q_2$	A	Steep	Oceanside	0.040	0.1040	N/A
$0.1Q_2$	B	Flat	Oceanside	0.065	0.1690	N/A
$0.1Q_2$	B	Moderate	Oceanside	0.065	0.1690	N/A
$0.1Q_2$	B	Steep	Oceanside	0.060	0.1560	N/A

Sizing Factors for Hydromodification Flow Control Infiltration BMPs Designed Using Sizing Factor Method						
Lower Flow Threshold	Soil Group	Slope	Rain Gauge	A	V_1	V_2
$0.1Q_2$	C	Flat	Oceanside	N/A	N/A	N/A
$0.1Q_2$	C	Moderate	Oceanside	N/A	N/A	N/A
$0.1Q_2$	C	Steep	Oceanside	N/A	N/A	N/A
$0.1Q_2$	D	Flat	Oceanside	N/A	N/A	N/A
$0.1Q_2$	D	Moderate	Oceanside	N/A	N/A	N/A
$0.1Q_2$	D	Steep	Oceanside	N/A	N/A	N/A
$0.1Q_2$	A	Flat	L Wohlford	0.050	0.1300	N/A
$0.1Q_2$	A	Moderate	L Wohlford	0.050	0.1300	N/A
$0.1Q_2$	A	Steep	L Wohlford	0.040	0.1040	N/A
$0.1Q_2$	B	Flat	L Wohlford	0.078	0.2015	N/A
$0.1Q_2$	B	Moderate	L Wohlford	0.075	0.1950	N/A
$0.1Q_2$	B	Steep	L Wohlford	0.065	0.1690	N/A
$0.1Q_2$	C	Flat	L Wohlford	N/A	N/A	N/A
$0.1Q_2$	C	Moderate	L Wohlford	N/A	N/A	N/A
$0.1Q_2$	C	Steep	L Wohlford	N/A	N/A	N/A
$0.1Q_2$	D	Flat	L Wohlford	N/A	N/A	N/A
$0.1Q_2$	D	Moderate	L Wohlford	N/A	N/A	N/A
$0.1Q_2$	D	Steep	L Wohlford	N/A	N/A	N/A

Q_2 = 2-year pre-project flow rate based upon partial duration analysis of long-term hourly rainfall records

A = Surface area sizing factor for flow control

V_1 = Infiltration volume sizing factor for flow control

Definitions for "N/A"

- Soil groups A and B: N/A in column V2 means there is no V2 element in this infiltration BMP for soil groups A and B
- Soil groups C and D: N/A across all elements (A, V1, V2) means sizing factors were not developed for an infiltration BMP for soil groups C and D

G.2.3 Sizing Factors for Bioretention

Table G.2-4 presents sizing factors for calculating the required surface area (A) and surface volume (V1) for the bioretention BMP. The bioretention BMP consists of two layers:

- Ponding layer: 10-inches active storage, [minimum] 2-inches of freeboard above overflow relief
- Growing medium: 18-inches of soil [bioretention soil media]

This BMP is applicable in soil groups A and B. This BMP does not include an underdrain or a low flow orifice. This BMP does not include an impermeable layer at the bottom of the facility to prevent infiltration into underlying soils, regardless of hydrologic soil group. If a facility is to be lined, the designer must use the sizing factors for biofiltration with impermeable layer (formerly known as "flow-through planter").

How to use the sizing factors for flow control BMP Sizing:

Obtain sizing factors from Table G.2-4 based on the project's lower flow threshold fraction of Q2, hydrologic soil group, pre-development slope, and rain gauge (rainfall basin). Multiply the area tributary to the structural BMP (A, square feet) by the area weighted runoff factor (C, unitless) (see Table G.2-1) by the sizing factors to determine the required surface area (A, square feet) and surface volume (V1, cubic feet). Note the surface volume is the ponding layer. The BMP must also include 18 inches of bioretention soil media which does not contribute to V1. The civil engineer must provide the necessary volume and surface area of the BMP on the plans.

Additional steps to use this BMP as a combined pollutant control and flow control BMP:

To use this BMP as a combined pollutant control and flow control BMP, determine the size of the BMP using the sizing factors, then refer to Appendix B.4 to check whether the BMP meets performance standards for infiltration for pollutant control. If necessary, adjust the surface area, depth of storage layer, or depth of growing medium as needed to meet pollutant control standards.

Table G.2-4: Sizing Factors for Hydromodification Flow Control Bioretention BMPs Designed Using Sizing Factor Method

Sizing Factors for Hydromodification Flow Control Bioretention BMPs Designed Using Sizing Factor Method						
Lower Flow Threshold	Soil Group	Slope	Rain Gauge	A	V_1	V_2
$0.5Q_2$	A	Flat	Lindbergh	0.060	0.0500	N/A
$0.5Q_2$	A	Moderate	Lindbergh	0.055	0.0458	N/A
$0.5Q_2$	A	Steep	Lindbergh	0.045	0.0375	N/A

Sizing Factors for Hydromodification Flow Control Bioretention BMPs Designed Using Sizing Factor Method						
Lower Flow Threshold	Soil Group	Slope	Rain Gauge	A	V_1	V_2
$0.5Q_2$	B	Flat	Lindbergh	0.093	0.0771	N/A
$0.5Q_2$	B	Moderate	Lindbergh	0.085	0.0708	N/A
$0.5Q_2$	B	Steep	Lindbergh	0.065	0.0542	N/A
$0.5Q_2$	C	Flat	Lindbergh	N/A	N/A	N/A
$0.5Q_2$	C	Moderate	Lindbergh	N/A	N/A	N/A
$0.5Q_2$	C	Steep	Lindbergh	N/A	N/A	N/A
$0.5Q_2$	D	Flat	Lindbergh	N/A	N/A	N/A
$0.5Q_2$	D	Moderate	Lindbergh	N/A	N/A	N/A
$0.5Q_2$	D	Steep	Lindbergh	N/A	N/A	N/A
$0.5Q_2$	A	Flat	Oceanside	0.070	0.0583	N/A
$0.5Q_2$	A	Moderate	Oceanside	0.065	0.0542	N/A
$0.5Q_2$	A	Steep	Oceanside	0.060	0.0500	N/A
$0.5Q_2$	B	Flat	Oceanside	0.098	0.0813	N/A
$0.5Q_2$	B	Moderate	Oceanside	0.090	0.0750	N/A
$0.5Q_2$	B	Steep	Oceanside	0.075	0.0625	N/A
$0.5Q_2$	C	Flat	Oceanside	N/A	N/A	N/A
$0.5Q_2$	C	Moderate	Oceanside	N/A	N/A	N/A
$0.5Q_2$	C	Steep	Oceanside	N/A	N/A	N/A
$0.5Q_2$	D	Flat	Oceanside	N/A	N/A	N/A
$0.5Q_2$	D	Moderate	Oceanside	N/A	N/A	N/A
$0.5Q_2$	D	Steep	Oceanside	N/A	N/A	N/A
$0.5Q_2$	A	Flat	L Wohlford	0.050	0.0417	N/A
$0.5Q_2$	A	Moderate	L Wohlford	0.045	0.0375	N/A
$0.5Q_2$	A	Steep	L Wohlford	0.040	0.0333	N/A
$0.5Q_2$	B	Flat	L Wohlford	0.048	0.0396	N/A
$0.5Q_2$	B	Moderate	L Wohlford	0.045	0.0375	N/A
$0.5Q_2$	B	Steep	L Wohlford	0.040	0.0333	N/A
$0.5Q_2$	C	Flat	L Wohlford	N/A	N/A	N/A
$0.5Q_2$	C	Moderate	L Wohlford	N/A	N/A	N/A
$0.5Q_2$	C	Steep	L Wohlford	N/A	N/A	N/A
$0.5Q_2$	D	Flat	L Wohlford	N/A	N/A	N/A
$0.5Q_2$	D	Moderate	L Wohlford	N/A	N/A	N/A
$0.5Q_2$	D	Steep	L Wohlford	N/A	N/A	N/A

Sizing Factors for Hydromodification Flow Control Bioretention BMPs Designed Using Sizing Factor Method						
Lower Flow Threshold	Soil Group	Slope	Rain Gauge	A	V_1	V_2
$0.3Q_2$	A	Flat	Lindbergh	0.060	0.0500	N/A
$0.3Q_2$	A	Moderate	Lindbergh	0.055	0.0458	N/A
$0.3Q_2$	A	Steep	Lindbergh	0.045	0.0375	N/A
$0.3Q_2$	B	Flat	Lindbergh	0.098	0.0813	N/A
$0.3Q_2$	B	Moderate	Lindbergh	0.090	0.0750	N/A
$0.3Q_2$	B	Steep	Lindbergh	0.070	0.0583	N/A
$0.3Q_2$	C	Flat	Lindbergh	N/A	N/A	N/A
$0.3Q_2$	C	Moderate	Lindbergh	N/A	N/A	N/A
$0.3Q_2$	C	Steep	Lindbergh	N/A	N/A	N/A
$0.3Q_2$	D	Flat	Lindbergh	N/A	N/A	N/A
$0.3Q_2$	D	Moderate	Lindbergh	N/A	N/A	N/A
$0.3Q_2$	D	Steep	Lindbergh	N/A	N/A	N/A
$0.3Q_2$	A	Flat	Oceanside	0.070	0.0583	N/A
$0.3Q_2$	A	Moderate	Oceanside	0.065	0.0542	N/A
$0.3Q_2$	A	Steep	Oceanside	0.060	0.0500	N/A
$0.3Q_2$	B	Flat	Oceanside	0.098	0.0813	N/A
$0.3Q_2$	B	Moderate	Oceanside	0.090	0.0750	N/A
$0.3Q_2$	B	Steep	Oceanside	0.075	0.0625	N/A
$0.3Q_2$	C	Flat	Oceanside	N/A	N/A	N/A
$0.3Q_2$	C	Moderate	Oceanside	N/A	N/A	N/A
$0.3Q_2$	C	Steep	Oceanside	N/A	N/A	N/A
$0.3Q_2$	D	Flat	Oceanside	N/A	N/A	N/A
$0.3Q_2$	D	Moderate	Oceanside	N/A	N/A	N/A
$0.3Q_2$	D	Steep	Oceanside	N/A	N/A	N/A
$0.3Q_2$	A	Flat	L Wohlford	0.050	0.0417	N/A
$0.3Q_2$	A	Moderate	L Wohlford	0.045	0.0375	N/A
$0.3Q_2$	A	Steep	L Wohlford	0.040	0.0333	N/A
$0.3Q_2$	B	Flat	L Wohlford	0.060	0.0500	N/A
$0.3Q_2$	B	Moderate	L Wohlford	0.055	0.0458	N/A
$0.3Q_2$	B	Steep	L Wohlford	0.045	0.0375	N/A
$0.3Q_2$	C	Flat	L Wohlford	N/A	N/A	N/A
$0.3Q_2$	C	Moderate	L Wohlford	N/A	N/A	N/A
$0.3Q_2$	C	Steep	L Wohlford	N/A	N/A	N/A

Sizing Factors for Hydromodification Flow Control Bioretention BMPs Designed Using Sizing Factor Method						
Lower Flow Threshold	Soil Group	Slope	Rain Gauge	A	V_1	V_2
$0.3Q_2$	D	Flat	L Wohlford	N/A	N/A	N/A
$0.3Q_2$	D	Moderate	L Wohlford	N/A	N/A	N/A
$0.3Q_2$	D	Steep	L Wohlford	N/A	N/A	N/A
$0.1Q_2$	A	Flat	Lindbergh	0.060	0.0500	N/A
$0.1Q_2$	A	Moderate	Lindbergh	0.055	0.0458	N/A
$0.1Q_2$	A	Steep	Lindbergh	0.045	0.0375	N/A
$0.1Q_2$	B	Flat	Lindbergh	0.100	0.0833	N/A
$0.1Q_2$	B	Moderate	Lindbergh	0.095	0.0792	N/A
$0.1Q_2$	B	Steep	Lindbergh	0.080	0.0667	N/A
$0.1Q_2$	C	Flat	Lindbergh	N/A	N/A	N/A
$0.1Q_2$	C	Moderate	Lindbergh	N/A	N/A	N/A
$0.1Q_2$	C	Steep	Lindbergh	N/A	N/A	N/A
$0.1Q_2$	D	Flat	Lindbergh	N/A	N/A	N/A
$0.1Q_2$	D	Moderate	Lindbergh	N/A	N/A	N/A
$0.1Q_2$	D	Steep	Lindbergh	N/A	N/A	N/A
$0.1Q_2$	A	Flat	Oceanside	0.070	0.0583	N/A
$0.1Q_2$	A	Moderate	Oceanside	0.065	0.0542	N/A
$0.1Q_2$	A	Steep	Oceanside	0.060	0.0500	N/A
$0.1Q_2$	B	Flat	Oceanside	0.103	0.0854	N/A
$0.1Q_2$	B	Moderate	Oceanside	0.090	0.0750	N/A
$0.1Q_2$	B	Steep	Oceanside	0.075	0.0625	N/A
$0.1Q_2$	C	Flat	Oceanside	N/A	N/A	N/A
$0.1Q_2$	C	Moderate	Oceanside	N/A	N/A	N/A
$0.1Q_2$	C	Steep	Oceanside	N/A	N/A	N/A
$0.1Q_2$	D	Flat	Oceanside	N/A	N/A	N/A
$0.1Q_2$	D	Moderate	Oceanside	N/A	N/A	N/A
$0.1Q_2$	D	Steep	Oceanside	N/A	N/A	N/A
$0.1Q_2$	A	Flat	L Wohlford	0.050	0.0417	N/A
$0.1Q_2$	A	Moderate	L Wohlford	0.045	0.0375	N/A
$0.1Q_2$	A	Steep	L Wohlford	0.040	0.0333	N/A
$0.1Q_2$	B	Flat	L Wohlford	0.090	0.0750	N/A
$0.1Q_2$	B	Moderate	L Wohlford	0.085	0.0708	N/A
$0.1Q_2$	B	Steep	L Wohlford	0.065	0.0542	N/A

Sizing Factors for Hydromodification Flow Control Bioretention BMPs Designed Using Sizing Factor Method						
Lower Flow Threshold	Soil Group	Slope	Rain Gauge	A	V_1	V_2
$0.1Q_2$	C	Flat	L Wohlford	N/A	N/A	N/A
$0.1Q_2$	C	Moderate	L Wohlford	N/A	N/A	N/A
$0.1Q_2$	C	Steep	L Wohlford	N/A	N/A	N/A
$0.1Q_2$	D	Flat	L Wohlford	N/A	N/A	N/A
$0.1Q_2$	D	Moderate	L Wohlford	N/A	N/A	N/A
$0.1Q_2$	D	Steep	L Wohlford	N/A	N/A	N/A

Q_2 = 2-year pre-project flow rate based upon partial duration analysis of long-term hourly rainfall records

A = Surface area sizing factor for flow control

V_1 = Surface volume sizing factor for flow control

Definitions for "N/A"

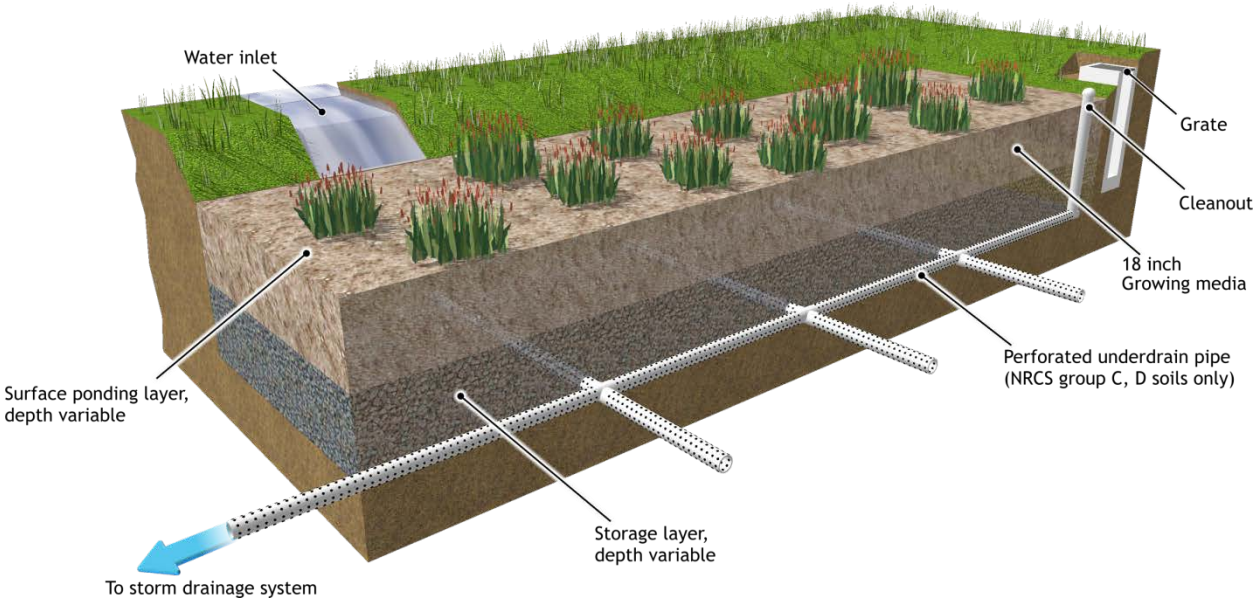
- Soil groups A and B: N/A in column V2 means there is no V2 element in this bioretention BMP for soil groups A and B
- Soil groups C and D: N/A in all elements (A, V1, V2) for soil groups C and D means sizing factors developed for "bioretention" in soil groups C and D under the 2007 MS4 Permit are not applicable in the "bioretention" category under the 2013 MS4 Permit because they were developed with the assumption that an underdrain is operating. Refer to Appendix G.2.4, Sizing Factors for Biofiltration with Partial Retention and Biofiltration

G.2.4 Sizing Factors for Biofiltration with Partial Retention and Biofiltration

Table G.2-5 presents sizing factors for calculating the required surface area (A), surface volume (V1), and sub-surface volume (V2) for a biofiltration with partial retention and biofiltration BMP. The BMPs consist of three layers:

- Ponding layer: 10-inches active storage, [minimum] 2-inches of freeboard above overflow relief
- Growing medium: 18-inches of soil [bioretention soil media]
- Storage layer: 30-inches of gravel at 40 percent porosity [18 inches active storage above underdrain is required, additional dead storage depth below underdrain is optional and can vary]

This BMP is applicable in soil groups C and D. This BMP includes an underdrain with a low flow orifice 18 inches (1.5 feet) below the bottom of the growing medium. This BMP can include additional dead storage below the underdrain. This BMP does not include an impermeable layer at the bottom of the facility to prevent infiltration into underlying soils, regardless of hydrologic soil group. If a facility is to be lined, the designer must use the sizing factors for biofiltration with impermeable liner (formerly known as "flow-through planter").



Biofiltration BMP Example Illustration

Reference: "San Diego BMP Sizing Calculator Methodology," prepared by Brown and Caldwell, dated January 2012

How to use the sizing factors for flow control BMP Sizing:

Obtain sizing factors from Table G.2-5 based on the project's lower flow threshold fraction of Q2, hydrologic soil group, pre-development slope, and rain gauge (rainfall basin). Multiply the area tributary to the structural BMP (A, square feet) by the area weighted runoff factor (C, unitless) (see Table G.2-1) by the sizing factors to determine the required surface area (A, square feet), surface volume (V1, cubic feet), and sub-surface volume (V2, cubic feet). Select a low flow orifice for the underdrain that will discharge the lower flow threshold flow when there is 1.5 feet of head over the underdrain orifice. The civil engineer must provide the necessary volume and surface area of the BMP and the underdrain and orifice detail on the plans.

Additional steps to use this BMP as a combined pollutant control and flow control BMP:

To use this BMP as a combined pollutant control and flow control BMP, determine the size of the BMP using the sizing factors. For BMPs without dead storage below the underdrain, then refer to Appendix B.5 and Appendix F to check whether the BMP meets performance standards for biofiltration for pollutant control. If necessary, adjust the surface area, depth of storage layer, or depth of growing medium as needed to meet pollutant control standards. For BMPs with dead storage below the underdrain, refer to Appendix B.4 to determine the portion of the DCV to be infiltrated for pollutant control, then Appendix B.5 and Appendix F to check whether the BMP meets performance standards for biofiltration for pollutant control for the balance of the DCV. If necessary, adjust the surface area, depth of storage layer, or depth of growing medium as needed to meet pollutant control standards.

Table G.2-5: Sizing Factors for Hydromodification Flow Control Biofiltration with Partial Retention and Biofiltration BMPs Designed Using Sizing Factor Method

Sizing Factors for Hydromodification Flow Control Biofiltration with Partial Retention and Biofiltration BMPs Designed Using Sizing Factor Method						
Lower Flow Threshold	Soil Group	Slope	Rain Gauge	A	V_1	V_2
$0.5Q_2$	A	Flat	Lindbergh	N/A	N/A	N/A
$0.5Q_2$	A	Moderate	Lindbergh	N/A	N/A	N/A
$0.5Q_2$	A	Steep	Lindbergh	N/A	N/A	N/A
$0.5Q_2$	B	Flat	Lindbergh	N/A	N/A	N/A
$0.5Q_2$	B	Moderate	Lindbergh	N/A	N/A	N/A
$0.5Q_2$	B	Steep	Lindbergh	N/A	N/A	N/A
$0.5Q_2$	C	Flat	Lindbergh	0.100	0.0833	0.0600
$0.5Q_2$	C	Moderate	Lindbergh	0.100	0.0833	0.0600
$0.5Q_2$	C	Steep	Lindbergh	0.075	0.0625	0.0450
$0.5Q_2$	D	Flat	Lindbergh	0.080	0.0667	0.0480

Sizing Factors for Hydromodification Flow Control Biofiltration with Partial Retention and Biofiltration BMPs Designed Using Sizing Factor Method						
Lower Flow Threshold	Soil Group	Slope	Rain Gauge	A	V_1	V_2
$0.5Q_2$	D	Moderate	Lindbergh	0.080	0.0667	0.0480
$0.5Q_2$	D	Steep	Lindbergh	0.060	0.0500	0.0360
$0.5Q_2$	A	Flat	Oceanside	N/A	N/A	N/A
$0.5Q_2$	A	Moderate	Oceanside	N/A	N/A	N/A
$0.5Q_2$	A	Steep	Oceanside	N/A	N/A	N/A
$0.5Q_2$	B	Flat	Oceanside	N/A	N/A	N/A
$0.5Q_2$	B	Moderate	Oceanside	N/A	N/A	N/A
$0.5Q_2$	B	Steep	Oceanside	N/A	N/A	N/A
$0.5Q_2$	C	Flat	Oceanside	0.075	0.0625	0.0450
$0.5Q_2$	C	Moderate	Oceanside	0.075	0.0625	0.0450
$0.5Q_2$	C	Steep	Oceanside	0.060	0.0500	0.0360
$0.5Q_2$	D	Flat	Oceanside	0.065	0.0542	0.0390
$0.5Q_2$	D	Moderate	Oceanside	0.065	0.0542	0.0390
$0.5Q_2$	D	Steep	Oceanside	0.050	0.0417	0.0300
$0.5Q_2$	A	Flat	L Wohlford	N/A	N/A	N/A
$0.5Q_2$	A	Moderate	L Wohlford	N/A	N/A	N/A
$0.5Q_2$	A	Steep	L Wohlford	N/A	N/A	N/A
$0.5Q_2$	B	Flat	L Wohlford	N/A	N/A	N/A
$0.5Q_2$	B	Moderate	L Wohlford	N/A	N/A	N/A
$0.5Q_2$	B	Steep	L Wohlford	N/A	N/A	N/A
$0.5Q_2$	C	Flat	L Wohlford	0.065	0.0542	0.0390
$0.5Q_2$	C	Moderate	L Wohlford	0.065	0.0542	0.0390
$0.5Q_2$	C	Steep	L Wohlford	0.050	0.0417	0.0300
$0.5Q_2$	D	Flat	L Wohlford	0.055	0.0458	0.0330
$0.5Q_2$	D	Moderate	L Wohlford	0.055	0.0458	0.0330
$0.5Q_2$	D	Steep	L Wohlford	0.045	0.0375	0.0270
$0.3Q_2$	A	Flat	Lindbergh	N/A	N/A	N/A
$0.3Q_2$	A	Moderate	Lindbergh	N/A	N/A	N/A
$0.3Q_2$	A	Steep	Lindbergh	N/A	N/A	N/A
$0.3Q_2$	B	Flat	Lindbergh	N/A	N/A	N/A
$0.3Q_2$	B	Moderate	Lindbergh	N/A	N/A	N/A
$0.3Q_2$	B	Steep	Lindbergh	N/A	N/A	N/A
$0.3Q_2$	C	Flat	Lindbergh	0.110	0.0917	0.0660

Sizing Factors for Hydromodification Flow Control Biofiltration with Partial Retention and Biofiltration BMPs Designed Using Sizing Factor Method						
Lower Flow Threshold	Soil Group	Slope	Rain Gauge	A	V_1	V_2
$0.3Q_2$	C	Moderate	Lindbergh	0.110	0.0917	0.0660
$0.3Q_2$	C	Steep	Lindbergh	0.085	0.0708	0.0510
$0.3Q_2$	D	Flat	Lindbergh	0.100	0.0833	0.0600
$0.3Q_2$	D	Moderate	Lindbergh	0.100	0.0833	0.0600
$0.3Q_2$	D	Steep	Lindbergh	0.070	0.0583	0.0420
$0.3Q_2$	A	Flat	Oceanside	N/A	N/A	N/A
$0.3Q_2$	A	Moderate	Oceanside	N/A	N/A	N/A
$0.3Q_2$	A	Steep	Oceanside	N/A	N/A	N/A
$0.3Q_2$	B	Flat	Oceanside	N/A	N/A	N/A
$0.3Q_2$	B	Moderate	Oceanside	N/A	N/A	N/A
$0.3Q_2$	B	Steep	Oceanside	N/A	N/A	N/A
$0.3Q_2$	C	Flat	Oceanside	0.100	0.0833	0.0600
$0.3Q_2$	C	Moderate	Oceanside	0.100	0.0833	0.0600
$0.3Q_2$	C	Steep	Oceanside	0.080	0.0667	0.0480
$0.3Q_2$	D	Flat	Oceanside	0.085	0.0708	0.0510
$0.3Q_2$	D	Moderate	Oceanside	0.085	0.0708	0.0510
$0.3Q_2$	D	Steep	Oceanside	0.065	0.0542	0.0390
$0.3Q_2$	A	Flat	L Wohlford	N/A	N/A	N/A
$0.3Q_2$	A	Moderate	L Wohlford	N/A	N/A	N/A
$0.3Q_2$	A	Steep	L Wohlford	N/A	N/A	N/A
$0.3Q_2$	B	Flat	L Wohlford	N/A	N/A	N/A
$0.3Q_2$	B	Moderate	L Wohlford	N/A	N/A	N/A
$0.3Q_2$	B	Steep	L Wohlford	N/A	N/A	N/A
$0.3Q_2$	C	Flat	L Wohlford	0.075	0.0625	0.0450
$0.3Q_2$	C	Moderate	L Wohlford	0.075	0.0625	0.0450
$0.3Q_2$	C	Steep	L Wohlford	0.060	0.0500	0.0360
$0.3Q_2$	D	Flat	L Wohlford	0.065	0.0542	0.0390
$0.3Q_2$	D	Moderate	L Wohlford	0.065	0.0542	0.0390
$0.3Q_2$	D	Steep	L Wohlford	0.050	0.0417	0.0300
$0.1Q_2$	A	Flat	Lindbergh	N/A	N/A	N/A
$0.1Q_2$	A	Moderate	Lindbergh	N/A	N/A	N/A
$0.1Q_2$	A	Steep	Lindbergh	N/A	N/A	N/A
$0.1Q_2$	B	Flat	Lindbergh	N/A	N/A	N/A

Sizing Factors for Hydromodification Flow Control Biofiltration with Partial Retention and Biofiltration BMPs Designed Using Sizing Factor Method						
Lower Flow Threshold	Soil Group	Slope	Rain Gauge	A	V_1	V_2
$0.1Q_2$	B	Moderate	Lindbergh	N/A	N/A	N/A
$0.1Q_2$	B	Steep	Lindbergh	N/A	N/A	N/A
$0.1Q_2$	C	Flat	Lindbergh	0.145	0.1208	0.0870
$0.1Q_2$	C	Moderate	Lindbergh	0.145	0.1208	0.0870
$0.1Q_2$	C	Steep	Lindbergh	0.120	0.1000	0.0720
$0.1Q_2$	D	Flat	Lindbergh	0.160	0.1333	0.0960
$0.1Q_2$	D	Moderate	Lindbergh	0.160	0.1333	0.0960
$0.1Q_2$	D	Steep	Lindbergh	0.115	0.0958	0.0690
$0.1Q_2$	A	Flat	Oceanside	N/A	N/A	N/A
$0.1Q_2$	A	Moderate	Oceanside	N/A	N/A	N/A
$0.1Q_2$	A	Steep	Oceanside	N/A	N/A	N/A
$0.1Q_2$	B	Flat	Oceanside	N/A	N/A	N/A
$0.1Q_2$	B	Moderate	Oceanside	N/A	N/A	N/A
$0.1Q_2$	B	Steep	Oceanside	N/A	N/A	N/A
$0.1Q_2$	C	Flat	Oceanside	0.130	0.1083	0.0780
$0.1Q_2$	C	Moderate	Oceanside	0.130	0.1083	0.0780
$0.1Q_2$	C	Steep	Oceanside	0.110	0.0917	0.0660
$0.1Q_2$	D	Flat	Oceanside	0.130	0.1083	0.0780
$0.1Q_2$	D	Moderate	Oceanside	0.130	0.1083	0.0780
$0.1Q_2$	D	Steep	Oceanside	0.065	0.0542	0.0390
$0.1Q_2$	A	Flat	L Wohlford	N/A	N/A	N/A
$0.1Q_2$	A	Moderate	L Wohlford	N/A	N/A	N/A
$0.1Q_2$	A	Steep	L Wohlford	N/A	N/A	N/A
$0.1Q_2$	B	Flat	L Wohlford	N/A	N/A	N/A
$0.1Q_2$	B	Moderate	L Wohlford	N/A	N/A	N/A
$0.1Q_2$	B	Steep	L Wohlford	N/A	N/A	N/A
$0.1Q_2$	C	Flat	L Wohlford	0.110	0.0917	0.0660
$0.1Q_2$	C	Moderate	L Wohlford	0.110	0.0917	0.0660
$0.1Q_2$	C	Steep	L Wohlford	0.090	0.0750	0.0540
$0.1Q_2$	D	Flat	L Wohlford	0.100	0.0833	0.0600
$0.1Q_2$	D	Moderate	L Wohlford	0.100	0.0833	0.0600
$0.1Q_2$	D	Steep	L Wohlford	0.075	0.0625	0.0450

Q_2 = 2-year pre-project flow rate based upon partial duration analysis of long-term hourly rainfall records

A = Surface area sizing factor for flow control

V_1 = Surface volume sizing factor for flow control

V_2 = Subsurface volume sizing factor for flow control

Definitions for "N/A"

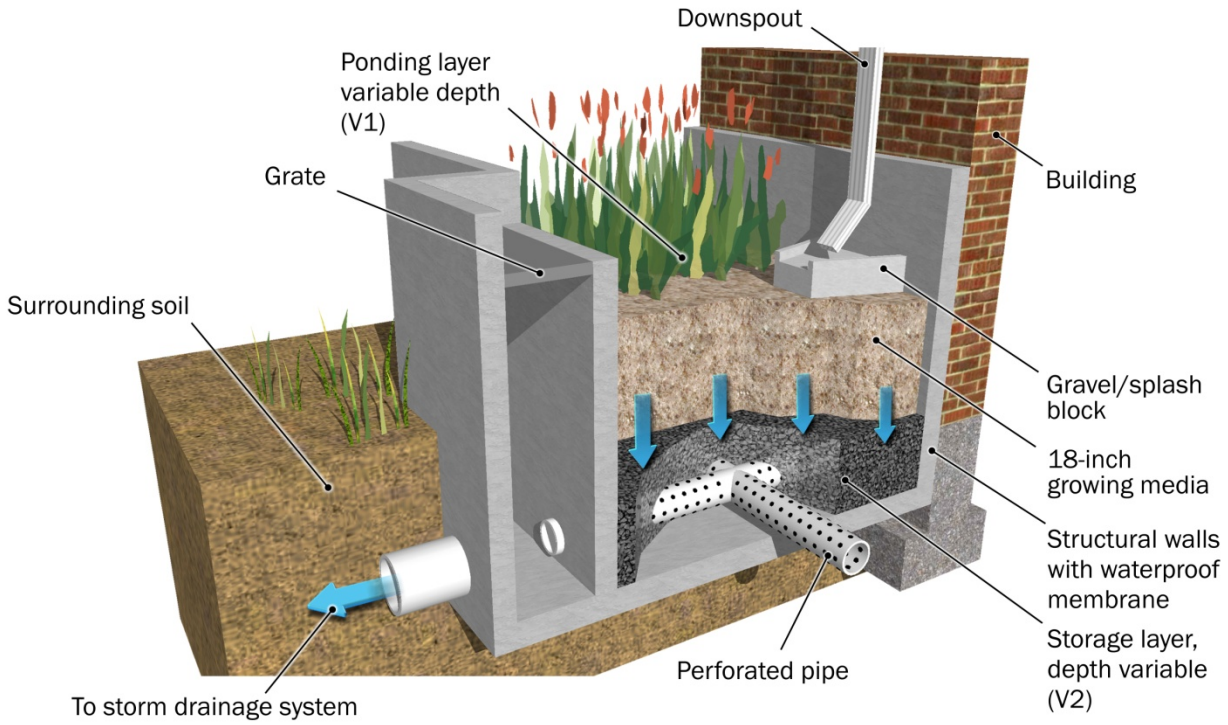
- Soil groups A and B: N/A in all elements (A, V1, V2) for soil groups A and B means sizing factors were not developed for biofiltration (i.e., with an underdrain) for soil groups A and B. If no underdrain is proposed, refer to Appendix G.2.3, Sizing Factors for Bioretention. If an underdrain is proposed, use project-specific continuous simulation modeling.

G.2.5 Sizing Factors for Biofiltration with Impermeable Liner

Table G.2-6 presents sizing factors for calculating the required surface area (A), surface volume (V1), and sub-surface volume (V2) for a biofiltration BMP with impermeable liner (formerly known as flow-through planter). The BMP consists of three layers:

- Ponding layer: 10-inches active storage, [minimum] 2-inches of freeboard above overflow relief
- Growing medium: 18-inches of soil [bioretention soil media]
- Storage layer: 30-inches of gravel at 40 percent porosity [18 inches active storage above underdrain is required, additional dead storage depth below underdrain is optional and can vary]

This BMP includes an underdrain with a low flow orifice 18 inches (1.5 feet) below the bottom of the growing medium. This BMP includes an impermeable liner to prevent infiltration into underlying soils.



Biofiltration with impermeable liner BMP Example Illustration

Reference: "San Diego BMP Sizing Calculator Methodology," prepared by Brown and Caldwell, dated January 2012

How to use the sizing factors for flow control BMP Sizing:

Obtain sizing factors from Table G.2-6 based on the project's lower flow threshold fraction of Q2, hydrologic soil group, pre-development slope, and rain gauge (rainfall basin). Multiply the area tributary to the structural BMP (A, square feet) by the area weighted runoff factor (C, unitless) (see Table G.2-1) by the sizing factors to determine the required surface area (A, square feet), surface volume (V1, cubic feet), and sub-surface volume (V2, cubic feet). Select a low flow orifice for the underdrain that will discharge the lower flow threshold flow when there is 1.5 feet of head over the underdrain orifice. The civil engineer must provide the necessary volume and surface area of the BMP and the underdrain and orifice detail on the plans.

Additional steps to use this BMP as a combined pollutant control and flow control BMP:

To use this BMP as a combined pollutant control and flow control BMP, determine the size using the sizing factors, then refer to Appendix B.5 and Appendix F to check whether the BMP meets performance standards for biofiltration for pollutant control. If necessary, adjust the surface area, depth of growing medium, or depth of storage layer as needed to meet pollutant control standards.

Table G.2-6: Sizing Factors for Hydromodification Flow Control Biofiltration BMPs (formerly known as Flow-Through Planters) Designed Using Sizing Factor Method

Sizing Factors for Hydromodification Flow Control Biofiltration with Impermeable Liner BMPs Designed Using Sizing Factor Method						
Lower Flow Threshold	Soil Group	Slope	Rain Gauge	A	V_1	V_2
$0.5Q_2$	A	Flat	Lindbergh	N/A	N/A	N/A
$0.5Q_2$	A	Moderate	Lindbergh	N/A	N/A	N/A
$0.5Q_2$	A	Steep	Lindbergh	N/A	N/A	N/A
$0.5Q_2$	B	Flat	Lindbergh	N/A	N/A	N/A
$0.5Q_2$	B	Moderate	Lindbergh	N/A	N/A	N/A
$0.5Q_2$	B	Steep	Lindbergh	N/A	N/A	N/A
$0.5Q_2$	C	Flat	Lindbergh	0.115	0.0958	0.0690
$0.5Q_2$	C	Moderate	Lindbergh	0.115	0.0958	0.0690
$0.5Q_2$	C	Steep	Lindbergh	0.080	0.0667	0.0480
$0.5Q_2$	D	Flat	Lindbergh	0.085	0.0708	0.0510
$0.5Q_2$	D	Moderate	Lindbergh	0.085	0.0708	0.0510
$0.5Q_2$	D	Steep	Lindbergh	0.065	0.0542	0.0390
$0.5Q_2$	A	Flat	Oceanside	N/A	N/A	N/A
$0.5Q_2$	A	Moderate	Oceanside	N/A	N/A	N/A
$0.5Q_2$	A	Steep	Oceanside	N/A	N/A	N/A

Sizing Factors for Hydromodification Flow Control Biofiltration with Impermeable Liner BMPs Designed Using Sizing Factor Method						
Lower Flow Threshold	Soil Group	Slope	Rain Gauge	A	V_1	V_2
$0.5Q_2$	B	Flat	Oceanside	N/A	N/A	N/A
$0.5Q_2$	B	Moderate	Oceanside	N/A	N/A	N/A
$0.5Q_2$	B	Steep	Oceanside	N/A	N/A	N/A
$0.5Q_2$	C	Flat	Oceanside	0.075	0.0625	0.0450
$0.5Q_2$	C	Moderate	Oceanside	0.075	0.0625	0.0450
$0.5Q_2$	C	Steep	Oceanside	0.065	0.0542	0.0390
$0.5Q_2$	D	Flat	Oceanside	0.070	0.0583	0.0420
$0.5Q_2$	D	Moderate	Oceanside	0.070	0.0583	0.0420
$0.5Q_2$	D	Steep	Oceanside	0.050	0.0417	0.0300
$0.5Q_2$	A	Flat	L Wohlford	N/A	N/A	N/A
$0.5Q_2$	A	Moderate	L Wohlford	N/A	N/A	N/A
$0.5Q_2$	A	Steep	L Wohlford	N/A	N/A	N/A
$0.5Q_2$	B	Flat	L Wohlford	N/A	N/A	N/A
$0.5Q_2$	B	Moderate	L Wohlford	N/A	N/A	N/A
$0.5Q_2$	B	Steep	L Wohlford	N/A	N/A	N/A
$0.5Q_2$	C	Flat	L Wohlford	0.070	0.0583	0.0420
$0.5Q_2$	C	Moderate	L Wohlford	0.070	0.0583	0.0420
$0.5Q_2$	C	Steep	L Wohlford	0.050	0.0417	0.0300
$0.5Q_2$	D	Flat	L Wohlford	0.055	0.0458	0.0330
$0.5Q_2$	D	Moderate	L Wohlford	0.055	0.0458	0.0330
$0.5Q_2$	D	Steep	L Wohlford	0.045	0.0375	0.0270
$0.3Q_2$	A	Flat	Lindbergh	N/A	N/A	N/A
$0.3Q_2$	A	Moderate	Lindbergh	N/A	N/A	N/A
$0.3Q_2$	A	Steep	Lindbergh	N/A	N/A	N/A
$0.3Q_2$	B	Flat	Lindbergh	N/A	N/A	N/A
$0.3Q_2$	B	Moderate	Lindbergh	N/A	N/A	N/A
$0.3Q_2$	B	Steep	Lindbergh	N/A	N/A	N/A
$0.3Q_2$	C	Flat	Lindbergh	0.130	0.1083	0.0780
$0.3Q_2$	C	Moderate	Lindbergh	0.130	0.1083	0.0780
$0.3Q_2$	C	Steep	Lindbergh	0.100	0.0833	0.0600
$0.3Q_2$	D	Flat	Lindbergh	0.105	0.0875	0.0630
$0.3Q_2$	D	Moderate	Lindbergh	0.105	0.0875	0.0630
$0.3Q_2$	D	Steep	Lindbergh	0.075	0.0625	0.0450

Sizing Factors for Hydromodification Flow Control Biofiltration with Impermeable Liner BMPs Designed Using Sizing Factor Method						
Lower Flow Threshold	Soil Group	Slope	Rain Gauge	A	V_1	V_2
$0.3Q_2$	A	Flat	Oceanside	N/A	N/A	N/A
$0.3Q_2$	A	Moderate	Oceanside	N/A	N/A	N/A
$0.3Q_2$	A	Steep	Oceanside	N/A	N/A	N/A
$0.3Q_2$	B	Flat	Oceanside	N/A	N/A	N/A
$0.3Q_2$	B	Moderate	Oceanside	N/A	N/A	N/A
$0.3Q_2$	B	Steep	Oceanside	N/A	N/A	N/A
$0.3Q_2$	C	Flat	Oceanside	0.105	0.0875	0.0630
$0.3Q_2$	C	Moderate	Oceanside	0.105	0.0875	0.0630
$0.3Q_2$	C	Steep	Oceanside	0.085	0.0708	0.0510
$0.3Q_2$	D	Flat	Oceanside	0.090	0.0750	0.0540
$0.3Q_2$	D	Moderate	Oceanside	0.090	0.0750	0.0540
$0.3Q_2$	D	Steep	Oceanside	0.070	0.0583	0.0420
$0.3Q_2$	A	Flat	L Wohlford	N/A	N/A	N/A
$0.3Q_2$	A	Moderate	L Wohlford	N/A	N/A	N/A
$0.3Q_2$	A	Steep	L Wohlford	N/A	N/A	N/A
$0.3Q_2$	B	Flat	L Wohlford	N/A	N/A	N/A
$0.3Q_2$	B	Moderate	L Wohlford	N/A	N/A	N/A
$0.3Q_2$	B	Steep	L Wohlford	N/A	N/A	N/A
$0.3Q_2$	C	Flat	L Wohlford	0.085	0.0708	0.0510
$0.3Q_2$	C	Moderate	L Wohlford	0.085	0.0708	0.0510
$0.3Q_2$	C	Steep	L Wohlford	0.060	0.0500	0.0360
$0.3Q_2$	D	Flat	L Wohlford	0.065	0.0542	0.0390
$0.3Q_2$	D	Moderate	L Wohlford	0.065	0.0542	0.0390
$0.3Q_2$	D	Steep	L Wohlford	0.050	0.0417	0.0300
$0.1Q_2$	A	Flat	Lindbergh	N/A	N/A	N/A
$0.1Q_2$	A	Moderate	Lindbergh	N/A	N/A	N/A
$0.1Q_2$	A	Steep	Lindbergh	N/A	N/A	N/A
$0.1Q_2$	B	Flat	Lindbergh	N/A	N/A	N/A
$0.1Q_2$	B	Moderate	Lindbergh	N/A	N/A	N/A
$0.1Q_2$	B	Steep	Lindbergh	N/A	N/A	N/A
$0.1Q_2$	C	Flat	Lindbergh	0.250	0.2083	0.1500
$0.1Q_2$	C	Moderate	Lindbergh	0.250	0.2083	0.1500
$0.1Q_2$	C	Steep	Lindbergh	0.185	0.1542	0.1110

Sizing Factors for Hydromodification Flow Control Biofiltration with Impermeable Liner BMPs Designed Using Sizing Factor Method						
Lower Flow Threshold	Soil Group	Slope	Rain Gauge	A	V_1	V_2
$0.1Q_2$	D	Flat	Lindbergh	0.200	0.1667	0.1200
$0.1Q_2$	D	Moderate	Lindbergh	0.200	0.1667	0.1200
$0.1Q_2$	D	Steep	Lindbergh	0.130	0.1083	0.0780
$0.1Q_2$	A	Flat	Oceanside	N/A	N/A	N/A
$0.1Q_2$	A	Moderate	Oceanside	N/A	N/A	N/A
$0.1Q_2$	A	Steep	Oceanside	N/A	N/A	N/A
$0.1Q_2$	B	Flat	Oceanside	N/A	N/A	N/A
$0.1Q_2$	B	Moderate	Oceanside	N/A	N/A	N/A
$0.1Q_2$	B	Steep	Oceanside	N/A	N/A	N/A
$0.1Q_2$	C	Flat	Oceanside	0.190	0.1583	0.1140
$0.1Q_2$	C	Moderate	Oceanside	0.190	0.1583	0.1140
$0.1Q_2$	C	Steep	Oceanside	0.140	0.1167	0.0840
$0.1Q_2$	D	Flat	Oceanside	0.160	0.1333	0.0960
$0.1Q_2$	D	Moderate	Oceanside	0.160	0.1333	0.0960
$0.1Q_2$	D	Steep	Oceanside	0.105	0.0875	0.0630
$0.1Q_2$	A	Flat	L Wohlford	N/A	N/A	N/A
$0.1Q_2$	A	Moderate	L Wohlford	N/A	N/A	N/A
$0.1Q_2$	A	Steep	L Wohlford	N/A	N/A	N/A
$0.1Q_2$	B	Flat	L Wohlford	N/A	N/A	N/A
$0.1Q_2$	B	Moderate	L Wohlford	N/A	N/A	N/A
$0.1Q_2$	B	Steep	L Wohlford	N/A	N/A	N/A
$0.1Q_2$	C	Flat	L Wohlford	0.135	0.1125	0.0810
$0.1Q_2$	C	Moderate	L Wohlford	0.135	0.1125	0.0810
$0.1Q_2$	C	Steep	L Wohlford	0.105	0.0875	0.0630
$0.1Q_2$	D	Flat	L Wohlford	0.110	0.0917	0.0660
$0.1Q_2$	D	Moderate	L Wohlford	0.110	0.0917	0.0660
$0.1Q_2$	D	Steep	L Wohlford	0.080	0.0667	0.0480

Q_2 = 2-year pre-project flow rate based upon partial duration analysis of long-term hourly rainfall records

A = Surface area sizing factor for flow control

V_1 = Surface volume sizing factor for flow control

V_2 = Subsurface volume sizing factor for flow control

Definitions for "N/A"

- Soil groups A and B: N/A in all elements (A, V1, V2) for soil groups A and B means sizing factors were not developed for biofiltration (i.e., with an underdrain) for soil groups A and B. If no underdrain is proposed, refer to Appendix G.2.3, Sizing Factors for Bioretention. If an underdrain is proposed, use project-specific continuous simulation modeling.

G.2.6 Sizing Factors for "Cistern" BMP

Table G.2-7 presents sizing factors for calculating the required volume (V1) for a cistern BMP. In this context, a "cistern" is a detention facility that stores runoff and releases it at a controlled rate. A cistern can be a component of a harvest and use system, however the sizing factor method will not account for any retention occurring in the system. The sizing factors were developed assuming runoff is released from the cistern. The sizing factors presented in this section are to meet the hydromodification management performance standard only. The cistern BMP is based on the following assumptions:

- Cistern configuration: The cistern is modeled as a 4-foot tall vessel. However, designers could use other configurations (different cistern heights), as long as the lower outlet orifice is sized to properly restrict outflows and the minimum required volume is provided.
- Cistern upper outlet: The upper outlet from the cistern would consist of a weir or other flow control structure with the overflow invert set at an elevation of 7/8 of the water height associated with the required volume of the cistern – V1. For the assumed 4-foot water depth in the cistern associated with the sizing factor analysis, the overflow invert is assumed to be located at an elevation of 3.5 feet above the bottom of the cistern. The overflow weir would be sized to pass the peak design flow based on the tributary drainage area.

How to use the sizing factors:

Obtain sizing factors from Table G.2-7 based on the project's lower flow threshold fraction of Q_2, hydrologic soil group, pre-development slope, and rain gauge (rainfall basin). Multiply the area tributary to the structural BMP (A, square feet) by the area weighted runoff factor (C, unitless) (see Table G.2-1) by the sizing factors to determine the required volume (V_1, cubic feet). Select a low flow orifice that will discharge the lower flow threshold flow when there is 4 feet of head over the lower outlet orifice (or adjusted head as appropriate if the cistern configuration is not 4 feet tall). The civil engineer must provide the necessary volume of the BMP and the lower outlet orifice detail on the plans.

Additional steps to use this BMP as a combined pollutant control and flow control BMP:

A cistern could be a component of a full retention, partial retention, or no retention BMP depending on how the outflow is disposed. However use of the sizing factor method for design of the cistern in a combined pollutant control and flow control system is not recommended. The sizing factor method for designing a cistern does not account for any retention or storage occurring in BMPs combined with the cistern (i.e., cistern sized using sizing factors may be larger than necessary because sizing factor method does not recognize volume losses occurring in other elements of a combined system). Furthermore when the cistern is designed using the sizing factor method, the cistern outflow must be set to the low flow threshold flow for the drainage area, which may be inconsistent with requirements for other elements of a combined system. To optimize a system in

which a cistern provides temporary storage for runoff to be either used onsite (harvest and use), infiltrated, or biofiltered, project-specific continuous simulation modeling is recommended. Refer to Sections 5.6 and 6.3.6.

Table G.2-7: Sizing Factors for Hydromodification Flow Control Cistern Facilities Designed Using Sizing Factor Method

Sizing Factors for Hydromodification Flow Control Cistern Facilities Designed Using Sizing Factor Method						
Lower Flow Threshold	Soil Group	Slope	Rain Gauge	A	V_1	V_2
$0.5Q_2$	A	Flat	Lindbergh	N/A	0.1200	N/A
$0.5Q_2$	A	Moderate	Lindbergh	N/A	0.1000	N/A
$0.5Q_2$	A	Steep	Lindbergh	N/A	0.1000	N/A
$0.5Q_2$	B	Flat	Lindbergh	N/A	0.3900	N/A
$0.5Q_2$	B	Moderate	Lindbergh	N/A	0.2000	N/A
$0.5Q_2$	B	Steep	Lindbergh	N/A	0.1200	N/A
$0.5Q_2$	C	Flat	Lindbergh	N/A	0.1200	N/A
$0.5Q_2$	C	Moderate	Lindbergh	N/A	0.1200	N/A
$0.5Q_2$	C	Steep	Lindbergh	N/A	0.1000	N/A
$0.5Q_2$	D	Flat	Lindbergh	N/A	0.1000	N/A
$0.5Q_2$	D	Moderate	Lindbergh	N/A	0.1000	N/A
$0.5Q_2$	D	Steep	Lindbergh	N/A	0.0800	N/A
$0.5Q_2$	A	Flat	Oceanside	N/A	0.1600	N/A
$0.5Q_2$	A	Moderate	Oceanside	N/A	0.1400	N/A
$0.5Q_2$	A	Steep	Oceanside	N/A	0.1200	N/A
$0.5Q_2$	B	Flat	Oceanside	N/A	0.1900	N/A
$0.5Q_2$	B	Moderate	Oceanside	N/A	0.1600	N/A
$0.5Q_2$	B	Steep	Oceanside	N/A	0.1400	N/A
$0.5Q_2$	C	Flat	Oceanside	N/A	0.1400	N/A
$0.5Q_2$	C	Moderate	Oceanside	N/A	0.1400	N/A
$0.5Q_2$	C	Steep	Oceanside	N/A	0.1200	N/A
$0.5Q_2$	D	Flat	Oceanside	N/A	0.1200	N/A
$0.5Q_2$	D	Moderate	Oceanside	N/A	0.1200	N/A
$0.5Q_2$	D	Steep	Oceanside	N/A	0.1000	N/A
$0.5Q_2$	A	Flat	L Wohlford	N/A	0.1800	N/A
$0.5Q_2$	A	Moderate	L Wohlford	N/A	0.1400	N/A
$0.5Q_2$	A	Steep	L Wohlford	N/A	0.0800	N/A
$0.5Q_2$	B	Flat	L Wohlford	N/A	0.2100	N/A
$0.5Q_2$	B	Moderate	L Wohlford	N/A	0.2000	N/A

Sizing Factors for Hydromodification Flow Control Cistern Facilities Designed Using Sizing Factor Method						
Lower Flow Threshold	Soil Group	Slope	Rain Gauge	A	V_1	V_2
$0.5Q_2$	B	Steep	L Wohlford	N/A	0.1400	N/A
$0.5Q_2$	C	Flat	L Wohlford	N/A	0.1400	N/A
$0.5Q_2$	C	Moderate	L Wohlford	N/A	0.1400	N/A
$0.5Q_2$	C	Steep	L Wohlford	N/A	0.1000	N/A
$0.5Q_2$	D	Flat	L Wohlford	N/A	0.1000	N/A
$0.5Q_2$	D	Moderate	L Wohlford	N/A	0.1000	N/A
$0.5Q_2$	D	Steep	L Wohlford	N/A	0.0800	N/A
$0.3Q_2$	A	Flat	Lindbergh	N/A	0.1200	N/A
$0.3Q_2$	A	Moderate	Lindbergh	N/A	0.1000	N/A
$0.3Q_2$	A	Steep	Lindbergh	N/A	0.1000	N/A
$0.3Q_2$	B	Flat	Lindbergh	N/A	0.5900	N/A
$0.3Q_2$	B	Moderate	Lindbergh	N/A	0.3600	N/A
$0.3Q_2$	B	Steep	Lindbergh	N/A	0.1800	N/A
$0.3Q_2$	C	Flat	Lindbergh	N/A	0.1800	N/A
$0.3Q_2$	C	Moderate	Lindbergh	N/A	0.1800	N/A
$0.3Q_2$	C	Steep	Lindbergh	N/A	0.1400	N/A
$0.3Q_2$	D	Flat	Lindbergh	N/A	0.1400	N/A
$0.3Q_2$	D	Moderate	Lindbergh	N/A	0.1400	N/A
$0.3Q_2$	D	Steep	Lindbergh	N/A	0.0800	N/A
$0.3Q_2$	A	Flat	Oceanside	N/A	0.1600	N/A
$0.3Q_2$	A	Moderate	Oceanside	N/A	0.1400	N/A
$0.3Q_2$	A	Steep	Oceanside	N/A	0.1200	N/A
$0.3Q_2$	B	Flat	Oceanside	N/A	0.2200	N/A
$0.3Q_2$	B	Moderate	Oceanside	N/A	0.1800	N/A
$0.3Q_2$	B	Steep	Oceanside	N/A	0.1600	N/A
$0.3Q_2$	C	Flat	Oceanside	N/A	0.1600	N/A
$0.3Q_2$	C	Moderate	Oceanside	N/A	0.1600	N/A
$0.3Q_2$	C	Steep	Oceanside	N/A	0.1400	N/A
$0.3Q_2$	D	Flat	Oceanside	N/A	0.1400	N/A
$0.3Q_2$	D	Moderate	Oceanside	N/A	0.1400	N/A
$0.3Q_2$	D	Steep	Oceanside	N/A	0.1200	N/A
$0.3Q_2$	A	Flat	L Wohlford	N/A	0.1800	N/A
$0.3Q_2$	A	Moderate	L Wohlford	N/A	0.1400	N/A
$0.3Q_2$	A	Steep	L Wohlford	N/A	0.0800	N/A

Sizing Factors for Hydromodification Flow Control Cistern Facilities Designed Using Sizing Factor Method						
Lower Flow Threshold	Soil Group	Slope	Rain Gauge	A	V_1	V_2
$0.3Q_2$	B	Flat	L Wohlford	N/A	0.2600	N/A
$0.3Q_2$	B	Moderate	L Wohlford	N/A	0.2400	N/A
$0.3Q_2$	B	Steep	L Wohlford	N/A	0.1800	N/A
$0.3Q_2$	C	Flat	L Wohlford	N/A	0.1800	N/A
$0.3Q_2$	C	Moderate	L Wohlford	N/A	0.1800	N/A
$0.3Q_2$	C	Steep	L Wohlford	N/A	0.1400	N/A
$0.3Q_2$	D	Flat	L Wohlford	N/A	0.1400	N/A
$0.3Q_2$	D	Moderate	L Wohlford	N/A	0.1400	N/A
$0.3Q_2$	D	Steep	L Wohlford	N/A	0.1000	N/A
$0.1Q_2$	A	Flat	Lindbergh	N/A	0.1200	N/A
$0.1Q_2$	A	Moderate	Lindbergh	N/A	0.1000	N/A
$0.1Q_2$	A	Steep	Lindbergh	N/A	0.1000	N/A
$0.1Q_2$	B	Flat	Lindbergh	N/A	0.5400	N/A
$0.1Q_2$	B	Moderate	Lindbergh	N/A	0.7800	N/A
$0.1Q_2$	B	Steep	Lindbergh	N/A	0.3400	N/A
$0.1Q_2$	C	Flat	Lindbergh	N/A	0.3600	N/A
$0.1Q_2$	C	Moderate	Lindbergh	N/A	0.3600	N/A
$0.1Q_2$	C	Steep	Lindbergh	N/A	0.2400	N/A
$0.1Q_2$	D	Flat	Lindbergh	N/A	0.2600	N/A
$0.1Q_2$	D	Moderate	Lindbergh	N/A	0.2600	N/A
$0.1Q_2$	D	Steep	Lindbergh	N/A	0.1600	N/A
$0.1Q_2$	A	Flat	Oceanside	N/A	0.1600	N/A
$0.1Q_2$	A	Moderate	Oceanside	N/A	0.1400	N/A
$0.1Q_2$	A	Steep	Oceanside	N/A	0.1200	N/A
$0.1Q_2$	B	Flat	Oceanside	N/A	0.5100	N/A
$0.1Q_2$	B	Moderate	Oceanside	N/A	0.3400	N/A
$0.1Q_2$	B	Steep	Oceanside	N/A	0.2400	N/A
$0.1Q_2$	C	Flat	Oceanside	N/A	0.2600	N/A
$0.1Q_2$	C	Moderate	Oceanside	N/A	0.2600	N/A
$0.1Q_2$	C	Steep	Oceanside	N/A	0.2000	N/A
$0.1Q_2$	D	Flat	Oceanside	N/A	0.2000	N/A
$0.1Q_2$	D	Moderate	Oceanside	N/A	0.2000	N/A
$0.1Q_2$	D	Steep	Oceanside	N/A	0.1800	N/A
$0.1Q_2$	A	Flat	L Wohlford	N/A	0.1800	N/A

Sizing Factors for Hydromodification Flow Control Cistern Facilities Designed Using Sizing Factor Method						
Lower Flow Threshold	Soil Group	Slope	Rain Gauge	A	V_1	V_2
$0.1Q_2$	A	Moderate	L Wohlford	N/A	0.1400	N/A
$0.1Q_2$	A	Steep	L Wohlford	N/A	0.0800	N/A
$0.1Q_2$	B	Flat	L Wohlford	N/A	0.4400	N/A
$0.1Q_2$	B	Moderate	L Wohlford	N/A	0.4000	N/A
$0.1Q_2$	B	Steep	L Wohlford	N/A	0.3200	N/A
$0.1Q_2$	C	Flat	L Wohlford	N/A	0.3200	N/A
$0.1Q_2$	C	Moderate	L Wohlford	N/A	0.3200	N/A
$0.1Q_2$	C	Steep	L Wohlford	N/A	0.2200	N/A
$0.1Q_2$	D	Flat	L Wohlford	N/A	0.2400	N/A
$0.1Q_2$	D	Moderate	L Wohlford	N/A	0.2400	N/A
$0.1Q_2$	D	Steep	L Wohlford	N/A	0.1800	N/A

Q_2 = 2-year pre-project flow rate based upon partial duration analysis of long-term hourly rainfall records
A = Bioretention surface area sizing factor (not applicable under this manual standards – use methods presented in Chapter 5 and Appendix B or Appendix F to size bioretention or biofiltration facility for pollutant control)
V_1 = Cistern volume sizing factor

Definitions for "N/A"

- Column V2: N/A in column V2 means there is no V2 element in the cistern BMP
- Column A: N/A in column A means there is no A element in the cistern BMP. Note sizing factors previously created for sizing a bioretention or biofiltration facility downstream of a cistern under the 2007 MS4 Permit are not applicable under the MS4 Permit.

Appendix

H

Guidance for Investigating Potential Critical Coarse Sediment Yield Areas

February 26, 2016

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Appendix H Guidance for Investigating Potential Critical Coarse Sediment Yield Areas

The following guidance provides methodologies for protecting CCSYAs:

H.1. Step 1: Identify CCSYAs
H.2. Step 2: Avoidance of Onsite CCSYAs
H.3. Step 3: Bypass Onsite and Upstream CCSYAs
H.4. Step 4: Demonstrate No Net Impact
H.5. References
H.6. PCCSYAs: Regional WMAA Maps
H.7. PCCSYAs: Refinement Options
H.8. Calculation Methodology for Ep and Sp
H.9. Mitigation Measures Fact Sheets

H.1 Step 1: Identify CCSYAs

A CCSYA is an active or potential source of bed sediment to downstream channel reaches. When a Priority Development Project (PDP) is constructed, it has the potential to negatively impact characteristics of sediment supply and delivery which can lead to degradation of receiving waters. In order to prevent these impacts, PDP applicants must examine the tributary areas delineated in the project's storm water management plans and identify sources of critical coarse sediment within the following locations:

- **Onsite CCSYAs**: CCSYAs identified within the project's property boundary as indicated in the SWQMP. Refer to Section 1.3 for defining a project.
- **Upstream CCSYAs**: CCSYAs identified within the drainage area draining through the project's property boundary as indicated in the SWQMP. Refer to Section 1.3 for defining a project.

Applicants must first identify potential critical coarse sediment yield areas (PCCSYAs) using one of the methods presented in Appendix H.1.1. Once these PCCSYAs are identified, applicants may either accept the PCCSYA mapping as final, or may elect to further refine the results of the mapping through consideration of the refinement methods outlined in Appendix H.1.2. At the end of Step 1, applicants will have identified CCSYAs that must be avoided and bypassed by the project.

H.1.1 Identification Methods

As outlined on the following pages, applicants have two available options to identify PCCSYAs; (1) the RPO Method, and (2) the WMAA Method.

H.1.1.1 RPO Method

The County of San Diego has performed a jurisdictional analysis demonstrating that, in most cases, enforcement of the existing Resource Protection Ordinance (RPO) effectively preserves sources critical coarse sediment within the Unincorporated County of San Diego. This correlation between critical coarse sediment and lands that are currently protected through existing ordinances typically makes it more feasible for a development project to satisfy critical coarse sediment criteria. As outlined below, the process for identifying onsite sources of critical coarse sediment through the RPO Method may vary with respect to the project scenario, while the process for identifying upstream PCCSYAs through the RPO Method is identical for all project types.

Identification of Onsite PCCSYAs

- **Scenario 1:** PDP is subject to and in compliance with RPO requirements (without utilization of RPO exemptions 86.604(e)(2)(cc) or 86.604(e)(3) that result in impacts to more than 15% of the project-scale CCSYAs).
    - Applicant must identify onsite PCCSYAs as areas that are coarse grained[24], ≥25% slope, and ≥50' in height.
- **Scenario 2:** PDP is entirely exempt/not subject to RPO requirements without utilization of exemptions 86.604(e)(2)(cc) or 86.604(e)(3).
    - Applicant has no obligation to identify and/or avoid onsite critical coarse sediment.
- **Scenario 3:** PDP utilizes exemption(s) via RPO Section 86.604(e)(2)(cc) or 86.604(e)(3) and impacts more than 15% of the project-scale CCSYAs.
    - Applicant is not permitted to use the RPO Method to identify sources of critical coarse sediment. Applicant must instead demonstrate no net impact through utilization of Appendix H.4 of this guidance.

Identification of Upstream PCCSYAs

- **All Scenarios:** All PDP applicants must identify upstream[25] PCCSYAs that drain through their project site as areas that are coarse grained, ≥25% slope and ≥50' in height.

[24] Refer to Table H.6-1 for a list of geologic units that are anticipated to produce coarse grained sediment.

[25] If an applicant can demonstrate that the entire upstream boundary incorporates drainage elements that bypass the 2 year 24 hour flow rate at a peak velocity of 3 fps, then identification of upstream sources may be omitted from the analysis.

H.1.1.2 WMAA Mapping Method

It is anticipated that most applicants will elect to identify critical coarse sediment yield areas through the RPO Method presented in the section above; however, applicants are not expressly forbidden from utilizing the Watershed Management Area Analysis PCCSYA maps that were developed through previous regional analysis. Applicants electing to pursue this alternate method must identify onsite and/or upstream sources of critical coarse sediment through examination of the PCCSYA maps provided in Appendix H.6.

H.1.2 Refinement Options

After identifying PCCSYAs using one of the methods above, the applicant may either accept the PCCSYA mapping as final, or may elect to further refine the results of the mapping through consideration of one or more of the refinement methods outlined below.

H.1.2.1 Depositional Analysis

Areas identified as PCCSYAs may be removed from consideration if it is demonstrated that these sources are deposited into existing systems prior to reaching the first downstream unlined water of the state. Systems resulting in deposition may include existing natural sinks, existing structural BMPs, existing hardened MS4 systems, or other existing similar features that produce a peak velocity from the discrete 2-year, 24 hour runoff event of less than three feet per second in the system being analyzed. Applicants electing to perform depositional analysis to refine PCCSYA mapping must refer to the detailed guidance provided in Appendix H.7.1.

H.1.2.2 Threshold Channel Analysis

Areas identified as PCCSYAs may be removed from consideration if they discharge to a "threshold channel" that does not exhibit characteristics associated with significant bed load movement during design flows. Applicants electing to perform threshold channel analysis to refine PCCSYA mapping must refer to the detailed guidance provided in Appendix H.7.2.

H.1.2.3 Coarse Sediment Source Area Verification

Areas identified as PCCSYAs may be removed from consideration if an applicant demonstrates that these areas actually consist of fine grained sediment. Applicants electing to perform coarse sediment source area verification to refine PCCSYA mapping must refer to the detailed guidance provided in Appendix H.7.3.

H.1.2.4 Verification of Geomorphic Landscape Units (GLUs)

If an applicant has identified sources of critical coarse sediment via the alternate WMAA Method discussed in Appendix H.1.1, PCCSYAs mapping may be refined through verification of GLUs. If this method is used, applicants must refer to detailed guidance provided in Appendix H.6.1.

H.2 Step 2: Avoidance of Onsite CCSYAs

A key element of preserving the stability of receiving waters is to avoid changes in bed sediment supply by avoiding development on CCSYAs. Avoidance is best achieved through proper site design. The following are some potential strategies that should be considered while determining the site layout to avoid CCSYAs:

- The civil engineer shall designate onsite CCSYAs that are to be avoided (undisturbed) for the purpose of preserving coarse soil supply. When feasible, use and/or access restriction should be established for these areas.
- Minimize new impervious footprint. Refer to SD-3 in Chapter 4 for guidance on minimizing impervious footprint.

If onsite CCSYAs are not avoided per the metrics defined below, the applicant must demonstrate no net impact to the receiving water using guidance in Appendix H.4.

H.2.1 Avoidance Metrics

H.2.1.1 RPO Method

Avoidance of onsite CCSYA does not always mean that 100% of the CCSYAs must be avoided. Applicants that have identified CCSYAs using the RPO Method are typically permitted to encroach anywhere from 10-20% into the onsite CCSYAs that were determined in Step 1. This onsite encroachment is permitted through the existing RPO enforcement mechanism, which allows each lot within a project to encroach into steep slope areas anywhere from 10-20% depending on the percentage of the lot that is comprised of steep slopes. For example, a lot comprised of less than 75% steep slopes is typically permitted a 10% encroachment while a lot comprised of 100% steep slopes is typically permitted a 20% encroachment.

In some instances, a project (or portions of a project) may be exempted from RPO requirements such that encroachments beyond 10-20% may be permitted. Utilization of specific RPO exemptions 86.604(e)(2)(cc) or 86.604(e)(3) will require an applicant to translate conventional lot-level impact values into a single project-level impact value for analysis.

As outlined below, the metric for avoiding impacts to onsite sources of critical coarse sediment through the RPO Method may vary with respect to the project scenario

Avoidance of Onsite CCSYAs

- **Scenario 1:** PDP is subject to and in compliance with RPO requirements (without utilization of RPO exemptions 86.604(e)(2)(cc) or 86.604(e)(3) that result in impacts to more than 15% of the project-scale CCSYAs).
    - Applicant demonstrates avoidance of onsite critical coarse sediment by simply complying with existing RPO encroachment allowances.
- **Scenario 2:** PDP is entirely exempt/not subject to RPO requirements without utilization of exemptions 86.604(e)(2)(cc) or 86.604(e)(3).
    - Applicant has no obligation to identify and/or avoid onsite critical coarse sediment.
- **Scenario 3:** PDP utilizes exemption(s) via RPO Section 86.604(e)(2)(cc) or 86.604(e)(3) and impacts more than 15% of the project-scale CCSYAs.
    - Applicant is not permitted to use the RPO Method to demonstrate avoidance of critical coarse sediment. Applicant must instead demonstrate no net impact through utilization of Appendix H.4 of this guidance.

Avoidance of Upstream CCSYAs

- **All Scenarios:** Upstream CCSYAs must be bypassed per criteria presented in Section H.3 of this guidance.

H.2.1.2 WMAA Mapping Method

If the applicant has identified onsite CCSYAs using the WMAA Mapping Method, encroachments of up to 5% into the onsite CCSYAs may be permitted.

H.3 Step 3: Bypass Onsite and Upstream CCSYAs

Another key element of preserving the stability of receiving waters is to maintain current bed sediment supply characteristics through effective bypass of onsite and upstream sediment sources. Upstream bed sediment sources may include overland flow from CCSYAs and/or concentrated channel flows. Applicants must ensure both onsite and upstream sources of bed sediment are effectively bypassed through their project. If onsite and/or upstream CCSYAs are not effectively bypassed per the criteria below, applicant must demonstrate no net impact to the receiving water per the guidance presented in Appendix H.4.

H.3.1 Bypass CCSYAs from Hillslopes

Both onsite and upstream hillslopes mapped as CCSYAs must be effectively bypassed through and/or around the proposed project site.

- Proposed hardened drainage systems (e.g. storm drains, drainage ditches) that convey the bed sediment from the hillslopes to the downstream waters of the state should maintain a peak velocity from the discrete 2-year, 24-hour runoff event greater than three feet per second.
    - When drainage ditches are proposed for bypass, this velocity may be achieved by designing to the minimum dimensions listed in the San Diego Regional Standard drawing D-75.
    - When an 18" concrete storm drain is proposed for bypass, this velocity may typically be achieved by maintaining a storm drain slope of ≥0.5%. In instances where 2 year, 24-hour peak flow rates associated with the storm drain are less than 1.1 cfs, applicants may refer to the table below for minimum slopes needed to maintain three feet per second. Applicants may interpolate the values from the table below, or may elect to perform more detailed cleansing velocity calculations presented in Appendix H.7.1.

2-Year, 24-Hour Peak Flow (cfs)	Minimum Slope for 18" Concrete Storm Drain
<0.25	n/a, this PCCSYA is considered de-minimis
0.25	2.0%
0.50	1.0%
1.10	0.5%

- Storm water runoff that contains the bed sediment from CCSYAs must not be routed through detention basins or other facilities with restricted outlets that will trap sediment. Bypass systems shall be designed as necessary so that the bed material is conveyed to the downstream receiving water. Structural BMPs (including most flow-thru BMPs) are likely to trap sediment.
- For scenarios where a BMP must be constructed to treat offsite drainage area and there are CCSYAs outside of the project footprint, it may be feasible to achieve mitigation by construction of an outlet structure that can convey the bed load to the downstream receiving water and clear water through a bypass structure to a BMP.
- Proposed crossings (culverts, driveways, etc.) should not impede the transport of upstream critical coarse sediment. Crossings should be designed to avoid headwater conditions that would result in the trapping/settling of sediment.

H.3.2 Bypass CCSYAs from Channels

Projects that effectively avoid and bypass CCSYAs mapped in Step 1 of this guidance are not required to take specific action to ensure bypass of channel flows. This guidance does not set forth channel bypass criteria for this scenario because it recognizes that existing regulator mechanisms (such as 401 certifications, site design requirements, etc) are generally sufficient to preserve the sediment transport functions of onsite channels.

However, projects that do not effectively avoid and bypass the CCSYAs mapped in Step 1, will be required to specifically account for bypass of channel flows as part of the demonstration of no net impact outlined in Appendix H.4.

H.3.3 De Minimis Upstream CCSYA

Applicants have an option to exclude de minimis upstream CCSYAs. De minimis upstream CCSYAs consist of coarse hillslope areas that are not significant contributors of bed sediment yield due to their small size, and are considered by the owner and County as not practicable to bypass to the downstream waters of the state. In limited scenarios where all of the criteria below are satisfied, de minimis upstream CCSYAs may be omitted from consideration.

- De minimis upstream CCSYA is not disturbed through the proposed project activities.
- De minimis upstream CCSYA is not part of an upstream drainage contributing more than 0.31 total acres to the project site.
- Multiple de minimis upstream CCSYAs cannot be adjacent to each other and hydraulically connected.
- The SWQMP must document the reason why each de minimis upstream CCSYA could not be bypassed to the downstream waters of the state.

The 0.31-acre (13,500 square feet) de minimis threshold was established using 0.25 cfs as the cut off peak flow for the 2-year, 24-hour event, rational method equation and the following assumptions:

- C = 0.225 (average runoff coefficient (C) for soil type A and B);
- Average 6-hour, 2-year storm depth = 1.5 inches;
- Time of concentration = 6 minutes; and
- 2-year peak intensity = 3.51 in/hr. (based on procedures from the County Hydrology Manual).

The strategies for sediment bypass do not mitigate for the reduction of CCSYA that have been replaced by development onsite but can only mitigate scenarios where development hinders movement of bed sediment through the project footprint. When preservation of existing channels and/or implementation of sediment bypass measures is not feasible and/or not implemented, the applicant must demonstrate no net impact to the receiving water via the guidance presented in Appendix H.4.

H.4 Step 4: Demonstrate No Net Impact

When impacts to CCSYAs cannot be avoided or effectively bypassed, the applicant must demonstrate that their project generates no net impact to the receiving water per the performance metrics identified herein.

- **Appendix H.4.1** provides background on the state of the current science for predicting hydromodification impacts due to reductions in sediment supply;
- **Appendix H.4.2** defines the management standard that will be the basis for evaluating whether "no net impact to the receiving water" is achieved;
- **Appendix H.4.3** identifies the type of mitigation measures (i.e., additional flow control, stream rehabilitation, and applicant proposed mitigation measures) that can be used to meet the management standard;
- **Appendix H.8** provides the methodology for calculation of Erosion Potential (Ep) and Sediment Supply Potential (Sp); and
- **Appendix H.9** provides fact sheets for implementation of the mitigation measures.

H.4.1 Background

Channel form, by definition, is composed of bed and bank material as well as channel geometry (in plan, cross-section, and profile); however, the dominant forces typically controlling channel form are discharge and sediment supply (notably bed material) since a stream's most basic function is to convey water and sediment (Knighton, 1998). The interaction between form and function is qualitatively described through Lane's relationship:

$$Q_s \times d \propto Q_w \times S$$ Equation H.4.1

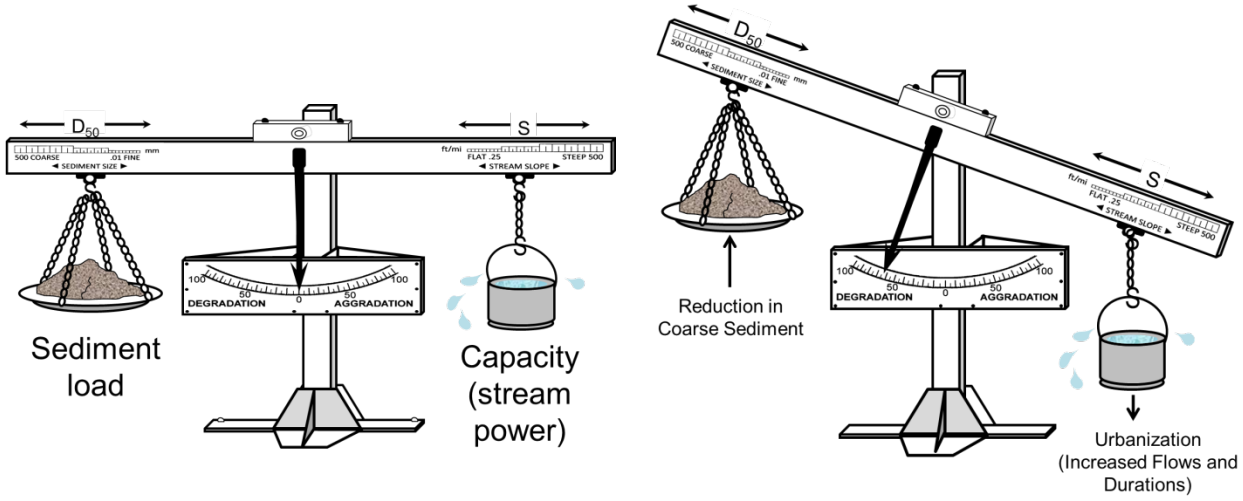
Where Q_s = Sediment discharge
d = Particle diameter or size of sediment
Q_w = Streamflow
S = Stream slope

Lane's relationship qualitatively states that the sediment load (size and volume of sediment), which is the first half of the relationship, is proportional to the stream power (volume of runoff and slope) which is represented by the second half of the relationship. The sediment discharge (Q_s) in the relationship is the coarser part of sediment load, referred to as the "bed sediment", since this is the part of the load which largely molds the bed formation (Lane, 1955). Lane's relationship (Equation H.4.1) cannot be used for quantitative calculations since the proportionality is not necessarily linear.

For a stream at equilibrium, Lane's relationship states that if one of the variables changes and the other variables do not change proportionately, then the stream channel is no longer in equilibrium.

Sediment load and stream power can change considerably during and following new development, leading to changes in the equilibrium state of the receiving channel.

- Typically, sediment load increases during the construction period, due to the additional exposure of bare soil during the grading and construction process, and before landscaping vegetation has stabilized the soil. This is regulated through the construction-phase BMP requirements established by the Construction General Permit and/or the MS4 Permit.
- Following the construction period, sediment load typically decreases to below pre-development levels, as less sediment is available from areas that have been paved or stabilized by landscape vegetation. When this decrease is not regulated, the bed sediment supplied to the stream (first half of the relationship) is reduced and the sediment transport capacity (stream power) is increased due to increased flows and durations resulting from the addition of impervious areas (second half of the relationship). This may result in degradation of the stream system as illustrated in **Figure H.4-1**.



Stream in equilibrium

Post-construction condition with no flow control and/or sediment supply regulations

Schematics credit: SCCWRP

Figure H.4-1 Illustration of Lane's Relationship

Lane's relationship is useful for making qualitative predictions concerning channel impacts due to changes in runoff and/or sediment loads from the watershed. Although this qualitative assessment is useful for understanding how the watershed responds to development, quantitative predictions are valuable for determining the magnitude of response and they can inform the identification of locations where the greatest management attention should be invested.

Lane's relationship can be supplemented by the use of quantitative predictions which allow the evaluation of the stream under changing conditions. Quantitative predictions will include bed sediment supply calculations for the first half of the Lane relationship, and bed sediment transport capacity calculations for the second half of the Lane relationship. Imbalances between the bed sediment supply rate and transport capacity determines the rate of sediment deposition or erosion in the channel and the associated channel change (Wilcock et al., 2009).

The common practice is to use the Erosion Potential (Ep) metric to evaluate the changes in sediment transport capacity and the Sediment Supply Potential (Sp) metric to evaluate the changes in bed sediment supply for susceptible receiving channels of concern. In regards to Ep metric,

- SCCWRP Technical Report 667 (SCCWRP, 2012) states:

  "The underlying premise of the erosion potential approach advances the concept of flow duration control by addressing in-stream processes related to sediment transport. An erosion potential calculation combines flow parameters with stream geometry to assess long term (decadal) changes in the sediment transport capacity. The cumulative distribution of shear stress, specific stream power and sediment transport capacity across the entire range of relevant flows can be calculated and expressed using an erosion potential metric, Ep."

- SCCWRP Technical Report 753 (SCCWRP, 2013) states the following based on review of field measurements from 61 sites in Southern California:

  "Results indicate that channel enlargement is highly dependent on the ratio of post- to pre-urban sediment-transport capacity over cumulative duration simulations of 25 years (load ratio, a.k.a. erosion potential), which explained nearly 60% of the variance."

For the purposes of implementing mitigation measures within the MS4-permitted region of the County of San Diego: this manual defines Ep as the ratio of post-project/pre-development (natural) long-term transport capacity or work; and Sp as the ratio of post-project/pre-project (existing) long-term bed sediment supply. Guidance for calculating Ep and Sp are provided in Appendix H.8.

H.4.2 Management Standard

This guidance defines a sediment supply management standard through which no net impact to receiving water can be quantitatively indicated. This management standard is demonstrated through the Net Impact Index (NII), a dimensionless index that must be used by the applicant to evaluate if there is, or is not, a net impact to the receiving water. NII is defined in this manual as the ratio of Ep to Sp. Mitigation measures shall be designed to meet the NII management standard shown in Equation H.4.2 to achieve no net impact to the receiving water. The NII management standard is based on Lane's relationship (Ep is directly proportional to Sp) and an allowance of 10% (based on Appendix H.4.2.1). This represents the most appropriate current understanding of how to quantitatively account for sediment supply changes without replacing bed sediment sources (Palhegyi and Rathfelder, 2007 and Parra, 2015).

$$NII = \frac{Ep}{Sp} \leq 1.1$$ Equation H.4.2

If NII ≤ 1.1, then the project produces no net impact to the receiving water in terms of coarse sediment yield, and no further analysis is required. If NII > 1.1, then the project generates an impact on the receiving water and the project is required to implement mitigation measures defined in Appendix H.4.3 such that the NII is reduced to a compliant value (NII ≤ 1.1).

H.4.2.1 Allowance to the NII Management Standard

This manual establishes the NII defined in Appendix H.4.2 as the management standard for coarse sediment supply. The 10% allowance to the management standard is supported by the following research studies or projects:

- The authors of the USACE report for channel design (USACE, 2001) state that, "achieving an optimum Capacity-Supply Ratio, within 10 percent of unity, should ensure dynamic stability while allowing the river itself to recover some of the fluvial detail that cannot be engineered."
- The authors of SCCWRP Technical Report 605 (SCCWRP, 2010), "anticipate that changes of less than 10% in either driver [discharge or sediment flux] are unlikely to instigate, on their own, significant channel changes. This value is a conservative estimate of the year-to-year variability in either discharge or sediment flux that can be accommodated by a channel system in a state of dynamic equilibrium."
- Sediment transport and supply measurements and calculations are inherently inexact. Discrepancies of up to 10% should not be a source of concern (PCR et al., 2002).

H.4.3 Types of Mitigation Measures

The following text discusses mitigation measures that may be used by the applicant to meet the NII management standard defined in Appendix H.4.2. These include:

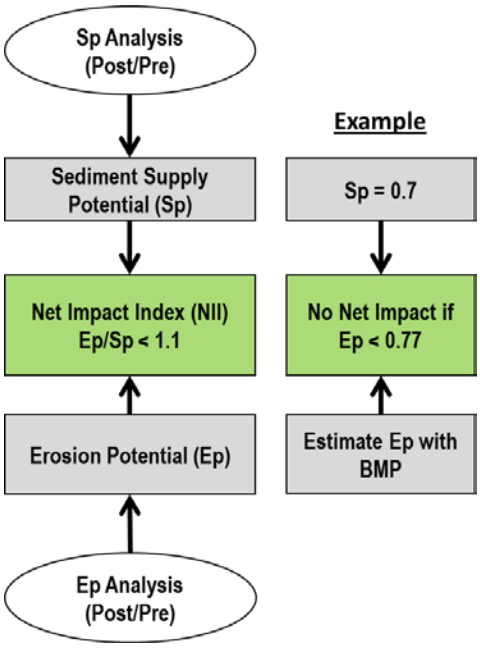
- Additional Flow Control;
- Stream Rehabilitation; and
- Applicant Proposed Mitigation Measures

Appendix H.9 provides additional guidance for implementation of these mitigation measures.

H.4.3.1 Additional Flow Control

One option for managing bed sediment supply reductions is to provide additional detention and retention of site runoff to compensate for the reduction of bed sediment supply. This measure requires increasing flow attenuation by adding storage volume in structural BMPs. This management

option accounts for changes in hydrology, channel geometry, and bed/bank material, but not sediment supply. For example, if there is a 30% reduction in bed-load due to proposed urbanization, then the sediment supply potential (Sp) equals 0.7. Assuming the appropriate range is +10%, hydromodification controls can be sized and situated such that the post-project effective in-stream work is lowered to less than 77% of the baseline pre-development condition.



Structural BMPs designed for hydromodification control utilize the following two basic principles:

- Detain runoff and release it in a controlled way that either mimics pre-development in-stream sediment transport capacity, mimics flow durations, or reduces flow durations to account for a reduction in bed sediment supply.
- Manage excess runoff volumes through one or more of the following pathways: (1) infiltration; (2) evapotranspiration; (3) storage and use; (4) discharge at a rate below the critical low flowrate; or (5) discharge downstream to a receiving water that is not susceptible to hydromodification impacts.

If desired, structural BMPs can be designed to support flood control and LID objectives in addition to hydromodification control. To the maximum extent possible, structural BMPs should be designed to receive flows from developed areas only. This facilitates design optimization as well as avoiding intercepting coarse sediments from open spaces that should ideally be passed through to the stream channel.

A fact sheet for additional flow control is provided in Appendix H.9.1.

H.4.3.2 Stream Rehabilitation

Hydromodification control can be achieved by stream rehabilitation projects including: drop structures, grade control structures, bed and bank reinforcement, increased channel sinuosity or meandering, increased channel width, and flow diversion. The objective of these in-stream controls, or stream restoration measures, is to reduce or maintain the overall Erosion Potential (Ep) of the receiving channel by modifying its hydraulic properties and/or bed/bank material resistance without fully replacing sediment supply or controlling increases in runoff. Stream rehabilitation is only an option where the receiving channel of concern is already impacted by erosive flows and shows evidence of excessive sediment, erosion, deposition, or is a hardened channel.

Stream rehabilitation projects are subject to the permitting requirements of the resource agencies. Stream rehabilitation projects may require the following permits:

- California Department of Fish and Wildlife – 1602 Streambed Alteration Agreement.
- US Fish and Wildlife Service – Authorization under the Endangered Species Act.
- US Army Corps of Engineers – Clean Water Act Section 404 Permit.
- Regional Water Quality Control Board – Clean Water Act Section 401 Water Quality Certification.
- Local Grading Permit

A fact sheet for stream rehabilitation is provided in Appendix H.9.2.

H.4.3.3 Applicant Proposed Mitigation Measures

The applicant may propose a mitigation measure not identified in this manual if it will achieve no net impact to the receiving water. Additional analysis may be requested by the County prior to approval of the mitigation measure to substantiate the finding of no net impact to the receiving water.

H.5 References

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H.5.1 Terms of Reference

The guidance described in Appendix H of this manual was developed by Geosyntec Consultants (Geosyntec) on behalf of the County of San Diego and the City of San Diego. Appendix H was specifically developed to provide PDP applicants guidance to meet the MS4 Permit Provision E.3.c.(2)(b) within the MS4-permitted region within the San Diego County. This guidance is not intended to be used for purposes, other than to meet this MS4 Permit requirement.

The guidance was developed with input from a Technical Advisory Committee (TAC) members through a series of meetings conducted in January 2016. The TAC input resulted in a streamlined guidance enhanced to provide applicants with simplified methods to determine impacts to coarse sediment delivery based on complex scientific principles. TAC participants included:

Bill Woolsey | Brian Haines | Charles Mohrlock | Chris Wolff | Dave Hammar | David Garcia | Emir Williams | Eric Mosolgo | Eric Stein | Erica Ryan | Howard Chang | Jon VanRhyn | Jonard Talamayan| Judd Goodman| Ken Susilo| Laura Henry| Luis Parra| Max Dugan | Rich Lucera | Sheri McPherson | Sumer Hasenin | Trevor Alsop | Venkat Gummadi | Wayne Chiu |

H.6 PCCSYAs: Regional WMAA Maps

PCCSYAs identified by the Regional WMAA were delineated using regional datasets for elevation, land cover, and geology. The methodology used to identify PCCSYAs from these datasets is based on Geomorphic Landscape Unit (GLU) methodology presented in the SCCWRP Technical Report 605. GLUs characterize the magnitude of sediment production from areas through three factors judged to exert the greatest influence on the variability on sediment-production rates: geology types, hillslope gradient, and land cover. The Regional WMAA document and the GIS layers for the map can be found on the Project Clean Water website at the following address:

http://www.projectcleanwater.org/index.php?option=com_content&view=article&id=248&Itemid=219

The regional-level mapping is based on the following sources:

Dataset	Source	Year	Description
Elevation	USGS	2013	1/3rd Arc Second (~10 meter cells) digital elevation model for San Diego County
Land Cover	SanGIS	2013	Ecology-Vegetation layer for San Diego County downloaded from SanGIS
Geology	Kennedy, M.P., and Tan, S.S.	2002	Geologic Map of the Oceanside 30'x60' Quadrangle, California, California Geological Survey, Regional Geologic Map No. 2, 1:100,000 scale.
	Kennedy, M.P., and Tan, S.S.	2008	Geologic Map of the San Diego 30'x60' Quadrangle, California, California Geological Survey, Regional Geologic Map No. 3, 1:100,000 scale.
	Todd, V.R.	2004	Preliminary Geologic Map of the El Cajon 30'x60' Quadrangle, Southern California, United States Geological Survey, Southern California Areal Mapping Project, Open File Report 2004-1361, 1:100,000 scale.
	Jennings et al.	2010	"Geologic Map of California," California Geological Survey, Map No. 2 – Geologic Map of California, 1:750,000 scale

The regional data set is a function of the inherent data resolution of the macro-level data sets and may not conform to all site conditions, or does not reflect changes to particular areas that have occurred since the underlying data was developed. This means slopes, geology, or land cover at the project site can be mischaracterized in the regional data set. If an applicant feels the Regional WMAA analysis inaccurately mapped their project area, they may elect to perform a site-specific GLU analysis based on data collected from project-level investigations to refine the mapping as outlined below.

The following PCCSYAs may be removed from the mapping without performing the full GLU analysis described in Appendix H.6.1 a) areas under 10% slope, b) paved areas.

H.6.1 Site-Specific GLU Analysis

In order to perform a site-specific GLU analysis the applicant must first delineate the project boundary and any areas draining through the project boundary. The applicant must then determine appropriate slopes, geology, and land cover categories for this area as identified below.

There are four slope categories in the GLU analysis. Category numbers shown (1 to 4) were assigned for the purpose of GIS processing.

- 0% to 10% (1)
- 10% to 20% (2)
- 20% to 40% (3)
- >40% (4)

There are seven geology categories in the GLU analysis:

- Coarse bedrock (CB)
- Coarse sedimentary impermeable (CSI)
- Coarse sedimentary permeable (CSP)
- Fine bedrock (FB)
- Fine sedimentary impermeable (FSI)
- Fine sedimentary permeable (FSP)
- Other (O)

There are six land cover categories in the GLU analysis:

- Agriculture/grass
- Forest
- Developed
- Scrub/shrub
- Other
- Unknown

Project site slopes shall be classified into the categories based on project-level topography. Project site geology may be determined from geologic maps (may be the same as regional-level information) or classified in the field by a qualified geologist. Table H.6-1 provides information to classify geologic map units into each geology category. Project site land cover shall be determined from

aerial photography and/or field visit. For reference, Table H.6-2 provides information to classify land cover categories from the SanGIS Ecology-Vegetation data set into land cover categories. The civil engineer shall not rely on the SanGIS Ecology-Vegetation data set to identify actual land cover at the project site (for project-level investigation land cover must be confirmed by aerial photo or field visit). Intersect the geologic categories, land cover categories, and slope categories within the project boundary to create GLUs. The GLUs listed in Table H.6-3 are considered to be PCCSYAs. Note the GLU nomenclature is presented in the following format: Geology – Land Cover – Slope Category (e.g., "CB-Agricultural/Grass-3" for a GLU consisting of coarse bedrock geology, agricultural/grass land cover, and 20% to 40% slope).

GLUs are created by intersecting the geologic categories, land cover categories, and slope categories. This is a similar procedure to intersecting land uses with soil types to determine runoff coefficients or runoff curve numbers for hydrologic studies, but there are three categories to consider for the GLU analysis (slope, geology, and land cover), and the GLUs are not to be composited into a single GLU. When GLUs have been created, determine whether any of the GLUs listed in Table H.6-3 are found within the project boundary. The GLUs listed in Table H.6-3 are considered to be PCCSYAs.

If none of the GLUs listed in Table H.6-3 are present within the project boundary and area draining through the project boundary, no measures for protection of critical coarse sediment yield areas are necessary. If one or more GLUs listed in Table H.6-3 are present within the project boundary, they shall be considered critical coarse sediment yield areas. Complete Worksheet H.6-1 to document verification of GLUs.

