MS4 PERMITTING PROGRAM COMPLIANCE AND IMPLEMENTATION

POST CONSTRUCTION STORMWATER MANAGEMENT MANUAL

METROPOLITAN TRANSIT SYSTEM

FINAL

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WSP
WELLS FARGO BANK BUILDING
401 B STREET, SUITE 1650
SAN DIEGO, CA 92101-4245

TEL.: +1 619 338-9376
FAX: +1 619 338-8123
WSP.COM

SIGNATURES

PREPARED BY

Robert Merritt, PE
Lead Civil Engineer

Veronica Seyde
Water Quality Manager

REVIEWED BY

Richard Bottcher, PE
Senior Engineering Manager

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1 INTRODUCTION

1.1 PURPOSE AND GAOLS

The Metropolitan Transit System (MTS) is classified as a Non-Traditional Phase II Small Municipal Separate Storm Sewer System (MS4). In 2013 the California State Water Resources Control Board (SWRCB) adopted a National Pollutant Discharge Elimination System (NPDES) general permit (Phase II Permit), to regulate stormwater and non-stormwater discharges from MS4s to waters of the United States. As part of the Phase II Permit, MTS is required to develop post-construction standards to address stormwater discharges from new development and redevelopment projects (Phase II Permit, Provision F.5.g).

MTS prepared this 2019 Post-Construction Storm Water Management Manual (Manual) to assist MTS and developers in complying with the requirements of Provision F.5.g of the Phase II Permit.

This Manual provides guidance for planning, implementing and maintaining effective control measures with the intention of protecting water quality and mitigating potential water quality impacts from stormwater and non-stormwater discharges. This Manual provides guidance that responds to the following objectives:

- Guide MTS staff, MTS tenants, and private property owners in the MTS jurisdiction area;
- Establish procedures to evaluate runoff from new development or redevelopment during the project planning phase;
- Establish Site Design measures that reduce project site runoff
- Establish Low Impact Development (LID) design standards to effectively reduce runoff and pollutants associated with runoff from development projects;
- Establish guidance and applicability regarding alternative post-construction measures; and
- Provide guidance on the establishment of an Operations and Maintenance Plan that ensures continued effectiveness of stormwater treatment measures.

1.2 MTS JURISDICTIONAL AREA

This Manual applies to all MTS Light Rail Right of Way, Light Rail and Bus Rapid Transit Stations, Storage Facilities, Parking Facilities, and Maintenance Facilities. The MTS area is mostly developed and covered with impervious surfaces. As a property owner, MTS has authority to control development and use of its property. Maps of the MTS jurisdictional area are included in Appendix A.

1.3 REGULATORY BACKGROUND

In 1972, Congress amended the Federal Water Pollution Control Act (commonly referred to as the Clean Water Act (CWA)) to prohibit the discharge of any pollutant to waters of the United States from a point source unless the discharge is authorized by a NPDES permit. In 1987, CWA amendments added section 402(p), which established a framework for regulating storm water discharges from MS4s under the NPDES Program. A MS4 is a conveyance or system of conveyances that is: (1) owned by a state, city, town, village, or other public entity that discharges to waters of the United States; (2) designed or used to collect or convey storm water (including storm drains, pipes, ditches, etc.); (3) not a combined sewage and storm water system; and (4) not part of a Publicly Owned Treatment Works or sewage treatment plant.

On December 8, 1999, USEPA promulgated regulations, known as Phase II regulations, requiring operators of small MS4s to obtain and comply with NPDES storm water permits for Small MS4s under the authority of the CWA section 402(p)(6). Title 40 of the Code of Federal Regulations (40 C.F.R.) section 122.26(b)(16) defines Small MS4s as those MS4s not defined as "large" or "medium" MS4s under 40 CFR section 122.26(b)(4) or (b)(7) or designated under 40 C.F.R. section 122.26(a)(1)(v). The Phase II Permit identified categories of dischargers that the State Water Resources Control Board (SWRCB) considers to be Non-traditional Small MS4s, including but not limited to: community services district, fairgrounds, higher education institutions, ports, state parks, school districts K-12, state vehicle recreation areas, water agencies, and transit agencies. The Phase II Permit authorizes the Regional Water Quality Control Boards (RWQCBs) to designate additional Regulated Small MS4s on a case-by-case basis during the permit term. Designations must be "based on the potential of a Small MS4's discharges to result in exceedances of water quality standards, including impairment of designated uses, or other significant water quality impacts, including habitat and biological impacts."