Table H.6-1 Geologic Grouping for Different Map Units

Map Unit	Map Name	Anticipated Grain size of Weathered Material	Bedrock or Sedimentary	Impermeable / Permeable	Geology Grouping
gr-m	Jennings; CA	Coarse	Bedrock	Impermeable	CB
grMz	Jennings; CA	Coarse	Bedrock	Impermeable	CB
Jcr	El Cajon 30' x 60'	Coarse	Bedrock	Impermeable	CB
Jhc	El Cajon 30' x 60'	Coarse	Bedrock	Impermeable	CB
Jsp	El Cajon 30' x 60'	Coarse	Bedrock	Impermeable	CB
Ka	El Cajon 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kbm	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kbp	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kcc	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kcg	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kcm	El Cajon 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kcp	El Cajon 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kd	San Diego & Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kdl	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kg	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kgbf	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kgd	San Diego &	Coarse	Bedrock	Impermeable	CB

Map Unit	Map Name	Anticipated Grain size of Weathered Material	Bedrock or Sedimentary	Impermeable / Permeable	Geology Grouping
	Oceanside 30' x 60'				
Kgdf	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kgh	San Diego 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kgm	El Cajon 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kgm1	El Cajon 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kgm2	El Cajon 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kgm3	El Cajon 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kgm4	El Cajon 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kgp	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kgr	El Cajon 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kgu	San Diego 30' x 60'	Coarse	Bedrock	Impermeable	CB
Khg	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Ki	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kis	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kjd	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
KJem	El Cajon 30' x 60'	Coarse	Bedrock	Impermeable	CB
KJld	El Cajon 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kjv	El Cajon 30' x 60'	Coarse	Bedrock	Impermeable	CB
Klb	El Cajon 30' x 60'	Coarse	Bedrock	Impermeable	CB
Klh	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Klp	El Cajon 30' x 60'	Coarse	Bedrock	Impermeable	CB
Km	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kmg	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kmgp	El Cajon 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kmm	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kpa	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kpv	El Cajon 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kqbd	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kr	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Krm	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Krr	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kt	San Diego & Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Ktr	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kvc	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kwm	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kwp	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kwsr	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
m	Jennings; CA	Coarse	Bedrock	Impermeable	CB
Mzd	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Mzg	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Mzq	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Mzs	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
sch	Jennings; CA	Coarse	Bedrock	Impermeable	CB

Map Unit	Map Name	Anticipated Grain size of Weathered Material	Bedrock or Sedimentary	Impermeable / Permeable	Geology Grouping
Kp	San Diego & Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Ql	El Cajon 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
QTf	El Cajon 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Ec	Jennings; CA	Coarse	Sedimentary	Impermeable	CSI
K	Jennings; CA	Coarse	Sedimentary	Impermeable	CSI
Kccg	San Diego 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Kcs	San Diego 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Kl	San Diego, Oceanside & El Cajon 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Ku	Jennings; CA	Coarse	Sedimentary	Impermeable	CSI
Qvof	Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvop8a	San Diego 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvop9a	San Diego 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Tmsc	San Diego 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Tmss	San Diego 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Tp	San Diego & El Cajon 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Tpm	San Diego 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Tsc	San Diego 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Tscu	San Diego 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Tsd	San Diego & El Cajon 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Tsdcg	San Diego 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Tsdss	San Diego 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Tsm	Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Tso	Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Tst	San Diego, Oceanside & El Cajon 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Tt	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Tta	Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Tmv	San Diego, Oceanside & El Cajon 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Tsi	Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvoa	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvoa11	Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvoa12	Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvoa13	Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvoc	Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI

Map Unit	Map Name	Anticipated Grain size of Weathered Material	Bedrock or Sedimentary	Impermeable / Permeable	Geology Grouping
Qvop	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvop1	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvop10	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvop10a	San Diego 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvop11	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvop11a	San Diego 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvop12	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvop13	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvop2	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvop3	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvop4	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvop5	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvop6	San Diego 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvop7	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvop8	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvop9	San Diego 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Tsa	Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qof	Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qof1	Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qof2	Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Q	Jennings; CA	Coarse	Sedimentary	Permeable	CSP
Qa	Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qd	Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qf	Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qmb	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qop	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qw	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qyf	Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qt	El Cajon 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qoa1-2	Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP

Map Unit	Map Name	Anticipated Grain size of Weathered Material	Bedrock or Sedimentary	Impermeable / Permeable	Geology Grouping
Qoa2-6	Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qoa5	Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qoa6	Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qoa7	Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qoc	Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qop1	Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qc	El Cajon 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qu	El Cajon 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qoa	San Diego, Oceanside & El Cajon 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qop2-4	San Diego 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qop3	Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qop4	Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qop6	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qop7	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qya	San Diego, Oceanside & El Cajon 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qyc	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Mzu	San Diego & Oceanside 30' x 60'	Fine	Bedrock	Impermeable	FB
gb	Jennings; CA	Fine	Bedrock	Impermeable	FB
JTRm	El Cajon 30' x 60'	Fine	Bedrock	Impermeable	FB
Kat	Oceanside 30' x 60'	Fine	Bedrock	Impermeable	FB
Kc	El Cajon 30' x 60'	Fine	Bedrock	Impermeable	FB
Kgb	Oceanside 30' x 60'	Fine	Bedrock	Impermeable	FB
KJvs	El Cajon 30' x 60'	Fine	Bedrock	Impermeable	FB
Kmv	El Cajon 30' x 60'	Fine	Bedrock	Impermeable	FB
Ksp	El Cajon 30' x 60'	Fine	Bedrock	Impermeable	FB
Kvsp	Oceanside 30' x 60'	Fine	Bedrock	Impermeable	FB
Kwmt	Oceanside 30' x 60'	Fine	Bedrock	Impermeable	FB
Qv	Jennings; CA	Fine	Bedrock	Impermeable	FB
Tba	San Diego 30' x 60'	Fine	Bedrock	Impermeable	FB
Tda	Oceanside 30' x 60'	Fine	Bedrock	Impermeable	FB
Tv	Oceanside 30' x 60'	Fine	Bedrock	Impermeable	FB
Tvsr	Oceanside 30' x 60'	Fine	Bedrock	Impermeable	FB
Kgdfg	Oceanside 30' x 60'	Fine	Bedrock	Impermeable	FB
Ta	San Diego 30' x 60'	Fine	Sedimentary	Impermeable	FSI
Tcs	Oceanside 30' x 60'	Fine	Sedimentary	Impermeable	FSI
Td	San Diego &	Fine	Sedimentary	Impermeable	FSI

Map Unit	Map Name	Anticipated Grain size of Weathered Material	Bedrock or Sedimentary	Impermeable / Permeable	Geology Grouping
	Oceanside 30' x 60'				
Td+Tf	San Diego 30' x 60'	Fine	Sedimentary	Impermeable	FSI
Qls	San Diego, Oceanside & El Cajon 30' x 60'	Fine	Sedimentary	Impermeable	FSI
Tm	Oceanside 30' x 60'	Fine	Sedimentary	Impermeable	FSI
Tf	San Diego, Oceanside & El Cajon 30' x 60'	Fine	Sedimentary	Impermeable	FSI
Tfr	El Cajon 30' x 60'	Fine	Sedimentary	Impermeable	FSI
To	San Diego & El Cajon 30' x 60'	Fine	Sedimentary	Impermeable	FSI
Qpe	San Diego & Oceanside 30' x 60'	Fine	Sedimentary	Permeable	FSP
Mexico	San Diego 30' x 60'	NA	NA	Permeable	Other
Kuo	San Diego 30' x 60'	NA (Offshore)	NA	Permeable	Other
Teo	San Diego & Oceanside 30' x 60'	NA (Offshore)	Sedimentary	Permeable	Other
Tmo	Oceanside 30' x 60'	NA (Offshore)	Sedimentary	Permeable	Other
Qmo	San Diego 30' x 60'	NA (Offshore)	Sedimentary	Permeable	Other
QTso	San Diego 30' x 60'	NA (Offshore)	Sedimentary	Permeable	Other
af	San Diego & Oceanside 30' x 60'	Variable, dependent on source material	Sedimentary		Other

TableH.6-2: Land Cover Grouping for SanGIS Ecology-Vegetation Data Set

Id	SanGIS Legend	SanGIS Grouping	Land Cover Grouping
1	42000 Valley and Foothill Grassland	Grasslands, Vernal Pools, Meadows, and Other Herb Communities	Agricultural/Grass
2	42100 Native Grassland		Agricultural/Grass
3	42110 Valley Needlegrass Grassland		Agricultural/Grass
4	42120 Valley Sacaton Grassland		Agricultural/Grass
5	42200 Non-Native Grassland	Grasslands, Vernal Pools, Meadows, and Other Herb Communities	Agricultural/Grass
6	42300 Wildflower Field		Agriculture/Grass
7	42400 Foothill/Mountain Perennial Grassland		Agriculture/Grass
8	42470 Transmontane Dropseed Grassland		Agriculture/Grass
9	45000 Meadow and Seep		Agriculture/Grass
10	45100 Montane Meadow		Agriculture/Grass
11	45110 Wet Montane Meadow		Agriculture/Grass
12	45120 Dry Montane Meadows		Agriculture/Grass
13	45300 Alkali Meadows and Seeps		Agriculture/Grass
14	45320 Alkali Seep		Agriculture/Grass
15	45400 Freshwater Seep		Agriculture/Grass
16	46000 Alkali Playa Community		Agriculture/Grass

Id	SanGIS Legend	SanGIS Grouping	Land Cover Grouping
17	46100 Badlands/Mudhill Forbs		Agriculture/Grass
18	Non-Native Grassland		Agriculture/Grass
19	18000 General Agriculture	Non-Native Vegetation, Developed Areas, or Unvegetated Habitat	Agriculture/Grass
20	18100 Orchards and Vineyards		Agriculture/Grass
21	18200 Intensive Agriculture		Agriculture/Grass
22	18200 Intensive Agriculture - Dairies, Nurseries, Chicken Ranches		Agriculture/Grass
23	18300 Extensive Agriculture - Field/Pasture, Row Crops		Agriculture/Grass
24	18310 Field/Pasture		Agriculture/Grass
25	18310 Pasture		Agriculture/Grass
26	18320 Row Crops		Agriculture/Grass
27	12000 Urban/Developed		Developed
28	12000 Urban/Develpped		Developed
29	81100 Mixed Evergreen Forest	Forest	Forest
30	81300 Oak Forest		Forest
31	81310 Coast Live Oak Forest		Forest
32	81320 Canyon Live Oak Forest		Forest
33	81340 Black Oak Forest		Forest
34	83140 Torrey Pine Forest		Forest
35	83230 Southern Interior Cypress Forest		Forest
36	84000 Lower Montane Coniferous Forest		Forest
37	84100 Coast Range, Klamath and Peninsular Coniferous Forest		Forest
38	84140 Coulter Pine Forest	Forest	Forest
39	84150 Bigcone Spruce (Bigcone Douglas Fir)-Canyon Oak Forest		Forest
40	84230 Sierran Mixed Coniferous Forest		Forest
41	84500 Mixed Oak/Coniferous/Bigcone/Coulter		Forest
42	85100 Jeffrey Pine Forest		Forest
43	11100 Eucalyptus Woodland	Non-Native Vegetation, Developed Areas, or Unvegetated Habitat	Forest
44	60000 RIPARIAN AND BOTTOMLAND HABITAT	Riparian and Bottomland Habitat	Forest
45	61000 Riparian Forests		Forest
46	61300 Southern Riparian Forest		Forest
47	61310 Southern Coast Live Oak Riparian Forest		Forest
48	61320 Southern Arroyo Willow Riparian Forest		Forest
49	61330 Southern Cottonwood-willow Riparian Forest		Forest
50	61510 White Alder Riparian Forest		Forest
51	61810 Sonoran Cottonwood-willow Riparian Forest		Forest

Id	SanGIS Legend	SanGIS Grouping	Land Cover Grouping
52	61820 Mesquite Bosque		Forest
53	62000 Riparian Woodlands		Forest
54	62200 Desert Dry Wash Woodland		Forest
55	62300 Desert Fan Palm Oasis Woodland		Forest
56	62400 Southern Sycamore-alder Riparian Woodland		Forest
57	70000 WOODLAND	Woodland	Forest
58	71000 Cismontane Woodland		Forest
59	71100 Oak Woodland		Forest
60	71120 Black Oak Woodland		Forest
61	71160 Coast Live Oak Woodland		Forest
62	71161 Open Coast Live Oak Woodland		Forest
63	71162 Dense Coast Live Oak Woodland		Forest
64	71162 Dense Coast Love Oak Woodland		Forest
65	71180 Engelmann Oak Woodland	Woodland	Forest
66	71181 Open Engelmann Oak Woodland		Forest
67	71182 Dense Engelmann Oak Woodland		Forest
68	72300 Peninsular Pinon and Juniper Woodlands		Forest
69	72310 Peninsular Pinon Woodland		Forest
70	72320 Peninsular Juniper Woodland and Scrub		Forest
71	75100 Elephant Tree Woodland		Forest
72	77000 Mixed Oak Woodland		Forest
73	78000 Undifferentiated Open Woodland		Forest
74	79000 Undifferentiated Dense Woodland		Forest
75	Engelmann Oak Woodland		Forest
76	52120 Southern Coastal Salt Marsh	Bog and Marsh	Other
77	52300 Alkali Marsh		Other
78	52310 Cismontane Alkali Marsh		Other
79	52400 Freshwater Marsh		Other
80	52410 Coastal and Valley Freshwater Marsh		Other
81	52420 Transmontane Freshwater Marsh		Other
82	52440 Emergent Wetland		Other
83	44000 Vernal Pool	Grasslands, Vernal Pools, Meadows, and Other Herb Communities	Other
84	44320 San Diego Mesa Vernal Pool		Other
85	44322 San Diego Mesa Claypan Vernal Pool (southern mesas)		Other
86	13100 Open Water	Non-Native Vegetation, Developed Areas, or Unvegetated Habitat	Other
87	13110 Marine		Other
88	13111 Subtidal		Other
89	13112 Intertidal		Other
90	13121 Deep Bay		Other
91	13122 Intermediate Bay		Other
92	13123 Shallow Bay		Other
93	13130 Estuarine		Other

Id	SanGIS Legend	SanGIS Grouping	Land Cover Grouping
94	13131 Subtidal		Other
95	13133 Brackishwater		Other
96	13140 Freshwater	Non-Native Vegetation, Developed Areas, or Unvegetated Habitat	Other
97	13200 Non-Vegetated Channel, Floodway, Lakeshore Fringe		Other
98	13300 Saltpan/Mudflats		Other
99	13400 Beach		Other
100	21230 Southern Foredunes	Dune Community	Scrub/Shrub
101	22100 Active Desert Dunes		Scrub/Shrub
102	22300 Stabilized and Partially-Stabilized Desert Sand Field		Scrub/Shrub
103	24000 Stabilized Alkaline Dunes		Scrub/Shrub
104	29000 ACACIA SCRUB		Scrub/Shrub
105	63000 Riparian Scrubs	Riparian and Bottomland Habitat	Scrub/Shrub
106	63300 Southern Riparian Scrub		Scrub/Shrub
107	63310 Mule Fat Scrub		Scrub/Shrub
108	63310 Mulefat Scrub		Scrub/Shrub
109	63320 Southern Willow Scrub		Scrub/Shrub
110	63321 Arundo donnax Dominant/Southern Willow Scrub		Scrub/Shrub
111	63330 Southern Riparian Scrub		Scrub/Shrub
112	63400 Great Valley Scrub		Scrub/Shrub
113	63410 Great Valley Willow Scrub		Scrub/Shrub
114	63800 Colorado Riparian Scrub		Scrub/Shrub
115	63810 Tamarisk Scrub		Scrub/Shrub
116	63820 Arrowweed Scrub		Scrub/Shrub
117	31200 Southern Coastal Bluff Scrub	Scrub and Chaparral	Scrub/Shrub
118	32000 Coastal Scrub		Scrub/Shrub
119	32400 Maritime Succulent Scrub		Scrub/Shrub
120	32500 Diegan Coastal Sage Scrub		Scrub/Shrub
121	32510 Coastal form		Scrub/Shrub
122	32520 Inland form (> 1,000 ft. elevation)		Scrub/Shrub
123	32700 Riversidian Sage Scrub		Scrub/Shrub
124	32710 Riversidian Upland Sage Scrub		Scrub/Shrub
125	32720 Alluvial Fan Scrub		Scrub/Shrub
126	33000 Sonoran Desert Scrub		Scrub/Shrub
127	33100 Sonoran Creosote Bush Scrub		Scrub/Shrub
128	33200 Sonoran Desert Mixed Scrub		Scrub/Shrub
129	33210 Sonoran Mixed Woody Scrub		Scrub/Shrub
130	33220 Sonoran Mixed Woody and Succulent Scrub	Scrub and Chaparral	Scrub/Shrub
131	33230 Sonoran Wash Scrub		Scrub/Shrub
132	33300 Colorado Desert Wash Scrub		Scrub/Shrub
133	33600 Encelia Scrub		Scrub/Shrub
134	34000 Mojavean Desert Scrub		Scrub/Shrub
135	34300 Blackbush Scrub		Scrub/Shrub

Id	SanGIS Legend	SanGIS Grouping	Land Cover Grouping
136	35000 Great Basin Scrub		Scrub/Shrub
137	35200 Sagebrush Scrub		Scrub/Shrub
138	35210 Big Sagebrush Scrub		Scrub/Shrub
139	35210 Sagebrush Scrub		Scrub/Shrub
140	36110 Desert Saltbush Scrub		Scrub/Shrub
141	36120 Desert Sink Scrub		Scrub/Shrub
142	37000 Chaparral		Scrub/Shrub
143	37120 Southern Mixed Chaparral		Scrub/Shrub
144	37120 Southern Mixed Chapparal		Scrub/Shrub
145	37121 Granitic Southern Mixed Chaparral		Scrub/Shrub
146	37121 Southern Mixed Chaparral		Scrub/Shrub
147	37122 Mafic Southern Mixed Chaparral		Scrub/Shrub
148	37130 Northern Mixed Chaparral		Scrub/Shrub
149	37131 Granitic Northern Mixed Chaparral		Scrub/Shrub
150	37132 Mafic Northern Mixed Chaparral		Scrub/Shrub
151	37200 Chamise Chaparral		Scrub/Shrub
152	37210 Granitic Chamise Chaparral		Scrub/Shrub
153	37220 Mafic Chamise Chaparral		Scrub/Shrub
154	37300 Red Shank Chaparral		Scrub/Shrub
155	37400 Semi-Desert Chaparral		Scrub/Shrub
156	37500 Montane Chaparral		Scrub/Shrub
157	37510 Mixed Montane Chaparral		Scrub/Shrub
158	37520 Montane Manzanita Chaparral		Scrub/Shrub
159	37530 Montane Ceanothus Chaparral		Scrub/Shrub
160	37540 Montane Scrub Oak Chaparral		Scrub/Shrub
161	37800 Upper Sonoran Ceanothus Chaparral		Scrub/Shrub
162	37830 Ceanothus crassifolius Chaparral		Scrub/Shrub
163	37900 Scrub Oak Chaparral		Scrub/Shrub
164	37A00 Interior Live Oak Chaparral		Scrub/Shrub
165	37C30 Southern Maritime Chaparral	Scrub and Chaparral	Scrub/Shrub
166	37G00 Coastal Sage-Chaparral Scrub		Scrub/Shrub
167	37K00 Flat-topped Buckwheat		Scrub/Shrub
168	39000 Upper Sonoran Subshrub Scrub		Scrub/Shrub
169	Diegan Coastal Sage Scrub		Scrub/Shrub
170	Granitic Northern Mixed Chaparral		Scrub/Shrub
171	Southern Mixed Chaparral		Scrub/Shrub
172	11000 Non-Native Vegetation	Non-Native Vegetation, Developed Areas, or Unvegetated Habitat	Unknown
173	11000 Non-Native VegetionVegetation		Unknown
174	11200 Disturbed Wetland		Unknown
175	11300 Disturbed Habitat		Unknown
176	13000 Unvegetated Habitat		Unknown
177	Disturbed Habitat		Unknown

Table H.6-8: Potential Critical Coarse Sediment Yield Areas

GLU	Geology	Land Cover	Slope (%)
CB-Agricultural/Grass-3	Coarse Bedrock	Agricultural/Grass	20% - 40%
CB-Agricultural/Grass-4	Coarse Bedrock	Agricultural/Grass	>40%
CB-Forest-2	Coarse Bedrock	Forest	10 – 20%
CB-Forest-3	Coarse Bedrock	Forest	20% - 40%
CB-Forest-4	Coarse Bedrock	Forest	>40%
CB-Scrub/Shrub-4	Coarse Bedrock	Scrub/Shrub	>40%
CB-Unknown-4	Coarse Bedrock	Unknown	>40%
CSI-Agricultural/Grass-2	Coarse Sedimentary Impermeable	Agricultural/Grass	10 – 20%
CSI-Agricultural/Grass-3	Coarse Sedimentary Impermeable	Agricultural/Grass	20% - 40%
CSI-Agricultural/Grass-4	Coarse Sedimentary Impermeable	Agricultural/Grass	>40%
CSP-Agricultural/Grass-4	Coarse Sedimentary Permeable	Agricultural/Grass	>40%
CSP-Forest-3	Coarse Sedimentary Permeable	Forest	20% - 40%
CSP-Forest-4	Coarse Sedimentary Permeable	Forest	>40%
CSP-Scrub/Shrub-4	Coarse Sedimentary Permeable	Scrub/Shrub	>40%

Verification of GLUs		Worksheet H.6-1
Detailed project-level review of GLUs may be performed to verify the presence or absence of potential critical coarse sediment yield areas within the project site and/or upstream areas. Use this form to document the evaluation of slope, geology, and land cover combined to determine the site-specific GLUs. Complete all sections of this form.		
Project Name:		
Project Tracking Number / Permit Application Number:		
1	What are the pre-project slopes?	☐ 0% to 10% (1) ☐ 10% to 20% (2) ☐ 20% to 40% (3) ☐ >40% (4)
2	What is the underlying geology? Refer to Appendix H.6 to classify geologic categories into a geology grouping. Note: site-specific geology may be determined in the field by a qualified geologist.	☐ Coarse bedrock (CB) ☐ Coarse sedimentary impermeable (CSI) ☐ Coarse sedimentary permeable (CSP) ☐ Fine bedrock (FB) ☐ Fine sedimentary impermeable (FSI) ☐ Fine sedimentary permeable (FSP) ☐ Other (O)
3	What is the pre-project land cover? Refer to Appendix H.6 for land cover category definitions. Note: Land cover shall be determined from aerial photography and/or field visit.	☐ Agriculture/grass ☐ Forest ☐ Developed ☐ Scrub/shrub ☐ Other ☐ Unknown
4	List the GLU(s) within the project site and/or upstream areas. Note the GLU nomenclature format is as follows: Geology – Land Cover – Slope Category (e.g. "CB-Agricultural/Grass-3" for a GLU consisting of coarse bedrock geology, agricultural/grass land cover, and 20% to 40% slope).	

Worksheet H.6-1; Page 2 of 2			
5	Photo(s) Insert photos representative of the slopes, land cover, and geology.		
6	Are any of the GLUs found within the project boundary and/or upstream areas listed in Table H.6-3?	☐ Yes	Go to 7
		☐ No	Go to 8
7	End – Provide management measures for preservation of coarse sediment supply as described in this guidance document, or the project applicant may elect to determine whether downstream systems would be sensitive to reduction of coarse sediment yield from the project site and/or perform site-specific method for mapping critical coarse sediment yield areas.		
8	End – Site-specific GLUs do not warrant preservation of coarse sediment supply, no measures for protection of critical coarse sediment yield areas onsite are necessary. Optional: use the note section below to provide justification for these findings.		
9	Notes		

H.6.2 Assumptions for Regional WMAA PCCSYA Maps

This appendix summarizes the assumptions used while developing Regional WMAA PCCSYA maps that are not discussed in Appendix H.6.1:

- Critical coarse sediment would be generated from GLUs that are
  - composed of geologic units likely to generate coarse sediment (i.e. produces greater than 50% sand (0.074 mm; no. 200 sieve) by weight when weathered); and
  - have a potential for high relative sediment production (GLUs that produce soil loss greater than 8.4 tons/acre/year are assigned a high relative rating, this corresponds to 42% of the total coarse soil loss from the MS4-permitted region within the County of San Diego)
- Relative sediment production was assigned using RUSLE analysis of GLUs. It was assumed that this relative rating represents sediment production from sheet erosion, rill erosion, gullies and lower order channels, since these features are mostly on the hillslopes that are represented by the GLUs.
  - While performing the RUSLE analysis to assign the relative ranking, C factor from the regional maps from USEPA was adjusted to 0 for developed land covers to account for management actions implemented on developed sites (e.g. impervious surfaces).
- WMAA mapping does not account for sediment production from in-stream sediment supply (since these are mostly protected through other regulations) and sediment production from mass failures like landslides which are difficult to estimate on a regional scale without performing extensive field investigations.
- Regional WMAA map assumes that all receiving waters require coarse sediment and the map also does not account for potential existing impediments that may hinder delivery of coarse sediment to receiving waters.

For additional details refer to the Regional WMAA document on the Project Clean Water website at the following address:

http://www.projectcleanwater.org/index.php?option=com_content&view=article&id=248&Itemid=219

H.6.3 Encroachment Allowance for Regional PCCSYA WMAA Map

When an applicant uses the regional PCCSYA map from WMAA to define onsite CCSYAs an encroachment allowance of up to 5% is allowed.

The following provides the supporting rational for 5% encroachment:

Step 1. Sp has to be greater than 0.5, based on current understanding of risks to receiving waters arising from changes in sediment production (SCCWRP Technical Report 605, 2010).

Step 2. Estimated Sp (Equation H.8.11) = $0.7*SY_{RUSLE}+0.3*SY_{NHD} = 0.7*0.42 + 0.3*1 = 0.59$

a. Based on RUSLE analysis conducted during Regional WMAA the GLUs mapped as PCCSYAs contribute 42% of the bed sediment yield (i.e. $SY_{RUSLE} = 0.42$)

b. Disturbance to NHDPlus channels are protected through 401 water quality certifications issued by the RWQCB, so it is assumed that $SY_{NHD} = 1$

Step 3. Dividing the Sp estimate from Step 2 by the required Sp in Step 1 provides the factor of safety that is currently implicit in the regional WMAA PCCSYA map = 0.59/0.5 = 1.18 or 18% factor of safety

Step 4. The remaining factor of safety after accounting for the proposed encroachment of 5% = 18% - 5% = 13%

H.7 PCCSYAs: Refinement Options

If an applicant has identified onsite and/or upstream PCCSYAs and elects to perform additional optional analyses to refine the PCCSYA designation, the guidance presented below should be followed. Protection of critical coarse sediment yield areas is a necessary element of hydromodification management because coarse sediment supply is as much an issue for causing erosive conditions to receiving streams as are accelerated flows. However, not all downstream systems warrant preservation of coarse sediment supply nor all source areas need to be protected. The following guidance shall be used to refine PCCSYA designations:

- Depositional Analysis (Appendix H.7.1)
- Threshold Channel Analysis (Appendix H.7.2)
- Coarse Sediment Source Area Verification (Appendix H.7.3)

H.7.1 Depositional Analysis

Areas identified as PCCSYAs may be removed from consideration if it is demonstrated that these sources are deposited into existing systems prior to reaching the first downstream unlined water of the state. Systems resulting in deposition may include existing natural sinks, existing structural BMPs, existing hardened MS4 systems, or other existing similar features. Applicants electing to perform depositional analysis to refine PCCSYA mapping must meet the following criteria to qualify for exemption from CCSYA designation:

- The existing hardened MS4 system that is being analyzed should be upstream of the first downstream unlined waters of the state; and
- The peak velocity from the discrete 2-year, 24-hour runoff event for the existing hardened MS4 system that is being analyzed is less than three feet per second.

The three feet per second criteria is consistent with the recommended minimum velocity for storm and sanitary sewers in ASCE Manual of Engineering Practice No. 37 (ASCE, 1970).

In limited scenarios, applicant may have the option to establish site specific minimum self-cleansing velocity using Equation H.7-1 or other appropriate equations instead of using the default three feet per second criteria. This site specific analysis must be documented in the SWQMP and the County has the discretion to request additional analysis prior to approving a site specific minimum self-cleansing velocity. If an applicant chooses to establish a site specific minimum self-cleansing velocity for refinement, then the applicant must design any new bypass hardened conveyance systems proposed by the project to meet the site specific criteria.

Equation H.7-1: Minimum Self Cleansing Velocity

$$V = \frac{1.486}{n} R^{1/6}\left[B\left(s_g - 1\right)D_g\right]^{1/2}$$

Where:

V = minimum self-cleansing velocity (ft/sec)
R = hydraulic radius (ft)
n = Manning's roughness coefficient (unitless)
B = constant equal to 0.04 for clean granular particles (unitless)
s_g = specific gravity of sediment particle (unitless): **Use 2.65**
D_g = sediment particle diameter (inches): **Use 0.20 in**

H.7.2 Threshold Channel Analysis

A threshold channel is a stream channel in which channel boundary material has no significant movement during the design flow. If there is no movement of bed load in the stream channel, then it is not anticipated that reductions in sediment supply will be detrimental to stream stability because the channel bed consists of the parent material and not coarse sediment supplied from upstream. In such a situation, changes in sediment supply are not considered a geomorphic condition of concern. SCCWRP Technical Report 562 (2008) states the following in regards to sand vs. gravel bed behavior/threshold vs. live-bed contrasts:

> "Sand and gravel systems are quite varied in their transport of sediment and their sensitivity to sediment supply. On the former, sand-bed channels typically have live beds, which transport sediment continuously even at relatively low flows. Conversely, gravel/cobble-bed channels generally transport the bulk of their bed sediment load more episodically, requiring higher flow events for bed mobility (i.e., threshold behavior)."
>
> "Sand-bed streams without vertical control are much more sensitive to perturbations in flow and sediment regimes than coarse-grain (gravel/cobble) threshold channels. This has clear implications in their respective management regarding hydromodification (i.e., sand systems being relatively more susceptible than coarser systems). This also has direct implications for the issue of sediment trapping by storm water practices in watersheds draining to sand-bed streams, as well as general loss of sediment supply following the conversion from undeveloped sparsely-vegetated to developed well-vegetated via irrigation."

The following provides guidance for evaluating whether a stream channel is a threshold channel or not. This determination is important because while accounting for changes in bed sediment supply is appropriate for quantifying geomorphic impacts in non-threshold stream channels, it is not considered appropriate for threshold channels. The domain of analysis for this evaluation shall be the same as that used to evaluate susceptibility, per SCCWRP Technical Report 606, Field Manual

for Assessing Channel Susceptibility (2010). This domain is defined by the following upstream and downstream boundaries:

- From the point of compliance proceed downstream until reaching one of the following:
    - At least one reach downstream of the first grade-control point (preferably second downstream grade control location);
    - Tidal backwater/lentic (still water) waterbody;
    - Equal order tributary (Strahler 1952);
    - A 2-fold increase in drainage area.

  OR demonstrate sufficient flow attenuation through existing hydrologic modeling.

- From the point of compliance proceed upstream for 20 channel top widths OR to the first grade control in good condition, whichever comes first.

Applicant must complete Worksheet H.7-1 to document selection of the domain of analysis. If the entire domain of analysis is classified as a threshold channel, then the PDP can be exempt from the MS4 Permit requirement for sediment supply. The following definitions from the Natural Resources Conservation Service's (NRCS) National Engineering Handbook Part 654 - Stream Restoration Design (2007) are helpful in understanding what a threshold channel is.

- **Alluvial Channel**: Streams and channels that have bed and banks formed of material transported by the stream. There is an exchange of material between the inflowing sediment load and the bed and banks of an alluvial channel (NRCS, 2007).
- **Threshold Channel**: A channel in which channel boundary material has no significant movement during the design flow (NRCS, 2007).

The key factor for determining whether a channel is a threshold channel is the composition of its bed material. Larger bed sediment consisting primarily of cobbles and boulders are typically immobile, unless the channel is a large river with sufficient discharge to regularly transport such grain sizes as bed load. As a rule-of-thumb, channels with bed material that can withstand a 10-year peak discharge without incipient motion are considered threshold channels and not live-bed alluvial channels. Threshold channel beds typically consist of cobbles, boulders, bedrock, or very dense vegetation (e.g., a thicket). Threshold channels also includes channels that have existing grade control structures that protect the stream channels from hydromodification impacts.

For a project to be exempt from coarse sediment supply requirements, the applicant must submit the following for approval by the County:

- Photographic documentation and grain size analysis used to determine the d_{50} of the bed material; and

- Calculations that show that the receiving water of concern meets the specific stream power criteria defined below or a finding from a geomorphologist that the stream channel has existing grade control structures that protect the stream channel from hydromodification impacts.

Specific Stream Power

Specific (i.e., unit) stream power is the rate at which the energy of flowing water is expended on the bed and banks of a channel (refer to Equation H.7-2). SCCWRP studies have found that locating channels on a plot of Specific Stream Power at Q_{10} (as calculated by the Hawley et al. method optimized for Southern California watersheds – Figure H.7-2) versus median channel grain size is a good predictor of channel stability. The Q_{10} equation from SCCWRP TR 606 is presented as Equation H.7-3.

Equation H.7-2: Calculation of Specific Stream Power

$$Specific\ Stream\ Power = \frac{Total\ Stream\ Power}{Channel\ Width} = \frac{\gamma QS}{w}$$

Where:

γ: Specific Weight of Water (9810 N/m^3)
Q: Flow Rate (dominant discharge in many cases, m^3/sec)
S: Slope of Channel
w: Channel Width (meters)

Equation H.7-3: Calculation of Q_{10} using the Hawley et al. method

$$Q_{10cfs} = 18.2 * A^{0.87} * P^{0.77}$$

Where:

Q_{10cfs}: 10 year Flow Rate in cubic feet per second
A: Drainage Area in sq. miles
P: Mean Annual Precipitation in inches

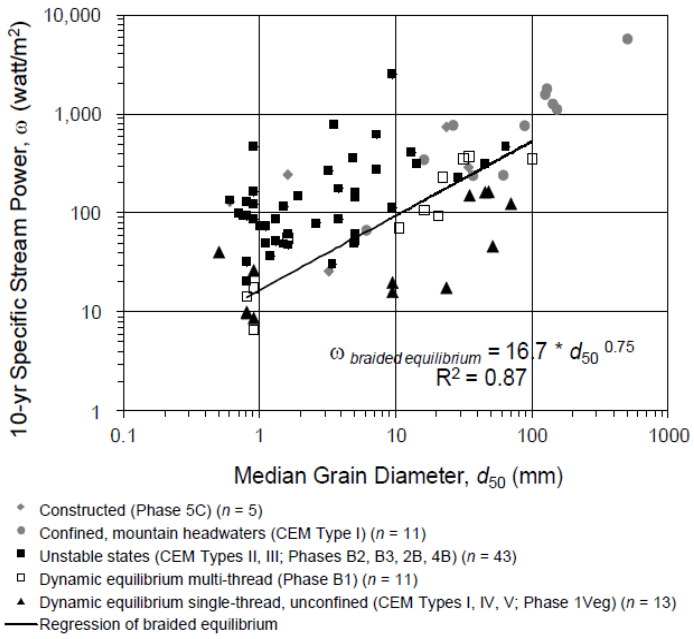

Figure H.7-1: Threshold of stream instability based on specific stream power and channel sediment diameter

Since the SCCWRP TR 606 Q_{10} (Equation H.7-3) does not explicitly consider watershed imperviousness, adjustment factors (AF) shown in Figure H.7-2 were developed using the following Equation H.7-4 for Q_{10} from SCCWRP TR 654 to account for imperviousness while estimating Q_{10}.

Equation H.7-4: Calculation of Q_{10} using equation from SCCWRP TR 654

$$Q_{10} = e^{3.61} * A^{0.865} * DD^{0.804} * P_{224}{}^{0.778} * IMP^{0.096}$$

Where:

Q_{10}: 10 year Flow Rate
A: Drainage Area in sq. miles
DD: Drainage Density
P_{224}: 2-Year 24-Hour Precipitation in inches
IMP: Watershed Imperviousness

Adjustment factors were developed as part of this methodology by changing the watershed imperviousness in Equation H.7-4 and keeping the remaining terms constant. Adjustment factor for imperviousness of 3.6% was set to 1; since it is the mean imperviousness of the dataset used to develop the stability curve in Figure H.7-1. Updated Q_{10} equation with adjustment factor is presented as Equation H.7-5 below:

Equation H.7-5: Calculation of Q_{10} with Adjustment Factor for Watershed Imperviousness

$Q_{10cfs} = AF * 18.2 * A^{0.87} * P^{0.77}$

Where:

Q_{10cfs}: 10 year Flow Rate in cubic feet per second
AF: Adjustment Factor
A: Drainage Area in sq. miles
P: Mean Annual Precipitation in inches

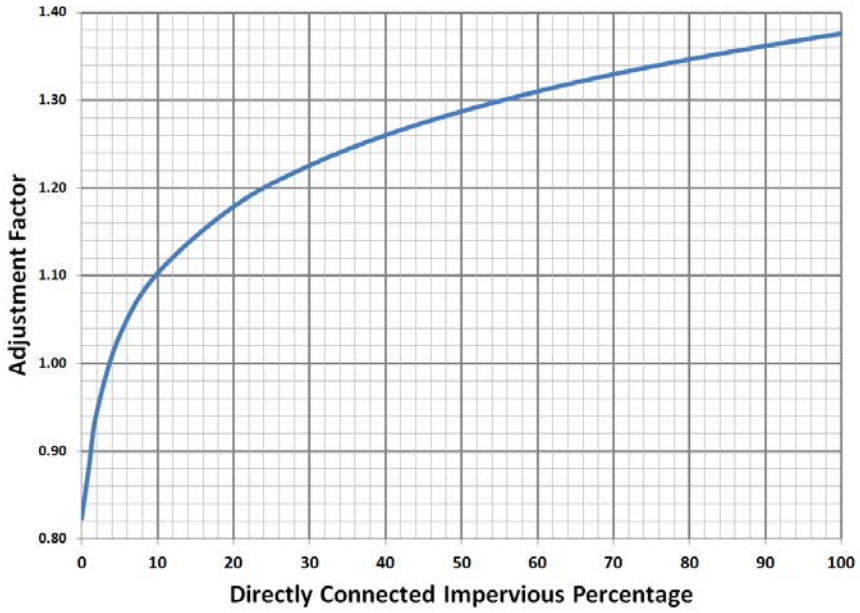

Figure H.7-2: Adjustment factor to account for imperviousness while estimating Q_{10}

Steps for evaluating the specific stream power criteria are presented below:

- **Step 1**: Calculate the specific stream power for the receiving water. Use Equation H.7-2, H.7-5 and Figure H.7-2. Directly connected imperviousness shall be estimated using guidance provided in the Water Quality Equivalency guidance document.
- **Step 2**: Determine the d_{50} of representative cross section within the domain of analysis.
- **Step 3**: Use results from Step 1 and Step 2; and Figure H.7-1 to determine if the receiving water meets the specific stream power criteria. Receiving water shall be considered meeting the specific stream power criteria when the point plotted based on results from Step 1 and Step 2 is below the solid line in Figure H.7-1.

H.7.3 Coarse Sediment Source Area Verification

When it has been determined that PCCSYAs are present, and it has been determined that downstream systems require protection, additional analysis may be performed that may refine the extents of actual CCSYAs to be protected onsite. The following analysis shall be performed to determine if the mapped PCCSYAs are a significant source of bed sediment supply to the receiving water, based on the coarse sediment proportion of the soil onsite

- Obtain a grain size distribution per ASTM D422 for the project's PCCSYA that is being evaluated.
- Identify whether the source material is a coarse grained or fine grained soil. Coarse grained is defined as over 50% by weight coarse than no. 200 sieve (i.e., $d_{50} > 0.074$ mm).
- By performing this analysis, the applicant can exclude PCCSYAs that are determined to be fine grained (i.e., $d_{50} < 0.074$ mm). Fine grained soils are not considered significant sources of bed sediment supply.
- Applicant shall include the following information in the SWQMP when this refinement option is performed:
    - Map with locations on where the grain size distribution analysis was performed;
    - Photographic documentation; and
    - Grain size distribution.
- Additional grain size distribution analysis may be requested at specific locations by the County prior to approval of this refinement.

Areas that are not expected to be a significant source of bed sediment supply (i.e. fine grained soils) to the receiving stream do not require protection and are not considered CCSYAs.
If it is determined that the PCCSYAs are producing sediment that is critical to receiving streams, or if the optional additional analysis presented above has not been performed, the project must provide management measures for protection of critical coarse sediment yield (refer to Appendix H.2, H.3 and H.4).

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Domain of Analysis			Worksheet H.7-1
Use this form to document the domain of analysis			
Project Name:			
Project Tracking Number / Permit Application Number:			
Part 1: Identify Domain of Analysis			
Project Location (at proposed storm water discharge point)			
1	Address:		
2	Latitude (decimal degrees):		
3	Longitude (decimal degrees):		
4	Watershed:		
Basis for determining downstream limit:			
Channel length from discharge point to downstream limit:			
Basis for determining upstream limit:			
Channel length from discharge point to upstream limit:			

Worksheet H.7-1; Page 2 of 2
Photo(s) Map or aerial photo of site. Include channel alignment and tributaries, project discharge point, upstream and downstream limits of analysis, ID number and boundaries of geomorphic channel units, and any other features used to determine limits (e.g. exempt water body, grade control).

H.8 Calculation Methodology for Ep and Sp

One method for quantifying hydromodification impacts to stream channels, which takes into account changes in the four factors in Lane's relationship (i.e., hydrology, channel geometry, bed and bank material, and sediment supply), is to compare long-term changes in sediment transport capacity, or in-stream work, to bed sediment supply. For the purposes of demonstrating no net impact within the MS4-permitted region of the County of San Diego, Erosion Potential (Ep) is defined as the ratio of post-project/pre-development (natural) long-term transport capacity or work. To calculate Ep, the hydrology, channel geometry, and bed/bank material factors mentioned above need to be characterized for both land use scenarios. Sediment Supply Potential (Sp) is defined as the ratio of post-project/pre-project (existing) long-term bed sediment supply. While evaluating changes in discharge and sediment supply is done primarily as a desktop analysis, geomorphic field assessment is often necessary to characterize channel geometry and bed/bank material, and to ground truth assumptions for the desktop analyses. This appendix provides methodologies for the following:

- Calculation of Ep, and
- Calculation of Sp.

H.8.1 Calculation of Ep

Erosion Potential (Ep) is defined as the ratio of post-project/pre-development (natural) long-term transport capacity or work. To calculate Ep, the hydrology, channel geometry, and bed/bank material factors mentioned above need to be characterized for both land use scenarios. Traditionally, Ep is calculated based on a watershed-scale analysis (using future built out conditions) of the area tributary to a given receiving channel of concern at the point of compliance. However, watershed-scale continuous hydrologic modeling might not be feasible for small projects, with this understanding specific simplification steps for project-scale modeling are provided in this appendix. The applicant shall perform Ep calculations using one of the following methods, as applicable:

- **Simplified Ep Method**: Applicable when the default low flow threshold of $0.1Q_2$ is used and no changes to the receiving water are proposed. Refer to Appendix H.8.1.1.
- **Standard Ep Method**: Applicable for all scenarios. Refer to Appendix H.8.1.2.

H.8.1.1 Simplified Ep Method

The simplified method is based on the relationships developed by Parra (2016) between the flow duration curve in the pre-development and post-project conditions and the standard simplified work equation. These relationships were developed using standard hydraulic equations and approximations that are applicable for channels of any lateral slope and the following geometrical cross sections: (a) wide rectangular sections; (b) relatively wide parabolic sections, and (c) triangular sections. The simplified Ep method is only applicable when the default low flow threshold of $0.1Q_2$ has been selected by the applicant for flow duration control and no changes to the receiving water geometry are proposed. Applicants shall follow Steps 1 through 3 to calculate Ep using the simplified methodology:

1. Perform continuous hydrologic simulation for the pre-development and post-project condition following guidelines in Appendix G. Generate flow bins and flow duration tables for the range of flows from $0.1Q_2$ to Q_{10}.
2. Calculate the total work in the pre-development and the post-project condition using Equation H.8.1

$$W_t = \sum_{j=1}^{n} \Delta t_j . \left(Q^{3m/2} - (0.1Q_2)^{3m/2}\right)^{1.5} Q^m$$

Equation H.8.1

Where:

W_t = Total Work [dimensionless]

Δt_j = Duration per flow bin

Q = Flow Rates estimated in STEP 1 [cfs] for a typical bin "j". Usually, in Flow Duration Curve (FDC) analyses, the number of bins is 100, so j = 1 to n (with n= 100). However, the number of bins can be as small as 20 (n = 20).

Q_2 = Pre-development 2-year peak flow [cfs]

m = exponent based on the function of the receiving channels geometry.

- For narrow creek where the top width is 7 times or less the corresponding depth, m = 1/4.
- For intermediate creeks, where the top width is more than 7 times but less than 25 times the depth, m = 4/13.
- For wide creeks, where the top width is more than 25 times the depth, m = 2/5.

3. Ep is calculated by dividing the total work of the post-project condition by that of the pre-development (natural) condition. Ep is expressed as:

$E_p = W_{t,post} / W_{t,pre}$ Equation H.8.2

Where:

E_p = Erosion Potential [unitless]

$W_{t,post}$ = Total Work associated with the post-project condition [unitless]

$W_{t,pre}$ = Total Work associated with the pre-development condition [unitless]

H.8.1.2 Standard Ep Method

While using the standard method, Ep calculation must be performed using the receiving water information from the point of compliance. Suggested steps for performing an Ep analysis are shown in the Figure H.8-1 below. This appendix describes each analysis step shown in Figure H.8-1, including the inputs and outputs of each step.

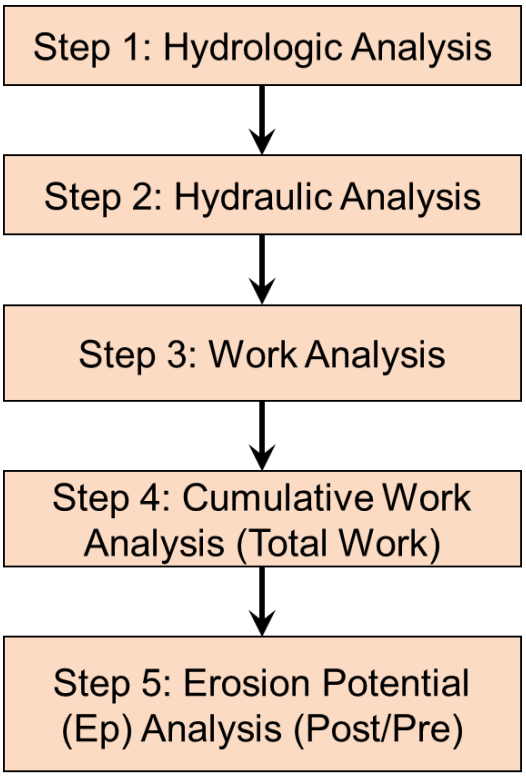

Figure H.8-1 Erosion Potential Flow Chart

STEP 1: CONTINUOUS HYDROLOGIC ANALYSIS

Hydrologic models are applied to simulate the hydrologic response of the watershed under pre-development and post-project conditions for a continuous period of record. Modeling software appropriate for this type of simulation includes USEPA's Storm Water Management Model (SWMM), Hydrological Simulation Program – Fortran (HSPF) developed by the USGS and USEPA, USACE's Hydrologic Modeling System (HEC-HMS), and the San Diego Hydrology Model (SDHM) developed by Clear Creek Solutions, Inc. SDHM uses an HSPF computational engine, long-term

precipitation data, and is a visually-oriented interactive tool for automated modeling and facility sizing.

Input parameters for these continuous simulations are hourly precipitation data for a long-term (>30 years) record, sub-catchment delineation, impervious cover, soil type, vegetative cover, terrain steepness, lag time or flow path length, and monthly evapotranspiration rate. The primary output is a simulated discharge record associated with the receiving channel of concern. Flow routing through drainage conveyances is necessary for continuous hydrologic analysis at the watershed scale. Appendix G provides guidance for developing continuous simulation models.

Traditionally, a hydrograph (Figure H.8-2) is the primary means for graphically comparing discharge records; however, a hydrograph is not ideal because long-term flow records span several decades.

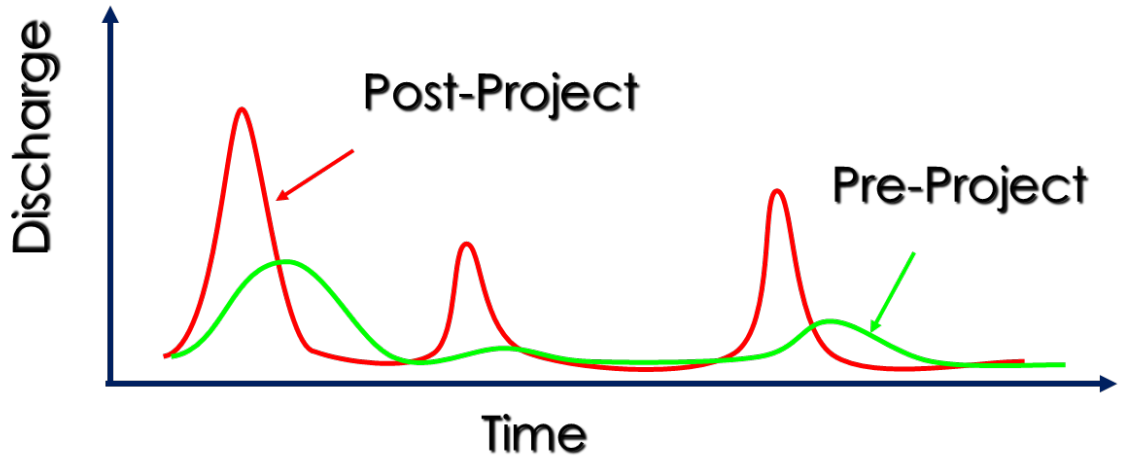

Figure H.8-2 Example Hydrograph Comparison

Instead, a more effective means for comparing long-term continuous discharge records is to create a flow histogram, which differentiates the simulated flowrates into distinct "flow bins" so that the duration of flow for each bin can be tabulated. One method for establishing the distribution of flow bins is to increment the flow bins according to increments of flow stage using a hydraulic analysis, such as the normal depth equation. In this way, the hydraulic analysis step (Step 2) can be considered an input to the continuous hydrologic analysis step. While there is no established rule of thumb for how many flow bins are necessary, it is suggested that no less than 20 be used for an Ep analysis. An example of a flow histogram is provided on Figure H.8-3.

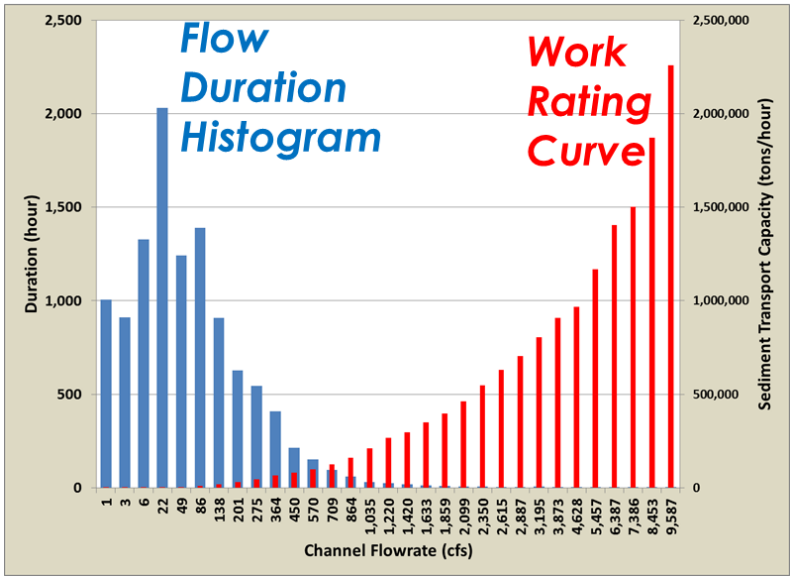

Figure H.8-3 Example Flow Duration Histogram

Flow duration curves are another commonly used method for graphically interpreting long-term flow records. A flow duration curve is simply a plot of flowrate (y-axis) versus the cumulative duration, or percentage of time, that a flowrate is equaled or exceeded in the simulation record (x-axis). Figure H.8-4 provides an example flow duration curve comparison.

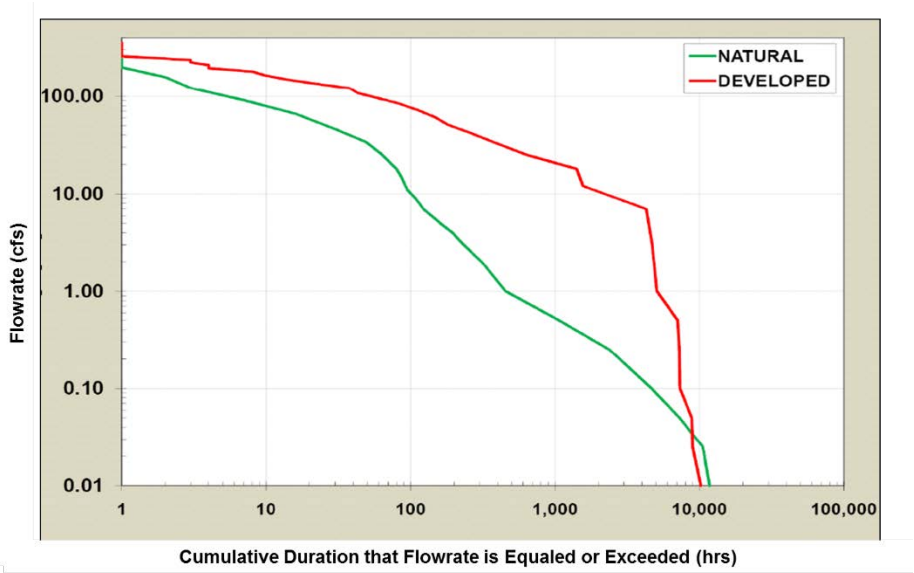

Figure H.8-4 Example Flow Duration Curve

Scaling Factor for Project-Scale Modeling

Project-scale flow rates derived from continuous hydrologic simulation can be scaled using the ratio of the pre-development 2-year peak discharge for the watershed and project catchment (i.e., Q_2 watershed / Q_2 project catchment) so that hydraulic and effective work calculations can be

performed at the point of compliance with a larger tributary watershed. This scaling translates the runoff from the project catchment to its contribution to erosivity in the down gradient receiving channel, without the need for a complex watershed-scale continuous hydrologic model.

Applicant can estimate the scaling factor using Equation H.8.3. The scaling factor equation was developed using the 2-year peak flow rate empirical equation from Hawley and Bledsoe (2011) and removing the terms (average annual precipitation and imperviousness (pre-development condition as required by the MS4 Permit) that are constant.

$$Scaling\ Factor = \left(\frac{A_{watershed}}{A_{project}}\right)^{0.667} \qquad \text{Equation H.8.3}$$

Where:

$A_{watershed}$ = total watershed drainage area at the point of compliance(mi^2)

$A_{project}$ = total project drainage area (mi^2)

STEP 2: HYDRAULIC ANALYSIS

Hydraulic parameters, such as stage, effective shear stress, and flow velocity, are computed for each designated flow bin using channel geometry and roughness data. Hydraulic calculations can be as simple as using the normal flow equation and obtaining results for the central channel or as complicated as using hydraulic models which account for backwater effects, such as HEC-RAS.

Using the formula for unit tractive force (Chow 1959), effective shear stress is expressed using equation H.8.4

$$\tau = \gamma RS \qquad \text{Equation H.8.4}$$

Where:

τ = Effective Shear Stress [lb/ft^2]

γ = Unit Weight of Water [62.4 lb/ft^3]

R= Hydraulic Radius [ft]

S = Energy Gradient Assumed Equal to Longitudinal Slope [ft/ft].

Normal depth can be estimated using Manning's equation (Equation H.8.5). Several sources provide lists of roughness coefficients for use in hydraulic analysis (Chow, 1959).

$$Q = \frac{1.49AR^{0.67}S^{0.5}}{n} \; or \; V = \frac{1.49R^{0.67}S^{0.5}}{n} \qquad \text{Equation H.8.5}$$

Where

Q = Peak Flowrate [cfs]

V = Average Flow Velocity [ft/s]

A = Cross-Section Flow Area [ft^2]

R = Hydraulic Radius [ft] = A/P

P = Wetted Perimeter [ft]

S = Energy Gradient Assumed Equal to Longitudinal Slope [ft/ft]

n = Manning Roughness [unit less]

Channel geometry inputs should be characterized by surveying cross-sections and longitudinal profiles of the active channel at strategic locations. Methods of collecting topographic survey data can range from traditional survey techniques (auto level, cloth tape, and survey rod), to conducting a detailed ground-based LiDAR survey.

STEP 3: WORK ANALYSIS

Hydraulic results for each flow bin along with the critical bed/bank material strength parameters are input into a work or sediment transport function in order to produce a work or transport rating curve. An example of such a rating curve is provided on Figure H.8-3. The work equations can range from simplistic indices, material-specific sediment transport equations, or more complex functions based on site-calibrated sediment transport rating curves.

- **Simplistic indices:** An acceptable equation for effective work, as stated in the Los Angeles Regional MS4 Permit (LARWQCB, 2012) is expressed using equation H.8.6:

$$W = (\tau - \tau_c)^{1.5} V \qquad \text{Equation H.8.6}$$

Where:

W = Work [dimensionless];

τ = Effective Shear Stress [lb/ft^2];

τ_c = Critical Shear Stress [lb/ft^2];

V = Mid-Channel Flow Velocity [ft/s]

- **Material-specific sediment transport equations**: Material specific sediment transport equations are allowed to estimate the sediment transport capacity in the post-project and pre-development condition.

- **Site-calibrated sediment transport curves**: Applicants may have an option to use site-calibrated sediment transport curves. In the future these may be available based on monitoring efforts being performed to support the County of San Diego's Hydromodification Management Plan.

The critical shear stress to be used in equation H.8.6 must be estimated using one of the following:

- Shear stress corresponding to the critical flow rate or low flow threshold (Qc). Qc is the flowrate that results in incipient motion of bed or bank material, whichever is least resistant. Qc is expressed as a fraction of the pre-development 2-year peak flow. The allowable low flow threshold Qc can be estimated as 10%, 30%, or 50% of the pre-development 2-year peak flow ($0.1Q_2$, $0.3Q_2$, or $0.5Q_2$) depending on the receiving stream susceptibility to erosion, per SCCWRP Technical Report 606, Field Manual for Assessing Channel Susceptibility (SCCWRP, 2010). If a channel susceptibility assessment is not performed, then the conservative default is a Qc equal to $0.1Q_2$.

- Bed and bank material can also be characterized through a geomorphic field assessment. For each stream location analyzed, a measure of critical shear stress can be obtained for the weakest bed or bank material prevalent in the channel. For non-cohesive material, a Wolman pebble count or sieve analysis can be used to obtain a grain size distribution, which can be converted to a critical shear stress using empirical relationships or published reference tables.

For cohesive material, an in-situ jet test or reference tables are used. For banks reinforced with vegetation, reference tables are generally used. Appropriate references for critical shear stress values are provided in ASCE No.77 (1992) and Fischenich (2001). To account for the effects of vegetation density and channel irregularities, the applied shear stress can be partitioned into channel form and bed/bank roughness components. SCCWRP Technical Report 667 also has guidance for estimating critical shear stress.

STEP 4: CUMULATIVE WORK ANALYSIS

Cumulative work is a measure of the long-term total work or sediment transport capacity performed at a creek location. It incorporates the distribution of both discharge magnitude and duration for the flow rates simulated. The cumulative work analysis must be performed up to the maximum geomorphically significant flow of Q_{10}. To calculate cumulative work, first multiply the work (from STEP 3) and duration associated with each flow bin (from STEP 1). Then, the total work is obtained by summing the cumulative for all flow binds (Q_c to Q_{10}). This analysis can be expressed as:

$$W_t = \sum_{i=1}^{n} W_i \, \Delta t_i \qquad \text{Equation H.8.7}$$

Where:

W_t = Total Work [dimensionless]

W_i = Work per flow bin [dimensionless]

Δt = Duration per flow bin [hours]

n = number of flow bins

The distribution of cumulative work, also referred to as a work curve (or work histogram), is helpful in understanding which flow rates are performing the most work on the channel of interest. An example work curve is provided in Figure H.8-5.

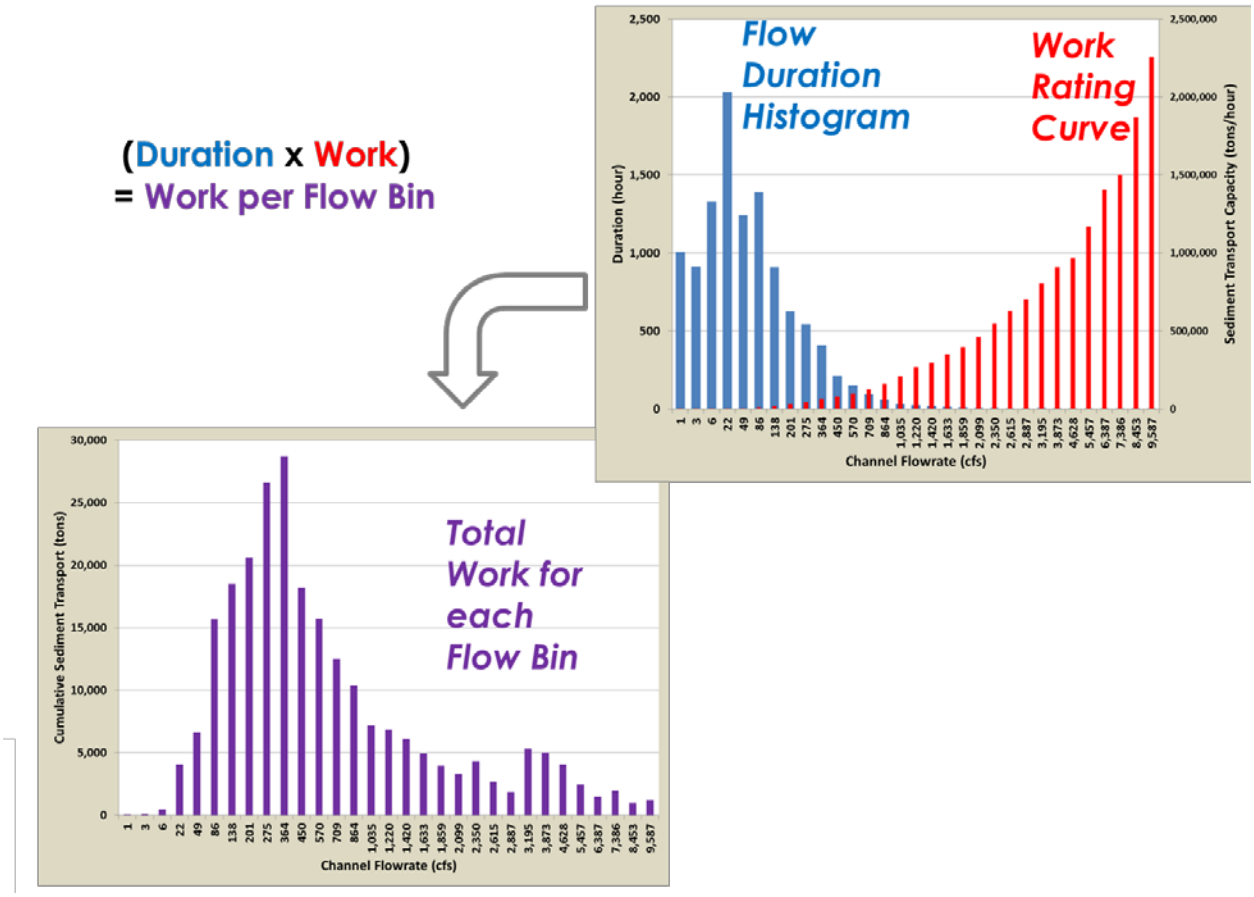

Figure H.8-5 Example Work Curve

STEP 5: EROSION POTENTIAL ANALYSIS

Ep is calculated by simply dividing the total work of the post-project condition by that of the pre-development (natural) condition. Ep is expressed as:

$$E_p = W_{t,post} / W_{t,pre}$$ Equation H.8.8

Where:

E_p = Erosion Potential [unitless]

$W_{t,post}$ = Total Work associated with the post-project condition [unitless]

$W_{t,pre}$ = Total Work associated with the pre-development condition [unitless]

As applicable, the applicant must use Worksheet H.8.1-1 and H.8.1-2 to document the Ep calculations for each point of compliance.

Erosion Potential (Ep) Analysis		Worksheet H.8.1-1	
Background Information			
1	Low Flow Threshold: results of SCCWRP channel susceptibility analysis (Select 0.1*Q_2 if analysis has not been performed).	☐ 0.1*Q2 ☐ 0.3*Q2 ☐ 0.5*Q2	
2	Selected Ep Method	☐ Simplified Ep Method ☐ Standard Ep Method	
2	Hydrologic Analysis: Select hydrologic analysis method.	☐ Project-Scale ☐ Project-Scale and Watershed-Scale Continuous Simulation	
4	Number of Points of Compliance (Copy and complete worksheet for each Point of Compliance)		unitless
Step 1: Hydrologic Analysis (not applicable for Simplified Ep Method)			
5	Project-Scale Q_2 (from continuous simulation)		cfs
6	Project Area draining to the point of compliance		sq. miles
7	Watershed Area draining to the point of compliance		sq. miles
8	Scaling Factor for Flows (Line 7/Line 6)$^{0.667}$		unitless
9	Low flow threshold (factor from Line 1 x Line 6)		cfs
10	Watershed-Scale Q_{10} at Point of Compliance (from continuous simulation or Project Q_{10} * Line 8)		cfs
	Hydrologic analysis results (Attach results of continuous simulation including: full pre-development runoff time series at POC, full post-development runoff time series at POC, and flow duration histogram and/or cumulative flow duration curve for each POC).		☐ Yes ☐ No
Step 2: Hydraulic Analysis (not applicable for Simplified Ep Method)			
11	Provide details about the cross-section (width, depth, slope, roughness, etc.)		

Erosion Potential (Ep) Analysis		Worksheet H.8.1-1	
Step 3: Work Analysis (not applicable for Simplified Ep Method)			
12	Select work index, equation, or transport curve method for use in work analysis.	☐ Equation H.8.6 ☐ Sediment Transport Equation ☐ Sediment Transport Curve ☐ Other: _____	
13	Describe/Justify selection in Line 12 above:		
14	Calculate work done for each flow bin under the pre-development and post-project condition using Worksheet H.8.1-2. Or similar documentation for sediment transport modeling or transport curve analysis.	☐ Yes ☐ No	
Step 4: Cumulative Work Analysis			
14	Cumulative pre-development work (Equation H.8.1 for Simplified Ep Method) (from Worksheet H.8.1-2 for Standard Ep Method)		
15	Cumulative post-project work (Equation H.8.1 for Simplified Ep Method) (from Worksheet H.8.1-2 for Standard Ep Method)		
Step 5: Erosion Potential Analysis			
16	Erosion Potential (Line 15 / Line 14)		unitless

Work Calculations (Supplement to Worksheet H.8.1-1)									Worksheet H.8.1-2	
1	Channel Slope								(ft/ft)	
2	Channel Roughness (n)								(unitless)	
3	Low Flow Threshold (Line 9 from Worksheet H.8.1-1)								cfs	
4	Critical Shear Stress								(lb/ft^2)	
A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**
Bin	**Flow (cfs)**			**Duration (hours)**		**Hydraulic Radius (ft)**	**Average Velocity (ft/s)**	**Shear Stress (lb/ft^2)**	**Work (unitless)**	
	Lower Limit	**Upper Limit**	**Average**	**Pre-development**	**Post-Project**				**Pre-development**	**Post-Project**
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										
13										
14										
15										
16										
17										
18										
19										
20										
n										
Sum (Bins 1 to n) =										

Worksheet H.8.2-2 Key

A Number of flow bins, add additional rows as needed

B Lower limit for the corresponding flow bin

C Upper limit for the corresponding flow bin

D Average flow for the corresponding flow bin; [(**B** + **C**)/2]

E Duration in hours for the corresponding flow bin in pre development condition

F Duration in hours for the corresponding flow bin in post project condition

G Hydraulic radius (in feet) associated with the average flow for the corresponding flow bin (from Manning's equation and/or hydraulic analysis)

H Average flow velocity (in fps) associated with the average flow for the corresponding flow bin (from Manning's equation and/or hydraulic analysis)

I Shear stress (lb/ft^2) associated with the average flow for the corresponding flow bin = γ * Hydraulic Radius*Slope = 62.4 * **G** * Line 1

J Pre-development work for associated flow bin

J = 0; If (**I** – Line 4) ≤ 0

J = **E** * (**I** – Line 4)$^{1.5}$ * **H**; If (**I** – Line 4) > 0

K Post-project work for associated flow bin

K = 0; If (**I** – Line 4) ≤ 0

K = **F** * (**I** – Line 4)$^{1.5}$ * **H**; If (**I** – Line 4) > 0

Note: If the receiving water dimensions are different in pre-development and post-project condition then Worksheet H.8.1-2 is not valid for work calculations.

H.8.2 Calculation of Sp

While there are many categories of erosion processes (e.g., landslides, debris flows, gullies, tree throw, animal burrows, sheetwash erosion, wind erosion, dry ravel, bank erosion), in this evaluation processes will be simplified to sediment production from hillslopes and channels. Under ideal circumstances, the total bed sediment supply rate (tons/year) would be calculated for both the post-project built-out condition and pre-project condition using a watershed-scale Geomorphic Landscape Unit (GLU) and Geomorphic Channel Unit (GCU) approach which:

(1) identifies different sources of sediment supply based on categories of terrain slope, geology, land cover, and stream order;
(2) estimates the base erosion rate of those sources (GLUs and GCUs);
(3) approximates the sediment delivery ratio (SDR) to the receiving channel;
(4) evaluates the coarse bed-load fraction of the sources; and
(5) integrates these considerations into a bed-load yield rate for both the existing condition and proposed built-out condition.

However, calculation of sediment yield rates for each GLU (tons/mi^2-yr) and GCU (tons/mi-yr) using the available science is inherently inexact and requires extensive field calibration. Additionally, performing the geospatial calculations necessary for such a comprehensive GLU and GCU analysis may not be straightforward for some project applicants. Since the objective is to determine the fraction of reduction in bed sediment supply in the post-project condition compared to the pre-project condition, but not to determine the bed sediment yield in physical units (tons/year/acre, for example) the following simplifications are allowed. These simplifications take into consideration the regional sediment yield map shown in Figure H.8.6.

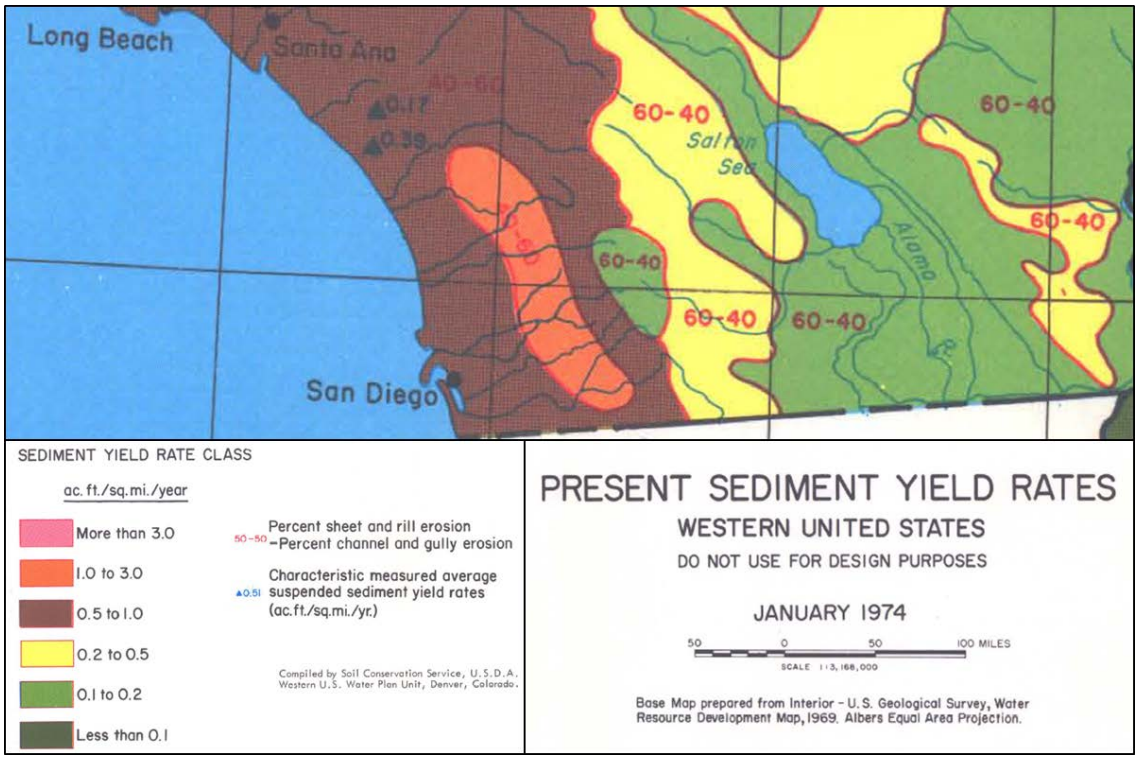

Figure H.8-6 Regional Sediment Yield Map

According to a regional sediment yield map of the Western US (USDA, 1974), hillslope processes (sheet and rill erosion) account for approximately 40% of the sediment yield in the San Diego County region, while channel processes (in-stream and gully erosion) account for approximately 60% of the sediment yield. Figure H.8-7 shows the different erosion processes. Provision E.3.a.(3)(a) of the MS4 Permit requires, "maintenance or restoration of natural storage reservoirs and drainage corridors (including topographic depressions, areas of permeable soils, natural swales, and ephemeral and intermittent streams)", effectively making maintenance or restoration of channels and gullies within a project site a site design requirement.

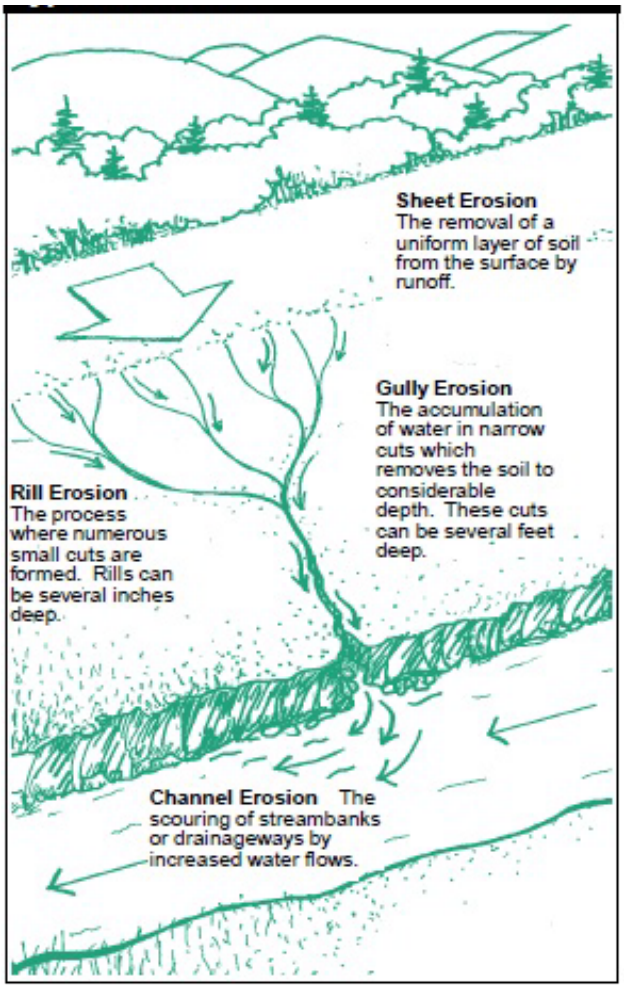

Figure H.8-7 Different Erosion Processes that Contribute Sediment

Source: http://www.fairfaxcounty.gov/nvswcd/youyourland/soil.htm

Sediment yield from hillslope processes (sheet and rill erosion) can be estimated using the Revised Universal Soil Loss Equation (RUSLE) and a sediment delivery ratio. For channel processes, the best available regional datasets are the USGS National Hydrography Dataset (NHD) and the NHDPlus dataset from USEPA and USGS (http://www.horizon-systems.com/nhdplus/). Both these datasets may not include the lowest order channels or gullies in the stream network, which can contribute a considerable amount of sediment produced from channel processes. Since the lower order channels and gullies originate and are mostly on the hillslopes, it is assumed for the Sp analysis that the sediment yield from lower order channels and gullies is proportional to the sediment yield from hill slopes. Based on feedback received during the TAC meetings (Appendix H.5.1) the following distribution is proposed for the calculation of Sp:

- 70% of bed sediment yield ratio from RUSLE analysis (assumed to account for sediment yield from hillslope processes (sheet and rill erosion) and channels and gullies not part of the NHDPlus dataset); and

- 30% of bed sediment yield ratio from channels in the NHDPlus dataset.

Note:

- If an applicant elects to map the waters of the state, the Sp distribution shall be revised to
  - 40% of bed sediment yield ratio from RUSLE analysis;
  - 30% of bed sediment yield ratio from waters of the state that are not part of NHDPlus dataset; and
  - 30% of bed sediment yield ratio from channels in the NHDPlus dataset.

SCALE OF ANALYSIS

The project applicant shall perform the Sp analysis at point (or points) where runoff leaves the project site[26]. The steps for performing an Sp analysis are shown in Figure H.8-8 and described below.

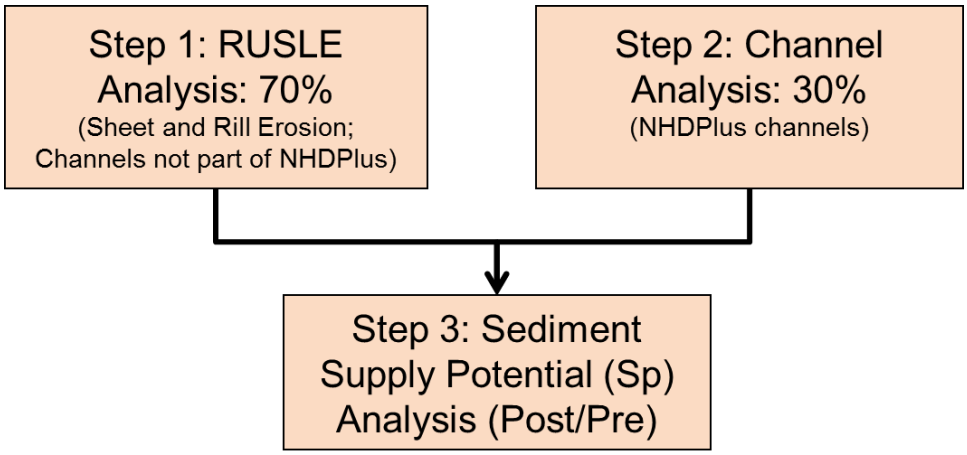

Figure H.8-8 Sediment Supply Potential Flow Chart

STEP 1: RUSLE ANALYSIS

RUSLE analysis is assumed to account for sediment yield from hillslope processes (sheet and rill erosion) and channels and gullies not part of the NHDPlus dataset. The change in bed sediment yield in the post-project condition compared to the pre-project condition using the RUSLE analysis must be estimated using equation H.8.9. This equation is a modified form of the standard RUSLE equation. Only hillslopes that are anticipated to generate coarse sediment must be used in this

[26] In limited scenarios, the County has the discretion allow for a watershed-scale Sp analysis to be performed at the point of compliance it the future built-out conditions of the watershed are used in the analysis.

analysis. Since Sp is a dimensionless index the terms that are relatively constant in the pre and post project condition, such as rainfall factor, have been removed.

$$SY_{RUSLE} = \frac{Post-Project \sum\{A \times K \times LS \times C \times P\}}{Pre-Project \sum\{A \times K \times LS \times C\}}$$ Equation H.8.9

Where:

A = Hillslope Area (acres)

K = Soil erodibility factor, this value can be obtained from regional K factor map from SWRCB or web soil survey or site-specific grain size analysis

LS = Slope length and steepness factor, this value can be obtained from the regional LS factor map from SWRCB or site-specific determination using look up tables based on slope and horizontal slope length from USDA Agriculture Handbook Number 703 (Renard et al., 1997) or other relevant sources

C= Cover management factor, use regional C factor map from USEPA or site-specific information; this is the reciprocal of the amount of surface cover on soil, whether it be vegetation, temporary mulch or other material. It is roughly the percentage of exposed soil, i.e., 95 percent cover yields a "C" value of 0.05. Use C=0 for areas where management actions are implemented (e.g. impervious areas)

P = Practice factor, only included in post-project condition. This term is added to account for sediment yield from engineered slopes. Practice factor of 0.25 shall be used for fill slopes and a practice factor of 0.50 shall be used for cut slopes. Use a practice factor of 1 for undisturbed areas.

The applicant may be allowed to receive credit for bed sediment yield from engineered slopes on the project perimeter directly discharging to conveyance systems if <u>all</u> of the following criteria are met:

- The engineered slopes consist of coarse bed material. This is confirmed by performing grain size distribution per ASTM D422 for the engineered slope and verifying that the d_{50} is greater than no. 200 sieve (0.074 mm).
- Cover factor in the post project condition shall not be greater than the cover factor used in the pre project condition for the same area.
- A maximum practice factor of 0.25 may applied to proposed fill slopes. A maximum practice factor of 0.50 may be applied to proposed cut slopes.
- A statement from the geotechnical engineer is included in the SWQMP certifying that the engineered slope will be stable even after accounting for bed sediment generation and the anticipated soil loss during the planned lifetime of the engineered slope is acceptable.

Additional analysis and/or documentation may be requested by the County prior to approval of the credit for bed sediment yield from engineered slopes.

STEP 2: CHANNEL ANALYSIS

If an NHDPlus mapped channel exists within the project property boundary, applicants must consider the sediment production from this existing channel system. The change is bed sediment yield in the post-project condition compared to the pre-project condition from channels in the NHDPlus dataset must be estimated using equation H.8.10 (SY_{NHD}). This equation is based on screening-level GIS calculations of stream length that will be contributing sediment in the post-project condition in the watershed tributary to the point of compliance.

$$SY_{NHD} = \frac{L_{post}}{L_{pre}} \qquad \text{Equation H.8.10}$$

Where:

L_{post} = Length of NHDplus streams in the watershed contributing to bed sediment supply in the post-project condition [miles]

L_{pre} = Length of NHDplus streams in the watershed contributing to bed sediment supply in the pre-project existing condition [miles]

STEP 3: SEDIMENT SUPPLY POTENTIAL ANALYSIS

Sediment Supply Potential (Sp) is defined as the ratio of post-project/pre-project (existing) long-term bed sediment supply. Sp must be calculated using equation H.8.11 presented below:

$$S_p = 0.7 \times SY_{RUSLE} + 0.3 \times SY_{NHD} \qquad \text{Equation H.8.11}$$

Where:

S_p = Sediment Supply Potential [unitless]

SY_{RUSLE} = Change in bed sediment yield from hillslopes and lower order channels and gullies not part of NHDPlus dataset [unitless]

SY_{NHD} = Change in bed sediment yield from channels in NHDPlus dataset [unitless]

When estimating Sp the following additional conditions apply:

- Projects that do not have onsite NHDPlus channels shall omit consideration of SY_{NHD} and weighting factors depicted in Equation H.8.11. This simply results in Sp = $SY_{RUSLE.}$
- It must be assumed that the sediment yield from an area that drains to a structural BMP is zero. Consideration of sediment yield from an area draining to the structural BMP may be allowed if sediment bypass measures are implemented upstream of the structural BMP. However, additional analysis may be requested by the County to substantiate the sediment yield estimates proposed by the applicant from implementing sediment bypass measures.
- For scenarios where an upstream coarse sediment yield area drains through the project footprint and the project footprint cuts off conveyance of bed sediment generated upstream

of the project footprint to the point of compliance, (e.g., via debris basins) the contribution from the upstream area shall be assumed to be zero.

As applicable, the applicant must use Worksheet H.8.2-1 to document the Sp calculations for each point of compliance.

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Sediment Supply Potential (Sp) Analysis												Worksheet H.8.2-1
1	Scale of Analysis						☐ Project Scale ☐ Watershed Scale (built-out condition)					
Step 1: RUSLE Analysis												
2	GLU	Pre-Project					Post-Project					
		A	K	LS	C	A*K*LS*C	A	K	LS	C	P	A*K*LS*C*P
	1											
	2											
	3											
	4											
	5											
	6											
	7											
	8											
	Add additional rows as needed											
3	Sum Pre-Project						Sum Post-Project					
4	SY_{RUSLE}: (Sum Post-Project/ Sum Pre-Project) (From Line 3)											unitless
Step 2: Channel Analysis: NHDPlus Channels												
5	L_{pre} (from GIS analysis of pre-project existing condition)											miles
6	L_{post} (from GIS analysis of post-project condition)											miles
7	SY_{NHD}: (Line 6 / Line 5)											unitless
Step 3: Sediment Supply Potential Analysis												
8	RUSLE Analysis Bed Sediment Yield Ratio Calculated (Line 4)											unitless
9	Channel Bed Sediment Yield Ratio from NHDPlus dataset (Line 7)											unitless
10	Sediment Supply Potential Calculated using Equation H.8.11. (0.7 x Line 8 + 0.3 x Line 9)											unitless

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H.9 Mitigation Measures Fact Sheets

The following fact sheets were developed to assist the project applicants with designing mitigation measures:

- Additional flow control
- Stream Rehabilitation

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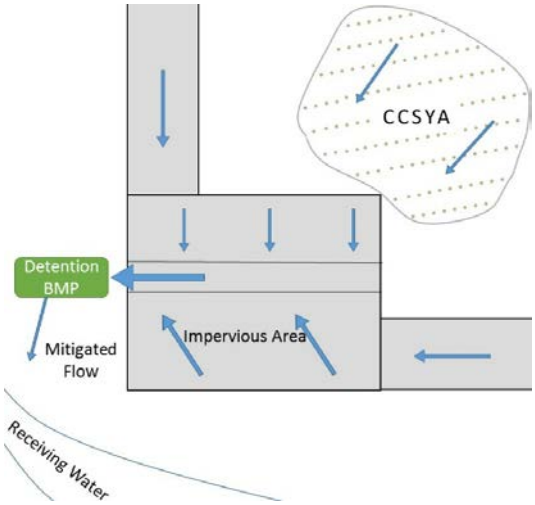
H.9.1 Additional Flow Control



Description

Additional flow control refers to the modification of post-development flow rates and durations beyond the levels required by standard HMP criteria (i.e. control of flow rates and durations from Q_c to Q10). Additional flow control can mitigate the effect of decreased sediment delivery by equivalently limiting sediment transport capacity. BMPs providing additional flow control are detention/retention type BMPs and will typically be larger than those that meet HMP criteria only. The performance standard for additional flow control can be demonstrated through the NII management standard.

Management Standard and Sizing Approach

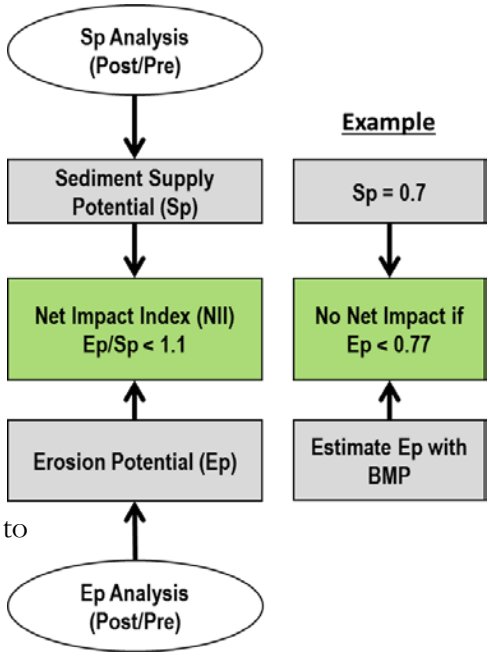
The management standard additional flow control BMPs need to meet to demonstrate that there is no net impact to the receiving waters is presented in the equation below:

$$NII = \frac{Ep}{Sp} \leq 1.1$$

Where:

Ep: is the ratio of post-project/pre-development sediment transport capacity

Sp: ratio of post-project/pre-project (existing) long-term bed sediment supply



Note: Redevelopment projects typically do not have critical coarse sediment yield areas onsite because management actions have been implemented onsite (e.g. impervious areas, etc.). Refer to Appendix H.8 for methodologies to calculate Ep and Sp.

Project applicants must demonstrate that the NII management standard will be met under the post-project scenario through the following steps:

1. Calculate the Sp at the point of compliance using guidance in Appendix H.8.2.

2. Determine the Target Ep: $Ep_{Target} \leq 1.1 * Sp$
3. Calculate the pre-development sediment transport capacity or work (Ep denominator). Refer to Section 6.3.3 for definition of pre-development and refer to Appendix H.8.1 for guidance on calculating the sediment transport capacity or work.
4. Iteratively size additional flow control BMPs and calculate the post-project sediment transport capacity (Ep numerator) until the target Ep is reached.
5. Summarize the calculations performed to size the BMPs in the SWQMP.

In addition to the general approach outlined above, additional flow control BMPs must meet the design criteria presented in the Appendix E Fact Sheets. Deviations from these criteria may be approved at the discretion of the County if it is determined appropriate.

Design Adaption for Project Goals

NII management standard is met by additional flow control. Larger BMPs may be able to provide adequate additional flow control to meet the required performance standard. In this scenario no additional sediment BMPs are required.

For example, project that has an Sp = 0 (i.e. 100% of the bed sediment in the drainage area to the point of compliance is impacted by the project) can be mitigated by designing a BMP such that there is no discharge within the geomorphically significant flow range (i.e. Q_c to Q_{10}).

NII management standard is not fully met by additional flow control. Additional flow control alone may not be able to entirely meet the NII management standard due to site, or other, constraints. In scenarios where the target Ep cannot be met by additional flow control, additional BMPs that increase the supply of bed sediment or reduce the susceptibility of the receiving channel will be required.

Note: Additional flow control BMPs can be independent BMPs that provide flow control only or they can be integrated with storm water pollutant control BMPs.

Conceptual Design and Sizing Approach

The following steps detail an approach that can be used to appropriately size BMPs that provide additional flow control:

Step 1: **Calculate the Sediment Supply Potential (Sp) based on pre- and post-project condition at the point of compliance.**

- Refer to Appendix H.8.2 for methodology to calculate Sp. Applicant must document this analysis using Worksheet H.8.2-1.

Step 2: D**etermine the Target Ep based on the results of Step 1.**

- $Ep_{Target} \leq 1.1 * Sp$

Step 3: **Perform continuous simulation modeling for pre-development condition.**

- Perform continuous simulation (refer to Appendix G) for the pre-development condition.
- Determine the flow durations for the pre-project scenario as described in Appendix G.1.6.2.

Step 4: Perform pre-development work analysis.

- Calculate the cumulative work performed by the range of geomorphically significant flows for the pre-development scenario, (refer to Step 3 and Step 4 in Appendix H.8.1 for calculation of work).

Step 5: **Implement flow control BMPs and perform continuous simulation modeling for post-project scenario.**

- Appropriately size pollutant control and hydromodification management BMPs according to the procedures presented in this manual.
- Perform continuous simulation (refer to Appendix G) for the post-project condition.
- Determine the flow durations for the post-project scenario as described in Appendix G.1.6.2.
- Typically, BMPs sized to satisfy the flow duration control will provide for some level of Sp reduction and will ensure that the minimum design standards and sizing requirements are met.

Step 6: **Perform post-project work analysis.**

- Follow the steps presented in Step 4 to determine the post-project total work.

Step 7: **Calculate Ep and determine if Target Ep has been met.**

- Divide the post-project total work by the pre-development total work and determine if the target Ep has been met.
- If the target Ep is met by the standard BMPs, document results and compliance with hydrologic and sediment supply performance standards.
- If the target Ep is not met, proceed to Step 8.

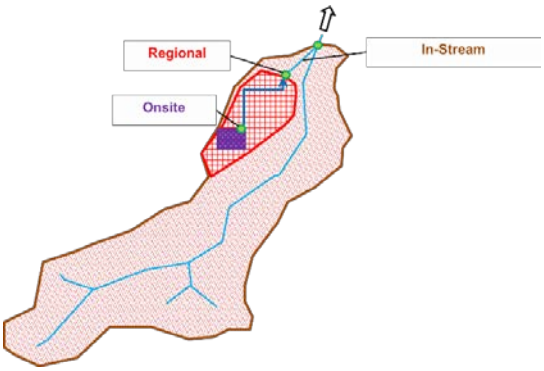
Step 8: Provide additional flow control storage and calculate Ep.

- Following the procedures presented in the previous steps, iteratively calculate Ep for increasingly large BMPs until the target Ep is met.
- Document results and compliance with hydrologic and NII management standard.

As applicable, the applicant must use Worksheet H.8.1-1, Worksheet H.8.2-1 and Worksheet H.9.1-1 to document sizing of the additional flow control mitigation measure.

Additional Flow Control Mitigation Measure		Worksheet H.9.1-1	
1	Sediment Supply Potential (Line 10 of Worksheet H.8.2-1)		unitless
2	Attached completed Worksheet H.8.2-1 and associated documentation	☐ Yes ☐ No	
3	Target Ep ≤ 1.1 * Line 1		unitless
4	Erosion Potential (Line 16 of Worksheet H.8.1-1)		unitless
5	Attached completed Worksheet H.8.1-1 and associated documentation	☐ Yes ☐ No	
6	Is Line 4 ≤ Line 3? If Yes, NII management standard is met. If No, increase the size of the BMP and recalculate Line 4.	☐ Yes ☐ No	

H.9.2 Stream Rehabilitation



Description

Hydromodification control can be achieved by stream rehabilitation projects including: drop structures, grade control structures, bed and bank reinforcement, increased channel sinuosity or meandering, increased channel width, and flow diversion. The objective of these in-stream controls, or stream restoration measures, is to reduce or maintain the overall Erosion Potential (Ep) of the receiving channel. Stream rehabilitation option is only available when the receiving channel of concern is already impacted by erosive flows and shows evidence of excessive sediment, erosion, deposition, or is a hardened channel.

Management Standard and Sizing Approach

The management standard stream rehabilitation projects need to meet to demonstrate that there is no net impact to the receiving waters is presented in the equation below:

$$NII = \frac{Ep}{Sp} \leq 1.1$$

Where:

Ep: is the ratio of post-project/pre-development sediment transport capacity

Sp: ratio of post-project/pre-project (existing) long-term bed sediment supply

Note: Stream rehabilitation project reduce Ep by modifying the stream's hydraulic properties and/or bed/bank material resistance without fully replacing sediment supply or controlling increases in runoff. Refer to Appendix H.8 for methodologies to calculate Ep and Sp.

Design Adaption for Project Goals

The following describes different types of stream rehabilitation projects that could be implemented to meet the NII management standard by reducing or maintaining the overall Ep:

Drop Structures: Drop structures are designed to reduce the average channel slope, thereby reducing the shear stresses generated by stream flows. These controls can be incorporated as natural looking rock structures with a step-pool design which allows drop energy to be dissipated into the pools while providing a reduced longitudinal slope between structures.

Grade Control Structures: Grade control structures are designed to maintain the existing channel slope while allowing for minor amounts of local scour. These control measures are often buried and entail a narrow trench across the width of the stream backfilled with concrete or similar material, as well as the creation of a "plunge pool" feature by placing boulders and vegetation on the downstream side of the sill. A grade control structure provides a reduced footprint and impact as compared to drop structures, which are designed to alter the channel slope.

Bed and Bank Reinforcement: Channel reinforcement serves to increase bed and bank resistance to instream erosion. A number of vegetated approaches are widely used. Such approaches include large woody debris, live crib walls, vegetated mechanically stabilized earth, live siltation, live brushlayering, willow posts and poles, live staking, live fascine, rootwad revetment, live brush mattresses, and vegetated reinforcement mats. These technologies provide erosion control that stabilizes bed and bank surfaces and allows for re-establishment of native plants, which serves to further increase channel stability.

Channel Sinuosity: Increasing channel sinuosity (meandering) can serve to reduce the channel slope, thereby reducing the shear stresses generated by stream flows. However, forcing a channel to be too sinuous is likely to lead to subsequent channel avulsion (cutting a new stream path) to a straighter course. Channel sinuosity needs to be supported by a geomorphic basis of design that shows the proposed form and gradient are appropriate for the valley slope, sediment, and water regime. This support may take the form of reference reaches in similar watersheds that have supported the proposed morphology over a significant period of time, or comparison between the proposed form and typical literature values.

Channel Widening: Increasing the width-to-depth ratio of a stream's cross section is meant to spread flows out over a wider cross section with lower depths, thereby reducing shear stress for a given flow rate. This approach can be a useful management strategy in incised creeks to restore them to equilibrium conditions once vertical incision has ceased. As with sinuosity, it is important to develop a robust geomorphic basis of design that shows the increase in width-to-depth ratio to be sustainable.

Flow Diversion: Flow diversions can be designed to divert the excess flows caused by development to an hydromodification management exempt water body so that the shear stresses do no increase in the susceptible receiving water. When diversions are proposed to a water body exempt through watershed management area analysis, the applicant is required to provide a supporting analysis that the excess flows diverted to the exempt water body do not invalidate the exemption.

Design Considerations

Each stream rehabilitation project is to some degree unique because of differences in geomorphic process, morphology and previous watershed history. For this reason, this fact sheet does not provide a prescriptive 'cookery book' approach for rehabilitating streams, but instead provides guidelines and recommendations. Shields (1996) provides a helpful overview of the analytical steps involved in stream restoration and Shields et al. (1999) provides examples of approaches used to rehabilitate incised channels. Applicant will need to provide geomorphic and engineering information to support their proposed project approach. It is recommended that multiple lines of technical evidence be used by applicants to develop creek restoration plans based on the preponderance of evidence for design criteria such as channel width, depth, slope and planform. It is also important to understand that all creek rehabilitation projects must comply with relevant Federal, State and local regulations and permits. These will likely include obtaining permits from the RWQCB, USACE and California DF&W, and may involve additional permits or consultation with USDF&W and FEMA, as well as permits from the local jurisdiction. The proposed design shall also meet local drainage design guidelines for channel design.

Appendix

I

Forms and Checklists

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Appendix I Forms and Checklists

The following Forms/Checklists/Worksheets were developed for use by the project applicant to document the storm water management design and were not included in Appendix A:

- I.1 Form I-8: Categorization of Infiltration Feasibility Condition
- I.2 Form I-9: Factor of Safety and Design Infiltration Rate
- I.3 Structural BMP Acceptance Memorandum
- I.4 Structural BMP Label Template

I.1 Categorization of Infiltration Feasibility Condition

Categorization of Infiltration Feasibility Condition	Form I-8

Part 1 - Full Infiltration Feasibility Screening Criteria

Would infiltration of the full design volume be feasible from a physical perspective without any undesirable consequences that cannot be reasonably mitigated?

Note that it is not necessary to investigate each and every criterion in the worksheet if infiltration is precluded. Instead a letter of justification from a geotechnical professional familiar with the local conditions substantiating any geotechnical issues will be required.

Criteria	Screening Question	Yes	No
1	**Is the estimated reliable infiltration rate below proposed facility locations greater than 0.5 inches per hour?** The response to this Screening Question must be based on a comprehensive evaluation of the factors presented in Appendix C.2 and Appendix D.		

Provide basis:

Summarize findings of studies; provide reference to studies, calculations, maps, data sources, etc. Provide narrative discussion of study/data source applicability.

2	**Can infiltration greater than 0.5 inches per hour be allowed without increasing risk of geotechnical hazards (slope stability, groundwater mounding, utilities, or other factors) that cannot be mitigated to an acceptable level?** The response to this Screening Question must be based on a comprehensive evaluation of the factors presented in Appendix C.2.		

Provide basis:

Summarize findings of studies; provide reference to studies, calculations, maps, data sources, etc. Provide narrative discussion of study/data source applicability.

Form I-8 Page 2 of 4			
Criteria	Screening Question	**Yes**	**No**
3	**Can infiltration greater than 0.5 inches per hour be allowed without increasing risk of groundwater contamination (shallow water table, storm water pollutants or other factors) that cannot be mitigated to an acceptable level?** The response to this Screening Question must be based on a comprehensive evaluation of the factors presented in Appendix C.3.		
Provide basis: Summarize findings of studies; provide reference to studies, calculations, maps, data sources, etc. Provide narrative discussion of study/data source applicability.			
4	**Can infiltration greater than 0.5 inches per hour be allowed without causing potential water balance issues such as change of seasonality of ephemeral streams or increased discharge of contaminated groundwater to surface waters?** The response to this Screening Question must be based on a comprehensive evaluation of the factors presented in Appendix C.3.		
Provide basis: Summarize findings of studies; provide reference to studies, calculations, maps, data sources, etc. Provide narrative discussion of study/data source applicability.			
Part 1 Result *	If all answers to rows 1 - 4 are "**Yes**" a full infiltration design is potentially feasible. The feasibility screening category is **Full Infiltration** If any answer from row 1-4 is "**No**", infiltration may be possible to some extent but would not generally be feasible or desirable to achieve a "full infiltration" design. Proceed to Part 2		

*To be completed using gathered site information and best professional judgment considering the definition of MEP in the MS4 Permit. Additional testing and/or studies may be required by Agency/Jurisdictions to substantiate findings

Form I-8 Page 3 of 4

Part 2 – Partial Infiltration vs. No Infiltration Feasibility Screening Criteria

Would infiltration of water in any appreciable amount be physically feasible without any negative consequences that cannot be reasonably mitigated?

Criteria	Screening Question	Yes	No
5	**Do soil and geologic conditions allow for infiltration in any appreciable rate or volume?** The response to this Screening Question must be based on a comprehensive evaluation of the factors presented in Appendix C.2 and Appendix D.		

Provide basis:

Summarize findings of studies; provide reference to studies, calculations, maps, data sources, etc. Provide narrative discussion of study/data source applicability and why it was not feasible to mitigate low infiltration rates.

6	**Can Infiltration in any appreciable quantity be allowed without increasing risk of geotechnical hazards (slope stability, groundwater mounding, utilities, or other factors) that cannot be mitigated to an acceptable level**? The response to this Screening Question must be based on a comprehensive evaluation of the factors presented in Appendix C.2.		

Provide basis:

Summarize findings of studies; provide reference to studies, calculations, maps, data sources, etc. Provide narrative discussion of study/data source applicability and why it was not feasible to mitigate low infiltration rates.

Form I-8 Page 4 of 4			
Criteria	Screening Question	**Yes**	**No**
7	**Can Infiltration in any appreciable quantity be allowed without posing significant risk for groundwater related concerns (shallow water table, storm water pollutants or other factors)?** The response to this Screening Question must be based on a comprehensive evaluation of the factors presented in Appendix C.3.		
Provide basis: Summarize findings of studies; provide reference to studies, calculations, maps, data sources, etc. Provide narrative discussion of study/data source applicability and why it was not feasible to mitigate low infiltration rates.			
8	**Can infiltration be allowed without violating downstream water rights**? The response to this Screening Question must be based on a comprehensive evaluation of the factors presented in Appendix C.3.		
Provide basis: Summarize findings of studies; provide reference to studies, calculations, maps, data sources, etc. Provide narrative discussion of study/data source applicability and why it was not feasible to mitigate low infiltration rates.			
Part 2 Result*	If all answers from row 1-4 are yes then partial infiltration design is potentially feasible. The feasibility screening category is **Partial Infiltration.** If any answer from row 5-8 is no, then infiltration of any volume is considered to be **infeasible** within the drainage area. The feasibility screening category is **No Infiltration.**		

*To be completed using gathered site information and best professional judgment considering the definition of MEP in the MS4 Permit. Additional testing and/or studies may be required by Agency/Jurisdictions to substantiate findings

I.2 Factor of Safety and Design Infiltration Rate Worksheet

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Factor of Safety and Design Infiltration Rate Worksheet			Form I-9		
Factor Category		Factor Description	Assigned Weight (w)	Factor Value (v)	Product (p) p = w x v
A	Suitability Assessment	Soil assessment methods	0.25		
		Predominant soil texture	0.25		
		Site soil variability	0.25		
		Depth to groundwater / impervious layer	0.25		
		Suitability Assessment Safety Factor, $S_A = \Sigma p$			
B	Design	Level of pretreatment/ expected sediment loads	0.5		
		Redundancy/resiliency	0.25		
		Compaction during construction	0.25		
		Design Safety Factor, $S_B = \Sigma p$			
Combined Safety Factor, $S_{total} = S_A \times S_B$					
Observed Infiltration Rate, inch/hr, $K_{observed}$ (corrected for test-specific bias)					
Design Infiltration Rate, in/hr, $K_{design} = K_{observed} / S_{total}$					
Supporting Data					
Briefly describe infiltration test and provide reference to test forms:					

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I.3 Structural BMP Maintenance Guarantees

I.3.1 Category 1: Maintenance Agreement Notification

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RECORDING REQUESTED BY: WHEN RECORDED MAIL TO: *(property owner)*	

SPACE ABOVE THIS LINE FOR RECORDER'S USE

MAINTENANCE NOTIFICATION AGREEMENT FOR CATEGORY 1 STORMWATER STRUCTURAL BMP's

THIS AGREEMENT is made on the _____ day of _____, 20_____.
_____, the Owner(s) of the hereinafter described real property:
Address_____ Post Office _____ Zip Code _____
Assessor Parcel No.(s) _____

List, identify, locate (plan/drawing number) and describe the Structural

_____

_____

Owner(s) of the above property acknowledge the existence of the storm water Structural Best Management Practice on the said property. Perpetual maintenance of the Structural BMP(s) is the requirement of the State NPDES Permit, Order No. R9-2015-0001, Section E.3.e.(1)(c) and the County of San Diego Watershed Protection Ordinance (WPO) Ordinance No. 10385 Section 67.812 through Section 67.814, and County BMP Design Manual (BMP DM) Chapters 7 & 8. In consideration of the requirement to construct and maintain Structural BMP(s), as conditioned by Discretionary Permit, Grading Permit, and/or Building Permit (as may be applicable), I/we hereby covenant and agree that:

1. I/We are the owner(s) of the existing (or to be constructed concurrently) premises located on the above described property.
2. I/We shall take the responsibility for the perpetual maintenance of the Structural BMP(s) as listed above in accordance with the maintenance plan and in compliance with County's self-inspection reporting and verification for as long as I/we have ownership of said property(ies).
3. I/We shall cooperate with and allow the County staff to come onto said property(ies) and perform inspection duties as prescribed by local and state regulators.
4. I/We shall inform future buyer(s) or successors of said property(ies) of the existence and perpetual maintenance requirement responsibilities for Structural BMP(s) as listed above and to ensure that such responsibility shall transfer to the future owner(s).
5. I/We will abide by all of the requirements and standards of Section 67.812 through Section 67.814 of the WPO (or renumbering thereof) as it exists on the date of this Agreement, and which hereby is incorporated herein by reference.

This Agreement shall run with the land. If the subject property is conveyed to any other person, firm, or corporation, the instrument that conveys title or any interest in or to said property, or any portion thereof, shall contain a provision transferring maintenance responsibility for Structural BMP(s) to the successive owner according to the terms of this Agreement. Any violation of this Agreement is grounds for the County to impose penalties upon the property owner as prescribed in County Code of Regulatory Ordinances, Title 1, Division 8, Chapter 1 Administrative Citations §§18.101-18.116.

_____ _____
Owner(s) Signature(s)

_____ _____
Print Owner(s) Name(s) and Title

STATE OF CALIFORNIA)
COUNTY OF _____)

On _____ before me, _____Notary Public,
personally appeared _____ who proved to me on the basis of satisfactory evidence to be the person(s) whose name(s) is/are subscribed to the within instrument and acknowledged to me that he/she/they executed the same in his/her/their authorized capacity(ies), and that by his/her/their signature(s) on the instrument the person(s) or the entity upon behalf of which the person(s) acted, executed the instrument.
I certify under PENALTY OF PERJURY under the laws of the State of California that the foregoing paragraph is true and correct.
WITNESS my hand and official seal.

Include Exhibits that illustrate:

- the Project Site Vicinity;
- the Project Site Map; and
- a map for each BMP and it's Drainage Management Area .

Samples of each of these map types are shown in Figure I.11-1 through Figure I.11-4.