On February 5, 2013, the SWRCB adopted Water Quality Order No. 2013-0001-DWQ, NPDES General Permit No. CAS000004, Waste Discharge Requirements for Storm Water Discharges from Small Municipal Separate Storm Sewer Systems (Phase II Permit) to comply with CWA section 402(p)(6). The Phase II Permit became effective on July 1, 2013. From July 2013 to October 2013, the San Diego RWQCB designated nine Small MS4s including a transit district, two military bases, a state prison, a state fairground, a large hospital, and three universities as Regulated Non-traditional Small MS4s subject to the NPDES permitting program. In 2017, under Resolution No. R9-2017-0006, San Diego Metropolitan Transit System (MTS) was designated as a Regulated Non-traditional Small MS4 subject to the NPDES permitting program.

1.4 PHASE II STORMWATER PROGRAM REQUIREMENTS

Under the Phase II Permit, MTS is required to implement and enforce a stormwater management program that is designed to reduce the discharge of pollutants to the maximum extent practicable, protect water quality and satisfy the applicable water quality requirements of the CWA. The Phase II Permit states that a Post Construction Stormwater Management Program shall be developed to address the following:

- Site Design Measures (Phase II Permit, Provisions F.5.g.1)
- Low Impact Development Design Standards (Phase II Permit, Provisions F.5.g.2)
- Alternative Post-Construction Storm Water Management (Phase II Permit, Provisions F.5.g.3)[1]
- Operation and Maintenance of Post Construction Storm Water Management Measures (Phase II Permit, Provisions F.5.g.4)

To comply with the Phase II Permit provisions for a Non-traditional Small MS4, specifically Section F.5.g, MTS has developed this Post Construction Storm Water Management Manual for all development within its jurisdiction.

1.4.1 OTHER STATE OF CALIFORNIA REGULATIONS

In addition to the Phase II Permit requirements, proposed projects may be subject to the SWRCB Waste Discharge Requirements for Discharges of Stormwater Associated with Industrial Activities Excluding Construction Activities (Industrial General Permit, Order No. 2014-0057-DWQ) and/or the General Permit for

[1] MTS reserves the option to participate in the City of San Diego Alternative Compliance Program if it is available.

Storm Water Discharges Associated with Construction and Land Disturbance Activities (Construction General Permit, Order No. 2009-0006-DWQ, as amended).

1.4.2 MTS ORDINANCES

MTS is authorized to own property. (Pub. Util. Code, § 120240.) MTS is also authorized to adopt ordinances and make rules and regulations to regulate the use, operation and maintenance of its property and facilities. (Pub. Util. Code, § 120105.) To implement this authority, MTS has adopted, in part, Ordinance Numbers 3, 5, and 13. Together with MTS's statutory authority, these ordinances provide legal authority to prohibit non-stormwater discharges to the MTS storm drains.

1.5 PROJECT MANAGER

MTS has designated the Environmental Health and Safety Specialist (EHS) as the Post Construction Stormwater Project Manager. This person will be responsible for ensuring all site design measures, standards and operation and maintenance measures are performed in accordance with this Manual, the Phase II Permit, the MTS Ordinance and applicable state and federal laws.

2 APPLICABILITY

This Post-Construction Storm Water Management Manual becomes effective on June 1, 2019 (or the date that this Manual is adopted by MTS, whichever is sooner). Until this date all projects must comply with the existing post-construction requirements found within the Construction General Permit[2]. After June 1, 2019 (or the date that this plan is adopted by MTS, whichever is sooner) this Post-Construction Storm Water Management Manual will apply to all new and redevelopment projects. These include projects that have not been deemed complete for processing and projects without vesting tentative maps that have not requested and received an extension of previously granted approvals. Discretionary projects that have been deemed complete prior to June 1, 2019 (or the date that this Manual is adopted by MTS, whichever is sooner) are not subject to the Post-Construction standards herein. For MTS projects, the effective date shall be the date their governing body or designee approves initiation of the project design.