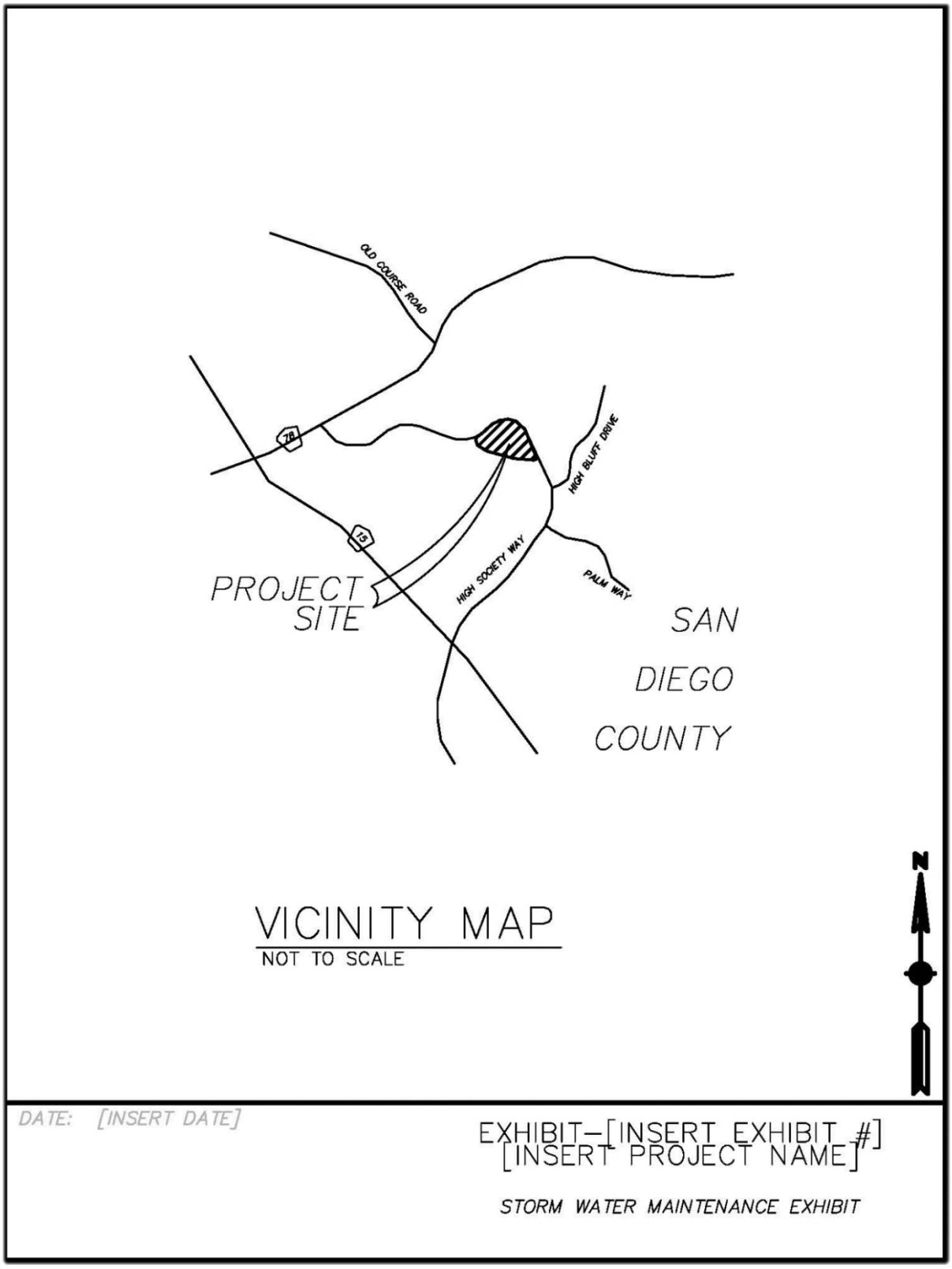

Figure I.11-1 Sample Vicinity Map

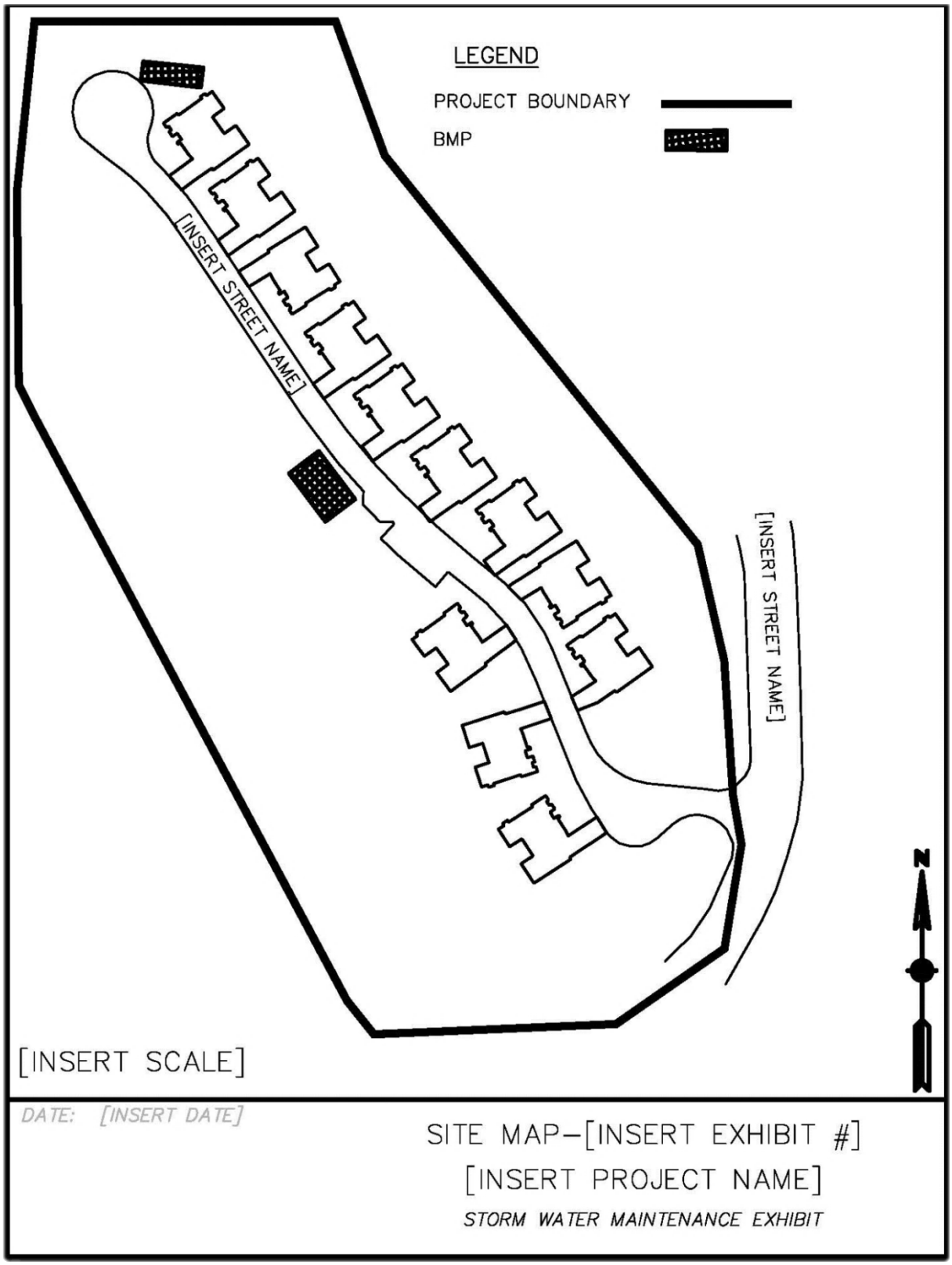

Figure I.11-2 Sample Site Map Showing Structural BMP Location

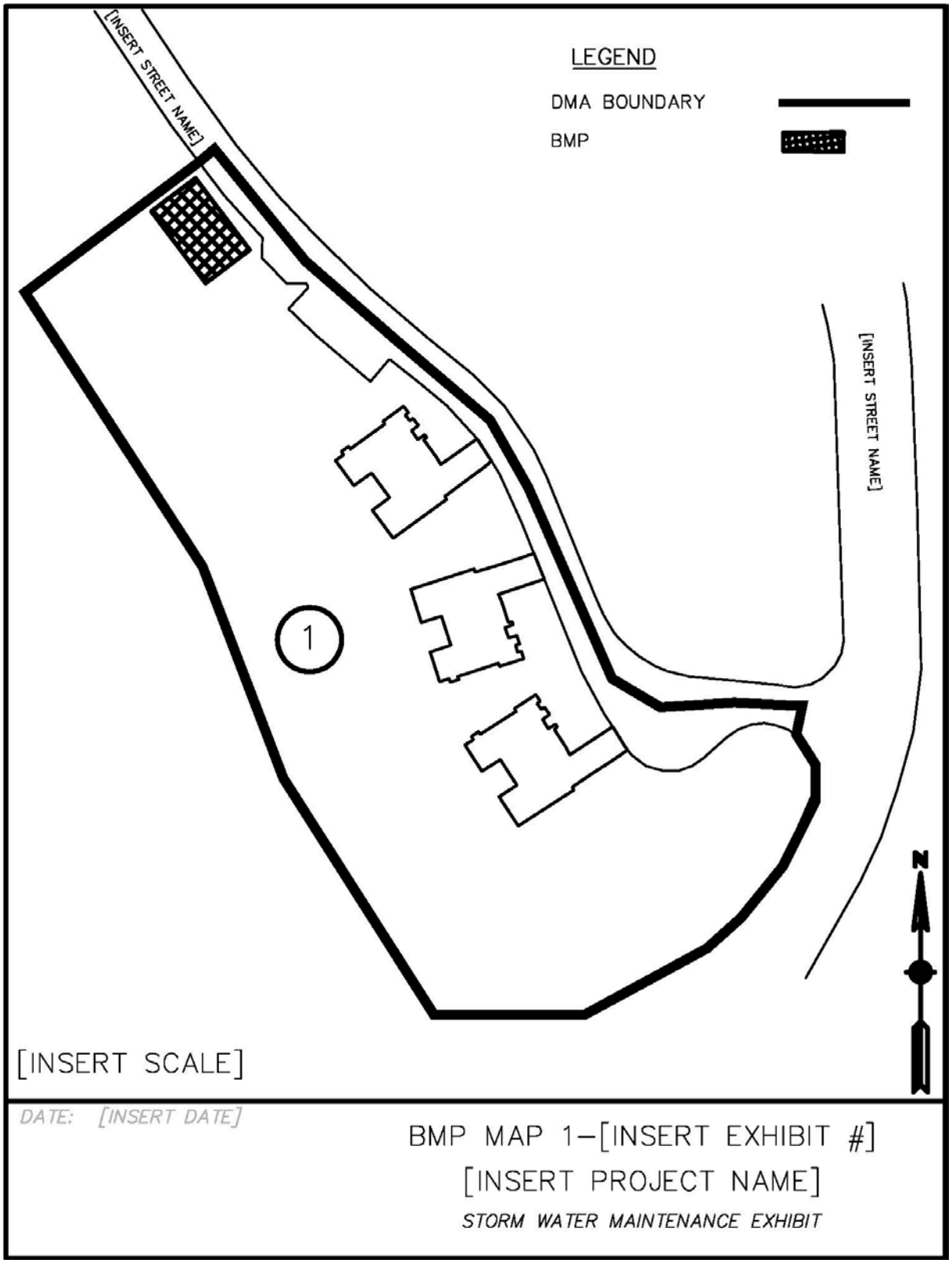

Figure I.11-3 Sample Structural BMP Map 1

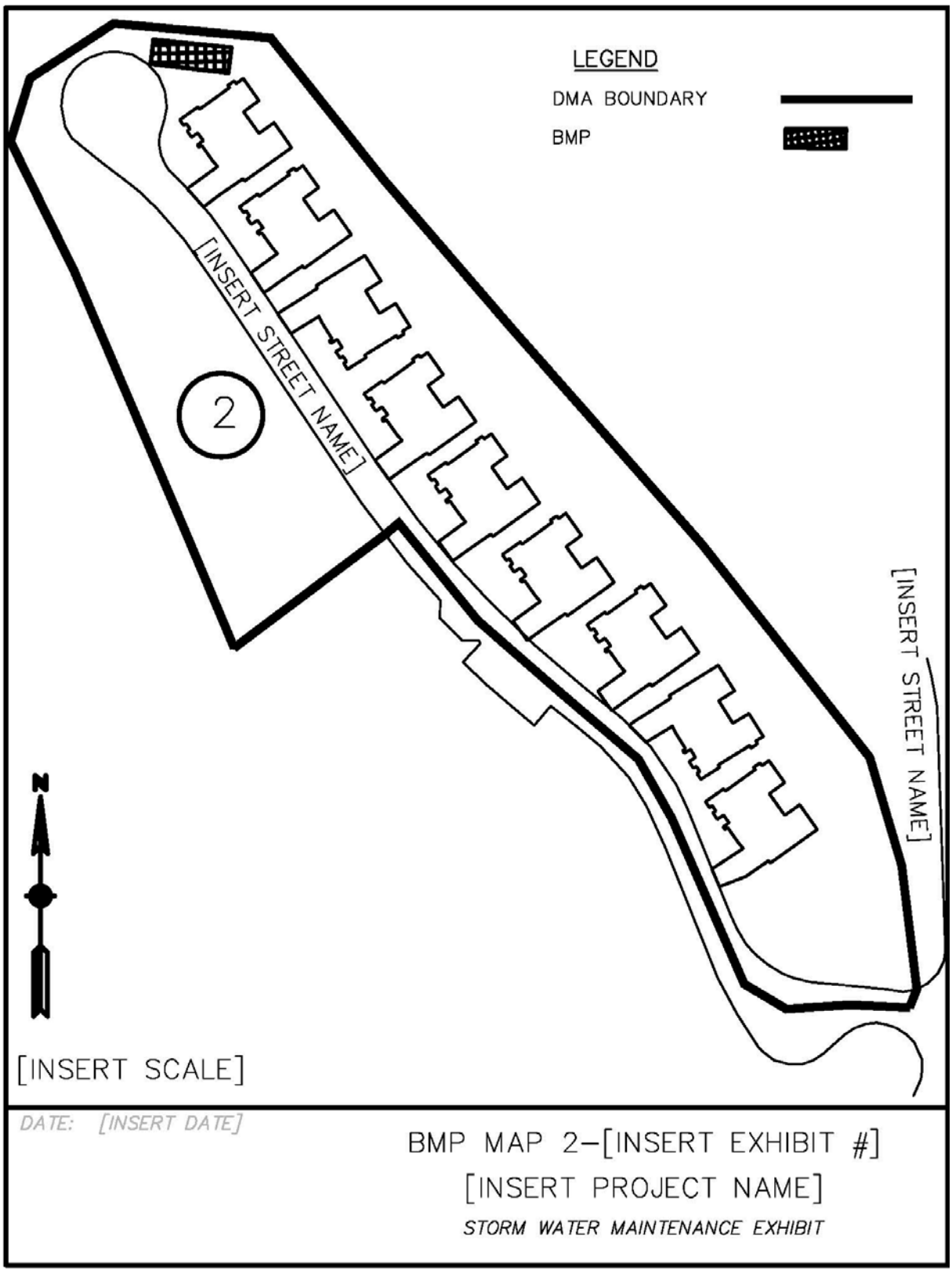

Figure I.11-3 Sample Structural BMP Map 2

I.3.2 Category 2: Storm Water Facilities Maintenance Agreement

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REQUEST AND INSTRUCTIONS FOR PREPARATION OF STORM WATER FACILITIES MAINTENANCE AGREEMENT

Provide the following information, to enable PDS to prepare the "STORMWATER FACILITIES MAINTENANCE AGREEMENT, WITH EASEMENT AND COVENANTS":

#	Done	Information to be Inserted

[1] ☐ County staff document custodian to receive document after recording will be:

_____ _____

Name of Custodian Mail Stop

[2] ☐ Provide applicable Project **Reference Number(s)**:

Tentative Map:	TM_____
Tentative Parcel Map:	TPM_____
Grading Plan / Grading Permit:	L-_____
Major Use Permit:	MUP_____
Site Plan:	STP_____

[3] ☐ Provide EXACT **name of Owner** [This must be word-for-word, letter-for-letter identical to vesting title information]:

_____

Name of Owner

[4] ☐ Indicate the status of the Owner:

☐ a natural person; or

☐ a business entity.

If the Owner is a business entity, then please indicate what type ("a California Corporation", "a [other state] Corporation", "a California General Partnership", "a California Limited Partnership" or "a California Limited Liability Company"):

_____

Type of Owner's Business Entity

[5] ☐ Create and attach an "Exhibit A", which is an accurate Legal Description of the property involved in the entire project

[6] ☐ Provide brief Description of Type of Project [E.g. "a 100-unit residential subdivision"]:

_____

Project Description

[7] ☐ Provide official name, number and date of plan or drawing which shows the BMPs in detail ["Improvement Plans", "Site Plan", "Grading Plans" etc.]:

_____ _____ _____

Type of Plan Plan Number Plan Date

[8] ☐ Create and attach an "Exhibit B", using the format of Attachment 2 ("BMP MAINTENANCE PROGRAM") as an example.

[9] ☐ Create and attach an "Exhibit C", which shows the locations of the installed BMPs.

[10] Advise us whether the on-site easement to be granted to the County to access and maintain the BMPs, covers:

☐ the entire project property; or

☐ a smaller area

☐ If "a smaller area" is checked, then create and provide an Exhibit C, being a legal description of the access and maintenance area

[11] ☐ If a private off-site easement or right of way is used to access the PROPERTY, please provide the following information about the off-site easement:

_____

Date of Easement

_____

Grantor of Easement

_____

Grantee of Easement

_____
Date Easement Was Recorded

_____
Recording File/Page No. or Document No.

☐ ALSO, please attach a copy of the Easement and a copy of a "plan view" drawing showing the Easement, if available.

[12] Advise us whether the owner will provide as security:

~~☐ a Letter of Credit; or~~ ☐ a Cash Deposit

[13] ☐ Specify the amount of the security:

$_____

[14] ☐ Provide Name and Address of the person who the Owner designates as his/her/its Agent for administration of the Agreement and receipt of notices:

Name: _____

Address: _____

[15] Advise us whether or not the project is a **Common Interest Development**:

☐ No ☐ Yes

[16] ☐ Provide the Name(s) and title(s) of **persons who will sign** agreement for the Owner:

_____
Name

_____
Title

If the Owner (see #3 above) is a natural person, County Counsel will assume that person will sign the agreement, and will so provide in the signature block. If the Owner is a business entity, please indicate the names and titles of all persons who will sign on behalf of the business entity.

A sample signature block for a corporation would look like:

"Clean Water, Inc., a California Corporation

By: _____ _____
John Q. Adams, President Date

By: _____ _____
Adam Q. Johns, Secretary Date"

Include Exhibits that illustrate:

- the Project Site Vicinity;
- the Project Site Map; and
- a map for each BMP and it's Drainage Management Area .

Samples of each of these map types are shown in Figure I.11-1 through Figure I.11-4.

I.3.3 Category 4: Maintenance Acceptance Memorandum

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COUNTY OF SAN DIEGO ▪ DEPARTMENT OF PUBLIC WORKS

I.11.4 Category 4: STRUCTURAL BMP ACCEPTANCE MEMORANDUM

Project No: APN:

The Structural BMPs on project: _____
Project Name

have been completed in accordance with the Stormwater Quality Management Plan (SWQMP) and approved Grading and/or Improvement Plans and is recommended for County acceptance for ongoing maintenance. A list of **Structural BMPs** and **map** showing their location must be attached.

Yes **No**

☐ ☐ Permanent Stormwater Structural Best Management Practices have been installed in accordance with the WPO and BMP Design Manual requirements.

Location description:
Transfer Date:

RECOMMENDED FOR ACCEPTANCE	**COMMENTS**
Resident Engineer Date	
Operations Manager Date	
Project Manager Date	
Construction Project Manager Date	
Construction Program Manager Date	
Other Date	

Distribution: Operations Manager ; Project Manager ; Materials Lab ; Traffic Engineering ; Resident Engineer ; Project File ; Watershed Protection Program ; Others ;

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I.4 Structural BMP Label Template



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Appendix

J

Offsite Alternative Compliance Requirements and Guidance

February 26, 2016

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Appendix J Offsite Alternative Compliance Requirements and Guidance

J.1 Background

The 2013 MS4 Permit lowers the minimum threshold necessary to trigger classification of projects as Priority Development Projects (PDPs) and sets forth more stringent onsite requirements for stormwater pollutant control and hydromodification management. It also allows the County and other Copermittees to establish programs under which project applicants may satisfy applicable PDP requirements through the completion of offsite Alternative Compliance Projects (ACPs).

The MS4 Permit provides two potential pathways in which participation in an offsite alternative compliance program may be determined necessary or allowable. The first pathway is when an applicant has determined that the PDP cannot meet all of the onsite pollutant control obligations via retention and/or biofiltration. This pathway requires performing feasibility analyses for retention and biofiltration BMPs prior to participation in an offsite alternative compliance program. The County may also allow for an applicant to proceed directly to an offsite alternative compliance project without demonstrating infeasibility of retention and/or biofiltration BMPs onsite.

The County Watershed Protection Ordinance (WPO) incorporates the MS4 Permit requirements and provides the policies for implementation with the unincorporated county.

- Section 67.811(b)(4)(C) establishes the requirements for the flow-thru treatment control BMPs to be implemented onsite by the PDP; and
- Section 67.811(b)(6) establishes the ability to utilize offsite alternative compliance projects in lieu of complying with pollutant control and hydromodification BMP performance requirements onsite.
- Offsite ACPs are considered an extension of the PDPs to which they correspond. They must be designed, constructed and maintained consistent with all applicable requirements of Provision E.3.e of the 2013 MS4 Permit and WPO Section 67.812.

This Appendix introduces the types and varieties of ACPs that may potentially be allowed by the County, conditions and restrictions applicable to them, and requirements for obtaining approvals and implementing offsite ACPs in the unincorporated County of San Diego.

J.2 Key Concepts

IMPLEMENTATION SCENARIOS

In accordance with the 2013 MS4 Permit, the December 2015 *Water Quality Equivalency (WQE) Guidance for Region 9* (WQE Guidance) establishes two ACP implementation scenarios that may be included in Copermittee programs, (1) Applicant-implemented ACPs, and (2) Independent ACPs.

- **Applicant-implemented ACPs** are those for which a project applicant owns or proposes to construct an ACP that will be functional[27] prior to the final release of the proposed PDP. The defining feature of Applicant-implemented ACPs is that the same party is legally responsible for ensuring that all applicable requirements (e.g., design, construction, operation and long term maintenance) are satisfied for both the ACP and the PDP. Because only a single applicant is involved, ACPs can be approved in the absence of a Credit System to track and trade associated Water Quality Impacts and Water Quality Benefits.
- **Independent ACPs** are projects initiated independently of specific PDP impacts. In most instances, they are owned, constructed, or otherwise under the control of a party other than the PDP applicant. Because the completion and approval of Independent ACPs involves more than one legally responsible party, these projects can only be used to mitigate for PDPs within a RWQCB-approved credit system.

At this time, Independent ACPs cannot be approved in the unincorporated County of San Diego. Until such time as the County establishes an in lieu fee structure and/or RWQCB-accepted credit system, Independent ACPs are not allowed under the MS4 Permit. However, please note that Applicant-implemented ACPs providing treatment control or hydromodification benefits in excess of impacts associated with a corresponding PDP may be able to "bank" this additional capacity for future use in the event that a qualifying credit system is established. Applicants are therefore encouraged to fully document excess benefits for potential future application.

ACP TYPES

There are two primary types of ACP: Structural BMPs and Natural System Management Practices (NSMPs). **Structural BMPs** are a subset of BMPs which detain, retain, filter, remove, or prevent the release of pollutants to surface waters from development projects in perpetuity, after

[27] For ACPs implemented under an in lieu fee structure, a 4-year time frame for completion of the ACP is allowable. However, applicable treatment or hydromodification performance standards must be met through temporal mitigation of the PDP impacts until the final ACP controls are fully functional.

construction of the project is completed. These can be further subdivided according to the following project categories:

- A **Retrofit BMP** adds or modifies structural BMPs in areas of existing development where practices do not already exist, are ineffective, or can be significantly enhanced.
- A **Regional BMP** treats stormwater from a tributary consisting of more than one development. Its primary purpose is to improve water quality, protect downstream channels, reduce flooding, or to meet other specific jurisdictional water quality objectives.
- A **Water Supply BMP** captures stormwater and infiltrates, pumps, or otherwise replenishes groundwater, surface water reservoirs, or other water supply systems.

NSMPs are practices that are implemented to restore and/or preserve predevelopment watershed functions in lieu of providing direct management of stormwater pollutant control and hydromodification flow control. NSMPs include projects that either reduce the release of pollutants through the reduction of runoff volume (e.g.; removal of impervious surfaces) or provide hydromodification management through the restoration of a sensitive stream segment to address impacts caused by the PDP and legacy impacts. They can include structural or engineered elements as part of the system, but non-engineered elements also provide some level of pollutant control and/or hydromodification management benefits. NSMPs include the following project categories:

- **Land Restoration** permanently restores currently developed land back to a stabilized, predevelopment condition. Land Restoration may provide quantifiable stormwater pollutant control and hydromodification flow control benefits by restoring the predevelopment stormwater runoff volumes, peak flows, and pollutant concentrations of a tributary.
- **Land Preservation** permanently preserves undeveloped land in its current state. In limited scenarios, Land Preservation may provide quantifiable stormwater pollutant control and hydromodification flow control benefits by preventing increases in stormwater runoff volumes, peak flows, and pollutant concentrations associated with the future built out condition of a tributary.
- **Stream Rehabilitation** restores a stream to a natural, stabilized condition that can accommodate both legacy and future hydromodification impacts. Stream Rehabilitation may provide quantifiable hydromodification flow control benefits through permanent stabilization of streams. In limited scenarios, Stream Rehabilitation may also provide quantifiable stormwater pollutant control benefits by reducing impervious channel surfaces.

POTENTIAL ACP BENEFITS

Water quality equivalency for stormwater pollutant control is demonstrated when the stormwater pollutant control benefits provided by the ACP are greater than or equal to the stormwater pollutant control impacts generated by the PDP. These benefits may include either of the following:

- **Stormwater Pollutant Control (pollutant or volume reduction), and**
- **Hydromodification Flow Control**

Both structural BMPs and NSMPs can provide pollutant control or hydromodification management benefits, or a combination of both. Regardless of the proposed implementation scenario, applicant options will vary depending both on the ACP type and benefit under consideration. **Figure J-1** summarizes the current availability of different ACP type-benefit combinations. The availability of specific options is largely dependent on the current state of science regarding the demonstration of each benefit type. Because the availability of options is likely to change over time, applicants are advised to consult with staff to make sure they are fully aware of their current availability.

Figure J-1: Current Availability ACP Options by Type and Benefit (Source: *Water Quality Equivalency Guidance for Region 9*)

ACP Category	Stormwater Pollutant Control Benefits				Hydromod Flow Control Benefits
	Pollutant Reduction			Volume Reduction	
	Retention	Biofiltration	Flow-Thru		
Retrofit	**Available**	**Available**	Limited Availability	**Available**	**Available**
Regional	**Available**	**Available**	Limited Availability	**Available**	**Available**
Water Supply	**Available**	**Available**	Limited Availability	**Available**	**Available**
Land Restoration	*Not Available*	*Not Available*	*Not Available*	**Available**	**Available**
Land Preservation	*Not Available*	*Not Available*	*Not Available*	Limited Availability	**Available**
Stream Rehabilitation	*Not Available*	*Not Available*	*Not Available*	Limited Availability	**Available**

J.3 Requirements for ACPs in the County of San Diego

The requirements below are applicable if participating in an offsite alternative compliance program. Section 1.8 of the County BMP Design Manual describes policy and procedural requirements for development projects in greater detail. Applicants should also check with County staff for additional information on the availability of, and requirements pertaining to, specific ACP options. As previously noted, all ACP projects are required to utilize the WQE Guidance. This guidance provides additional detail on the general concepts associated with implementing an ACP along with methodologies for calculating the ACP benefits, example calculations and Water Quality Equivalency Worksheets which can be found at Projectcleanwater.org.

PDP REQUIREMENTS

A PDP wishing to utilize offsite alternative compliance must apply the following requirements to the PDP:

- Determine the portion of the design capture volume or total impervious area not managed on the PDP site;
- Provide onsite flow-thru treatment control BMPs that provide a medium to high pollutant removal efficiency to treat runoff leaving the site consistent with the guidance in Section 5.5.4 of the BMP Design Manual and the methodology for selecting and sizing BMPs described in Appendix B.6; and
- Provide temporal mitigation if the ACP is constructed after the completion of the development project that ensures equivalent or better pollutant removal and/or hydrologic control (as applicable) as compared to the case where the ACP is completed at the same time as the PDP.

ACP REQUIREMENTS

A PDP wishing to utilize offsite alternative compliance must apply the following requirements to the ACP:

- The ACP must demonstrate the water quality benefits generated are greater than or equal to the impact of the PDP that is not treated onsite;
- The benefits generated by ACP must be determined utilizing the water quality equivalency metrics established in the *December 2015 Water Quality Equivalency (WQE) Guidance for Region 9* (WQE Guidance), or any other WQE Guidance Document subsequently accepted by the RWQCB;
- The ACP must be located within the same watershed management area (WMA) as the PDP project;

- The ACP must implement all applicable site design and source control BMPs in accordance with the requirements Section 4 of BMP Design Manual;
- ACPs that are Structural BMPS must be designed in accordance with the requirements in Sections 5 and 6 of the BMP Design Manual;
- ACPs designed to manage hydromodification flow control must meet the location requirements defined in the WQE Guidance; and
- The ACP applicant must ensure effective operation and maintenance in perpetuity consistent with the requirements in Section 7 of the BMP Design Manual.

In addition to the above requirements, any ACP that is partially or wholly located in the County Right-of-way must obtain approval from the Authorized Enforcement Officer.

J.4 Submittal Requirements for Offsite Alternative Compliance Projects

The ACP must be documented using an ACP SWQMP Template provided in Appendix A of the County BMP Design Manual and consistent with the submittal requirements in Section 8. Any time a design change to the PDP site layout and/or features occurs that requires the PDP SWQMP to be updated; the ACP SWQMP must be reviewed to ensure that the ACP still provides a greater or equal water quality benefit consistent with the requirements of this Manual and the MS4 Permit.

Based on the nature of the project proposal, the County has the discretion to request the submittal of additional information above and beyond the minimum the information listed in the ACP SWQMP Template.

Appendix

K

Guidance on Green Infrastructure

February 26, 2016

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Appendix K Guidance on Green Infrastructure

K.1 Guidance on Green Infrastructure

K.2 Green Streets Guidelines

K.3 Green Streets Design Criteria

K.4 Green Streets Design Standard Drawings

K.5 Green Streets Maintenance Schedule

K.6 Green Streets Specifications

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K.1 Guidance on Green Infrastructure

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County of San Diego Guidance on Green Infrastructure

January 2016

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COUNTY OF SAN DIEGO GUIDANCE ON GREEN INFRASTRUCTURE

Green Infrastructure is an approach to stormwater and flood management that protects, restores, and mimics the natural water cycle using vegetation, mulch, soils, and natural processes while creating healthier environments. At the County scale, green infrastructure refers to the network of natural features that provides habitat, flood protection, cleaner air, and cleaner water. At the scale of a neighborhood or site, green infrastructure refers to stormwater and flood management systems that mimic nature by soaking up and storing water.

Roadways present many opportunities for coordinated Green Infrastructure use. A Green Street uses a natural system approach to reduce stormwater flow, improve water quality, reduce urban heating, enhance pedestrian safety, reduce carbon footprints, and beautify neighborhoods. Green Streets are a component of Green Infrastructure, integrating strategies into roads and right-of-ways.

Green Streets Guidelines are an outreach tool and are also intended to serve as a companion to the rest of the Green Streets publications. They include an introduction, strategies, procedures and design examples for implementing Green Streets projects. The strategies include tree wells, rain gardens, rock gardens, and permeable pavement.

Green Streets Design Criteria lay out general definitions, general policy, and landscape design criteria for Green Infrastructure strategies in the right-of-way.

Green Streets Supplement to County Design Standard Drawings includes construction details which may be referenced in improvement plans similar to current County Design standard drawings.

Green Streets Maintenance Schedules include a list with maintenance tasks, frequency, and time of year for initial, routine, and as-needed maintenance of each Green Infrastructure strategy.

Green Streets Specifications include detailed construction material and installation requirements for Green Infrastructure strategies including aggregates, geosynthetics, underdrains, permeable pavement, engineered soil media, mulch, overflow risers, check dams, and tree grates.

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K.2 Green Streets Guidelines

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Green Streets Guidelines

A Guide to Green Street Implementation in the County of San Diego







January 2016

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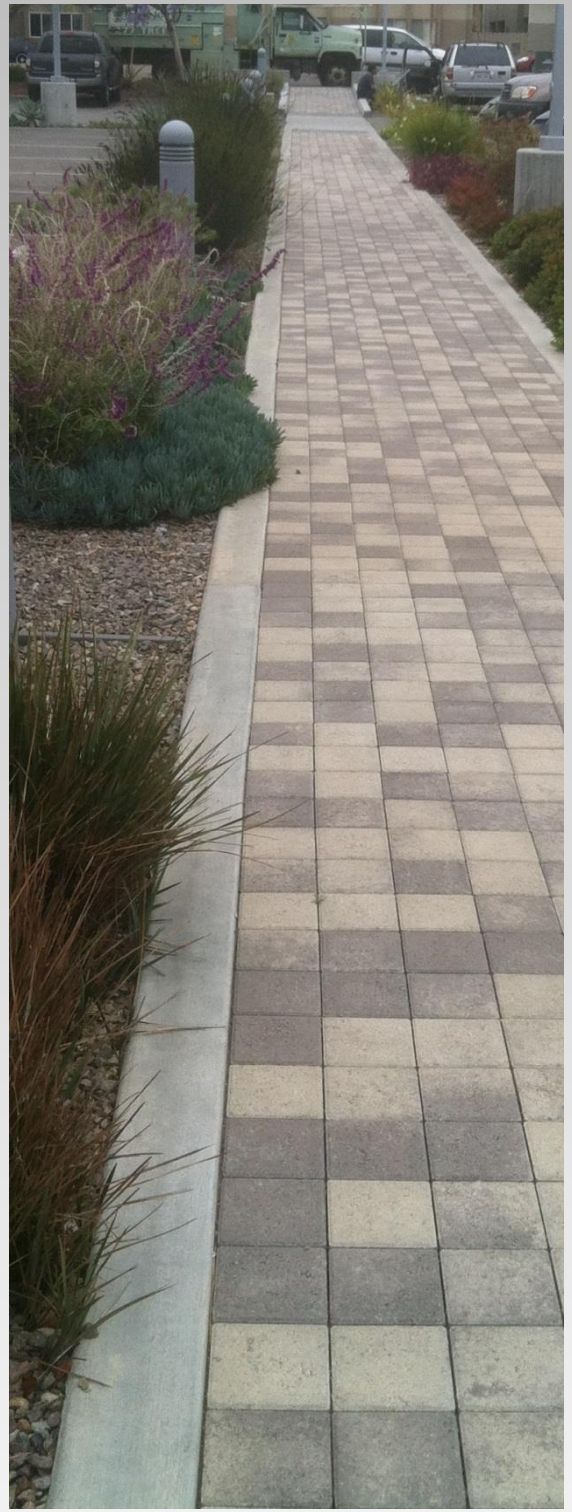

WHAT IS A GREEN STREET?

Pavement on roadways can contribute to excess stormwater runoff and increased levels of pollutants in the County's waterways. Green infrastructure reduces stormwater runoff and improves water quality. The Green Streets program incorporates a wide variety of Green Infrastructure design elements including, but not limited to: tree wells, rain gardens, rock gardens and permeable pavement. The use of Green Streets offers the capability of transforming a significant stormwater and pollutant source into an innovative treatment system.

Additionally, the State of California is in the midst of a severe drought, with water years of 2012-14 recording the driest three consecutive years in the state's history, as well as setting new records for statewide average temperatures. On April 1st, 2015 Governor Brown signed executive order B-29-15 setting the first mandatory statewide water restrictions. This order prohibits ornamental turf on public street medians, and requires a reduction in potable water use for irrigation. The Green Streets program promotes water conservation through the use of low water use and drought tolerant plants (xeriscape) and improving groundwater supplies through infiltration.

Green infrastructure, unlike traditional "gray" infrastructure approaches to stormwater management, provides multiple benefits to communities. Planting more trees and landscaping in public spaces cleans the air, cools the land, provides more habitat for wildlife, adds green maintenance jobs, increases property values and promotes a better, healthier quality of life for San Diego County residents and visitors.

Under the Municipal Separate Storm Sewer System (MS4) Permit for San Diego Region (Permit [Order No. R9-2013-0001]), the County may make Priority Development Project (PDP) Exemptions for projects redeveloping or retrofitting existing paved roads, streets, and alleys as "EPA Green Streets." This is accomplished by meeting the criteria set forth in section 1.4.3 of the County of San Diego BMP Design Manual and based in part on the EPA publication "Green Streets: Municipal Handbook, Managing Wet Weather with Green Infrastructure."

This guide is to be used along with the County's BMP Design Manual for meeting stormwater requirements within the County's public right-of-way. These Green Streets measures, when implemented, will ensure the County remains a green community for many years to come.

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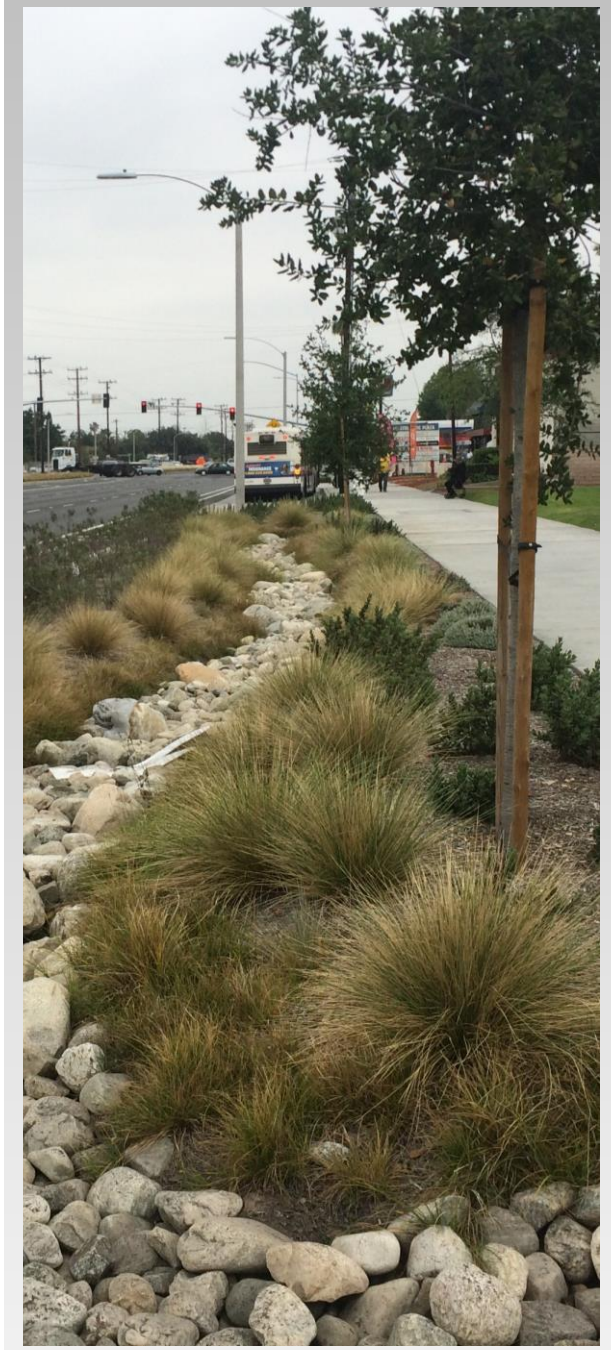




CHAPTER 1 Introduction to Green Streets

1.1 INTRODUCTION

These guidelines have been prepared to assist in the design and construction of projects that retrofit or redevelop existing paved streets and roads. These Guidelines and Standards have been developed in accordance with the United States Environmental Protection Agency Green Streets Guidance "Green Streets: Municipal Handbook, Managing Wet Weather with Green Infrastructure."

These Guidelines may also be used to assist in the design and construction of new or retrofit paved sidewalks, bicycle lanes, or trails.

The functional goals of these guidelines are to:

- Provide source control of stormwater;
- Limit stormwater transport and pollutant conveyance to the collection system;
- Restore predevelopment hydrology to the extent possible by slowing the runoff down and allowing for infiltration; and
- Provide environmentally enhanced roads.

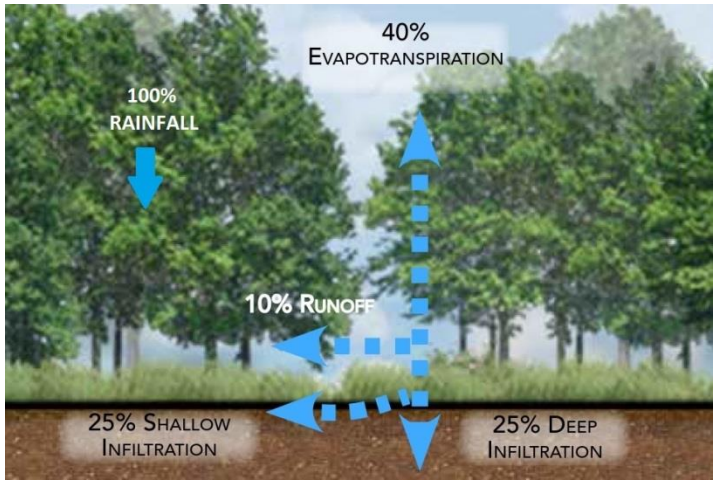
A review of existing County policies has been performed and included in the accompanying Green Streets Standards document that includes an addendum to the Public Road Standards, as well as Green Streets Standard Drawings and Specifications.

Green Streets configurations and locations presented in this guideline are schematic/conceptual in nature. The configurations (or locations) could be modified as long as the design and construction details are in conformance with the Green Streets technical documents (i.e. – Green Streets Supplement to Public Road Standards, Standard Drawings, Specifications, Plant List, and Maintenance Schedule).

1.2 The Natural and Developed Environment

Natural Areas

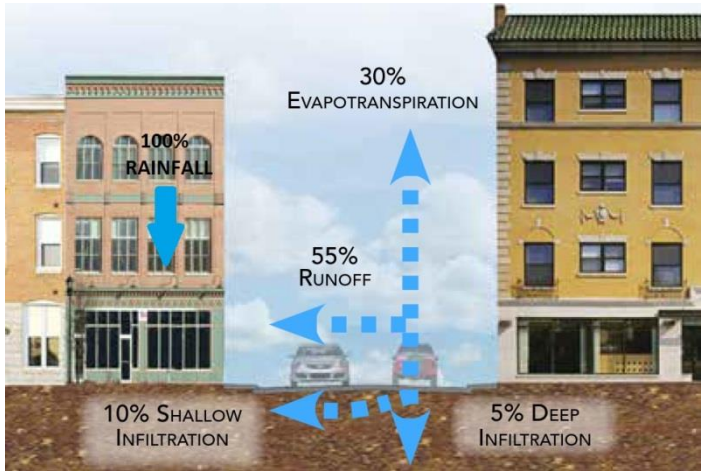
In areas such as meadows, thickets, woodlands, and parks, rain can soak into the ground and be used by plants. Trees and shrubs intercept rainfall and it slowly trickles down to the ground where it is absorbed by mulch and humic soil.
Shaded areas are cooler, moister and provide wildlife habitat. Very little rainwater runs off the ground.



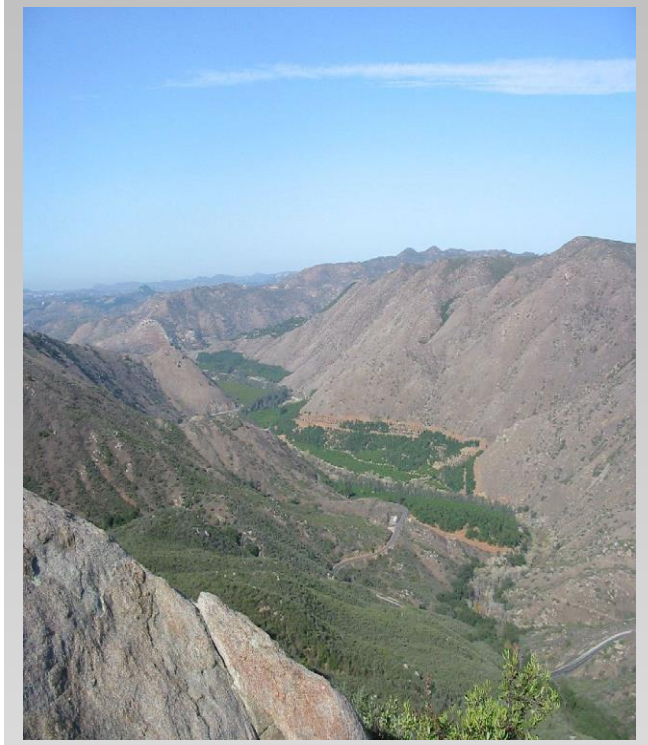
Natural Area Diagram
(Source: DDOT, 2014)

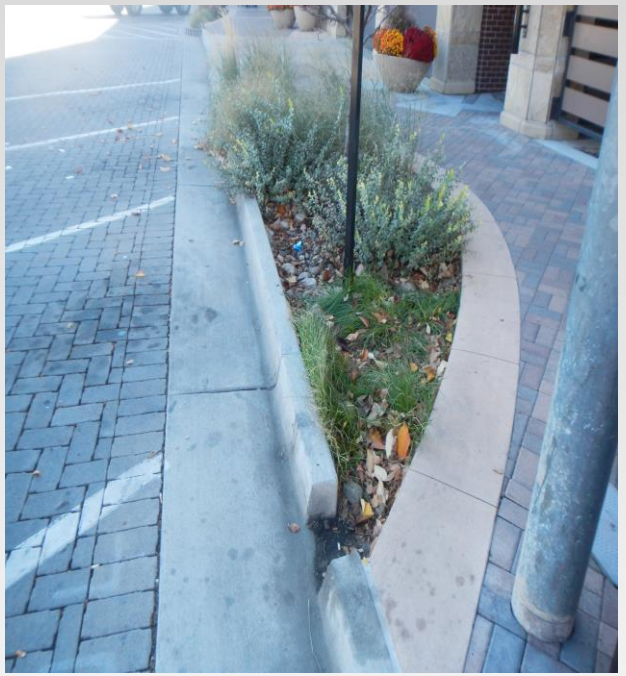
Urban Areas

In urban areas, building rooftops, streets, alleys, sidewalks, and other paved surfaces are smooth and mostly impervious. Very little rain has a chance to soak into the ground. These paved urban areas are hotter and offer very little wildlife habitat. Most of the rain that falls in the urban areas quickly runs off impervious surfaces picking up pollutants and carrying them into storm drains. These flows quickly combine to create flash floods that degrade downstream waterways.

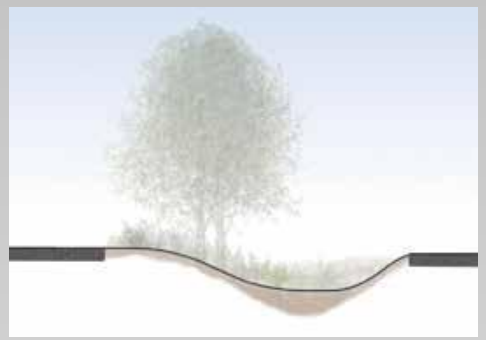


Urban Area Diagram
(Source: DDOT, 2014)



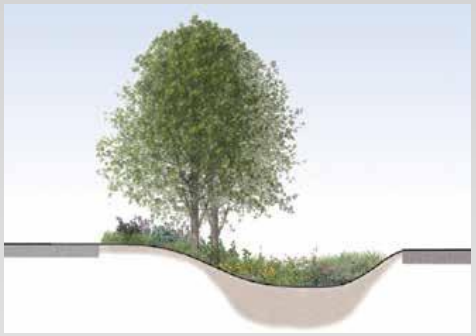


STORMWATER CAPTURE



Runoff from impervious surfacing

STORE



Store and retain captured runoff

INFILTRATE/EVAPOTRANSPIRE

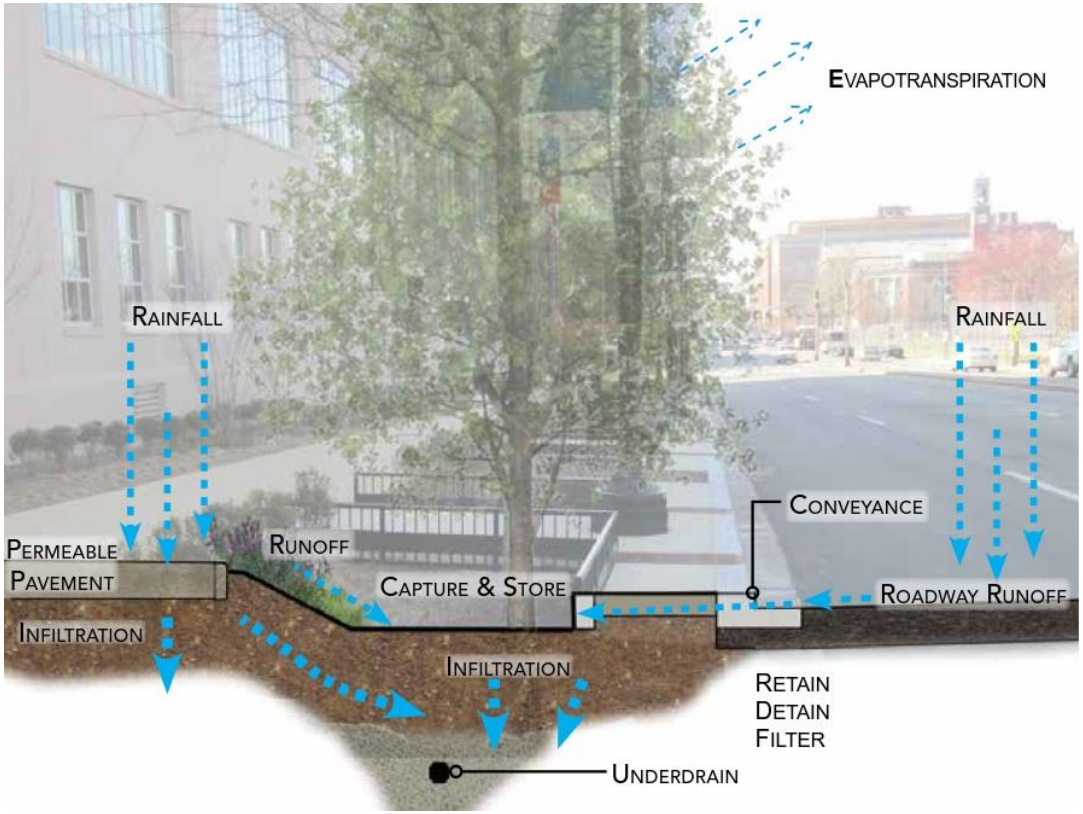


Water is infiltrated into the ground, evapotranspired by plants or drained

(Source: DDOT, 2014)

1.3 GREENING THE STREETS

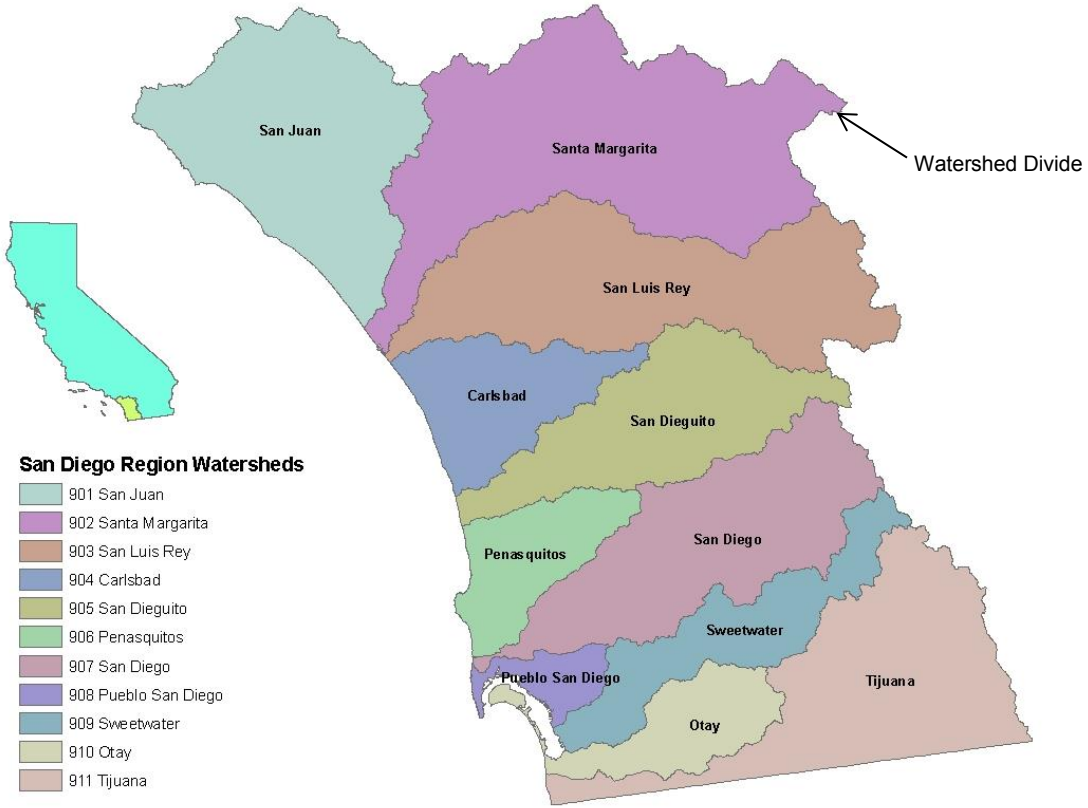
Green Streets, which includes Green Infrastructure (GI), incorporates elements found in natural areas into the County road right of way. GI is the living network that connects impervious areas to landscape areas, natural areas, and waterways. GI captures rainfall; cools buildings and pavement; and creates natural pathways for wildlife. GI includes Low Impact Development (LID) techniques, which mimic nature to capture and treat stormwater as close to the source as possible. When implemented, GI creates living green streets that capture, store, and infiltrate stormwater to treat it as a resource and improve the County environment.

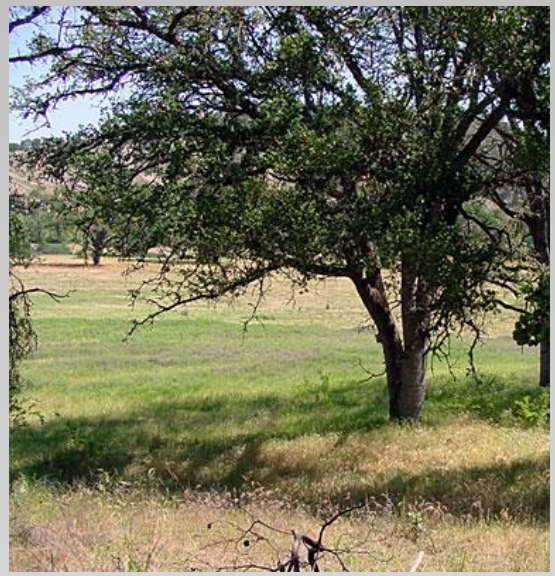


Green Streets Stormwater Diagram
(Source: DDOT, 2014)

1.4 The County Environment

The County of San Diego is a unique environment made up of natural, rural, and urban areas. When rain falls in the County and becomes stormwater runoff, it flows through eleven major watersheds. Stormwater carries the pollutants, trash, and warmer temperatures it collects from roads, buildings, and other impervious surfaces and delivers them into our rivers, streams, bays, lagoons, and ocean. Urbanization and other land use changes in the County can modify the natural watershed hydrologic processes and stormwater runoff characteristics resulting in increased stormwater runoff and erosion.







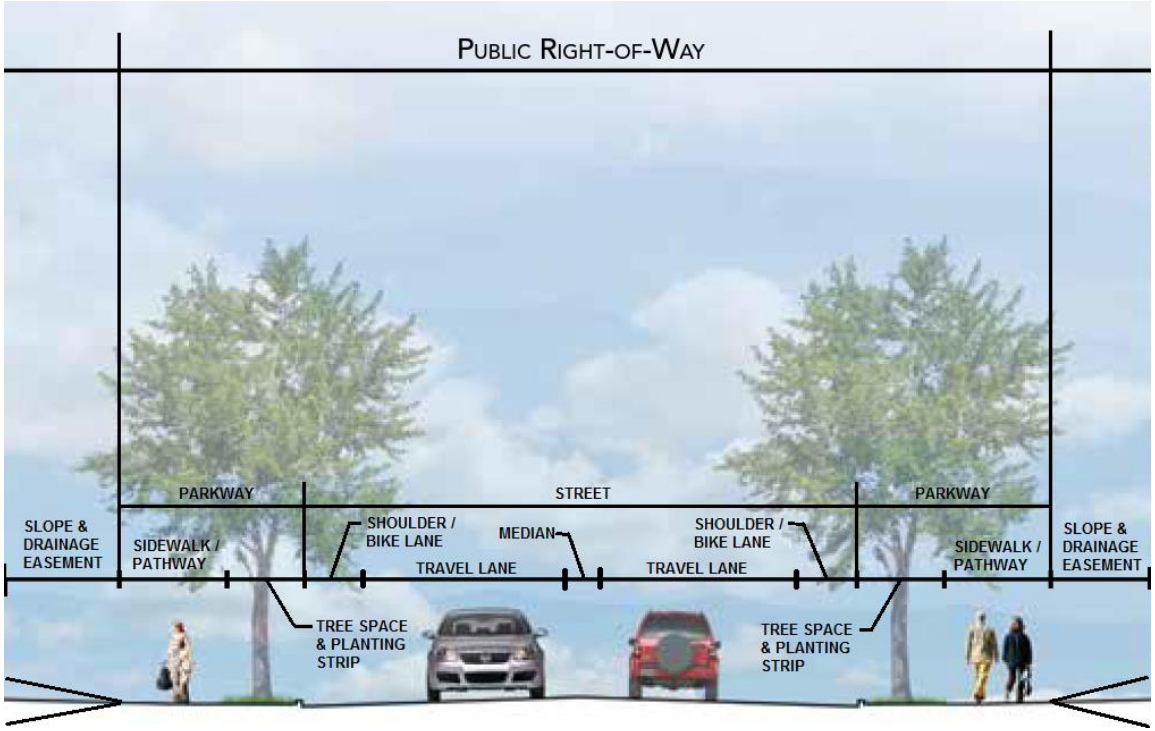


(Source: DDOT, 2014)



1.5 County Right-of-Way

Land within the road right-of-way (ROW) presents a significant opportunity to reduce runoff and improve the urban environment through Green Streets. This manual introduces techniques to install green infrastructure in the median, street, bike lane, shoulder, parkway, and slope and drainage easements. This guide and the "Green Streets Standards," which includes supplements to the Public Road Standards, Green Streets Standard Drawings, and specifications, should be used the maximum extent practicable for all public and private project design in the County ROW.



ROAD RIGHT-OF-WAY DIAGRAM
(Source: DDOT, 2014)

Early in the green street planning and design process careful consideration should be given to the location of existing and proposed utilities and appurtenances (utility poles, vaults, and pedestals), fire hydrants, traffic signals, signage, mail boxes, bus stops, and their interaction with the proposed green street measures.







CHAPTER 2 Green Streets Strategies

2.1 Introduction

Green Streets, including Green Infrastructure (GI), and Low Impact Development (LID) solutions are intended to be sustainable, attractive, and cost effective. The range of opportunities includes tree wells, landscape areas, rain gardens, rock gardens, permeable pavement, and removal of impervious pavement. These strategies use natural processes to reduce the volume of runoff, peak flow, and pollutants. This chapter will focus on five (5) areas appropriate for use in the road right-of-way.

Tree Wells

Trees are a powerful green streets tool due to their ability to intercept water on leaves, slowly deliver it to the mulch and soil, absorb it through root systems, and transpire it as water vapor directly back to the atmosphere.

Rain Gardens

Rain gardens use the natural functions of plants, mulch, and soils to remove pollutants and slow stormwater runoff. The strategy uses storage, sediment capture, and biological processes to clean the water. These mimic processes that occur in nature before water reaches waterways.

Rock Gardens

Rock gardens utilize shallow depressions to provide storage, evapotranspiration, and infiltration. This strategy also slows runoff, reduces peak flows and runoff volume.

Permeable Pavement

Permeable paving systems provide a hard surface, while allowing water to flow through to the underlying soils instead of directly to the drainage system. The areas where this strategy may be used include: sidewalks, pathways, medians, and parking lanes.

Remove Impervious Pavement

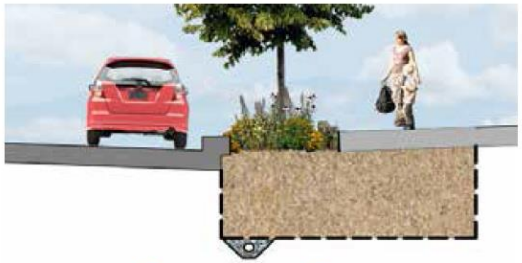
Roadway improvement projects have the opportunity to remove portions of impervious pavement within the right of way and replace it with permeable material.

2.2 Tree wells

Why Are Trees Important?

Trees make a streetscape feel welcoming, help manage stormwater, and reduce the urban heat island effect by providing shade. An urban heat island remains significantly warmer than the surrounding rural areas due to less vegetation. Trees promote air quality, natural habitat, the human environment, and well-being.

Trees in a congested road right-of-way are confined to small planting areas where they struggle to reach a mature size or live a long life. Through the use of Structural Soil, Structural Cell, or Suspended Sidewalk techniques, soil volumes and space for tree roots to grow uninhibited can be greatly increased. These techniques also allow for more water and air to reach the tree roots.



Structural Soils

A specific mix of stone and soil that supports the sidewalk while allowing tree roots to grow normally.



Structural Cells

Manufactured cells support the sidewalk allowing uncompacted soil to promote tree roots to grow below.



Suspended Sidewalk

Thickened sidewalk with reinforcement and/or footings can be used allowing tree roots to grow below the sidewalk.

(Source: DDOT, 2014)



Soil Volume Sizing

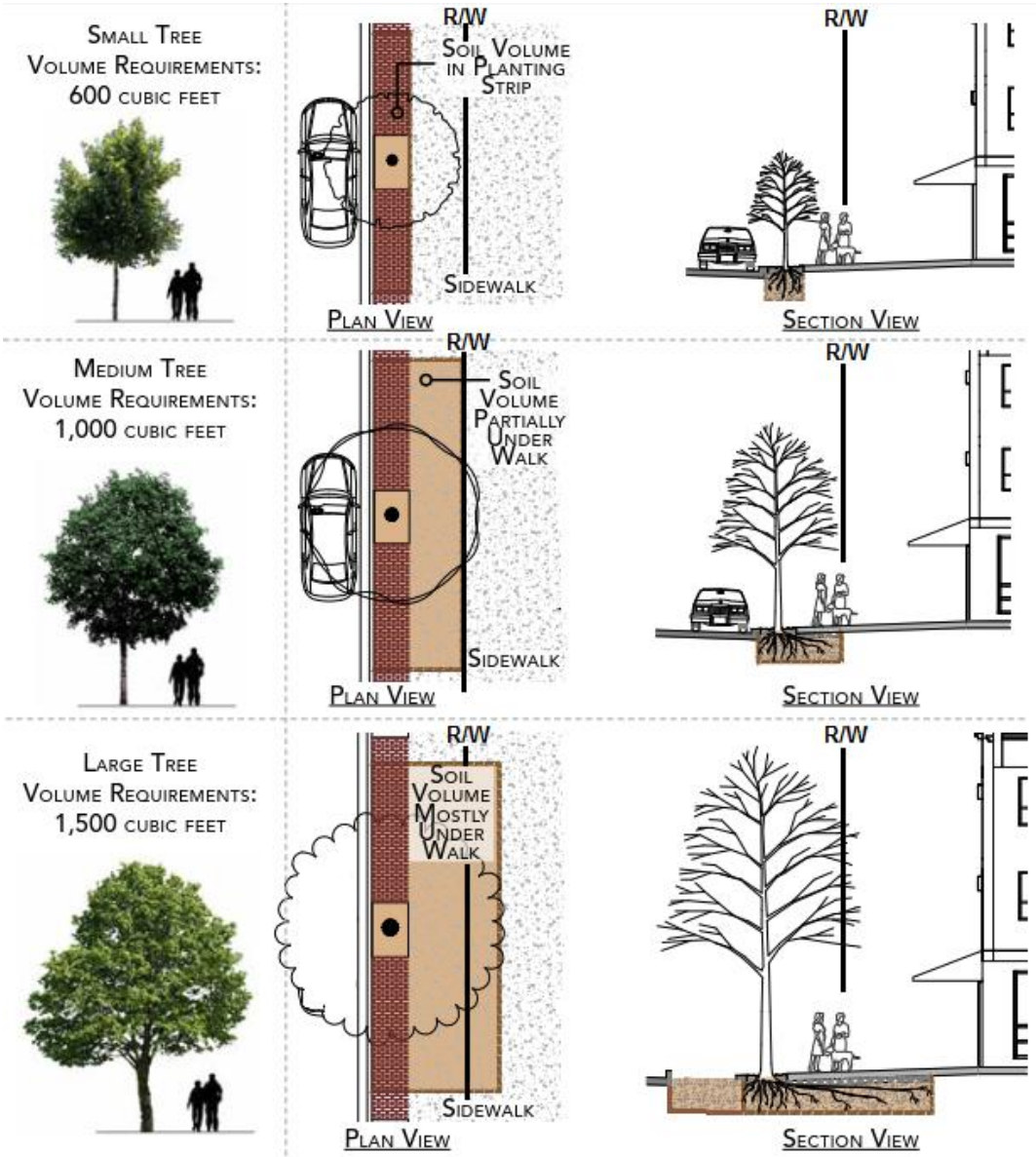
- Adequate planting soil space provides the nutrients, water, air, and root space that trees need to have a long, healthy life.
- The planting soil volume required depends on the fully-grown tree size (generally two cubic feet of soil per one square foot of the tree's mature drip line area).
- Planting soil amendments for trees should be three-feet deep; the length and width must ensure the appropriate volume for the tree species and site.

Other Considerations

- Provide as much open space as possible for the tree to allow the tree to grow and access water.
- Providing structural soils, suspended sidewalks, or structural slabs to edges of paved areas prevents planting soil compaction and encourages tree roots to extend further and into adjacent green areas.
- Evaluate temporary and permanent irrigation needs
- Evaluate utility locations and required clearance.

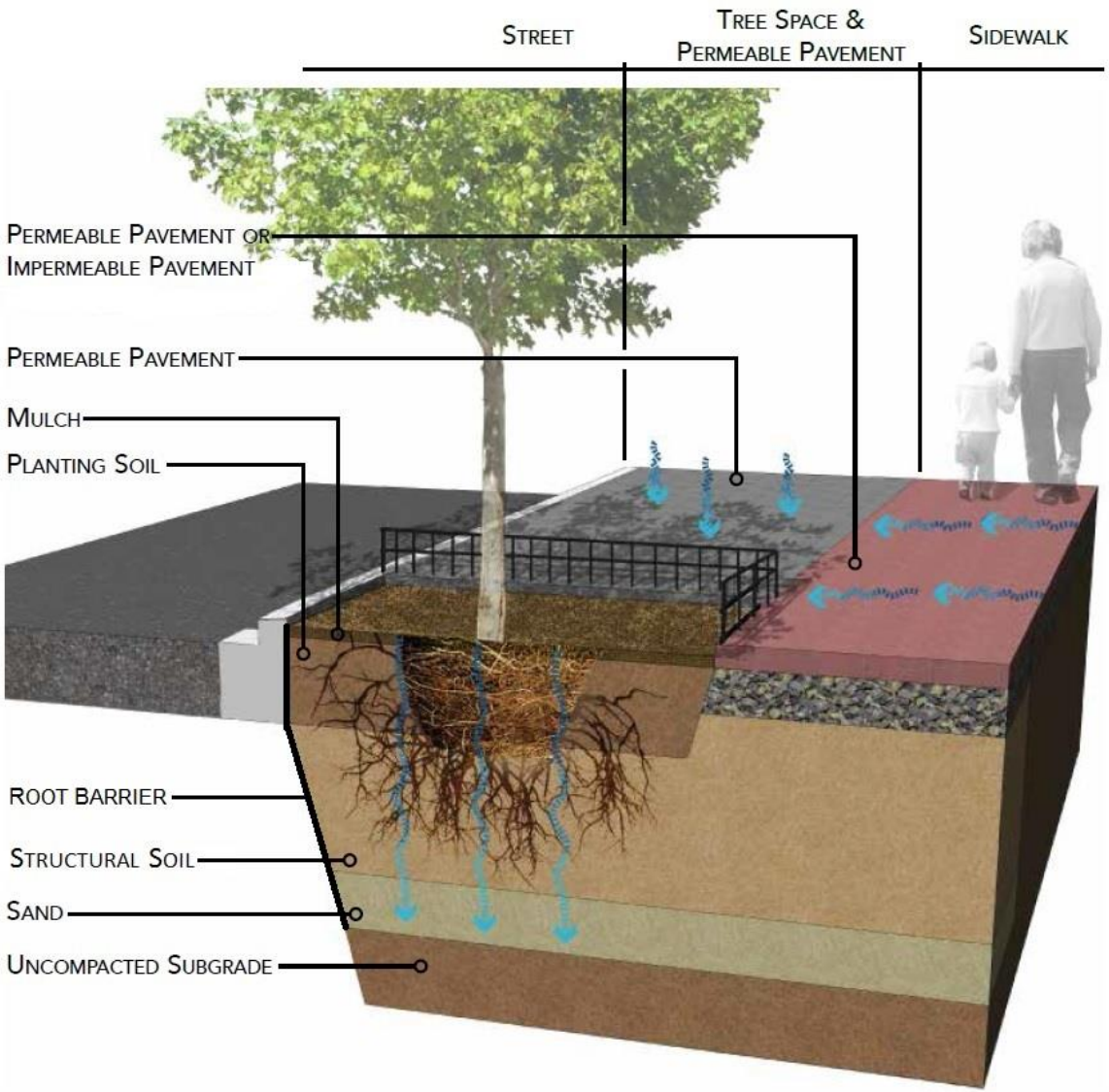
Design Issues

- Maintenance Access: allow for maintenance access from road
- Pedestrian Considerations: allow for 18-inch minimum setback from curb and minimum 48-inch sidewalk width. Comply with ADA requirements.
- Suspended sidewalks and structural slabs/cells: may require evaluation by geotechnical and structural engineers
- Clear Recovery Zone: Consider clear recovery zone requirements and minimum setback requirements.
- Tree Size: Evaluate tree size versus the right of way width.



(Source: DDOT, 2014)
Note: Trees may also be located behind the sidewalk/pathway.

TREE WELLS – WHAT'S UNDERNEATH?



(Source: DDOT, 2014)

Note: Other options include suspended sidewalks and structural cells as shown on page 7.

PUTTING IT TOGETHER

- Permeable Paver: Permeable pavers allow water to infiltrate into the planting soil to be used by the trees.
- Mulch: A soil topping that may be organic or inorganic material which covers the planting soil to retain water and trap pollutants.
- Planting Soil: Uncompacted and amended soil mix allows root growth when used in open areas, with structural cells, or suspended sidewalks.
- Structural Soil: Supports pavement and allows root growth.
- Sand: Acts as a drainage layer for excess stormwater (when needed).
- Uncompacted Subgrade: Existing soil where stormwater may infiltrate.

WATER TREES WITH STORMWATER

In addition to large planting soil volumes, trees need sufficient water, air, and nutrients to be successful in the road right-of-way environment. Tree space design includes integrating opportunities for directing stormwater into the soil. See the County of San Diego's Water Conservation in Landscaping Ordinance for irrigation requirements.



2.3 Types of Rain Gardens

What is a Rain Garden?

Rain gardens are landscape systems that filter pollutants and sediment from runoff. The layers of plant material, mulch, engineered soil media (a mix of planting soil, sand, and compost), and stone capture metals, nutrients, and bacteria that would otherwise flow into the surrounding creeks and rivers. The rainwater is held in the planting bed until it infiltrates into the ground or evaporates. The entire system can fit into small spaces, making it adaptable to tree spaces along the road, planter boxes, curb extensions, medians, roundabouts, and open areas.



Planter Boxes

Runoff follows the existing curb line and enters the facility through curb cuts. Excess runoff exits through the same curb cuts or into drains located in the planting area.



Curb Extension

Runoff follows the existing curb line and enters the facility directly. Excess runoff flows through the system and returns to the curb and gutter downstream.



Medians

Runoff follows the existing curb line and enters the facility through curb cuts. Excess runoff flows through the system or into drain inlets.



Bulb-out at Intersection

Runoff follows the existing curb line and enters the facility through curb cuts. Excess runoff flows through the system or into drains inlets.



VEGETATED FILTER STRIP

Runoff enters the facility directly via sheet flow. Excess runoff flows through the system to a drain inlet downslope.



SWALES

Runoff enters the facility directly or through curb cuts. Excess runoff flows through the system to a drainage outlet.



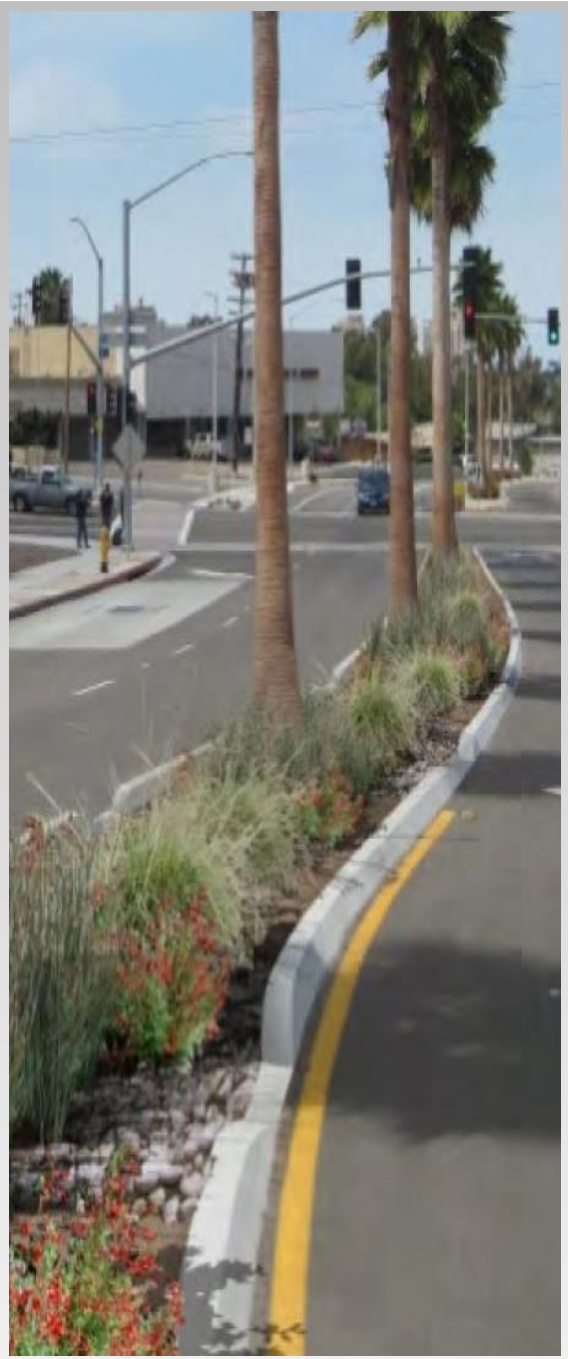
TRAFFIC CIRCLE/ROUNDABOUT

Runoff follows the existing curb line and enters the facility through curb cuts. Excess runoff flows through the system or into drains located in the planting area.



OPEN AREAS

Runoff drains into the planting area from the surrounding area. The size and shape can fit the available space.



(Source: County of San Diego, 2014)

Where to Use?

- Street with no adjacent on-street parking.
- Where Tree wells are needed.
- Street where bike lane is adjacent to curb.

Limitations

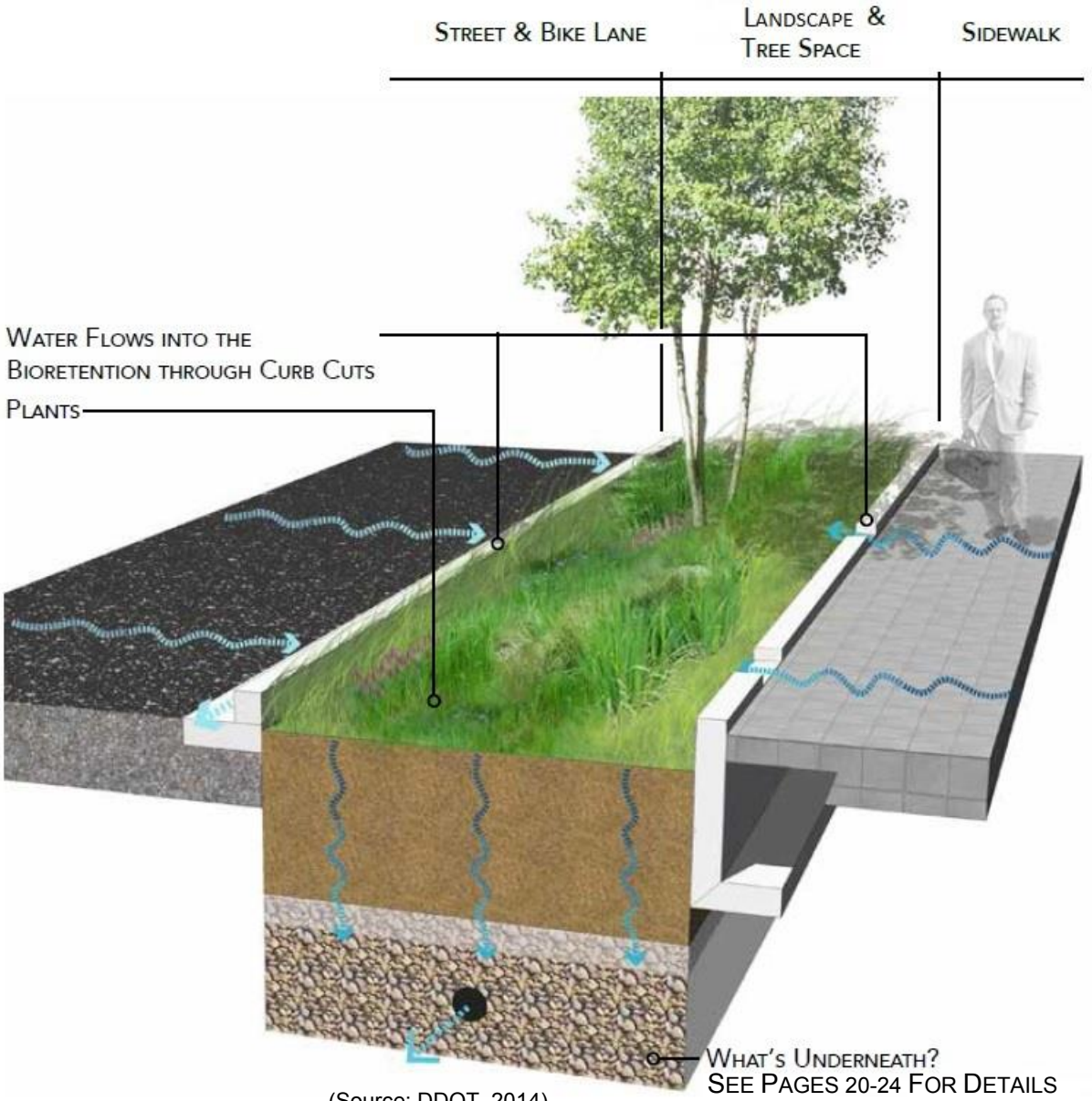
- Not for on-street parking.

Design Issues

Maintenance Access: Allow for adequate maintenance access from road.

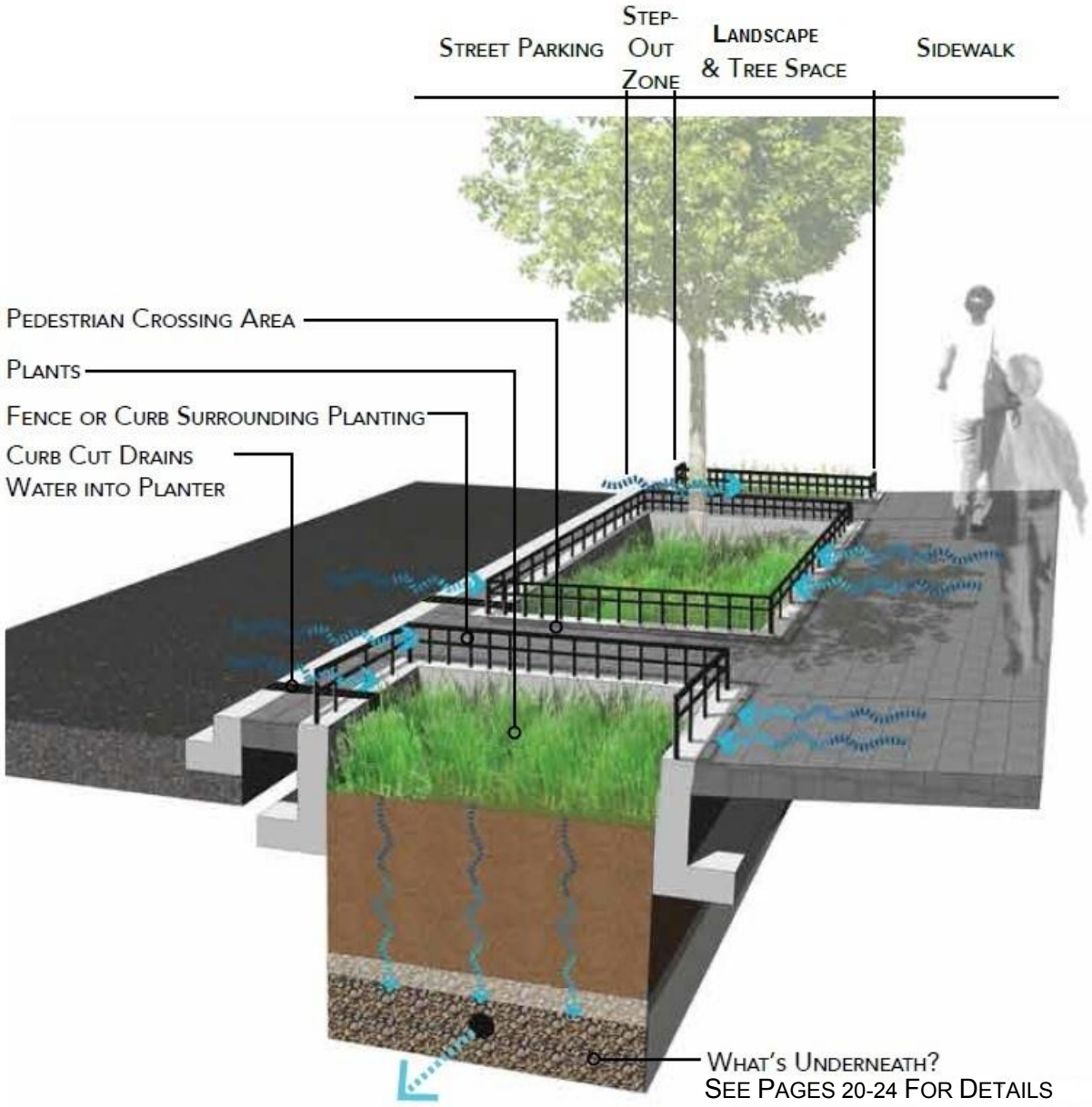
Pedestrian Considerations: Allow for minimum allowable sidewalk width. Consider trip hazards and fall protection. Comply with ADA requirements.

Planter Box Adjacent to Roadway



(Source: DDOT, 2014)

PLANTER BOX WITH STEP OUT ZONE



(Source: DDOT, 2014)

WHERE TO USE?

- Wide sidewalk area with adjacent on-street parking.
- High-volume pedestrian areas.
- Areas with other streetscape features (lights, bike racks, bus stops, etc.).

LIMITATIONS

- Do not disturb existing, mature trees and root systems.
- Provide low fence or curb for pedestrian safety.

DESIGN ISSUES

Planting Design: Same as for planter box adjacent to roadway.

Maintenance Access: Allow for adequate maintenance access from road.

Pedestrian Considerations: Areas in the streetscape can have dropped or have sloped sides. Short fences or curbs prevent pedestrians from stepping into a recessed area. Planter boxes with side slopes can use a small step-out area in place of a fence or curb. When the planter box is next to street parking areas, a step-out zone must be provided to allow access from the vehicle to the sidewalk. Crossing areas must be provided between street parking and the sidewalk. Comply with ADA requirements.

Where to Use?

- Areas with low on-street parking demand.
- In wide roadways.
- For traffic calming.
- In “no parking areas” on street (excluding loading zones and curb cuts).
- Next to mature trees.

Limitations

- Sufficient street parking or off-street parking must be available to residents.
- Do not disturb existing, mature trees and root systems.
- Ensure sight lines and turning radii are preserved.

Design Issues

Maintenance Access: Allow for adequate maintenance access from road.

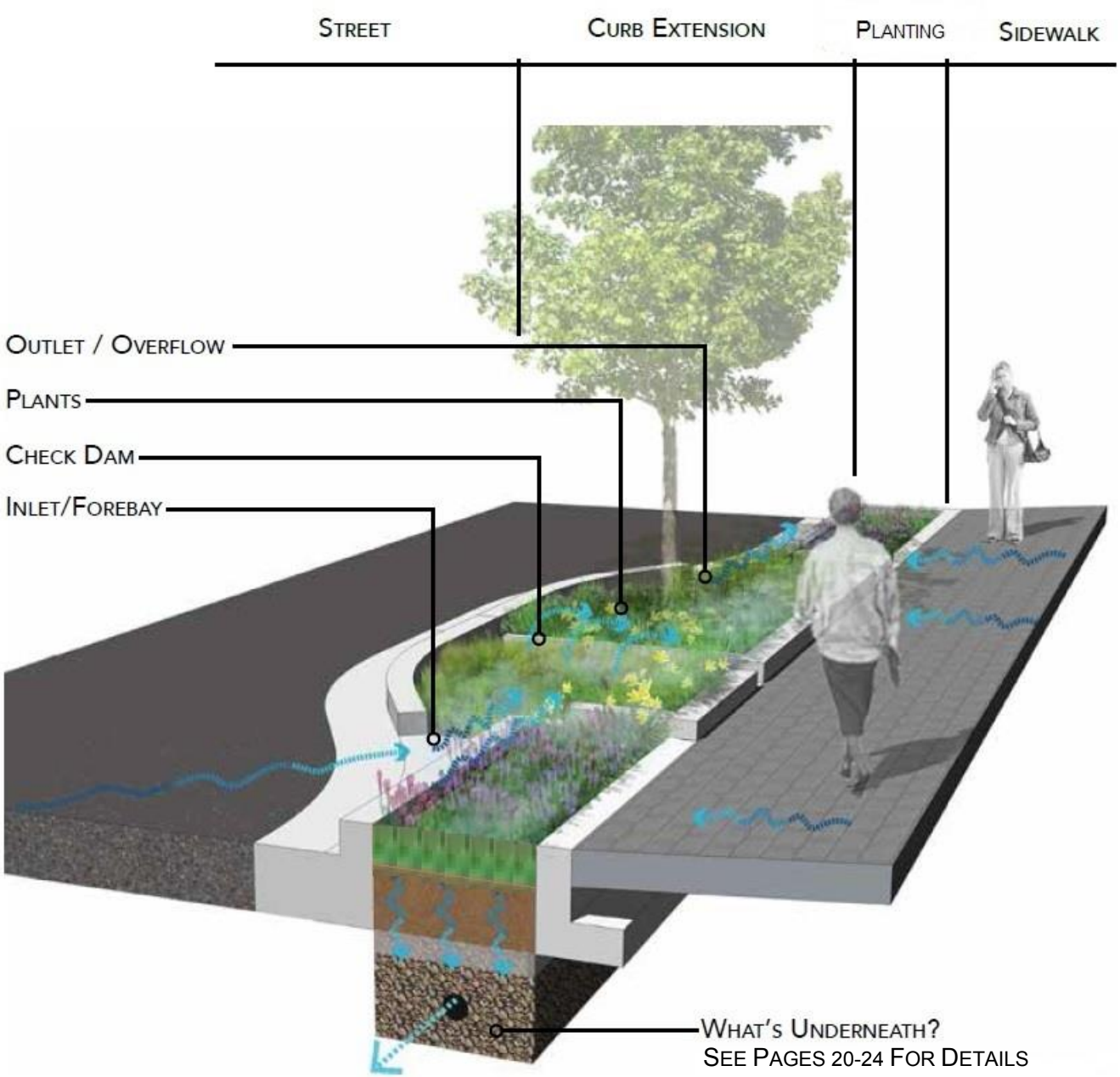
Pedestrian Considerations: Consider trip hazards and fall protection. Short fences or curbs prevent pedestrians from stepping into a recessed area. A 3:1 transition from the sidewalk to planter bottom is an alternative. Comply with ADA requirements.

Parking: Consider trip hazards and adequate spacing in order to park.

Flood Control: Locate so that stormwater can drain away from the roadway and be directed through the curb inlet.

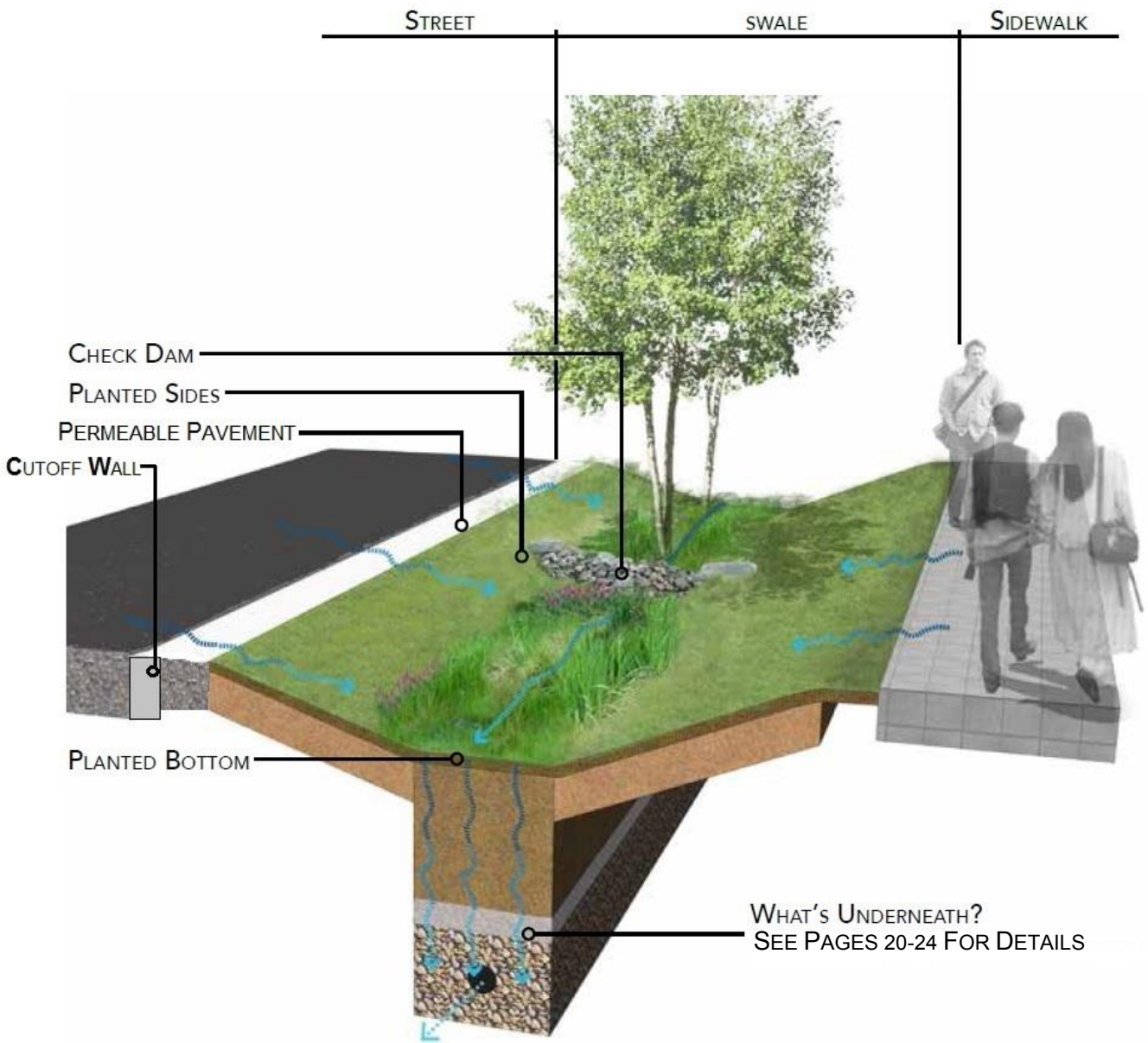
Bike Lanes: Consider bike lane traffic.

Curb Extension



(Source: DDOT, 2014)

SWALE ADJACENT TO ROADWAY



(Source: DDOT, 2014)

WHERE TO USE?

- On street with no curb.
- In wide ROW area with or without sidewalk.
- Areas with less pedestrian use.

LIMITATIONS

- Not suitable for narrow sidewalk areas.

DESIGN ISSUES

Slope and Check Dams: Swales are placed where street runoff is flowing and optimally before catch basins that convey water from the street to the drainage system. Swales may be built on moderate slopes with the use of check dams. Rock armoring or turf reinforcement mat may be required in steep areas with erosive velocities between check dams.

Maintenance Access: Allow for adequate maintenance access from road.

Pedestrian Considerations: Limit pedestrian access to swale. Transition swale at intersections for pedestrian facilities. Comply with ADA requirements.

Driveway Crossings: Driveway crossings may limit swale lengths.

Vegetated Filter Strip

Where to Use?

- Where runoff can sheet flow into filter strip area.
- Moderate slopes (less than 5%) adjacent to impervious area of treatment (sidewalk or road).
- Rural areas.

Limitations

- Not recommended on steep slopes.
- Prone to rill formation.
- Areas with on-street parking.

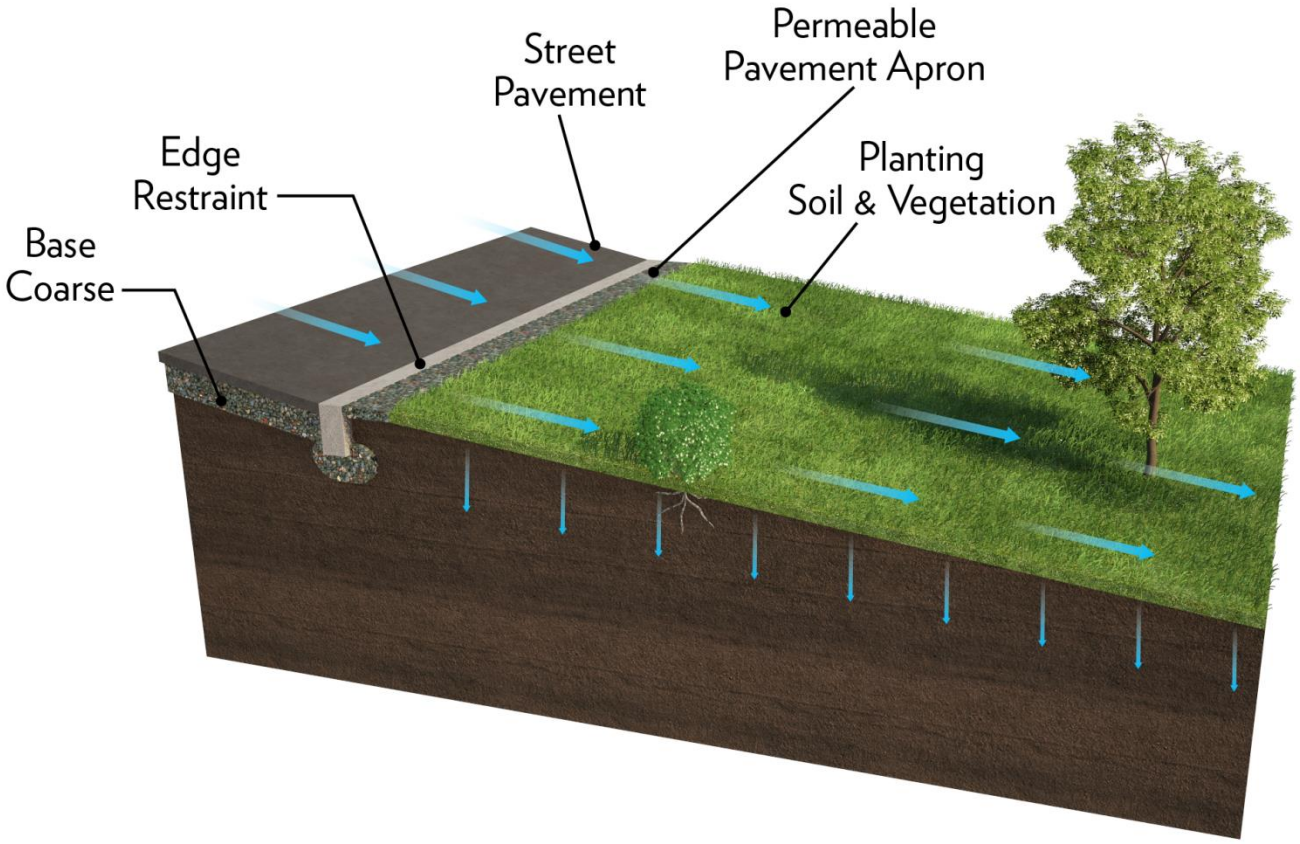
Design Issues

Maintenance: Vegetated cover must be maintained to ensure that filter strips do not export sediment due to erosion of exposed ground.

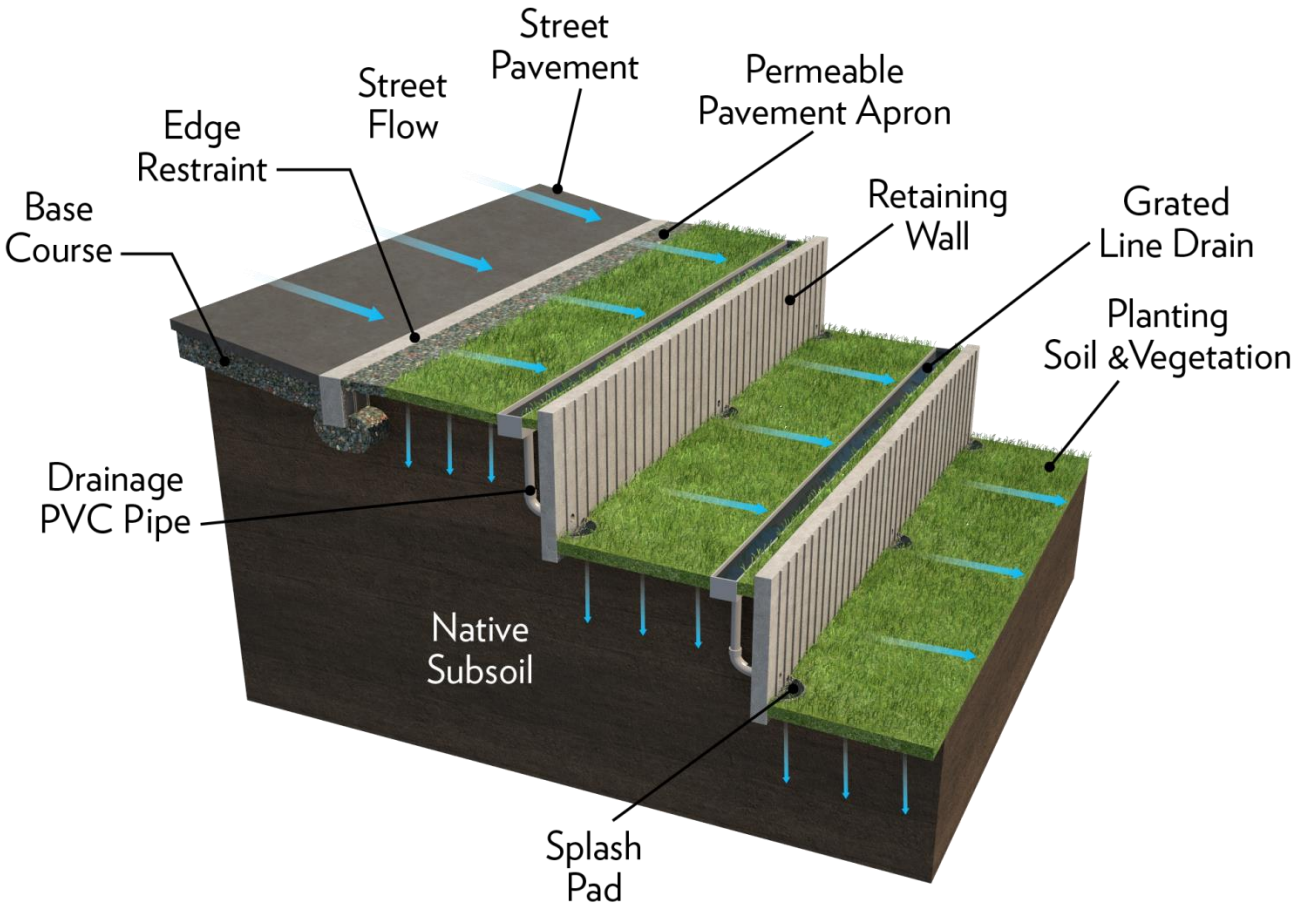
Slope: Maximum slopes in the direction of flow will be based upon drainage area size, soil type, vegetation cover, and slope length to prevent rill formation. Slopes less than 5% are preferred.

Maintenance Access: Allow for adequate maintenance access from road.

Pedestrian Considerations: Limit pedestrian access across filter strip to prevent formation of dirt pathways. Comply with ADA requirements.



VEGETATED TERRACED FILTER STRIP



WHERE TO USE?

- Where runoff can sheet flow into filter strip area.
- Steep slopes (greater than 5%) adjacent to impervious area of treatment (sidewalk or road).
- Rural areas.

LIMITATIONS

- Prone to rill formation.
- Areas with on-street parking.
- Walls over 3 feet tall require structural design.

DESIGN ISSUES

Maintenance: Vegetated cover must be maintained to ensure that filter strips do not export sediment due to erosion of exposed ground.

Slope: Maximum slopes in the direction of flow will be based upon drainage area size, soil type, vegetation cover, and slope length to prevent rill formation. Slopes less than 5% are preferred.

Maintenance Access: Allow for adequate maintenance access from road and bottom of slope.

Pedestrian Considerations: Limit pedestrian access across filter strip to prevent formation of dirt pathways. Comply with ADA requirements.

Where to Use?

- Areas with low on-street parking demand.
- In wide roadways.
- For traffic calming.
- In “no parking areas” on street (excluding loading zones and curb cuts).

Limitations

- Sufficient street parking or off-street parking must be available to residents.
- Ensure sight lines and turning radii are preserved.

Design Issues

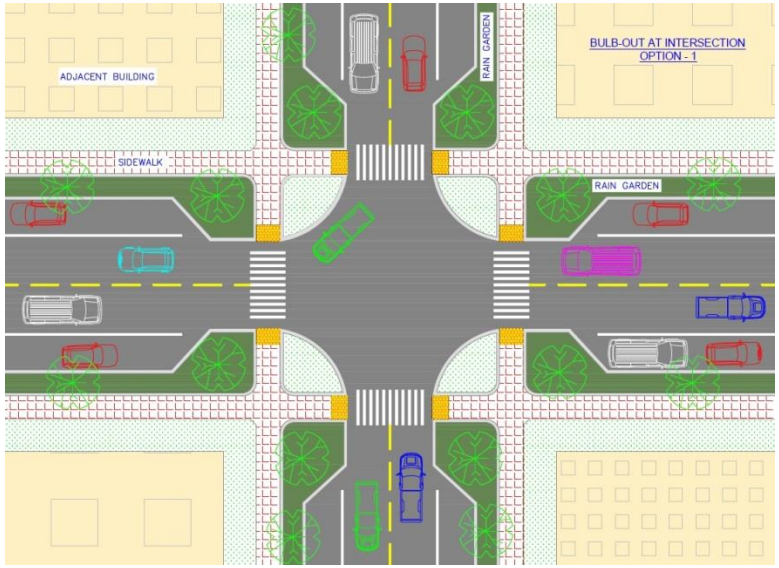
Maintenance access: Allow for adequate maintenance access from road.

Pedestrian considerations: Short fences or curbs prevent pedestrians from stepping into a recessed area. Walkways and ramps may need to be designed through bulb-outs to provide pedestrian access at intersections. Comply with ADA requirements.

Design: Requires County Traffic Engineering Section approval.

Bulb-Out at Intersection





ROUNDABOUT





WHERE TO USE?

- Areas with low on-street parking demand.
- In wide roadways.
- For traffic calming.

LIMITATIONS

- Sufficient street parking or off-street parking must be available to residents.
- Ensure sight lines and turning radii are preserved.

DESIGN ISSUES

Maintenance Access: Allow for adequate maintenance access from road.

Pedestrian Considerations: Short fences or curbs prevent pedestrians from stepping into a recessed area. Comply with ADA requirements.

Design: Requires County Traffic Engineering Section approval.

Rain Gardens – What's Underneath?

Soil Type and Infiltration Rate

Rain gardens can be located in many areas. However, site constraints will help to determine what goes underneath the rain garden. Common considerations include soil type, relative soil compaction, required utility setbacks, slope setbacks, and structural setbacks. Depending on the factors at the site, what's underneath the rain garden is determined by the level of infiltration: high, medium, low, or none.

A qualified engineer practicing geotechnical services shall review the proposed stormwater infiltration to provide a professional opinion regarding the potential adverse geotechnical conditions that the implementation of these practices may create. Geotechnical conditions such as slope stability, expansive soils, compressible soils, seepage, groundwater, and loss of foundation or pavement subgrade strength should be considered.

The U.S. Department of Agriculture Natural Resources Conservation Service (NRCS), formerly the Soil Conservation Service, conducted a soil survey of the San Diego area in the early 1970s. The NRCS has classified San Diego area soils with respect to: (1) their ability to accept and absorb water, (2) their tendency to produce runoff, and (3) their erodibility.

The soil survey classified soil runoff potential into four hydrologic soil groups labeled A through D. Group A and B soils exhibit the greatest infiltration rates (unless soils are compacted during construction) and are generally best suited to stormwater percolation. The San Diego area, however, has a relatively high concentration of group C and D soils, which exhibit lower percolation rates that generally limit the use of infiltration-based stormwater management systems. Instead, rain garden facilities are often equipped with underdrains. Such a design provides for filtration of the water quality design event through an engineered soil media as well as incidental infiltration of low flows.

Retaining a geotechnical engineer and conducting exploratory excavations at the site are highly recommended. Consideration should be given to the effects of urbanization on the natural hydrologic soil group. If heavy equipment can be expected to compact the soil during construction, or if grading will mix the surface and subsurface soils, appropriate changes should be made in the soil group selected.

The NRCS hydrologic soil groups are defined as:

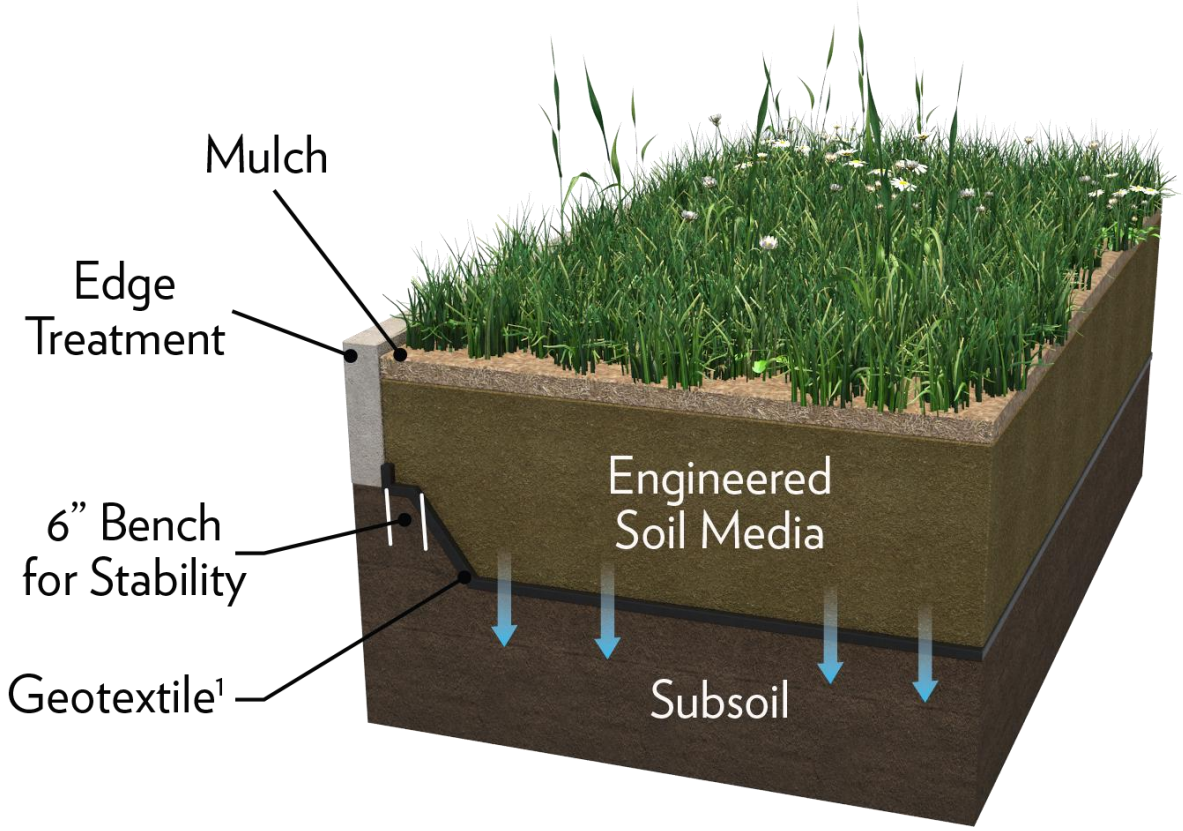
• **Group A** soils have a high rate of percolation and a low runoff potential. The rate of water transmission is high; thus, runoff potential is low. Group A soils are generally referred to as sandy soils.

• **Group B** soils have moderate percolation rates when thoroughly wet. These are chiefly soils that are moderately deep to deep, moderately well-drained to well-drained, and moderately coarse textured. Rate of water transmission is moderate.

• **Group C** soils have a slow percolation rate when thoroughly wet. They are chiefly soils that have a layer impeding the downward movement of water, or they are moderately fine to fine-textured soils that have a slow infiltration rate. The rate of water transmission is slow.

• **Group D** soils have very slow percolation rates when thoroughly wet. They are clays that have a high shrink-swell potential, soils that have a high permanent water table, soils that have a claypan or clay layer at or near the surface, or soils that are shallow over nearly impervious material. The rate of water transmission for group D soils is very slow.

HIGH INFILTRATION



HIGH INFILTRATION

Notes:
1. Geotextile per Geotechnical Engineer's Recommendations (street side and sidewalk side).

PUTTING IT TOGETHER

- Ponding Depth: Stores runoff within the planting area prior to treatment.
- Mulch: A soil topping that may be organic or inorganic material which covers the planting soil to retain water and trap pollutants.
- Engineered Soil Media: A specific blend of soil, compost, and sand to retain and drain water and support plant growth.
- Geotextile: Prevents existing soil from migrating into the engineered soil media.
- Uncompacted Subsoil: Existing soil where stormwater infiltrates.

COMMON DESIGN ISSUES

Utilities: In the County, utility lines are common and necessary components of infrastructure within the right-of-way. Utility lines should be avoided where necessary and allowed to coexist where possible.

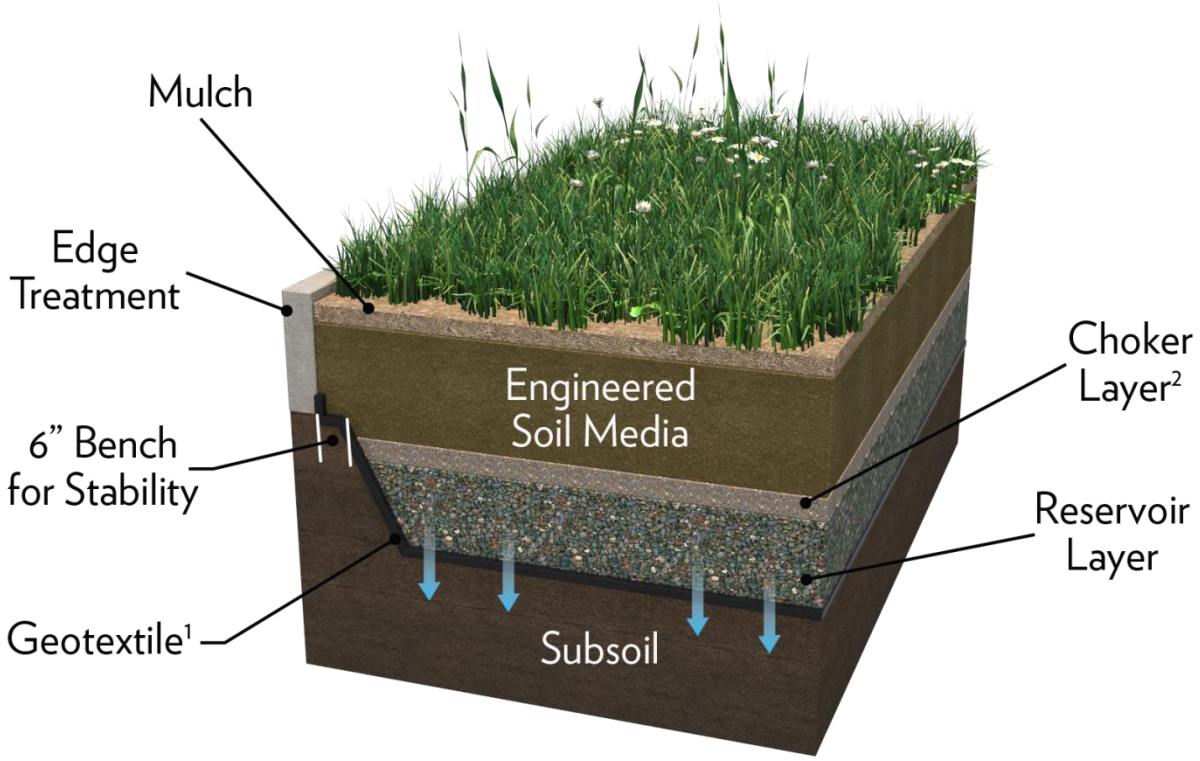
Putting it Together

- Ponding Depth: Stores runoff within the planting area prior to treatment.
- Mulch: A soil topping that may be organic or inorganic material which covers the planting soil to retain water and trap pollutants.
- Engineered Soil Media: A specific blend of soil, compost, and sand to retain and drain water and support plant growth.
- Choker Layer: Sand and gravel to prevent engineered soil media from migrating into the reservoir.
- Reservoir Layer: Stone to hold excess water until it infiltrates.
- Geotextile: Prevents existing soil from migrating into the engineered soil media and stone reservoir layer.
- Uncompacted Subgrade: Existing soil where stormwater infiltrates.

Common Design Issues

Utilities: In the County, utility lines are common and necessary components of infrastructure within the right-of-way. Utility lines should be avoided where necessary and allowed to coexist where possible.

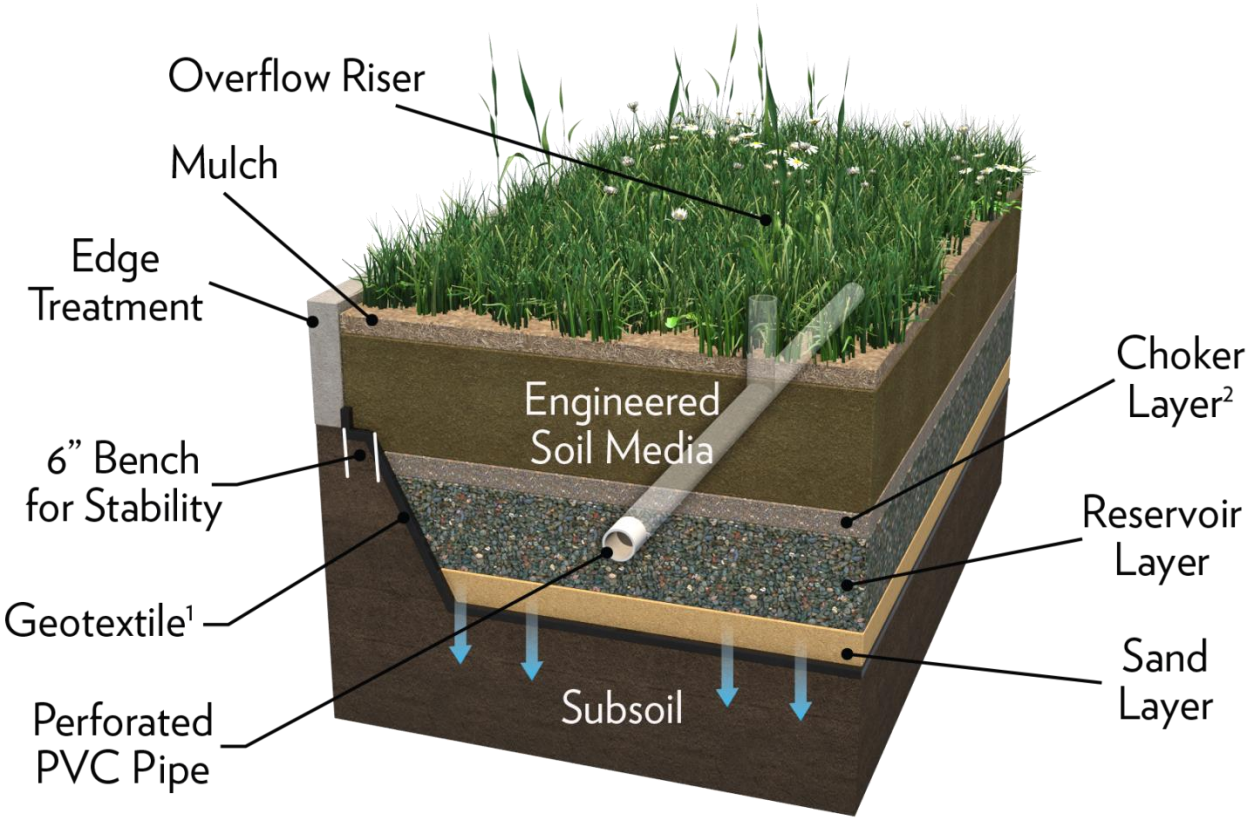
Medium Infiltration



MEDIUM INFILTRATION

Notes:
1. **Geotextile per Geotechnical Engineer's Recommendations (street side and sidewalk side).**
2. **Choker layer may be required depending the type of reservoir layer.**

LOW INFILTRATION



LOW INFILTRATION

Notes:
1. Geotextile per Geotechnical Engineer's Recommendations (street side and sidewalk side).
2. Choker layer may be required depending the type of reservoir layer.

PUTTING IT TOGETHER

- Ponding Depth: Stores runoff within the planting area prior to treatment.
- Overflow Riser: Pipe to capture high water flow.
- Mulch: A soil topping that may be organic or inorganic material which covers the planting soil to retain water and trap pollutants.
- Engineered Soil Media: A specific blend of soil, compost, and sand to retain and drain water and support plant growth.
- Choker Layer: Sand and gravel to prevent engineered soil media from migrating into the reservoir.
- Reservoir Layer: Stone to hold excess water until it infiltrates.
- Underdrain: An underdrain is required.
- Geotextile: Prevents existing soil from migrating into the engineered soil media and stone reservoir layer.
- Uncompacted Subgrade: Existing soil where stormwater infiltrates.

COMMON DESIGN ISSUES

Utilities: In the County, utility lines are common and necessary components of infrastructure within the right-of-way. Utility lines should be avoided where necessary and allowed to coexist where possible.

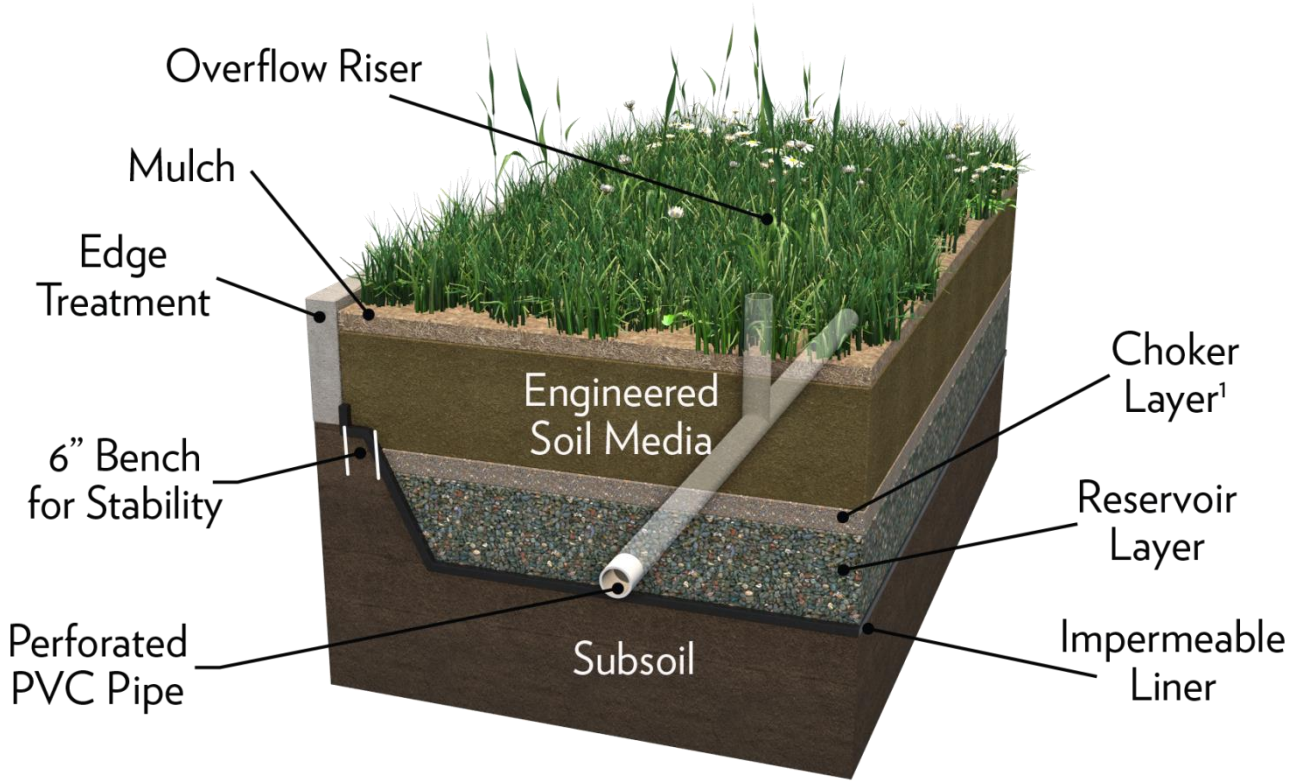
Putting it Together

- Ponding Depth: Stores runoff within the planting area prior to treatment.
- Overflow Riser: Pipe to capture high water flow.
- Mulch: A soil topping that may be organic or inorganic material which covers the planting soil to retain water and trap pollutants.
- Engineered Soil Media: A specific blend of soil, compost, and sand to retain and drain water and support plant growth.
- Choker Layer: Sand and gravel to prevent engineered soil media from migrating into the reservoir.
- Reservoir Layer: Stone to hold excess water until it enters the underdrain.
- Underdrain: An underdrain is required.
- Impermeable Liner: Prevents infiltration and prevents existing soil from migrating into the engineered soil media and stone reservoir layer.

Common Design Issues

Utilities: In the County, utility lines are common and necessary components of infrastructure within the right-of-way. Utility lines should be avoided where necessary and allowed to coexist where possible.

No Infiltration



NO INFILTRATION

Notes:
1. Choker layer may be required depending the type of reservoir layer.

2.4 Planting & Irrigation of Rain Gardens, Trees, and Other Areas

Planting Design

Tree wells and rain gardens add a landscape amenity to the street-scape. Trees, shrubs, grasses and perennials are used to create a diverse landscape suitable for the site conditions and neighborhood. Plants should be chosen based on the level of care expected at the facility. Planting design must be done to ensure sight lines are preserved for pedestrians, cyclists, and vehicles on the street.

Existing trees are an important component of the green street. Mature trees capture stormwater, provide shade, and cool pavement. Existing trees should be protected when implementing green streets and not disturbed during construction.

Refer to the County of San Diego's Water Efficient Landscape Design Manual and Low Impact Development Handbook for suitable plant species to use in rain garden areas. Also refer to the community right of way development standards for suitable plants within specific communities.

Irrigation Design

Irrigation design should comply with the County of San Diego's Water Efficient Landscape Design Manual.

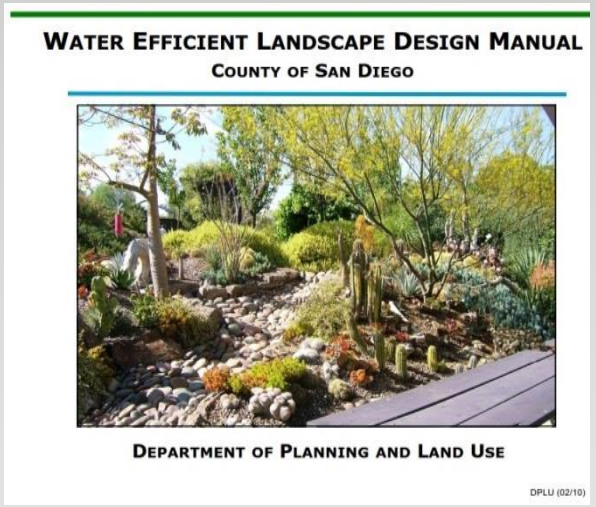
Planting Zones (Hydrozones)

Grouping plants into hydrozones is an approach to irrigation and planting design where plants with similar water needs are grouped together. Ideally, each zone of the irrigation system will supply plants with the same water needs with the appropriate amount of water.

Water Conservation

State executive order B-29-15 requires mandatory statewide water restrictions. This order prohibits ornamental turf on public street medians, and requires a reduction in potable water use for irrigation. Low water use, drought tolerant, native plants should be used for Green Streets applications. The use of reclaimed water is recommended to reduce the amount of potable water used for irrigation.









2.5 Types of Rock Gardens

What Is a Rock Garden?

Rock gardens utilize swales and shallow depressions to provide storage, evaporation, and infiltration. Runoff is stored in the void space between the stones in a rock swale or rock basin. It then infiltrates through the bottom into the soil matrix. Infiltration removes fine sediment and associated pollutants by filtering stormwater through engineered soil media. Medians and other areas with difficult maintenance or no pedestrian access are potential locations for rock gardens.



Rock Swale

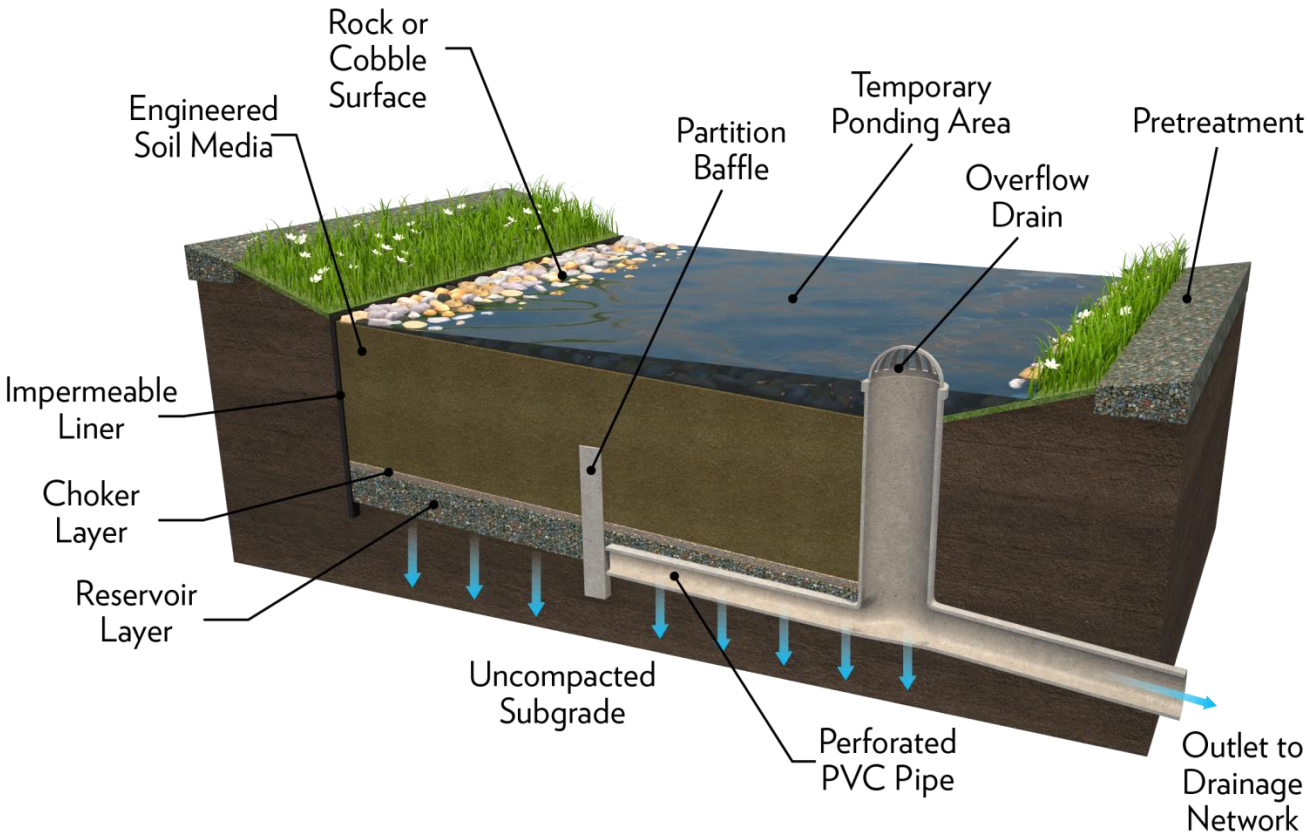
Rock swales are identical to rain garden swales except that the surface is typically covered by rock mulch rather than organic mulch and vegetation. Rock swales can serve as conveyance for stormwater and can be used in place of traditional curbs and gutters in some locations; however, when compared to traditional conveyance systems rock swales slow stormwater down and increases the time of concentration. This can reduce peak flows at drainage inlets and reduce flooding downstream. With a narrow width, rock swales can be integrated into site plans with various configurations.



Rock Basin

A rock basin is a shallow impoundment that is designed to infiltrate stormwater into the soil. The basic design goal of a rock basin is to provide opportunities for runoff from small storms to enter the soil rather than discharging directly into a drainage system. Rock basins typically have high pollutant removal efficiency, and can also help recharge the groundwater, thus restoring low flows to stream systems. Rock basins also act as miniature detention basins that reduce peak flows and reduce flooding downstream. Multiple rock basins can be distributed across a site instead of constructing a single large detention basin.

ROCK SWALE



Note: The section above includes the use of an underdrain. As with vegetated swales and rain gardens, the subsurface drainage may consist of one of several options that may or may not include an underdrain, choker layer, stone reservoir or permeable/impermeable geotextile liner.

WHERE TO USE?

- Where vegetation growth will be difficult.
- Along borders or medians of parking lots.
- Where traditional swale widths are too wide for application.
- Within a "Hazardous Fire Area," as that term is defined in the County Fire Code.

LIMITATIONS

- May not be suitable in areas with high pedestrian traffic.

DESIGN ISSUES

Utilities: Utility lines should be avoided where necessary and allowed to coexist where possible.

Maintenance access: Allow for adequate maintenance access from road. A forebay or pretreatment to remove sediment improves maintainability of swale.

Pedestrian considerations: Limit pedestrian access into rock swale.

Where to Use?

- In areas with wide rights of way.
- Where vegetation growth will be difficult.
- Where soil infiltration rates are high.

Limitations

- Soil infiltration rates will limit use to areas with quickly draining soils if underdrain systems are not utilized.

Design Issues

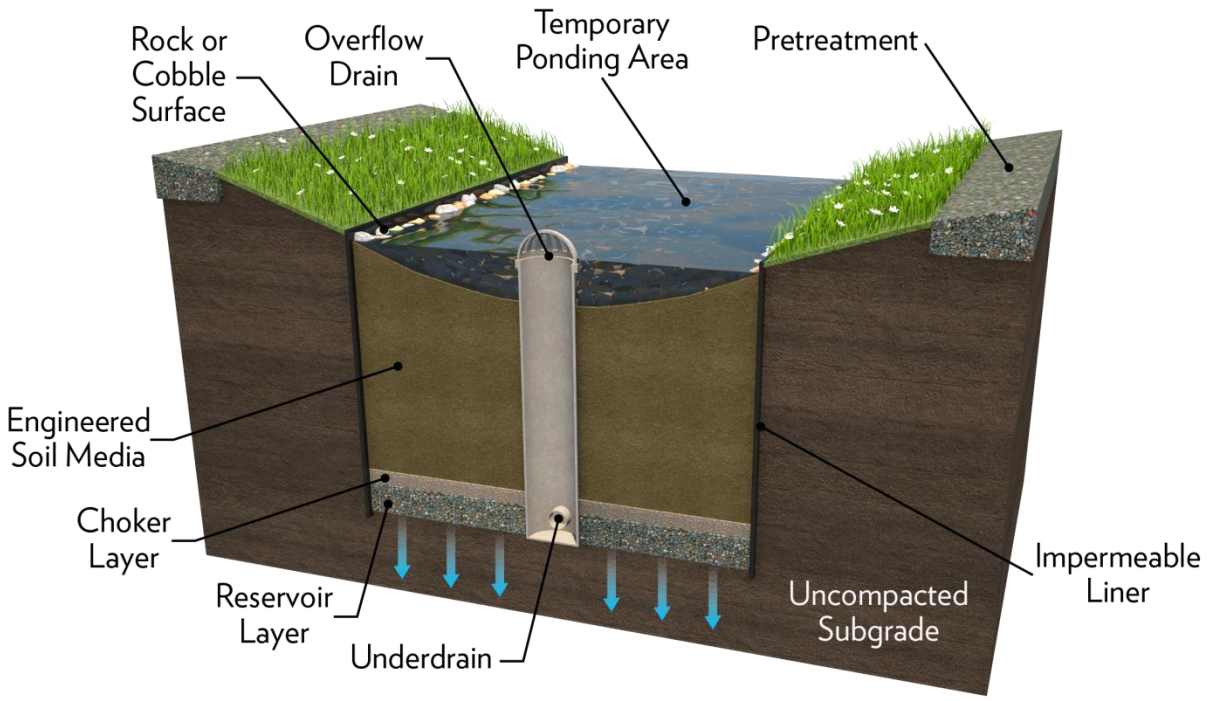
Standing water: Basin must be designed to drain within 96 hours. When subgrade infiltration rates are slower than 0.5 inches per hour, filtered water is directed toward a stormwater conveyance system or other LID facility via underdrain pipes.

Utilities: Locate rock basin outside of utility corridor.

Maintenance Access: Allow for adequate maintenance access from road. A forebay or pretreatment to remove sediment improves maintainability of basin.

Pedestrian Considerations: Basins will typically be located outside of areas with high pedestrian use. Fence may be required if side slopes or depth exceeds standards.

Rock Basin



Note: The section above includes the use of an underdrain. As with rain gardens, the subsurface drainage may consist of one of several options that may or may not include an underdrain, choker layer, stone reservoir or permeable/impermeable geotextile liner.

2.6 Types of Permeable Pavement

What is Permeable Pavement

Permeable pavement is an engineered top layer and base layer that allows water to move through it. The goal is to take rainwater as it falls and quickly move it to the lower layers of the system. Stormwater is stored in an underlying stone layer until it infiltrates into the soil below, aiding in groundwater recharge, or releases slowly to the storm drain system. Pollutants are filtered through the pavement and base layers. The terms 'Permeable Concrete Pavers', 'Pervious Concrete', 'Porous Asphalt', and 'Porous Rubber' are industry standard names, but all surfaces are 'permeable' and provide sufficient openings at the surface to allow stormwater to infiltrate.



Permeable Concrete Pavers

Unlike traditional pavers, there are gaps between each paver to allow water to flow between the pavers and into the base layer.



Pervious Concrete

Sands and "fines" are reduced in the concrete mix to allow water to flow through the pavement into a stone bed and eventually the ground.









TYPES OF PERMEABLE PAVEMENT (CONTINUED)



POROUS ASPHALT

Porous asphalt is very similar to traditional asphalt except that the sands or "fines" are reduced in the mix so water can move through the pavement.



POROUS RUBBER

Made from recycled rubber and small stones, porous rubber works like pervious concrete, but can be installed over tree roots.



DECOMPOSED GRANITE (DG) PATHWAY

Decomposed granite can be used for pathways. It can be installed and compacted to meet ADA handicapped accessibility specifications and criteria. Although highly compacted, the surface has some infiltration capacity.



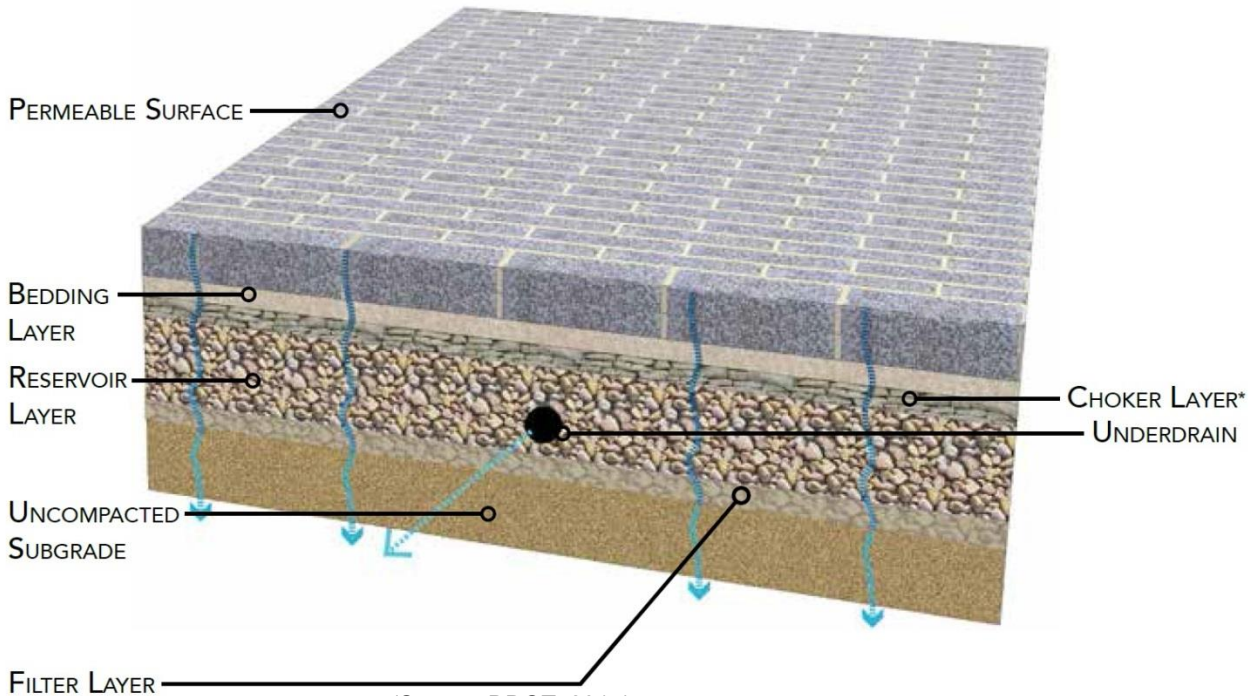
BOARDWALK

Made from wood or composite, boardwalks may be used for pathways. Rain easily passes through the spaces between the boards to the earth below.

Putting it Together

- Permeable Surface: Permeable concrete pavers, pervious concrete, porous asphalt, porous rubber, DG, or boardwalk.
- Bedding Layer: Used for pavers so they can be laid flat.
- Choker Layer: A layer of small rock to prevent fine material from migrating into the reservoir layer.
- Reservoir Layer: Stone to hold excess water until it infiltrates.
- Underdrain: Conveys excess water into drainage system when the reservoir fills.
- Filter Layer/Geotextile: A layer of stone or permeable geotextile to separate the reservoir layer from the soil below and prevent migration of fines into the reservoir layer.
- Impermeable Liner: Prevents infiltration into subgrade or adjacent roadway structural section.
- Uncompacted Subgrade: Existing soil into which stormwater infiltrates.

Permeable Pavement – What's Underneath?



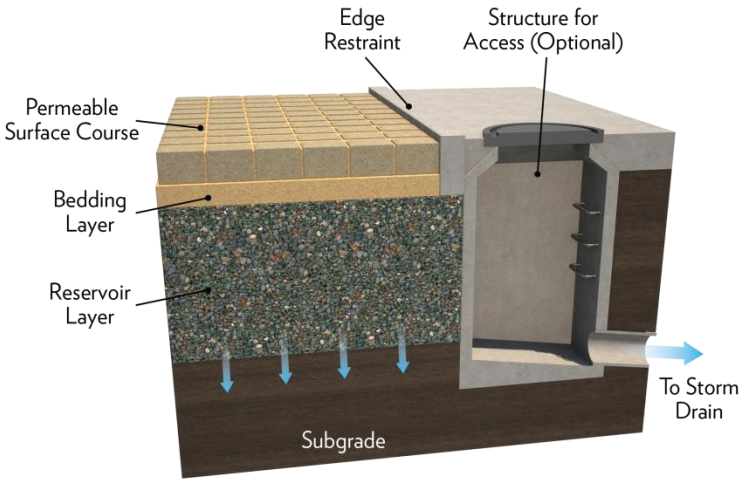
(Source: DDOT, 2014)

*Per Geotechnical Engineer's Recommendations

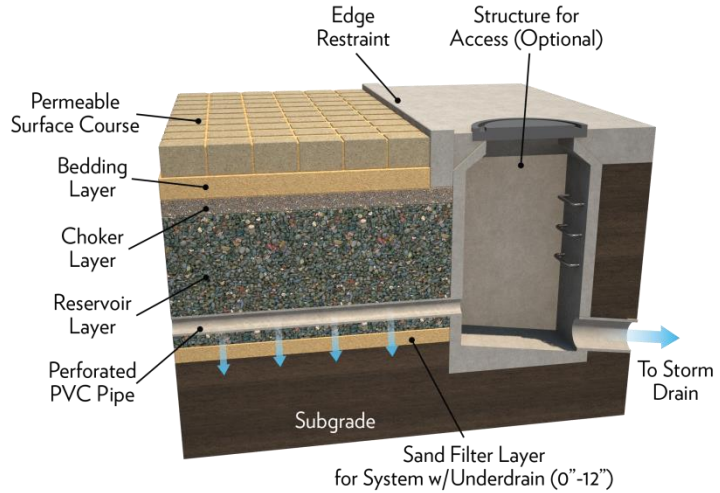
As with rain gardens and rock gardens, there are multiple options for the subsurface components for permeable pavement including:

- Reservoir layer only with no underdrain
- Reservoir layer with underdrain (shown)
- Reservoir layer with underdrain and impermeable liner

PERMEABLE PAVEMENT SUBSURFACE DESIGN OPTIONS



Reservoir layer only with no underdrain



Reservoir layer with underdrain

WHERE TO USE?

- Pedestrian areas
- Pathways
- Parking lanes

LIMITATIONS

- Use is limited to areas curb-separated from the traveled way.
- Use in areas with little to no sediment production.

DESIGN ISSUES

Soil Infiltration and Drainage: Soil infiltration tests must be completed to determine if an underdrain system is required.

Structural Section: A qualified and licensed professional should complete a pavement structural analysis.

Edge Restraints: Provide a concrete transition strip between any permeable and impermeable surface and around the perimeter of paver installations.

Pedestrian Considerations: Provide signage to indicate prohibited activities that cause premature clogging.

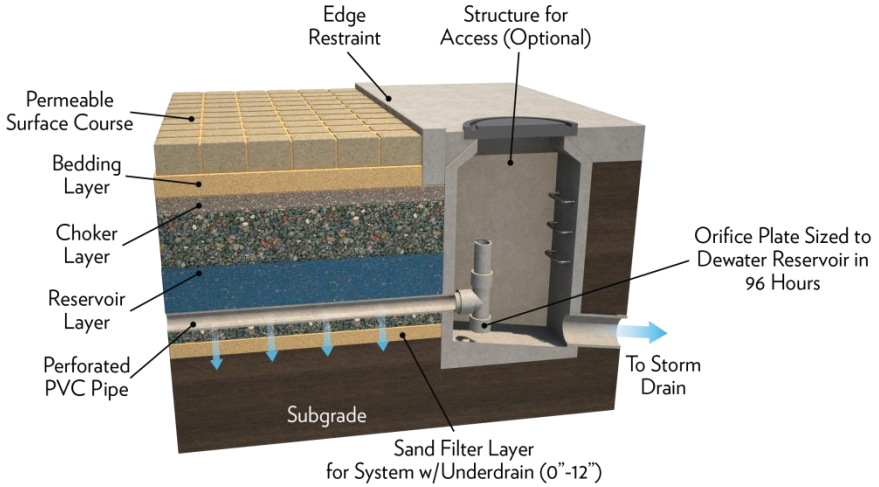
Maintenance Access: Provide adequate access for sweeping and/or vacuuming of surface.



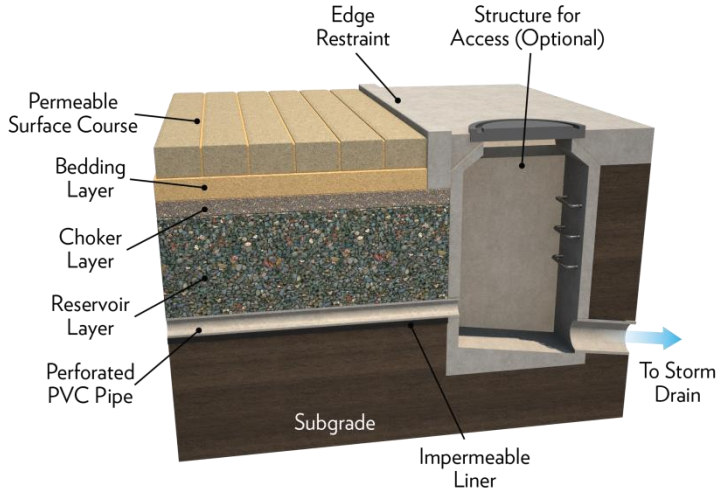




PERMEABLE PAVEMENT SUBSURFACE DESIGN OPTIONS (CONTINUED)



Reservoir layer with upturned underdrain



Reservoir layer with underdrain and impermeable liner

CHAPTER 3



(Source: DDOT, 2014)

Procedures and Design Examples

3.1 INTRODUCTION

Implementing Green Infrastructure (GI) and Low Impact Development (LID) within the road right-of-way requires a number of considerations to create an amenity that is attractive while treating stormwater from the surrounding streets and sidewalks.

Implementation of Green Streets features can be approached from evaluating the opportunities within each zone of the right-of-way: median, traveled lane, bike lane, shoulder, parkway, sidewalk/pathway, slopes and drainage easements. Each zone presents different opportunities, benefits, risks and technical design factors for GI and LID implementation to enhance stormwater quality within the right-of-way.

Conducting a comprehensive inventory and assessment of site conditions is the crucial initial step for implementing GI and LID. The County LID Handbook inventory check list can be used to assist with identifying and evaluating a potential site for LID and to produce a list of opportunities and constraints.

The LID concept from the EPA of “slow it down, spread it out, and soak it in” should be at the forefront in the planning stages of project evaluating the implementation of Green Streets design practices to control runoff and enhance water quality.







The following site design principles should be evaluated and implemented to “slow it down, spread it out, and soak it in”:

- Minimize the impervious footprint of the site by constructing streets and sidewalks to the minimum required widths.
- Minimize soil compaction in landscaped areas. Landscape with native or drought-tolerant species.
- Disconnect impervious surfaces by dispersing runoff from impervious surfaces to pervious areas. To be considered ‘disconnected’ impervious areas should be designed to drain to a pervious area at least one-half their size.
- Design and construct Tree wells, rain gardens, rock gardens, and permeable pavements to effectively receive and infiltrate or retain runoff from impervious areas before it discharges to the storm drain or exits the right of way.

When green street design principles are employed over street design techniques that utilize conventional stormwater quality treatment techniques they have the potential to significantly reduce impervious areas and provide potential project cost savings.



Conventional Design Approach

- Impervious median and parking lane
- Rain garden and stormwater vault in parkway



Green Street Design Approach

- Permeable median and parking lane
- Tree wells and rain garden in parkway

GREEN STREET APPROACH

Direct stormwater runoff from impervious roadway elements to:

- Tree wells, Rain Gardens or Rock Gardens in the median or parkway.
- Permeable pavement surfaces located in the median or parking lane.

Construct sidewalks and trails with permeable pavement or direct runoff to adjacent landscaped area.

CONSTRAINTS

In no way shall green streets LID features be designed to block sight distance for motorists from adjacent streets and driveways, create obstacles for pedestrians, impede the visibility and maintenance of traffic control devices and signs, and reduce or eliminate clear recovery area and minimum horizontal clearances from fixed objects.





3.2 Design Procedure

Qualification

Under the Municipal Separate Storm Sewer System (MS4) Permit for San Diego Region (Permit [Order No. R9-2013-0001]), the County may make Priority Development Project (PDP) Exemptions for projects redeveloping or retrofitting existing paved roads, streets, and alleys as "EPA Green Streets." This is accomplished under an adopted Green Streets program by the County of San Diego and based in part on the EPA publication "Green Streets: Municipal Handbook, Managing Wet Weather with Green Infrastructure."

Opportunities and Constraints

- Conduct a comprehensive inventory and assessment of site conditions.
- Evaluate each zone of the right-of-way for Green Street implementation opportunties: median, traveled lane, shoulder, parkway, sidewalk/pathway, slopes and drainage easements.
- Evaluate constraints including, but not limited to: right-of-way width, utilities, roadway geometry and slope, site distance, proximity to storm drain, maintenance access, pedestrian and vehicle safety, bike and parking lanes, etc.

Design Capture Volume/Flow Rate

- For volume based features (rain gardens) use the 24-hour, 85th percentile volume. For flow based features (swales) utilize the 24-hour, 85th percentile rainfall intensity (use CASQA method within Caltrans Basin Sizer).

Treatment Train

- Utilize a treatment train approach that connects and combines features to maximize water quality treatment within the Green Street. An example Green Street treatment train approach is provided in Section 3.6.

Documentation

- Document the design criteria, methodology, drainage areas/treatment areas, calculated volumes/flows, BMP selection, and maintenance requirements in the project Stormwater Management Plan and/or Drainage Report.

3.3 MEDIANS

The median presents an opportunity to implement green streets principles by use of Tree wells, rain gardens, rock gardens or permeable pavements. The graphics below illustrate various green streets design concepts that can be utilized within the median.



Roadway before Green Streets



Roadway with depressed median and bulb out planter at intersection



Conventional raised median curb, impermeable surfacing and trees



Green street depressed median with curb cuts and planter/swale

DESIGN ELEMENTS

- Raised median:
  - Plant low water use/drought tolerant trees and landscaping.
  - Install permeable pavement.

- Depressed median: Utilize roadway cross slope to direct stormwater runoff from impervious roadway elements to:
  - Tree wells
  - Planter Boxes
  - Vegetated Swale
  - Rock Swale

DESIGN CONSIDERATIONS

- Vehicle safety
- Median width and length
- Roadway longitudinal and cross slope
- Structural integrity of adjacent traveled way (design to prevent subsurface infiltration or ponding under traveled way)
- Underdrain and overflow devices
- Proximity of storm drain
- Maintenance access
- ‘Mid-block’ pedestrian crossing potential

Design Elements

- Raised section:
  - Plant low water use/drought tolerant trees and landscaping.
  - Install permeable pavement.

- Depressed section: Utilize roadway cross slope to direct stormwater runoff from impervious roadway elements to:
  - Tree wells
  - Planter boxes
  - Vegetated Swale
  - Rock Swale or Basin

Design Considerations

- Roadway geometrics
- Structural integrity of adjacent traveled way to prevent subsurface infiltration or ponding under traveled way
- Underdrain and overflow devices
- Proximity of storm drain
- Maintenance access

3.4 Intersections

Roundabouts

The design elements and design considerations for roundabouts are similar to medians.



Aerial view of rural intersection before roundabout



Aerial view of constructed roundabout with permeable pavement and rain garden with connection to storm drain



Closeup view of same roundabout



Street view of same roundabout

Bulb-Out at Intersection

The design elements and design considerations for bulb-outs are similar to curb extensions. Bulb-outs provide traffic calming at intersections, increase pedestrian visibility, and decrease cross-walk lengths. Bulb-outs at intersections prevent motorists from parking too close to a cross-walk or from blocking a curb ramp. Motor vehicles parked too close to corners present a safety concern, since they block sight lines, obscure visibility of pedestrians and other vehicles, and make turning difficult for emergency vehicles and trucks. Bulb-outs are only appropriate where there is an on-street parking lane or shoulder and must not extend into bike lanes or travel lanes. The turning requirements of larger vehicles such as fire trucks and school buses require consideration in design.



Bulb-out planter box at intersection



Bulb-out at intersection

Design Elements

- Raised section:
  - Plant low water use/drought tolerant Tree wells and landscaping
  - Install permeable pavement.

- Depressed section: Utilize roadway cross slope to direct stormwater runoff from impervious roadway elements to:
  - Tree wells
  - Planter boxes
  - Vegetated Swale
  - Rock Swale or Basin

Design Considerations

- Appropriate only where there is on-street parking or shoulder
- Roadway geometrics
- Structural integrity of adjacent traveled way to prevent subsurface infiltration or ponding under traveled way
- Underdrain and overflow devices
- Proximity of storm drain
- Maintenance access
- Turning requirements for large vehicles
- Bike lanes

Design Elements

- Traveled Way and Bike Lane:
  - Design lane widths to minimum allowable.
- Shoulder/Parking Lane:
  - Utilize permeable pavement with edge restraint at interface with traveled way

Design Considerations

- Permeable pavement not acceptable in traveled way, bike lane, and parkway
- Structural section design to handle vehicle loading
- Shoulder utilization (with or without parking, temporary use during lane closures)
- Roadway geometrics
- Hydrologic design requirements (stone reservoir depth and underdrain requirements)
- Design to maintain structural integrity of adjacent traveled way with edge restraints and prevention of infiltration beneath traveled way section
- Interrupt permeable pavement at intersections
- Surrounding land use and sediment sources
- Long term maintenance
- Pedestrian safety
- Maintenance access

3.5 Traveled Way, Bike Lane, and Shoulder Permeable Pavement

The use of permeable pavements within the traveled way and bike lanes of County maintained roads is not currently permitted. However, their use may be considered for low volume driving lanes in parking lots, private streets, alleys, and fire access roads. The use of permeable pavement in the shoulder/parking lane should be evaluated based upon the following design considerations listed to the left.



Conventional street with bike lane and shoulder



Green street with permeable pavement in parking lane

Curb Extensions

Curb extensions reduce overall street dimensions and provide traffic calming. Among other benefits, curb extensions provide added space for rain gardens.

Curb extensions shall never encroach upon the traveled way or bike lanes. When existing tree roots are damaging adjacent curb, gutter, or pavement curb extensions provide an excellent opportunity to preserve the tree and provide green infrastructure.

Careful survey of street parking impacts should be considered when locating curb extensions.



Curb extension with planter box



Curb extenstion with planter box

Design Elements

- Low water use/drought tolerant trees and landscaping
- Permeable pavement
- Planter boxes

Design Considerations

- Roadway geometrics
- Structural integrity of adjacent traveled way to prevent subsurface infiltration or ponding under traveled way
- Underdrain and overflow devices
- Sight distance at intersection
- Proximity of storm drain
- Utility conflicts
- Pedestrian mobility aspects
- Maintenance access
- Parking requirements

Parkway Design Elements

- Landscape area:
  - Tree wells
  - Planter boxes,
  - Curb extensions
  - Bulb outs at intersections
  - Swales.
- Sidewalk or trail:
  - Drain to adjacent landscaping
  - Drain to green street LID practice
  - Permeable pavement
- Other areas:
  - Filter Strip
  - Rock basin

3.6 Parkway

The parkway including the tree space, planting strip, sidewalk, pathway, and other areas has numerous opportunities for Green Street implementation.

Tree Wells



Existing Road



Conceptual desgin with Tree wells, and permeable sidewalk



Existing Road



Reconstructed Road with Trees and planter boxes

PLANTER BOXES



Before and After Concept



Road retrofit with planter boxes and trees



Planter Box with step out zone



Planter box with step out zone

PARKWAY DESIGN CONSIDERATIONS

- Roadway classification and parkway width
- Location (urban or rural setting)
- Tree type and spacing requirements
- Sidewalk or trail width requirements
- Streetside parking requirements
- Roadway and parkway horizontal and vertical geometrics (curves and longitudinal slope)
- Pedestrian mobility and safety
- Maintenance access
- Interface with driveways
- Utilities and appurtenant structure locations
- Hydrologic design requirements
- Proximity of storm drain systems
- Structural integrity of adjacent traveled way (utilize edge restraints and prevent infiltration beneath roadway section)
- Low water use/drought tolerant Trees and landscaping

Design Elements

- Low water use/drought tolerant landscaping
- Rock
- Curb cuts and outlet design
- Energy dissipation
- Check dams

Design Considerations

- Roadway geometrics
- Structural integrity of adjacent traveled way to prevent subsurface infiltration or ponding under traveled way
- Underdrain and overflow devices
- Proximity of storm drain
- Pedestrian mobility aspects
- Maintenance access

Swales



Swale adjacent to road



Rock swale adjacent to road



Rock swale adjacent to road



Swale adjacent to road

SIDEWALKS AND PATHWAYS



Permeable pavement sidewalk with rain garden in curb extension



DG pathway with rock swale



Pervious concrete sidewalk



Porous asphalt pathway

DESIGN ELEMENTS

- Drain to adjacent landscaping or adjacent LID facility
- Permeable pavement

DESIGN CONSIDERATIONS

- Sidewalk width and ADA requirements
- Public safety
- Pedestrian mobility aspects
- Maintenance access

Design Elements

- Low water use/drought tolerant landscaping
- Swales
- Rock basins
- Vegetated filter strips

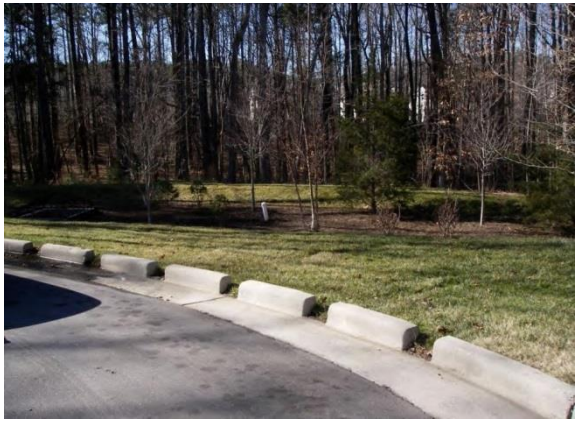
Design Considerations

- Available space
- Vehicle and public safety
- Structural integrity of adjacent traveled way to prevent subsurface infiltration or ponding under traveled way
- Underdrain and overflow devices
- Proximity of storm drain
- Maintenance access

Other Parkway Areas



Swale outside of sidewalk and road



Curb cuts with filter strip



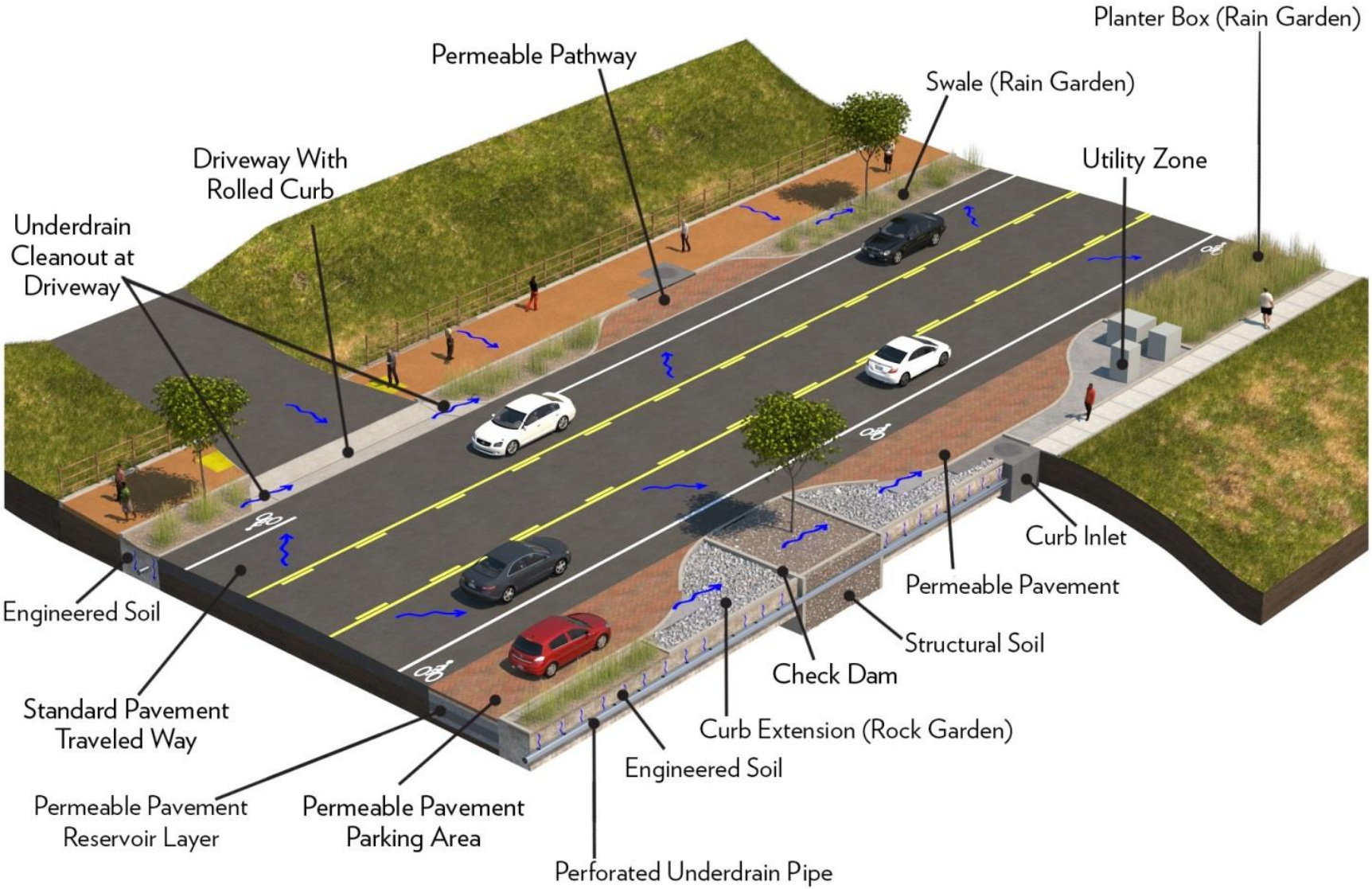
Rock garden



Rock swale

3.6 PUTTING IT ALL TOGETHER

This graphic shows a treatment train concept as an example of how several different techniques may be combined for Green Street implementation.





CHAPTER 4 Implementing Green Streets

2.7
2.8
2.9





4.1 Design and Construction

The goal of the County of San Diego (the County) Low Impact Development (LID) Program is to protect stormwater quality by preserving and simulating natural hydrologic functions through the use of stormwater planning and management techniques on a project site. Both public and private projects constructing in the ROW are required to retain stormwater to the maximum extent practicable. Designers must examine all uses of public space and place stormwater management where space and use allows.

DPW is installing green infrastructure as part of regulated construction projects and retrofit projects to reduce stormwater runoff in more areas of the County. Green Street projects utilize green infrastructure techniques and may be constructed independently to improve watershed health, or as a part of other infrastructure improvement projects.

These Green Street Guidelines are a planning tool intended to assist project engineers with identifying and selecting suitable Best Management Practices (BMPs) for their respective Green Infrastructure projects. Technical standards, including drawings, specifications, maintenance schedule, and plant list, can be found in the Green Street Standards document.



4.2 MAINTENANCE

Implementing green infrastructure and Low Impact Development (LID) practices requires maintenance to keep them attractive and functioning. Maintenance levels of care should be considered during the design phase and plants selected from the Green Streets Plant List according to the following levels:

- Low level of care: Annual maintenance; no irrigation
- Medium level of care: Quarterly maintenance; some water available
- High level of care: Monthly maintenance; site is potentially irrigated

San Diego County DPW is typically responsible for maintaining publicly-installed green infrastructure and LID facilities within their right-of-way. The final determination of maintenance responsibility is determined during project review. Private installations must have a maintenance covenant from the owner. Residents can help with maintenance by removing trash and weeds. Refer to the Green Streets Maintenance Schedule for frequency and detail of maintenance.

Type of Maintenance	Rain Garden or Rock Garden	Permeable Pavement	Tree Space
Inspect after storms	•	•	
Remove trash/sediment/leaves	•	•	•
Clean inlets/outlets	•		
Adjust mulch and/or stone	•		
Water for establishment	•		•
Weed/remove invasive species	•		•
Prune (as needed)	•		•
Replace mulch (3” depth)	•		•
Street sweeper/vacuum (as needed)		•	

4.3 FUNDING

Funding mechanisms for Green Streets maintenance may include:

- Community Service Districts
- Home Owner’s Associations or other private sources









REFERENCES

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County of San Diego – Low Impact Development Handbook, 2014:
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DDOT – Greening DC Streets, 2014:
ddot.dc.gov/GreenInfrastructure

Low Impact Development Center, Inc. - Low Impact Development Manual for Southern California, 2010:
https://www.casqa.org/resources/lid/socal-lid-manual

Montgomery County, MD - Environmental Site Design Implementation in Montgomery County, Maryland: Image Library,2011:
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K.3 Green Streets Design Criteria

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Green Streets
Design Criteria



County of San Diego
Department of Public Works

January 2016

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SECTION 1

INTRODUCTION

Section 1.1 INTRODUCTION

These design criteria are for use by individuals who as a result of the land development process desire to have the County accept improvements using green infrastructure strategies into the County's system of maintained public roads.

Section 1.2 PURPOSE

The purpose of this document is to provide for the regulation of improvements using green infrastructure strategies to be dedicated to the public and accepted by the County as a result of the land development process. The design criteria are intended to keep the operating cost of maintaining green infrastructure at a reasonable level at the same time provide for the service and protection of the public.

When these design criteria are applied to a project to the size and extent specified in section 2.2 of the County of San Diego BMP Design Manual, that project shall be deemed to be designed and constructed in accordance with the USEPA Green Streets Guidance (Managing Wet Weather with Green Infrastructure, USEPA, 2008) as long as these design criteria are as protective of water quality as the USEPA Green Streets Guidance. Green Streets projects are subject to County review and approval. Green Streets Design Criteria in this document build upon the Public Road Standards and Flexibility in County Road Design (FCRD) to provide the minimum requirements and procedures necessary to implement Green Streets design. The Green Streets Design Criteria are to be used in addition to the Public Road Standards for the County of San Diego. The Design Standard Drawings, minimum requirements, and procedures stated herein may be revised or amended from time to time, but only to the extent specified under the supplemental specifications or special provision included in a specific contract.

References by date and title shall be made to these Design Criteria with construction plans or other contract documents as notification of their application to those documents.

Section 1.3 BACKGROUND

The Public Road Standards were created to provide for the regulation of right of way improvements to be dedicated to the public and accepted by the County as a result of the land development process. The Public Road Standards are intended to keep the operating cost of maintaining public facilities at a reasonable level and at the same time provide for the service and protection of the public.

Section 3.2 of the Public Road Standards states that: *"Where the requirements for any subdivision major use permit, rezone, or other improvements are not covered by these Standards, such requirements shall be specified by the Planning Commission, or Board of Supervisors, or, if not so specified, by the Director."*

Section 9.2 of the Public Road Standards references the FCRD document which is a companion to the Public Road Standards: *"Flexibility is available in the implementation of the County Public Road Standards so that specific road designs may be developed that are more suitable for the context in which they are used."*

FCRD is not intended to supersede existing County of San Diego Public Road Standards, procedures or practices, but it is a compilation of possible options that under appropriate conditions may be used to enhance established traffic engineering and design practices, policies and standards. The purpose of the FCRD is to provide additional information and guidance regarding designing County public roads that incorporate community values, provide adequate emergency access and are safe, efficient, effective mechanisms for the movement of people and goods. Additionally, FCRD encourages a comprehensive design process, involving the public and incorporating a multi-disciplinary design approach early and throughout the design process.

Furthermore, the FCRD states that: *"Implementation or construction of County road improvement projects often result in significant environmental impacts. These include impacts to sensitive environmental features such as biological habitat, structures or features of community interest, residential buildings or areas. These impacts may be avoided or reduced through the selection of alternative designs. Alternative design features may also be selected to enhance or preserve environmental or cultural resources. Design features may also be provided to reduce or filter storm water runoff to assist in achieving low impact development goals."*

SECTION 2
GENERAL DEFINITIONS

Section 2.1 GENERAL DEFINITIONS

In addition to the general definitions included in the Public Road Standards, the following definitions shall be applicable to these Green Streets Design Criteria.

1. "CHECK DAM" is a small dam constructed across a rain garden, curb-extension, channel, swale, etc. of storm water facilities that controls (slows) the runoff velocity, reduces erosion, promotes sediment deposition, and increases infiltration.

2. "CURB CUT" is a part of curb that has been removed to allow an unobstructed pathway from the street level and is often used to redirect water from traditional drainage ways to a Stormwater BMP.

3. "CURB EXTENSION" is a traffic calming strategy that provides a widening of the sidewalk and a narrowing of the roadway, which allows space for Rain Garden or Rock Garden within the extension.

4. "DETENTION" and "RETENTION"
   4a. "DETENTION" is a technique that stormwater runoff is directed, held (detained) for a period of time into a depressed area or structure (detention basin or pond) and slowly released to a surface water body. The structure is not designed to permanently contain water. It can help improve water quality by allowing suspended solids to settle over a period of time. The temporary storage of storm runoff water also decreases downstream peak flow rates which can reduced potential flooding.

   4b. "RETENTION" is a technique that holds or retains runoff water, allowing it to infiltrate, evaporate, or/and emergency overflow to be used on-site in order to reduce off-site transportation of runoff and improve water quality.

5. "ENGINEERED SOIL" is soil or growing media that has been formulated with specific components for specific purpose or application; For example, engineered soil media for rain garden may contain native soil from the site mixed with compost and sand to improve drainage, infiltration, and plant growth.

6. "FILTER FABRIC" is textile of relatively small mesh or pore size that is used to allow water to pass through while keeping sediment out (permeable), or prevent both runoff and sediment from passing through (impermeable).

7. “FILTER STRIP” Filter strip is a vegetated area used to reduce stormwater runoff velocity, filter out pollutants, and enhance infiltration. Filter strips are often used around the perimeter of a rain garden, at the edge of a roadway, or along a stream channel. Vegetated filter strips may also be referred to as buffer strips. Filter strips are often used at the edge of a roadway.

8. “FILTRATION” and “INFILTRATION”
   8a. “FILTRATION” is the process that treats stormwater runoff by capturing and passing the water volume through a bed of sand, other soil material, or other acceptable treatment media to remove pollutants from the water. Filtering practices differ from infiltration practices in that the stormwater filters through an engineered filter media, rather than native soil. However, filtering practices can be constructed in combination with infiltration practices, where the filtered water is discharged into the ground beneath the BMP. Alternatively, filters can be designed with an underdrain to collect the treated water and convey it to discharge. Underdrained filters can be lined to isolate the filters from the adjacent soil material or underlying groundwater.

   8b. “INFILTRATION” is the process of water moving into the native soil from the soil surface to the groundwater storage.

9. “GREEN INFRASTRUCTURE is an approach to stormwater and flood management that protects, restores, and mimics the natural water cycle. Environmental benefits of green infrastructure include improved water quality, enriched habitats, reduced heat-island effect, and recharged water tables.

10. “GREEN STREET” is a street right-of-way that uses a variety of low impact development facilities to manage stormwater runoff close to its source. Green infrastructure includes the facilities that compose a green street.

11. “HIGH VOLUME PEDESTRIAN AREA” is an area with relatively high pedestrian-oriented land uses, which may include the following: Civic (government and public facility buildings), Schools, Commercial, Higher Density Residential (apartment complexes, condominiums, town homes, or detached single-family homes on small lots), Parks and Open Space (with connectivity to one of the above land use elements).

12. “IMPERVIOUS SURFACE” is any material that prevents or substantially reduces infiltration of water into the soil.

13. “LOW IMPACT DEVELOPMENT” is a stormwater management and land development strategy that emphasizes conservation and the use of on-site natural features integrated with

engineered, small-scale hydrologic controls to more closely reflect pre-development hydrologic functions.

14. “LOW VOLUME PEDESTRIAN AREA” is an area with relatively low pedestrian oriented land uses such as low density housing.

15. “OFFLINE FACILITIES” are systems that provide stormwater treatment away from the flowpath of the runoff, then return the treated flow to the conveyance system.

16. “ONLINE FACILITIES” are systems that provide stormwater control within the flowpath of the runoff.

17. “PERVIOUS” refers to a soil or material that allows the passage of water or other liquid.

18. “PERMEABLE PAVEMENT” is a paving material that has sufficient interconnected voids to provide a high rate of permeability. Permeable pavement is inclusive of permeable interlocking concrete pavers, pervious concrete, porous asphalt, and porous rubber. These terms are reflective of the industry standard nomenclature.

19. “RAIN GARDEN” is a shallow landscape depression designed to capture and treat stormwater runoff. The plants and soil in a rain garden facilitate infiltration and pollutant removal. Rain Gardens are designed to hold water for a short period of time following a storm event. Water collected in a Rain Garden will infiltrate, evaporate, or overflow as surface runoff.

20. “SPLASH PAD” is a stormwater flow control device designed to diffuse and decrease the velocity of the inflow water into a stormwater facility to provide erosion protection and to trap sediments and debris; splash pad is also required at outfall points of the stormwater facility.

21. “STREET TREE” is a tree growing in the public street right-of-way.

22. “STRUCTURAL SOIL” is a designed medium which can meet or exceed pavement design and installation requirements while remaining root penetrable and supportive of tree growth, such as CU-Structural Soil™.

23. “SWALE” is an open drainage channel that has been explicitly designed to detain, evaporate, and/or infiltrate runoff associated with a storm event. A swale collects and filters urban stormwater and may include grass and sand filters, loamy soils, mulch, shallow ponding, native trees and shrubs, or rock. Swales typically have some longitudinal slope.
24. tree well

SECTION 3
GENERAL POLICY

Under the Municipal Separate Storm Sewer System (MS4) permit for San Diego Region (Permit [Order No. R9-2013-0001]), the County is allowed to make Priority Development Project (PDP) Exemptions for roadway type projects by redeveloping or retrofitting existing paved roads, streets, and alleys as "EPA Green Streets" under an adopted program by the County and based in part on the EPA publication *"Green Streets: Municipal Handbook, Managing Wet Weather with Green Infrastructure."*

The Green Streets program incorporates a wide variety of Low Impact Development (LID) design elements including, but not limited to, tree wells, rain gardens, rock gardens, pervious pavements, and removal of unnecessary pavement. Features implemented as part of the Green Streets program are designed to meet the treatment control requirements of Section 2.2 and Appendix 'B' of the County's BMP Design Manual, but are not necessarily designed to meet the flow control requirements of the County's Hydromodification Management Plan (HMP) and are not categorized as TCBMPs.

Section 3.1 PLANS TO BE APPROVED BY DIRECTOR, DEPARTMENT OF PUBLIC WORKS

In addition to the requirements set forth in the Public Road Standards, the Developer shall cause to be prepared by a California Registered Civil Engineer, in accordance with these Green Street design criteria, plans, profiles, specifications, and calculations for the proposed green infrastructure improvements as follows:

3.1.1 Storm Water Quality Management Plan (SWQMP)

A Storm Water Quality Management Plan shall be prepared to meet Storm Water Pollutant Control Requirements as described in Chapter 2.2 and Chapter 5 of the County BMP Design Manual.

3.1.2 Landscape and Irrigation Plans

Landscape and Irrigation plans shall comply with the most current version of the County of San Diego Water Efficient Landscape Design Manual. Plants should be selected based upon LID feature drawdown times. Only plants tolerant of saturated soil conditions should be planted in zones subject to frequent inundation. Details for planting, structural soils, engineered soil media shall be specified in the SWQMP and shall correlate exactly with the plan. Clear recovery zones and horizontal sight distances associated with travel lanes shall be plotted on the Landscape and Irrigation plans. Additional information for tree well design shall include:

- The type, locations and dimensions of all tree wells.
- Clearly depict the locations, dimensions, open and covered soil area, and soil volume method for each tree.
- Details shall be provided which illustrate the overall size, depth, soil composition, and drainage of the planting space.
- Calculations of soil rooting volume and maximum tree canopy supported.

3.1.3 Project Improvement Plans

Separate from the conventional plans Storm Water Management Plan set shall be included in the project improvement plans. Storm water management plans will include

- Drainage management areas
- Land uses and cover types
- Peak flow rates for Q100 design storm

Plans with the type, locations and dimensions of all stormwater management facilities with key elevations depicted as follows:

- Inflow elevation
- Outflow elevation (for online facilities)
- Invert elevation of rain garden surface
- Top of ponding elevation
- Bottom of reservoir/stone layer (bottom of storage)
- If applicable, underdrain connection point with tie-in invert elevation, and
- Sections and profiles to show any steps, underdrains, and utility lines through the facility.

SECTION 4

REQUIRED PUBLIC ROAD RIGHTS-OF-WAY IMPROVEMENTS

Section 4.2 ROAD CROSS SECTIONS

The data specified in Tables 2A and 2B of the Public Road Standards are minimums and are subject to modification for Green Street implementation with the approval of the Director.

Section 4.3 GENERAL NOTES

A. Additional right-of-way width, beyond that specified in Tables 2A and 2B of the Public Road Standards may be required to accommodate Green Street features or improvements.

SECTION 5
REQUIRED ROAD IMPROVEMENTS

Section 5.1 CURBS AND DIKES

Per approval of the Director, flush curb may also be considered for a Green Street to accommodate drainage into rain gardens, rock gardens, swales, and filter strips.

Section 5.2 SIDEWALKS

Sidewalks constructed with permeable pavement conforming to the Green Street Standard Drawings may also be considered for construction.

Section 5.4 DRIVEWAYS

Per the approval of the Director, residential and commercial driveway aprons in the public right may be constructed of permeable pavements but will remain the responsibility of the owner of the property being served.

Section 5.6 TRAFFIC SIGNALS, REGULATORY, AND WARNING SIGNS

Signage for education and public awareness of Green Street LID facilities shall be included in the design at locations specified by the Director as part of the Green Street improvement.

Section 5.10 MEDIANS

Per approval of the Director, tree wells, permeable pavement, rain gardens, or rock gardens may be used rather than conventional concrete median curb and gutter drainage provided the requirements of the Hydraulic Design Manual are met. Tree wells, permeable pavement, rain gardens, and rock gardens shall conform to the Green Street Standard Drawings.

Section 5.11 DRAINAGE IMPROVEMENTS

5.11.1. Green Streets Facilities

5.11.1.1 General

Green Streets facilities to be used in the public ROW may include tree wells, rain gardens, rock gardens, or permeable pavement. Other Green Streets facilities may be used with approval by the Director.

5.11.1.2 Design Storm

Green Streets roadway drainage design shall comply with the most current versions of the County of San Diego Hydrology Manual and the Hydraulic Design Manual. Green Streets LID BMP facilities shall be sized to convey the 100 year storm within the public right of way.

5.11.1.3 Design Guidance

Choice of green streets stormwater facilities should be based on the context of the surrounding streetscape. In addition to the benefits to stormwater quality and quantity, multi-purpose design of stormwater facilities can add aesthetic value to the County by providing varied landscaping, visually appealing pavement design and enhanced community spaces on streets. They can also be combined with traffic calming features.

The process for selecting and designing LID facilities in a roadway project begins with site analysis:

- Address the street layout – The dimensions of the travel lanes, location of medians, islands and buffer strips, and all elements related to the functionality of the roadway will be established in the design plan.

- Identify clear recovery zones and sight distance corridors – Tree and shrub plantings should never compromise public safety. Trees with an expected mature diameter of 4" or larger at chest height shall not be planted within clear recovery zones. Sight distance through horizontal curves, at intersections, and driveways shall not contain vegetation that will obstruct sight

- Include other transportation modes – The requirements for pedestrian traffic, cyclists, mass transit, and other possible modes are incorporated into the right of way as well.

- Choose stormwater locations and types – implement stormwater facilities that can capture and treat the runoff from impervious surfaces prior to entering the storm drain system. Consider space between curb and sidewalk, behind sidewalk, in channelized islands and medians for vegetative practices. Consider parking lanes, alleys, sidewalks, and other roadways for permeable pavement. Maximize tree well locations. LID facilities should be placed to maximize volume capture. Adjacent LID and BMP facilities should be closely reviewed to ensure they will receive stormwater flow from the design storm.

5.11.1.4 Green Street Facilities

- Green Street Facilities shall be placed within vegetated areas of the public ROW and landscaped with a selection of plants consistent with the Water Efficient Landscape Design Manual and LID Handbook. Possible areas for Green Street Facilities include tree well, parking lanes, curb extensions, intersection triangles, open areas, swales, and areas adjacent to the sidewalk. Green Street Facility design shall comply with the Green Streets Guidelines

and Standard Plans.

5.11.1.4.1 Types of Green Street Facilities

- Tree well:
- Curb Extension: This type is generally placed in locations where a new curb is constructed into the parking lane to create an opportunity for a Rain Garden, which may or may not incorporate a portion of the tree well. In most cases, curb extensions will be designed as online facilities.

- Streetscape Planter: This type is typically a small-scale Green Street Facility, often located between the curb and sidewalk. These facilities may include tree, shrub and groundcover plantings. In most cases, Streetscape planters will be designed as offline facilities. The facility may need to incorporate fencing or a barrier around the perimeter for pedestrian safety. Refer to Section 5.11.1.5.6 for more information on safety and access.

- Swale: This facility type is includes drainage channels or linear Rock Garden basin adjacent to either the roadway or the sidewalk, typically vegetated with trees, shrubs, or groundcovers. Swales may be designed to convey or retain stormwater. Swales adjacent to roadways that receive stormwater runoff from roadway surfaces shall be designed according to the requirements of the Hydraulic Design Manual as open channels, with the exception of freeboard requirements. Swales without curbs are online facilities. Vegetation within the swale should be sufficient to visually depict the slope and depression within the swale.

5.11.1.5.2 Green Street Facilities Cross Section

Materials used in the various Green Street Facilities shall be in accordance with the Green Streets Specifications. Green Street Facilities shall be designed per the Green Street Standard Drawings. Impermeable PVC liners are required in Green Street Facilities as follows:

- Facilities within 10 feet of a structure (e.g. an existing building) shall be lined on the side adjacent to the structure.
- Facilities within 5 feet of the roadway face of curb shall be lined on the side adjacent to the roadway.
- In areas where infiltration is not permitted facilities shall be lined on all sides and subsurface drainage is required.

5.11.1.5.4 Allowable Ponding Depths

Allowable ponding depth in Green Street Facilities shall be selected based on the adjacent land use, and the associated need for barriers around the facilities as described in Section 5.11.1.5.6 on Safety & Access.

- The maximum allowed ponding depth in Green Street Facilities is 18 inches.
- Green Street Facilities in high-volume pedestrian and residential areas will typically have a 6 inch maximum ponding depth. The ponding depth may vary based on slope conditions.

5.11.1.5.5 Subsurface Drainage

- A minimum of one clean-out is required for basins and curb extensions, and shall be shown on design plans. For other Green Street facilities, a clean-out shall be provided within 10 feet of the underdrain connection to the catch basin or manhole.
- Connect underdrains to catch basins, manholes, or direct connect to storm sewer pipe. Connection to catch basin is generally the most cost effective option. When directly connected to the storm drain, place a backflow preventer valve on the underdrain connection.
- For Green Street Facilities without underdrains, observation wells are required and shall be shown on the design plans. The maximum spacing of observation wells shall be 100 feet.
- Use curb openings with depressed gutters to convey runoff to Green Street Facilities adjacent curbed roadways. Space the openings to deliver the design capture volume to the facility:
  - Convert the flow associated with the design capture volume for which the BMP is being designed into peak discharge.
  - Space the curb opening to achieve 100-percent interception of the DCV. Multiple curb openings can be used for each facility to deliver the required volume.
- Curb cuts across sidewalks require trench covers.
- Check dams in Green Street Facilities may be necessary to allow ponding volume, achieve the storage volume, to slow velocities, or both. Check dams will be placed in sloped facilities at intervals to maintain ponding depth and facility depth within allowable limits.
- Pre-treatment devices are required to trap coarse sediment and dissipate energy. Applicable choices include:
  - Green Street Facilities in Open Area: or Vegetated filter strip.
  - Curb Extensions: Splash pad as depicted in standard drawings.
  - Streetscape Planters: /Splash pad adjacent to curb cut. Overflow devices are required for online facilities and for off-line facilities where the lowest adjacent top of curb or sidewalk is equal to or lower than the inflow point elevation. Typical overflow devices include outflow curb openings to gutter, and overflow structures. Size overflow devices

for online Green Street Facilities to convey the 10 year storm. Where in the roadway, the overflow device shall be sized to meet the roadway drainage requirements listed din Section 2.2.1 of the Hydraulic Design Manual. For online facilities, provide a minimum of 3-inches of freeboard from overflow structure to overtopping elevation.

- Side slopes of swales shall be designed to prevent erosion based on anticipated stormwater flow rates. Temporary soil stabilization and erosion control measures shall be used to stabilize soils until plant materials have been established.

5.11.1.5.6 Safety and Access

- Edge conditions around green street facilities adjacent to pedestrian areas may be sloped or with a vertical drop.
  - Railings are required around Green Street Facilities with a vertical drop adjacent to sidewalks in high-volume pedestrian areas.
    - Top of railing shall be 18" above sidewalk, with vertical and/or horizontal member spacing which meets ADA detection requirements for visually impaired pedestrians.
  - Green Street Facilities with a vertical drop adjacent to sidewalks in low-volume pedestrian areas must be surrounded by a minimum 4 inch high curb.
  - Green Street Facilities with a vertical drop must have a minimum 4-inch curb or railing between the parking step out zone and the drop.
  - Green Street Facilities with a sloped side must provide a flat (5% maximum slope) 6-inch minimum width buffer of different material to meet flush with adjacent sidewalk. Green Street Facilities with a depth greater than 3-feet must provide a flat (5% maximum slope) 24-inch minimum width buffer. When sides are sloped, the finished grade must be stabilized with plants, sod, seed, mulch, or stone.
  - Green Street Facilities adjacent to a designed shared use path (bicycle facilities) must provide a 5% maximum slope, 24-inch width buffer of different material to meet flush with adjacent path. A sloped side with maximum 3:1 slope and maximum 5-foot depth or 12-inch maximum drop is allowed. If either of those conditions is exceeded, a 42-inch height guard is required.
- Pedestrian crossings of continuous Green Street Facilities adjacent to curb are required as below.
  - One 4' wide paved crossing between each tree well and 35 foot maximum spacing in high-volume pedestrian areas
  - One 4' wide crossing every other tree and 70 foot maximum spacing in other areas consistent with surrounding area (paved, vegetated, or mulched).
- Parking step out zone of a width between 18" and 36", (measured from face of curb) is required for Green Street Facilities adjacent to parking lanes. When placing and designing Green Street Facilities adjacent to travel ways, check for clear zone and traffic barrier needs. Adjust design to avoid use of traffic barriers whenever possible. The curb serves as a barrier for vehicle safety on most County streets. On streets without curb, provide a

concrete header between the road and Green Street Facilities, with maximum 10:1 side slope beyond the header to a maximum drop of 18 inches.

- Green Street Facilities with sloped sides with a total depth of more than 18 inches shall require a fence of 36-inch height enclosing the entire facility.
- Green Street Facilities with a greater than 18" vertical drop require a 42" railing meeting International Building Code 1013 (Guards).
- Access is required to all Green Street Facility areas for maintenance. For facilities off the road, an access road may be needed. For facilities on high speed roads, ensure safe access via a shoulder or designated area. Within the facility area, the overflow structure must be accessible to maintenance crews.

5.11.1.5.7 Limitations

- A vertical separation of 10 feet is required between the bottom of Green Street Facilities proposing infiltration and the top of the seasonally high groundwater table.
- Green Street Facilities with infiltration are not allowed in areas with contaminated soil or groundwater.

5.11.1.6 Permeable Pavement

Permeable pavement is being demonstrated for suitability and durability in the County ROW. Permeable pavement may be proposed for use in place of impervious surfaces, in appropriate locations. The Director must approve any use of permeable pavement at specific locations in County roadways, alleys, and trails.

5.11.1.6.1 Types of Permeable Pavement Facilities

The types of permeable pavement facilities and appropriate uses are tabulated below. Types subjected to vehicular traffic loads include permeable asphalt, pervious concrete, and permeable interlocking concrete pavers. Other types not subjected to traffic loads, may be allowed on a project by project basis. Designs which differ from the table below may be allowed with approval by the Director.

Permeable Pavement Type	Appropriate Uses
Permeable Interlocking Concrete Pavers	Shoulders Parking Spaces Sidewalks
Pervious Concrete	
Pervious Asphalt	
Stabilized Decomposed Granite	Walkways and trails
Pervious Rubber	Tree well covers

5.11.1.6.2 Contributing Drainage Area

Stormwater runoff from pervious areas often contribute sediment and lead to clogging and increased maintenance requirements for pervious pavement, and should be avoided to the extent possible. Ideally, at least 90-percent of the area draining to pervious pavement shall be impervious, not including the permeable pavement area itself. Pretreatment, drainage area stabilization, and specific maintenance program are options that the County will consider for implementation where contributing drainage area is less than 90-percent impervious.

5.11.1.6.3 Permeable Pavement Base Design

All Permeable Pavement Systems:

- The wearing surface is the pavement material plus any required bedding layers under the surface and inside of the joints, in accordance with all applicable standard details, specifications and manufacturer recommendations as applicable. The wearing surface shall meet the latest ADA requirements.

5.11.1.6.4 Stormwater Conveyance and Retention

Stormwater conveyance from all impervious areas including standard pavement shall, to the extent feasible, drain to permeable pavement as sheet flow. Otherwise pre-treatment for energy dissipation and sediment control may be required where any concentrated flow is directed onto pervious pavement. Level spreaders may be designed to convert concentrated flow to sheet flow into the pervious pavement facility.

Reservoir and Underdrain - Sizing for Retention Volume

The volume of storage for permeable pavements systems shall be designed to meet the regulatory requirements promulgated by County. Storage design shall meet the following:

- Subsurface drainage will consist of a minimum 6-inch diameter perforated underdrain in the reservoir layer or a separate layer of open graded stone below the reservoir layer. Subsurface drainage is recommended beneath all vehicular use permeable pavement installations unless elimination of the underdrain is expressly approved by the Director.

Permeable pavement may be installed in areas with no traffic volume without underdrains if infiltration results are good and underdrain connections are not feasible.

- For sites where native soil design infiltration rate sufficient to drain the volume below the underdrain within 72 hours, the subsurface pipes may be elevated to provide infiltration sumps of reservoir stone. Use of a raised underdrain is encouraged and provides enhanced retention. An alternative approach to a raised underdrain is an underdrain with an up-turned elbow outlet.

- For designs with a waterproof membrane on the bottom as required in the Geotextiles and Liners section, the minimum slope of the subsurface drainage pipes is 2-percent and shall match the bottom (invert) slope of the facility.

- For designs without a waterproof membrane, the minimum slope of subsurface drainage pipes shall be 0.5-percent.

- Clean-outs are required for all underdrained permeable pavement facilities. Clean-outs shall be spaced at 100 foot maximum intervals. Where a storm drain structure such as catch basin, manhole, or overflow structure is within 100 feet of a clean-out, it will serve the same function as a clean-out.

- Observation wells are required for facilities without underdrain and shall be shown on design plans. Observation wells shall be spaced at 100 foot maximum intervals.

- Drawdown time for shall be 24 hours minimum and 96 hours maximum. Drawdown time is calculated based on infiltration rate of native soils at the invert of the facility, and the flow through underdrains.

- The reservoir will be sized so that the runoff associated with the 2 year, 24 hour frequency storm does not surcharge the wearing surface at the low end of the facility.

- Overflow conveyance for higher storms shall be designed to surface convey into existing or new storm sewer systems adjacent to the permeable pavement.

To achieve the design volume, the profile of the pavement shall be designed in one of the following scenarios, which shall be selected based on topography of the site, location of utilities and other underground features, project budget, and any other constraints related to specific site:

- Use of a continuous bottom slope less than or equal to 2-percent.

- Use of a terraced invert, with the slope between steps less than or equal to 2-percent. Vertical drop of terraced invert shall generally be 6-inches to 12-inches, but can vary to achieve design requirements.

- Use of check dams with variable bottom slope, located so that the 2 year, 24 hour runoff volume does not surcharge the low end of the wearing course Check dam material options include waterproof membrane, PVC sheeting, acrylic sheeting, and concrete. Use of membranes and sheeting are the most cost effective and generally preferred options. A transverse underdrain may be needed in check dam systems if the base of a step does not slope to the longitudinal underdrain or if needed due to the width of the permeable pavement system.

5.11.1.6.5 Pavement Structural Design

For pavements subjected to vehicle traffic loading, pavement design calculations shall be required. Pavement design may result modifications to the pavement cross section in the County approved standard drawings to meet or exceed the pavement strength requirements.

Caltrans methods for rigid pavement design shall be used for permeable concrete. Caltrans methods for flexible pavement design shall be used for pervious asphalt. Caltrans methods for flexible pavement design, with appropriate layer coefficients as applicable to the interlocking, shape, and thickness of the pavers, shall be used for interlocking permeable unit pavers. Guidance for layer coefficients is provided by the Interlocking Concrete Pavers Institute.

Testing of the bearing capacity for underlying soils shall be required for all permeable pavements for vehicular use, shall be site specific, and shall be in accordance with ASTM D4429-09a, Standard Test for California Bearing Capacity of Soils in Place. Other considerations for the pavement design include:

- Edge restraints shall be used for all permeable unit pavers. Edge restraints may also be used for permeable asphalt and permeable concrete as necessary.
- In soft soils with low bearing capacity where infiltration is planned, geo-grid as the preferred option over removal of the material and placement/compaction of select backfill.

5.11.1.6.6 Limitations

- Permeable pavements are not to be used in the traveled way.
- A 10-foot vertical separation is required between the bottom of the permeable pavement system and the top of the groundwater table.
- Permeable pavements with infiltration are not allowed in areas of soil or groundwater contamination.

SECTION 6
DESIGN PRINCIPLES

All Green Streets facilities shall comply with the most current version of the County of San Diego Hydraulic Design Manual

Section 6.4 PAVEMENT AND STRUCTURAL SECTION

6.4.1 Green Street Surfacing

Per approval of the Director, permeable pavement roadway may only be used in medians, shoulders and parking lanes if deemed appropriate for use immediately adjacent to a standard structural section. The permeable pavement facility can be designed to provide an adequate drainage system. Overflows and storm drain lines may still be required. The permeable pavement shall conform to the Green Street Standard Drawings.

Section 6.6 UTILITY PLACEMENT

Potential conflicts between Green Streets LID BMP facilities and utilities within the street and parkway will need to be addressed during the early design phases of the project and may require flexibility in the design to accommodate utility locations and access.

6.6.1 Utility Clearances at LID Facilities

Utilities are allowed to co-locate in LID facilities subject to acceptance by the utility owner. Individual projects should be coordinated with the utility owners for specific requirements. Current guidelines for clearances of utilities are as follows:

6.6.1.1 Communications/Power

a. Offsets to communications, power and Gas facilities must be coordinated with the Utility company on a project by project basis.

6.6.1.2 Gas

a. For gas lines within 6 inches of LID facilities, the contractor must install a protective shield around the pipe. The shield must be made of fiberglass reinforced plastic (FRP), or other approved insulating material, in either a 12-inch by 12-inch flat-tie plate or clip-on configuration. The shield must be placed over the gas pipe and secured in place to provide adequate protection.

b. For gas lines that are less than 6-inches from the LID facility or within the LID facility, the contractor must install a combination of a protective shield and sleeve. The protective sleeve must consist of either a gray PVC semi-circular sleeve, which comes in 60-inch lengths, or a larger plastic pipe. This protective sleeve must be installed over the gas pipe so

that the protective sleeve extends at least 9-inches on either side of the area in conflict. The shield shall meet requirements described above.

c. Maintain a minimum of 12-inches separation from underdrains to gas facility.

d. Four (4) foot minimum clearance is required between the top of gas facilities and finished road surface grade.

e. Three (3) foot minimum cover is required over gas facilities in open drainage or road ditches.

6.6.1.3 Water and Sewer

a. A minimum of 12-inches of cover is required between bottom of LID facilities and water main, sewer main, or sewer lateral.

b. When less than 5 feet vertical clearance is provided between bottom of LID facility and sanitary sewer main, an impermeable liner shall be used at the bottom of the LID facility to a horizontal distance at least 3 feet beyond the sewer main.

c. Water service laterals my run through LID facilities. Impermeable liners must be properly sealed where penetrated by water service laterals.

d. Concrete collars shall be provided around surface structures within LID facilities (cleanouts, valve boxes, etc.). Top of collar shall be above ponding depth in Rain Garden.

6.6.1.4 Street Lights

a. Street light conduits and poles can run through LID facilities.

b. The designer shall ensure that installation of shrubs or plants do not block access to openings of the transformer base. Access to transformer bases can face either the roadway or towards the sidewalk.

6.6.1.5 Fire Hydrants

a. On sidewalk side, 3 feet minimum clearance must be provided around hydrants.

b. On street side, clearance must be provided for 10 feet in each direction longitudinally along the street, and 4 feet into the street to create a 4 feet by 20 feet access area. This access area may be paved with permeable pavement capable of supporting fire equipment.

Section 6.7 DRIVEWAYS

Curb openings shall be allowed where drainage is conveyed to Rain Garden swales or other Green Infrastructure.

Section 6.9 GREEN STREETS LANDSCAPE DESIGN CRITERIA

6.9.1 Tree Well Design

Tree wells shall be selected from approved lists, and placed in appropriate locations within the

public ROW out of the Clear Recovery Zone and lines of sight. Surrounding soils, including nearby soils under sidewalks shall comply with the design requirements noted below.

6.9.1.1 Minimum Soil Volumes

The following are the minimum allowable soil volumes for tree rooting:

a. 2 cubic feet of soil volume shall be provided for each square foot of mature tree canopy footprint. Soil volume must be within 1.5 times the canopy radius. Soil depth shall be a minimum of 30 inches deep, preferably 36 inches deep.

b. Where soil volumes within the maximum allowable radii for adjacent trees overlap, up to 25-percent of the required soil volume per tree may be shared.

c. For trees that are designed to have a covered soil volume which connects to an open area (for example behind the sidewalk), the open area can be considered as part of the required soil volume.

d. For existing trees to remain, the root structure of existing tree shall be protected to the extent feasible and provided with additional soil volumes to meet the above requirements.

e. Soil Volume calculation shall be calculated as:

   i. (Area of Open Soil x Depth of soil) plus (Area of Covered Soil x Depth of soil)

   ii. All soil types are calculated at full volume.

   iii. There may be multiple soil volume areas included in the calculation depending on design.

6.9.1.2 Tree Planting Design in New or Reconstructed Streetscapes

- Maximized open soil area for tree planting is the most cost effective method of achieving the required soil volume.

- Open tree wells within sidewalks that have soil volume beneath pavement will be a minimum of four feet wide by six feet long. Larger areas may be required to accommodate large root balls or additional plant materials.

- Tree well planting space with continuous open areas adjacent to sidewalk may utilize mulched areas between trees, defined as "plant bed."

- The size of the open tree well planting area is influenced by the site as follows:
  - For narrow public space areas, the open tree well will typically be covered by a tree well grate, with a goal of providing additional paved surface for pedestrian usage.

  - For wider public space areas, the open tree well can be continuous, with pedestrian crossings.

6.9.1.3 Tree Planting Design in Confined Spaces

Reductions in tree well planting space and soil volumes must be justified by physical constraints and approved by the Director.

- Open tree well planting space within existing sidewalk areas that do not have soil volume beneath pavement will be a minimum of four feet wide by six feet long.

- To the extent feasible, soil rooting volumes shall be expanded by creating vegetated areas adjacent to trees longitudinally, or by placing structural soils beneath pavements extending along the sidewalk or across the sidewalk.

- Other soil expansion options include reducing compaction, air spading around roots and addition of planting soil, or other methods as recommended by arborist or landscape architect.

6.9.1.4 Covered Soil for Meeting Tree Soil Volume Requirements

In order to provide adequate soil volume for tree wells, horticulturally appropriate soils must often be placed beneath the adjacent paved surfaces. Acceptable soil systems include suspended pavements, structural cells, and several types of structural soils:

- Suspended pavements include structural slabs that span between structural supports that allow uncompacted growing soil beneath the sidewalk, and commercially available structural systems. Manufacturer details and certification must be provided for commercial systems. Structural calculations and details must be provided for Suspended Pavement installations.

- Structural cells are commercially-available structural systems placed subsurface that support the sidewalk and are filled with amended soil. Manufacturer details and certification must be provided for commercial systems. Amended soil placed within structural cells shall be a minimum of 36 inches.

- Proprietary structural soil systems, such as CU-StructuralSoil™ or Stalite Structural Soil, or equivalent, may be used however; there use may be limited in conjunction with stormwater infiltration.

- Stalite Structural Soil is a proprietary product consisting of lightweight aggregate with a horticultural application.

6.9.1.5 Tree Well Soil Volume Cross Section

Soil Types

Soil types used in the tree well, in accordance with the County's approved specification, are generally described as follows:

- Planting Soil: used for the top 12 inches of open planting beds.
- Engineered Soil Media: used in Rain Garden basins, swales, curb extensions, and beneath suspended pavements.
- Proprietary soil systems such as CU Soil® or equivalent: used to support pavements and obtained only from licensed providers.

6.9.1.6 Stormwater Retention and Treatment Volume

Tree wells with expanded soil volume will serve as a method of capturing and retaining the required volume of stormwater in accordance with County requirements. These facilities can be designed to meet the requirements of the County's Rain Garden type "Engineered Tree Box" when surface ponding volume is provided, whether designed as an enclosed plant bed with covered soil volume, or a continuous open area (either mulched or with turf) with soil volume under the adjacent sidewalk. The tree well can function as an area for "Disconnected Impervious Surface" to capture runoff from the sidewalk.

6.9.2 Access and Safety Barriers

- Pedestrian crossings of continuous open planting strips adjacent to curb are required as below.
  - 4 foot paved area between each tree in high-volume pedestrian areas
  - Alternating every other tree in other areas, with surface material appropriate to surrounding area (paved, vegetated, or mulch).
- Parking egress strip of an 18-inch minimum width (measured from face of curb) may be provided adjacent to curb in street parking zones where total public space width is at least 10 feet between face of curb and back of sidewalk, using the remaining space available after deducting the required sidewalk width and minimum open tree well dimension requirements.
- Ornamental fencing meeting County requirements may be required around open tree planting space to protect planting soil from pedestrian foot traffic.
- Bike racks may be combined with ornamental fencing around open tree planting space. Type of rack to be selected in coordination with the Department of Public Works.

6.9.3 Structural Support

All structural elements, including pavements and curbs, must be founded over structurally stable soils. Stable buried soils should extend laterally from the point of support at a slope of 1 horizontal to 2 vertical in the downward direction. Plant Bed and Engineered Soil Media are not structurally stable. Products such as CU Soil^{TM} are structurally stable.

6.9.4 Planting Guidance for Vegetated Stormwater Systems

Selection of plant species, locations, and spacing within vegetated stormwater management facilities (Rain Garden) will be based on the following parameters:

a. Light - full sun, partial shade, full shade

b. Water - Some plants will succeed in areas that are inundated with water frequently while others will only do well when they are located in the driest part of the facility

c. Salt - Plants that have a high salt tolerance are the best choice for facilities that will receive a large amount of salt-tainted runoff

d. Pollution – Generally, plants that are in areas with higher pollution will require more maintenance and care throughout their lifespan in order to remain aesthetically pleasing

e. Maintenance – Areas with low maintenance should be planted with plants that do not require intensive care. Areas that will be maintained several times a year can be planted with plants that require more attention.

f. Survivability in urban environment - All of the above factors relate to the plant's ability to survive in a green street facility

g. Size – plants should be the appropriate mature size for the site. Site viewing lines, pedestrian, and vehicle safety should be considered. Plants, except tree wells, between the curb and sidewalk should be less than 18-inches high above the sidewalk level. Trees located within the clear recovery zone shall have a mature diameter less than 4” at breast height.

The designer will select the plants for the Rain Garden facilities that are compatible with the Water Efficient Landscape Design Manual. The list is organized in accordance with the above factors, and is grouped into three maintenance categories: low level of care, medium level of care, and high level of care.

SECTION 9

EXCEPTIONS

Section 9.1 EXCEPTION PROCESSING PROCEDURES

Green Street facilities should allow for fire vehicle access such that an exception request for roadway width or median width is not required due to Fire Authority approval.

Section 9.2 FLEXIBILITY IN COUNTY ROAD DESIGN

Design guidelines for considering and implementing design flexibilities that allow variations for environmental constraints are included within these Green Street Design Criteria.