2.1 APPLICABILITY OF THE 2019 POST CONSTRUCTION STORMWATER MANAGEMENT MANUAL

The requirements of this Manual apply to all projects in the MTS area, including development and redevelopment projects proposed by private property owners, tenants, and projects implemented by MTS. Projects that occur on MTS property and that are also within the planning jurisdiction of another jurisdiction (e.g., City of San Diego, City of La Mesa, etc.) are subject to the planning jurisdiction of that agency and need to comply with the post construction standards of that agency. Table 2-1 defines the types of projects applicable to the MTS development and redevelopment program.

Table 2-1. Applicable MTS Projects

Project Type	Definitions
MTS Project	Capital projects where the design and construction are managed by MTS.
SANDAG Project	Large capital projects where SANDAG manages design and construction.
Third-Party Project	Non-MTS projects requiring a Right of Entry (ROE) or Joint ROE permit from MTS given encroachment into a MTS jurisdictional area

The Phase II Permit specifies two types of projects that must implement post construction stormwater measures, to varying degrees, as discussed below:

- Small Projects[3] - Projects that create and/or replace at least 2,500, but less than 5,000 square feet of impervious surface. This includes projects with no net increase in impervious footprint that create and/or replace 2,500 square feet or more of impervious surface and are not part of a larger plan of development.
- Regulated Projects[4] - Projects that create and/or replace greater than 5,000 square feet of impervious surface.

[2] During construction, any construction or demolition activity, including, but not limited to clearing, grading, grubbing, or excavation, or any other activity that results in a land disturbance of equal to or greater than one acre, must comply with the Construction General Permit. Projects that result in a land disturbance of less than one acre, must comply with MTS Standard Specifications and Special Provisions (SPSP). For projects that disturb less than one acre, the SPSP requires development and implementation of a Water Pollution Control Program (WPCP) using the MTS WPCP template.

[3] Provision F.5.g.1 of the Phase II Permit

[4] Provision F.5.g.2 of the Phase II Permit

The applicability of this Manual for Small and Regulated Projects is presented in Figure 2-1. A summary of the post-construction stormwater requirements that are applicable to a project are presented in Table 2.2. MTS projects and Third- Party projects must complete the Stormwater Requirements Checklist (Checklist). The Checklist is submitted to the Right of Way Engineer/Permits and EHS during the project delivery phase or during the right of entry (ROE)/Joint ROE permit process. Once completed and reviewed, the Checklist will be submitted and maintained by the EHS office. The Checklist provides documentation that the project was reviewed for its applicability to construction and post construction design standards and demonstrates how the project will comply with water pollution control requirements. The Checklist is provided in Appendix B.

Table 2-2. Applicable Post Construction Stormwater Requirements

Post Construction Stormwater Requirement	Small Project, 2,500 – 5,000 ft^2	Regulated Project ≥5,000 ft^2
Site Assessment	X	X
Source Control Measures	X	X
Site Design Measures	X	X
Treatment Measures		X
Operations & Maintenance Plan		X
Post Construction Stormwater Management Plan	X	X