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K.4 Green Streets Design Standard Drawings

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Green Streets
Supplement to County of San Diego Design Standard Drawings



County of San Diego
Department of Public Works

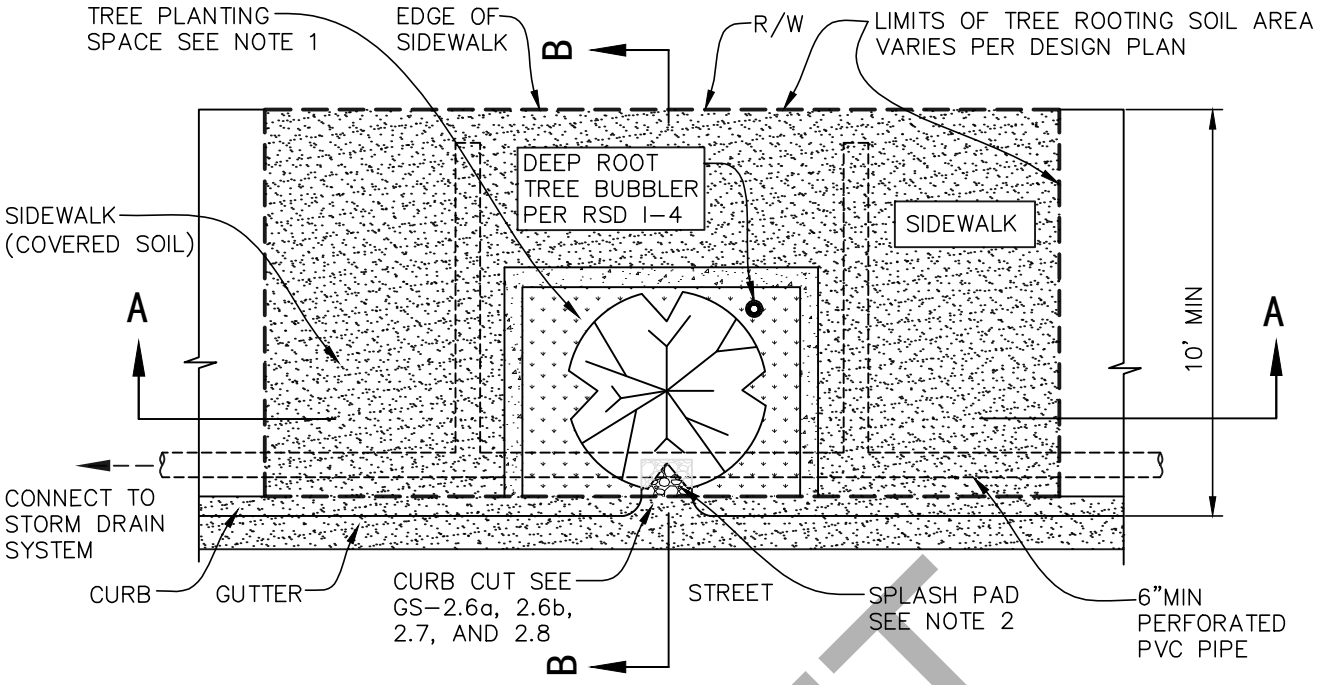
January 2016

SAN DIEGO COUNTY
DEPARTMENT OF PUBLIC WORKS

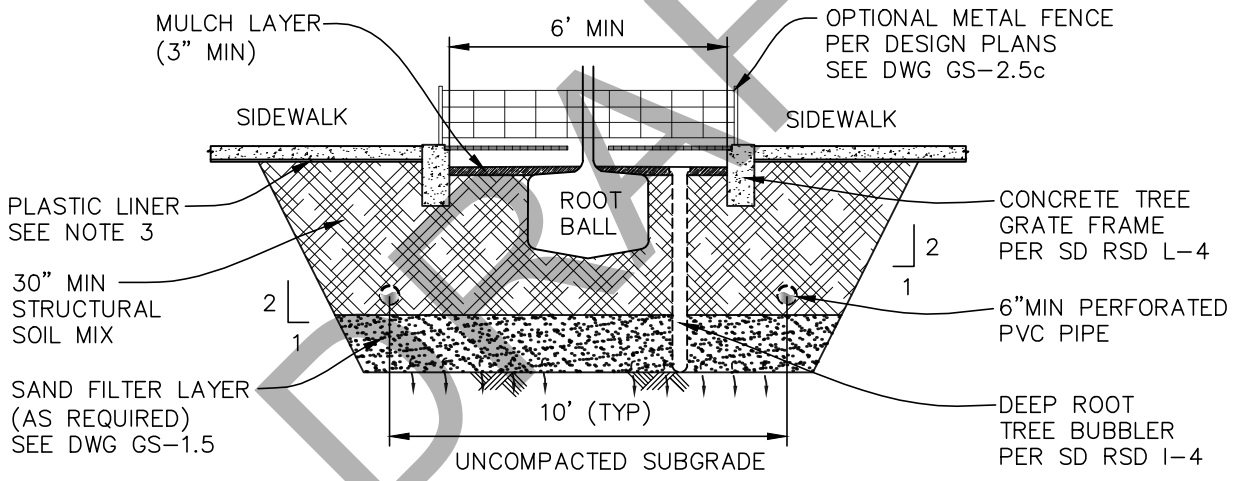
GREEN STREETS STANDARD DRAWINGS

NUMBER	TITLE
GS-1.1a	STRUCTURAL SOIL UNDER SIDEWALK - COVERED TREE SPACE
GS-1.1b	STRUCTURAL SOIL UNDER SIDEWALK - COVERED TREE SPACE
GS-1.2a	STRUCTURAL SOIL UNDER SIDEWALK - CONFINED TREE SPACE
GS-1.2b	STRUCTURAL SOIL UNDER SIDEWALK - CONFINED TREE SPACE
GS-1.3a	STRUCTURAL SOIL UNDER PERMEABLE PAVEMENT- COVERED TREE SPACE
GS-1.3b	STRUCTURAL SOIL UNDER PERMEABLE PAVEMENT- COVERED TREE SPACE
GS-1.4a	STRUCTURAL SOIL UNDER SIDEWALK - CONTINUOUS OPEN TREE SPACE
GS-1.4b	STRUCTURAL SOIL UNDER SIDEWALK - CONTINUOUS OPEN TREE SPACE
GS-1.5	STRUCTURAL SOIL SUBSURFACE DRAINAGE OPTIONS
GS-2.1	RAIN GARDEN PLANTER ADJACENT TO ROADWAY - 1 (NO STEP OUT ZONE)
GS-2.2	RAIN GARDEN PLANTER ADJACENT TO ROADWAY - 2 (WITH STEP OUT ZONE)
GS-2.3	RAIN GARDEN IN OPEN AREA
GS-2.3b	*RAIN GARDEN PLANTER BETWEEN SIDEWALK AND RIGHT-OF-WAY (FUTURE DETAIL)*
GS-2.3c	*STREET TREE BETWEEN SIDEWALK AND RIGHT-OF-WAY (FUTURE DETAIL)*
GS-2.4	SWALES ADJACENT TO ROADWAY
GS-2.5a	STREET SIDE EDGE TREATMENT -1 (NO STEP OUT ZONE)
GS-2.5b	STREET SIDE EDGE TREATMENT - 2 (WITH STEP OUT ZONE)
GS-2.5c	SIDEWALK SIDE EDGE TREATMENT
GS-2.5d	*FENCING OPTIONS (FUTURE DETAIL)*
GS-2.6a	CURB CUT WITH SPLASH PAD - 1
GS-2.6b	CURB CUT WITH SPLASH PAD - 2
GS-2.7	CURB CUT METAL TRENCH COVER
GS-2.8	GALVANIZED STEEL CHANNEL OVER CURB CUT
GS-3.1a	CURB EXTENSION ADJACENT TO PLANTING STRIP
GS-3.1b	CURB EXTENSION ADJACENT TO PLANTING STRIP
GS-3.2	CURB EXTENSION ADJACENT TO SIDEWALK
GS-3.3	INLET AND OUTLET DETAILS FOR CURB EXTENSION
GS-4.1a	CONCRETE CHECK DAM
GS-4.1b	CONCRETE CHECK DAM
GS-4.2a	ROCK CHECK DAM

GS-4.2b	ROCK CHECK DAM
GS-5.1a	PERMEABLE CONCRETE PAVEMENT
GS-5.1b	PERMEABLE CONCRETE PAVEMENT (SIDEWALK)
GS-5.2a	PERMEABLE ASPHALT PAVEMENT
GS-5.2b	PERMEABLE ASPHALT PAVEMENT (SIDEWALK)
GS-5.3a	PERMEABLE PAVERS
GS-5.3b	PERMEABLE PAVERS (SIDEWALK)
GS-5.4a	PERMEABLE PAVEMENT ELEVATION - 1
GS-5.4b	PERMEABLE PAVEMENT ELEVATION – 2
GS-5.4c	PERMEABLE PAVEMENT CHECK DAMS
GS-5.5	PERMEABLE PAVEMENT EDGE RESTRAINT
GS-6.1	OVERFLOW RISER WITH BEEHIVE GRATE
GS-6.2	STORMWATER FACILITY CLEANOUT/ OBSERVATION WELL
GS-6.3	STORMWATER FACILITY UNDERDRAIN BEDDING AND CATCH BASIN CONNECTION
GS-7.1	GREEN STREET VEGETATED SWALE WITH CURB
GS-7.2	ROCK INFILTRATION SWALE
GS-7.3	RAIN GARDEN / ROCK GARDEN INFILTRATION
GS-7.4	VEGETATED FILTER STRIP
GS-7.5	*LEVEL SPREADER (FUTURE DETAIL)*



PLAN VIEW



SECTION A-A

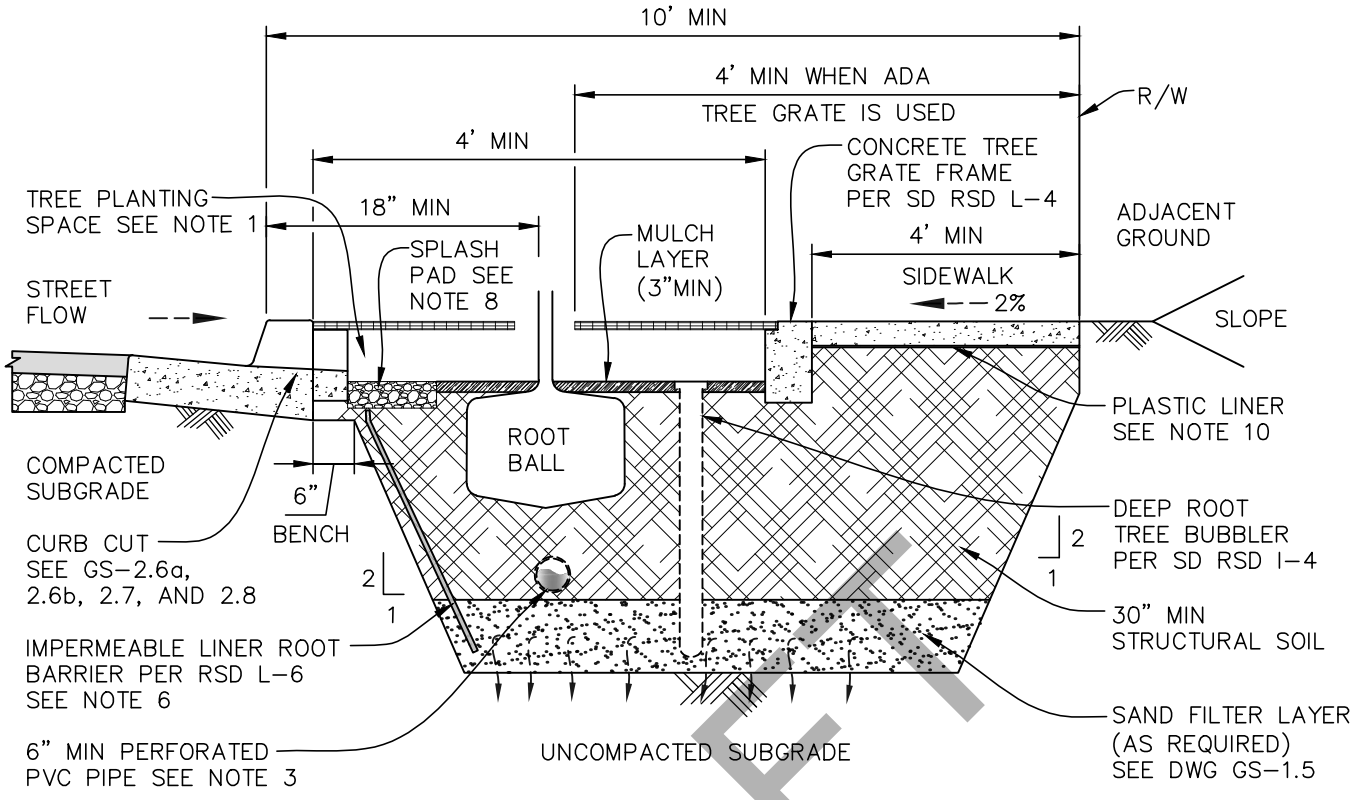
DRAFT

NOTES:

1. MINIMUM OPEN TREE PLANTING SPACE DIMENSION 4'x6'.
2. PROVIDE SPLASH PAD FOR TREE PLANTING SPACE PER GS-2.6b.
3. PROVIDE PLASTIC LINER WHERE CONCRETE WILL BE POURED ON TOP OF STRUCTURAL SOIL PER GREEN BOOK STANDARD SPECIFICATIONS SECTION 210-2.

DRAWING NOT TO SCALE

DRAWN BY:____ CHECKED BY:____	SAN DIEGO COUNTY DESIGN STANDARD	REVISIONS	APPROVED	DATE
RECOMMENDED BY: JEFF S. MOODY, P.E.				
APPROVED BY COUNTY ENGINEER	**STRUCTURAL SOIL UNDER SIDEWALK - COVERED TREE SPACE**			
DATE: ____ DEYLAMIAN SIROUS, P.E. R.C.E. NO. 53192, EXP 6/30/2017		DRAWING NUMBER	**GS-1.1a**	



SECTION B-B

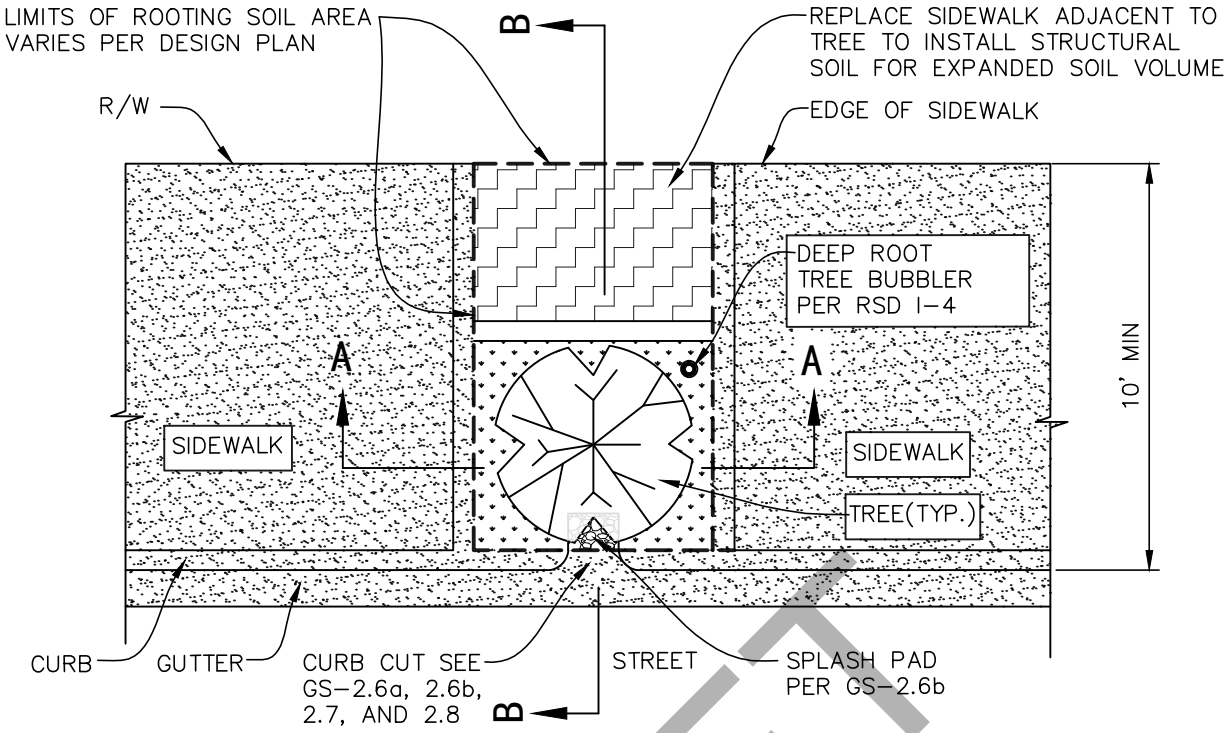
DRAFT

NOTES:

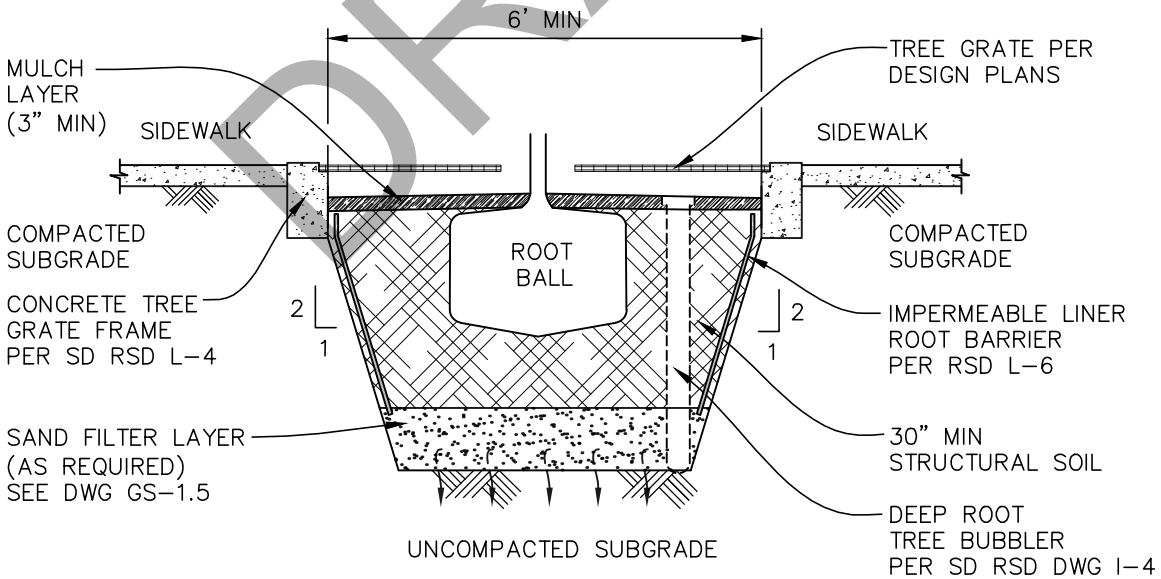
1. MINIMUM OPEN TREE PLANTING SPACE DIMENSION 4'x6'.
2. MAXIMUM WATERSHED AREA: 6 TIMES AREA OF THE OPEN TREE PLANTING AREA.
3. SEE DWG GS-1.5 FOR BOTTOM SAND LAYER AND SUBSURFACE DRAINAGE REQUIREMENTS.
4. FOR SIDEWALK OVER STRUCTURAL SOIL DETAIL OPTIONS, SEE DWG GS-1.5.
5. SEE SD RSD DWG L-1 THROUGH L-4 FOR TREE INSTALLATION REQUIREMENTS.
6. PROVIDE 18" DEEP ROOT BARRIER ON STREET SIDE OF TREE WELL AS NECESSARY.
7. REMOVE WIRE AND BURLAP FROM ROOT BALL PRIOR TO BACKFILLING.
8. PROVIDE SPLASH PAD FOR TREE PLANTING SPACE PER GS-2.6b.
9. IN SOME INSTANCES A MODIFIED SECTION BELOW CURB MAY BE REQUIRED BASED ON SOIL CONDITIONS.
10. PROVIDE PLASTIC LINER WHERE CONCRETE WILL BE POURED ON TOP OF STRUCTURAL SOIL PER GREEN BOOK STANDARD SPECIFICATIONS SECTION 210-2.

DRAWING NOT TO SCALE

DRAWN BY:____ CHECKED BY:____	SAN DIEGO COUNTY DESIGN STANDARD	REVISIONS	APPROVED	DATE
RECOMMENDED BY: JEFF S. MOODY, P.E.				
APPROVED BY COUNTY ENGINEER	**STRUCTURAL SOIL UNDER SIDEWALK - COVERED TREE SPACE**			
_____ DATE: _____ DEYLAMIAN SIROUS, P.E. R.C.E. NO. 53192, EXP 6/30/2017		DRAWING NUMBER	**GS-1.1b**	



PLAN VIEW

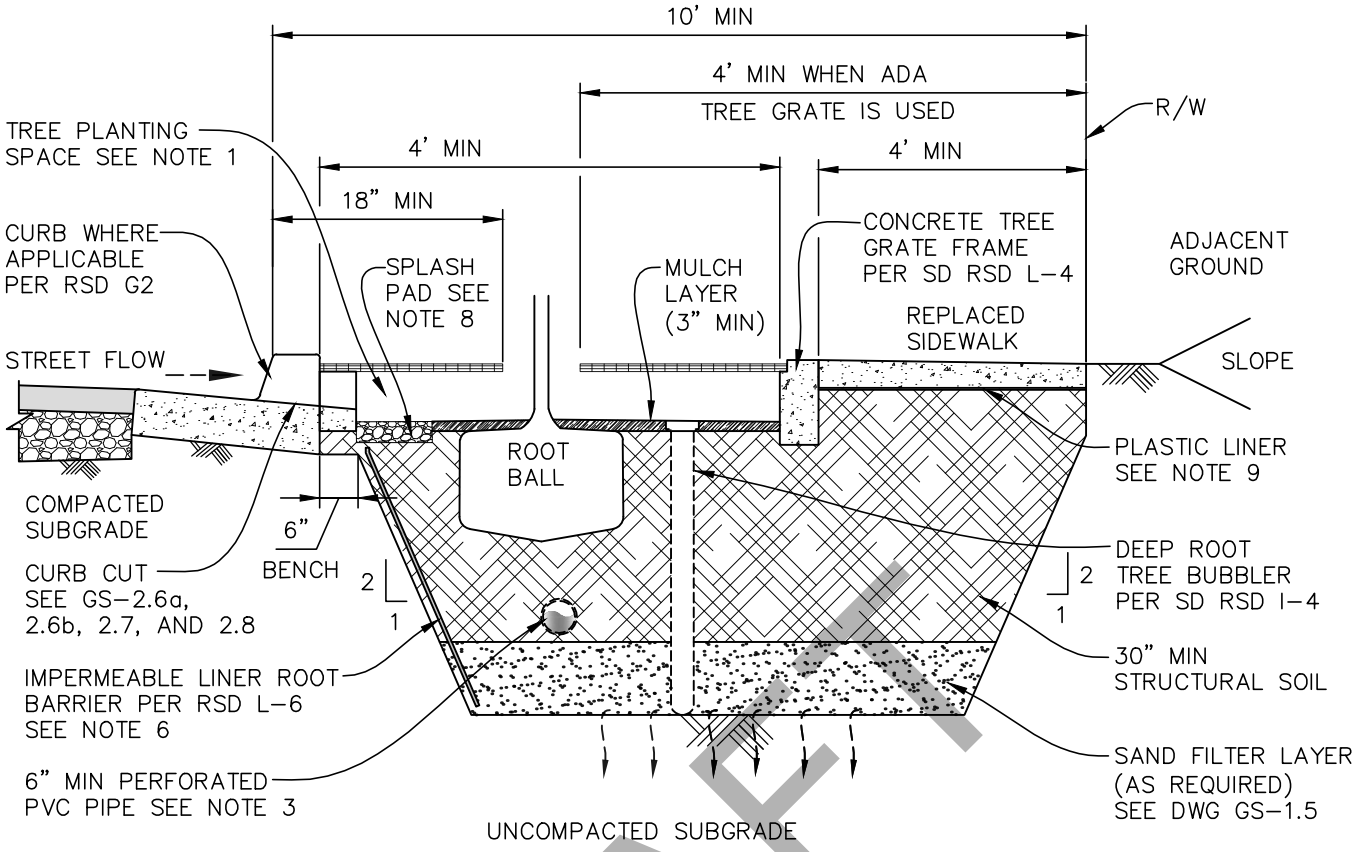


SECTION A-A

DRAWING NOT TO SCALE

DRAFT

DRAWN BY:____ CHECKED BY:____	SAN DIEGO COUNTY DESIGN STANDARD	REVISIONS	APPROVED	DATE
RECOMMENDED BY: JEFF S. MOODY, P.E.				
APPROVED BY COUNTY ENGINEER	**STRUCTURAL SOIL UNDER SIDEWALK CONFINED TREE SPACE**			
_____ DATE: _____ DEYLAMIAN SIROUS, P.E. R.C.E. NO. 53192, EXP 6/30/2017		DRAWING NUMBER	**GS-1.2a**	



SECTION B-B

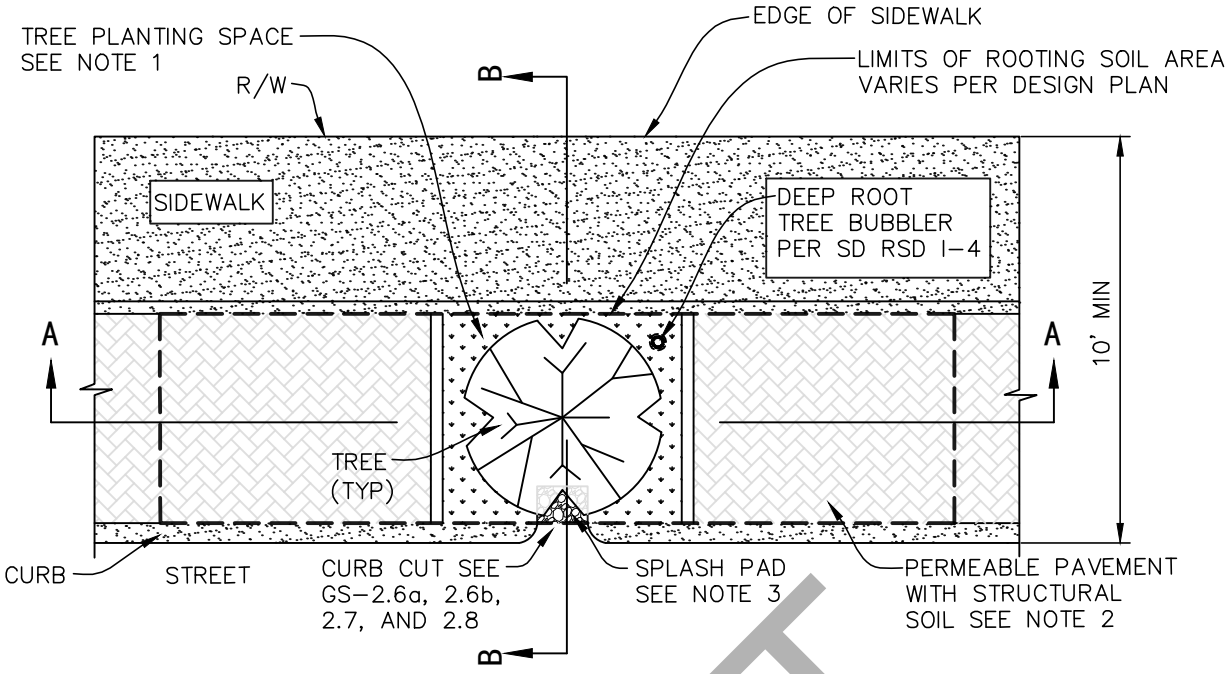
DRAFT

NOTES:

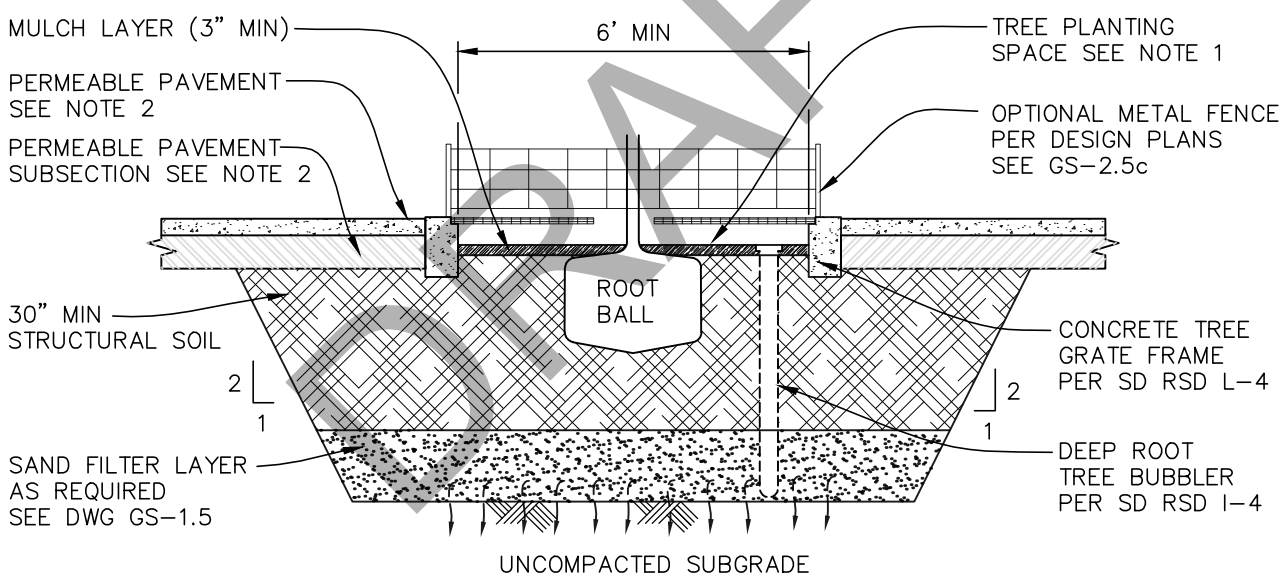
1. MINIMUM OPEN TREE PLANTING SPACE DIMENSION 4'x6'.
2. MAXIMUM WATERSHED AREA: 6 TIMES AREA OF THE OPEN TREE PLANTING AREA.
3. SEE DWG GS-1.5 FOR BOTTOM SAND LAYER AND SUBSURFACE DRAINAGE REQUIREMENTS.
4. DETAIL INTENDED FOR NEW TREE PLANTINGS ON SITES WITH CONSTRAINTS TO ACHIEVE FULL SOIL VOLUME.
5. TO ADAPT DETAIL TO EXISTING TREE LOCATION, PROVIDE EXPANDED SOIL VOLUMES BEYOND EXISTING TREE ROOTING AREA; DO NOT DISTURB AROUND EXISTING TREE ROOT.
6. PROVIDE 18" DEEP ROOT BARRIER ON STREET SIDE OF TREE WELL AS NECESSARY.
7. SEE SD RSD DWG L-1 THRU L-4 FOR TREE INSTALLATION REQUIREMENTS.
8. PROVIDE SPLASH PAD FOR TREE PLANTING SPACE PER GS-2.6b.
9. PROVIDE PLASTIC LINER WHERE CONCRETE WILL BE POURED ON TOP OF STRUCTURAL SOIL PER GREEN BOOK STANDARD SPECIFICATIONS SECTION 210-2.

DRAWING NOT TO SCALE

DRAWN BY:____ CHECKED BY:____	SAN DIEGO COUNTY DESIGN STANDARD	REVISIONS	APPROVED	DATE
RECOMMENDED BY: JEFF S. MOODY, P.E.				
APPROVED BY COUNTY ENGINEER	**STRUCTURAL SOIL UNDER SIDEWALK CONFINED TREE SPACE**			
_____ DATE: _____ DEYLAMIAN SIROUS, P.E. R.C.E. NO. 53192, EXP 6/30/2017		DRAWING NUMBER	**GS-1.2b**	



PLAN VIEW



SECTION A-A

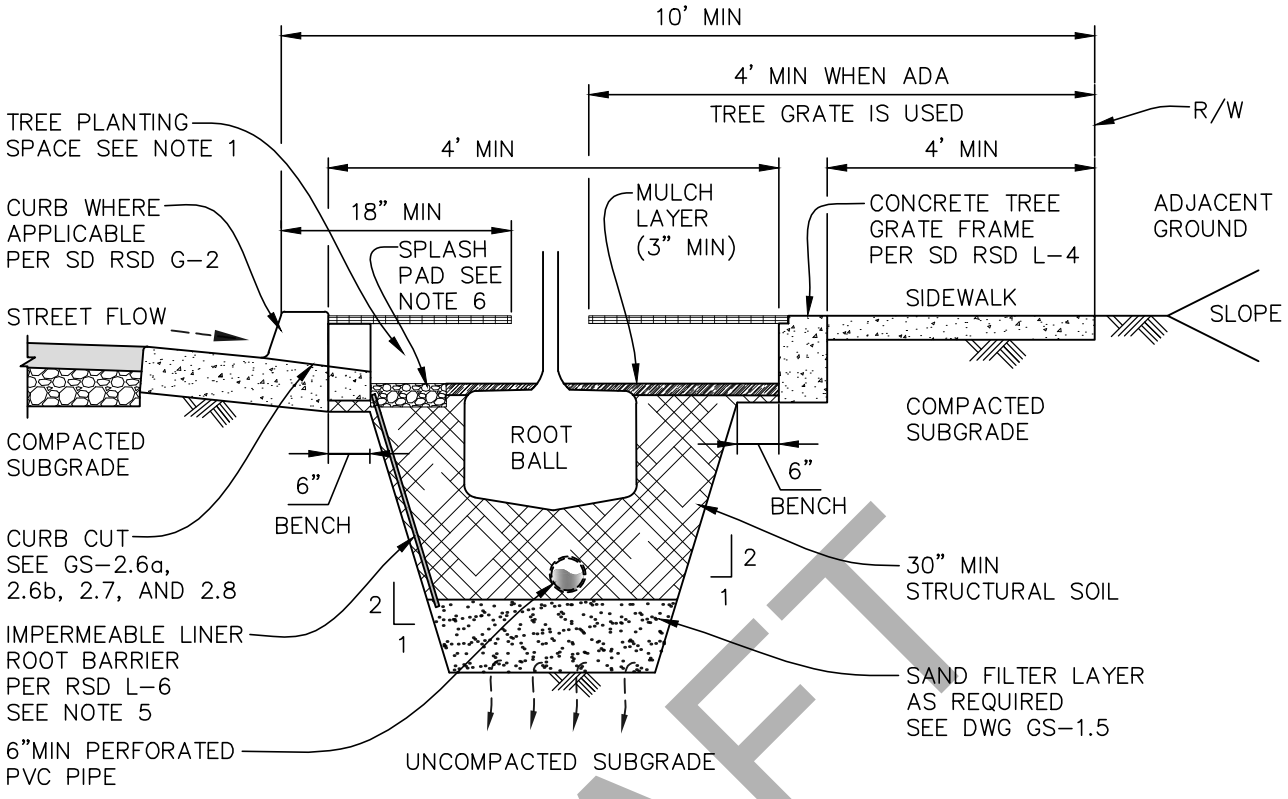
DRAFT

NOTES:

1. MINIMUM OPEN TREE PLANTING SPACE DIMENSION 4'x6'.
2. SEE DRAWING GS-5.1, GS-5.2, AND GS-5.3 FOR PERMEABLE PAVEMENT DETAIL OPTIONS.
3. PROVIDE SPLASH PAD FOR TREE PLANTING SPACE PER GS-2.6b.

DRAWING NOT TO SCALE

DRAWN BY:____ CHECKED BY:____	SAN DIEGO COUNTY DESIGN STANDARD	REVISIONS	APPROVED	DATE
RECOMMENDED BY: JEFF S. MOODY, P.E.				
APPROVED BY COUNTY ENGINEER	**STRUCTURAL SOIL UNDER PERMEABLE PAVEMENT-COVERED TREE SPACE**			
_____ DATE: _____ DEYLAMIAN SIROUS, P.E. R.C.E. NO. 53192, EXP 6/30/2017		DRAWING NUMBER	**GS-1.3a**	



SECTION B-B

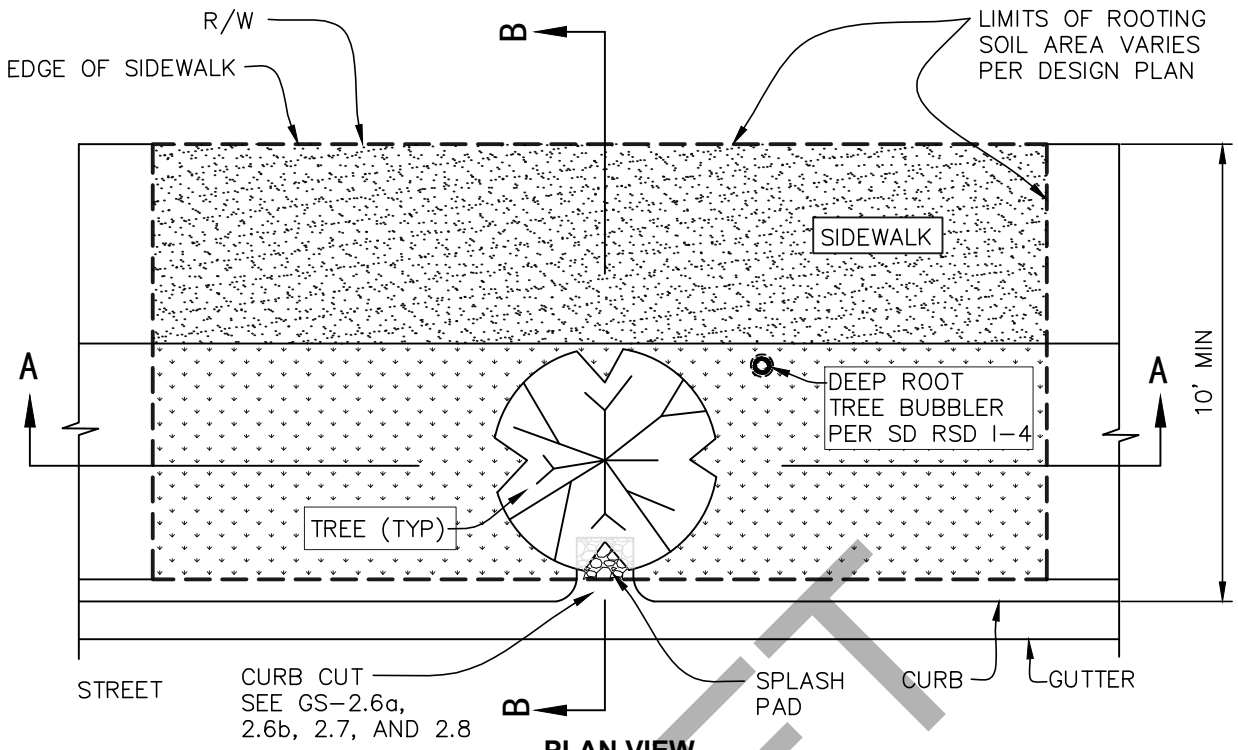
DRAFT

NOTES:

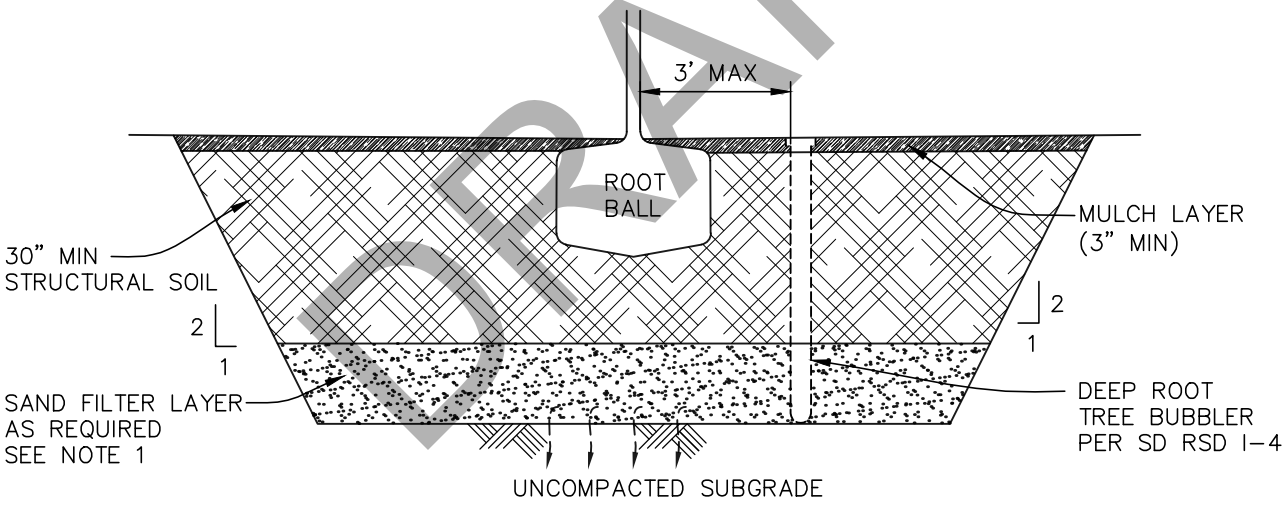
1. MINIMUM TREE PLANTING SPACE DIMENSION 4'X6'.
2. MAXIMUM WATERSHED AREA: 6 TIMES AREA OF THE TREE PLANTING BED.
3. DETAIL INTENDED FOR NEW TREE PLANTINGS ON SITES WITH CONSTRAINTS TO ACHIEVE FULL SOIL VOLUME.
4. TO ADAPT DETAIL TO EXISTING TREE LOCATION, PROVIDE EXPANDED SOIL VOLUMES BEYOND EXISTING TREE ROOTING AREA; DO NOT DISTURB AROUND EXISTING TREE ROOT.
5. PROVIDE 18" DEEP ROOT BARRIER ON STREET SIDE OF TREE WELL AS NECESSARY.
6. PROVIDE SPLASH PAD FOR TREE PLANTING SPACE PER GS-2.6b.

DRAWING NOT TO SCALE

DRAWN BY:____ CHECKED BY:____	SAN DIEGO COUNTY DESIGN STANDARD	REVISIONS	APPROVED	DATE
RECOMMENDED BY: JEFF S. MOODY, P.E.				
APPROVED BY COUNTY ENGINEER	STRUCTURAL SOIL UNDER PERMEABLE PAVEMENT-COVERED TREE SPACE			
_____ DATE: _____ DEYLAMIAN SIROUS, P.E. R.C.E. NO. 53192, EXP 6/30/2017		DRAWING NUMBER	GS-1.3b	



PLAN VIEW



SECTION A-A

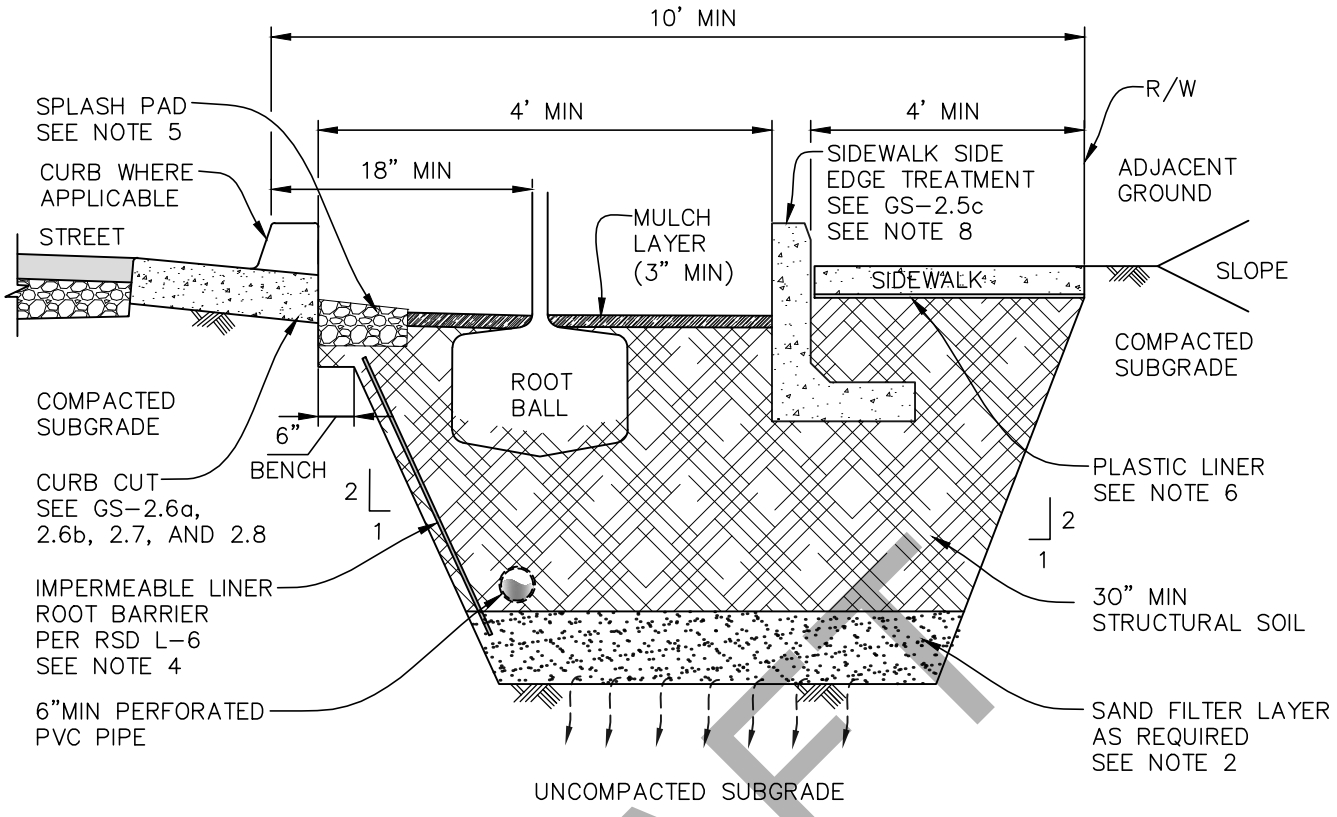
DRAFT

NOTES:

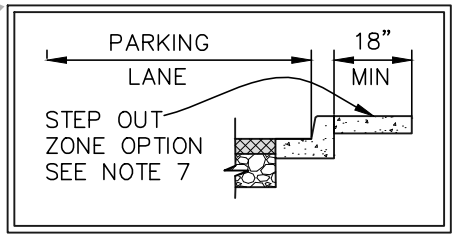
1. SEE DRAWING GS-1.5 FOR BOTTOM SAND FILTER LAYER AND SUBSURFACE DRAINAGE REQUIREMENTS.

DRAWING NOT TO SCALE

DRAWN BY:____ CHECKED BY:____	SAN DIEGO COUNTY DESIGN STANDARD	REVISIONS	APPROVED	DATE
RECOMMENDED BY: JEFF S. MOODY, P.E.				
APPROVED BY COUNTY ENGINEER	**STRUCTURAL SOIL UNDER SIDEWALK – CONTINUOUS OPEN TREE SPACE**			
DATE: ____				
DEYLAMIAN SIROUS, P.E. R.C.E. NO. 53192, EXP 6/30/2017		DRAWING NUMBER	**GS-1.4a**	



SECTION B-B



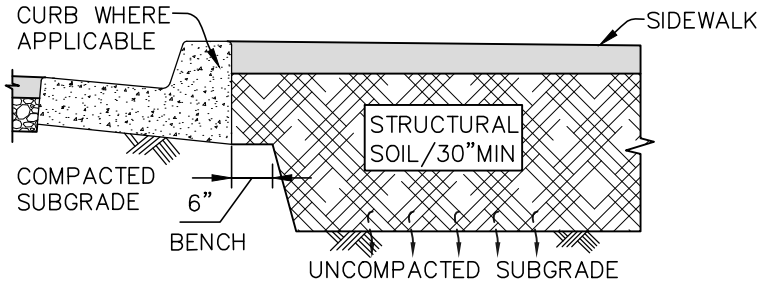
NOTES:

1. MAXIMUM WATERSHED AREA :6 TIMES AREA OF THE TREE PLANTING BED.
2. SEE DWG GS-1.5 FOR BOTTOM SAND LAYER AND SUBSURFACE DRAINAGE REQUIREMENTS.
3. SEE SD RSD DWG L-1 THRU L-4 FOR TREE INSTALLATION REQUIREMENTS.
4. PROVIDE 18 " DEEP ROOT BARRIER ON STREET SIDE AS NECESSARY.
5. PROVIDE SPLASH PAD FOR TREE PLANTING SPACE PER GS-2.6b.
6. PROVIDE PLASTIC LINER WHERE CONCRETE WILL BE POURED ON TOP OF STRUCTURAL SOIL PER GREEN BOOK STANDARD SPECIFICATIONS SECTION 210-2.
7. 18" MINIMUM STEP OUT ZONE IS REQUIRED WHEN PARALLEL PARKING IS PROVIDED.
8. A 3 TO 1 SLOPE MAY BE USED IN LIEU OF THE L-WALL WHERE ADEQUATE SPACE IS AVAILABLE SEE GS-3.1b.

DRAFT

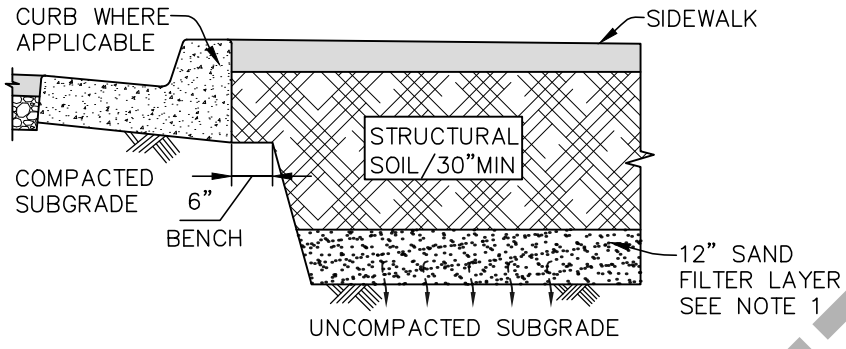
DRAWING NOT TO SCALE

DRAWN BY:____	CHECKED BY:____	SAN DIEGO COUNTY DESIGN STANDARD	REVISIONS	APPROVED	DATE
RECOMMENDED BY: JEFF S. MOODY, P.E.					
APPROVED BY COUNTY ENGINEER		STRUCTURAL SOIL UNDER SIDEWALK - CONTINUOUS OPEN TREE SPACE			
DATE: ____					
DEYLAMIAN SIROUS, P.E. R.C.E. NO. 53192, EXP 6/30/2017			DRAWING NUMBER	GS-1.4b	



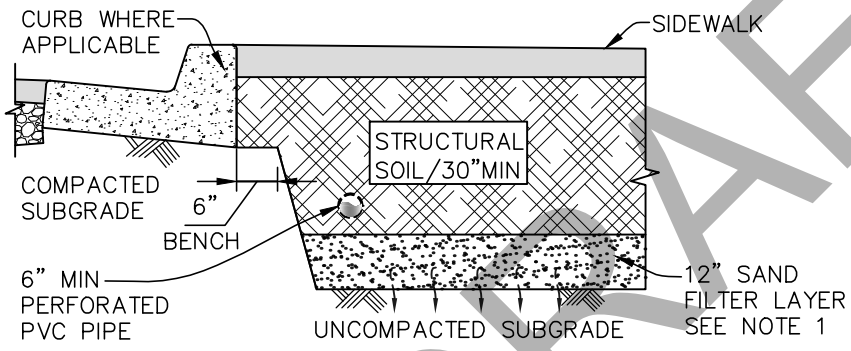
STRUCTURAL SOIL

1. IF NRCS HYDROLOGIC SOIL GROUP IS A OR B, OR MEASURED SUBSOIL INFILTRATION RATE IS 0.5 IN/HR OR GREATER, STRUCTURAL SOIL MAY BE PLACED OVER UNCOMPACTED SUBGRADE.



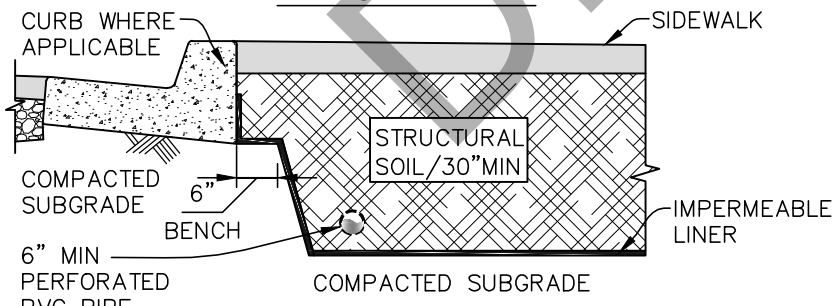
STRUCTURAL SOIL OVER SAND

2. IF NRCS HYDROLOGIC SOIL GROUP IS C, OR MEASURED SUBSOIL INFILTRATION RATE IS BETWEEN 0.14 AND 0.5 IN/HR, STRUCTURAL SOIL SHALL BE PLACED OVER 12 IN OF SAND OVER UNCOMPACTED SUBGRADE.



STRUCTURAL SOIL OVER SAND WITH UNDERDRAIN

3. IF NRCS HYDROLOGIC SOIL GROUP IS D, OR MEASURED SUBSOIL INFILTRATION RATE IS LESS THAN 0.14 IN/HR, PERFORATED 6" MINIMUM PVC UNDERDRAIN PIPE SHALL BE EMBEDDED IN SAND FILTER OR STRUCTURAL SOIL LAYER AND CONNECTED TO THE STORM DRAINAGE SYSTEM.



STRUCTURAL SOIL WITH UNDERDRAIN AND IMPERMEABLE LINER

4. IF NRCS HYDROLOGIC SOIL GROUP HAS NO SIGNIFICANT INFILTRATION CHARACTERISTICS OR THE SUBGRADE IS CONTAMINATED, PERFORATED 6" MINIMUM PVC UNDERDRAIN PIPE SHALL BE EMBEDDED ON IMPERMEABLE LINEAR OVER COMPACTED SUBGRADE AND CONNECTED TO THE STORM DRAINAGE SYSTEM.

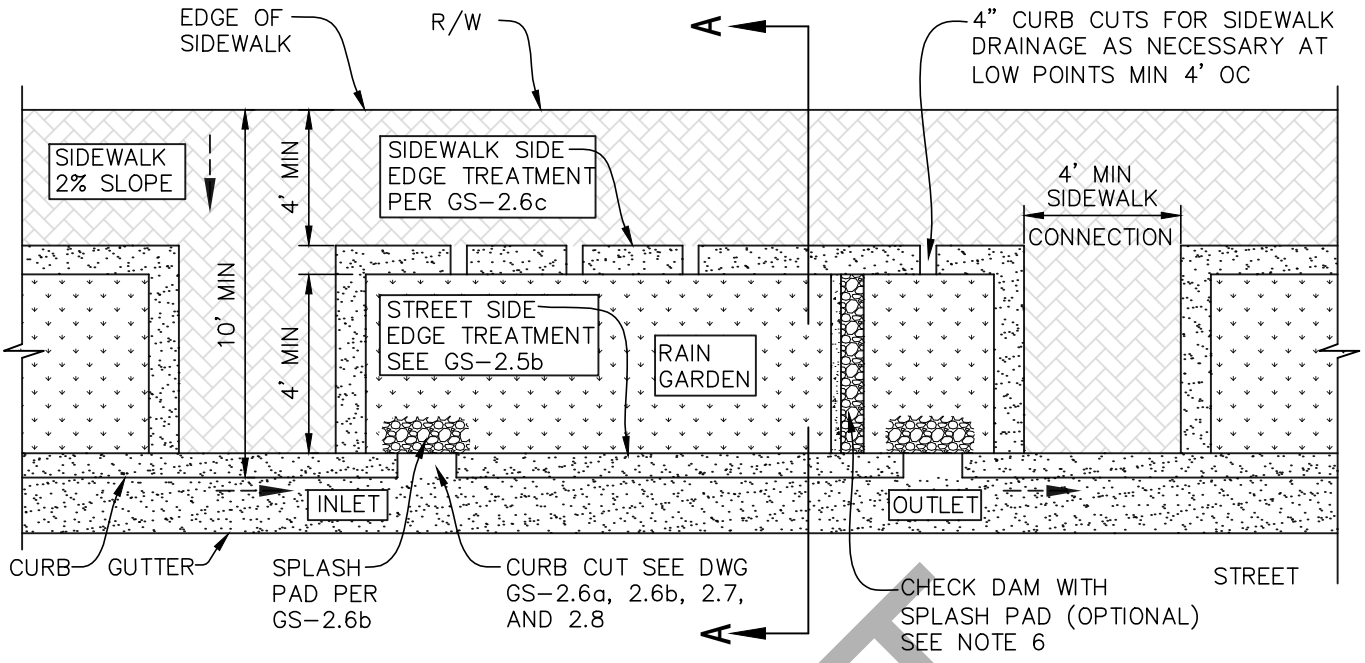
DRAFT

NOTES:

1. SAND SHALL BE PER THE GREEN STREET "ENGINEERED SOIL" SPECIFICATIONS SECTION B-3.

DRAWING NOT TO SCALE

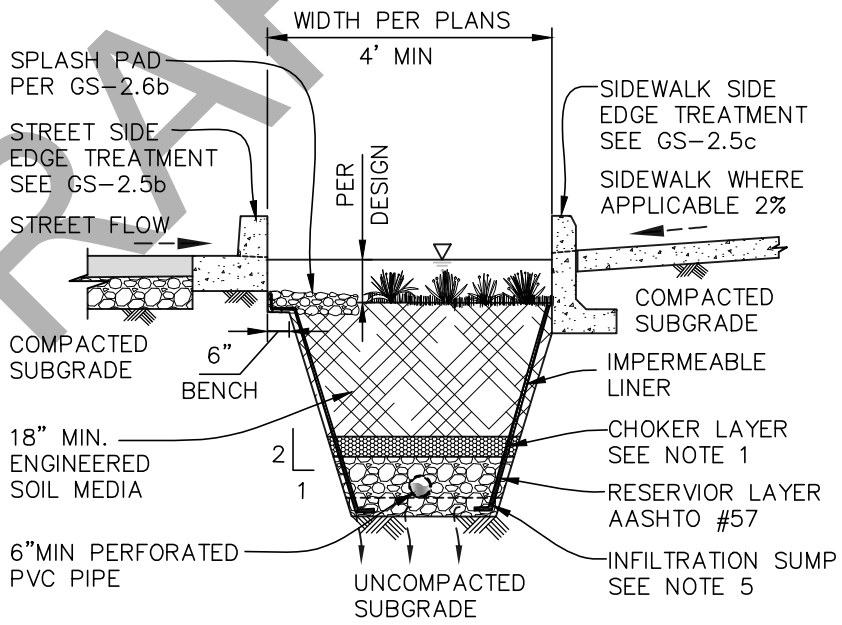
DRAWN BY:____ CHECKED BY:____	SAN DIEGO COUNTY DESIGN STANDARD	REVISIONS	APPROVED	DATE
RECOMMENDED BY: JEFF S. MOODY, P.E.				
APPROVED BY COUNTY ENGINEER	**STRUCTURAL SOIL SUBSURFACE DRAINAGE OPTIONS**			
DATE: ____ DEYLAMIAN SIROUS, P.E. R.C.E. NO. 53192, EXP 6/30/2017		DRAWING NUMBER	**GS-1.5**	



PLAN VIEW

NOTES:

1. CHOKER LAYER IS OPTIONAL PER GEOTECHNICAL ENGINEER RECOMMENDATION.
2. MATERIALS AND CONSTRUCTION SHALL MEET CURRENT SPECIFICATION FOR PLANTING AND ENGINEERED SOIL MEDIA.
3. PLANTINGS SHALL BE INSTALLED IN ACCORDANCE WITH DESIGN PLAN.
4. BOTTOM OF RAIN GARDEN SHALL BE AT LEAST 10' ABOVE THE SEASONAL HIGH WATER TABLE OR 2' ABOVE BEDROCK, AS DETERMINED BY GEOTECHNICAL INVESTIGATION.
5. DEPTH OF INFILTRATION SUMP AS SHOWN ON DESIGN PLANS SHALL BE SIZED TO ADDRESS STORMWATER MANAGEMENT REQUIREMENTS.
6. CHECK DAM SHALL BE SPECIFIED AS NECESSARY PER GS-4.1 OR GS-4.2

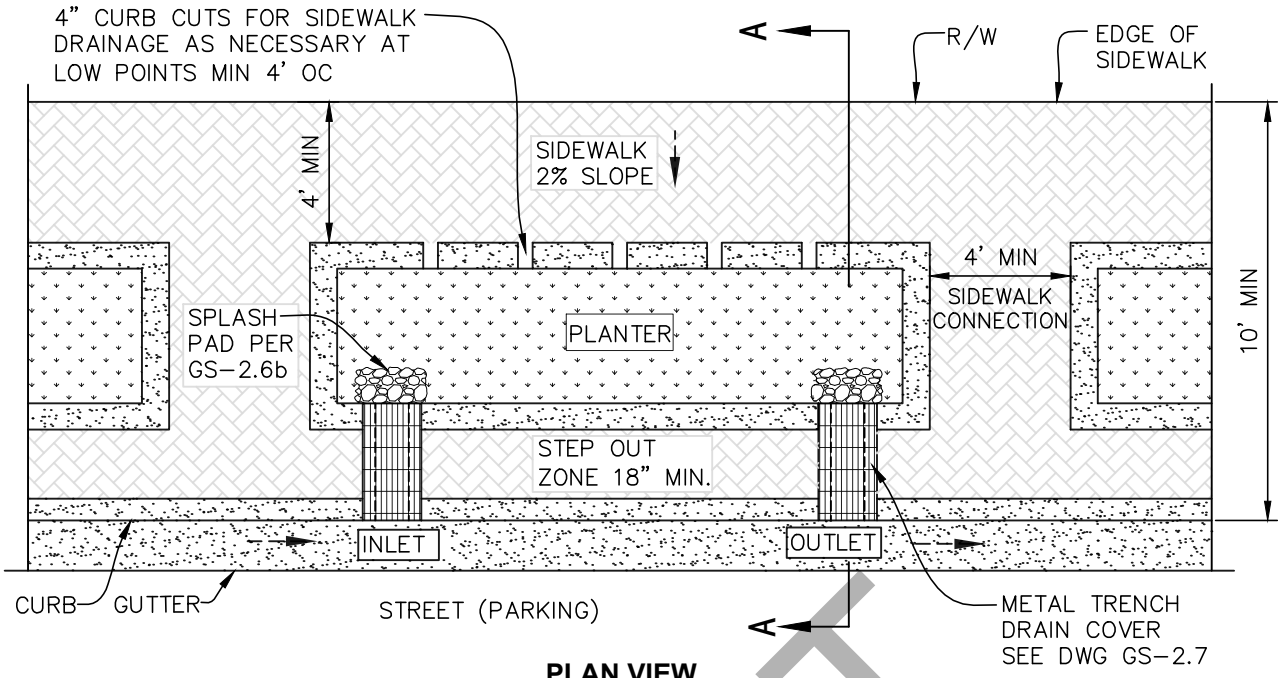


SECTION A-A

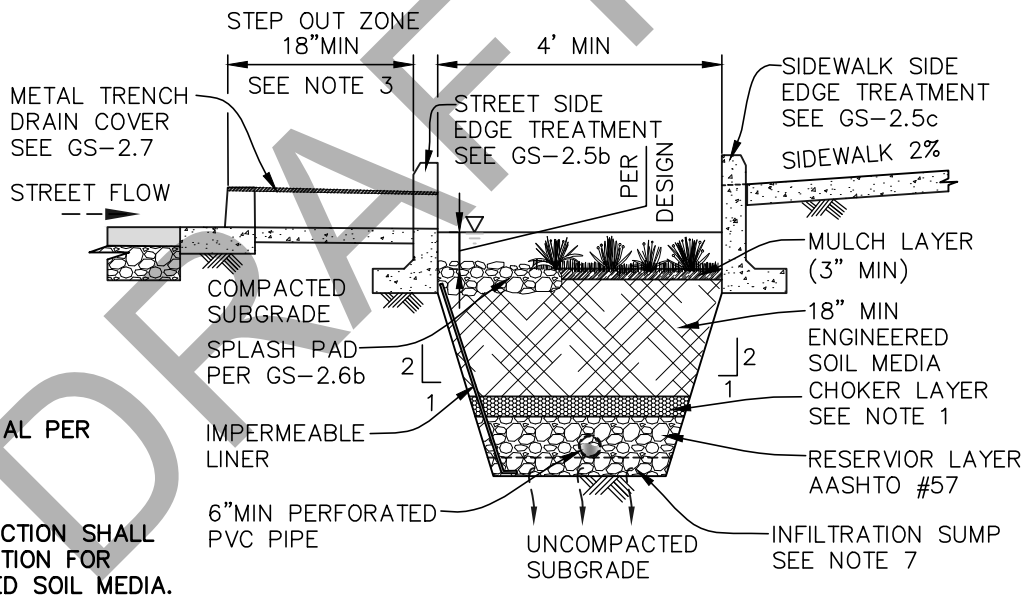
DRAFT

DRAWING NOT TO SCALE

DRAWN BY:____ CHECKED BY:____	SAN DIEGO COUNTY DESIGN STANDARD	REVISIONS	APPROVED	DATE
RECOMMENDED BY: JEFF S. MOODY, P.E.				
APPROVED BY COUNTY ENGINEER	**RAIN GARDEN PLANTER ADJACENT TO ROADWAY-1** (NO STEP OUT ZONE)			
_____ DATE: _____ DEYLAMIAN SIROUS, P.E. R.C.E. NO. 53192, EXP 6/30/2017		DRAWING NUMBER	**GS-2.1**	



PLAN VIEW



SECTION A-A

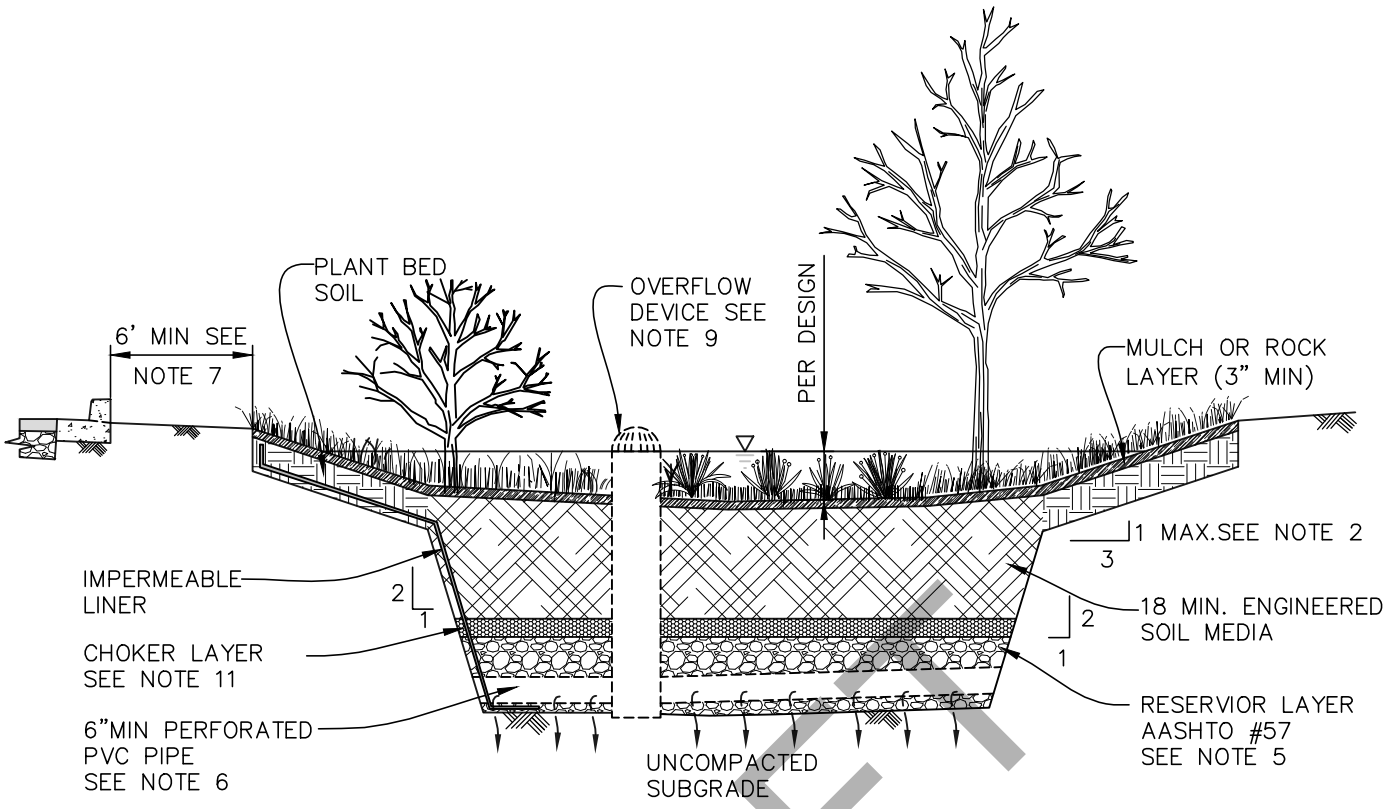
DRAFT

NOTES:

1. CHOKER LAYER IS OPTIONAL PER GEOTECHNICAL ENGINEER RECOMMENDATION.
2. MATERIALS AND CONSTRUCTION SHALL MEET CURRENT SPECIFICATION FOR PLANTING AND ENGINEERED SOIL MEDIA.
3. STEP OUT ZONE REQUIRED WHEN PARALLEL PARKING IS PROVIDED. INSTALLATION MAY BE STANDARD CONCRETE SIDEWALK OR PAVEMENT BASED ON SURROUNDING CONDITIONS.
4. FOR EDGE TREATMENT OPTIONS SEE DWG GS-2.5
5. PLANTINGS SHALL BE INSTALLED IN ACCORDANCE WITH DESIGN PLAN.
6. BOTTOM OF RAIN GARDEN SHALL BE AT LEAST 10' ABOVE THE SEASONAL HIGH WATER TABLE OR 2' ABOVE BEDROCK, AS DETERMINED BY GEOTECHNICAL INVESTIGATION.
7. DEPTH OF INFILTRATION SUMP AS SHOWN ON DESIGN PLANS SHOULD BE SIZED TO ADDRESS STORMWATER MANAGEMENT REQUIREMENTS.
8. OUTLET REQUIRED AS SPECIFIED BY PLANS.

DRAWING NOT TO SCALE

DRAWN BY:____ CHECKED BY:____	SAN DIEGO COUNTY DESIGN STANDARD	REVISIONS	APPROVED	DATE
RECOMMENDED BY: JEFF S. MOODY, P.E.				
APPROVED BY COUNTY ENGINEER	**RAIN GARDEN PLANTER ADJACENT TO ROADWAY-2** (WITH STEP OUT ZONE)			
_____ DATE: _____				
DEYLAMIAN SIROUS, P.E. R.C.E. NO. 53192, EXP 6/30/2017		DRAWING NUMBER	**GS-2.2**	



ELEVATION

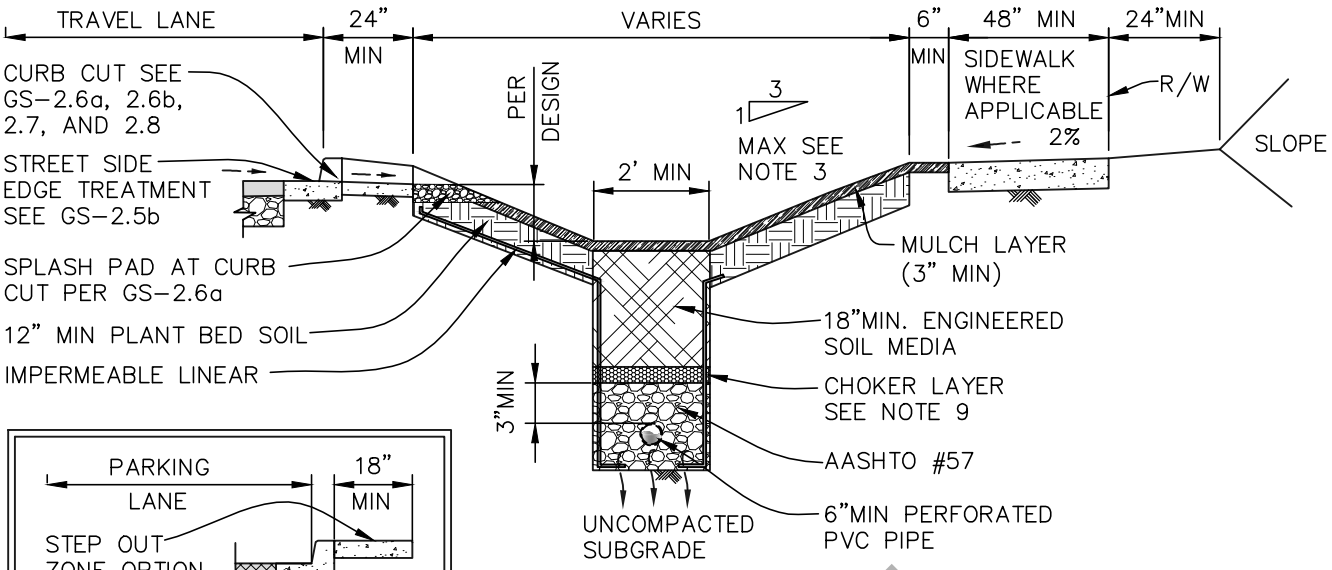
DRAFT

NOTES:

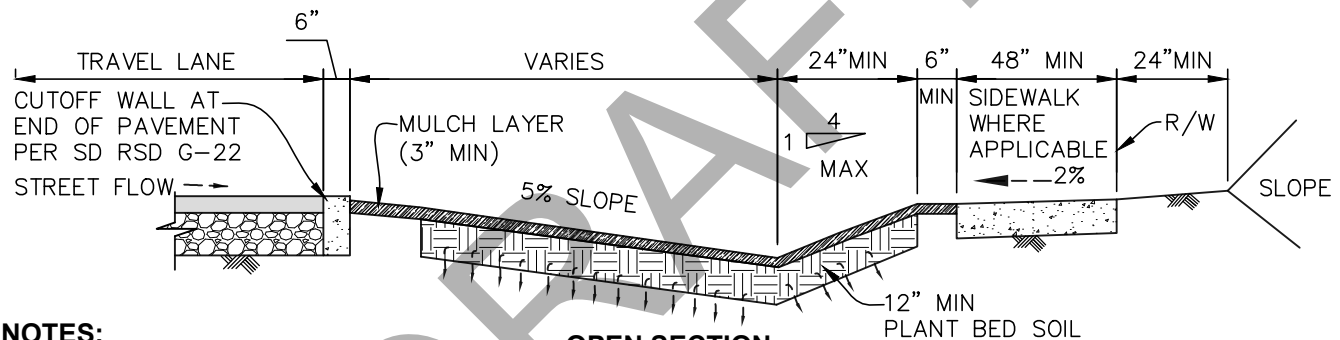
1. MATERIALS AND CONSTRUCTION SHALL MEET CURRENT APPROVED COUNTY SPECIFICATION FOR PLANTING AND ENGINEERED SOIL MEDIA.
2. SIDE SLOPES STEEPER THAN 3:1 MAY BE ALLOWED WITH COUNTY APPROVAL.
3. FOR ALTERNATIVE EDGE TREATMENT CONDITIONS, SEE DWG GS–2.5.
4. BOTTOM OF RAIN GARDEN SHALL BE AT LEAST 10' ABOVE THE SEASONAL HIGH WATER TABLE OR 2' ABOVE BEDROCK, AS DETERMINED BY GEOTECHNICAL INVESTIGATION.
5. RESERVOIR LAYER DEPTH SHALL VARY PER DESIGN PLANS, TO ACHIEVE A WATER STORAGE LAYER/ INFILTRATION SUMP WHEN APPLICABLE.
6. PROVIDE UNDERDRAIN WHEN CALLED FOR PER DESIGN PLANS, SEE DWG GS–6.3 FOR MINIMUM BEDDING REQUIREMENT.
7. DISTANCE TO ROADWAY MAY BE REDUCED WHEN THE SIDE IS LINED WITH IMPERMEABLE LINER, PER DESIGN PLANS.
8. SEE GS–6.2 FOR CLEAN OUT AND OBSERVATION WELL DETAIL.
9. RAIN GARDEN FACILITY DEPICTED IS ONE WITH AN OVERFLOW STRUCTURE. "OFF–LINE" FACILITIES DESIGNED TO LIMIT INFLOW SO THAT OVERFLOW STRUCTURES ARE NOT REQUIRED ARE ALSO PERMISSIBLE, AS SHOWN ON DESIGN PLANS; OUTFALL/ OVERFLOW ELEVATION 2" MIN BELOW SIDEWALK.
10. IF DEPTH FROM SURROUNDING GRADE TO LOW POINT OF FACILITY EXCEEDS 5 FEET, A FENCE IS REQUIRED AROUND ENTIRE FACILITY.
11. CHOKER LAYER IS OPTIONAL PER GEOTECHNICAL ENGINEER RECOMMENDATION.

DRAWING NOT TO SCALE

DRAWN BY:____ CHECKED BY:____	SAN DIEGO COUNTY DESIGN STANDARD	REVISIONS	APPROVED	DATE
RECOMMENDED BY: JEFF S. MOODY, P.E.				
APPROVED BY COUNTY ENGINEER	**RAIN GARDEN IN OPEN AREA**			
_____ DATE: _____				
DEYLAMIAN SIROUS, P.E. R.C.E. NO. 53192, EXP 6/30/2017		DRAWING NUMBER	**GS-2.3**	



CLOSED SECTION



OPEN SECTION

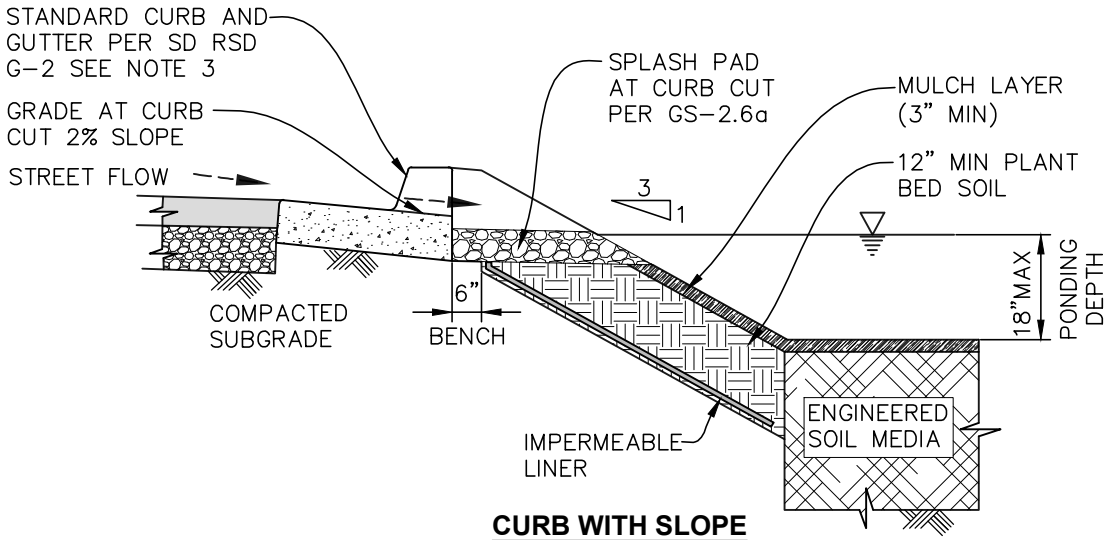
DRAFT

NOTES:

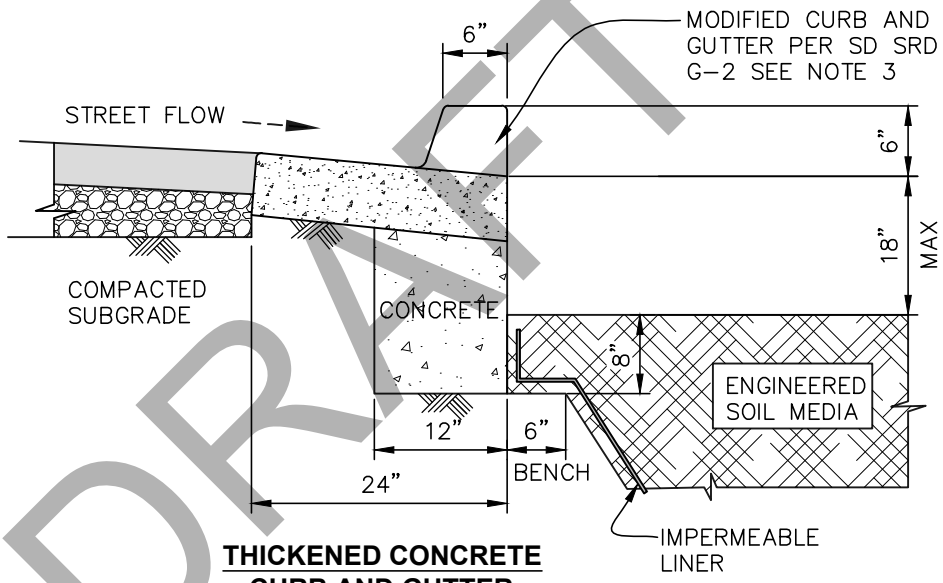
1. MATERIALS AND CONSTRUCTION SHALL MEET CURRENT APPROVED COUNTY SPECIFICATION FOR PLANTING AND ENGINEERED SOIL MEDIA.
2. STEP OUT ZONE REQUIRED WHEN PARALLEL PARKING IS PROVIDED. INSTALLATION MAY BE STANDARD CONCRETE SIDEWALK OR PAVEMENT BASED ON SURROUNDING CONDITIONS.
3. SIDE SLOPES STEEPER THAN 3:1 MAY BE ALLOWED WITH COUNTY APPROVAL.
4. TREES AND PLANTS SHALL BE INSTALLED IN ACCORDANCE WITH DESIGN PLANS.
5. BOTTOM OF SWALES SHALL BE AT LEAST 10' ABOVE THE SEASONAL HIGH WATER TABLE OR 2' ABOVE BEDROCK, AS DETERMINED BY GEOTECHNICAL INVESTIGATION.
6. OFFSET TO SWALES MAY BE REDUCED IF ALTERNATIVE EDGE TREATMENT IS USED, SEE DWG GS-2.5
7. DEPTH OF INFILTRATION SUMP AS SHOWN ON DESIGN PLANS SHOULD BE SIZED TO ADDRESS STORMWATER REQUIREMENTS.
8. INSTALL TRAFFIC BARRIER AS NECESSARY BASED ON ROADWAY DESIGN.
9. CHOKER LAYER IS OPTIONAL PER GEOTECHNICAL ENGINEER RECOMMENDATION.

DRAWING NOT TO SCALE

DRAWN BY:____ CHECKED BY:____	SAN DIEGO COUNTY DESIGN STANDARD	REVISIONS	APPROVED	DATE
RECOMMENDED BY: JEFF S. MOODY, P.E.				
APPROVED BY COUNTY ENGINEER	**SWALES ADJACENT TO ROADWAY**			
_____ DATE: _____ DEYLAMIAN SIROUS, P.E. R.C.E. NO. 53192, EXP 6/30/2017		DRAWING NUMBER	**GS-2.4**	



CURB WITH SLOPE



THICKENED CONCRETE CURB AND GUTTER

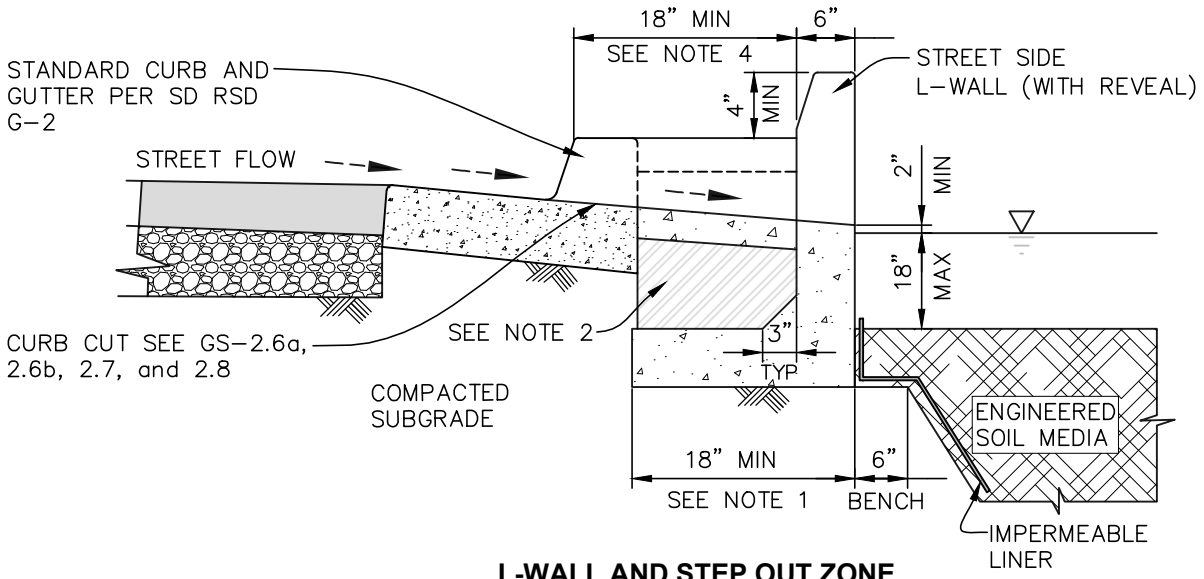
DRAFT

NOTES:

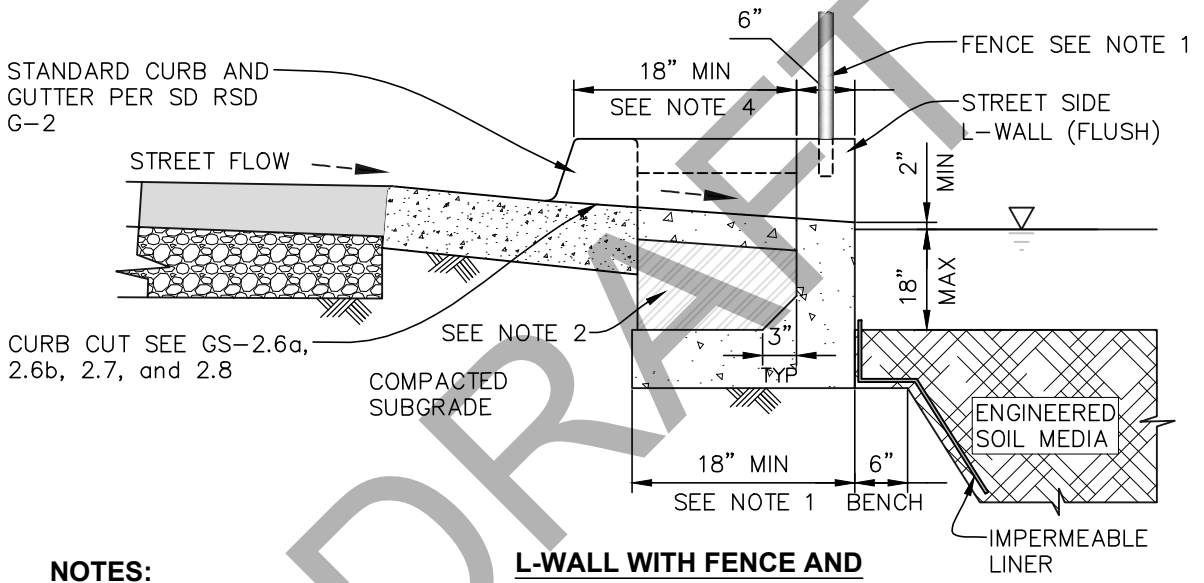
1. FINISH ALL EXPOSED CONCRETE SURFACES.
2. CURB TYPE AND MATERIAL TO MATCH PLANS.
3. SLOPE OF GUTTER AND CURB REVEAL TO MATCH STANDARD CURB AND GUTTER PER SD RSD DWG G-2.
4. EXPANSION AND CONTRACTION JOINTS SHALL BE PLACED IN ACCORDANCE WITH STANDARD CONCRETE CURB REQUIREMENTS.
5. PROVIDE AND MAINTAIN A SAFE PEDESTRIAN WALKWAY ACCESS THAT COMPLIES WITH APPLICABLE ADA STANDARDS AND SD SUPPLEMENT TO GREEN BOOK SEC 7-10 "PUBLIC CONVENIENCE AND SAFETY".

DRAWING NOT TO SCALE

DRAWN BY:____ CHECKED BY:____	SAN DIEGO COUNTY DESIGN STANDARD	REVISIONS	APPROVED	DATE
RECOMMENDED BY: JEFF S. MOODY, P.E.				
APPROVED BY COUNTY ENGINEER	**STREET SIDE EDGE TREATMENT-1**			
_____ DATE: _____	(NO STEP OUT ZONE)	DRAWING NUMBER	**GS-2.5a**	
DEYLAMIAN SIROUS, P.E. R.C.E. NO. 53192, EXP 6/30/2017				



L-WALL AND STEP OUT ZONE



L-WALL WITH FENCE AND STEP OUT ZONE

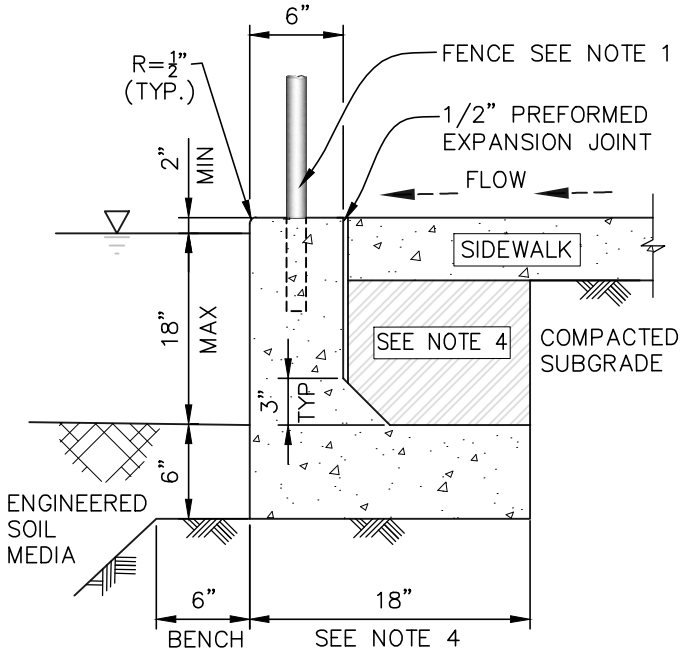
DRAFT

NOTES:

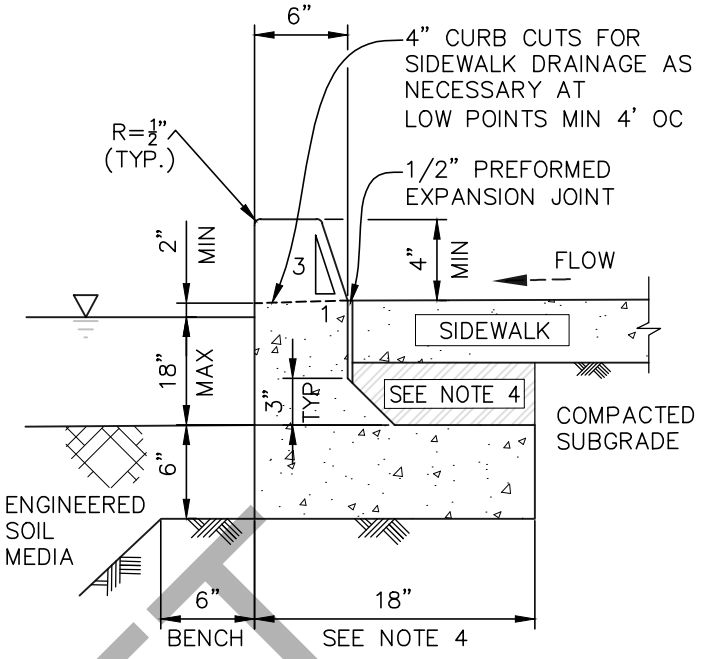
1. WHEN FLUSH WALLS ARE SELECTED, TYPICALLY IN HIGH-VOLUME PEDESTRIAN AREAS, PROVIDE RAILING OR FENCE PER PLAN.
2. 18" BASE WIDTH MAY BE REDUCED TO 15" IF CONCRETE IS USED IN THE HATCHED AREA.
3. FINISH ALL EXPOSED CONCRETE SURFACES.
4. STEP OUT ZONE INSTALLATION MAY BE STANDARD CONCRETE SIDEWALK OR OTHER PAVEMENT AS SHOWN ON PLANS.
5. EXPANSION JOINTS SHALL BE PLACED AT MAXIMUM 90 FOOT INTERVAL. CONTRACTION JOINTS SHALL BE FORMED OR SAWED AT 30 FOOT MAXIMUM INTERVALS BETWEEN EXPANSION JOINTS. WHERE ADJACENT TO CURB, SIDEWALK OR CONCRETE PAVEMENT, JOINTS SHALL LINE UP.

DRAWING NOT TO SCALE

DRAWN BY:____ CHECKED BY:____	SAN DIEGO COUNTY DESIGN STANDARD	REVISIONS	APPROVED	DATE
RECOMMENDED BY: JEFF S. MOODY, P.E.				
APPROVED BY COUNTY ENGINEER	**STREET SIDE EDGE TREATMENT-2**			
_____ DATE: _____	(WITH STEP OUT ZONE)	DRAWING NUMBER	**GS-2.5b**	
DEYLAMIAN SIROUS, P.E. R.C.E. NO. 53192, EXP 6/30/2017				



WITH PEDESTRIAN FENCE



WITH CURB

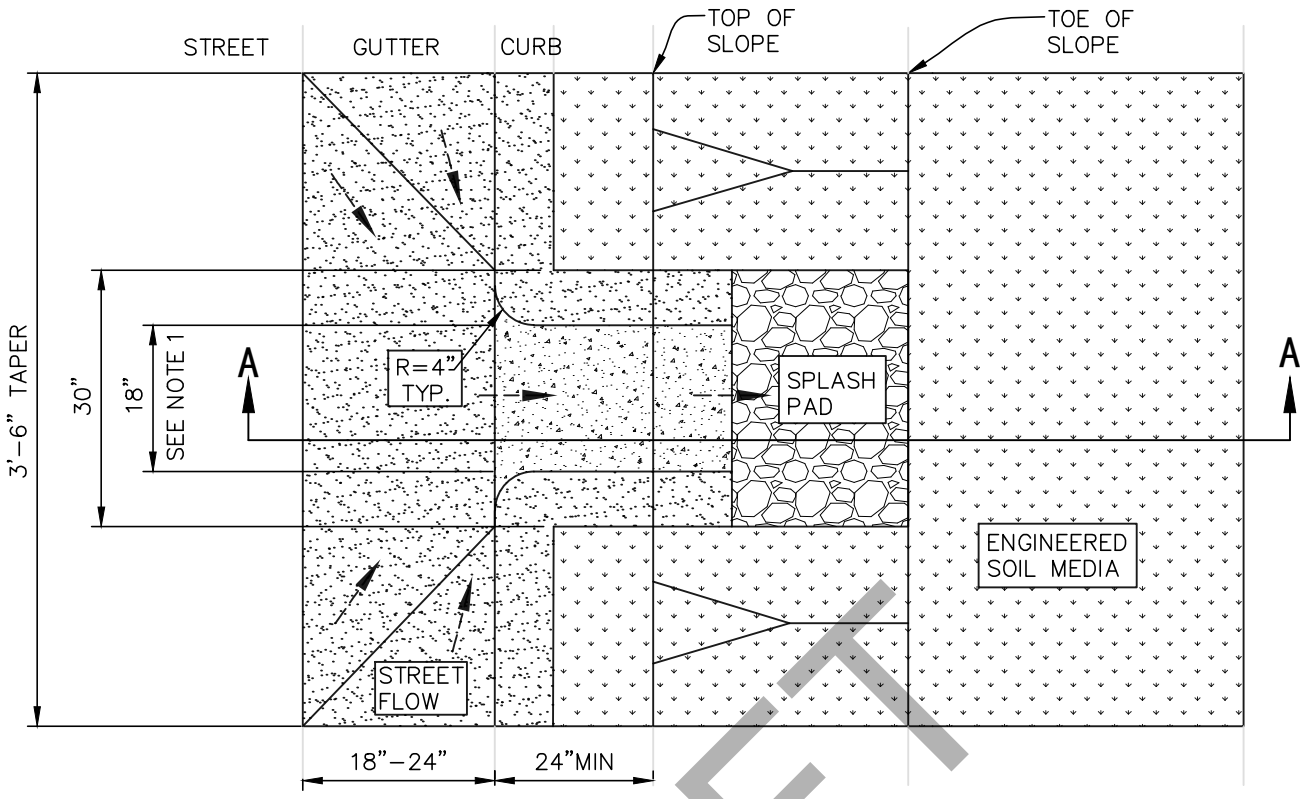
DRAFT

NOTES:

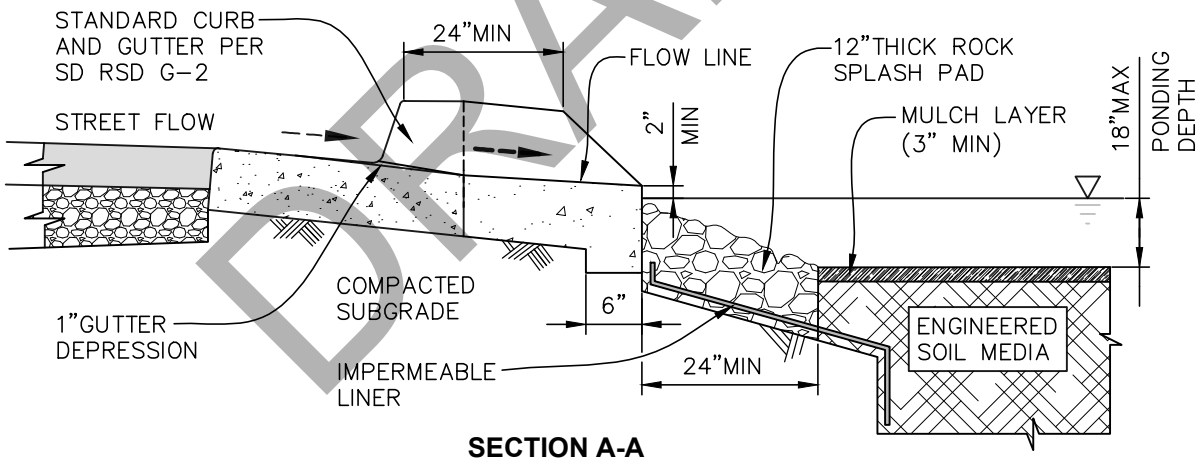
1. WHEN FLUSH WALLS ARE SELECTED, TYPICALLY IN HIGH–VOLUME PEDESTRIAN AREAS, PROVIDE RAILING OR FENCE PER PLAN.
2. WHEN WALLS WITH REVEALS ARE USED, TYPICALLY IN LOW–VOLUME PEDESTRIAN AREA, PROVIDE BREAKS IN REVEAL AS SHOWN ON PLANS TO ALLOW FOR SIDEWALK RUNOFF INTO STORMWATER MANAGEMENT FACILITY.
3. FINISH ALL EXPOSED CONCRETE SURFACES.
4. BASE WIDTH MAY BE REDUCED TO 15" IF CONCRETE IS USED IN THE HATCHED AREA.
5. EXPANSION JOINTS SHALL BE PLACED AT MAXIMUM 90 FOOT INTERVAL. CONTRACTION JOINTS SHALL BE FORMED OR SAWED AT 30 FOOT MAXIMUM INTERVALS BETWEEN EXPANSION JOINTS. WHERE ADJACENT TO CURB, SIDEWALK OR CONCRETE PAVEMENT, JOINTS SHALL LINE UP.

DRAWING NOT TO SCALE

DRAWN BY:____	CHECKED BY:____	SAN DIEGO COUNTY DESIGN STANDARD	REVISIONS	APPROVED	DATE
RECOMMENDED BY: JEFF S. MOODY, P.E.					
APPROVED BY COUNTY ENGINEER		**SIDEWALK SIDE EDGE TREATMENT**			
_____ DATE: _____					
DEYLAMIAN SIROUS, P.E. R.C.E. NO. 53192, EXP 6/30/2017			DRAWING NUMBER	**GS-2.5c**	



CONCRETE FLUME WITH WINGWALLS AND ROCK SPLASH PAD



SECTION A-A

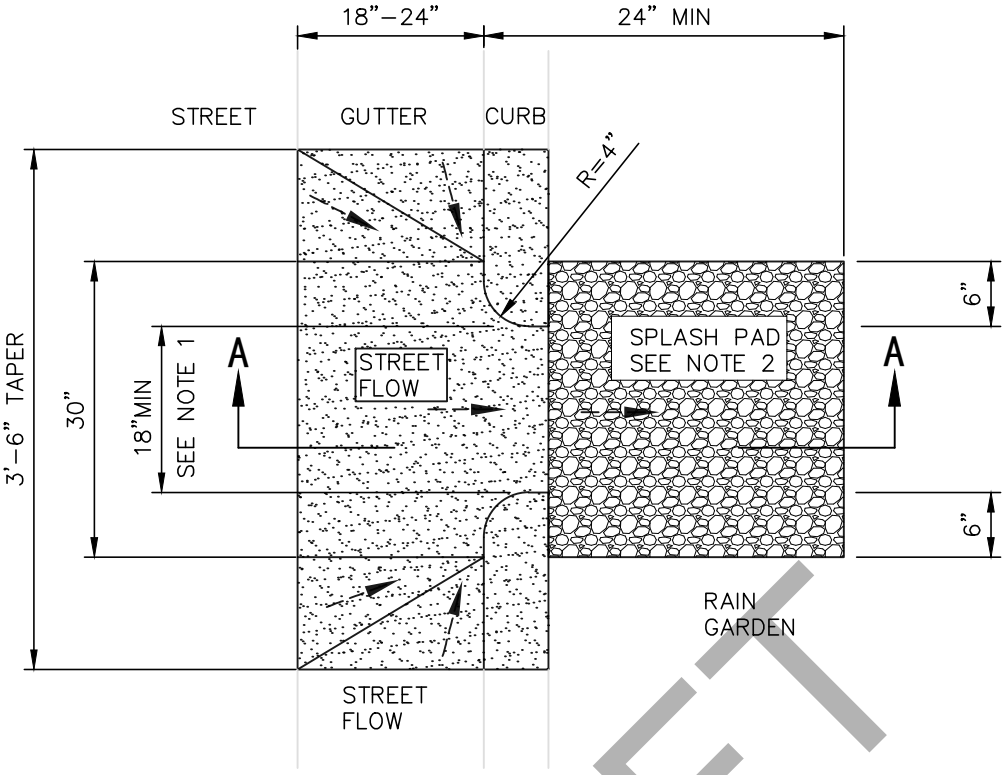
DRAFT

NOTES:

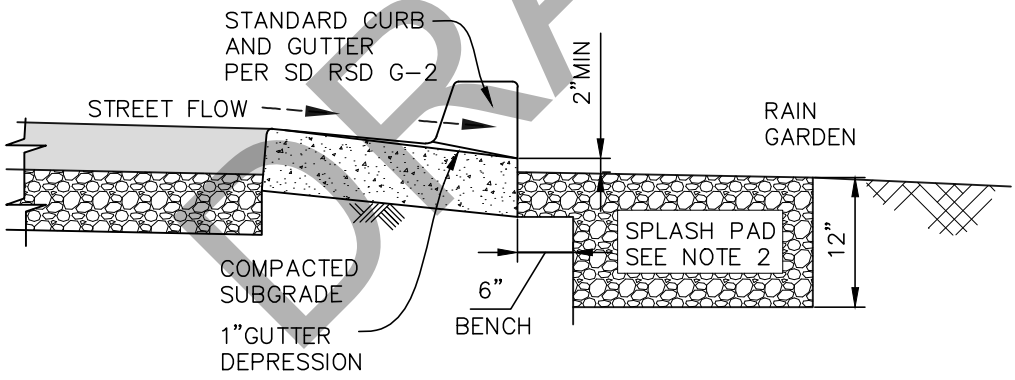
1. CURB OPENING DIMENSION SHOWN IS A MINIMUM. CURB CUT SHALL BE SIZED TO CONVEY 85TH PERCENTILE RAINFALL.
2. SEE DWG GS-2.8 FOR METAL TRENCH DRAIN COVER CURB CUT.
3. SIDE SLOPES STEEPER THAN 3:1 MAY BE ALLOWED WITH COUNTY APPROVAL.

DRAWING NOT TO SCALE

DRAWN BY:____ CHECKED BY:____	SAN DIEGO COUNTY DESIGN STANDARD	REVISIONS	APPROVED	DATE
RECOMMENDED BY: JEFF S. MOODY, P.E.				
APPROVED BY COUNTY ENGINEER	**CURB CUT WITH SPLASH PAD - 1**			
DATE: ____ DEYLAMIAN SIROUS, P.E. R.C.E. NO. 53192, EXP 6/30/2017		DRAWING NUMBER	**GS-2.6a**	



CONCRETE FLUME WITH ROCK SPLASH PAD



SECTION A-A

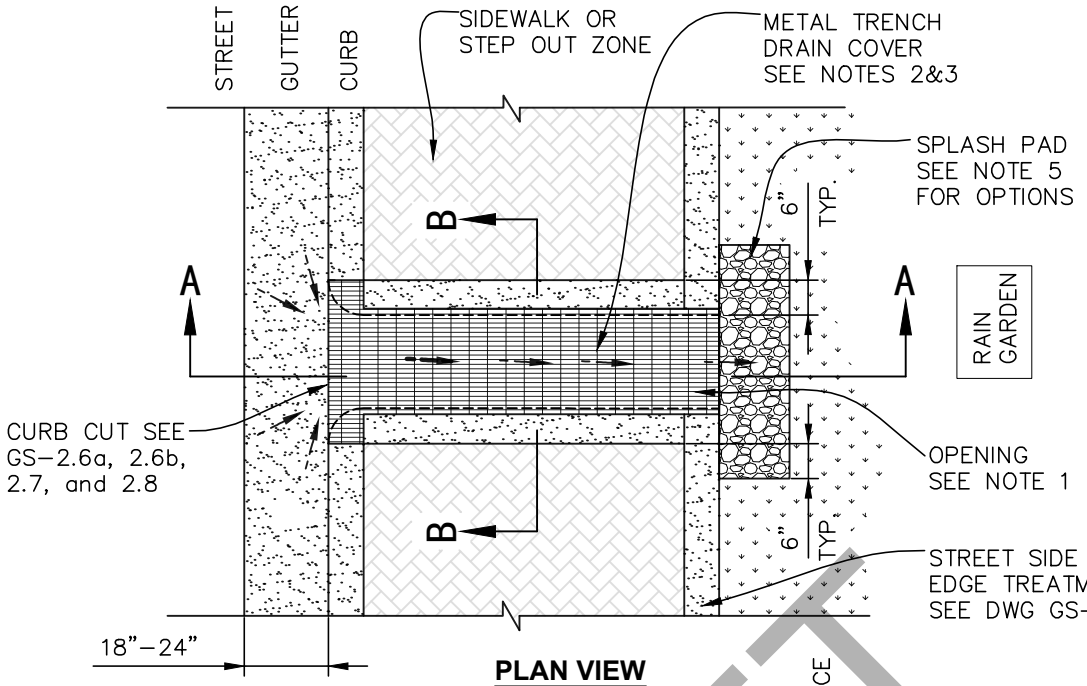
NOTES:

1. CURB OPENING DIMENSION SHOWN IS A MINIMUM. CURB CUT SHALL BE SIZED TO CONVEY 85TH PERCENTILE RAINFALL.
2. SPLASH PAD THICKNESS OPTIONS: 12" STONE #2, 4" CONCRETE SLAB, OR PAVER BLOCKS ON 6" AGGREGATE AASHTO #57.

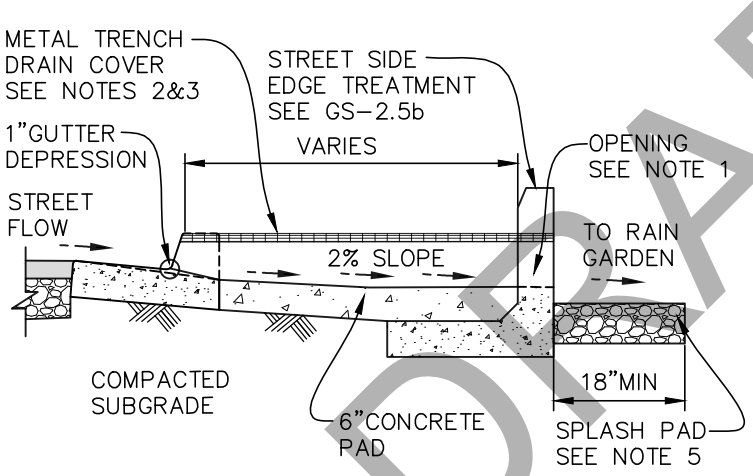
DRAWING NOT TO SCALE

DRAFT

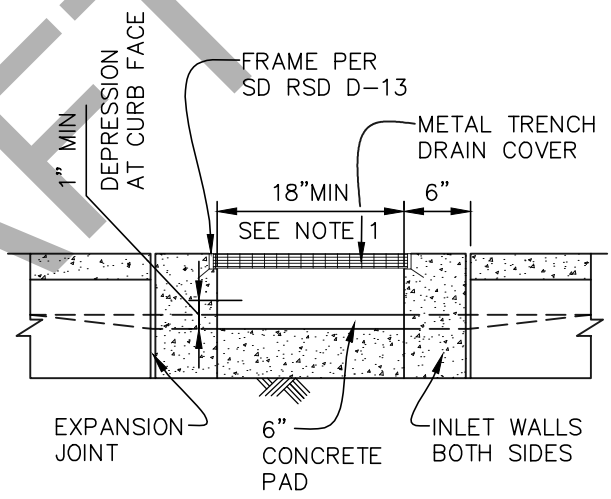
DRAWN BY:____ CHECKED BY:____	SAN DIEGO COUNTY DESIGN STANDARD	REVISIONS	APPROVED	DATE
RECOMMENDED BY: JEFF S. MOODY, P.E.				
APPROVED BY COUNTY ENGINEER	**CURB CUT WITH SPLASH PAD – 2**			
_____ DATE: _____				
DEYLAMIAN SIROUS, P.E. R.C.E. NO. 53192, EXP 6/30/2017		DRAWING NUMBER **GS-2.6b**		



PLAN VIEW



SECTION A-A



SECTION B-B

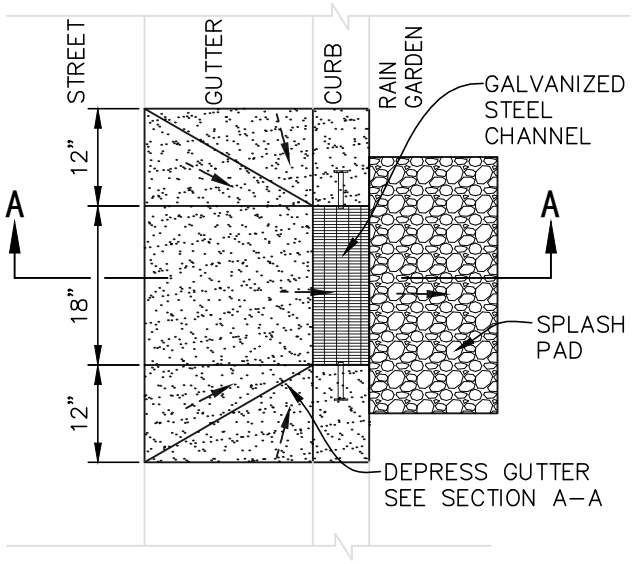
DRAFT

NOTES:

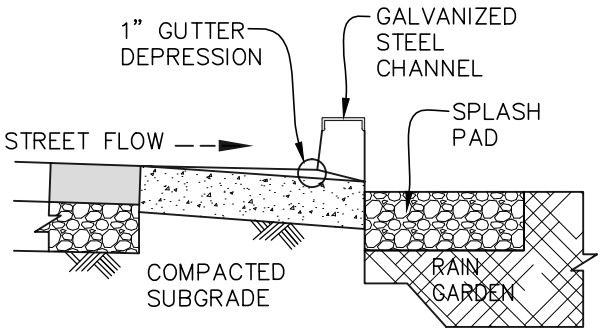
1. CURB OPENING DIMENSION SHOWN IS 18" MINIMUM. CURB CUT SHALL BE SIZED TO CONVEY 85TH PERCENTILE RAINFALL.
2. PROVIDE AND MAINTAIN A SAFE PEDESTRIAN WALKWAY ACCESS THAT COMPLIES WITH APPLICABLE ADA STANDARDS AND SD SUPPLEMENT TO GREEN BOOK SEC 7-10 "PUBLIC CONVENIENCE AND SAFETY".
3. REFER TO DESIGN PLANS FOR SIZE AND TYPE OF COVER.
4. METAL TRENCH DRAIN COVER TO BE BOLTED DOWN (THEFT PROTECTED) BUT REMOVABLE.
5. SPLASH PAD DEPTH OPTIONS: 12" STONE #2, 4" CONCRETE SLAB, OR PAVER BLOCKS ON 6" AGGREGATE AASHTO #57.

DRAWING NOT TO SCALE

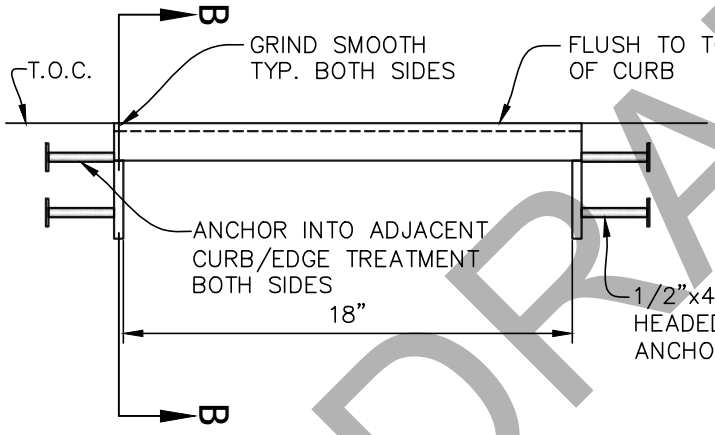
DRAWN BY:____	CHECKED BY:____	SAN DIEGO COUNTY DESIGN STANDARD	REVISIONS	APPROVED	DATE
RECOMMENDED BY: JEFF S. MOODY, P.E.					
APPROVED BY COUNTY ENGINEER		CURB CUT METAL TRENCH COVER			
_____ DATE: _____					
DEYLAMIAN SIROUS, P.E. R.C.E. NO. 53192, EXP 6/30/2017			DRAWING NUMBER	GS-2.7	



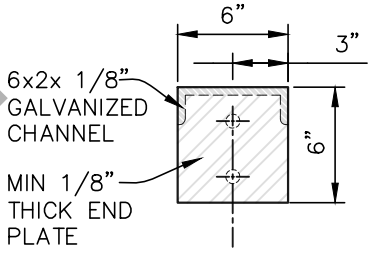
PLAN VIEW



SECTION A-A



ELEVATION



SECTION B-B

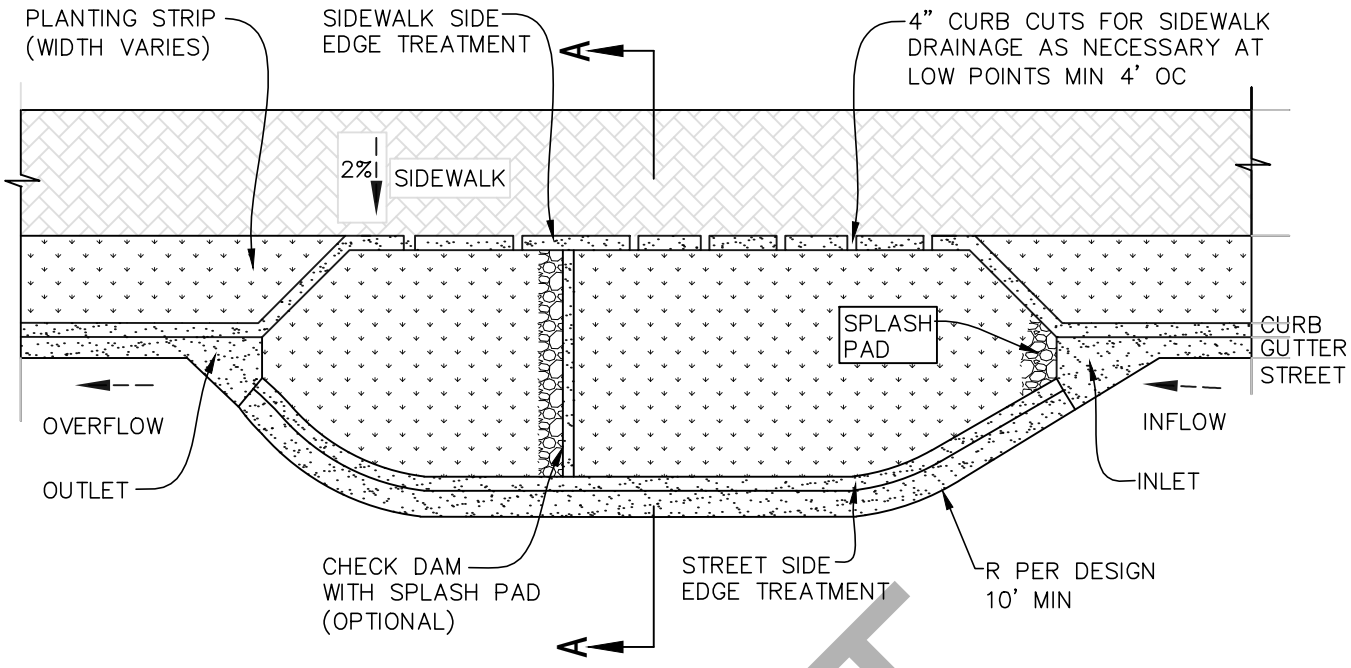
DRAFT

NOTES:

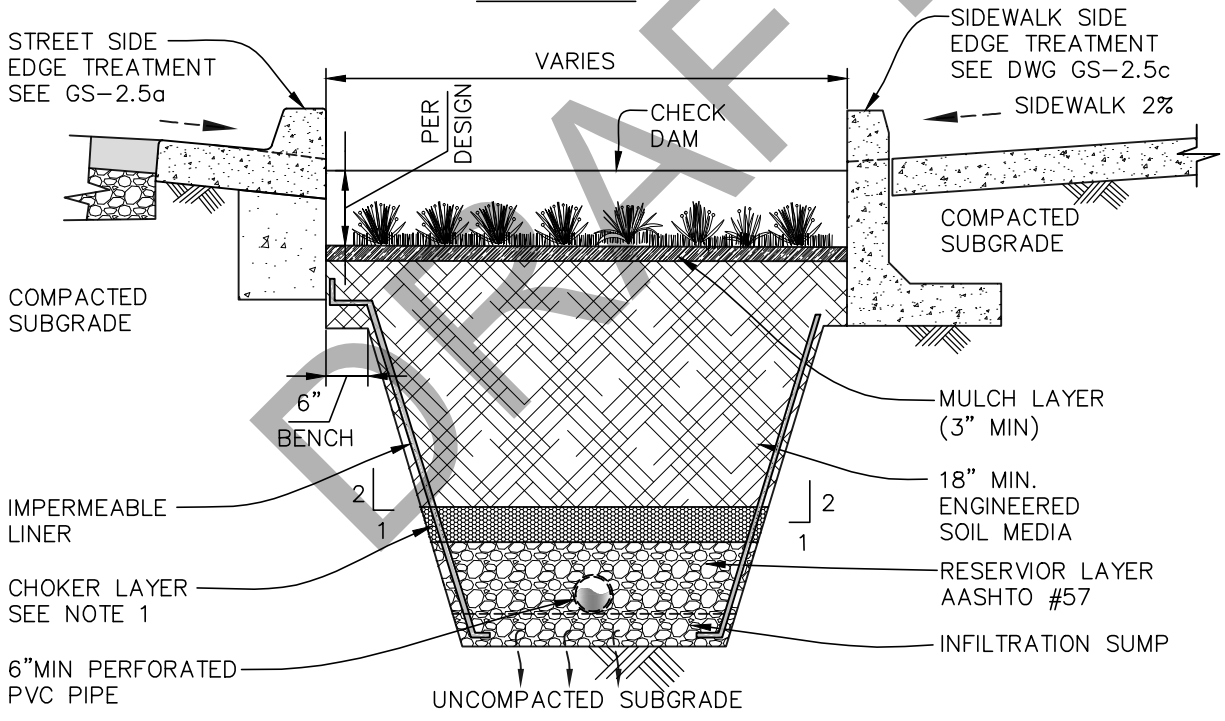
1. METAL COVER OVER CURB CUT MAY BE OMITTED WITH COUNTY APPROVAL.
2. ENTIRE ASSEMBLY SHALL BE HOT DIP GALVANIZED STEEL IN ACCORDANCE WITH ASTM A–123.
3. SHARP POINTS, CORNERS AND EDGES OF METAL COVER SHALL BE POLISHED SMOOTH.
4. SINGLE BEVEL GROOVE WELD.
5. DESIGN VERTICAL WHEEL LOAD IS 8.5 KIPS ONE HALF OF TANDEM AXLE WEIGHT SPECIFIED IN FHWA HOP–06–105).
6. ALTERNATE MATERIAL FOR ASSEMBLY MAY BE USED PER COUNTY APPROVAL.

DRAWING NOT TO SCALE

DRAWN BY:____ CHECKED BY:____	SAN DIEGO COUNTY DESIGN STANDARD	REVISIONS	APPROVED	DATE
RECOMMENDED BY: JEFF S. MOODY, P.E.				
APPROVED BY COUNTY ENGINEER	**GALVANIZED STEEL CHANNEL OVER CURB CUT**			
_____ DATE: _____				
DEYLAMIAN SIROUS, P.E. R.C.E. NO. 53192, EXP 6/30/2017		DRAWING NUMBER	**GS-2.8**	



IN-PLANTING STRIP
PLAN VIEW



SECTION A-A
(WALL OPTION)

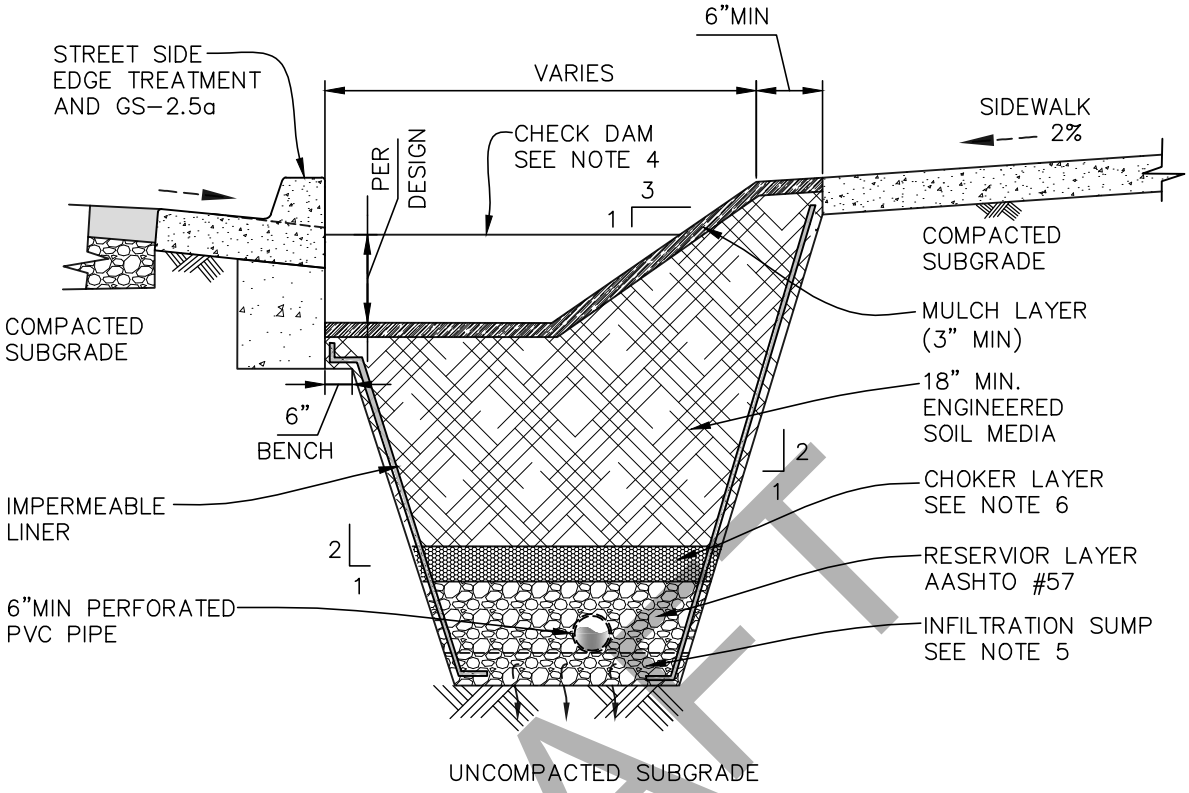
DRAFT

NOTES:

1. CHOKER LAYER IS OPTIONAL PER GEOTECHNICAL ENGINEER RECOMMENDATION.

DRAWING NOT TO SCALE

DRAWN BY:____ CHECKED BY:____	SAN DIEGO COUNTY DESIGN STANDARD	REVISIONS	APPROVED	DATE
RECOMMENDED BY: JEFF S. MOODY, P.E.				
APPROVED BY COUNTY ENGINEER	**CURB EXTENSION ADJACENT TO PLANTING STRIP**			
_____ DATE: _____ DEYLAMIAN SIROUS, P.E. R.C.E. NO. 53192, EXP 6/30/2017		DRAWING NUMBER	**GS-3.1a**	



SECTION A-A
(SLOPE OPTION)

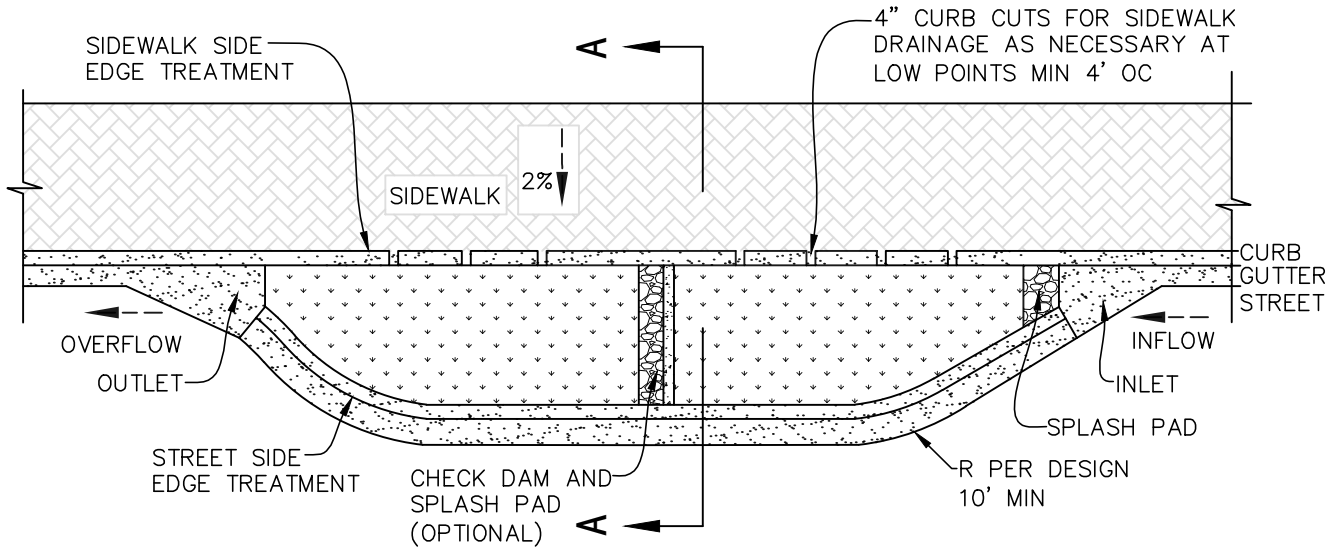
DRAFT

NOTES:

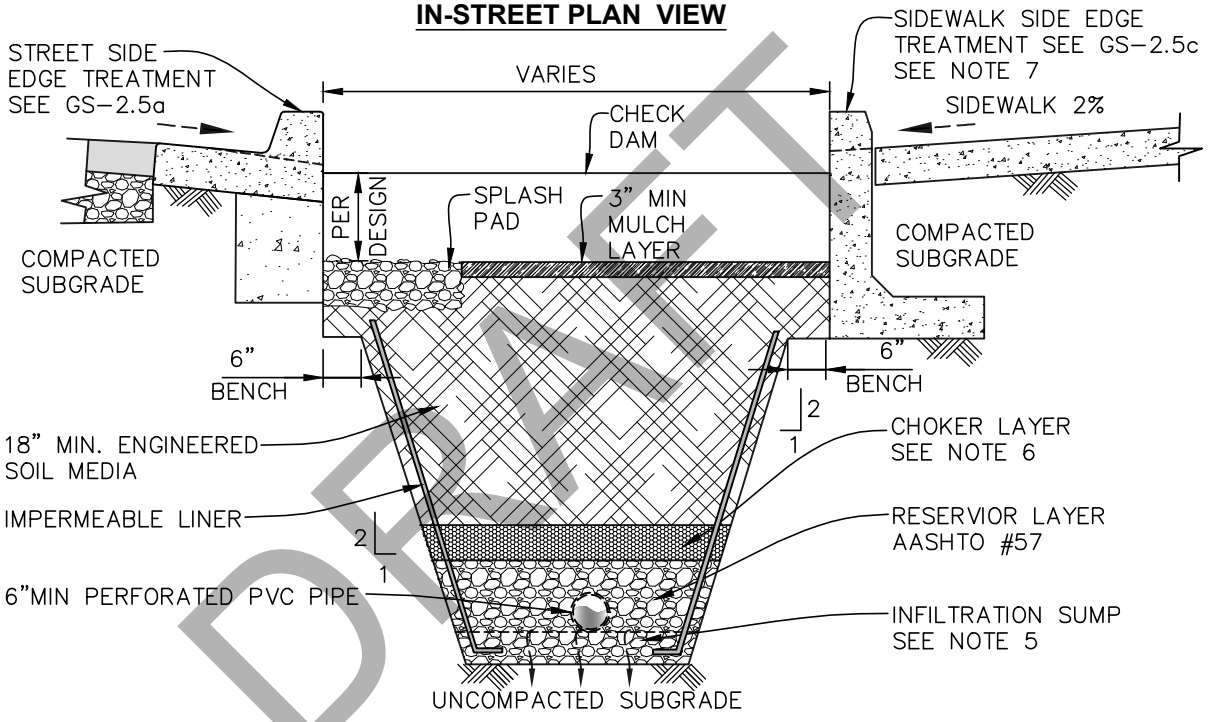
1. LONGITUDINAL SLOPE OF PLANTER MATCHES ROAD OR FLATTER AS REQUIRED PER DESIGN PLANS.
2. SIDEWALK ELEVATION MUST BE SET ABOVE INLET AND OUTLET ELEVATIONS TO ALLOW OVERFLOW TO DRAIN TO STREET BEFORE PONDING LEVEL REACHES SIDEWALK.
3. SEE DWG GS-3.2c FOR INLET AND OUTLET DETAILS.
4. CHECK DAMS REQUIRED AS PER DESIGN PLANS SEE DWG GS-4.1 THRU GS-4.3
5. DEPTH OF INFILTRATION SUMP AS SHOWN ON DESIGN PLANS SHOULD BE SIZED TO ADDRESS STORMWATER MANAGEMENT REQUIREMENTS.
6. CHOKER LAYER IS OPTIONAL PER GEOTECHNICAL ENGINEER RECOMMENDATION.

DRAWING NOT TO SCALE

DRAWN BY:____ CHECKED BY:____	SAN DIEGO COUNTY DESIGN STANDARD	REVISIONS	APPROVED	DATE
RECOMMENDED BY: JEFF S. MOODY, P.E.				
APPROVED BY COUNTY ENGINEER	**CURB EXTENSION ADJACENT TO PLANTING STRIP**			
_____ DATE: _____ DEYLAMIAN SIROUS, P.E. R.C.E. NO. 53192, EXP 6/30/2017		DRAWING NUMBER	**GS-3.1b**	



IN-STREET PLAN VIEW



SECTION A-A

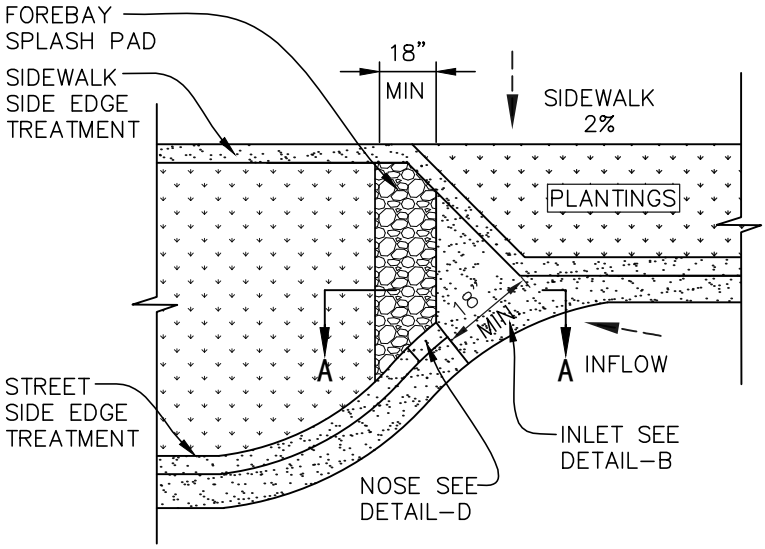
DRAFT

NOTES:

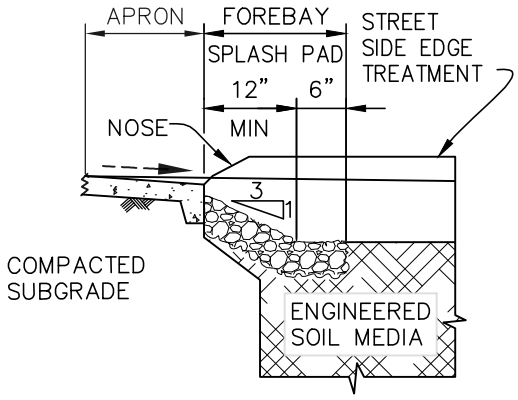
1. LONGITUDINAL SLOPE OF PLANTER MATCHES ROAD OR FLATTER AS REQUIRED PER DESIGN PLANS.
2. SIDEWALK ELEVATION MUST BE SET ABOVE INLET AND OUTLET ELEVATIONS TO ALLOW OVERFLOW TO DRAIN TO STREET BEFORE PONDING LEVEL REACHES SIDEWALK.
3. SEE GS-3.3 FOR INLET AND OUTLET DETAILS.
4. CHECK DAMS REQUIRED AS PER DESIGN PLANS SEE S-4.1a, 4.1b. 4.2a, AND 4.2b.
5. DEPTH OF INFILTRATION SUMP AS SHOWN ON DESIGN PLANS SHOULD BE SIZED TO ADDRESS STORMWATER MANAGEMENT REQUIREMENTS.
6. CHOKER LAYER IS OPTIONAL PER GEOTECHNICAL ENGINEER RECOMMENDATION.
7. A 3 TO 1 SLOPE MAY BE USED IN LIEU OF THE L-WALL WHERE ADEQUATE SPACE IS AVAILABLE SEE GS-3.1b.

DRAWING NOT TO SCALE

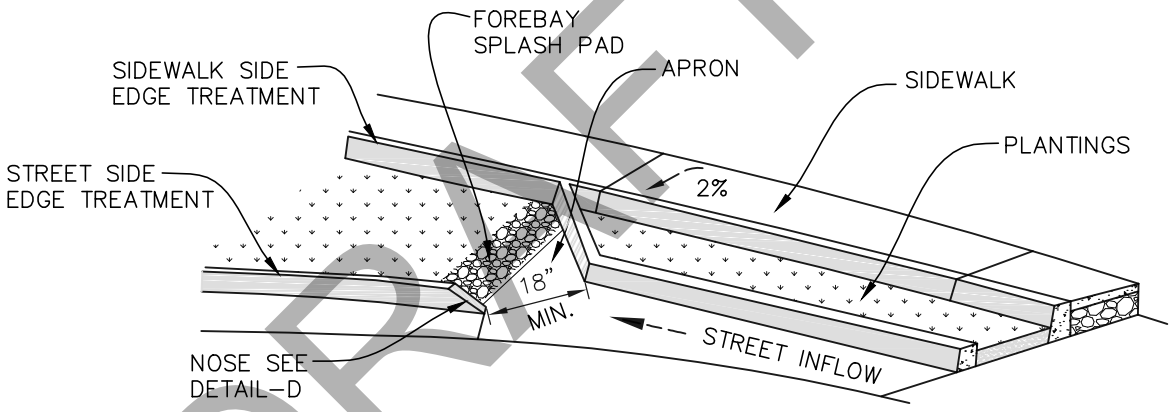
DRAWN BY:____	CHECKED BY:____	SAN DIEGO COUNTY DESIGN STANDARD	REVISIONS	APPROVED	DATE
RECOMMENDED BY: JEFF S. MOODY, P.E.					
APPROVED BY COUNTY ENGINEER _____ DATE: _____ DEYLAMIAN SIROUS, P.E. R.C.E. NO. 53192, EXP 6/30/2017		**CURB EXTENSION ADJACENT TO SIDEWALK**	DRAWING NUMBER	**GS-3.2**	



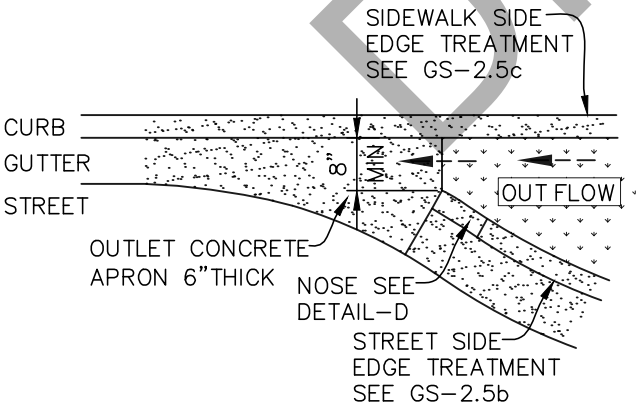
DETAIL - A
INLET PLAN VIEW



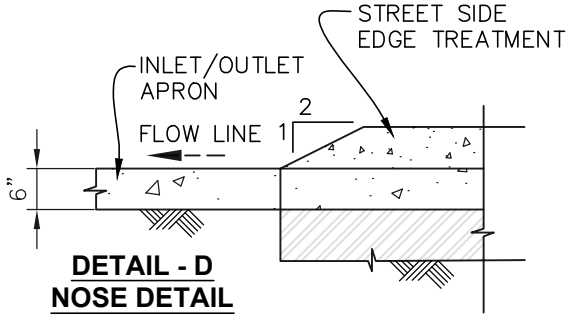
SECTION A-A



DETAIL - B
INLET ISOMETRIC VIEW



DETAIL - C
OUTLET PLAN VIEW

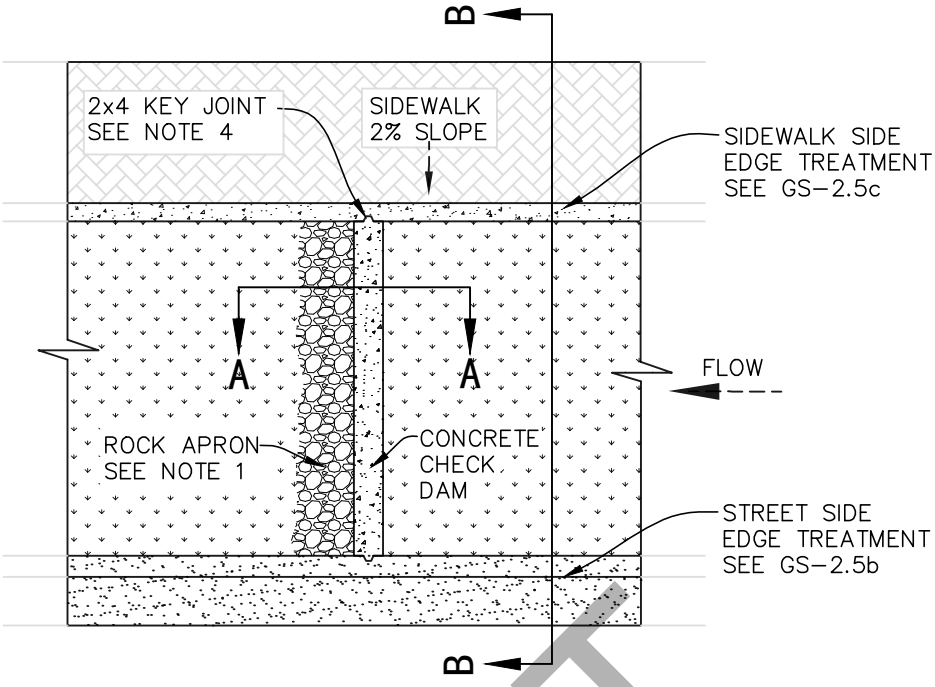


DETAIL - D
NOSE DETAIL

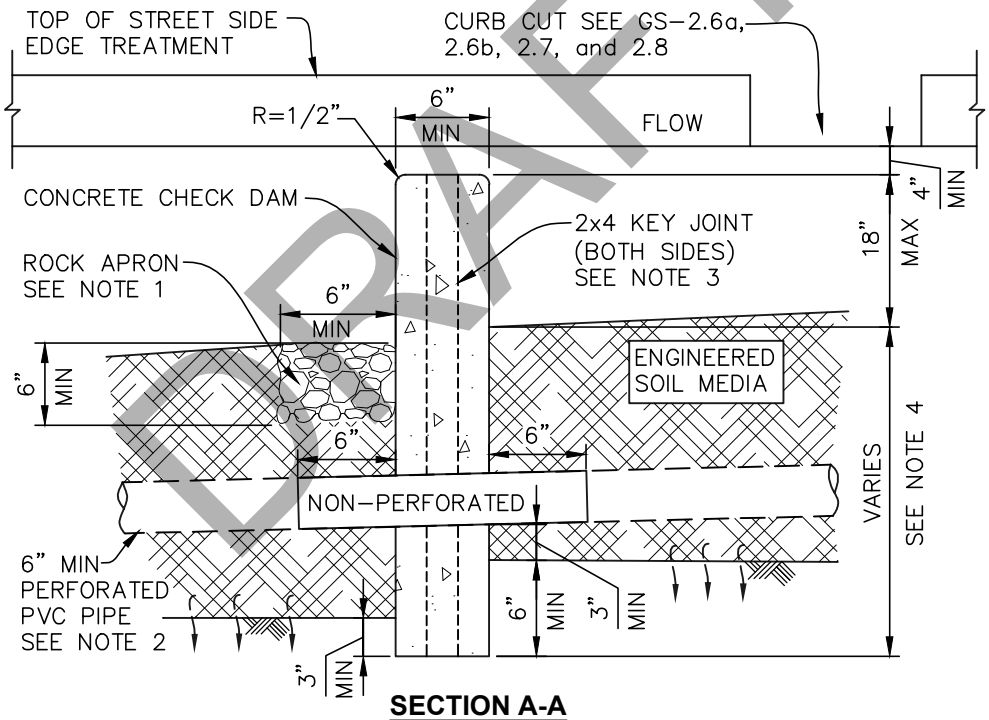
DRAFT

DRAWING NOT TO SCALE

DRAWN BY:____ CHECKED BY:____	SAN DIEGO COUNTY DESIGN STANDARD	REVISIONS	APPROVED	DATE
RECOMMENDED BY: JEFF S. MOODY, P.E.				
APPROVED BY COUNTY ENGINEER	INLET AND OUTLET DETAILS FOR CURB EXTENSION			
_____ DATE: _____ DEYLAMIAN SIROUS, P.E. R.C.E. NO. 53192, EXP 6/30/2017		DRAWING NUMBER	GS-3.3	



PLAN VIEW



SECTION A-A

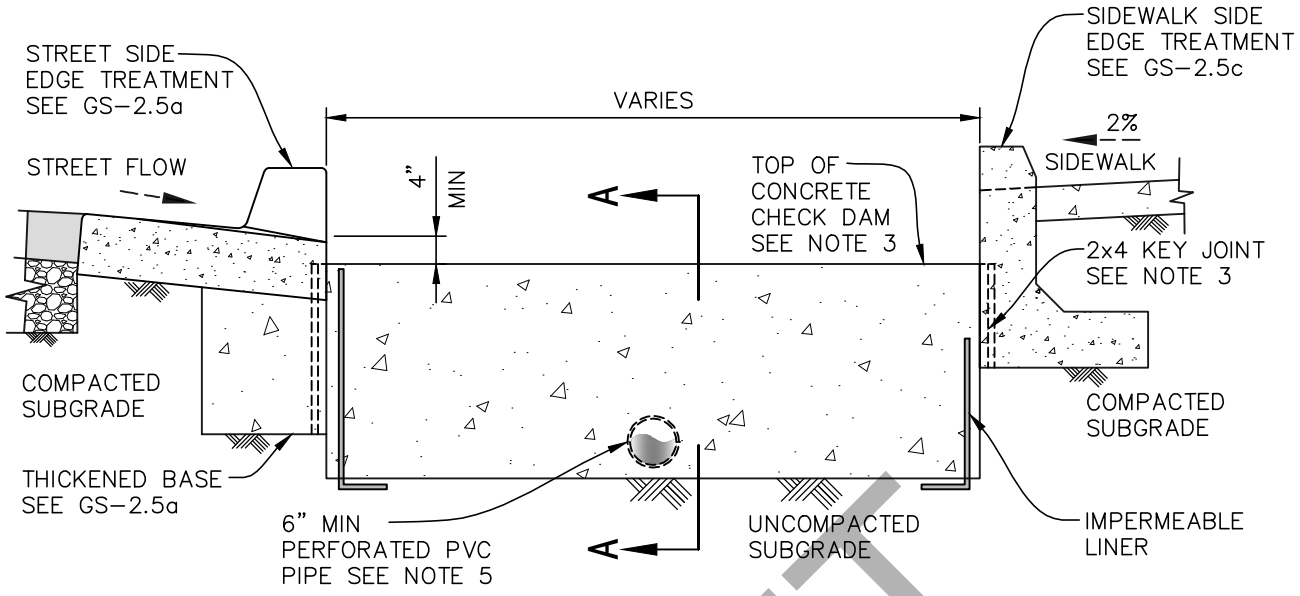
DRAFT

NOTES:

1. SIZE OF ROCK OR AGGREGATE TO BE SPECIFIED IN THE DESIGN PLANS.
2. IF PRESENT, UNDERDRAIN TO PASS THROUGH CHECK DAM IN A NON-PERFORATED PVC PIPE (6" MIN).
3. TO INSURE PROPER BONDING BETWEEN THE CONCRETE CHECK DAM AND THE EDGE TREATMENT, A 2x4 KEY JOINT SHALL BE FORMED ON BOTH SIDES PER SD RSD C-7.
4. DEPTH OF CHECK DAM VARIES DEPENDING ON THE DEPTH OF THE FACILITY.

DRAWING NOT TO SCALE

DRAWN BY:____ CHECKED BY:____	SAN DIEGO COUNTY DESIGN STANDARD	REVISIONS	APPROVED	DATE
RECOMMENDED BY: JEFF S. MOODY, P.E.				
APPROVED BY COUNTY ENGINEER				
DATE: ____	**CONCRETE CHECK DAM**			
DEYLAMIAN SIROUS, P.E. R.C.E. NO. 53192, EXP 6/30/2017		DRAWING NUMBER	**GS-4.1a**	



SECTION B-B

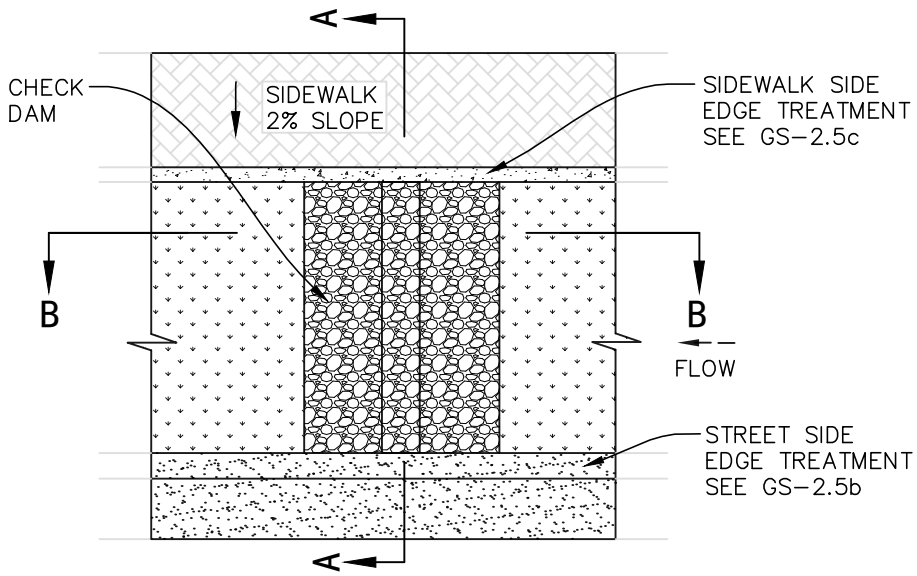
DRAFT

NOTES:

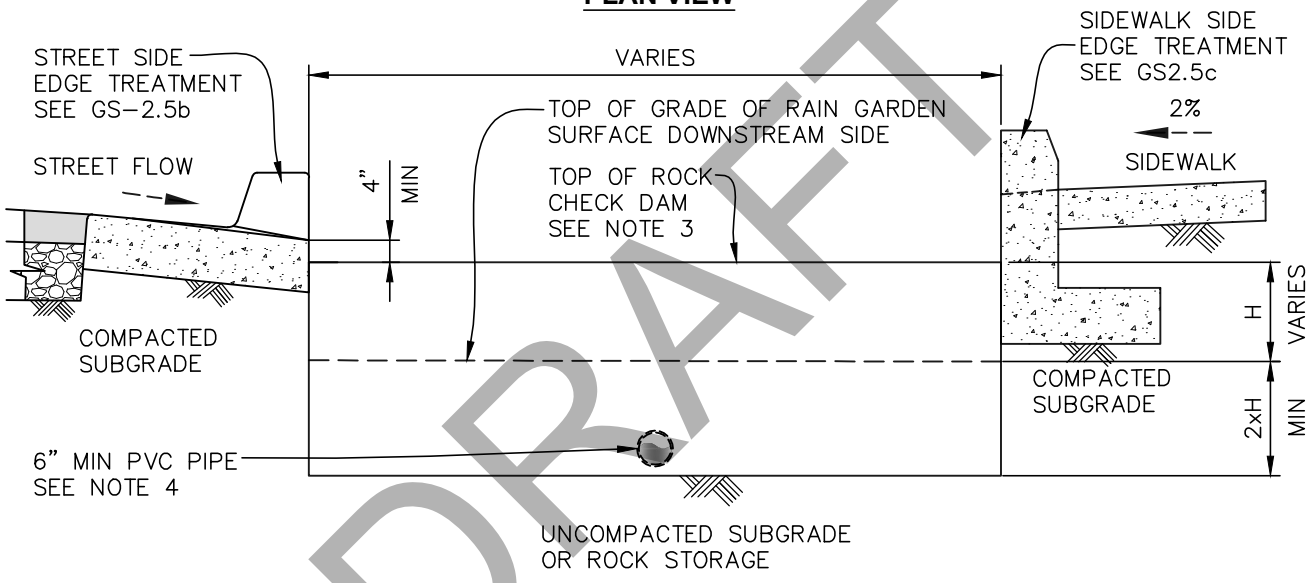
1. LOCATION, HEIGHT, AND WIDTH OF CHECK DAMS TO BE SPECIFIED IN THE DESIGN PLANS.
2. CONCRETE CHECK DAM SHALL BE CONTINUOUS (NO JOINTS).
3. TO INSURE PROPER BONDING BETWEEN THE CHECK DAM AND THE EDGE TREATMENT, A 2x4 KEY JOINT SHALL BE FORMED ON BOTH SIDES PER SD RSD C–7.
4. DEPTH OF CHECK DAM VARIES DEPENDING ON THE DEPTH OF THE FACILITY.
5. IF PRESENT, UNDERDRAIN TO PASS THROUGH CHECK DAM IN A NON–PERFORATED PVC PIPE.
6. FOR EDGE TREATMENT OPTIONS SEE DWG GS–2.5a, GS–2.5b, AND 2.5c.
7. EXCLUDE EDGE TREATMENT OPENING WHEN THE TOP OF SIDEWALK ELEVATION IS FLUSH WITH THE TOP OF EDGE TREATMENT WALL SEE DRAWING GS–2.5c.

DRAWING NOT TO SCALE

DRAWN BY:____ CHECKED BY:____	SAN DIEGO COUNTY DESIGN STANDARD	REVISIONS	APPROVED	DATE
RECOMMENDED BY: JEFF S. MOODY, P.E.				
APPROVED BY COUNTY ENGINEER				
_____ DATE: _____	**CONCRETE CHECK DAM**			
DEYLAMIAN SIROUS, P.E. R.C.E. NO. 53192, EXP 6/30/2017		DRAWING NUMBER	**GS-4.1b**	



PLAN VIEW



SECTION A-A

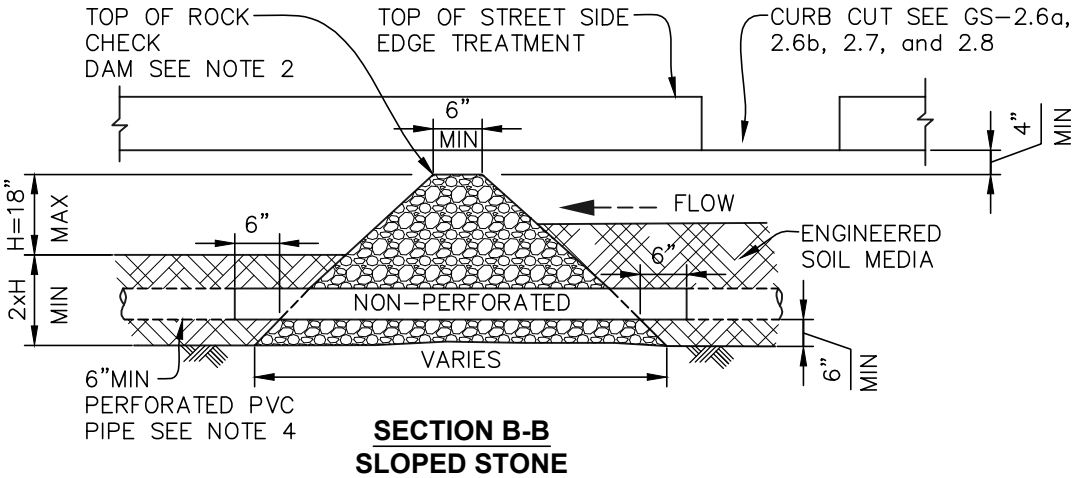
DRAFT

NOTES:

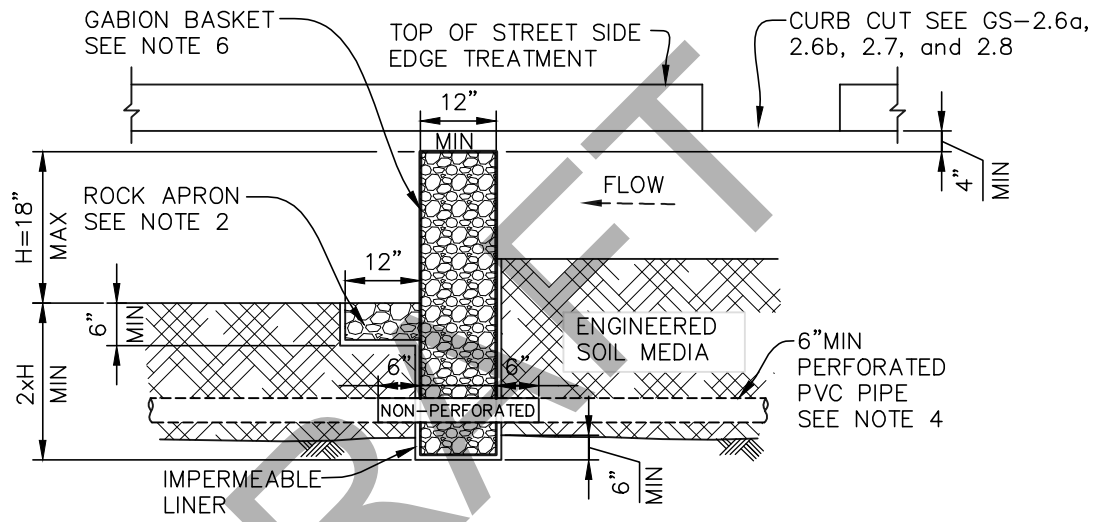
1. LOCATION, HEIGHTS, AND WIDTH OF CHECK DAMS TO BE SPECIFIED IN THE DESIGN PLANS.
2. SIZE OF STONE OR AGGREGATE TO BE SPECIFIED IN THE DESIGN PLANS.
3. DEPTH OF CHECK DAM VARIES DEPENDING ON THE DEPTH OF THE FACILITY.
4. IF PRESENT, UNDERDRAIN TO PASS THROUGH CHECK DAM IN A NON–PERFORATED PVC PIPE
5. FOR EDGE TREATMENT OPTIONS SEE DWG GS–2.5a, GS–2.5b, AND GS–2.5c
6. PROVIDE GABION BASKET, WELDED MESH TYPE WHEN UNDERDRAIN IS USED, TIE ALL WIRE BASKETS TOGETHER TO CREATE A CONTINUOUS STRUCTURE ALONG ITS LENGTH.

DRAWING NOT TO SCALE

DRAWN BY:____ CHECKED BY:____	SAN DIEGO COUNTY DESIGN STANDARD	REVISIONS	APPROVED	DATE
RECOMMENDED BY: JEFF S. MOODY, P.E.				
APPROVED BY COUNTY ENGINEER				
_____ DATE: _____	**ROCK CHECK DAM**			
DEYLAMIAN SIROUS, P.E. R.C.E. NO. 53192, EXP 6/30/2017		DRAWING NUMBER	**GS-4.2a**	



SECTION B-B
SLOPED STONE



SECTION B-B
GABION BASKET

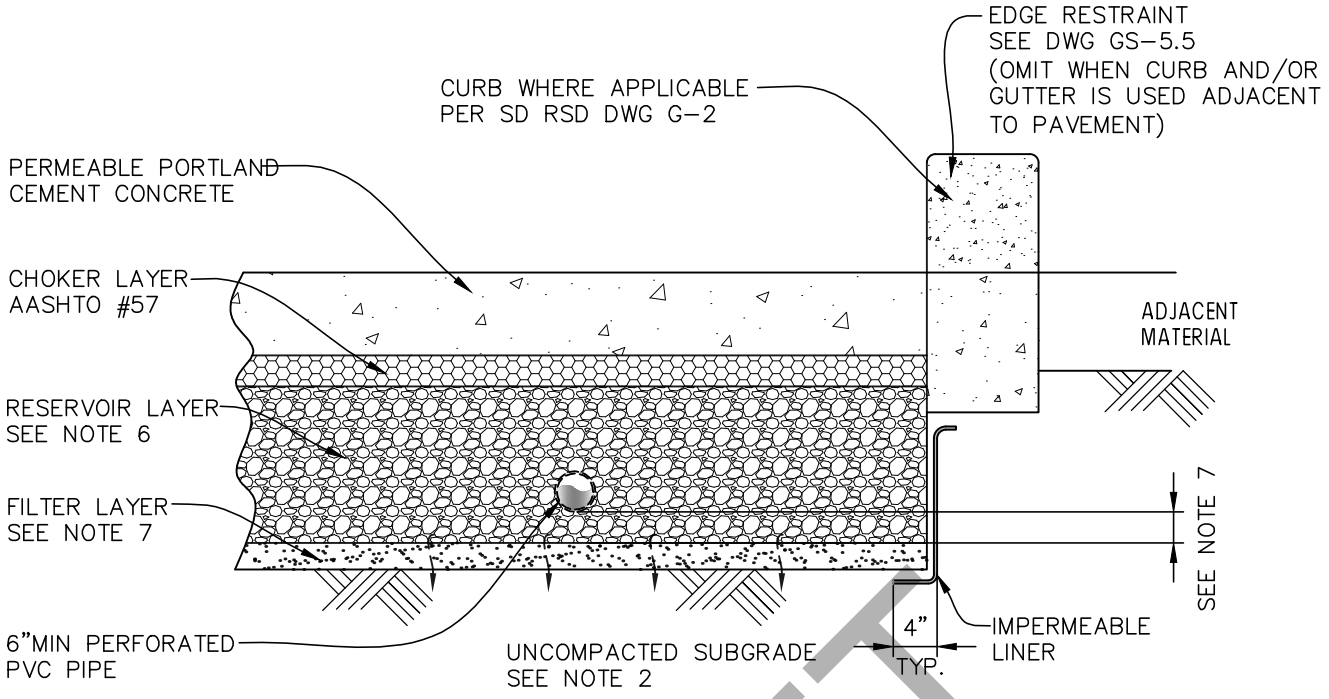
DRAFT

NOTES:

1. LOCATION, HEIGHTS, AND WIDTH OF CHECK DAMS TO BE SPECIFIED IN THE DESIGN PLANS.
2. SIZE OF ROCK OR AGGREGATE TO BE SPECIFIED IN THE DESIGN PLANS.
3. DEPTH OF CHECK DAM VARIES DEPENDING ON THE DEPTH OF THE FACILITY.
4. IF PRESENT, UNDERDRAIN TO PASS THROUGH CHECK DAM IN A NON-PERFORATED PVC PIPE
5. FOR EDGE TREATMENT OPTIONS SEE DWG GS-2.5a, GS-2.5b, AND GS-2.5c
6. FOR GABION BASKET CHECK DAM USE WELDED MESH TYPE WHEN UNDERDRAIN IS USED, TIE ALL WIRE BASKETS TOGETHER TO CREATE A CONTINUOUS STRUCTURE ALONG ITS LENGTH PER CALTRANS 2006 STANDARD PLAN D-100B.

DRAWING NOT TO SCALE

DRAWN BY:____ CHECKED BY:____	SAN DIEGO COUNTY DESIGN STANDARD	REVISIONS	APPROVED	DATE
RECOMMENDED BY: JEFF S. MOODY, P.E.				
APPROVED BY COUNTY ENGINEER				
_____ DATE: _____	**ROCK CHECK DAM**			
DEYLAMIAN SIROUS, P.E. R.C.E. NO. 53192, EXP 6/30/2017		DRAWING NUMBER	**GS-4.2b**	



MINIMUM PAVEMENT THICKNESS		
PAVEMENT ITEM	CLASS A	CLASS B
PERMEABLE CONCRETE	6"	8"
CHOKER LAYER	4"	4"
RESERVOIR LAYER	6" SEE NOTE 5	12" SEE NOTE 5
FILTER LAYER	4"	4"

CLASS A: ALLEY, PAVING LANE, LOCAL STREET
CLASS B: COLLECTOR OR ARTERIAL (NOT CURRENTLY ALLOWED)

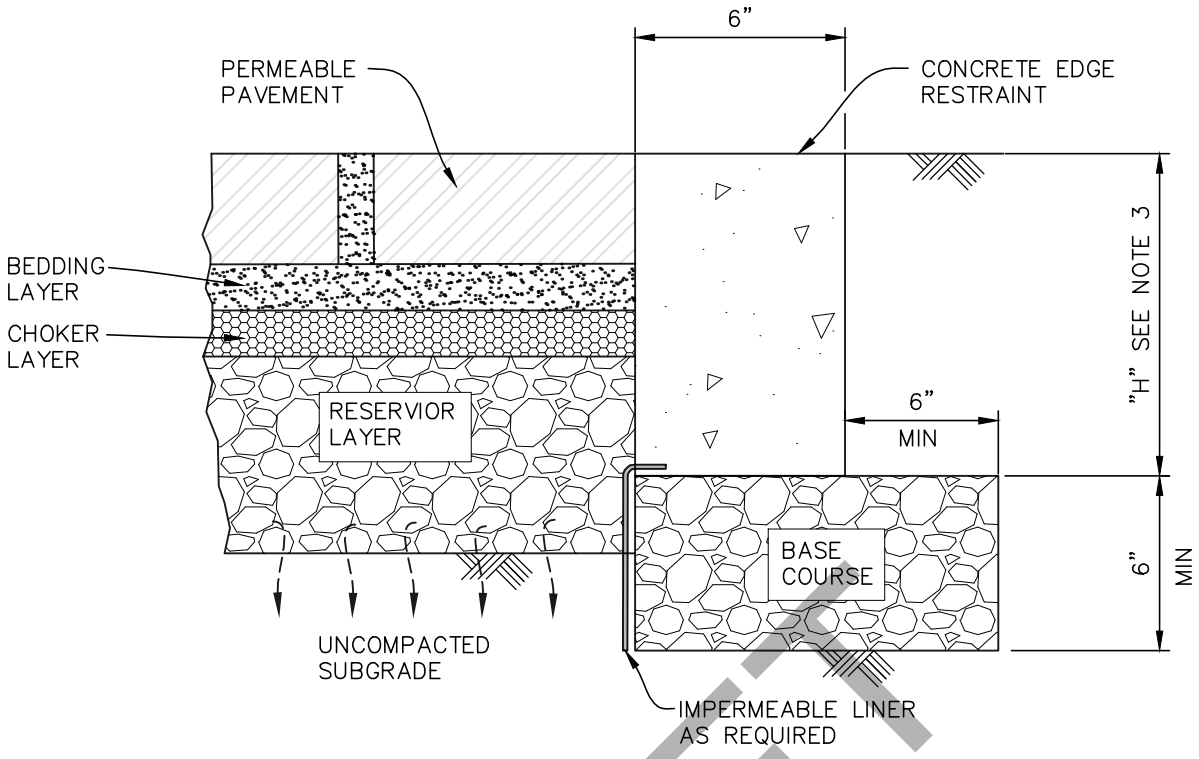
NOTES:

1. DETAIL TO BE USED ONLY WHEN APPROVED BY COUNTY AND SHALL MEET CURRENT APPROVED COUNTY SPECIFICATION FOR "IMPERMEABLE PORTLAND CEMENT CONCRETE PAVEMENT".
2. UNCOMPACTED SUBGRADE FOR AREAS DESIGNED FOR INFILTRATION PRACTICES. FOR OTHER AREAS, COMPACT AS SPECIFIED. FOR SOFT SOILS, INSTALL GEOGRID PER GEOTECHNICAL ENGINEER RECOMMENDATIONS.
3. AGGREGATE LAYERS SHALL MEET CURRENT APPROVED COUNTY SPECIFICATION FOR "AGGREGATE FOR PERMEABLE PAVEMENT AND RAIN GARDEN".
4. SEE DRAWING GS-5.4 FOR LONGITUDINAL AND CROSS SLOPE REQUIREMENTS.
5. IMPERMEABLE LINER TO BE USED TO PROMOTE WATER RE-USE, PROTECT NEARBY BUILDING FOUNDATIONS, AND AVOID INFILTRATION AROUND UTILITIES.
6. DEPTH OF RESERVOIR LAYER AS SHOWN ON DESIGN PLANS SHOULD BE SIZED TO ADDRESS STORMWATER CONVEYANCE REQUIREMENTS, AND PAVEMENTS STRUCTURAL DESIGN.
7. ENHANCED DESIGN CONTAINS A WATER STORAGE LAYER AND AN INFILTRATION SUMP BENEATH THE UNDERDRAIN SIZED TO DRAIN THE DESIGN STORM WITHIN 96 HOURS.
8. WHEN FILTER LAYER IS OMITTED, PROVIDE GEOTEXTILE BENEATH RESERVOIR LAYER MEETING CURRENT APPROVED COUNTY SPECIFICATION FOR GOESYNTHETICS.
9. BOTTOM OF RESERVOIR LAYER SHALL BE AT LEAST 10' ABOVE THE SEASONAL HIGH WATER TABLE OR 2' ABOVE BEDROCK, AS DETERMINED BY GEOTECHNICAL INVESTIGATION.
10. TOP OF PAVEMENT SHOULD BE DESIGNED TO ACHIEVE 1% MINIMUM SLOPE IN ANY DIRECTION.

DRAFT

DRAWING NOT TO SCALE

DRAWN BY:____ CHECKED BY:____	SAN DIEGO COUNTY DESIGN STANDARD	REVISIONS	APPROVED	DATE
RECOMMENDED BY: JEFF S. MOODY, P.E.				
APPROVED BY COUNTY ENGINEER	**PERMEABLE CONCRETE PAVEMENT**			
_____ DATE: _____ DEYLAMIAN SIROUS, P.E. R.C.E. NO. 53192, EXP 6/30/2017		DRAWING NUMBER	**GS-5.1a**	



STONE TYPE FOR GREEN STREET ELEMENTS		
LAYER NAME	GREEN STREET ELEMENTS	
	PERMEABLE PAVEMENTS	RAIN GARDENS
RESERVOIR	#2 – #3	#57
CHOKER	#57	See Table 1–3 SD Green Street Specifications
SAND FILTER	#8	#8
BEDDING LAYER	#8	N/A

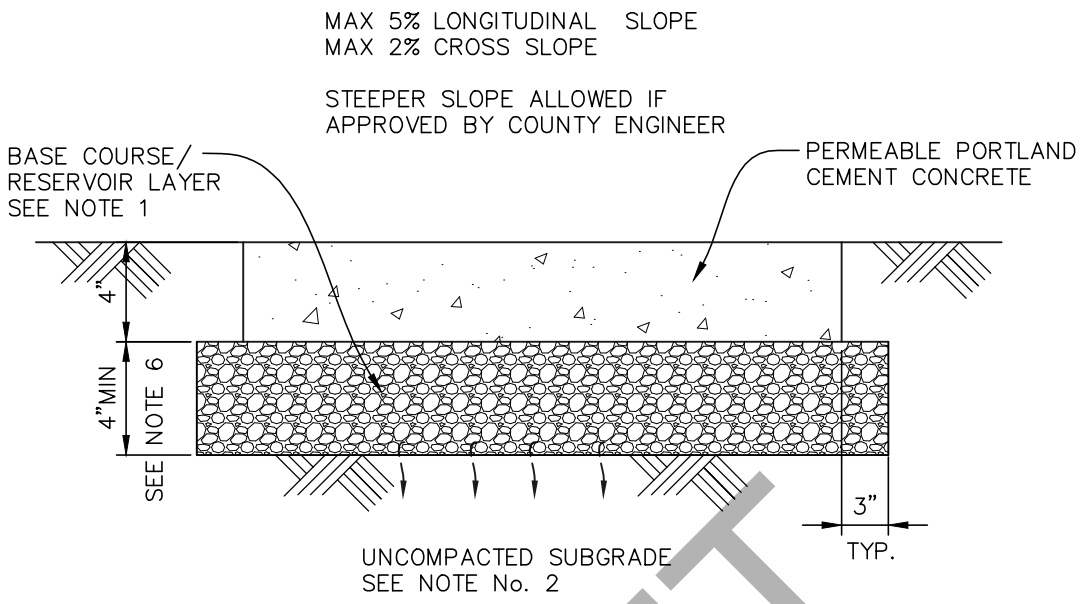
DRAFT

NOTES:

1. PERIMETER RESTRAINTS ARE REQUIRED FOR PERMEABLE INTERLOCKING CONCRETE PAVER SYSTEM. ENGINEER TO DETERMINE IF EDGE RESTRAINTS ARE NECESSARY FOR PERMEABLE ASPHALT AND PERMEABLE CONCRETE INSTALLATION.
2. MATERIALS, TYPE F, 3,500 PSI CONCRETE; OTHER TYPES OF EDGE RESTRAINT, SUCH AS STEEL OR PLASTIC SHALL BE ALLOWED AS APPROVED BY THE COUNTY ENGINEER, AND BASED ON MANUFACTURER'S RECOMMENDATIONS.
3. H = 10" FOR PERMEABLE ASPHALT CLASS B; 6" FOR PERMEABLE CONCRETE PAVERS AND PERMEABLE ASPHALT CLASS A.
4. FOR REGULAR PAVEMENT, USE CUTOFF WALL AT END OF PAVEMENT PER SAN DIEGO REGIONAL STANDARD DRAWING G–22.

DRAWING NOT TO SCALE

DRAWN BY:____ CHECKED BY:____	SAN DIEGO COUNTY DESIGN STANDARD	REVISIONS	APPROVED	DATE
RECOMMENDED BY: JEFF S. MOODY, P.E.				
APPROVED BY COUNTY ENGINEER	PERMEABLE PAVEMENT EDGE RESTRAINT			
_____ DATE: _____ DEYLAMIAN SIROUS, P.E. R.C.E. NO. 53192, EXP 6/30/2017		DRAWING NUMBER	GS-5.5	



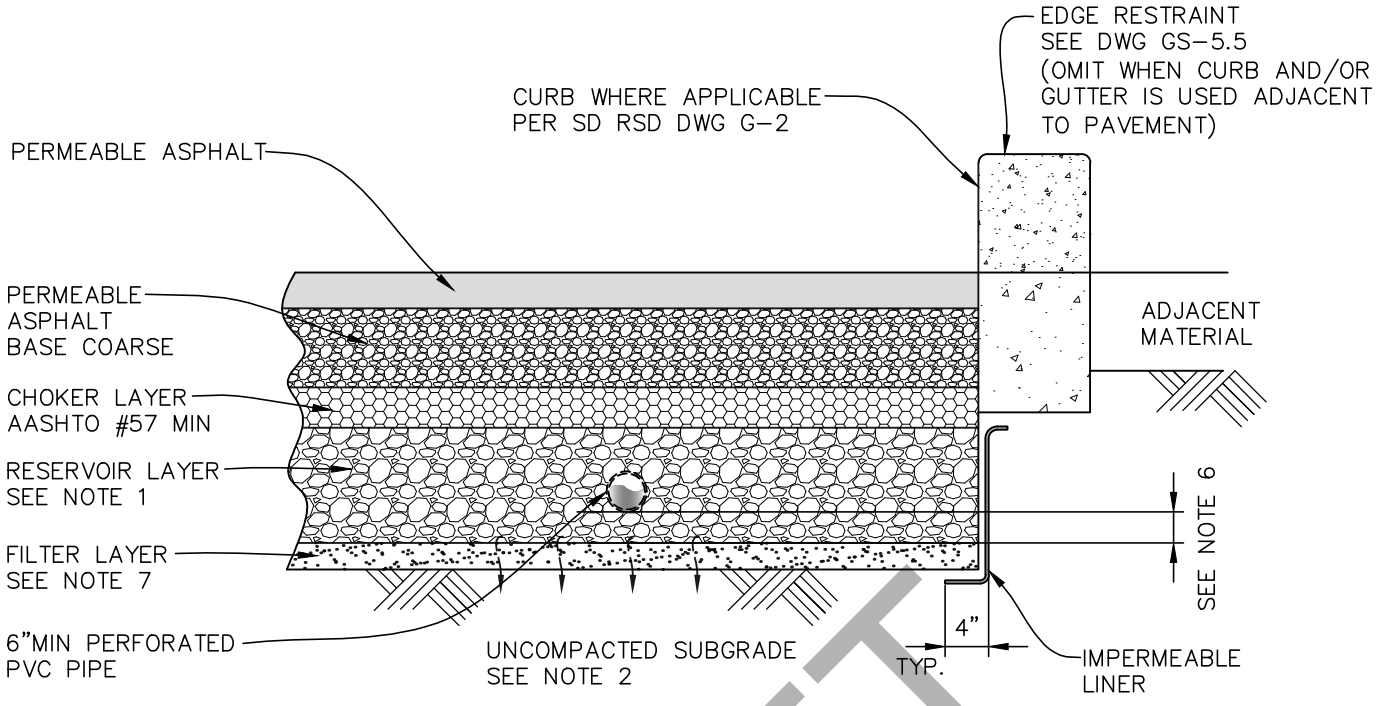
DRAFT

NOTES:

1. DETAIL TO BE USED ONLY WHEN APPROVED BY COUNTY AND SHALL MEET CURRENT APPROVED COUNTY SPECIFICATION FOR "PERVIOUS PORTLAND CEMENT CONCRETE PAVEMENT".
2. UNCOMPACTED SUBGRADE FOR AREAS DESIGNED FOR INFILTRATION PRACTICES. FOR OTHER AREAS, COMPACT AS SPECIFIED. FOR SOFT SOILS, INSTALL GEOGRID PER GEOTECHNICAL ENGINEER RECOMMENDATIONS.
3. AGGREGATE LAYERS SHALL MEET CURRENT APPROVED COUNTY SPECIFICATION FOR "AGGREGATE FOR PERMEABLE PAVEMENT AND RAIN GARDEN".
4. WHERE INSITU SOILS ARE NOT CONDUCIVE TO INFILTRATION OF DESIGN STORM VOLUME WITHIN 72 HOURS, UNDERDRAIN SHOULD BE CONSIDERED THROUGH COORDINATION WITH COUNTY ENGINEER.
5. IMPERMEABLE LINER TO BE USED TO PROMOTE WATER RE-USE, PROTECT NEARBY BUILDING FOUNDATIONS, AND AVOID INFILTRATION AROUND UTILITIES.
6. AGGREGATE DEPTH MAY BE GREATER THAN MINIMUM. AS SHOWN IN DESIGN PLANS TO ACHIEVE ADDITIONAL STORMWATER STORAGE.
7. BOTTOM OF RESERVOIR LAYER SHALL BE AT LEAST 10' ABOVE THE SEASONAL HIGH WATER TABLE OR 2' ABOVE BEDROCK, AS DETERMINED BY GEOTECHNICAL INVESTIGATION.
8. TOP OF PAVEMENT SHOULD BE DESIGNED TO achieve 1% MINIMUM SLOPE IN ANY DIRECTION.
9. IN CASE OF TREE PLANTINGS, STRUCTURAL SOIL MAY EXTEND UNDER RESERVOIR LAYER.

DRAWING NOT TO SCALE

DRAWN BY:____ CHECKED BY:____	SAN DIEGO COUNTY DESIGN STANDARD	REVISIONS	APPROVED	DATE
RECOMMENDED BY: JEFF S. MOODY, P.E.				
APPROVED BY COUNTY ENGINEER	**PERMEABLE CONCRETE PAVEMENT (SIDEWALK)**			
_____ DATE: _____ DEYLAMIAN SIROUS, P.E. R.C.E. NO. 53192, EXP 6/30/2017		DRAWING NUMBER **GS-5.1b**		



MINIMUM PAVEMENT THICKNESS		
PAVEMENT ITEM	CLASS A	CLASS B
PERMEABLE ASPHALT	1.5"	3"
AC BASE COURSE	3"	6"
CHOKER LAYER	4"	4"
RESERVOIR LAYER	6" SEE NOTE 5	12" SEE NOTE 5
FILTER LAYER	4"	4"

CLASS A: ALLEY, PAVING LANE, LOCAL STREET
CLASS B: COLLECTOR OR ARTERIAL (NOT CURRENTLY ALLOWED)

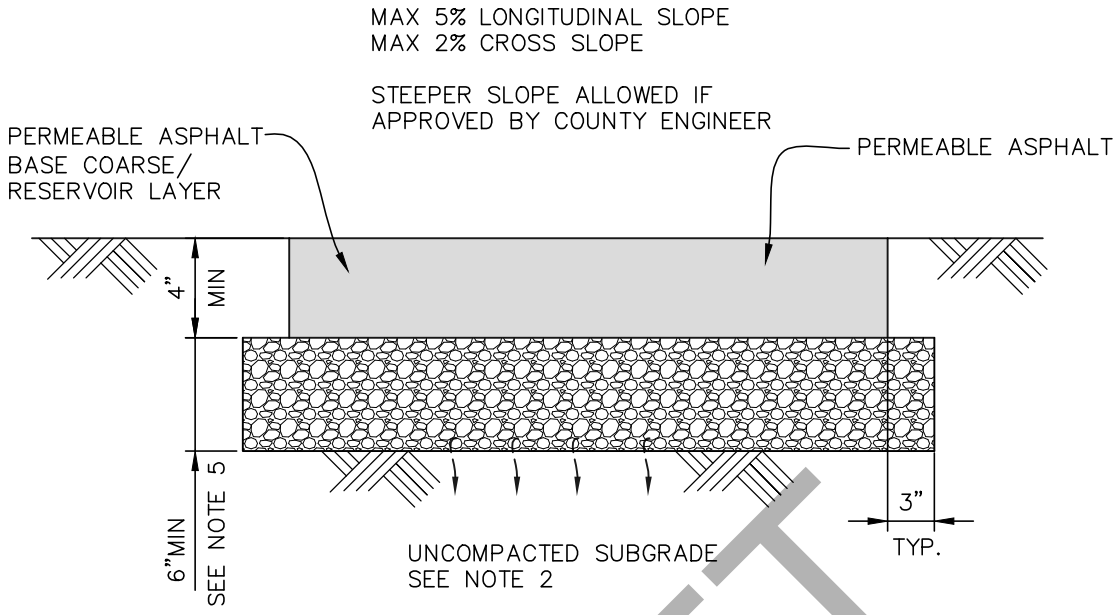
DRAFT

NOTES:

1. DETAIL TO BE USED ONLY WHEN APPROVED BY COUNTY AND SHALL MEET CURRENT APPROVED COUNTY SPECIFICATION FOR "PERMEABLE ASPHALT PAVEMENT".
2. UNCOMPACTED SUBGRADE FOR AREAS DESIGNED FOR INFILTRATION PRACTICES. FOR OTHER AREAS, COMPACT AS SPECIFIED. FOR SOFT SOILS, INSTALL GEOGRID PER GEOTECHNICAL ENGINEER RECOMMENDATIONS.
3. AGGREGATE LAYERS SHALL MEET CURRENT APPROVED COUNTY SPECIFICATION FOR "AGGREGATE FOR PERMEABLE PAVEMENT AND RAIN GARDEN".SEE DWG GS-5.4 FOR LONGITUDINAL AND CROSS SLOPE REQUIREMENTS.
4. IMPERMEABLE LINER TO BE USED TO PROMOTE WATER RE-USE, PROTECT NEARBY BUILDING FOUNDATIONS, AND AVOID INFILTRATION AROUND UTILITIES.
5. DEPTH OF RESERVOIR LAYER AS SHOWN ON DESIGN PLANS SHOULD BE SIZED TO ADDRESS STORMWATER CONVEYANCE REQUIREMENTS, AND PAVEMENTS STRUCTURAL DESIGN.
6. ENHANCED DESIGN CONTAINS A WATER STORAGE LAYER AND AN INFILTRATION SUMP BENEATH THE UNDERDRAIN SIZED TO DRAIN THE DESIGN STORM WITHIN 96 HOURS.
7. WHEN FILTER LAYER IS OMITTED, PROVIDE GEOTEXTILE BENEATH RESERVOIR LAYER MEETING CURRENT APPROVED COUNTY SPECIFICATION FOR GOESYNTHETICS MATERIALS.
8. BOTTOM OF RESERVOIR LAYER SHALL BE AT LEAST 10' ABOVE THE SEASONAL HIGH WATER TABLE OR 2' ABOVE BEDROCK, AS DETERMINED BY GEOTECHNICAL INVESTIGATION.
9. TOP OF PAVEMENT SHOULD BE DESIGNED TO ACHIEVE 1% MINIMUM SLOPE IN ANY DIRECTION.

DRAWING NOT TO SCALE

DRAWN BY:____ CHECKED BY:____	SAN DIEGO COUNTY DESIGN STANDARD	REVISIONS	APPROVED	DATE
RECOMMENDED BY: JEFF S. MOODY, P.E.				
APPROVED BY COUNTY ENGINEER	**PERMEABLE ASPHALT PAVEMENT**			
_____ DATE: _____				
DEYLAMIAN SIROUS, P.E. R.C.E. NO. 53192, EXP 6/30/2017		DRAWING NUMBER	**GS-5.2a**	



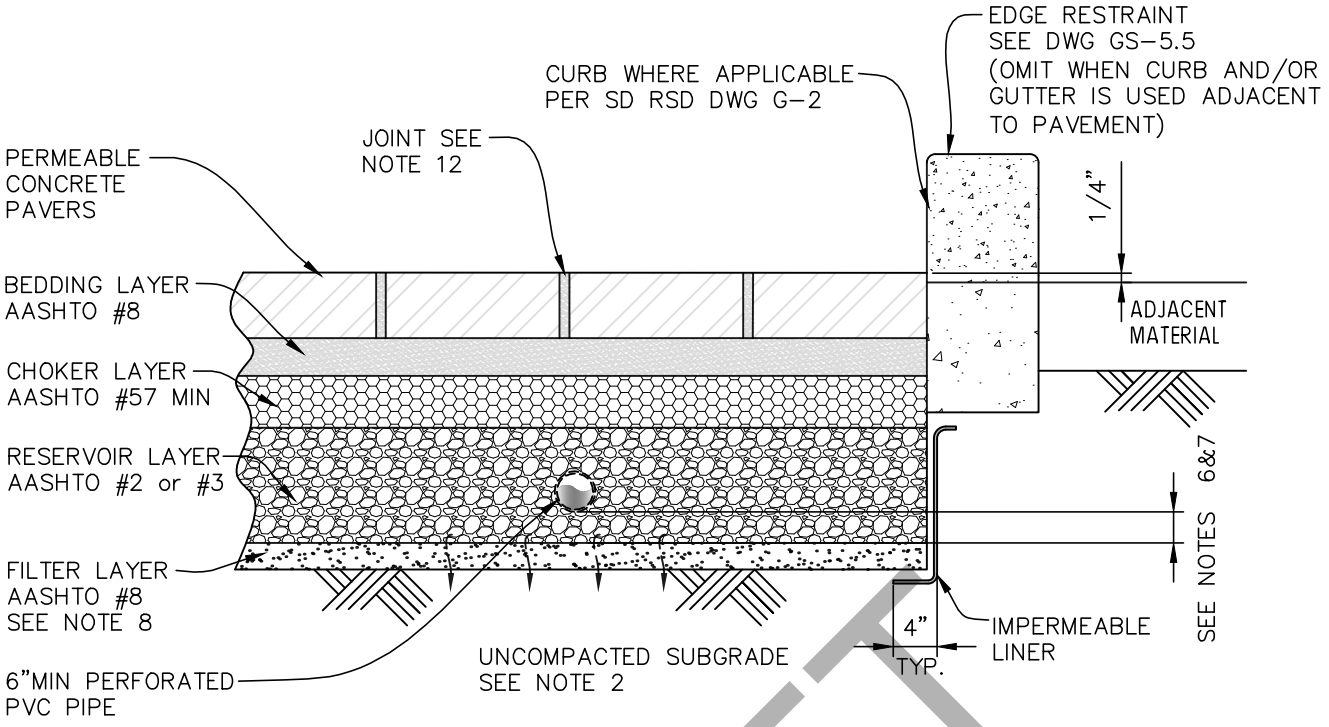
DRAFT

NOTES:

1. DETAIL TO BE USED ONLY WHEN APPROVED BY COUNTY AND SHALL MEET CURRENT APPROVED COUNTY SPECIFICATION FOR "PERMEABLE ASPHALT PAVEMENT".
2. UNCOMPACTED SUBGRADE FOR AREAS DESIGNED FOR INFILTRATION PRACTICES. FOR OTHER AREAS, COMPACT AS SPECIFIED. FOR SOFT SOILS, INSTALL GEOGRID PER GEOTECHNICAL ENGINEER RECOMMENDATIONS.
3. AGGREGATE LAYERS SHALL MEET CURRENT APPROVED COUNTY SPECIFICATION FOR "AGGREGATE FOR PERMEABLE PAVEMENT AND RAIN GARDEN".
4. WHERE INSITU SOILS ARE NOT CONDUCIVE TO INFILTRATION OF DESIGN STORM VOLUME WITHIN 72 HOURS, UNDERDRAIN SHOULD BE CONSIDERED THROUGH COORDINATION WITH COUNTY ENGINEER.
5. IMPERMEABLE LINER TO BE USED TO PROMOTE WATER RE-USE, PROTECT NEARBY BUILDING FOUNDATIONS, AND AVOID INFILTRATION AROUND UTILITIES.
6. AGGREGATE DEPTH MAY BE GREATER THAN MINIMUM AS SHOWN IN DESIGN PLANS TO ACHIEVE ADDITIONAL STORMWATER STORAGE.
7. BOTTOM OF RESERVOIR LAYER SHALL BE AT LEAST 10' ABOVE THE SEASONAL HIGH WATER TABLE OR 2' ABOVE BEDROCK, AS DETERMINED BY GEOTECHNICAL INVESTIGATION.
8. TOP OF PAVEMENT SHOULD BE DESIGNED TO ACHIEVE 1% MINIMUM SLOPE IN ANY DIRECTION.

DRAWING NOT TO SCALE

DRAWN BY:____	CHECKED BY:____	SAN DIEGO COUNTY DESIGN STANDARD	REVISIONS	APPROVED	DATE
RECOMMENDED BY: JEFF S. MOODY, P.E.					
APPROVED BY COUNTY ENGINEER		**PERMEABLE ASPHALT PAVEMENT (SIDEWALK)**			
_____ DATE: _____ DEYLAMIAN SIROUS, P.E. R.C.E. NO. 53192, EXP 6/30/2017			DRAWING NUMBER	**GS-5.2b**	



NOTES:

1. DETAIL TO BE USED ONLY WHEN APPROVED BY COUNTY AND SHALL MEET CURRENT APPROVED COUNTY SPECIFICATION FOR "PERMEABLE CONCRETE PAVERS".
2. UNCOMPACTED SUBGRADE FOR AREAS DESIGNED FOR INFILTRATION PRACTICES. FOR OTHER AREAS, COMPACT AS SPECIFIED SPECIFICATION. FOR SOFT SOILS, INSTALL GEOGRID PER GEOTECHNICAL ENGINEER RECOMMENDATIONS.
3. AGGREGATE LAYERS SHALL MEET CURRENT APPROVED COUNTY SPECIFICATION FOR "AGGREGATE FOR PERMEABLE PAVEMENT AND RAIN GARDEN".
4. SEE DWG GS-5.4 FOR LONGITUDINAL AND CROSS SLOPE REQUIREMENTS.
5. IMPERMEABLE LINER TO BE USED TO PROMOTE WATER RE-USE, PROTECT NEARBY BUILDING FOUNDATIONS AND AVOID INFILTRATION AROUND UTILITIES.
6. DEPTH OF RESERVOIR LAYER AS SHOWN ON DESIGN PLANS SHOULD BE SIZED TO ADDRESS STORMWATER CONVEYANCE REQUIREMENTS AND PAVEMENT STRUCTURAL DESIGN.
7. ENHANCED DESIGN CONTAINS A WATER STORAGE LAYER AND AN INFILTRATION SUMP BENEATH THE UNDERDRAIN SIZED TO DRAIN THE DESIGN STORM WITHIN 96 HOURS.
8. WHEN FILTER LAYER IS OMITTED, PROVIDE GEOTEXTILE BENEATH RESERVOIR LAYER MEETING CURRENT APPROVED COUNTY SPECIFICATION FOR "GOESYNTHETIC MATERIALS".
9. BOTTOM OF RESERVOIR LAYER SHALL BE AT LEAST 10' ABOVE THE SEASONAL HIGH WATER TABLE OR 2' ABOVE BEDROCK, AS DETERMINED BY GEOTECHNICAL INVESTIGATION.
10. TOP OF PAVEMENT SHOULD BE DESIGNED TO ACHIEVE 1% MINIMUM SLOPE IN ANY DIRECTION.
11. OTHER TYPES OF EDGE RESTRAINTS SUCH AS STEEL OR PLASTIC SHALL BE ALLOWED AS APPROVED BY THE COUNTY ENGINEER AND BASED ON MANUFACTURER'S RECOMMENDATIONS.
12. JOINT TO HAVE 1/2" MAXIMUM GAP IN ACCORDANCE WITH THE LATEST ADA REQUIREMENTS AND TO BE FILLED WITH AASHTO#8 OR APPROVED EQUIVALENT. MINIMUM GAP SHALL BE 1/4"OR PER MANUFACTURER'S RECOMMENDATIONS FOR PERMEABLE CONCRETE PAVERS.

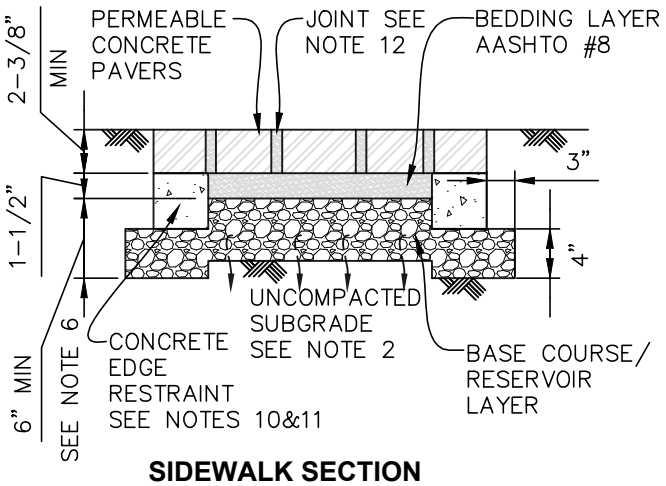
DRAFT

DRAWING NOT TO SCALE

DRAWN BY:____ CHECKED BY:____	SAN DIEGO COUNTY DESIGN STANDARD	REVISIONS	APPROVED	DATE
RECOMMENDED BY: JEFF S. MOODY, P.E.				
APPROVED BY COUNTY ENGINEER	**PERMEABLE PAVERS**			
_____ DATE: _____				
DEYLAMIAN SIROUS, P.E. R.C.E. NO. 53192, EXP 6/30/2017		DRAWING NUMBER	**GS-5.3a**	

MAX 5% LONGITUDINAL SLOPE
MAX 2% CROSS SLOPE

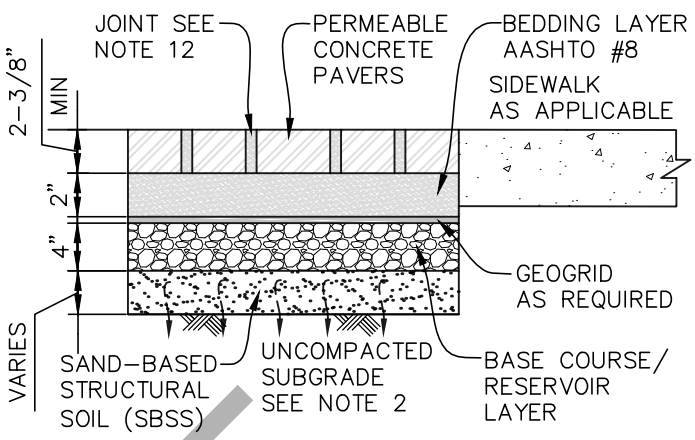
STEEPER SLOPE ALLOWED IF
APPROVED BY COUNTY ENGINEER



SIDEWALK SECTION

MAX 5% LONGITUDINAL SLOPE
MAX 2% CROSS SLOPE

STEEPER SLOPE ALLOWED IF
APPROVED BY COUNTY ENGINEER



PERMEABLE PAVERS OVER SAND-BASED STRUCTURAL SOIL

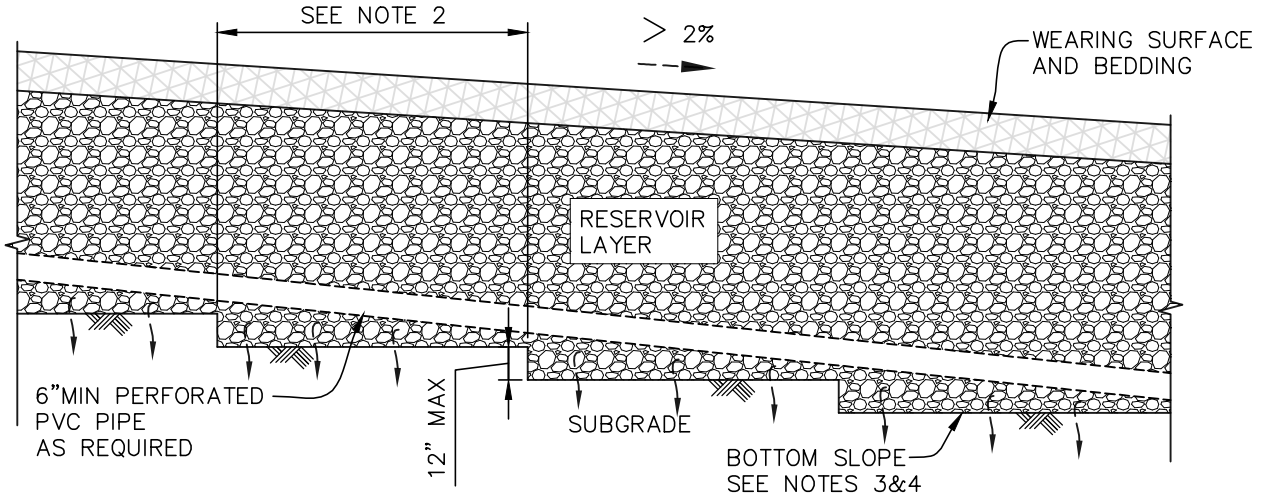
NOTES:

1. DETAIL TO BE USED ONLY WHEN APPROVED BY COUNTY AND SHALL MEET CURRENT APPROVED COUNTY SPECIFICATION FOR POROUS ASPHALT PAVEMENT.
2. UNCOMPACTED SUBGRADE FOR AREAS DESIGNED FOR INFILTRATION PRACTICES. FOR OTHER AREAS, COMPACT AS SPECIFIED. FOR SOFT SOILS, INSTALL GEOGRID PER GEOTECHNICAL ENGINEER RECOMMENDATIONS.
3. AGGREGATE LAYERS SHALL MEET CURRENT APPROVED COUNTY SPECIFICATION FOR "AGGREGATE FOR PERMEABLE PAVEMENT AND RAIN GARDEN".
4. WHERE INSITU SOILS ARE NOT CONDUCIVE TO INFILTRATION OF DESIGN STORM VOLUME WITHIN 72 HOURS, UNDERDRAIN SHOULD BE CONSIDERED THROUGH COORDINATION WITH COUNTY ENGINEER.
5. IMPERMEABLE LINER TO BE USED TO PROMOTE WATER RE-USE, PROTECT NEARBY BUILDING FOUNDATIONS, AND AVOID INFILTRATION AROUND UTILITIES.
6. AGGREGATE DEPTH MAY BE GREATER THAN MINIMUM AS SHOWN IN DESIGN PLANS TO ACHIEVE ADDITIONAL STORMWATER STORAGE.
7. BOTTOM OF PERMEABLE PAVEMENT STRUCTURE SHALL BE AT LEAST 10' ABOVE THE SEASONAL HIGH WATER TABLE OR 2' ABOVE BEDROCK, AS DETERMINED BY GEOTECHNICAL INVESTIGATION.
8. TOP OF PAVEMENT SHOULD BE DESIGNED TO ACHIEVE 1% MINIMUM SLOPE IN ANY DIRECTION.
9. IN AREAS OF TREE PLANTINGS WHICH CALL FOR SAND BASED STRUCTURAL SOIL (SSBS). THE SSBS MAY EXTEND UNDER THE AGGREGATE BASE LAYER OF THE SIDEWALK.
10. CONCRETE EDGE RESTRAINT MIN 4" WIDE AND 7 1/2" DEEP; MORTAR OR POLYMER ADHERED PAVERS TO TOP; ALTERNATIVELY EXTEND EDGE RESTRAINT TO SURFACE.
11. OTHER TYPE OF EDGE RESTRAINTS SUCH AS STEEL OR PLASTIC SHALL BE ALLOWED AS APPROVED BY COUNTY ENGINEER AND BASED ON MANUFACTURER'S RECOMMENDATIONS.
12. JOINT TO HAVE 1/2" MAXIMUM GAP IN ACCORDANCE WITH THE LATEST ADA REQUIREMENTS AND TO BE FILLED WITH AASHTO#8 OR APPROVED EQUIVALENT. MINIMUM GAP SHALL BE 1/4"OR PER MANUFACTURER'S RECOMMENDATIONS FOR PERMEABLE CONCRETE PAVERS.

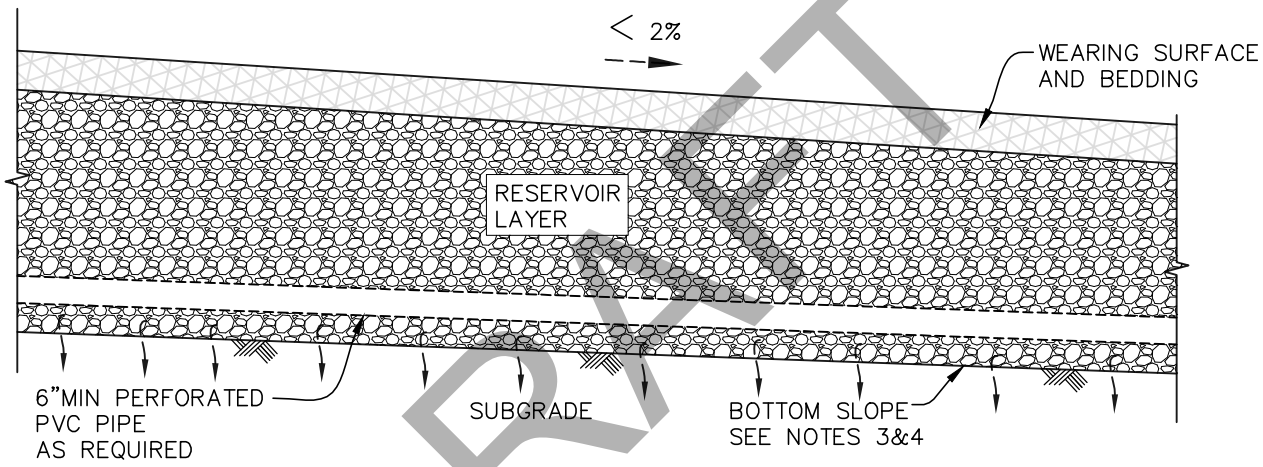
DRAFT

DRAWING NOT TO SCALE

DRAWN BY:____ CHECKED BY:____	SAN DIEGO COUNTY DESIGN STANDARD	REVISIONS	APPROVED	DATE
RECOMMENDED BY: JEFF S. MOODY, P.E.				
APPROVED BY COUNTY ENGINEER	**PERMEABLE PAVERS (SIDEWALK)**			
_____ DATE: _____ DEYLAMIAN SIROUS, P.E. R.C.E. NO. 53192, EXP 6/30/2017		DRAWING NUMBER **GS-5.3b**		



TERRACED SLOPE
LONGITUDINAL SLOPE > 2%



TERRACED SLOPE
LONGITUDINAL SLOPE < 2%

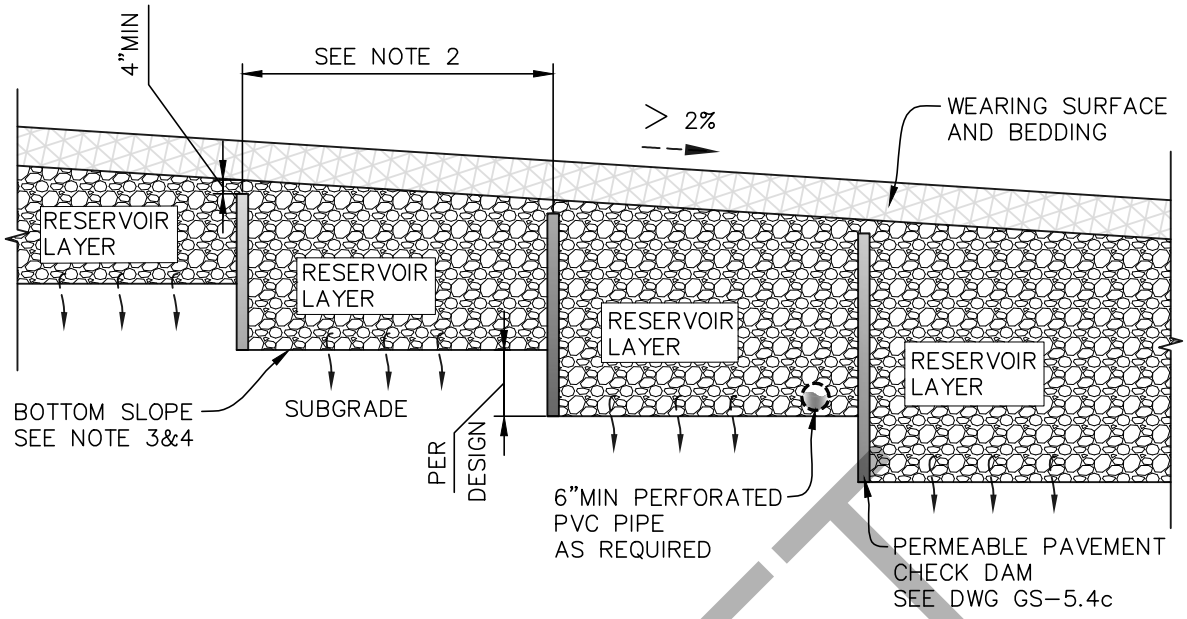
DRAFT

NOTES:

1. CHECK DAMS TO BE USED FOR INSTALLATION WITH BOTTOM SLOPES GREATER THAN 2% LONGITUDINAL. OR AS DIRECTED BY THE CONTRACT DOCUMENTS.
2. DISTANCE BETWEEN STEPS IS DETERMINED BY THE SLOPE OF THE PAVEMENT TO ACHIEVE A STEP NO MORE THAN 12" TALL.
3. BOTTOM SLOPE=0% TO 5% BUT NOT STEEPER THAN TOP SLOPE, PER DESIGN PLANS. ENGINEER TO DESIGN SYSTEM TO ACHIEVE STORAGE, DRAW-DOWN, AND STRUCTURAL REQUIREMENTS. BOTTOM SLOPE DOES NOT HAVE TO BE PARALLEL TO TOP SLOPE.
4. FOR FACILITIES WITH IMPERMEABLE LINER, MINIMUM BOTTOM SLOPE SHALL BE 2% TO DRAIN DRY.
5. TRANSVERSE BOTTOM SLOPES AND CROSS SLOPES SHALL BE LESS THAN 3%.