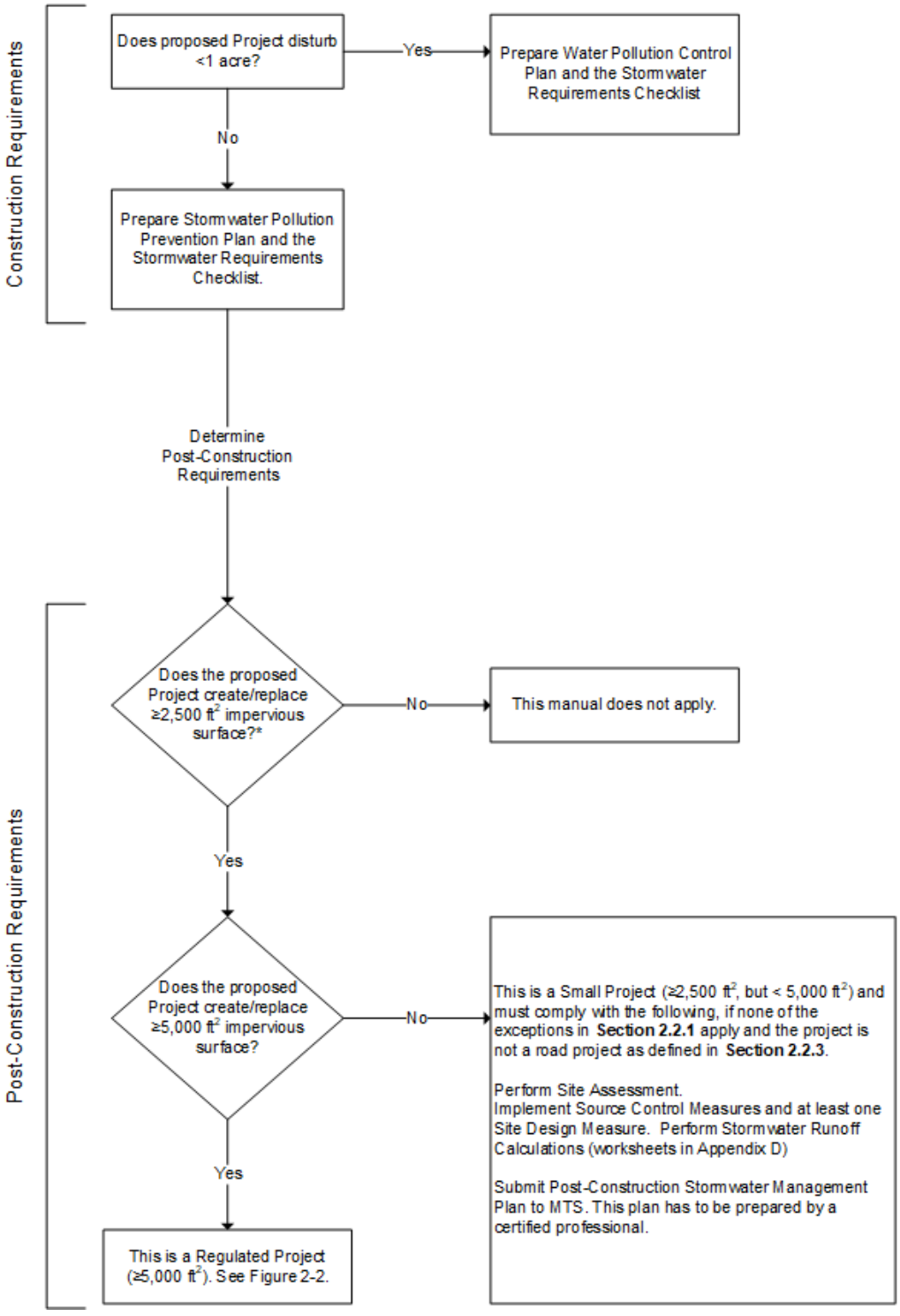

Figure 2-1. Stormwater Quality Requirements Flow Diagram

*Jack and bore projects are exempt if the entry and exit bore pits measure less than 2,500 square feet. Typically, working space for entry and exit bore pits measure 25 to 35 feet in length and 10 to 12 feet in width or 250 to 420 square feet (Virginia Center for Transportation & Research, 2015 [http://www.virginiadot.org/vtrc/main/online_reports/pdf/15-r16.pdf]).