DRAWING NOT TO SCALE

DRAWN BY:____ CHECKED BY:____	SAN DIEGO COUNTY DESIGN STANDARD	REVISIONS	APPROVED	DATE
RECOMMENDED BY: JEFF S. MOODY, P.E.				
APPROVED BY COUNTY ENGINEER	**PERMEABLE PAVEMENTS**			
_____ DATE: _____				
DEYLAMIAN SIROUS, P.E. R.C.E. NO. 53192, EXP 6/30/2017	**ELEVATION - 1**	DRAWING NUMBER	**GS-5.4a**	



LONGITUDINAL SLOPE > 2%

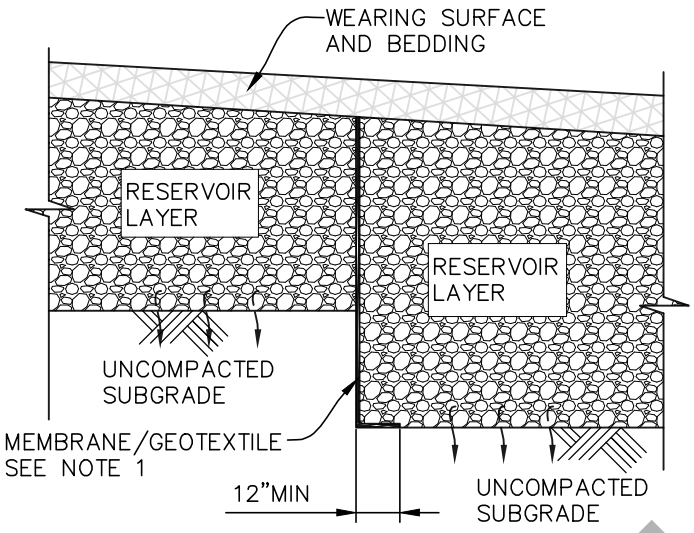
DRAFT

NOTES:

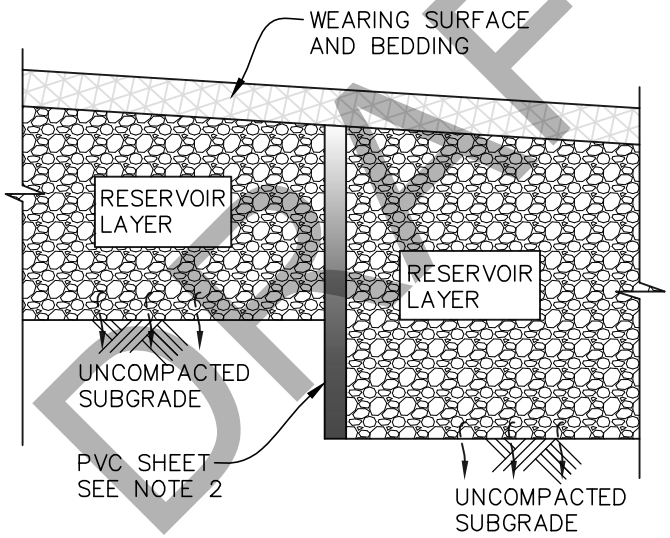
1. CHECK DAMS TO BE USED FOR INSTALLATION WITH BOTTOM SLOPES GREATER THAN 2% LONGITUDINAL, OR AS DIRECTED BY THE CONTRACT DOCUMENTS.
2. DISTANCE BETWEEN STEPS IS DETERMINED BY THE SLOPE OF THE PAVEMENT TO ACHIEVE A STEP NO MORE THAN 12" TALL.
3. BOTTOM SLOPE = 0% TO 5% BUT NOT STEEPER THAN TOP SLOPE, PER DESIGN PLANS. ENGINEER TO DESIGN SYSTEM TO ACHIEVE STORAGE, DRAW-DOWN, AND STRUCTURAL REQUIREMENTS. BOTTOM SLOPE DOES NOT HAVE TO BE PARALLEL TO TOP SLOPE.
4. FOR FACILITIES WITH WATERPROOF MEMBRANE, MINIMUM BOTTOM SLOPE SHALL BE 2% TO DRAIN DRY.
5. TRANSVERSE BOTTOM SLOPES AND CROSS SLOPES SHALL BE LESS THAN 3%.

DRAWING NOT TO SCALE

DRAWN BY:____ CHECKED BY:____	SAN DIEGO COUNTY DESIGN STANDARD	REVISIONS	APPROVED	DATE
RECOMMENDED BY: JEFF S. MOODY, P.E.				
APPROVED BY COUNTY ENGINEER	**PERMEABLE PAVEMENTS**			
_____ DATE: _____				
DEYLAMIAN SIROUS, P.E. R.C.E. NO. 53192, EXP 6/30/2017	**ELEVATION – 2**	DRAWING NUMBER	**GS-5.4b**	



MEMBRANE/GEOTEXTILE CHECK DAM



PVC SHEET CHECK DAM

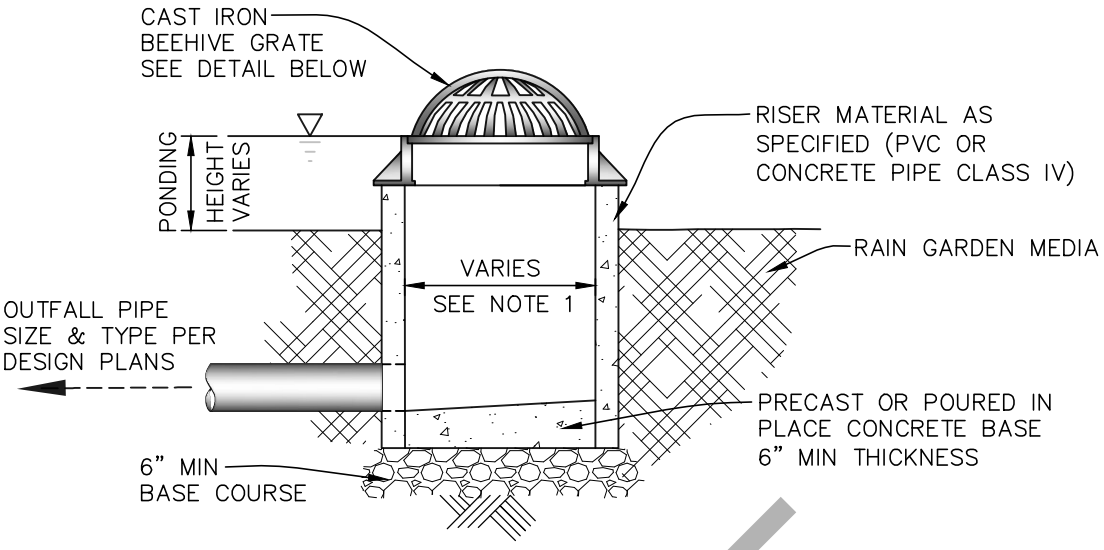
DRAFT

NOTES:

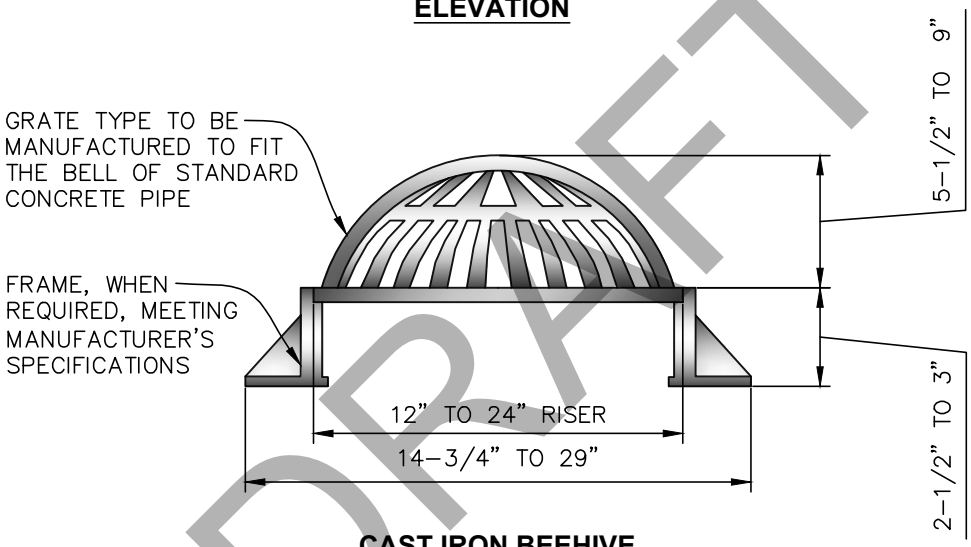
1. IMPERMEABLE LINER OR LOW PERMEABILITY GEOTEXTILE (PERMITTIVITY OF 0.05 SEC OR LESS).
2. SHEET TO BE 3/8" PVC SHEET TYPE I, GRAY.

DRAWING NOT TO SCALE

DRAWN BY:____ CHECKED BY:____	SAN DIEGO COUNTY DESIGN STANDARD	REVISIONS	APPROVED	DATE
RECOMMENDED BY: JEFF S. MOODY, P.E.				
APPROVED BY COUNTY ENGINEER	PERMEABLE PAVEMENT CHECK DAMS			
_____ DATE: _____ DEYLAMIAN SIROUS, P.E. R.C.E. NO. 53192, EXP 6/30/2017		DRAWING NUMBER	GS-5.4c	



ELEVATION



CAST IRON BEEHIVE GRATE DETAIL

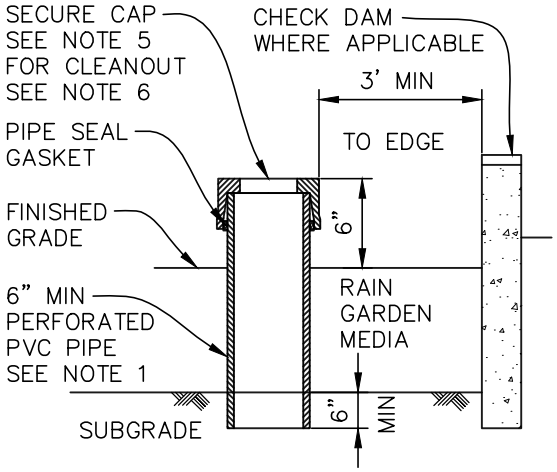
DRAFT

NOTES:

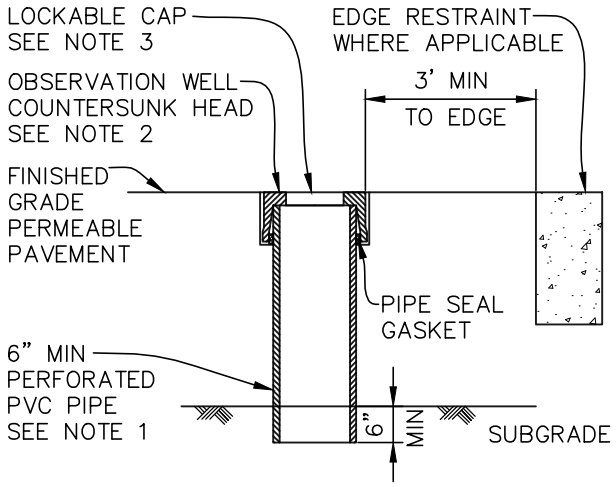
1. MINIMUM OPENING SIZE IN GRATE SHALL BE 1–1/4".
2. SIZE OF GRATE SHALL MATCH SIZE OF THE RISER, PER PLANS, SHALL FIT SNUG, AND SHALL BE REMOVABLE FOR MAINTENANCE PURPOSES.
3. ALTERNATIVE MATERIAL TO CAST IRON SHALL BE ALLOWED AS APPROVED BY COUNTY ENGINEER.

DRAWING NOT TO SCALE

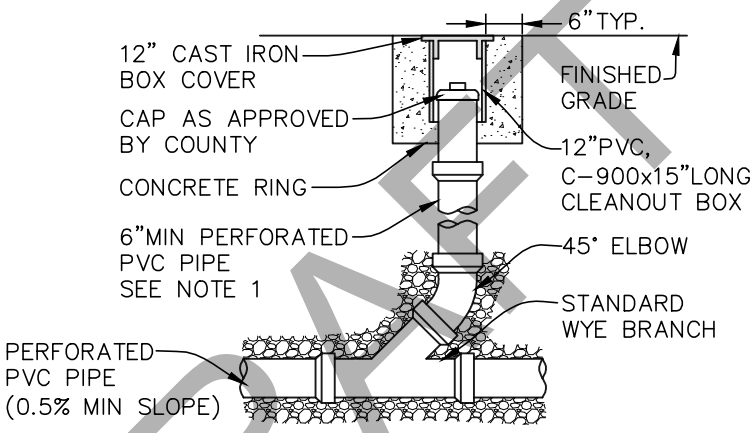
DRAWN BY:____ CHECKED BY:____	SAN DIEGO COUNTY DESIGN STANDARD	REVISIONS	APPROVED	DATE
RECOMMENDED BY: JEFF S. MOODY, P.E.				
APPROVED BY COUNTY ENGINEER	**OVERFLOW RISER WITH BEEHIVE GRATE**			
_____ DATE: _____ DEYLAMIAN SIROUS, P.E. R.C.E. NO. 53192, EXP 6/30/2017		DRAWING NUMBER	**GS-6.1**	



IN RAIN GARDEN



IN PERMEABLE PAVEMENT



CLEANOUT IN PERMEABLE PAVEMENT

(SEE NOTE 6)

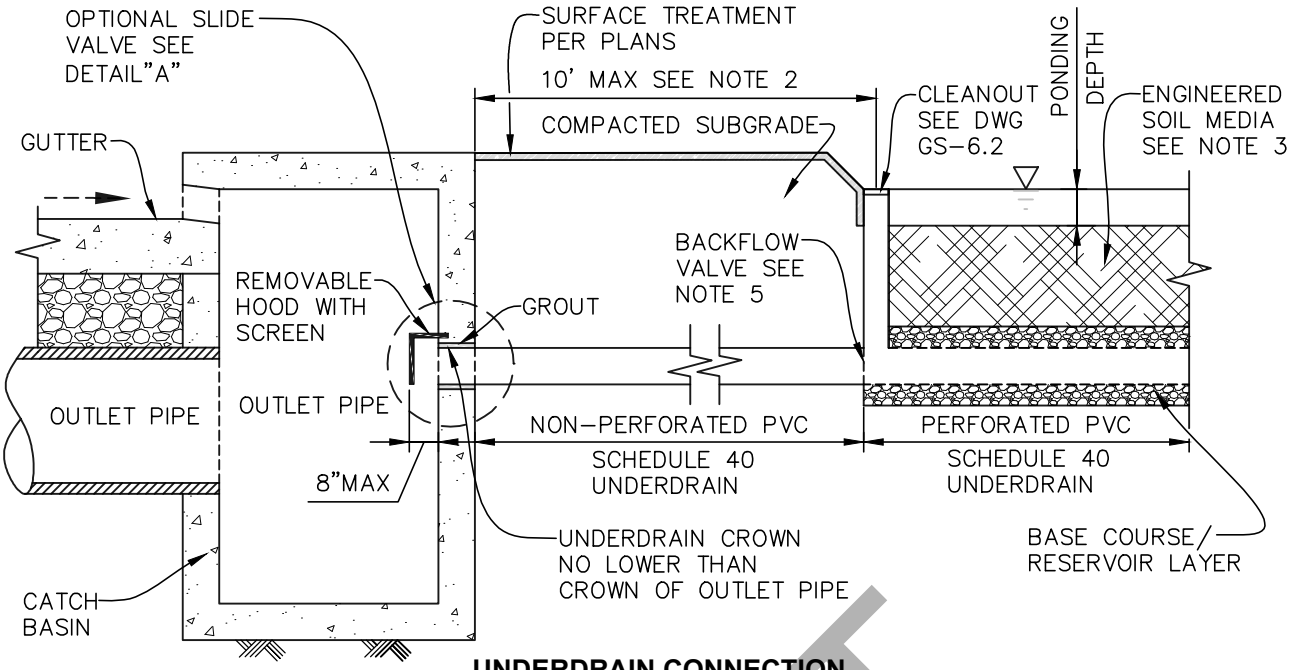
DRAFT

NOTES:

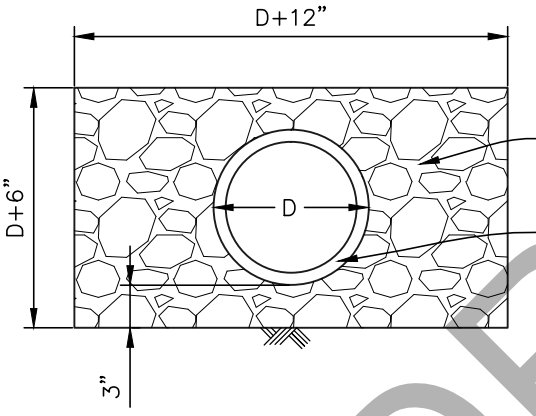
1. PROVIDE A TUBE MADE OF NON-CORROSIVE MATERIAL, SCHEDULE 40 PVC OR EQUAL, AT LEAST 3 FEET LONG WITH AN INSIDE DIAMETER OF 6" MINIMUM. PERFORATED PIPE IS REQUIRED FOR ALL OBSERVATION WELLS, OR CLEANOUTS USED AS OBSERVATION WELLS.
2. FACTORY ATTACHED BRASS OR HIGH IMPACT PLASTIC HEAD WITH RIBS TO PREVENT ROTATION WHEN REMOVING LOCKABLE CAP.
3. LOCKABLE CAP SHALL BE BRASS AND RATED FOR HS-20 LOADING IN VEHICULAR AREAS, MOUNTED FLUSH TO GRADE. LOCKABLE CAP MAY BE HIGH IMPACT PLASTIC THAT IS UV STABLE IN NON-VEHICULAR LOADING AREA, AT LEAST 6 INCHES ABOVE GRADE.
4. IN FACILITIES SUBJECT TO VEHICULAR TRAFFIC, CONCRETE APRONS AROUND CLEANOUTS ARE AN OPTION, AS SHOWN IN DESIGN PLANS.
5. CAP ON RISERS IN RAIN GARDEN FACILITY SHALL BE PVC SCREW IN PLUG.
6. FOR CLEANOUT IN RAIN GARDEN (NOT SHOWN), USE SIMILAR DETAIL, BUT USE PVC SCREW CAP SET 6" ABOVE FINISHED GRADE.

DRAWING NOT TO SCALE

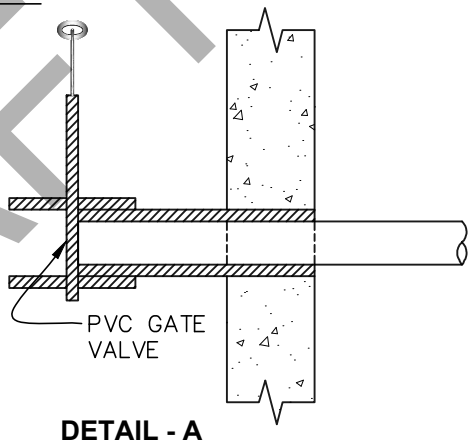
DRAWN BY:____ CHECKED BY:____	SAN DIEGO COUNTY DESIGN STANDARD	REVISIONS	APPROVED	DATE
RECOMMENDED BY: JEFF S. MOODY, P.E.				
APPROVED BY COUNTY ENGINEER	**STORMWATER FACILITY CLEANOUT/OBSERVATION WELL**			
DATE: ____				
DEYLAMIAN SIROUS, P.E. R.C.E. NO. 53192, EXP 6/30/2017		DRAWING NUMBER	**GS-6.2**	



UNDERDRAIN CONNECTION TO CATCH BASINS



UNDERDRAIN AND BEDDING SECTION



DETAIL - A OPTIONAL SLIDE VALVE

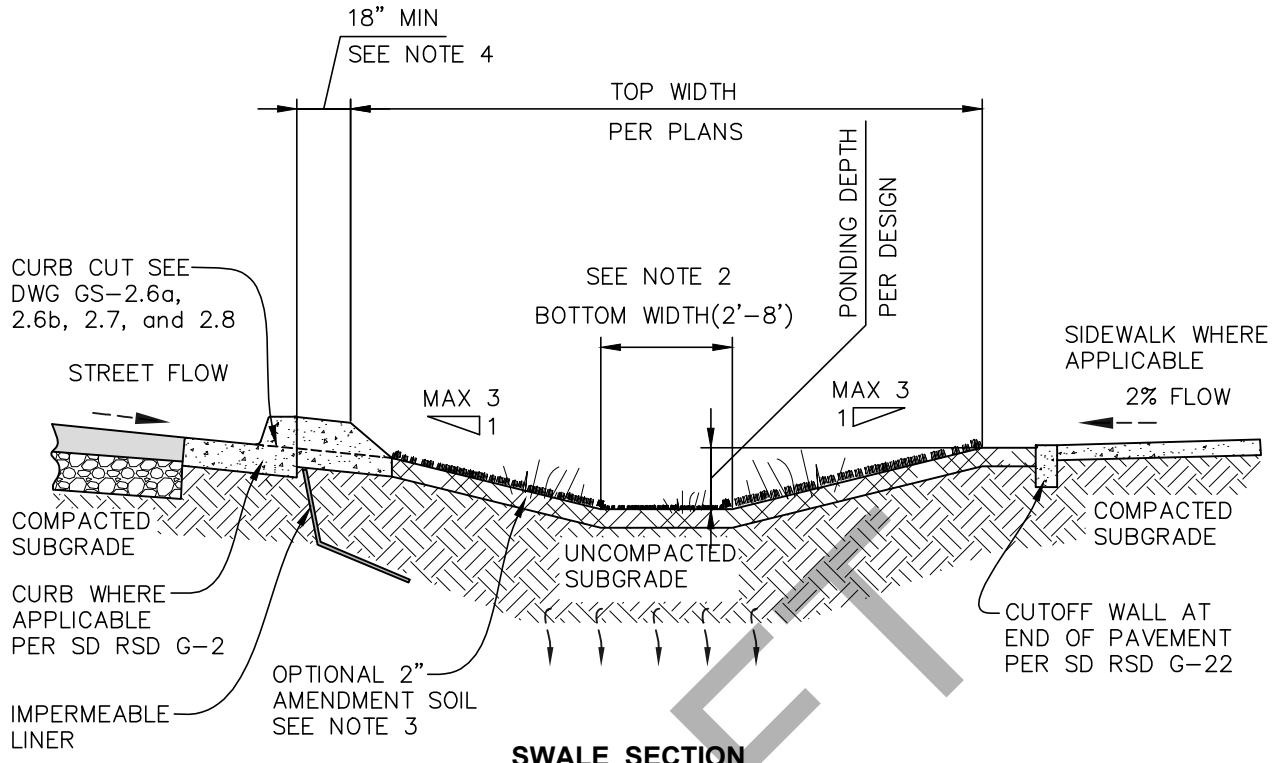
DRAFT

NOTES:

1. CATCH BASIN CONNECTIONS FROM UNDERDRAINS SERVICING PRIVATE PROPERTY ARE PROHIBITED.
2. WHEN STORMWATER FACILITY IS LOCATED > 10' FROM CATCH BASIN, PROVIDE ADDITIONAL CLEANOUT OUTSIDE OF STORMWATER FACILITY WITHIN 10' OF CATCH BASIN.
3. STORMWATER FACILITY DEPICTED IS RAIN GARDEN PRACTICE. CONNECTIONS TO CATCH BASIN WILL ALSO APPLY TO PERMEABLE PAVEMENTS AND SWALES WITH UNDERDRAINS.
4. OPTIONAL PVC GATE VALVE TO BE USED TO REGULATE FLOW IN UNDERDRAIN PIPE AS INDICATED IN PLANS. VALVE MAY ALSO BE USED IN OVERFLOW RISER AS DIRECTED.
5. PVC PIPE SLOPE SHALL BE PER PLAN.

DRAWING NOT TO SCALE

DRAWN BY:____ CHECKED BY:____	SAN DIEGO COUNTY DESIGN STANDARD	REVISIONS	APPROVED	DATE
RECOMMENDED BY: JEFF S. MOODY, P.E.				
APPROVED BY COUNTY ENGINEER	**STORMWATER FACILITY UNDERDRAIN BEDDING & CATCH BASIN CONNECTION**			
DATE: ____ DEYLAMIAN SIROUS, P.E. R.C.E. NO. 53192, EXP 6/30/2017		DRAWING NUMBER	**GS-6.3**	



SWALE SECTION

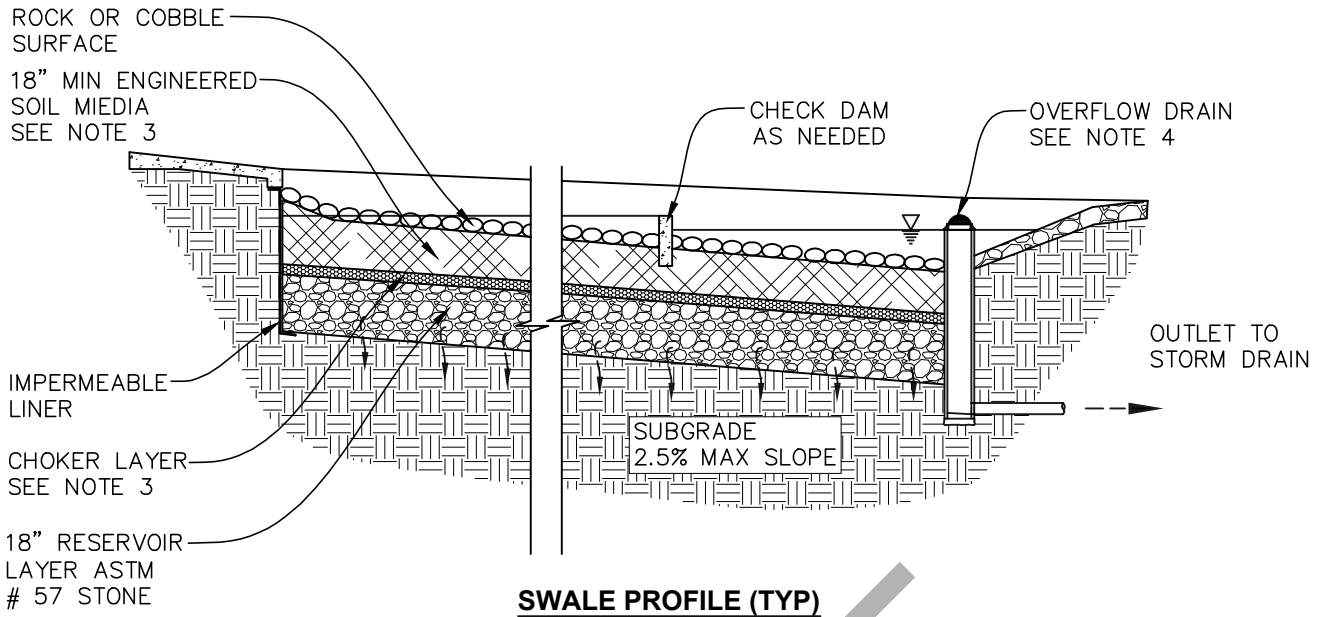
DRAFT

NOTES:

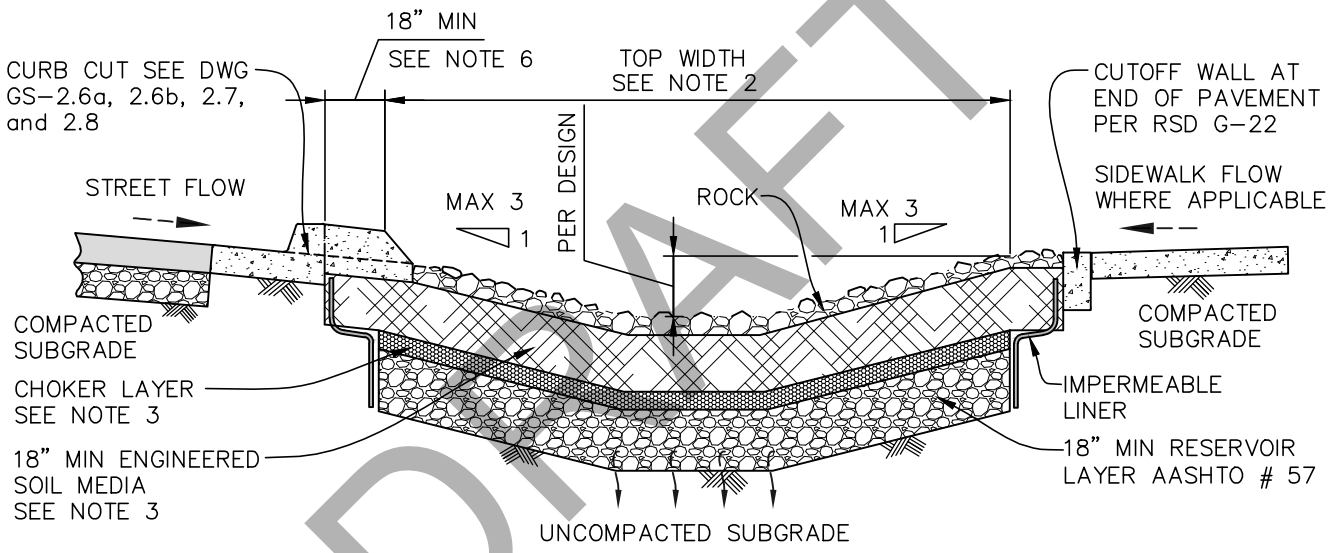
1. PROVIDE PROTECTION FROM ALL VEHICLE TRAFFIC, EQUIPMENT STAGING, AND FOOT TRAFFIC IN PROPOSED INFILTRATION AREAS PRIOR TO, DURING, AND AFTER CONSTRUCTION.
2. DIMENSIONS:
   a. BOTTOM WIDTH: IF WIDER THAN 8', CHANNEL DIVIDERS MAY BE NECESSARY TO PREVENT MEANDERING AND LOW FLOW CHANNEL FORMATION.
   b. FLOW DEPTH: WATER QUALITY DESIGN FLOW DEPTH NOT TO EXCEED TWO THIRDS THE HEIGHT OF THE VEGETATION FOR OPTIMUM WATER QUALITY TREATMENT.
   c. LONGITUDINAL SLOPE: 1% TO 6% OVERALL SLOPE. SLOPES GREATER THAN 2.5% SHOULD INCORPORATE 6"–18" CHECK DAM TO MAINTAIN 2.5% MAX LONGITUDINAL INVERT SLOPE. MAXIMUM FLOW VELOCITY SHALL MEET REQUIREMENTS OF COUNTY HYDRAULIC DESIGN MANUAL.
3. OPTIONAL 2" SOIL AMENDMENT PER SWALE SOIL SPECIFICATION; MIX THE AMENDMENT INTO NATIVE SOILS TO A DEPTH OF 6" TO PREVENT SOIL LAYERING.
4. 18" MINIMUM CONCRETE STEP OUT REQUIRED WHEN PARKING IS ADJACENT TO CURB.

DRAWING NOT TO SCALE

DRAWN BY:____ CHECKED BY:____	SAN DIEGO COUNTY DESIGN STANDARD	REVISIONS	APPROVED	DATE
RECOMMENDED BY: JEFF S. MOODY, P.E.				
APPROVED BY COUNTY ENGINEER	**GREEN STREET VEGETATED SWALE WITH CURB**			
_____ DATE: _____ DEYLAMIAN SIROUS, P.E. R.C.E. NO. 53192, EXP 6/30/2017		DRAWING NUMBER	**GS-7.1**	



SWALE PROFILE (TYP)



SWALE SECTION (TYP)

DRAFT

NOTES:

1. PROVIDE PROTECTION FROM ALL VEHICLE TRAFFIC, EQUIPMENT STAGING, AND FOOT TRAFFIC IN PROPOSED SWALE AREAS PRIOR TO, DURING, AND AFTER CONSTRUCTION.

2. DIMENSIONS:
   a. WIDTH 4' MINIMUM.
   b. DEPTH FROM TOP OF GROWING MEDIUM TO OVERFLOW ELEVATION; SIMPLIFIED: 6"–18".
   c. LONGITUDINAL SLOPE OF SWALE: 2.5% MAX.

3. MATERIALS
   a. ENGINEERED SOIL MEDIA: 65% SAND, 20% SANDY LOAM, 15% COMPOST (OR PER SPECIFICATIONS).
   b. CHOKER LAYER: 2"–4" WASHED SAND OVER 2" CHOKING STONE.

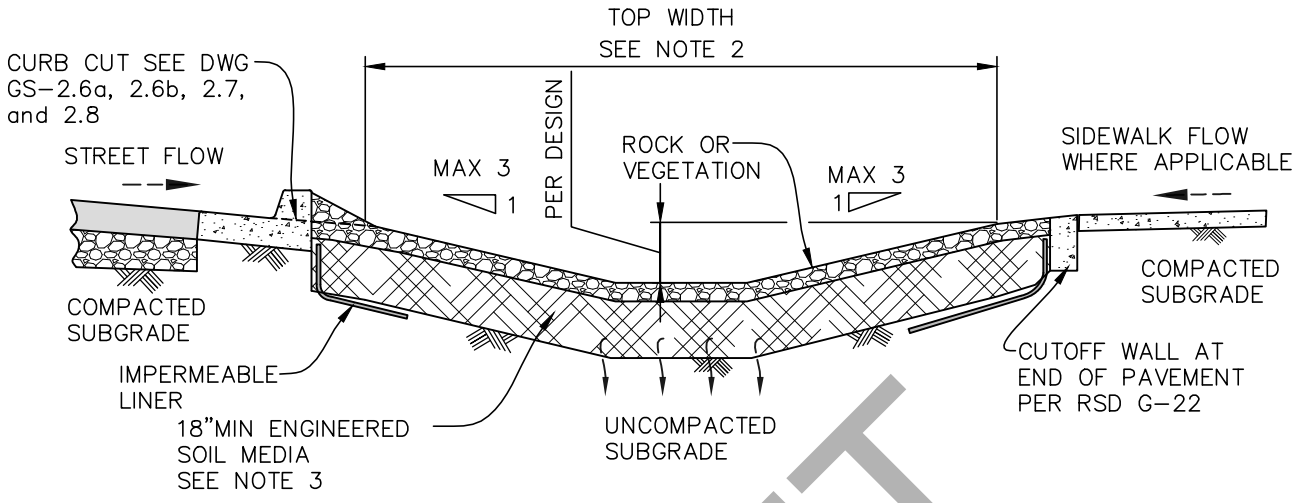
4. OVERFLOW:
   a. ALLOW FOR 2" OF FREEBOARD, MINIMUM.
   b. PROTECT FROM DEBRIS AND SEDIMENT WITH STRAINER OR GRATE.

5. BOTTOM OF SWALE SHALL BE AT LEAST 10' ABOVE THE SEASONAL HIGH WATER TABLE OR 2' ABOVE BEDROCK, AS DETERMINED BY GEOTECHNICAL INVESTIGATION.

6. 18" MINIMUM CONCRETE STEP OUT ZONE REQUIRED WHEN PARKING IS ADJACENT TO CURB.

DRAWING NOT TO SCALE

DRAWN BY:____	CHECKED BY:____	SAN DIEGO COUNTY DESIGN STANDARD	REVISIONS	APPROVED	DATE
RECOMMENDED BY: JEFF S. MOODY, P.E.					
APPROVED BY COUNTY ENGINEER _____ DATE: _____ DEYLAMIAN SIROUS, P.E. R.C.E. NO. 53192, EXP 6/30/2017		**ROCK INFILTRATION SWALE**	DRAWING NUMBER	**GS-7.2**	



BASIN SECTION

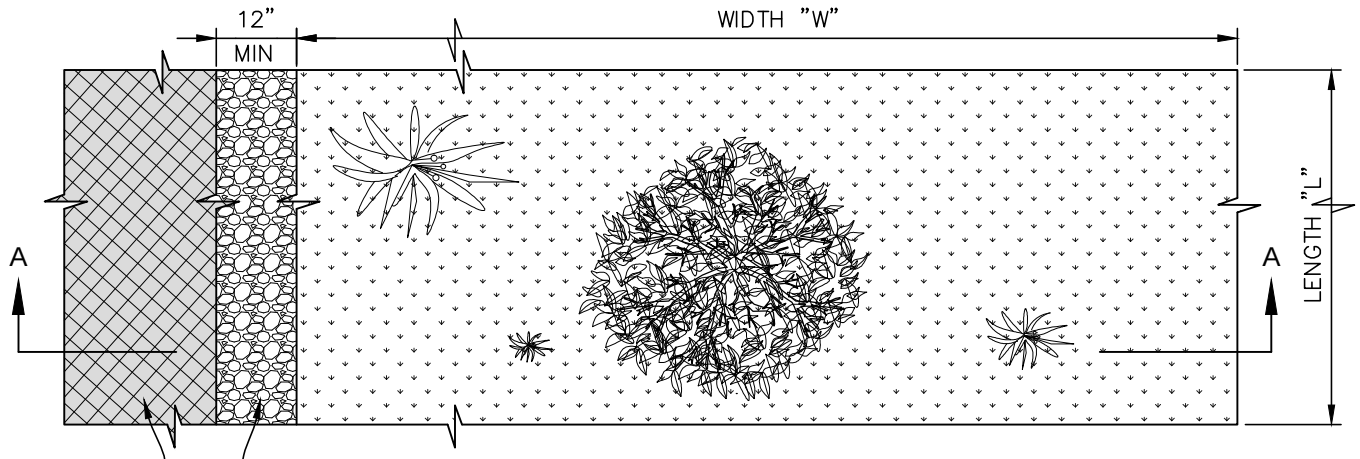
DRAFT

NOTES:

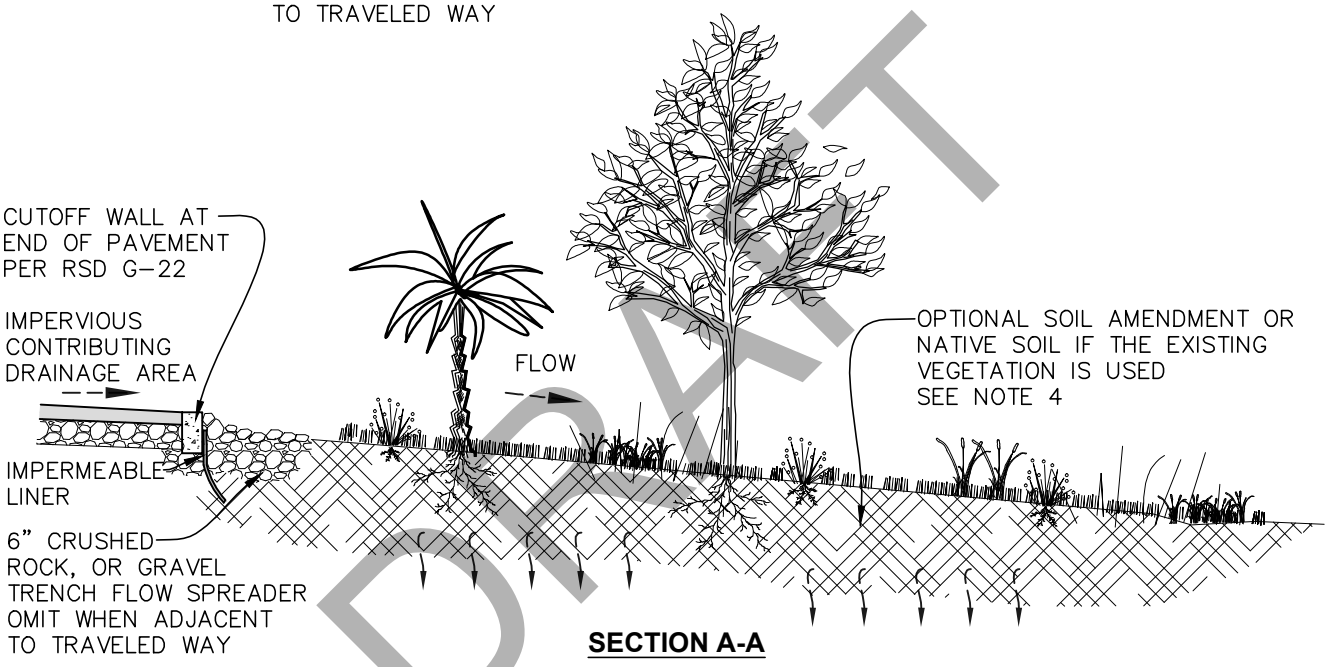
1. PROVIDE PROTECTION FROM ALL VEHICLE TRAFFIC, EQUIPMENT STAGING, AND FOOT TRAFFIC IN PROPOSED BASIN AREAS PRIOR TO, DURING, AND AFTER CONSTRUCTION.
2. DIMENSIONS:
   a. WIDTH 4' MINIMUM.
   b. DEPTH (FROM TOP OF GROWING MEDIUM TO OVERFLOW ELEVATION) 6"–18".
   c. LONGITUDINAL SLOPE OF BASIN: FLAT
3. MATERIALS OF ENGINEERED SOIL MEDIA: 65% SAND, 20% SANDY LOAM, AND 15% COMPOST, OR PER SPECIFICATION
4. OVERFLOW:
   a. ALLOW FOR 2" OF FREE BOARD, MINIMUM.
   b. PROTECT FROM DEBRIS AND SEDIMENT WITH STRAINER OR GRATE.
5. BOTTOM OF BASIN SHALL BE AT LEAST 10' ABOVE THE SEASONAL HIGH WATER TABLE OR 2' ABOVE BEDROCK, AS DETERMINED BY GEOTECHNICAL INVESTIGATION.

DRAWING NOT TO SCALE

DRAWN BY:____	CHECKED BY:____	SAN DIEGO COUNTY DESIGN STANDARD	REVISIONS	APPROVED	DATE
RECOMMENDED BY: JEFF S. MOODY, P.E.					
APPROVED BY COUNTY ENGINEER		**RAIN GARDEN/ROCK GARDEN INFILTRATION**			
_____ DATE: _____					
DEYLAMIAN SIROUS, P.E. R.C.E. NO. 53192, EXP 6/30/2017			DRAWING NUMBER	**GS-7.3**	



PLAN VIEW



SECTION A-A

DRAFT

NOTES:

1. PROVIDE PROTECTION FROM ALL VEHICLE TRAFFIC, EQUIPMENT STAGING, AND FOOT TRAFFIC IN PROPOSED INFILTRATION AREAS PRIOR TO, DURING, AND AFTER CONSTRUCTION.

2. DIMENSIONS:
   a. WIDTH: 15' MIN (SHOULD ALLOW FOR 10 MINUTES HYDRAULIC RESIDENCE TIME).
   b. SLOPES: 5% MAXIMUM.
   c. FLOW DEPTH: 1" MAXIMUM.

3. VEGETATION COVER MAINTAINED AT HEIGHT OF 4" MINIMUM.

4. OPTIONAL 2" SOIL AMENDMENT PER PROJECT SOIL SPECIFICATIONS. MIX THE AMENDMENT INTO NATIVE SOIL TO A DEPTH OF 6" TO PREVENT SOIL LAYERING.

DRAWING NOT TO SCALE

DRAWN BY:____	CHECKED BY:____	SAN DIEGO COUNTY DESIGN STANDARD	REVISIONS	APPROVED	DATE
RECOMMENDED BY: JEFF S. MOODY, P.E.					
APPROVED BY COUNTY ENGINEER		VEGETATED FILTER STRIP			
_____ DATE: _____					
DEYLAMIAN SIROUS, P.E. R.C.E. NO. 53192, EXP 6/30/2017			DRAWING NUMBER	GS-7.4	

K.5 Green Streets Maintenance Schedule

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Green Streets
Maintenance Schedule



County of San Diego
Department of Public Works

January 2016

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Rain Gardens and Rock Gardens 3

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Section 1 Introduction

The following maintenance schedule provides the maintenance tasks, frequency, and time of year for initial, routine, and as-needed maintenance for the following Green Streets facilities:

- Tree Wells,
- Rain Gardens,
- Rock Gardens, and
- Permeable Pavement.

This schedule should be used as a guideline for preparing a project specific maintenance schedule.

Section 2 Maintenance Schedule

Tree Wells			
When	**Maintenance Task**	**Frequency**	**Time of the Year**
Initial maintenance during establishment period (First three years)	Inspect tree for health and establishment and report any changes to County	Three times during establishment; Every five years for life of tree	Spring 1st Season Fall 1st Season Fall 2nd Season
	Remove stakes and wires.	One time	One year after planting
	Water tree – first year	25 gallons Weekly via slow release device	April-October
	Water tree – second & third year	25 gallons Bi-Monthly via slow release device	April-October
Routine Maintenance	Remove weeds and trash	Quarterly inspection at minimum and maintenance as needed.	March-November
	Remove sediment and trash from any inlets and slot drains	Annually or as needed.	
As-Needed Maintenance	Mulch with 3 inches double ground shredded hardwood mulch. Place mulch in a ring to capture rain water. Mulch shall not be mounded around tree.	Annually or as needed.	Feb-April
	Inspect tree for damage, disease, or interference with utilities. Contact County if pruning is required.	Annually or as needed.	Broken branches should be pruned at any time. Most trees should be pruned in the winter or fall.

Rain Gardens and Rock Gardens

When	Maintenance Task	Frequency	Time of the Year
Initial maintenance during establishment period (First three years)	Within 6 months following construction, the practice and drainage area should be inspected after storm events.	Twice after installation	Following storm events
	Remove stakes, wires, and tags on any new trees.	One time	One year after planting
	Water plants if applicable - initial three years	Weekly during first 2-3 months after installation, and when rainfall is less than 1 inch per week	April-October
Routine Inspection	• Conduct maintenance inspections • Check curb cuts and inlets for accumulated grit, leaves, and debris that may block inflow • Identify maintenance tasks needed • Look for erosion, bare areas, and where mulch, if applicable, needs to be applied	Quarterly inspection at minimum and maintain as needed.	
Routine Maintenance	• Spot weed • Adjust mulch, if applicable, as needed to ensure full cover • Remove trash and animal waste • Remove any dead or diseased plants • Remove sediment in pretreatment cells and inflow points • Mow filter strips with turf cover	Quarterly inspection at minimum and maintain as needed.	
	Mulch as needed to replace 3" surface cover	Annually or as needed.	February - April
As-Needed Maintenance	Prune trees and shrubs as needed to keep inlets and outlets clear.	As-needed	Feb-April and Sep - Nov as Appropriate

When	Maintenance Task	Frequency	Time of the Year
	Water plants, if applicable, after three years	Weekly during droughts (more than 2 weeks of no rain)	April-October
	• Remove invasive plants using recommended control methods • Add planting to maintain desired vegetation density, if applicable • Blow-off cleanouts using compressed air, high pressure water hose, or drain snake in practices that show evidence of clogged underdrain • Stabilize the surrounding drainage area to prevent erosion. • Repair or replace cracked pipes or planter box if cracks are greater than 1" • Secure or repair the liner, if applicable, if loose or damaged • If scouring is occurring at inlets, add splash pads or rock protection • Adjust the overflow structure if less than 6" above soil surface or 2" below waterproof liner/top of facility	As needed following inspection	• At appropriate time for disease or pest treatment. • October-April
	Replace drain rock surface material, if applicable, if water ponds at surface during storm events or operates at less than 90% of the design infiltration rate.	As needed following inspection	
	Remove and replace the mulch layer, if applicable	Once every 3 years	February-April

Permeable Interlocking Concrete Pavers

When	Maintenance Task	Frequency	Time of Year
Initial maintenance during establishment period (First year)	In the first year following construction, inspect the practice and contributing drainage area twice within 24 hours after storm events. Conduct any needed repairs or stabilization.	Twice after Installation	Within 24 hours after storm events
Routine Inspection	Conduct a maintenance inspection	Annually or as needed.	
Routine Maintenance	Mechanically sweep pavement to remove sediment using: - Conventional broom sweeper (acceptable for removing crust when joints/apertures are accessible to brushes) - Regenerative air sweeper (better option for maintaining permeable pavements) - Pure vacuum machines (best for restoration if clogged)	4 times per year in potential high sediment load areas, 2 times per year otherwise	Fall
	Remove any accumulated sediment in pretreatment cells and inflow points if applicable	Annually or as needed.	April -October
	Spot weed.		
As-Needed Maintenance	Stabilize contributing drainage area within public land to prevent siltation of pavement	As needed following annual inspection	

When	Maintenance Task	Frequency	Time of Year
	Maintain planted areas adjacent to pavement. Remove any soil or sediment deposited on pavement. Replace or repair any paver surfaces that are damaged that may compromise structural integrity of the surface. Repair ruts or deformations exceeding 0.5".		
	Blow-out cleanouts using compressed air, high pressure water hose, or drain snake in practices that show evidence of clogged underdrain.	If clogged	
	Conduct maintenance using a vacuum machine.		
	Replace any necessary joint filler material	As needed.	

Permeable Concrete Pavement

When	Maintenance Task	Frequency	Time of Year
Initial maintenance during establishment period (First year)	In the first year following construction, inspect the practice and contributing drainage area twice within 24 hours after storm events. Conduct any needed repairs or stabilization.	Twice after Installation	Within 24 hours after storm events
Routine Inspection	Conduct a maintenance inspection	Annually or as needed.	
Routine Maintenance	Mechanically sweep pavement with a vacuum sweeper or regenerative street sweeper to remove sediment	4 times per year in potential high sediment load areas, 2 times per year otherwise	
	Remove any accumulated sediment in pretreatment cells and inflow points if applicable	Annually or as needed.	Fall
	Spot weed for vegetation growth in pavement.	Annually or as needed.	April -October
As-Needed Maintenance	Stabilize contributing drainage area within public land to prevent siltation of pavement	As needed following annual inspection	
	Maintain planted areas adjacent to pavement. Remove any soil or sediment deposited on pavement.		

When	Maintenance Task	Frequency	Time of Year
	Replace or repair any pavement surfaces that are degenerating. For damaged areas of less than 50 square feet, a declivity could be patched by any means suitable with standard pavement, with the loss of porosity of that area being insignificant. The declivity can also be filled with porous mix. If an area greater than 50 SF is in need of repair, approval of patch type must be sought from either the engineer or owner.		
	Blow-out cleanouts using compressed air, high pressure water hose, or drain snake in practices that show evidence of clogged underdrain.	If clogged	
	Conduct maintenance using a regenerative street sweeper, or power washing (<500 psi, at an angle 30 or less).		

Permeable Asphalt Concrete Pavement

When	Maintenance Task	Frequency	Time of Year
Initial maintenance during establishment period (First year)	In the first year following construction, inspect the practice and contributing drainage area twice within 24 hours after storm events. Conduct any needed repairs or stabilization.	Twice after Installation	Within 24 hours after storm events
Routine Inspection	Conduct a maintenance inspection	Annually or as needed.	
Routine Maintenance	Mechanically sweep pavement with a vacuum sweeper or regenerative street sweeper to remove sediment	4 times per year in potential high sediment load areas, 2 times per year otherwise	
	Remove any accumulated sediment in pretreatment cells and inflow points if applicable	Annually or as needed.	Fall
	Spot weed for vegetation growth in pavement.	Annually or as needed.	April -October

When	Maintenance Task	Frequency	Time of Year
As-Needed Maintenance	Stabilize contributing drainage area within public land to prevent siltation of pavement	As needed following annual inspection	
	Maintain planted areas adjacent to pavement. Remove any soil or sediment deposited on pavement.		
	Replace or repair any pavement surfaces that are degenerating. For damaged areas of less than 50 square feet, a declivity could be patched by any means suitable with standard pavement, with the loss of porosity of that area being insignificant. The declivity can also be filled with porous mix. If an area greater than 50 SF is in need of repair, approval of patch type must be sought from either the engineer or owner.		
	Blow-out cleanouts using compressed air, high pressure water hose, or drain snake in practices that show evidence of clogged underdrain.	If clogged	
	Conduct maintenance using a regenerative street sweeper, or power washing (<500 psi, at an angle 30 or less).		
	Sealing is a common maintenance practice with conventional asphalt. Pervious asphalt must not be sealed or it will lose its pervious function. Owners should take extra care not to seal pervious asphalt pavement. If porous pavement is sealed, additional stormwater treatment may be required.		

K.6 Green Streets Specifications

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Green Streets
Specifications

County of San Diego
Department of Public Works

January 2016

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AGGREGATES FOR GREEN STREETS FACILITIES

(A) DESCRIPTION

This item shall consist of constructing base courses for permeable pavements and rain garden facilities to the specified depths on a prepared foundation conforming to the lines, grades and cross sections shown in the contract documents. Base courses may include reservoir layer, storage layer, choker layer, filter layer, and other layers included in the Contract Documents. Except as herein stated, the requirements for control of materials, submittals, sampling, and testing items specified in Green Book Standard Specification section 4 “Control of Materials” not described in sections below, are applicable to this specification.

(B) SUBMITTALS

Source Approval: Submit documentation of materials to the County as directed by the County Engineer prior to construction as follows:

1. Material Source -Certificate
2. Cleanliness – Certification that stone is double-washed per this provision.
3. Properties -Certified Test Results for:
    a) Gradation
    b) Smoothness
    c) Percentage of Wear
4. Sample: Prior to production and delivery of aggregates, take at least one (1) initial sample in accordance with ASTM D75. Collect each sample by taking three (3) incremental samples at random locations from source material to make a composite sample. See Table 1-1 for minimum sampling requirements. Repeat sampling procedure when source of material is changed or when deficiencies or variations from specified grading of materials are found in testing.

Table 1-1: Minimum Sampling Requirements

MATERIAL	MINIMUM SAMPLE REQUIRED	WORKING DAYS TO OBTAIN VERBAL TEST RESULTS
Admixtures (Portland Cement Concrete)	See 814	
Aggregate, Coarse (PVV & Asphalt)	70 Pounds	5
Aggregate, Fine Bituminous	20 Pounds	5
Blanket	10 Pounds	
Concrete	20 Pounds	
Filter	10 Pounds	
Mortar	10 pounds	
Vertical	10 pounds	
Aggregate, Source (new)	200 pounds	60
Anchor Bolts	1 specimen per lot	6
Asphalt Cement (complete)	Standard 16 oz. can	5
Asphalt Cores	Job Dependent	1
Asphalt, Cut-Back	1 quart	5
Asphalt, Emulsified	4 quarts	5
Asphalt Primer for Waterproofing	1 quart	5
Asphalt Seal Coat for Waterproofing	1 quart	5
Bituminous Mixtures	12 pounds	12
Job Mix Formulas	75 pounds	21
Brick		
Building	10 specimens	12
Sewer	10 specimens	12
Burlap	3 foot length x width of roll	4
Caulking Compound	1 pint	20
Canvas Ceramic Tile	2 square yards	4
Concrete Mix Design	25 specimens	40
Concrete, Wet (Dunagan)	6 cubic feet	50
Dowel Bars	30 pounds	
Electrical Items	3 specimens	6
Expansion Joint Filler	Job Dependent	16
Gravel	3 foot length x width (4- ½ inch min)	
High Tensile Strand (or wire)	70 pounds	
Load Transfer Devices	5 foot length	11
Masonry Cement	1 specimen	6
Membrane (liquid) Curing Compound	10 pounds 1 quarts	16 6

Table 1-1 (continued): Minimum Sampling Requirements

MATERIAL	MINIMUM SAMPLE REQUIRED	WORKING DAYS TO OBTAIN VERBAL TEST RESULTS
Mineral Fiber Paint and Coatings (2)	5 pounds	5
Pipe		
Clay	4-1 quart cans	30
Concrete	2 specimens	6
Polyethylene Sheeting	2 yards x 10 inches	11
Portland Cement	10 pounds	
Preformed Bearing Pads	4 inch x 4 inch	
Prestressed Reinforcement	Per Section 815.02	
Reinforcing Steel		
Bars Nos. 2 through 9	1 specimen 5 feet in length	6
Bars larger than No. 9	1 specimen 7 feet in length	6
Saturated Cotton Fabric	4 foot length x width of roll	6
Sealing Compounds		
Cold Poured, Emulsion	1 quart	16
Cold Poured, Mastic	1 quart	16
Cold Poured, Two-component	1 quart	20
Hot Poured	5 pounds	16
Shear Connector Studs	1 specimen	
Soils		
Gradation LL and PI	20 pounds	5
Gradation and Proctor	100 pounds	6
Top Soil	20 pounds	11
Subgrade Paper	3 foot length x width of roll	6
Tar (Creosote) Primer for Waterproofing	1 quart	6
Tar, Road	1 quart	6
Tar Seal, Coat for Waterproofing	1 quart	6
Tie rod assemblies	3 specimens	6
Waterproof Paper	2 square yards	11
Waterstop, Rubber	2 square feet	11
Waterstop, PVC	2 square feet	30
Weld Wire Fabric	3 feet x 3 feet	6
Miscellaneous Materials and Tests		
Determining Thickness of Metals	Representative sample	6
Determining Unit Weight of Metals	Representative sample	6
Determining Thickness of Galvanizing	Representative sample	6
Identification of Wrought Iron Infa Red Spectrum	Representative sample	2

(C) MATERIALS

1. Coarse aggregate shall be of the types designated in the Contract Documents, and shall consist of clean, tough, durable fragments of crushed stone, or crushed gravel, conforming to the gradations in Table 1-2 and shall also meet the following:
    a) Be double-washed, sufficient to remove dust and other coatings; and
    b) Be free from clay balls, organic matter, and other deleterious substances

2. Reservoir/storage layer for permeable pavements shall also meet the following:

a) Maximum percentage of wear as determined by the Los Angeles Abrasion Test shall not exceed 40, as per AASHTO T 96. The weighted percentage of loss shall not exceed 15 percent by weight when the coarse aggregate is subjected to 5 cycles of the magnesium soundness test per AASHTO T 104.

b) Minimum 75% by mass (weight) of the material coarser than the No. 4 sieve with at least two (2) fractured faces, and 90% shall have one or more fractured faces as determined by ASTM D5821;

c) Have not more than 5% of flat or elongated pieces (>5:1) as specified in ASTM D4791;

d) Material shall have a California bearing ratio (CBR) of at least thirty (30) as determined by laboratory test on a four (4) day soaked sample in accordance with ASTM D1883.

Table 1-2: Gradation for Base Courses

Pavement Reservoir Layer	Choker Layer for Permeable Pavements	Filter Layer	Rain Garden Storage/Drainage Layer
AASHTO No. 2 or No. 3 Stone	AASHTO No. 57 Stone	AASHTO No. 8 Stone	AASHTO No. 57 Stone

Table 1-2B: Stone type Used in Green Street Elements

Layer	Permeable Pavements	Rain Gardens
Reservoir Layer	AASHTO No.2 or No.3	AASHTO No. 57
Choker layer	AASHTO No. 57	See Table 1-3
Filter Layer	AASHTO No. 8	AASHTO No. 8

3. Choker Course for Rain Garden shall be a free-draining sand and gravel borrow shall consist of inert, hard, durable stone and coarse sand, free from loam, clay, mica, surface coatings and deleterious materials and shall conform with the following:

Table 1-3 Gradation of Choker Layer used for Rain Gardens

U.S. Sieve No.	% Passing by Weight	
	Minimum	Maximum
3 inch	100	-
½ inch	60	-
#4	40	100
#50	8	28
#200	0	8

Saturated hydraulic conductivity of the sand and gravel shall be not less than 10 inches per hour according to ASTM D5856-95 (2000) when compacted to a minimum of 95% Standard Proctor, ASTM 698.

(D) PREPARATION OF GRADE

Excavation and sub-grade preparation to the lines and grades shown on the Contract Documents shall be required:

1. Sub-grade shall not be compacted for installations where contract documents specify a minimum infiltration rate for the sub-grade.
2. For permeable pavements with soft or yielding soils in locations specifying a minimum infiltration rate for the sub-grade, Contractor shall install geogrid in accordance with contract documents. Geotextile fabric shall not be used.
3. For permeable pavements where no minimum infiltration rate is specified for the sub-grade, Contractor shall be allowed to perform subgrade compaction, and can utilize geotextile fabric or impermeable liners as specified in the Contract Documents.
4. Where erosion of sub-grade has caused accumulation of fine materials and/or surface ponding, this material shall be removed with light equipment and the underlying soils scarified to a minimum additional depth of 6 inches with a rake and a tracked vehicle used in combination, or equivalent.
5. Construction equipment shall not be allowed on the subgrade depending on the thickness of the section that is designed, except as noted above.

(E) HAULING

Trucks meeting the same cleanliness requirements of the double washed materials shall be used during hauling. Trucks shall be inspected and cleaned prior to each use.

(F) LIMITATIONS ON PLACING

Do not install aggregate base course when rainfall or other weather conditions will detrimentally affect the quality of the work.

(G) PLACING, SHAPING AND COMPACTING

1. Upon completion of sub-grade work, the Engineer shall be notified and shall inspect the sub-grade before the Contractor continues installation. Owner or Engineer shall have the option to perform infiltration testing on the subgrade to verify minimum infiltration rates, at the Contractor's expense where specified on the contract documents.
2. Any accumulation of debris or sediment which takes place after approval of sub-grade shall be removed prior to installation continuing at no extra cost.
3. Place geosynthetics, impermeable liner, pipe, and aggregate as required on the contract documents immediately after approval of sub-grade in accordance with Green Book Standard Specifications section 213 "Engineering Geosynthetics".

4. Do not dump aggregate base course in piles, but evenly spread and place aggregate on the prepared sub-grade in layers of uniform thickness without segregation. Where the base course is constructed in more than one layer, clean previously constructed layers of loose and foreign matter prior to placing subsequent layers.
5. Moisten and roll each lift of aggregate with a 10-ton roller, keeping equipment movement over exposed sub-grades to a minimum. Roll each lift between 4 and 6 passes. If a required depth of aggregate in a lift exceeds ten (10) inches, the aggregate layer shall be rolled in ten (10) inch lifts.
6. Make adjustments in placing procedures or equipment to obtain true grades, to minimize segregation and degradation, to reduce or increase water content, and to insure a satisfactory aggregate base course.

(H) FINISHING

1. Geosynthetics along Edges – Geotextile fabric or impermeable liners, or both, shall be used along the edges or sides of aggregate base course materials for permeable pavement and rain garden as specified in the contract documents. Following placement of an aggregate base course, and at the conclusion of each day's work, the geotextile or impermeable liner, or both, shall be folded back and secured to protect from sediment washout along all bed edges. At least a two foot (2') strip shall be used to protect stone from adjacent bare soil. This edge strip shall remain in place until all bare soils contiguous to beds are stabilized and fully vegetated or until the wearing surface for the permeable pavement has been placed.
2. Unfinished Edges Of Base Course – In fill conditions, place earth or other approved materials along any unfinished edges of the base course in such quantity that it will compact to the thickness of the aggregate base course being constructed. In each operation, allow at least a two (2) foot width of the shoulder along all unfinished edges to be rolled and compacted simultaneously with the rolling and compacting of each layer of aggregate.

(I) SAMPLING

1. Aggregates at the Source – See section (B).
2. During Construction -Take at least one (1) random sample during construction within the first 500 tons of placed aggregate material, in accordance with ASTM D 75. Collect each sample by taking three (3) incremental samples at random locations from the placed material to make a composite sample by weight of not less than 75 pounds.
3. Sample Identification -Place each sample in a clean container, securely fastened to prevent loss of material. Tag each sample for identification and with the following information:

Contract No._____
Sample No._____
Date of Sample_____
Sampler_____
Source_____
Intended Use_____

For Testing_____

4. Repeat Sampling **–** Repeat the above sampling when a material source is changed or when unacceptable deficiencies or variations from a specified gradation of materials is found in testing.

(J) ACCEPTANCE TESTING

Contractor is responsible for quality control and the County is responsible for acceptance testing to verify the contractor's quality control process. Assurance testing by an independent third party may be necessary. Testing responsibilities will be performed by the Contractor's testing agency or a County-approved lab at the Contractor's expense. Materials approval testing may be performed by the County of San Diego. Failure to detect defective work or materials early will not prevent rejection if a defect is discovered nor shall it obligate the owner for final acceptance at any time. Submit all Test Reports to the Engineer.

1. Gradation -Test each sample of aggregate base course material for gradation in accordance with ASTM C 136 and with the sampling described in Section (I).
2. Thickness– Measure each 100 square yards of each layer of aggregate base course placement. Make depth measurements by test holes, at least 3 inches in diameter, through the base course. Where base course deficiency is more than ½ inch, correct by scarifying, adding mixture of proper gradation, re-blading, and re-compacting. Where the measured thickness is more than ½ inch thicker than indicated, consider it as the indicated thickness plus ½ inch for determining the average. The average thickness is the average of the depth measurements for the entire area, and shall not under-run the thickness indicated in the Contract Documents without written approval from the Engineer.

(K) PROTECTION

Protection work will be performed by the Contractor at the Contractor's expense.

1. As construction is completed, maintain and protect the aggregate base course, except where a portion of the succeeding course is under construction thereon. Maintenance includes drainage, rolling, shaping, and watering, as necessary, to maintain the course in proper condition. Correct deficiencies in thickness, composition, and construction which develop during the maintenance, to conform to the requirements specified herein. Maintain sufficient moisture by light sprinkling with water at the surface to prevent a dusty condition.

2. Finishing along the edges of the permeable pavement for protection during construction shall be as described in Section (H) until the site is fully stabilized, at which time excess geotextile fabrics and impermeable liners can be cut back to the pavement edges.
3. In addition, runoff onto an aggregate base course shall be minimized until the site is fully stabilized. Diversion ditches or other approved types of erosion and sediment control measures shall be placed at the toe of slopes which are adjacent to permeable pavement and rain garden areas, to prevent sediment

from washing into areas aggregate base course at all times during and after construction. Any sediment accumulation into the aggregate base course shall be removed immediately by cleaning or replacement of the aggregate by the Contractor at no cost to the owner.

(L) MEASURE AND PAYMENT

The unit of measure for Aggregates for Green Streets Facilities will be the cubic yard for each course/type of material. The actual number of cubic yards measured complete in place will be paid for the contract unit price per cubic yard, which payment will include all labor, materials, tools, equipment and incidentals necessary to complete the work as specified herein. Payment will also include all subgrade preparation and testing necessary to achieve the required placement.

GEOSYNTHETICS FOR GREEN STREETS FACILITIES

(A) DESCRIPTION

This work consists of supplying and installing various geosynthetics for use in Green Streets Facilities, including the following:

1. Geotextile, Class 1: a geotextile fabric for use in applications where there is a high risk of damage during construction due to construction equipment or dumped aggregates, including due to its use at the bottom of Green Streets Facilities.
2. Geotextile, Class 2: a geotextile fabric for use in applications where there is little to average risk of damage during construction due to construction equipment or dumped aggregates, including use on the sides of Green Streets Facilities.
3. Geogrid: a geosynthetic with woven bands of synthetic material with large apertures for use in applications where the underlying soils are weak or yielding.

    a) If the following soil conditions are encountered when installing permeable pavement facilities, geogrid in accordance with this provision may be utilized in lieu of removal of soil and replacement with select backfill, as directed by the Green Book Standard Specifications Section 213 "Engineering Geosynthetics" and approved by the County Engineer:

        - unstable or highly erodible soils,
        - weak soils,
        - gap graded soils,
        - alternative sand / silt laminated soils,
        - dispersive clays, and / or rock flour

4. Waterproofing Membrane: Material that is used to prevent infiltration and contain stormwater within the facility by lining the sides and bottom.

Except as herein stated, the requirements specified by Green Book Standard Specifications Section 213 "Engineering Geosynthetics" are applicable to this specification.

(B) MATERIALS

1. Geotextile: Class 1 and Class 2 geotextiles for Green Streets Facilities shall meet the requirements of AASHTO M-288 and Green Book Standard Specifications Section 213-4 "Paving Fabric" as applicable.

    The permeability of the geotextile fabric should also be at least an order of magnitude higher (10x) the soil sub-grade permeability for Green Streets Facilities used as infiltration practices.

2. Geogrid: Shall meet the requirements of AASHTO M-288 and Green Book Standard Specification Section 213-5 Geotextiles and Geogrids", unless otherwise specified in the contract documents.
3. Waterproofing Membrane: shall have a thickness of 30 mil and conform to the

following requirements.

Table 1: Test Properties for Waterproofing Membrane

	Test Method	**Specifications Limits**
Thickness	D5199	+/-5%
Specific Gravity (min.)	D 792	1.20
100% Modulus (psi, min.) (lb. force/in width, min.)	D 882	1000 30
Tensile (psi, min.) (lb. force/in width, min.)	D 882	2300 73
Elongation at Break (%, min.)	D 882	380
Graves Tear (lb./in., min.) (lb. force/in. width, min.)	D 1004	325 8
Resistance to Soil Burial (% change, max.) (a) Break Strength (b) Elongation (c) Modulus at 100%	G 160	5 20 20
Low Temperature Impact (Pass/F)	D 1790	-20
Dimensional Stability (% change/max.)	D 1204 (212/F/15 min.)	3
Water Extraction (%, Max. Loss)	D 1239	0.15
Volatile Loss (%, max.)	D 1203	0.70
Hydrostatic Resistance (psi, min.)	D 751	100

(C) SUBMITTALS AND TESTING

1. Product Data: Submit most recent printed information from manufacturer for:

   a. Type and Source of Materials

   b. Qualifications of Manufacturer

   - Manufacturer shall have a minimum of five (5) years of experience supplying geotextile materials for stormwater applications.
   - Submit Manufacturer name, address, telephone and fax numbers, and contact name.
   - Submit certification that Manufacturer is able to provide sufficient quantities of materials for the entire project.

   c. Geotextile Material per Green Book Standard Specifications Section 213-5 “Geotextiles and Geogrids”
   - Weight, ounces per square foot
   - Grab Strength, pounds force
   - Puncture Strength, pounds force
   - Trapezoidal Tear Strength, pounds force
   - Permittivity, as a function of permeability, /sec
   - Minimum Apparent Opening Size, millimeters
   - Elongation at Failure, %
   - Ultraviolet stability, % strength retained after 500 hours

d. Geogrid Material per Green Book Standard Specifications Section 213-5 "Geotextiles and Geogrids"
   - Weight, ounces per square foot
   - Strength at 5% Strain, pounds per foot
   - Minimum Opening Size, inches
   - Maximum Opening Size, inches
   - Ultimate Tensile Strength, pounds per foot
   - Junction Strength, pounds force
   - Ultraviolet stability, % strength retained after 500 hours

e. Waterproofing Membrane per Table 1.
   - Thickness, mils
   - Specific Gravity
   - 100% Modulus, psi, pounds force/inch width
   - Tensile Strength, psi, pounds force/inch width
   - Elongation at Break, percent
   - Graves Tear, pounds/in, pounds force/inch width
   - Resistance to Soil Burial, % change
   - Low Temperature Impact, pass/degree Fahrenheit
   - Dimensional Stability, % change
   - Water Extraction, %, maximum loss
   - Volatile Loss, %
   - Hydrostatic Resistance, psi

2. Product Samples: Along with product data, submit representative samples to the County for review and approval. Do not order materials until the County Engineer has approved. Delivered materials shall match the approved samples.
3. Soil Tests: Submit certification that the geotextile has at least an order of magnitude (10x) higher permeability than the soil subgrade permeability as specified in the Contract Documents for infiltration practices.

(D) DELIVERY, STORAGE AND HANDLING

1. Deliver, store and handle packaged materials in strict compliance with all manufacturer's instructions and recommendations. Keep a record of all deliveries along with corresponding package labels.
2. Minimize exposure to ultraviolet (UV) degradation by keeping geotextile materials out of direct sunlight at all times. Protect all materials from weather, damage, injury and theft.
3. Sequence deliveries to avoid delays and UV exposure.

(E) PRE-INSTALLATION EXAMINATION AND PREPARATION

1. Pre-Installation Examination: Prior to beginning work, the Contractor shall examine previous work, related work, and conditions under which this work is to be performed and shall notify the County in writing of all deficiencies and conditions detrimental to the proper completion of this work. This includes:
   a. The subgrade is at incorrect depths, lines, and dimensions for installing the geotextile fabrics.
   b. Overly wet conditions exist or are anticipated to occur during installation, as

they will contaminate the geotextiles.

c. Construction debris is present within the placement area which may damage the geotextiles; work is to be sequenced to avoid construction traffic on the exposed geotextiles at any time.

(F) PLACEMENT

1. The Contractor shall not place any geotextile, geogrid or waterproofing membrane until all work in adjacent areas is complete and approved by the County.
2. Material shall be cut and fit to the dimensions shown on the plans with a minimal amount of seams, and with excess materials removed and disposed of properly. Clean and straight cuts are required to the line and grade of the plans.
3. Geosynthetics shall be placed on the prepared surface of the stormwater practice parallel to the longest side of the practice, and without dragging it across the grade. Wrinkles and folds shall be removed by stretching and pinning.
4. Securing pins or staples for geotextile fabric shall have a minimum length of 10 inches and shall be designed to securely hold the geotextile fabric in place during construction. Waterproofing membrane shall be held in place by backfilling or other means without puncturing the material. Other methods of pinning can also be used as allowed by the County Engineer.
5. Geotextiles shall be overlapped by a minimum of 3 feet at roll edges and ends. Roll edges, ends and overlaps shall be secured a minimum of 5 feet on center or sewed in accordance with Section 213.02 (C).
6. Geotextiles shall be folded or cut and overlapped in the direction of the turn for all curves. Folds, as well as edges, ends, and overlaps shall be pinned a minimum of 5 feet on center or sewed in accordance with Section 213.02 (C).
7. Waterproofing membrane shall be glued continuously at seams in accordance with all manufacturers' recommendations including any required overlap. Folds shall also be secured and pulled taught.

(G)PROTECTION

1. Protect newly placed geosynthetics from damage during construction, and protect them from ultraviolet (UV) degradation at all times.
2. Construction traffic on exposed geosynthetic materials is strictly prohibited.
3. After beginning work, coordinate activities with other work so that there is no disturbance or damage from traffic or other construction activities subsequent to placement.
4. Any damaged geotextile, geogrid, or waterproofing membrane shall be repaired or replaced immediately upon discovery of the damage, to the satisfaction of the Engineer, at the Contractor's expense.

(H) EXCESS MATERIALS

Unused material exposed to ultraviolet (UV) degradation or otherwise damaged shall also be disposed of properly.

(I) MEASURE AND PAYMENT

The unit of measure for geosynthetics will be square yards of the type of geosynthetic specified. The number of square yards will be the actual number of square yards complete in place, which will include furnishing, transporting, handling, installing, and testing the geosynthetics as well as all seams, overlaps, staking, embedment, and protection measures.

UNDERDRAINS FOR STORMWATER FACILITIES

(A) DESCRIPTION

This work shall consist of furnishing and placing the items specified to construct perforated PVC pipe for underdrains, cleanouts, observation wells, field connections to existing storm drain pipe or existing structures, and gate valves and backflow preventers as shown in the Drawings and in accordance with County Standards, where applicable. Except as herein stated, the requirements specified in Green Book Standard Specifications Section 207 “Gravity Pipe” and 306 “Open Trench Conduit Construction” are applicable to this specification.

Related Items: Trench excavation and backfill and non-perforated underdrain pipe will be constructed and installed per the standard specifications and special provisions and paid separately.

(B) REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AASHTO M 105 Gray Iron Castings

ASTM D 2729 Polyvinyl Chloride (PVC) Sewer pipe and Fittings

ASTM D 3034. Type PSM Polyvinyl Chloride (PVC) Sewer Pipe and Fittings

(C) MATERIALS

All materials shall meet the requirements set forth in the Standard Specifications or modified in the Special Provisions.

1. PVC (perforated or non-perforated as specified in the Contract Drawings): Shall be schedule 40 for underdrains and pipe risers, and shall conform to Green Book Standard Specification Section 207-17 “PVC Gravity Pipe”.
2. HDPE for underdrain pipe along curves, as indicated in the Contract Drawings.
3. Frame and Cover: Shall conform to Green Book Standard Specifications Section 206-3.3 “Manufacturing and Finishing”, 301-1.6 “Adjustment of Manhole Frame and Cover Sets to Grade”, and 302-5.8 “Manholes and Other Structure” or approved equal.
4. Screw Cap: Shall be threaded PVC with 2-inch square lug.
5. Concrete Encasement: Concrete encasement shall have a minimum compressive strength of 3000 psi and shall conform to Green Book Standard Specifications Section 201 “Concrete, Mortar and Related Materials”.
6. Fittings: Fittings shall be PVC and used as indicated on the design drawings.
7. Cleanout: The cleanout cover assembly in pavement shall be cast iron and have an adjustable housing with a scoriated cast iron cover as indicated in the design drawings and as referenced in Green Book Standard Specifications Section 206-3.3 “Manufacturing and Finishing”.
8. Observation Well: 2-inch well test plug using EnviroTech ErgoGrip or approved equal with tethering eyelet.

9. Field Connections: All materials shall meet the requirements set forth in Green Book Standard Specifications 208 “Pipe Joint Types and Materials”, or modified in the Special Provisions.
10. Backflow Valve – Shall be a backflow flapper valve (6-inch), Flex PVC ™ Item No. S675P or approved equal.
11. Gate Valve: Shall be manual slide valve, PVC plastic body and hubs with 304 stainless steel shaft and paddle (4-inch or 6-inch) and die cast aluminum handle, Valterra or approved equal.

(D) CONSTRUCTION REQUIREMENTS

1. Underdrain Pipes: Perforated pipes shall be placed with perforations down. Pipe shall be placed with the bell end up grade. Pipe sections shall be joined with appropriate couplings. The ends of underdrain pipe shall be plugged up grade as directed by the Engineer.

2. Risers for Cleanouts/Observation Wells

    a. Observation Well: Provide 2-inch PVC slotted well casing, with well point, extending twelve-inches into subgrade. Set casing approximately 2-inches below finished pavement elevation to allow clearance for test plug and cleanout cap. Provide 4-inch diameter PVC outer casing extending through permeable concrete into subbase and install 4-inch flush mounted cast iron cleanout with brass cap solvent welded to outer casing. Provide 2-inch well test plug with tethering eyelet.

    b. In paved areas: Provide frame and cover over cleanout and observation well riser pipes as indicated in the Drawings. For locations in permeable pavement, frames and covers shall be located within the permeable pavement area surrounded by PCC edge curb. Cleanouts and Observation Wells shall be encased in concrete as shown in the Drawings. Connect riser to underdrain piping.

    c. In non-paved areas: Provide screw cap covers. Covers shall be set 6-inches above final grade. Connect riser to underdrain pipe.

3. Field Connection at Existing Structure construction shall be shown on the contract Drawings.

4. Backflow preventer assembly to be located per the plans and as directed by the Engineer at a location upstream of proposed storm drain field connection yet downstream of perforated underdrain pipe. Provide PVC riser pipe to protect PVC access sleeve pipe. Connect assembly to underdrain piping, using the appropriate reducer and tee fittings.

5. Gate valve to be located per the plans and as directed by the Engineer within an accessible catch basin or overflow riser and upstream of proposed storm drain field connection yet downstream of perforated underdrain pipe. The incoming non-perforated PVC pipe shall extend into the catch basin or overflow riser a sufficient distance to allow for connection of the valve as well as sufficient operation of the valve handle but not more than a distance of 8 inches. Valves may also be placed within valve boxes as per plans and specifications and as directed by the Engineer. Catch basins, overflow risers and/or valve boxes must

have sufficient depth to allow for the height of the valve when in its fully open position plus at least 3 inches at the top.

(E) TESTING AND ACCEPTANCE

When construction is complete, the contractor shall test all completed underdrain systems for continuous, unimpeded flow.

a. Suggested test methods for each pipe run are as follows:
   i. At highpoint or upstream end of underdrain pipe, open cleanout and insert hose from water source.
   ii. Turn on water
   iii. Acceptance of pipe run consists of free flow of water through drain outlet into the existing storm drain structure.

b. Any sections of the underdrain that are clogged or crushed shall be repaired at the contractor's expense.

(F) MEASURE AND PAYMENT

a. UNDERDRAIN PIPE

Payment for Underdrain Pipe will include all costs for furnishing all materials, labor, tools, equipment and incidentals (including pipe risers, caps, and fittings) to complete the work. The unit of measurement will be linear feet.

b. CLEANOUTS/OBSERVATION WELLS

The unit of measure for Underdrain Cleanout and Observation Well will be each. Payment for Underdrain Cleanout or Underdrain Observation Well will be made at the Contract unit price per each which will include excavation, shoring, backfill, compaction, installation of cleanout including wye and jointing, pipe riser, gaskets, frame and cover or screw cap, concrete encasement, and all labor, materials, tools, equipment and incidentals needed to complete work specified.

c. FIELD CONNECTION Field connection at existing structure will be measured and paid for at the contract unit price per each and will include furnishing, installing, excavation, backfill, and all labor, materials, tools, equipment, and incidentals necessary to complete the work.

The unit of measure for field connection at storm drain will be each. Payment will be made at the Contract unit price per each, which payment will include, but not limited to, furnishing and installing wye branch connections, straight thimbles, maintaining storm drain service, and all labor, materials, tools, equipment and incidentals needed to complete work specified.

d. BACKFLOW PREVENTER

The unit of measure for Backflow Preventers will be each. Payment for Backflow Preventers will be made at the Contract unit price per each which will include excavation, shoring, backfill, compaction, installation of pipe riser, connections, gaskets,

backflow preventer (flapper valve), frame and cover or screw cap, concrete encasement, and all labor, materials, tools, equipment and incidentals needed to complete work specified.

e. GATE VALVE

The unit of measure for Gate Valves will be each. Payment for Gate Valves will be made at the Contract unit price per each which will include connections, gate valve (slide valve), and all labor, materials, tools, equipment and incidentals needed to complete work specified.

PERMEABLE CONCRETE PAVEMENT

(A) DESCRIPTION

This work shall consist of constructing permeable Portland cement concrete roadway pavements, alleys, sidewalks, or trails on a prepared sub-grade in accordance with these specifications and in conformity with the lines, grades, thicknesses and typical sections shown in the contract documents or as directed by the Engineer.

The permeable concrete pavements and sidewalks shall consist of a mixture of Portland cement, aggregate, water, admixtures and other ingredients as specified in Green Book Section 201-1.1.6 “Pervious Concrete”. Except as herein stated, the requirements specified for Green Book Standard Specifications Section 201 Concrete, Mortar and Relative Materials” and Section 303 Concrete and Masonry Construction” are applicable to this specification.

(B) REFERENCES

ACI 522R-10 Report on Pervious Concrete

ACI 522.1-08 Specifications for Pervious Concrete Pavement

ACI 211.3R - Guide for Selecting Proportions for No-Slump Concrete

ASTM C42 -Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete ASTM C94 -Standard Specification for Ready-Mixed Concrete

ASTM C150 – Standard Specification for Portland Cement

ASTM C595 -Standard Specification for Blended Hydraulic Cements

ASTM C979 – Standard Specification for Pigments for Integrally Colored Concrete

ASTM C1077 -Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction

ASTM C1116 – Standard Specification for Fiber Reinforced Concrete

ASTM C1688 -Standard Test Method for Density and Void Content of Freshly Mixed Pervious Concrete

ASTM C1701 -Standard Test Method for Infiltration Rate of In Place Pervious Concrete

ASTM C1754 -Standard Test Method for Density and Void Content of Hardened Pervious

Concrete

ASTM D994 -Standard Specification for Preformed Expansion Joint Filler for Concrete

ASTM D1751 -Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction

ASTM D1752 -Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction

NRMCA – National Ready Mix Concrete Association

(C) MATERIALS

1. Portland Cement shall be:
   a. Type I or II conforming to AASHTO M85 or ASTM C150; or
   b. Type IP or IS conforming to ASTM C595.
2. Aggregate
3. Maximum coarse aggregate size shall be No. 8.
4. Coarse and fine aggregate conforming to Standard Specifications shall be double-washed. Washing shall be sufficient to remove dust and other coatings.
5. Admixtures – Water reducing, hydration stabilizers, air entrainment, and other admixtures conforming to Green Book Standard Specifications Section 201-1.2.4 “Chemical Admixtures” shall be allowed in the mix design.
6. Fibers – Reinforcing fibers conforming to Greenbook Standard Specification Section 201-2.3 and ASTM C1116 shall be allowed in the mix design.
7. Pigments – Pigments conforming to ASTM C979 shall be allowed in the mix design.
8. Joint Material – Filler for expansion joints shall be in accordance with Green Book Standard Specifications Section 201-3 “Expansion Joint Filler and Joint Sealants”.

(D) PROPORTIONING

Comply with ASTM C94 and develop a concrete mix design meeting the following requirements in accordance with ACI 211.3R, Appendix 6:

1. Concrete shall achieve a minimum infiltration rate of 60 inches/hour (30 gallons/hour in a 12 inch diameter cylinder). Testing shall be in accordance with ASTM 1701.
2. Concrete shall meet a minimum compressive strength when specified in the Contract Documents.
3. A combined coarse and fine aggregates gradation shall be provided and material passing the #4 sieve shall be between 4% and 7%.
4. Mix Water: Mix water quantity shall be such that the cement paste displays a wet metallic sheen without causing the paste to flow from the aggregate. Mix water yielding a cement paste with a dull-dry appearance has insufficient water for hydration. Insufficient water results in inconsistency in the mix and poor bond

strength between aggregate particles. High water content results in the paste reducing or eliminating the void system required for porosity.

(E) SUBMITTALS

1. **Contractor Qualifications**

   a. At the time of bid submission, Contractor shall submit the name and qualifications of the permeable concrete installer, providing written evidence of the following:

      (i) Employment of one (1) NRMCA certified Pervious Concrete Craftsman who shall be on site, overseeing each placement crew, during all concrete placement; or

      (ii) Employment of at least two (2) NRMCA certified Pervious Concrete Installers who shall be on site, overseeing each placement crew, during all concrete placement.

   b. Not later than fourteen (14) days before construction of permeable concrete, Contractor shall furnish evidence of employment of at least three (3) certified Pervious Concrete Technicians who will perform the pervious concrete construction.

2. **Testing Agency** – Within seven (7) days after notice to proceed, Contractor shall furnish the name and location of the proposed testing agency meeting the requirements of Section O of this specification.
3. **Concrete Producer Qualifications** – Within seven (7) working days after notice to proceed, Contractor shall furnish the name and location of an NRMCA certified plant that will produce and provide permeable concrete.
4. **Concrete Mix Design** – Not later than thirty-five (35) days before construction of permeable concrete, Contractor shall furnish:

   a. A proposed mix design with proportions of materials for acceptance as described in section D of this specification or otherwise specified in Contract Documents. The data shall include unit weight, void ratio, and strength.

   b. Samples of individual concrete materials contained in the mix design for sampling and testing of material prior to use, in accordance with the Green Book Standard Specifications Section 4 “Control of Materials”.

5. **Product Sample (Test Panel)** – At least fifteen (15) working days before construction of permeable concrete, and following the Chief Engineer’s acceptance of the mix design, Contractor shall provide a sample of the product (test panel) in accordance with section F of this specification.

(F) TEST PANEL

1. Contractor shall provide a minimum of one (1) test panel for acceptance. Place, joint and cure the test panel, a minimum of 275 square feet in size or as specified in the Contract Documents, at the required project thickness to demonstrate that in-place void contents, unit weights, and infiltration rates can be met and to demonstrate

effective jointing that does not compromise the cured concrete integrity.

2. **Test Panel Infiltration:** Test panels shall be tested for infiltration in accordance with ASTM C1701.

3. **Test Panel Cores:** Test panels shall have three (3) cores, each six (6) inches in diameter, taken from the panel a minimum of seven (7) days after placement of the permeable concrete. At least one core shall be taken within six (6) inches of a contraction joint. The cores shall be measured for thickness, void structure, and unit weight. Untrimmed, hardened core samples shall be used to determine thickness in accordance with ASTM C42. After thickness determination, the cores shall be trimmed and measured for unit weight in a saturated condition and void content in accordance with ASTM C1754.

4. **Test Panel Acceptance**: Satisfactory test panels will be determined by:

   a. Infiltration rate of at least 60 inches per hour.
   b. Compacted thickness within 1/4" of the specified thickness.
   c. Void Content ± three (3) percent of the design void content.
   d. Unit weight ± five (5) pounds per cubic foot of the design unit weight.

   If test panels meet the above mentioned requirements, they can be left in-place and included in the completed work. If test panels do not meet the above mentioned requirements, they shall be removed and disposed of in an approved manner, and replaced with an acceptable test panel at the contractor's expense.

(G) PREPARATION OF GRADE

1. Sub-Grade Preparation – Shall be in accordance with Specification "Aggregates for Green Streets Facilities".
2. Base Materials – Shall be in accordance with Specification "Aggregates for Green Streets Facilities".

(H) HANDLING, MEASURING AND BATCHING MATERIALS

Permeable concrete shall be transported from batching plant to the location of placement by a rolling drum mixer truck with current (within 12 months) certification by the NRMCA. Non-agitating trucks shall not be used. Each truck should not haul more than two (2) loads before being cycled to another type of concrete, unless a stabilizing hydration agent is used in the permeable concrete mix design or if the County determines that there is no significant concrete buildup in the concrete mixer after delivery of each load.

(I) MIXING CONCRETE

1. Concrete shall be mixed for a minimum of one (1) minute after introduction of all materials into the mixer. Truck mixers shall be operated at the speed designated by the concrete producer for at least 75 to 100 revolutions of the drum.
2. Concrete mixing shall comply with ASTM C94 except that discharge shall be

completed within sixty (60) minutes after the introduction of mix water to the cement. This time can be increased to ninety (90) minutes when utilizing a hydration stabilizer. Further water addition is permitted at the point of discharge provided the design water/cement ratio is not exceeded.

(J) LIMITATIONS ON MIXING AND PLACING

Do not install permeable concrete when ambient temperature is below 40°F or above 90°F, or when ambient temperature is forecasted to be below 40°F or above 90°F at any time during the seven (7) days following placement, unless otherwise permitted in writing by the Engineer.

(K) PLACING AND CONSOLIDATING CONCRETE

1. Pre-Placement Conference -A mandatory pre-placement conference will take place at least seven (7) days prior to installation of work and shall include at a minimum engineer, inspector, general contractor, permeable concrete contractor, concrete supplier, and field testing agency.
2. Wet the base materials or sub-grade immediately prior to concrete placement.
3. Deposit concrete directly from the transporting equipment onto the base materials or sub-grade, as appropriate.
4. Discharge: Each truckload shall be visually inspected for moisture consistency prior to discharge. Water addition shall not be permitted at the point of discharge to obtain the required mixture consistency and truckloads lacking the required moisture consistency shall be rejected as determined by the inspector. Discharge shall be a continuous operation and shall be completed as quickly as possible. Concrete shall be deposited as close to its final position as practical and such that discharged concrete is incorporated into previously placed and plastic concrete. If consolidation occurs during concrete discharge, placement shall be halted, the mixture shall be addressed, and the consolidated portion removed and replaced immediately.
5. Other methods of discharging the concrete may be used when specified in the Contract Documents or as allowed by the County Engineer.
6. Spread the concrete using a come-along, short-handle square ended shovel or rake, or similar equipment.
7. Rolling compaction shall be achieved using a motorized or hydraulically actuated, rotating, weighted tube screed that spans the width of the section placed and exerts a minimum vertical pressure of 10 psi on the concrete. Alternatively a steel pipe roller meeting the same criteria may be used.
8. Plate compaction is not recommended, but may be necessary in small areas. When necessary, a standard soil plate compactor with a base area of at least two square feet that exerts a minimum pressure of 10 psi on the concrete through a ¾ inch minimum plywood cover shall be used.
9. Cross rolling shall be performed using a roller specifically designed to smooth and compact permeable concrete. Lawn rollers are not allowed.
10. Foot-traffic shall not be allowed on fresh concrete.

(L) STRIKE-OFF, CONSOLIDATION AND FINISHING

1. Strike off concrete between forms using a form riding paving machine, vibrating screed, or roller screed.
2. Do not use steel trowels or power finishing equipment.
3. Final surface texture shall be achieved by finishing the fresh concrete using a full-width steel roller that provides a minimum compactive pressure to achieve the required tolerances.
4. Hand tools shall be used to finish the concrete along the slab edges immediately adjacent to forms.
5. Other methods of producing final surface texture may be permitted when specified in the Contract Documents or approved by the engineer.

(M) CURING

1. Begin curing within twenty (20) minutes of concrete discharge unless longer working time is approved by the County Engineer.
2. **Curing Material**:
    a. The pavement surface shall be entirely covered with a minimum six (6) mil thick polyethylene sheet in accordance with-Green Book Standard Specifications Section 201-4.2 “Sheet Curing Materials”. Sheeting shall remain covered for at least seven (7) uninterrupted days.
    b. Alternate curing materials may be used as approved by the Engineer.
3. Curing sheets shall be secured and kept secure at all times without using dirt.
4. **Hot Weather Curing:** A fog shall be sprayed above the surface, before covering, when required due to hot weather conditions Equipment must include fog nozzles that atomize water using air pressure to create a fog blanket over the slab.
5. **Cold Weather Curing:** Curing shall be in accordance with ACI 306R-10 “Guide to Cold Weather Concreting”.

(N) JOINTS

1. Contraction joints shall be installed at locations and spacing shown in the Contract Documents at one-quarter (¼) the depth of the thickness or a maximum of one and a half (1½) inches for roadway and alley pavements, and at one-half inch (½”) for sidewalks and trails. Allowable methods for joint placement, as directed by the County Engineer, include:
    a. **Rolled Joints** -shall be formed in plastic concrete using a steel pipe roller to which a beveled fin with the required diameter to achieve the joint depth has been attached around the circumference of the roller. Rolled joints are formed immediately after roller compaction and before curing. Sidewalks and trails shall have rolled joints.
    b. **Sawed joints** -shall be constructed as soon as the permeable pavement can be sawed without raveling the sawed edge and before initial cracking occurs, using a wet saw or an early-entry saw. Sawed joints shall typically be constructed between 24 hours and 48 hours after concrete placement, depending on site

conditions. At no time during the sawing process shall more pavement surface be exposed than that needed for sawing. Any dust or slurry generated during sawing shall be immediately removed during the sawing operation.

2 Construction joints shall be installed at locations and spacing shown in the Contract Documents and whenever concrete placement is suspended for a sufficient length of time that concrete may begin to harden.

3 Expansion joints shall be installed when permeable concrete will abut existing concrete slabs or other structures such as walls, footings, columns, catch basins, stairs, light poles, and other points of restraint.

4 To reduce raveling at joints, or where permeable concrete meets impermeable pavement, finishing may be necessary in accordance with Section L, Item 4 of this specification.

(O) TESTING

Contractor is responsible for quality control and the County is responsible for acceptance testing to verify the contractor's quality control process. Assurance testing by an independent third party may be necessary. Testing responsibilities will be performed by the testing agency at the Contractor's expense. Concrete materials and operations may also be tested and inspected by the owner as work progresses. Use of testing services will not relieve Contractor of the responsibility to furnish materials and construction in full compliance with the Contract Documents. Failure to detect defective work or materials early will not prevent rejection if a defect is discovered later nor shall it obligate the Engineer for final acceptance at any time.

1. **Testing Agency:** Agencies that perform testing services on concrete shall be AASHTO accredited per AASHTO R18 and meet the requirements of ASTM C1077. Testing agencies performing the testing shall also have experience in testing permeable concrete and shall be accepted by the Engineer before performing any work. Field tests of concrete shall be made by an individual certified as an NRMCA Certified Pervious Concrete Technician, who is also an ACI Concrete Field Testing Technician, Grade 1 in accordance with ACI CPI.
2. **Testing Procedure:**

    a. Conduct tests in accordance with ASTM C1688 at the beginning of each permeable concrete placement operation for each batch, or for every 50 cubic yards (maximum), or a minimum of one test for each day's placement, to verify fresh density and void content.

    b. A minimum of seven (7) days following each placement, three (3) cores, six (6) inches in diameter, shall be taken. The cores shall be measured for thickness, void content and unit weight determined using the methods described in section F of this specification Test Panels. Satisfactory test panels will be determined by:

        i. Compacted thickness +3/4", -1/4" of the specified thickness.

        ii. Void Content ± three (3) percent of the design void content.

        iii. Unit weight ± five (5) pounds per cubic foot of the design unit weight.

    c. If permeable concrete fails to meet the above requirements, the County Engineer shall make a determination of acceptance, rejection, or acceptance at a reduced

price, unless otherwise specified in the special provisions

3. The infiltration of the pavement surface shall be tested in accordance with ASTM C1701. All applied water shall infiltrate directly without puddle formation or surface runoff, and the testing shall be observed by the County. A minimum infiltration rate of 60 inches per hour shall be achieved.
4. Submit all test results to the Engineer.
5. Cores holes shall be filled with standard concrete.

(P) OPENING TO TRAFFIC

Both vehicular traffic and pedestrian traffic shall be excluded from permeable concrete pavement after the placement of curing materials as follows:

- 7 days for pedestrian traffic on sidewalks or pavements
- As determined by County Engineer for vehicular traffic on roadways, but not less than 14 days.

(Q) TOLERANCES

Pavement must be mechanically swept and finished before testing for compliance with tolerances. Construct pavement to comply with the following tolerances:

- Thicknesses: + 3/4 inch; -1/4 inch; refer to Standard Specification for disposition on pavement with average thickness which is less than the thickness by more than 1/8 inch.
- Elevation: + or - 1/2 inch
- Contraction joint depth: +1/4 inch, -0 inch

(R) MEASURE AND PAYMENT

The unit of measure for Permeable Concrete Pavement will be the square yard at the specified thickness. The actual number of square yards, complete in place measured along the surface, will be paid for at the contract unit price per square yard, or adjusted unit price per square yard if required under Green Book Standard Specifications Section 9 “Measurement and Payment”, which payment will be full compensation for furnishing, hauling, and placing all materials, including formwork, concrete work, joints, expansion joint materials, waterproofing, load transfer devices, impermeable material, sealing of joints and curing. Payment for will include all costs for furnishing all materials, labor, tools, equipment and incidentals to complete the work.

PERMEABLE ASPHALT PAVEMENT

(A) DESCRIPTION

This work shall consist of constructing a permeable asphalt pavement on a prepared sub-grade in accordance with these specifications and in conformity with the lines, grades, thicknesses and typical sections shown in the contract documents or as directed by the Engineer.

The permeable asphalt pavement shall consist of a mixture of aggregates, bituminous binder material including polymer modified asphalt, fibers, mineral filler, anti-strip additives, and other optional additives as specified under Green Book Standard Specifications Sections 203-15 “Porous Asphalt Concrete“ and 302-13 “Porous Asphalt Concrete Pavement” .

(B) REFERENCES

AASHTO T96 -Standard Method of Test for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact

AASHTO T209 -Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures

AASHTO T275 -Standard Method of Test for Bulk Specific Gravity of Compacted Bituminous Mixtures Using Paraffin-Coated Specimens

AASHTO T283 -Standard Method of Test for Resistance of Compacted Asphalt Mixtures to Moisture-Induced Damage

ASTM D3203 -Standard Test Method for Percent Air Voids in Compacted Dense and Open Bituminous Paving Mixtures

ASTM D4791 -Standard Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate

ASTM D5821 -Standard Test Method for Determining the Percentage of Fractured Particles in Coarse Aggregate

ASTM D6390 -Standard Test Method for Determination of Draindown Characteristics in Uncompacted Asphalt Mixtures

ASTM D6752 -Standard Test Method for Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Automatic Vacuum Sealing Method

NAPA IS-115 -Open-Graded Asphalt Friction Courses, Design, Construction & Maintenance

NAPA IS-131 - Porous Asphalt Pavements for Stormwater Management NAPA – National

Asphalt Pavement Association

(C) MATERIALS

The materials for permeable asphalt pavement shall meet the requirements of Greenbook Standard Specification Section 203-15 and the following:

1. Performance graded asphalt binder (PGAB) for base and surface course shall meet the requirements of Green Book Standard Specifications Section 203-15.2 “Materials”.
2. Coarse aggregate shall confirm to Green Book Standard Specifications Section 203-15.2.2 “Aggregate”.

3. Additives such as cellulose or mineral filler, or anti-strip additives, shall be included when stipulated in the Contract Documents or as allowed by the Engineer.

(D) COMPOSITION OF THE MIXTURES

The Contractor shall develop for approval a job mix formula (JMF) for proportioning of each type of permeable asphalt pavement proposed for use as specified in the Contract Documents (surface, leveling, base, or other) in accordance with Green Book Standard Specifications Sections 203-15.3 “Composition and Grading” .

(E) SUBMITTALS

1. **Contractor Qualifications -**At the time of bid submission, Contractor shall submit the name and qualifications of the permeable asphalt installer, providing written evidence of project experience and proficiency in successfully completing permeable asphalt pavement construction including a minimum of three (3) completed projects, total square footage to exceed the project quantities with owner information, addresses of each project, and the following:

   (i) Job mix designs used;

   (ii) In-Situ pavement test results; and

2. **Testing Agency** – Within 7 days of notice to proceed, Contractor shall furnish the name and location of a third-party QA Inspection Agency with experience in testing permeable asphalt, who will oversee and document mix production. Use of testing services will not relieve the contractor of the responsibility to furnish materials and construction in full compliance with the Contract.

3. **Producer Qualifications** – Within seven (7) days after notice to proceed, the Contractor shall furnish the name and location of an asphalt plant that is an authorized material source as defined by the Department’s *Certification Program for Suppliers of Asphalt* and will produce and provide permeable asphalt.

   a. Job Mix Designs – At least thirty (30) working days before construction, Contractor shall furnish job mix designs for the permeable asphalt, which shall include at a minimum all mix design described in this specification.

   b. Material Sources: Submit a list of materials proposed for work under this Section including the name and address of all material sources and all bituminous mixing plants.

c. Certificates: Submit certificates, signed by the material sources and the relevant subcontractors, stating that the materials meet or exceed the specified requirements.

d. Samples: Submit samples of all materials and all current test results of the mix for review and approval by the Engineer and test results to a County-approved lab.

4. Test Results – Testing agency shall provide pavement test result:

a. Air void content shall be calculated using California Test 309 (Compact specimen and determine bulk specific gravity in accordance with CT 308 Method B (See Green Book Standard Specifications Section 203-15.3 “Composition and Grading”).

b. Test results per Table 1

Table 1 – Certification Requirements

Material*	**Properties to be reported on Certificate****
binder PGAB	Certification
coarse aggregate	gradation, wear, fracture faces (fractured and elongated)
fine aggregate	Gradation
Silicone, when applicable	manufacturer's certification
Fibers, when applicable	manufacturer's certification
Mineral filler, when applicable	manufacturer's certification

* Samples of each material shall be submitted to the Engineer. Samples must be in sufficient quantity to perform tests for each material per Green Book Standard Specifications Section 4 “Control of Materials”.

** At a minimum; more material properties may be required per Contract Documents.

(F) WEATHER AND SEASONAL RESTRICTIONS

Comply with the following:

1. The ambient air temperature during the past 24 hours shall be above 50°F
2. The asphalt laying temperature should be within 10°F of the compactive temperature in the approved job mix design.

(G) HAULING OF ASPHALTIC MATERIALS

1. The asphalt shall be transported in clean vehicles with tight, smooth dump beds that have been sprayed with a non-petroleum release agent or soap solution to prevent the mixture from adhering to the dump beds. Mineral filler, fine aggregate, slag dust, and similar materials shall not be used to dust truck beds.
2. The open graded mix shall be covered during transport to protect the mix from weather and to minimize mix cooling and prevent lumps. Long hauls, particularly those in excess of 25 miles may result in separation of the mix and its rejection, and are not recommended.

(H) PREPARATION OF GRADE

1. **Sub-Grade Preparation** – Shall be in accordance with the specification “Aggregates for Green Streets Facilities”.
2. **Base Materials –** Shall be in accordance with the specification “Aggregates for Green Streets Facilities”.

(I) SPREADING AND FINISHING

1. **Pre-Placement Conference** -A mandatory pre-placement conference will take place at least seven (7) days prior to installation of work and shall include at a minimum engineer, inspector, superintendent, asphalt installer, and QA inspector.
2. Contact surfaces such as curbing, gutters, and manholes shall be painted with a thin, uniform coat of Type RS-1 emulsified asphalt immediately before the asphalt mixture is placed against them.
3. Place the asphalt using self-propelled paving equipment with an activated screed or strike-off assembly capable of being heated if necessary, and capable of spreading and finishing the mixture without segregation. Track pavers are recommended.
4. The use of water to cool the pavement is prohibited.
5. Place lifts no more than 24 hours after each previous lift to minimize the use of tack coats. Tack coats will only be allowed if required by the Contract Documents or approved by the Engineer.
6. The finished surface shall be of a uniform texture and evenness, and shall not show any indication of tearing, shoving, or pulling of the pavement during placement.

(J) COMPACTION OF PERMEABLE ASPHALT

1. Roll the asphalt using a two-axle tandem roller when it is cool enough to withstand the roller without displacement of the asphalt, and using rollers sufficient to compact the asphalt without crushing the aggregate or compromising the required void content and infiltration rates.
2. The number, mass (weight), and type of rollers furnished shall be sufficient to obtain the required compaction while the mixture is in a workable condition. Generally one breakdown roller will be needed for each paver used in the spreading operation.

   a) Breakdown rolling shall occur when the mix temperature is between 275 and 325°F.

   b) Intermediate rolling shall occur when the mix temperature is between 200 and 275°F.

   c) Finish rolling shall occur when the mix temperature is between 150 and 200°F.
3. Unless otherwise specified, the longitudinal joints shall be rolled first. Next, the Contractor shall begin rolling at the low side of the pavement and shall proceed toward the center or high side with lapped rolling parallel to the centerline.
4. Roll until all roller marks are gone however avoid excessive rolling which could reduce the infiltration capabilities of the asphalt.
5. To prevent adhesion of the mixture to the rolls, rolls shall be kept moist with clean water or water mixed with very small quantities of detergent or other approved

materials. Excess liquid will not be permitted.

6. Along forms, curbs, headers, walls, and other places not accessible to the rollers, the mixture shall be thoroughly compacted with hot or lightly oiled hand tampers, smoothing irons or with mechanical tampers. On depressed areas, either a trench roller or cleated compression strips may be used under the roller to transmit compression to the depressed area.
7. Rollers will not be stopped or parked on the freshly placed mixture; Foot-traffic shall not be allowed on fresh asphalt for at least 24-hours.
8. Any mixture that becomes loose and broken, mixed with dirt, or is in any way defective shall be removed and replaced with fresh hot mixture. The mixture shall be compacted to conform to the surrounding area with segregation. Any area showing deficiencies shall be replaced at the Contractor's expense.

(K) JOINTS

1. Joints between old and new pavements or between successive days work shall be made to ensure a thorough and continuous bond between the old and new mixtures. Whenever the spreading process is interrupted long enough for the mixture to attain its initial stability, the paver shall be removed from the mat and a joint constructed.
2. Butt joints shall be formed by cutting the pavement in a vertical plane at right angles to the centerline, at locations approved by the Engineer. The Engineer will determine locations by using a straightedge at least 16 feet long. The butt joint shall be thoroughly coated with Type RS-1 emulsified asphalt just prior to depositing the pavement mixture when paving resumes.
3. Tapered joints shall not be allowed. Longitudinal joints that have become cold shall be coated with Type RS-1 emulsified asphalt before the adjacent mat is placed. If directed by the Engineer, joints shall be cut back to a clean vertical edge prior to applying the Type RS-1 emulsified asphalt.

(L) PAVEMENT SAMPLES

The Contractor shall cut 4" minimum diameter core samples for air voids and thickness plus box samples from the compacted pavement for testing within 24 hours of placement. Samples of the mixture shall be taken for the full depth of the pavement every 200 tons of placement or 1 sample per day, whichever is greater, or as directed by the Engineer.

(M) TESTING

1. **Quality Assurance (QA) Inspector**
   a. The Contractor shall provide at the Contractors' sole expense and the Engineer's approval a third-party QA Inspector to oversee and document mix production. All mix testing results during production shall be submitted to the QA Inspector.
   b. The QC plan may be altered at the discretion of the Engineer and based on written recommendations from the QA Inspector.
   c. For small batch production, the Engineer may also modify or eliminate some testing requirements in the QC plan.

2. **During Production**
   a. The Contractor shall sample, test and evaluate the mix in accordance with the methods and minimum frequencies in the Table 2. Test results shall be delivered to the Engineer.

Table 2: QC/QA testing requirements during production

Test	Minimum Frequency	Test Method
Temperature in Trucks Prior to leaving Plant	Six times per day	-
Gradation	Greater of either (a) 1 per 500 tons, (b) 2 per day, or (c) 3 per job	AASHTO T30
Binder Content	Greater of either (a) 1 per 500 tons, (b) 2 per day, or (c) 3 per job	AASHTO T164
Air Void Content	Greater of either (a) 1 per 500 tons, (b) 2 per day, or (c) 3 per job	ASTM D6752

   b. Testing of the temperature, binder content, and air void content shall be within the limits set by this specification.
   c. Testing of the gradation shall not vary from the approved design mix by more than the tolerances in Table 3.

Table 3: QC/QA testing tolerances during production

Sieve Size	Percent Passing
0.75	--
0.50	+ 6.0
0.375	+ 6.0
No. 4	+ 5.0
No. 8	+ 4.0
No. 200	+ 2.0
% PGAB	+ 0.4, -0.2

d. Should the asphalt fail to meet all testing requirements initially, production modifications shall be made until the permeable asphalt mix is within required tolerances. After the corrective action has been taken the resulting mix will be sampled and tested again at the Contractor's expense.

e. If the re-sampled asphalt fails to meet all testing requirements again, the Engineer will be immediately informed and provided with the test results. The Engineer may determine that it is in the best interest of project that production is ceased at that time. The Contractor will be responsible for all costs associated with the inability of the asphalt plant to meet all testing requirements.

3. **Following Placement**

a. The full permeability of the pavement surface shall be tested prior to final acceptance in accordance with ASTM D6390.

b. Test in-place base and surface course for compliance with requirements for thickness, void content and unit weight as described above by using 1' x 1' slab samples. Repair or remove and replace unacceptable work as directed by the Engineer at the Contractor's cost.

c. Surface Smoothness: Test finished surface for smoothness using a 10 foot straightedge applied parallel with and at right angles to the centerline of the paved area. Surface will not be accepted if gaps or ridges exceed 3/16 of an inch. The smoothness requirements specified herein apply only to the top lift of each layer, when asphalt is constructed in more than one lift.

d. QC/QA requirements during paving are summarized in Table 4.

Table 4. QC/QA requirements during paving

Activity Schedule	Frequency	Tolerance
Inspect truck beds for pooling (draindown)	every truck	NA
Take surface temp. behind joint heater	each pull	6°C (10°F) of compaction temp
Test surface smoothness & positive drainage with a 10 ft straight edge	After compaction	4.5 mm (3/16")
Hose test with at least 5 gpm water	after compaction	immediate infiltration, no ponding

(N) PROTECTION OF ASPHALTIC PAVEMENT

Minimum times prior to opening pavement to traffic are as follows:

- After pavement has been permitted to cool to below 100 °F for all traffic, and;
- 24 hours for pedestrian traffic, and;
- 48 hours for vehicular traffic.

The Contractor shall protect the permeable asphalt from severe weather conditions and contamination by dust, dirt, mud or other fine grained material or sediment. The asphalt shall be protected by an approved method from the time of placement until final acceptance of the project. Any damage to the permeable asphalt caused by the contractor's equipment shall be repaired by the contractor at no cost to the owner. Any portion of the permeable asphalt that becomes contaminated to the extent that drainage is reduced or inhibited shall be removed and replaced at no expense to the owner.

(O) MEASURE AND PAYMENT

The unit of measure for Permeable Asphalt Pavement will be tons. The number of tons will be the actual number of tons complete in place, as weighed on approved truck scales. The County Engineer will deduct the weight of all material lost, wasted, damaged, rejected or applied in excess of the Engineer's direction or contrary to these specifications. The number of tons of Permeable Asphalt Pavement type specified, as measured, will be paid at the contract unit price per ton, which payment will be full compensation for furnishing, hauling, and placing all materials and for furnishing all equipment, tools, labor and incidentals necessary to complete the work as specified herein.

PERMEABLE INTERLOCKING CONCRETE PAVERS

(A) DESCRIPTION

This work shall consist of constructing permeable interlocking concrete pavers on a prepared sub-grade in accordance with these specifications and in conformity with the lines, grades, thicknesses and typical sections shown in the contract documents or as directed by the Engineer.

The permeable interlocking concrete pavers shall consist of a concrete pavers, permeable joint material, open-graded bedding course, open graded base and subbase material, underdrain, geotextile to reduce runoff and water pollution.

(B) REFERENCES

ASTM C936 – Solid Concrete Interlocking Paving Units

ASTM C979 – Standard Specification for Pigments for Integrally Colored Concrete

ASTM No. 8, 9 and 89 – Grading Requirements for Bedding Material

ASTM No 57 – Grading Requirements for Base Material

ASTM No, 2, 3 and 4 - Grading Requirements for Subbase Material

ASTM C979 – Standard Specification for Pigments for Integrally Colored Concrete

ASTM C67 – Standard Test Methods for Sampling and Testing Brick and Structural Clay Tile

ASTM C140 - Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units

ASTM C150 – Standard Specification for Portland Cement

ASTM C418 - Standard Test Method for Abrasion Resistance of Concrete by Sandblasting

(C) MATERIALS

Materials shall be approved in accordance with the following:

1. All concrete pavers shall meet ASTM C936 requirements.
2. Bedding and Joints: AASHTO #8 aggregate or similar, as directed by the Contract Documents and in accordance with Specification for “Aggregates for Green Streets Facilities” section.
3. Open graded base layer should match the specifications on “Aggregates for Green Streets Facilities” section
4. Open graded subbase: The stone sizes are larger than the base, primarily 3 in. down to 2 in. (75 mm down to 50 mm), typically ASTM No. 2, 3 or 4 stone. Like the base layer, water is stored in the spaces among the stones. The subbase layer thickness de pends on water storage requirements and traffic loads. A subbase layer may not be required in pedestrian or residential driveway applications. In such instances, the base layer thickness is increased to provide water storage and support.

5. Underdrain pipes should match the standard specification on “underdrain for stormwater facilities” section

6. Geotextiles should match the standard specification on “Geosynthetics for stormwater” section

7. All unit pavers shall meet surface requirements of the latest Americans with Disabilities Act (ADA) requirements and accessibility guidelines.

8. Interlocking concrete pavers shall be of the type, style, color, and other details as described in the Contract Documents and in accordance with all manufacturer’s recommendations for the selected unit paver system.

a. Shapes: rectangular, L-shaped, hexagonal, square as specified in design plans
b. Thickness: 3 1/8 in. for vehicular use, 2 3/8 in. for pedestrian use.
c. Colors will match surrounding conditions as specified in design plans: Light gray, brick
d. Concrete Unit Pavers: The material and fabrication for the unit pavers shall meet or exceed the requirements of ASTM C936 "Solid Concrete Interlocking Paving Units” and must allow a minimum infiltration rate of 60 in/hr through the pavement upon installation.
    i. Portland cement: ASTM C150, Type 1.
    ii. Aggregate: Normal weight ASTM C33.
    iii. Pigments: ASTM C979 and as specified in the Contract Documents.
    iii. Other constituents: Previously established by test or experience as suitable for use in concrete, in compliance with applicable ASTM standards or as otherwise approved by the Engineer
    iv. Paver physical properties:
        (a) Provide only sound units free of defects that would allow proper placing of units to achieve the specified pavement strength and performance.
        (b) Compressive strength: ASTM C140, when delivered to the project site, average compressive strength of not less than 8,000 psi, with no individual unit less than 7,200 psi.
        (c) Absorption: ASTM C140, average absorption not greater than 5%, with no individual unit greater than 7%.
        (d) Resistance to freezing and thawing: ASTM C67, with no breakage and not greater than 1% loss in dry mass of any individual unit after 50 cycles of freezing and thawing.
        (e) Abrasion resistance: ASTM C418, maximum volume loss of 0.915 cubic inches / 7.75 sq. in. Average thickness loss of no more than 0.118” (3 mm) due to abrasion testing.
        (f) Dimension tolerances: Length +/- 1/16”, Height +/- 1/8”

(D) SUBMITTALS

Contractor shall submit drawings and documentation as required in this specification and obtain written acceptance of submittals before using the materials or methods requiring

approval.

1. **Contractor Qualifications** – At the time of bid submission, Contractor shall:
    a. Submit the name and qualifications of the installer, providing written evidence of project experience and proficiency in successfully completing permeable interlocking paver construction including a minimum of three (3) completed projects, total square footage to exceed the project quantities with owner information, address and a sample of the product used, or photographs thereof, and the following: complete description of the product type and style; and details of the manufacturer's mold assembly with patterns, dimensions, all edge details and radii, spacer bars, and the mold head or shoe; and
    b. Submit written evidence of an Installer who will be onsite at all times during the permeable interlocking paver installation, with a current certificate from the Interlocking Concrete Pavement Institute (ICPI) Installer Certification Program and a record of completion from the Permeable Interlocking Concrete Pavers (PICP) Specialist Course, or
    c. Submit written evidence that the Contractor will obtain the service of a consultant who has the required certifications and who will be on site at all times during the interlocking concrete paver installation, acting as the installer for the project.

2. **Testing Agency** – Within seven (7) days after notice to proceed, the Contractor shall submit the name and location of a third party QA testing agency with experience in testing permeable interlocking unit pavements, who will oversee and document production and assembly. Use of testing services will not relieve contractor of the responsibility to furnish materials and construction in full compliance with the Contract Documents.

3. **Producer Qualifications** – Within seven (7) days after notice to proceed, the Contractor shall furnish the name and location of the plant that will produce the interlocking concrete pavers.

    a. Product Information: The plant shall provide product information including all material sources and all manufacturers' recommendations that are relevant to the project.
    b. Certifications: The plant shall provide current certifications, signed by the material sources as relevant, stating that the materials will meet or exceed all specified requirements.
    c. Samples: The plant shall provide three (3) samples of interlocking concrete pavers.

4. **Test Panels –** At least fifteen (15) days before construction of interlocking concrete pavers, and following the engineer's acceptance of the qualifications described above, the Contractor shall provide a minimum of one (1) test panel for acceptance. Place, joint and cure the test panel, to be a minimum of 275 square feet in size or as specified in the Contract Documents, at the required project thickness to demonstrate to the engineer's satisfaction that the unit pavers and design flow rates are acceptable, and that a satisfactory pavement can be installed at the site location. Testing shall be in accordance with Section (G).

5. **Test Reports** - Submit test reports certifying compliance with all material and physical requirements stated herein. All tests shall have been conducted not more than twelve (12) months before manufacturing of the interlocking concrete pavers.

(E) PREPARATION OF GRADE

1. **Sub-Grade Preparation** – Shall be in accordance with Specification for Aggregates for Green Streets Facilities.

2. **Base Materials** – Shall be in accordance with Specification for Aggregates for Green Streets Facilities.

3. **Edge Restraints** - Install all edge restraints of the types, locations and dimensions shown on the Contract Documents and at the lines and grades required. Permeable interlocking pavement shall not be allowed without edge restraints around the entire perimeter without the written approval of the Engineer.

4. **Protection** - Shall be in accordance with Specification for Aggregates for Green Streets Facilities.

(F) INSTALLATION

1. Pre-Placement Conference - A mandatory pre-installation conference will take place at least two (2) weeks prior to installation of the unit pavers and shall include at a minimum engineer, inspector, general contractor, permeable interlocking concrete paver installer, manufacturer, and field testing agency.

2. Install geotextile, impermeable liner and drain pipes if required in the plans and contract in accordance with the specifications for the Geosynthetics for Green Streets Facilities

3. Install base materials in accordance with the Specification for Aggregates for Green Streets Facilities.

4. Moisten, spread and screed aggregate bedding material and fill any voids left by screed rails. Do not roll or compact the bedding material prior to placing permeable interlocking pavers.

5. Lay the interlocking concrete pavers in the type, style, pattern, dimensions, and locations with joint widths as recommended by the Manufacturer and shown on the Contract Documents. Maintain consistent and uniform patterns for the entire pavement area.

6. Fill gaps at the edges of the paved area with cut units. Cut pavers subject to vehicular traffic shall be no smaller than 1/3 of a whole unit and shall have no sharp edges. Patterns shall be maintained to the extent possible in placing cut units to fill gaps in the pattern. Stagger blocks to avoid running bond or other straight joints or seams in the pattern.

7. Fill the openings and joints with washed ASTM No. 8 aggregate. Some paver joint widths may be too narrow to accept most No. 8 stone. In such case, use joint material that will fill joints such as washed ASTM No. 89 or No. 9 stone. Sweep excess aggregate from the surface.

8. Compact and seat the interlocking concrete pavers into the bedding material using a low amplitude, 75-90 Hz plate compactor capable of at least 5,000 lbf centrifugal compaction force. This will require at least two (2) passes with the plate compactor over the entire surface.

9. Apply additional ASTM #8, #9 or #89 aggregate to the openings and joints as needed, filling them in completely, then remove excess aggregate by sweeping, and make at least two (2) more passes with the plate compactor over the entire surface.

10. All interlocking concrete pavers within six (6) feet of the laying face must be fully compacted at the completion of each day's work.

(G) TESTING

Testing responsibilities will be performed by the Contractor's testing agency or the

Manufacturer at the Contractor's expense, as described below. Materials approval testing will be performed by the County-approved lab. Failure to detect defective work or materials early will not prevent rejection if a defect is discovered nor shall it obligate the owner for final acceptance at any time.

1. **Manufacturer's Testing** – Testing of the materials to demonstrate compliance with the requirements of Section (C) of this specification shall be the combined responsibility of the Contractor and the manufacturer. Test results shall be approved by the Engineer in advance of the construction work.

2. **Smoothness Testing** - Test finished unit paver system with a 10 foot straightedge, applied parallel with and at right angles to the center line of the paved area. Correct deviations in the surface in excess of one-half (1/2) inch by removing the unit pavers as necessary and then loosening, adding or removing material, re-shaping, watering, and re-compacting. The smoothness requirements specified herein apply only to the top lift of each layer, when base course is constructed in more than one lift.

3. **Infiltration Testing** - The full permeability of the pavement surface shall be tested prior to final acceptance by application of clean water at least 5 gallons per minute, using a hose or other distribution device. Water used for the test shall be clean, free of suspended solids and deleterious liquids. All applied water shall infiltrate directly without large puddle formation or surface runoff, and the testing shall be observed by the Engineer. A minimum flow rate of 60 inches per hour is required.

(H) PROTECTION

1. As construction is completed, maintain and protect the permeable pavement. Correct deficiencies in thickness, composition, construction, and smoothness, which develop during the maintenance, to conform to the requirements specified herein.

2. Finishing along the edges of the permeable pavement for protection during construction shall be until the site is fully stabilized, at which time excess filter fabric and impermeable liners can be cut back to the pavement edges.

3. In addition, runoff onto permeable pavement shall be minimized until the site is fully stabilized as described in the Contract Documents. Diversion ditches or other approved types of erosion and sediment control measures shall be placed at the toe of slopes which are adjacent to permeable pavement, to prevent sediment from washing into pavement areas at all times during and after construction. Any sediment accumulation onto the permeable pavement shall be removed immediately by cleaning or replacement of the aggregate by the Contractor at no cost to the owner.

(I) MEASURE AND PAYMENT

The unit of measure for Permeable Interlocking Concrete Paver Pavement will be in square yards for the type(s) specified in the Contract Documents. The actual number of square yards complete in place will be paid for at the contract unit price per square yard, or adjusted unit price per square yard, which payment includes unit pavers, bedding material, and joint filler, complete and in place. Payment will include costs for furnishing all materials, labor, tools, equipment and incidentals to complete the work.

ENGINEERED SOILS: RAIN GARDEN, PLANT BED, AND SAND BASED SOILS

(A) DESCRIPTION

This work consists of supplying, testing, amending, mixing and installing various planting soil categories for use in stormwater management and horticultural plantings, covering the following:

1. Planting Soil shall refer to Rain Garden Soil, Plant Bed Soil, and/or Sand-Based Structural Soil.
2. Rain Garden Soil: soil blend for use in stormwater rain garden facilities.
3. Plant Bed Soil: planting medium for trees, shrubs, and groundcovers in Plant Beds
4. Sand Based Structural Soil: soil blend for trees where planting soils are beneath paved surfaces and horticultural subsoil.
5. Compost: a soil amendment to be used with existing soil
6. Sand: for beneath structural soils as required in Contract Documents

Except as herein stated, the requirements specified for Green Book Standard Specifications Section 800 “Landscaping and Irrigation” are applicable to this specification.

(B) MATERIALS

1. GENERAL – Rain Garden, Plant Bed, and Sand Based Structural Soil Mixtures

   a. Soils mixtures are composed of a blend of three base components: base loam, organic material and sand. The Soil Supplier is responsible for locating and obtaining approval of sources for base loam, organic material and sand that meet the Specification requirements. The Soil Supplier is responsible for mixing the components. Approximate mixing ratios are as specified herein, but may require adjustment, depending on the characteristics of the final base materials.

   b. Base Components

      (i) Base Loam: a natural A-horizon growing medium free from admixtures.

      (ii) Organic Material or Compost: a fully decomposed yard waste organic material.

      (iii) Sand: uniformly-graded medium to coarse sand.

   c. Soil medium materials shall fulfill the requirements as specified and be tested to confirm the specified characteristics.

2. BASE LOAM

   a. Base Loam shall be natural A-horizon topsoil free of subsoil, large stones, earth clods, sticks, stumps, clay lumps, roots or other objectionable, extraneous matter or debris. Base Loam shall also be free of primary noxious weeds. Base Loam shall not be delivered or used for planting while in a frozen or muddy condition.

Base Loam for mixing shall conform to the following grain size distribution for material passing the #10 sieve by weight:

U.S. Sieve Size Number	Percent Passing	
	Minimum	Maximum
10	100	---
18	85	100
35	70	95
60	54	85
140	42	68
270	36	60
0.002mm	3	12

b. Maximum size shall be one-inch largest dimension. The maximum retained on the #10 sieve shall be 20% by weight of the total sample. Tests shall be by combined hydrometer and wet sieving in compliance with ASTM D422 after burning off organic matter by ignition. The organic content shall be between 3.0 and 6.0 percent by weight. Base Loam shall have a well-developed and stable crumb structure.

c. Unless otherwise recommended by the Soil Supplier's Soil Scientist: Cation Exchange Capacity shall be not less than 12 and Soluble Salts shall be not more than 2,000 ppm/2.0 mmhos/cm.

3. COARSE SAND FOR SOIL MIXTURES

a. Sand for blending, protection layer above filter fabrics, and drainage below planting soils shall be uniformly graded medium to coarse sand consisting of clean, inert, rounded to sub-angular grains of quartz or other durable rock free from loam or clay, surface coatings and deleterious materials, include no more than 0.5% mica, and have the following gradation for material passing the #10 sieve by weight.

U.S. Sieve Size Number	Percent Passing	
	Minimum	Maximum
10	100	---
18	60	80
35	25	45
60	8	20
140	0	8
270	0	3
0.002mm	0	0.5

b. Maximum size shall be one-inch largest dimension. The maximum retained on the #10 sieve shall be 15% by weight of the total sample. The ratio of the particle size for 70% passing (D70) to the particle size for 20% passing (D20) shall be 3.0 or less (D70/D20 <3.0). Tests shall be by combined hydrometer and wet sieving in compliance with ASTM D422 after burning off organic matter by ignition.

c. Coarse sand shall be non-calcite and shall not be derived from serpentine. pH shall be less than 7.5.

4. ORGANIC AMENDMENT (COMPOST)

a. Organic Matter for amending planting soils shall be a stable, humus-like material produced from the aerobic decomposition and curing of leaf and yard waste composted for a minimum of one year (12 months). The leaf and yard waste compost shall be free of debris such as plastics, metal, concrete or other debris. The leaf and yard waste compost shall be free of stones larger than 1/2", larger branches and roots. Wood chips over 1" in length or diameter shall be removed by screening. The compost shall be a dark brown to black color and be capable of supporting plant growth with appropriate management practices in conjunction with addition of fertilizer and other amendments as applicable, with no visible free water or dust, with no unpleasant odor, and meeting the following criteria as reported by laboratory tests.

(i) The ratio of carbon to nitrogen shall be in the range of 12:1 to 25:1.

(ii) Stability shall be assessed by the Solvita procedure. Protocols are specified by the Solvita manual (latest version). The compost must achieve a maturity index of 6 or more as measured by the Solvita scale. Stability tests shall be

conducted by a County approved lab.

(iii) Pathogens/Metals/Vector Attraction reduction for compost material derived from biosolids shall meet 40 CFR Part 503 rule, Table 3, page 9392, Vol. 58 No. 32, (for applications to soils with human activity).

(iv) Organic Content shall be at least 20 percent (dry weight). One hundred percent of the material shall pass a 3/8-inch (or smaller) screen. Debris such as metal, glass, plastic, wood (other than residual chips), asphalt or masonry shall not be visible and shall not exceed one percent dry weight. Organic content shall be determined by weight loss on ignition for particles passing a number 10 sieve.

(v) pH: The pH shall be between 6.5 to 7.2 as determined from a 1:1 soil-distilled water suspension using a glass electrode pH meter American Society of Agronomy Methods of Soil Analysis.

(vi) Salinity: Electrical conductivity of a one to five soil to water ratio extract shall not exceed 2.5 mmhos/cm (dS/m).

(vii) The compost shall be screened to 1/2 inch maximum particle size and shall contain no more than 3 percent material finer than 0.002mm as determined by hydrometer test on ashed material.

(viii) Chemical analysis shall be undertaken for Nitrate Nitrogen, Ammonium Nitrogen, Phosphorus, Potassium, Calcium, Aluminum, Magnesium, Iron, Manganese, Lead, Soluble Salts, Cation Exchange Capacity, soil reaction (pH), and buffer pH. The Soil Supplier's Soil Scientist shall provide a recommendation as to the suitability of the compost based on review of the test results.

5. SOIL ADDITIVES

   a. Ground Limestone: dolomitic limestone and contain not less than 50 percent of total carbonates and 25 percent total magnesium with a neutralizing value of at least 100 percent. Material shall be ground to such fineness that 40 percent will pass through the 100 mesh U.S. standard sieve and 98 percent will pass through the 20 mesh U.S. standard sieve.

   b. Acidulant for adjustment of planting soils pH shall be commercial grade sulfur, ferrous sulfate, or aluminum sulfate for horticultural use that are unadulterated. Acidulants shall be delivered in unopened containers with the name of the manufacturer, material, analysis and net weight appearing on each container.

   c. Fertilizer: slow-release granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in a composition as recommended by the Soil Testing Laboratory.

   d. Use of peat moss is prohibited.

6. SAND – for the layer underneath structural soil as called for in the Contract Documents shall meet the gradation requirements of Section (B), Subsection 3 of this provision.

(C) SUBMITTALS AND TESTING

1. Critical Path Processing -Soils Testing Report Submittals. The Contractor is responsible for recognizing that these project materials warrant timely and serious attention, that the testing process to achieve approved materials shall be considered a lead time item, and that under no circumstance shall failure to comply with all specification requirements be an excuse for a delay or for expedient substitution of unacceptable material(s).

2. Sources for Soil Components and Soil Mixes: Within seven (7) days after notice to proceed, submit information identifying sources for soil components and the firm responsible for mixing of soil mixes:

   a. Soil mix supplier shall have a minimum of five years of experience supplying custom planting soil mixes.
   b. Submit supplier name, address, telephone and fax numbers and contact name.
   c. Submit certification that accepted supplier is able to provide sufficient quantities of materials and mixes for the entire project.

3. Testing Agency**:** Within seven (7) days after notice to proceed, Contractor shall furnish the name and location of the proposed testing agency. Agency proposed for testing of horticultural soils shall be an approved member of the Performance Assessment Program (PAP) administered by the North American Proficiency Testing (NAPT) Oversight Committee. The Testing agency shall be accepted by the County Engineer.

4. Product Data: No later than 30 days prior to planned soil construction, submit most recent printed information from manufacturer for:

   a. Organic Material: identify the material(s) from of which is it composed and identify the location where material was composted.
   b. Fertilizers
   c. Ground Limestone
   d. Sulfur

5. Samples and Test Reports: Submit representative samples and reports to the Engineer and the Testing Agency as described herein for approval. Delivered materials shall closely match the approved samples.

   a. Submit 1 gallon soil samples and horticultural soil test reports in two phases.

      (i) Planting Soil Base Components:

      - Base Loam
      - Organic Amendment (Compost)
      - Sand

      Submit samples of above to the Testing Agency. Submit soil testing reports to Engineer no later than 21 days prior to planned soil construction.

(ii) Only after approval of base components, submit soil blend mixes / mediums for approval. Mixing and batching of soil mediums in the same manner as bulk soils will be prepared for delivery to site, and shall include:

- Rain Garden Soil
- Plant Bed Soil
- Sand-Based Structural Soil

Submit samples of above to the Testing Agency. Submit duplicate samples and soil testing reports to Engineer no later than 14 days prior to planned soil construction.

(iii) Samples of each soil type delivered to the site shall be taken and tested for conformance with the Specification Requirements. Submit duplicate samples and soil testing reports to Engineer.

b. Soil Sampling: Sampling shall be done by the Soil Supplier. Samples shall be representative of the material to be brought to the site. Each sample shall be a Composite Sample, which consists of 5 separate sub-samples taken from a minimum of (5) different locations at each source and mixed together to make the test sample.

c. Test Reports shall be certified and shall cover the items below. <u>All reports must be from recent analyses, less than 90 days old, and represent materials that are available for delivery to the site.</u>

(i) Mechanical gradation (sieve analysis) shall be performed and compared to the USDA Soil Classification System.

(ii) The silt and clay content shall be determined by a Hydrometer Test of soil passing the #270 sieve. Percent clay (0.002 mm) shall be reported separately in addition to silt (ASTM D-422-63, hydrometer method).

(iii) Chemical analysis shall be undertaken for Nitrate Nitrogen, Ammonium Nitrogen, Phosphorus, Potassium, Calcium Magnesium, Aluminum, Manganese, Cation Exchange Capacity, Soluble Salts, acidity (pH) and buffer pH.

Tests shall be conducted in accordance with California Test Methods (CTM).

Certified reports on analyses from producers of composted organic materials are required. Analyses will include all tests for criteria specified herein.

(b) Density Tests: In-place density testing is required in all areas. Placed planting soils must be inspected for compaction level by the soil scientist or by the following: ASTM D1556 Density of Soil and Rock In Place Using Sand Cone Method, ASTM D6398-10 Nuclear Methods or ASTM D2167-08 Rubber Balloon method. AASHTO T-99 (Standard Effort) in accordance with County specifications shall be used for Laboratory Compaction Characteristics of Soil unless otherwise directed.

- Contractor shall perform In-place density tests at a rate of one test per 2,000 square feet for each type of material placed.

(c) Test data and recommendations for soil amendments including but not limited to: nitrogen, phosphorus, potassium and limestone

6. Certificates: No later than 7 days prior to planned soil construction, submit certification that soil blend components and soil mediums meet applicable environmental standards of the County.

(D) PROPORTIONING

Soil Supplier shall uniformly mix ingredients on an approved hard surface area or with soil blending equipment. Soils and Organic Amendment shall be maintained moist, not wet, during mixing. Amendments shall not be added unless approved to extent and quantity by the owner and additional tests have been conducted to verify type and quantity of amendment is acceptable. Percentages of components, unless otherwise noted, will be established upon completion of individual test results for components of the various mixes.

After component percentages are determined by the Soil Supplier's Soil Scientist, each planting soil medium shall be tested for physical and chemical analysis.

1. RAIN GARDEN SOIL

   Rain Garden Soil shall consist of a blend of approximately 55% by volume Coarse Sand, 20% by volume Base Loam and 25% by volume of Organic Amendment. This blend will comply with the rain garden soil requirement in the County of San Diego Low Impact Development Handbook, in which soil components are given by weight. The components shall be blended to create a uniform mixture that meets the following criteria. Percentages will be adjusted as necessary to achieve the following grain size distribution and criteria below for material passing the #10 sieve by weight:

U.S. Sieve Size Number	Percent Passing	
	Minimum	Maximum
10	100	--- (Coarse Sand)
18	68	95 (Coarse Sand)
35	38	65 (Coarse Sand)
60	22	37 (Fine Sand)
140	15	22 (Fine Sand)
270	12	14 (Silt)
0.002mm	1	4 (Clay)

a. Maximum size shall be one inch largest dimension. The maximum retained on the #10 sieve shall be 15% by weight of the total sample.
b. The ratio of the particle size for 70% passing (D70) to the particle size for 20% passing (D20) shall be 4.5 or less (D70/D20 <4.5).
c. The final mix shall have a saturated hydraulic conductivity of not less than 4.0 inches per hour according to test procedure ASTM D5856-95 (2000) when compacted to a minimum of 86 percent of the maximum density as determined by AASHTO T-99. The mix shall be compacted at 60% to 80% optimum moisture content.
d. Organic content shall be between 3.0 and 4.0 percent by weight.
e. Unless otherwise specified or recommended by the Soil Supplier's Soil Scientist: pH shall be between 6.5 and 7.2; CEC shall be a minimum of 7; P-Index shall be between 10 and 30; and Soluble Salts shall be less than 500 ppm/0.5 mmhos/cm.

2. PLANT BED SOIL

Base Loam, Sand and Compost, each as specified above, shall be combined in approximately equal parts by volume Sand, Base Loam and Compost to create a uniform blend which meets the following requirements. Percentages will be adjusted as necessary to achieve the following grain size distribution and criteria below for material passing the #10 sieve by weight:

U.S. Sieve Size Number	Percent Passing	
	Minimum	Maximum
10	100	--- (Coarse Sand)
18	80	95 (Coarse Sand)
35	56	80 (Coarse Sand)
60	32	56 (Fine Sand)
140	23	32 (Fine Sand)
270	19	23 (Silt)
0.002mm	2.5	8 (Clay)

a. Maximum size shall be one inch largest dimension. The maximum retained on the #10 sieve shall be 15% by weight of the total sample.
b. Saturated hydraulic conductivity of the mix: not less than 3 inches per hour according to ASTM D5856-95 (2000) when compacted to a minimum of 84% of the maximum density as determined by AASHTO T99. The mix shall be compacted at 60% to 80% optimum moisture content.
c. Organic content: between 5.0 and 6.5 percent by weight.
d. Unless otherwise specified or recommended by the Soil Supplier's Soil Scientist: pH shall be between 6.5 and 7.2; CEC shall be a minimum of 10; and Soluble Salts shall be less than 2,000 ppm/2.0 mmhos/cm.

4. SAND-BASED STRUCTURAL SOIL

Sand-Based Structural Soil shall consist of a blend of approximately 60% by volume Coarse Sand, 15% by volume Base Loam and 25% by volume Organic Amendment. The components shall be blended to create a uniform mixture. Percentages will be adjusted as necessary to achieve the following grain size distribution and criteria below for material passing the #10 sieve by weight:

U.S. Sieve Size Number	Percent Passing	
	Minimum	Maximum
10	100	--- (Coarse Sand)
18	68	90 (Coarse Sand)
35	38	63 (Coarse Sand)
60	18	39 (Fine Sand)
140	10	18 (Fine Sand)
270	8	10 (Silt)
0.002mm	1	4 (Clay)

a. Maximum size shall be one inch largest dimension. The maximum retained on the #10 sieve shall be 15% by weight of the total sample.
b. The ratio of the particle size for 70% passing (D70) to the particle size for 20% passing (D20) shall be 3.0 or less (D70/D20 <3.0).
c. The final mix shall have a saturated hydraulic conductivity of no less than 6.0 inches per hour according to test procedure ASTM D5856-95 (2000) when compacted to a minimum of 88 percent of the maximum density as determined by AASHTO T-99, unless the soil will be placed in an area that experiences loading. If the soil will be placed under sidewalk, curbs or gutter, the density shall be a minimum of 93 percent maximum dry density as determined by AASHTO T-180. The mixes shall be compacted at 60% to 80% optimum moisture content.
d. Organic content shall be between 2.5 and 3.5 percent by weight.
e. Unless otherwise specified or recommended by the Soil Supplier's Soil Scientist: pH shall be between 6.5 and 7.2; CEC shall be a minimum of 6; and Soluble Salts shall be less than 500 ppm/0.5 mmhos/cm.

(E) PREPARATION AND MIXING OF PLANTING SOIL MIXES

Preparation, amendment, and mixing of the planting soil shall be performed at the Soil Supplier location. The following procedure shall be followed:

1. Soil shall be amended to meet pH requirements and horticultural deficiencies as determined by the County-approved Testing Agency.

2. Examine soil and remove foreign materials, stones and organic debris over 1/2” in size.

3. Correct deficiencies in soil as directed by horticultural soil test results. If lime is to be added, it shall be mixed with dry soil before fertilizer is added and mixed.

4. Planting soil mixtures shall be produced with equipment that blends together each component in a thorough and uniform manner.

5. Preparation and mixing shall be accomplished when the soil moisture content is less than field capacity and at a moisture content approved by the County and the Soil Scientist.

6. Incorporate pre-plant fertilizer as directed.

(F) DELIVERY, STORAGE AND HANDLING

1. Material shall not be handled or hauled when it is wet or frozen. Soil shall be hauled only when the moisture content is between 60% and 100% of optimum moisture content as determined by AASHTO T-99 for all planting soils except Sand-Based Structural Soil which shall be determined by AASTO T-180. Stockpiles shall be covered during wet weather. The Soil Supplier is responsible for meeting these requirements until the soil is delivered to the site. Soil which is delivered that exceeds the allowable maximum moisture content shall be replaced with new soil that meets the requirements.

2. Contractor shall store and handle packaged materials in strict compliance with manufacturer's instructions and recommendations. Protect all materials from weather, damage, injury and theft.

(G) PRE-INSTALLATION EXAMINATION AND PREPARATION

1. Coordinate activities with other project contractors so that there is no soil disturbance from traffic or other construction activities subsequent to placement.

2. Pre-Installation Examination Required: The Contractor shall examine previous work, related work, and conditions under which this work is to be performed and shall notify the Engineer in writing of all deficiencies and conditions detrimental to the proper completion of this work. Beginning work means Contractor accepts substrates, previous work, and conditions. The Contractor shall not place any planting soil until all work in adjacent areas is complete and approved by the County.

3. Examination of Conditions: Prior to the start of soil placement existing conditions shall be reviewed. Any deficiencies shall be noted and related to the County in writing prior to acceptance of the subgrade by the Landscape Contractor. Deficiencies include, but shall not be limited to the following:

    a. Construction debris present within the planting areas.
    b. The subgrade is at incorrect depths for installing the designed soil profile and/or drainage layer.
    c. Incomplete irrigation and/or subsurface drainage installation.

(H) SUBGRADE PREPARATION

1. Coordinate the following scarification work to eliminate subgrade compaction resultant from Construction Operations when located in planting areas.

    a. General Site Subgrade Compaction Mitigation for all planting areas that are not heavily compacted:

        (i) Immediately prior to placing any Planting Soil or any drainage materials beneath planting soils, the entire subgrade shall be loosened to a minimum depth of 3-inches using the teeth of a backhoe or other suitable equipment.

        (ii) After the subgrade soils have been loosened, re-compressed and inspected, remove any stones or debris 6” or greater and dispose off of the project site. Do not bury large stones or debris.

(I) PREPARATION OF SOILS

The contractor or soil supplier shall not work soil when the moisture content is less than 60% nor more than 100% of optimum moisture content as determined by AASHTO T-99 for all planting soils except Sand-Based Structural Soil which shall be determined by AASTO T-180 or when it is frozen. Apply water, if necessary, or dry the soil to bring soil within the acceptable moisture content range.

(J) PLACEMENT OF DRAINAGE MATERIALS AND SOIL LAYERS

1. Preparation for Placement of Planting Soils

    a. Notify the County of soil placement operations at least seven calendar days prior to the beginning of work.
    b. Prevent compacting soils by beginning work in corner, against walls, or the center of isolated beds, and progressing outwards towards borders.
    c. Never move or work Planting Soils when wet or frozen.
    d. Place barricades as required to prevent compaction of planting soil from vehicles, equipment, or pedestrian traffic.

2. In accordance with the Contract Document and Detail Drawings, proceed with placement of base materials as follows:

    a. Where geosynthetics are required per the contract plans, place geosynthetic layers in accordance with the specification for Geosynthetics for Green Streets Facilities.
    b. Where subsurface storage is required, place sand or stone layer as shown on the drawings in accordance with the specification for Aggregates for Green Streets Facilities.
    c. Where subsurface drainage is required, install in accordance with the specification for Underdrains for Stormwater Facilities.

3. General Placement Requirements

    a. No rubber-tired equipment or heavy equipment except for a small bulldozer shall

pass over the subsoils (subgrade) after they have been loosened and recompressed. If the Contractor plans to utilize such areas for any use of heavy equipment, this work should be carried out prior to beginning the process of loosening soils or filling in that area.

b. Place and spread Planting Soils in layers as specified to a thickness greater than required such that after settlement,
c. The surface area of each lift, including the subgrade after it has been compacted, shall be scarified by raking immediately prior to placing the next lift.
d. Place and spread topmost layers of planting medium to the thickness such that, after settlement, finished grades conform to the lines, grades and elevations shown on the Drawings. Ensure proper drainage in an uninterrupted pattern free of hollows and pockets.
e. All planting soils shall be placed at a moisture content between 60% and 100% of optimum moisture content as determined by AASHTO T-99 for all planting soils except Sand-Based Structural Soil which shall be determined by AASTO T-180.

4. Place Rain Garden Soil as follows:

   a. Swales: Place and spread in lifts not greater than twelve inches and compact each layer to a density of 85% plus or minus 2% of maximum density as determined by AASHTO T-99.

   b. Other Rain Garden areas: Place and spread in lifts not greater than twelve inches and compact each layer to a density of 83% plus or minus 2% of maximum density as determined by AASHTO T-99.

5. Place and spread Planting Bed Soil in lifts not greater than twelve inches and compact to a density of 82% plus or minus 2% of maximum density as determined by AASHTO T-99.

6.

7. Place Sand Based Structural Soil as follows:

   a. Beneath Pavements: Spread in lifts not greater than eight inches and compact with a minimum of two passes of vibratory compaction equipment to a density of 93% plus or minus 1% of maximum density as determined by AASHTO T180.

   b. As Horticultural Subsoil: Spread in lifts not greater than twelve inches and compact to a density of 85% plus or minus 1% of maximum density as determined by AASHTO T-99.

   c. The Contractor shall construct a Mock Up of the initial installation of Sand Based Structural Soil in the presence of the County or its representative. The Mock Up may be part of the permanent installation. The Mock Up shall be conducted with the same equipment that will be used for the duration of the Sand Based Structural Soil installation. Mock Up must be conducted with compliant soil moisture conditions. A geotechnical testing agency shall be on site to conduct soil moisture and compaction/density tests for each lift installed during the Mock Up.

(K) PROTECTION

1. Protect newly graded areas from traffic, freezing and erosion. Keep free of trash, debris or construction materials from other work.
2. Repair and re-establish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or compaction due to subsequent construction operations or weather conditions. Scarify or remove and replace material to a depth as directed by the Engineer and the Soil Scientist; reshape and re-compact at optimum moisture content to the required density.
3. Where settling occurs, before final acceptance or during the warranty period, remove finish surfacing, backfill with additional approved soil, compact to specified rates, and restore any disturbed areas to a condition acceptable to the Owner.

(L) COORDINATION AND EXCESS MATERIALS

1. Coordinate activities with other project contractors so that there is no soil disturbance from traffic or other construction activities subsequent to placement.
2. Excess Planting Soil Mixtures and Materials: Remove excess planting mediums and materials from the site.

(M) POST-INSTALLATION TESTING

In-place density testing shall be performed by the Contractor at a rate of 1 per 2000 square feet for each type of material placed. The standard test for surface and subsurface density shall be ASTM D 2922-01: Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

(N) MEASURE AND PAYMENT

1. Rain Garden Soil, planting bed soil, sand-based structural soil, compost, and sand each will be measured in cubic yards complete in place.
2. Payment will be made at the respective contract unit price per cubic yard, which payment will include preparing areas to receive the soil, furnishing, transporting, installing and testing the soil mixtures including all amendments, and all labor, tools, equipment and incidentals necessary to complete the work.

DOMED OVERFLOW RISER

(A) DESCRIPTION

This work shall consist of furnishing and placing domed overflow risers in rain garden facilities as shown in the contract documents, or as directed by the Engineer. Except as herein stated, the requirements specified for Green Book Standard Specifications Sections 206 “Miscellaneous Metal item”, 207 “gravity Pipe”, and 208 “Pipe joint types and Material” are applicable to this specification.

(B) MATERIALS

1. PVC Riser Structure: Schedule 40 bell and spigot and conform to Green Book Standard Specifications Section 207-17 “PVC Gravity Pipe”.
2. Concrete Pipe Riser: PCC Pipe per Green Book Standard Specifications Section 207-2 “Reinforced Concrete Pipe”
3. Concrete for Riser or Catch Basin: per Green Book Standard Specifications Section 201-1.1.2 “Concrete Specified by Class and Alternate Class”.
4. Domed/Beehive Grate: 12” to 30” diameter domed grate using Cast Iron. Ductile Iron, or High Density Polyethylene as shown on the plans.

(C) CONSTRUCTION REQUIREMENT

Provide domed risers for rain garden facilities placed on aggregate stone as indicated in the Drawings. Top of riser shall be set as specified in the contract plans for ponding depth and a minimum 3 inches below adjacent sidewalk or top of curb. Connect riser to underdrain piping using the appropriate reducer fittings, tees, and/or elbows.

(D) MEASURE AND PAYMENT

The unit of measure for Domed Overflow Risers will be each. Payment for Domed Overflow Risers will be made at the Contract unit price per each for the diameter specified, which will include excavation, shoring, backfill, compaction, installation of pipe riser and stone base including connections, gaskets, domed/beehive grate, and all labor, materials, tools, equipment and incidentals needed to complete work specified.

CHECK DAMS FOR STORMWATER FACILITIES

(A) DESCRIPTION

Work under this item includes the installation of check dams to slow and hold water flow in the stormwater facilities. Except as herein stated, the requirements specified for Green Book Standard Specifications Sections 201 “Concrete, Mortar, and Related Materials” and 303 “Concrete and Masonry Construction” are applicable to this specification.

(B) MATERIALS

1. Stone: shall meet the requirements set forth in the Specification for Aggregates for Stormwater Management, design plans, or modified in the Special Provisions.
2. Concrete: per Green Book Standard Specifications Section 201-1.1.2 Concrete Specified by Class and Alternate Class”
3. Reinforcement: Reinforcing Steel, Grade 60 per Green Book Standard Specifications Section 201-2 “Reinforcement for Concrete”
4. Gabion:

   All wire including tie and connecting wire shall have a tensile strength of at least 60 000 psi when tested per ASTM A 370. All wire sizes and mesh spacing shall be as recommended by the manufacturer. Stainless steel interlocking fasteners meeting ASTM A 313 may be substituted for wire ties. When subjected to directional tension along its axis, the fastener shall remain in a closed and locked condition for a minimum force of 900 lb.

   Galvanized coating for fabric, ties, and connecting wire shall not be at least 0.8 oz/ft2 when tested per ASTM A 90.

   PVC coating for fabric, ties, and connecting wires shall exhibit no weight loss when tested per MSMT 508. Color shall meet Federal Standard 595, gray color No. 26440 or green color No. 24533, and match throughout the project.
5. Recycled Plastic Lumber: shall meet ASTM D6662-13.
6. Acrylic Sheeting: Cyro Industries ACRYLITE® DP-9, translucent or transparent, or approved equal.
7. PVC Sheeting: PVC Type 1, Gray
8. Polyurethane Foam: Dow Chemical Company ENERFOAM™ Professional Foam Sealant or approved equal.

(C) CONSTRUCTION REQUIREMENT

Construction shall be as follows:

1. Prepare rain garden or permeable pavement areas in accordance with the construction plans and specifications.

2. Stone Check Dam: Place class 1 geotextile on prepared subgrade. Construct the check dam with washed #2 stone or river rock with side slopes of 1:1 and a minimum top width of 6 inches. Place the stone so that it completely covers the width of the rain garden area and sides per the detail on the drawings. Form the weir so that top of the outlet crest is approximately 4 inches lower than the outer edges.

3. Gabion Check Dam: Place class 1 geotextile on the prepared subgrade. Overlap adjacent strips at least 12 inches. Replace or repair geotextile damaged during placement of the wire baskets.

   Set the empty units on the geotextile and bind the vertical ends together with wire ties or interlocking fasteners spaced to permit stretching of the units to remove kinks. Use stretching methods that do not damage the baskets. Use stakes, pins, or other approved methods to ensure proper alignment.

   Carefully fill the basket units with stone placed by hand or machine to ensure good alignment with a minimum of voids between stones. Avoid bulging of the mesh. Do not drop the stone from a height greater than 36 in. Place the stone to provide a minimum of two courses. Place the top layer of stone to a uniform surface. Avoid any bulging of the lid mesh. After a basket unit is filled, bend the lid over until it meets the ends of the unit. Secure the lid to the sides and ends with wire ties or interlocking fasteners. When a complete basket unit cannot be installed because of space limitations, cut the basket unit to fit as directed.

4. Concrete Dam: Construct following in accordance with the requirements of Green Book Standard Specifications Section 201-1.1.2 “Concrete Specified by Class and Alternate Class “or as specified in the Contract Documents or directed by the Engineer.

5. Acrylic or PVC Sheeting: Place in accordance with Contract Documents.

6. Set the height for the weir crest per details in the construction drawings.

(D) MEASURE AND PAYMENT

The unit of measure and payment for stone check dam will be made per cubic yard and include installation, setting, and leveling of stone and all labor, materials, tools, equipment and incidentals needed to complete work specified.

The unit of measure and payment for gabion check dam will be made per cubic yard and include installation, setting, and all labor, materials, tools, equipment and incidentals needed to complete work specified.

The unit of measure and payment for concrete check dam will be made per cubic yard and include installation, setting, reinforcement, and all labor, materials, tools, equipment and

incidentals needed to complete work specified.

The unit of measure and payment for acrylic or PVC sheet check dams will be made per square yard and include installation, setting, and all labor, materials, tools, equipment and incidentals needed to complete work specified.

The unit of measure and payment for recycled lumber check dam will be made per square foot for the thickness specified in the plans, and include installation, setting, and all labor, materials, tools, equipment and incidentals needed to complete work specified.

Geotextiles will be measured and paid for separately.

TREE SPACE GRATE CATCH BASIN

(A) DESCRIPTION

This work shall consist of furnishing and placing sidewalk catch basins in tree space with structural soil, as shown in the contract documents, or as directed by the Engineer. Except as herein stated, the requirements specified for Green Book Standard Specifications Sections 206-3.3 “Manufacturing and Finishing” and 800 “Landscaping and Irrigation”, are applicable to this specification.

(B) MATERIALS

1. Concrete for Catch Basin: per Green Book Standard Specifications Section 201-1.1.2 “Concrete Specified by Class and Alternate Class”
2. Catch Basin Grate: ADA compliant using Cast Iron, Ductile Iron, or High Density Polyethylene as shown on the plans.
3. Geotextile Catch Basin Insert: Removable round geotextile bag supported by a galvanized metal cage, sediment basket, or approved equivalent installed in accordance with manufacturer’s specifications.

(C) CONSTRUCTION REQUIREMENT

Provide sidewalk catch basin placed on aggregate stone in covered tree space areas as indicated in the Drawings. As specified in plans, provide removable geosynthetic bag catch basin insert for collection and removal of silt, debris and trash. Connect basin to distribution piping using the appropriate reducer fittings, tees, and/or elbows.

(D) MEASURE AND PAYMENT

The unit of measure Tree Space Grate Catch Basin will be each. Payment for Tree Space Grate Catch Basin will be made at the Contract unit price per each which will include excavation, shoring, backfill, compaction, installation of structure and stone base including connections, gaskets, grate, geotextile catch basin insert (when specified), and all labor, materials, tools, equipment and incidentals needed to complete work specified.

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Appendix

L

Grandfathering Requirements and Guidance

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Appendix L Prior Lawful Approval Requirements and Guidance

The effective date of the updated requirements of the Municipal Separate Storm Sewer System Permit (Order No. R9-2013-0001; hereinafter "2013 MS4 Permit") in the unincorporated County of San Diego is **February 26, 2016**. Any development or redevelopment project[28,29] that has not obtained a Prior Lawful Approval (PLA) to proceed under earlier MS4 Permit provisions before that date must fully comply with the 2013 MS4 Permit, and therefore with the applicable requirements of Watershed Protection Ordinance (WPO) Sections 67.811 and 67.812. Under specified conditions, a project may be vested or grandfathered under WPO Section 67.811(c)(1) or (2). To qualify to proceed under any earlier MS4 Permit provision, a PLA must be obtained prior to its effective date.

L.1 Applicability of MS4 Permit Provisions

The effective dates of specific MS4 Permits and provisions are summarized in **Table L.1-1**. Options and conditions for obtaining PLAs to proceed under earlier MS4 Permit provisions are described in **Sections 2 and 3** below. The left-hand column of **Table L.1-1** lists the effective dates of all land development requirements, beginning with their initial imposition under the 2001 MS4 Permit. The column on the right indicates the applicable MS4 Permit standards for a project obtaining a PLA before each of the effective dates on the left. In any instance where an applicant has established a PLA before the effective date of a newer provision, the project (or portion or phase of the project) may be considered provisionally covered under the earlier standard. So long as all applicable conditions on the PLA have been, and continue to be met (see **Sections 3 and 4** below), the earliest applicable date in **Table L.1-1** (i.e., the earliest date after which a PLA is obtained) will normally apply. However, the County may as it determines necessary impose additional conditions that are more restrictive than the minimum requirements of any applicable MS4 Permit provision.

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[28] **Development** means construction, rehabilitation, redevelopment, or reconstruction of any public or private projects. **Redevelopment** is a subset of development that applies specifically to the creation and/or replacement of impervious surface on an already developed site. Examples of redevelopment include the expansion of a building footprint, road widening, the addition to or replacement of a structure. Replacement of impervious surfaces includes any activity where impervious material(s) are removed, exposing underlying soil during construction. Redevelopment does not include routine maintenance activities, such as trenching and resurfacing associated with utility work; pavement grinding; resurfacing existing roadways, sidewalks, pedestrian ramps, or bike lanes on existing roads; and routine replacement of damaged pavement, such as pothole repair.

[29] For the purposes of this document, further references to development projects are inclusive of both development and redevelopment projects unless a distinction between the two is specifically noted.

Per WPO Section 67.811(c)(2), the requirements of WPO Sections 67.811(a) and (b) fully apply to all development projects unless a PLA to proceed under the provisions of an earlier MS4 Permit has been obtained from the County. The County may partially or wholly waive these requirements for any project meeting the conditions of either WPO Section 67.811(c)(1) or (2). As described further below, this may occur either because a project applicant[30] has obtained a **vested right** to proceed as a result of the operation of law (PLA Option 1), or because the project is **grandfathered** by satisfying specific conditions of the 2013 MS4 Permit (PLA Option 2).

[30] "Applicant" may either mean the original project applicant or any successor(s) in interest to all or any portion of a PDP or Standard Project.

Table L.1-1: Effective Dates of Land Development-Related MS4 Permit Provisions

Permit Provision Effective Dates	Applicable Standard for Projects Grandfathered Prior to Effective Date
2001 MS4 Permit (Order No. 2001-001)	
• **February 10, 2003** Initial SUSMP effective date	• Order No. 90-42 (adopted July 16, 1990) did not contain explicit requirements for land development projects (discuss on a case basis)
2007 MS4 Permit (Order No. 2007-0001)	
• **January 24, 2008** All requirements of Order No. 2007-0001 except interim and final hydromodification	• February 2003 SUSMP
• **March 24, 2008** Interim hydromodification requirements (for sites disturbing 50 acres or more)	• Land development requirements of 2007 MS4 Permit minus hydromodification
• **January 8, 2011** Final hydromodification requirements	• Land development requirements of 2007 MS4 Permit minus hydromodification
2013 MS4 Permit (Order No. R9-2013-0001 as amended by Order. No. R9-2015-0001 and R9-2015-0100)	
• **February 26, 2016** All requirements of Provision E.3	• 2007 MS4 Permit land development standards effective on January 24, 2008 (except interim and final hydromodification) • Hydromodification requirements apply after March 24, 2008 and January 8, 2011 effective dates

Applicants should note the following regarding the use of both PLA options:

- The two options are mutually exclusive. An applicant may utilize either PLA Option 1 or PLA Option 2, but not both at the same time. However, in some cases, it may make sense to document compliance with both options in case a change in approach is needed.
- Projects utilizing PLA Option 1 may potentially establish coverage under the requirements of any earlier MS4 Permit; however, PLA Option 2 establishes a "floor" of full compliance with the 2007 MS4 Permit.

- PLA Option 1 may be utilized both for Standard Projects and PDPs. Because the requirements for Standard Projects have changed very little since they were initially imposed under the 2001 MS4 Permit, there is normally little reason to consider the applicability of vested rights to these projects. However, some projects which were previously classified as Standard Projects under the 2007 MS4 Permit may need to be reclassified as PDPs under the 2013 MS4 Permit if they have not established a vested right to proceed under the earlier MS4 Permit. As such, these "newly designated" PDPs would be required to comply with the PDP requirements of the 2013 MS4 Permit.

L.2 Applicant Responsibilities

While documentation related to vesting rights (PLA Option 1) and grandfathering (PLA Option 2) determinations will be maintained by the County as part of the project record, the applicant ultimately bears the responsibility for demonstrating that a PLA has been granted or continues to exist. Failure to do so may result in the revocation of that right, in which case a project may be required to partially or wholly meet updated MS4 Permit requirements. Applicants must document the basis for their assertion in a written proposal to County staff that includes a detailed explanation and rationale, including supporting calculations and information requested by the County if applicable. Staff will review the proposal and make a determination as to whether or not a vested right exists, or whether additional analysis is required. The adequacy of submitted documentation will be determined on a case-by-case basis.

Applicants must submit proposals and other required documentation in a timely manner (i.e., allowing sufficient time for County review and comment, resubmittal, and approval prior to applicable deadlines), and to demonstrate and maintain documentation of ongoing compliance with the conditions of a vested right initially recognized by the County.

L.3 PLA Option 1 (Vested Rights; WPO Section 67.811(c)(1))

In accordance with the 2013 MS4 Permit, WPO Section 67.811(c)(1) provides that: *"Previous land development requirements may be allowed to apply to any portion or phase of a development project for which the Authorized Enforcement Official determines the County lacks the land use authority or legal authority to require the project to implement the requirements of Sections 67.811(a) and/or (b)."*

This means that any project that has obtained a legally vested right to proceed under an existing permit or approval may continue under the MS4 Permit standard applicable at the time that the permit or approval was issued. In most cases, this will mean compliance with the 2007 MS4 Permit

(these requirements are described in the *January 2011 Standard Urban Stormwater Mitigation Plan*, or SUSMP[31]). However, under limited circumstances a project may qualify for coverage under the provisions of an earlier MS4 Permit.

Vested rights may initially be established in a number of ways under California law, including the following:

- An applicant substantially relies on an issued permit, but then may be limited to work within the scope of that permit (See, for example, *Avco Community Developers v. South Coast Reg'l Comm'n (1976) 17 Cal.3'd 785.*).
- An applicant has entered into a development agreement restricting the application of new requirements (See, *Gov't Code S 65964 et seq.*).
- The *Subdivision Map Act, Gov't Code Sec. 66410 et seq*. sets forth circumstances whereby applicants can obtain a vested right to proceed under requirements in effect at the time a tentative map application is deemed complete. (See, for example, *Gov't Code SS 66474.2 & 66498.1-66498.9.*) Vested rights obtained in connection with a tentative map application do not always extend to subsequent discretionary permits or approvals needed to develop the subdivision.
- The County otherwise determines that it lacks the land use authority or legal authority to require the project to implement the requirements of a newer MS4 Permit.

The recognition of vested rights by the County is provisional, and remains valid only so long as all applicable conditions of the applicable PLA(s) continue to be satisfied. Under no circumstances does the mere issuance of a permit or approval guarantee that a vested right will continue to be recognized.

Vested rights granted under any County approval are limited to the conditions of that approval, including the scope and temporal extent of the work authorized under the approval. Applicants are responsible for understanding the specific conditions and limitations of any vested right granted by the County, as well the circumstances under which that right might be modified or revoked. PLA determinations will be periodically reviewed, and updated MS4 provisions applied where necessary.

Per WPO Section 67.803(a) the County may in some instances be required to impose newer requirements at the time that a subsequent permit or approval such as a building or grading permit is sought if it is legally feasible to do so at that time. This may apply in instances where applicable

[31] Approved January 2011 and updated September 2012; Available at http://www.sandiegocounty.gov/content/sdc/dpw/watersheds/susmp/susmp.html.

stormwater compliance obligations have either been partially or fully satisfied under the earlier approval.[32]

As noted, applicants must demonstrate, and maintain documentation of, ongoing compliance with the conditions of any vested right initially recognized by the County, including the following:

- Proof of establishment of use and reliance on construction permits. Examples of information that may be acceptable to the County, either as primary or supporting documentation, include:
    - Inspection records,
    - Supervised grading reports
    - Condition satisfaction,
    - Payroll records,
    - Contractor or vendor invoices or payments,
    - Aerial photographs, and
    - Any other form of documentation deemed acceptable by the County.

  The adequacy of submitted documentation will be determined on a case-by-case basis. In general, acceptable forms of documentation include only those that are independently verifiable by County staff. Statements by applicants or contractors (even if written or sworn) are not considered sufficient.

- Satisfaction of all applicable MS4 Permit and other County requirements prior to expiration of the permit(s) under which a right is initially deemed to be vested.
- Other documentation as requested by the County.

L.4 PLA Option 2 (Grandfathering Under the 2013 MS4 Permit; WPO Section 67.811(c) (2))

Provision E.3.e.(1)(a) of the 2013 MS4 Permit allows projects that meet specified criteria to be grandfathered under the requirements of the 2007 MS4 Permit. Under this option, compliance with the 2007 MS4 Permit (e.g., general, source control, low impact development, structural treatment

[32] For example, if treatment control best management practices (TCBMPs) are installed to treat runoff from streets under a grading permit, but treatment has not been provided under that permit for the individual lots in a development, updated treatment standards applicable at the time of building permit issuance for the lots may be applied. In such case, if any BMPs necessary to comply with the newer requirements cannot be accommodated within the confines of existing lots, the applicant may be compelled to remap the subdivision.

control, and hydromodification management BMP requirements) is established as a minimum compliance standard. Per WPO Section 67.811(c)(2), this option is as follows:

> *"(2) At its discretion, the Authorized Enforcement Official may allow the requirements of the immediately prior [2007] MS4 Permit to apply to any portion or phase of a Priority Development Project for which all of the conditions below have been satisfied.*
>
> *(A) Initial Approvals. Prior to the effective date of the current MS4 Permit provisions [i.e., February 26, 2016], the applicant must have:*
>
> *i. Obtained an approval of a design that incorporates the storm water drainage system for the Priority Development Project in its entirety, including all applicable structural and hydromodification management BMPs consistent with the requirements of the prior [2007] MS4 permit. For public projects, a design stamped by the County Engineer or engineer of record for the project is considered an approved design; and*
>
> *ii. Been issued a project permit or approval that authorizes the commencement of construction activities based on the design approved in Section 67.811(c)(2)(A)i;*
>
> *For purpose of Section 67.811(c), the effective date of the 2013 MS4 Permit provisions is February 26, 2016.*
>
> *(B) Demonstrated to the County's satisfaction that construction activities have commenced on any portion of the Priority Development Project site within 365 days prior to [i.e., February 16, 2015], or 180 days after [i.e., August 14, 2016], the effective date of the current [2013] MS4 Permit provisions, where construction activities are undertaken in reliance on the permit or approval.*
>
> *(C) Subsequent Approvals. Within five years of the effective date of the current MS4 Permit provisions [i.e., prior to February 16, 2021], the applicant must have obtained all subsequent project permits or approvals that are needed to implement the design initially approved in conformance with WPO Section 67.811(c)(2)(A)i. After that time, any portion or phase of a Priority Development Project for which subsequent approvals have not been obtained is required to meet the updated requirements of WPO Section 67.811(a) and (b).*
>
> (D) *Substantial Conformity. The storm water drainage system for the Priority Development Project in its entirety, including all applicable structural pollutant treatment control and hydromodification management BMPs, must remain in substantial conformity with the design initially approved in conformance with WPO Section 67.811(c)(2)(A)i. Any portion or phase of a Priority Development Project not maintaining substantial conformity with this design is required to meet the updated requirements of WPO Sections 67.811(a) and (b)."*

Applicants should note that the use of this option requires continued compliance with all of the conditions listed above (i.e., Conditions (A)i through (D)) throughout project completion. **Figure L-1** summarizes the dates and ranges applicable to each condition. General guidance for complying with them is also provided below. Applicants should work closely with County staff to assess their specific requirements, including checking for the development of updated or more detailed

guidance. As noted, applicants must demonstrate, and maintain documentation of, ongoing compliance with the conditions of any grandfathering right initially recognized by the County.

Condition (A)i: Initial Design Approvals

Applicants must initially obtain a County approval that incorporates the design of the storm water drainage system for the PDP in its entirety. Initial designs used to satisfy this requirement will normally be documented in the PDP Stormwater Quality Management Plan (SWQMP), drainage reports, and associated exhibits and plans. These documents may be submitted in support of any of the following types of approvals:

- Major Use Permits,
- Tentative Maps,
- Site Plans,
- Grading or Improvement Plans,
- Tentative Parcel Maps,
- Building Permits, and
- Any other approval deemed acceptable by the County.

The purpose of this provision is to require applicants to obtain early approval of a design that fully satisfies the requirements of the 2007 MS4 Permit for all areas and phases of the project. At a minimum, this includes the following design features:

- Delineation of Drainage Management Areas (DMAs) for the entire PDP,
- Identification of all applicable TCBMPs,
- Identification of all applicable hydromodification BMPs,
- Identification of all site design BMPs that affect the design or performance requirements of TCBMPs and/or hydromodification BMPs, and
- Supporting calculations and assumptions that demonstrate the ability of the PDP to fully meet all applicable treatment and hydromodification requirements for each identified DMA.

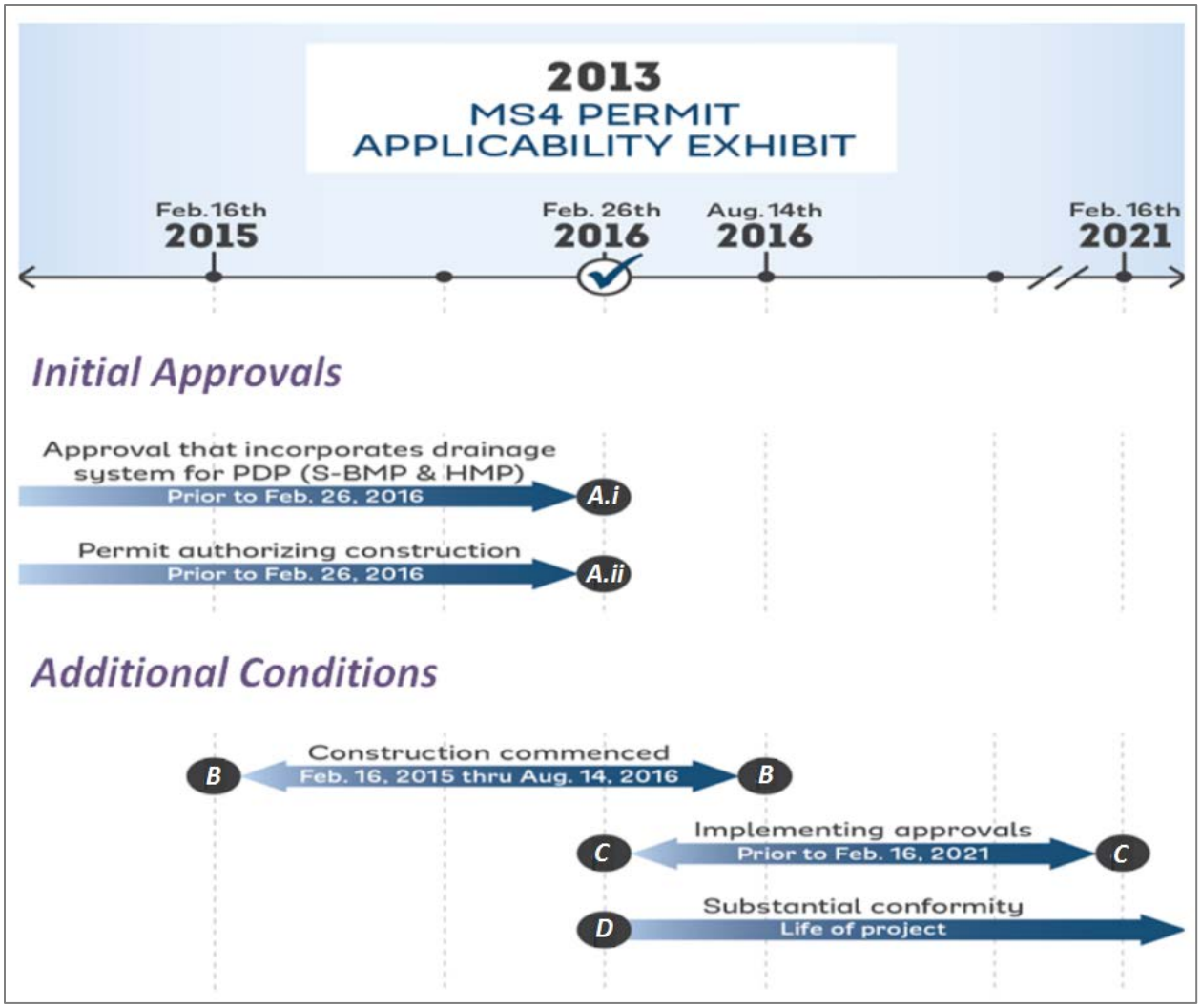

Figure L-1: Summary of Deadlines for Complying with 2013 MS4 Permit Grandfathering Provisions (PLA Option 2). Note: Lettering of provisions refers to subsections of WPO Section 67.811(c)(2).

This requirement must be satisfied for the PDP in its entirety; however, at the County's discretion it may be met by multiple approvals that collectively address the entire storm water drainage system, so long as all approvals are obtained prior to February 26, 2016. BMPs and other proposed design features must be identified and located with sufficient specificity to allow reviewers to fully evaluate the PDP's compliance with all applicable performance standards for the projected final buildout.

For projects such as business parks or phased residential developments, where the final design details are not initially known, it is acceptable to propose BMPs and delineate DMAs based on documented assumptions about final build-out (e.g., % imperviousness of individual lots or areas, site drainage patterns, and BMP types, locations, performance, etc.). However, as described under **Condition (D),** below, substantial conformance with these initial assumptions must be maintained

throughout the life of the project. Failure to do so may result in the imposition of updated standards during later stages of development.

Condition (A)ii: Issuance of Construction Permits or Approvals

Prior to February 26, 2016, the applicant must also have *"been issued a project permit or approval that authorizes the commencement of construction activities[33]"* based on the design approved under **Condition (A)ii** above. Permits and approvals that may be used to satisfy this requirement include:

- Grading permits,
- Building permits,
- Improvement plan permits,
- Clearing and grubbing permits,
- Well permits,
- Construction right of way permits, and
- Any other permit or approval recognized by the County as authorizing the applicant to commence construction activities on the PDP.

This condition is considered satisfied on issuance of a construction permit or approval for any portion or phase of the PDP prior to February 26, 2016. Once satisfied, this one-time condition is not subject to further County review.

Applicants are advised to consult with County staff as early as possible to ensure that a qualifying approval is issued before the effective date.

Condition (B): Commencement of Construction

Not more than 365 days before or 180 days after the BMPDM Effective Date, applicants must commence construction activities under a permit issued per **Condition (A)ii,** above. This is also a one-time condition that, once satisfied, is not subject to further review. Its purpose is twofold: (i) it prevents older inactive projects from being grandfathered under the 2007 MS4 Permit, and (ii) it ensures that newer projects are grandfathered only if they conduct work within six months of the

[33] Attachment C of the 2013 MS4 Permit defines Construction Activities as "Actions implemented during construction of development or redevelopment projects during the Preliminary Task (including rough grading and/or disking, clearing and grubbing operations, or any soil disturbance prior to mass grading), Grading or Land Development (including topography and slope reconfiguration, alluvium removals, canyon cleanouts, rock undercuts, keyway excavations, land form grading, and stockpiling of select material for capping operations), Streets and Utility Installation (including excavation and street paving, lot grading, curbs, gutters and sidewalks, public utilities, public water facilities including fire hydrants, public sanitary sewer systems, storm sewer systems and/or other drainage improvements), or Vertical Construction (including the build out of structures from foundations to roofing, including rough landscaping)."

effective date of the 2013 MS4 Permit. Together, they ensure that the grandfathering provisions of the 2013 MS4 Permit are extended only to active projects.

To satisfy this requirement, construction activities on the project site must have commenced between February 16, 2015 and August 14, 2016 under an open construction permit or approval (including modifications and renewals) issued by the County. Applicants are responsible for providing documentation of the commencement of these activities. Examples of information that may be acceptable to the County, either as primary or supporting documentation, include:

- Inspection records,
- Supervised grading reports
- Condition satisfaction,
- Payroll records,
- Contractor or vendor invoices or payments,
- Aerial photographs, and
- Any other form of documentation deemed acceptable by the County.

The adequacy of submitted documentation will be determined on a case-by-case basis. In general, acceptable forms of documentation include only those that are independently verifiable by County staff. Statements by applicants or contractors (even if written or sworn) are not considered sufficient.

Conditions (A)i through **(B),** above, provide a means for a PDP to initially be grandfathered under the provisions of the 2007 MS4 Permit. However, as noted, these determinations should always be considered provisional. **Conditions (C)** and **(D),** below, describe additional requirements that must be met for a project to maintain its grandfathered status. Failure to meet either of these conditions may result in the revocation of a grandfathering right, in which case a project may be required to partially or wholly meet updated MS4 Permit requirements. Grandfathering determinations will be periodically reviewed, and updated MS4 provisions applied where necessary.

Grandfathering rights granted under any County approval are limited to the conditions of that approval, including the scope and temporal extent of the work authorized under the approval. Applicants are responsible for understanding the specific conditions and limitations of any vested right granted by the County, as well the circumstances under which that right might be modified or revoked.

Condition C: Issuance of Implementing Approvals

This provision establishes a "shelf life" on grandfathering decisions by limiting the time allowed to obtain the approvals needed to fully implement the approved design. To maintain the grandfathered status of a PDP, applicants must also have been issued, by February 16, 2021, all subsequent project permits or approvals needed to implement the design initially approved under **Condition (A)i** above. In essence, only work authorized under permits or approvals issued prior to February 16, 2021 may be grandfathered under the 2007 MS4 Permit. Note that this requirement applies to

issuance of permits or other approvals, rather than completion of work under them. As such, work may continue to be conducted under 2007 MS4 Permit standards for the duration of the term of that permit or approval, including allowable modifications and extensions. Depending on the approval type this may be multiple years.

Implementing approvals obtained after February 16, 2021 will be subject to the MS4 Permit provisions applicable at the time that each approval is obtained. In instances where applicable stormwater compliance obligations have only been partially satisfied under earlier approvals, the County may be legally obligated to impose updated MS4 Permit requirements upon subsequent permit issuance[34].

The County will review the grandfathering status of PDPs at the time new permits or approvals are issued. All portions or phases of PDPs for which applicable permits or approvals have not been obtained prior to the February 16, 2021 deadline will be reviewed for the applicability of updated MS4 Permit provisions. At that time, applicants may be required to wholly or partially comply with updated MS4 Permit provisions, even where required BMPs cannot be accommodated within the confines of the existing design.

Condition D: Maintaining Substantial Conformity

The storm water drainage system for the PDP in its entirety, including all applicable structural pollutant treatment control and hydromodification management BMPs, must remain in substantial conformity with the design initially approved under **Condition (A)i** above. The intent of this provision is to allow reasonable modifications in the design of a project plan while preserving compliance with the performance standards initially applied to the PDP.

PDPs must always fully comply with the provisions of the 2007 MS4 Permit; however, some changes within the overall project design may be accommodated so long as all applicable narrative and numeric performance standards continue to be met for all portions and phases of the development. As noted above, for projects where initial design parameters were established based on assumptions about final buildout, it is expected that some parameters will be modified as more specific project design details emerge. This is acceptable so long as substantial conformity with all applicable performance standards is maintained over the life of the project. Failure to do so may result in the imposition of updated MS4 Permit standards during later stages of the development.

Proposed design modifications should be presented to and discussed with County staff as early as possible so that feedback and necessary approvals can be provided prior to their implementation.

[34] For example, see footnote 5.

While each proposed change must be evaluated individually, the following will generally be applied to determinations of substantial conformity[35]:

- Ministerial non-substantive changes such as a name change, engineer change, text update, or security/bond change are not considered substantial.
- Changes in the selection, location, or design of individual BMPs or site features that will result in equal or better ability to achieve all applicable narrative and numeric treatment and hydromodification performance standards for the PDP as a whole (including applicable portions of the PDP, such as individual lots or DMAs) may be allowed. However, compliance with all applicable standards must be maintained at all times. That is, a "lesser" standard cannot be approved for one portion of a project unless a corresponding change to offset any potential compliance deficits is also approved at the same time.
- Design changes, including the delineation of DMAs, that increase the overall amount of impervious surface within, or increase the overall footprint of, the PDP may be considered substantial, and will be evaluated on a case-by-case basis.

In instances where a PDP has fallen out of compliance with the requirements of **Condition (D)**, County staff will work with the applicant to determine whether the grandfathering status can be restored, or if updated MS4 Permit requirements must be applied.

[35] Allowable design changes, even if not determined to be substantial, may require a SWQMP Addendum to be processed for the PDP.

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Appendix

M

Glossary of Key Terms

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Appendix M Glossary of Key Terms

50% Rule	Refers to an MS4 Permit standard for redevelopment PDPs (PDPs on previously developed sites) that defines whether the redevelopment PDP must meet storm water management requirements for the entire development or only for the newly created or replaced impervious surface. Refer to **Section 1.7**.
Aggregate	Hard, durable material of mineral origin typically consisting of gravel, crushed stone, crushed quarry or mine rock. Gradation varies depending on application within a BMP as bedding, filter course, or storage.
Aggregate Storage Layer	Layer within a BMP that serves to provide a conduit for conveyance, detention storage, infiltration storage, saturated storage, or a combination thereof.
Alternative Compliance Programs	A program that allows PDPs to participate in an offsite mitigation project in lieu of implementing the onsite structural BMP performance requirements required under the MS4 Permit. Refer to **Section 1.8** for more information on alternative compliance programs.
Bed Sediment	The part of the sediment load in channel flow that moves along the bed by sliding or saltation, and part of the suspended sediment load, that principally constitutes the channel bed.
Bedding	Aggregate used to establish a foundation for structures such as pipes, manholes, and pavement.
Biodegradation	Decomposition of pollutants by biological means.

Biofiltration BMPs	Biofiltration BMPs are shallow basins filled with treatment media and drainage rock that treat storm water runoff by capturing and detaining inflows prior to controlled release through minimal incidental infiltration, evapotranspiration, or discharge via underdrain or surface outlet structure. Treatment is achieved through filtration, sedimentation, sorption, biochemical processes and/or vegetative uptake. These BMPs must be sized to:[a] Treat 1.5 times the DCV not reliably retained onsite, OR[b] Treat the DCV not reliably retained onsite with a flow-thru design that has a total volume, including pore spaces and pre-filter detention volume, sized to hold at least 0.75 times the portion of the DCV not reliably retained onsite. (See **Section 5.5.3** and **Appendix B.5** for illustration and additional information).
Biofiltration Treatment	Treatment from a BMP meeting the biofiltration standard.
Biofiltration with Partial Retention BMPs	Biofiltration with partial retention BMPs are shallow basins filled with treatment media and drainage rock that manage storm water runoff through infiltration, evapotranspiration, and biofiltration. Partial retention is characterized by a subsurface stone infiltration storage zone in the bottom of the BMP below the elevation of the discharge from the underdrains. The discharge of biofiltered water from the underdrain occurs when the water level in the infiltration storage zone exceeds the elevation of the underdrain outlet. (See **Section 5.5.2.1** for illustration and additional information).
Bioretention BMPs	Vegetated surface water systems that filter water through vegetation and soil, or engineered media prior to infiltrating into native soils. Bioretention BMPs in this manual retain the entire DCV prior to overflow to the downstream conveyance system. (See **Section 5.5.1.2** for illustration and additional information).
BMP	A procedure or device designed to minimize the quantity of runoff pollutants and / or volumes that flow to downstream receiving water bodies. Refer to **Section 2.2.2.1**.
BMP Sizing Calculator	An on-line tool that was developed under the 2007 MS4 Permit to facilitate the sizing factor method for designing flow control BMPs for hydromodification management. The BMP Sizing Calculator has been discontinued as of June 30, 2014.

Cistern	A vessel for storing water. In this manual, a cistern is typically a rain barrel, tank, vault, or other artificial reservoir.
Coarse Sediment Yield Area	A GLU with coarse-grained geologic material (material that is expected to produce greater than 50% sand when weathered). See the following terms modifying coarse sediment yield area: critical, potential critical.
Compact Biofiltration BMP	A biofiltration BMP, either proprietary or non-proprietary in origin, that is designed to provide storm water pollutant control within a smaller footprint than a typical biofiltration BMP, usually through use of specialized media that is able to efficiently treat high storm water inflow rates.
Conditions of Approval	Requirements a jurisdiction may adopt for a project in connection with a discretionary action (e.g., issuance of a use permit). COAs may include features to be incorporated into the final plans for the project and may also specify uses, activities, and operational measures that must be observed over the life of the project.
Contemporary Design Standards	This term refers to design standards that are reasonably consistent with the current state of practice and are based on desired outcomes that are reasonably consistent with the context of the MS4 Permit and Model BMP Design Manual. For example, a detention basin that is designed solely to mitigate peak flow rates would not be considered a contemporary water quality BMP design because it is not consistent with the goal of water quality improvement. Current state of the practice recognizes that a drawdown time of 24 to 72 hour is typically needed to promote settling. For practical purposes, design standards can be considered "contemporary" if they have been published within the last 10 years, preferably in California or Washington State, and are specifically intended for storm water quality management.
Continuous Simulation Modeling	A method of hydrological analysis in which a set of rainfall data (typically hourly for 30 years or more) is used as input, and a continuous runoff hydrograph is calculated over the same time period. Continuous simulation models typical track dynamic soil and storage conditions during and between storm events. The output is then analyzed statistically for the purposes of comparing runoff patterns under different conditions (for example, pre- and post-development-project).

Copermittees	See Jurisdiction.
Critical Channel Flow (Qc)	The channel flow that produces the critical shear stress that initiates bed movement or that erodes the toe of channel banks. When measuring Qc, it should be based on the weakest boundary material – either bed or bank.
Critical Coarse Sediment Yield Areas	A GLU with coarse-grained geologic material and high relative sediment production, where the sediment produced is critical to the receiving stream (a source of bed material to the receiving stream). See also: potential critical coarse sediment yield area.
Critical Shear Stress	The shear stress that initiates channel bed movement or that erodes the toe of channel banks. See also critical channel flow.
DCV	A volume of storm water runoff produced from the 85th percentile, 24-hour storm event. See **Section 2.2.2.2**.
De Minimis DMA	De minimis DMAs are very small areas that are not considered to be significant contributors of pollutants, and are considered not practicable to drain to a BMP. See **Section 5.2.2**.
Depth	The distance from the top, or surface, to the bottom of a BMP component.
Detention	Temporarily holding back storm water runoff via a designed outlet (e.g., underdrain, orifice) to provide flow rate and duration control.
Detention Storage	Storage that provides detention as the outflow mechanism.
Development Footprint	The limits of all grading and ground disturbance, including landscaping, associated with a project.
Development Project	Construction, rehabilitation, redevelopment, or reconstruction of any public or private projects. Includes both new development and redevelopment. Also includes whole of the action as defined by CEQA. See **Section 1.3.**

Direct Discharge	The connection of project site runoff to an exempt receiving water body, which could include an exempt river reach, reservoir or lagoon. To qualify as a direct discharge, the discharge elevation from the project site outfall must be at or below either the normal operating water surface elevation or the reservoir spillway elevation, and properly designed energy dissipation must be provided. "Direct discharge" may be more specifically defined by each municipality.
Direct Infiltration	Infiltration via methods or devices, such as dry wells or infiltration trenches, designed to bypass the mantle of surface soils that is unsaturated and more organically active and transmit runoff directly to deeper subsurface soils.
DMAs	See **Section 3.3.3**.
Drawdown Time	The time required for a storm water detention or infiltration facility to drain and return to the dry-weather condition. For detention facilities, drawdown time is a function of basin volume and outlet orifice size. For infiltration facilities, drawdown time is a function of basin volume and infiltration rate.
Enclosed Embayments (Enclosed Bays)	Enclosed bays are indentations along the coast that enclose an area of oceanic water within distinct headlands or harbor works. Enclosed bays include all bays where the narrowest distance between the headlands or outermost bay works is less than 75 percent of the greatest dimension of the enclosed portion of the bay. Enclosed bays do not include inland surface waters or ocean waters. In San Diego: Mission Bay and San Diego Bay.
Environmentally Sensitive Areas (ESAs)	Areas that include but are not limited to all Clean Water Act Section 303(d) impaired water bodies; areas designated as Areas of Special Biological Significance by the State Water Board and SDRWQCB; State Water Quality Protected Areas; water bodies designated with the RARE beneficial use by the State Water Board and SDRWQCB; and any other equivalent environmentally sensitive areas which have been identified by the County.
Filter Course	Aggregate used to prevent particle migration between two different materials when storm water runoff passes through.

Filter Fabric	A permeable textile material, also termed a non-woven geotextile, that prevents particle migration between two different materials when storm water runoff passes through.
Filtration	Controlled seepage of storm water runoff through media, vegetation, or aggregate to reduce pollutants via physical separation.
Flow Control	Control of runoff rates and durations as required by the HMP.
Flow Control BMP	A structural BMP designed to provide control of post-project runoff flow rates and durations for the purpose of hydromodification management.
Flow-thru Treatment	Treatment from a BMP meeting the flow-thru treatment control standard.
Flow-Thru Treatment BMPs	Flow-thru treatment control BMPs are structural, engineered facilities that are designed to remove pollutants from storm water runoff using treatment processes that do not incorporate significant biological methods. Flow-thru BMPs include vegetated swales, media filters, sand filters, and dry extended detention basins. (See **Section 5.5.4** for illustration and additional information).
Forebay	An initial storage area at the entrance to a structural BMP designed to trap and settle out solid pollutants such as sediment in a concentrated location, to provide pre-treatment within the structural BMP and facilitate removal of solid pollutants during maintenance operations.
Full Infiltration	Infiltration of a storm water runoff volume equal to the DCV.
Geomorphic Assessment	A quantification or measure of the changing properties of a stream channel.
Geomorphically Significant Flows	Flows that have the potential to cause, or accelerate, stream channel erosion or other adverse impacts to beneficial stream uses. The range of geomorphically significant flows was determined as part of the development of the March 2011 Final HMP, and has not changed under the 2013 MS4 Permit. However, under the 2013 MS4 Permit, Q2 and Q10 must be based on the pre-development condition rather than the pre-project condition, meaning that no pre-project impervious area may be considered in the computation of pre-development Q2 and Q10.

GLUs	Classifications that provide an estimate of sediment yield based upon three factors: geology, hillslope, and land cover. GLUs are developed based on the methodology presented in the SCCWRP Technical Report 605 titled "Hydromodification Screening Tools: GIS-Based Catchment Analyses of Potential Changes in Runoff and Sediment Discharge" (SCCWRP, 2010).
Gross Pollutants	In storm water, generally litter (trash), organic debris (leaves, branches, seeds, twigs, grass clippings), and coarse sediments (inorganic breakdown products from soils, pavement, or building materials).
Harvest and Use BMP	Harvest and use (aka rainwater harvesting) BMPs capture and store storm water runoff for later use. These BMPs are engineered to store a specified volume of water and have no design surface discharge until this volume is exceeded. (See **Section 5.5.1.1** for illustration and additional information).
HMP	A plan implemented by the Copermittees so that post-project runoff must not exceed estimated pre-development rates and/or durations by more than 10%, where increased runoff would result in increased potential for erosion or other adverse impacts to beneficial uses. The March 2011 Final HMP and the updated MS4 Permit are the basis of the flow control requirements of this manual.
Hungry Water	Also known as "sediment-starved" water, "hungry" water refers to channel flow that is hungry for sediment from the channel bed or banks because it currently contains less bed material sediment than it is capable of conveying. The "hungry water" phenomenon occurs when the natural sediment load decreases and the erosive force of the runoff increases as a natural counterbalance, as described by Lane's Equation.
Hydraulic Head	Energy represented as a difference in elevation, typically as the difference between the inlet and outlet water surface elevation for a BMP.
Hydraulic Residence Time	The length of time between inflow and outflow that runoff remains in a BMP.
Hydrologic Soil Group	Classification of soils by the Natural Resources Conservation Service (NRCS) into A, B, C, and D groups according to infiltration capacity.

Hydromodification	The change in the natural watershed hydrologic processes and runoff characteristics (i.e., interception, infiltration, overland flow, interflow and groundwater flow) caused by urbanization or other land use changes that result in increased stream flows and sediment transport. In addition, alteration of stream and river channels, installation of dams and water impoundments, and excessive stream-bank and shoreline erosion are also considered hydromodification, due to their disruption of natural watershed hydrologic processes.
Hydromodification Management BMP	A structural BMP for the purpose of hydromodification management, either for protection of critical coarse sediment yield areas or for flow control. See also flow control BMP.
Impervious Surface	Any material that prevents or substantially reduces infiltration of water into the soil.
Infeasible	As applied to BMPs, refers to condition in which a BMP approach is not practicable based on technical constraints specific to the site, including by not limited to physical constraints, risks of impacts to environmental resources, risks of harm to human health, or risk of loss or damage to property. Feasibility criteria are provided in this manual.
Infiltration	In the context of LID, infiltration is defined as the percolation of water into the ground. Infiltration is often expressed as a rate (inches per hour), which is determined through an infiltration test. In the context of non-storm water, infiltration is water other than wastewater that enters a sewer system (including sewer service connections and foundation drains) from the ground through such means as defective pipes, pipe joints, connections, or manholes. Infiltration does not include, and is distinguished from, inflow [40 CFR 35.2005(20)].
Infiltration BMP	Infiltration BMPs are structural measures that capture, store and infiltrate storm water runoff. These BMPs are engineered to store a specified volume of water and have no design surface discharge (underdrain or outlet structure) until this volume is exceeded. These types of BMPs may also support evapotranspiration processes, but are characterized by having their most dominant volume losses due to infiltration. (See **Section 5.5.1.2** for illustration and additional information).

Jurisdiction	The term "jurisdiction" is used in this manual to refer to individual copermittees who have independent responsibility for implementing the requirements of the MS4 Permit.
LID	A storm water management and land development strategy that emphasizes conservation and the use of onsite natural features integrated with engineered, small-scale hydrologic controls to more closely reflect pre-development hydrologic functions. See **Site Design**.
Lower Flow Threshold	The lower limit of the range of flows to be controlled for hydromodification management. The lower flow threshold is the flow at which erosion of sediment from the stream bed or banks begins to occur. See also critical channel flow. For the San Diego region, the lower flow threshold must be a fraction (0.1, 0.3, or 0.5) of the pre-development 2-year flow rate based on continuous simulation modeling (0.1Q2, 0.3Q2, or 0.5Q2).
Media	Storm Water runoff pollutant treatment material, typically included as a permeable constructed bed or container (cartridge) within a BMP.
MEP	The technology-based standard established by Congress in CWA section 402(p)(3)(B)(iii) for storm water that operators of MS4s must meet. Technology-based standards establish the level of pollutant reductions that dischargers must achieve, typically by treatment or by a combination of source control and treatment control BMPs. MEP generally emphasizes pollution prevention and source control BMPs primarily (as the first line of defense) in combination with treatment methods serving as a backup (additional line of defense). MEP considers economics and is generally, but not necessarily, less stringent than BAT. Refer to the MS4 Permit [(Order No R9-2013-001) Appendix C, Definitions, Page C-6] for more details.
National Pollutant Discharge Elimination System	The national program for issuing, modifying, revoking and reissuing, terminating, monitoring and enforcing permits, and imposing and enforcing pretreatment requirements, under Sections 307, 318, 402, and 405 of the Clean Water Act.

New Development	Land disturbing activities; structural development, including construction or installation of a building or structure, the creation of impervious surfaces; and land subdivision. Any development project that will create and/or replace 10,000 square feet or more of impervious surface (collectively over the entire project site) is considered new development.
O&M	Requirements in the MS4 Permit to inspect structural BMPs and verify the implementation of operational practices and preventative and corrective maintenance in perpetuity.
Pacific/Salton Sea Divide	The highest ridge of land in San Diego County which divides run off that drains west to the Pacific Ocean and run off that drain east to the Salton Sea. Also referred to as the Tecate Ridge. The area to the West is governed by Region 9 Water Quality Control Board and the area to the East is governed by Region 7.
Partial Infiltration	Infiltration of a storm water runoff volume less than the DCV.
Partial Retention	Partial retention category is defined by structural measures that incorporate both infiltration (in the lower treatment zone) and biofiltration (in the upper treatment zone).
PDPs	As defined by the MS4 Permit provision E.3.b, land development projects that fall under the planning and building authority of the Copermittee for which the Copermittee must impose specific requirements in addition to those required of Standard Projects. Refer to **Section 1.4** to determine if your project is a PDP.
PDPs with only Pollutant Control Requirements	PDPs that need to meet Source Control, Site Design and Pollutant Control Requirements (but are exempt from Hydromodification Management Requirements).
PDPs with Pollutant Control and Hydromodification Management Requirements	PDPs that need to meet Source Control, Site Design, Pollutant Control and Hydromodification Management Requirements.

Point of Compliance	1. For channel screening and determination of low flow threshold: the point at which collected storm water from a development is delivered from a constructed or modified drainage system into a natural or un-lined channel. POC for channel screening may be located onsite or offsite, depending on where runoff from the project meets a natural or un-lined channel. 2. For flow control: the point at which pre-development and post-development flow rates and durations will be compared. POC for flow control is typically onsite. A project may have a different POC for channel screening vs. POC for flow control if runoff from the project site is conveyed in hardened systems from the project site boundary to the natural or un-lined channel.
Pollutant Control	Control of pollutants via physical, chemical or biological processes
Pollution Prevention	Pollution prevention is defined as practices and processes that reduce or eliminate the generation of pollutants, in contrast to source control BMPs, treatment control BMPs, or disposal.
Post-Project Hydrology Flows, Volumes	The peak runoff flows and runoff volume anticipated after the project has been constructed taking into account all permeable and impermeable surfaces, soil and vegetation types and conditions after landscaping is complete, detention or retention basins or other water storage elements incorporated into the site design, and any other site features that would affect runoff volumes and peak flows.
Potential Critical Coarse Sediment Yield Area	A GLU with coarse-grained geologic material and high relative sediment production, as defined in the Regional WMAA. The Regional WMAA identified GLUs as potential critical coarse sediment yield areas based on slope, geology, and land cover. GLU analysis does not determine whether the sediment produced is critical to the receiving stream (a source of bed material to the receiving stream) therefore the areas are designated as potential.

Pre-Development Runoff Conditions	Approximate flow rates and durations that exist or existed onsite before land development occurs. For new development projects, this equates to runoff conditions immediately before any new project disturbance or grading. For redevelopment projects, this equates to runoff conditions from the project footprint assuming infiltration characteristics of the underlying soil, and existing grade. Runoff coefficients of concrete or asphalt must not be used. A redevelopment PDP must use available information pertaining to existing underlying soil type and onsite existing grade to estimate pre-development runoff conditions.
Pre-Project Condition	The condition prior to any project work or the existing condition. Note that pre-project condition and pre-development condition will not be the same for redevelopment projects.
Pretreatment	Removal of gross solids, including organic debris and coarse sediment, from runoff to minimize clogging and increase the effectiveness of BMPs.
Project Area	All areas proposed by an applicant to be altered or developed, plus any additional areas that drain on to areas to be altered or developed. Also see **Section 1.3**.
Project Submittal	Documents submitted to a jurisdiction or Copermittee in connection with an application for development approval and demonstrating compliance with MS4 Permit requirements for the project. Specific requirements vary from municipality to municipality.
Proprietary BMP	BMP designed and marketed by private business for treatment of storm water. Check with County staff prior to proposing to use a proprietary BMP.
Receiving Waters	See **Waters of the United States**.

Redevelopment	The creation, addition, and or replacement of impervious surface on an already developed site. Examples include the expansion of a building footprint, road widening, the addition to or replacement of a structure. Replacement of impervious surfaces includes any activity where impervious material(s) are removed, exposing underlying soil during construction. Redevelopment does not include routine maintenance activities, such as trenching and resurfacing associated with utility work; pavement grinding; resurfacing existing roadways, sidewalks, pedestrian ramps, or bike lanes on existing roads; and routine replacement of damaged pavement, such as pothole repair.
Retrofitting	Storm Water management practice put into place after development has occurred in watersheds where the practices previously did not exist or are ineffective. Retrofitting of developed areas is intended to improve water quality, protect downstream channels, reduce flooding, or meet other specific objectives. Retrofitting developed areas may include, but is not limited to replacing roofs with green roofs, disconnecting downspouts or impervious surfaces to drain to pervious surfaces, replacing impervious surfaces with pervious surfaces, installing rain barrels, installing rain gardens, and trash area enclosures.
Retention (Retention BMPs)	A category of BMP that does not have any service outlets that discharge to surface water or to a conveyance system that drains to surface waters for the design event (i.e. 85th percentile 24-hour). Mechanisms used for storm water retention include infiltration, evapotranspiration, and use of retained water for non-potable or potable purposes.
Saturated Storage	Storage that provides a permanent volume of water at the bottom of the BMP as an anaerobic zone to promote denitrification and/or thermal pollution control. Also known as internal water storage or a saturation zone.
Self-mitigating Areas	A natural, landscaped, or turf area that does not generate significant pollutants and drains directly offsite or to the public storm drain system without being treated by a structural BMP. See **Section 5.2.1**.
Self-retaining DMA via Qualifying Site Design BMPs	An area designed to retain runoff to fully eliminate storm water runoff from the 85th percentile 24 hours storm event; See **Section 5.2.3**.

SIC	A Federal government system for classifying industries by 4-digit code. It is being supplanted by the North American Industrial Classification System but SIC codes are still referenced by the Regional Water Board in identifying development sites subject to regulation under the National Pollutant Discharge Elimination System permit. Information and an SIC search function are available at https://www.osha.gov/pls/imis/sicsearch.html
Significant Redevelopment	Redevelopment that meets the definition of a "PDP" in this manual. See **Section 1.4**.
Site Design	A storm water management and land development strategy that emphasizes conservation of natural features and the use of onsite natural features integrated with engineered, small-scale hydrologic controls to more closely reflect pre-development hydrologic functions.
Sizing Factor Method	A method for designing flow control BMPs for hydromodification management using sizing factors developed from unit area continuous simulation models.
Sorption	Physical and/or chemical process where pollutants are taken out of runoff through attachment to another substance.
Source Control	Land use or site planning practices, or structures that aim to prevent runoff pollution by reducing the potential for contamination at the source of pollution. Source control BMPs minimizes the contact between pollutants and storm water runoff. Examples include roof structures over trash or material storage areas, and berms around fuel dispensing areas. Source control BMPs are described within this manual.
Standard Project	Any development project that is not defined as a PDP by the MS4 Permit.

Storm Water Conveyance System	A conveyance or system of conveyances (including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, man-made channels, or storm drains): (i) Owned or operated by a State, city, town, borough, county, parish, district, association, or other public body (created by or pursuant to State law) having jurisdiction over disposal of sewage, industrial wastes, storm water, or other wastes, including special districts under State law such as a sewer district, flood control district or drainage district, or similar entity, or an Indian tribe or an authorized Indian tribal organization, or designated and approved management agency under section 208 of the Clean Water Act that discharges to waters of the United States; (ii) Designated or used for collecting or conveying storm water; (iii) Which is not a combined sewer; (iv) Which is not part of the Publicly Owned Treatment Works as defined at 40 CFR 122.26.
Storm Water Pollutant Control BMP	A category of storm water management requirements that includes treatment of storm water to remove pollutants by measures such as retention, biofiltration, and/or flow-thru treatment control, as specified in this manual. Also called a Pollutant Control BMP.
Structural BMP	Throughout the manual, the term "structural BMP" is a general term that encompasses the pollutant control BMPs and hydromodification BMPs required for PDPs under the MS4 Permit. A structural BMP may be a pollutant control BMP, a hydromodification management BMP, or an integrated pollutant control and hydromodification management BMP. Structural BMPs as defined in the MS4 Permit are: a subset of BMPs which detains, retains, filters, removes, or prevents the release of pollutants to surface waters from development projects in perpetuity, after construction of a project is completed.
Subgrade	In-situ soil that lies underneath a BMP.
Tributary Area	The total surface area of land or hardscape that contributes runoff to the BMP; including any offsite or onsite areas that comingles with project runoff and drains to the BMP. Refer to **Section 3.3.3** for additional guidance Also termed the drainage area or catchment area.

Unified BMP Design Approach

This term refers to the standardized process for site and watershed investigation, BMP selection, BMP sizing, and BMP design that is outlined and described in this manual with associated appendices and templates. This approach is considered to be "unified" because it represents a pathway for compliance with MS4 Permit requirements that is anticipated to be reasonably consistent across the local jurisdictions in San Diego County. In contrast, applicants may choose to take an alternative approach where they demonstrate to the satisfaction of the Copermittee, in their submittal, compliance with applicable performance standards without necessarily following the process identified in this manual.

Upper Flow Threshold

The upper limit of the range of flows to be controlled for hydromodification management. For the San Diego region, the upper flow threshold must be the pre-development 10-year flow rate (Q10) based on continuous simulation modeling.

Vactor

Refers to a sewer or storm drain cleaning truck equipped to remove materials from sewer or storm drain pipes or structures, including some storm water BMPs.

Vector

An animal or insect capable of transmitting the causative agent of human disease. An example of a vector in San Diego County that is of concern in storm water management is a mosquito.

Water Quality Improvement Plan

Copermittees are required to develop a Water Quality Improvement Plan for each Watershed Management Area in the San Diego Region. The purpose of the Water Quality Improvement Plans is to guide the Copermittees' jurisdictional runoff management programs towards achieving the outcome of improved water quality in MS4 discharges and receiving waters. WQIPs requirements are defined in the MS4 Permit provision B.

Waters of the United States

Surface bodies of water, including naturally occurring wetlands, streams (perennial, intermittent, and ephemeral (exhibiting bed, bank, and ordinary high water mark)), creeks, rivers, reservoirs, lakes, lagoons, estuaries, harbors, bays and the Pacific Ocean which directly or indirectly receive discharges from storm water conveyance systems. The Copermittee must determine the definition for wetlands and the limits thereof for the purposes of this definition, which must be as protective as the Federal definition utilized by the United States Army Corps of Engineers and the United States Environmental Protection Agency. Constructed wetlands are not considered wetlands under this definition, unless the wetlands were constructed as mitigation for habitat loss. Other constructed BMPs are not considered receiving waters under this definition, unless the BMP was originally constructed within the boundaries of the receiving waters. Also see MS4 permit definition.

Watershed Management Area

The ten areas defined by the SDRWQCB in Regional MS4 Permit provision B.1, Table B-1. Each Watershed Management Area is defined by one or more Hydrologic Unit, major surface water body, and responsible Copermittee.

Watershed Management Area Analysis

For each Watershed Management Area, the Copermittees have the option to perform a WMAA for the purpose of developing watershed-specific requirements for structural BMP implementation. Each WMAA includes: GIS layers developed to provide physical characteristics of the watershed management area, a list of potential offsite alternative compliance projects, and areas exempt from hydromodification management requirements.

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