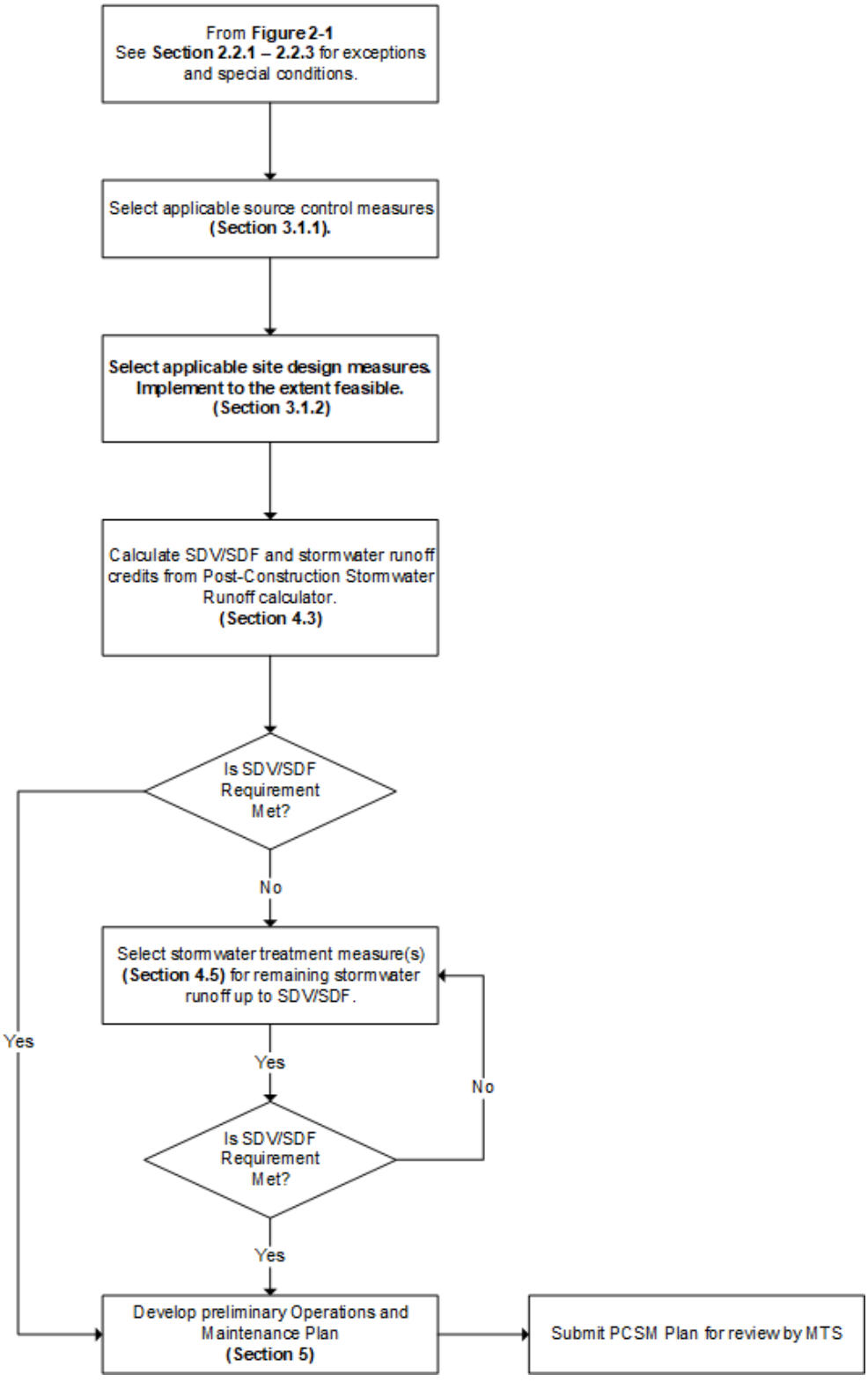

Figure 2-2. Post Construction Requirements Flow Diagram

2.1.1 EXCEPTIONS FOR SPECIFIC PROJECT TYPES

The following types of projects listed below are exempt from post construction stormwater requirements:

- Interior remodels that do not modify the existing footprint;
- Routine maintenance or repair projects that maintain the original purpose and footprint of the facility such as:
  - Exterior wall surface replacement;
  - Roof replacement;
  - Routine replacement of damaged pavement, such as pothole repair, or non-contiguous sections of roadway;
- Pavement grinding and resurfacing of existing roadways;
- Bicycle lanes and sidewalks built as part of new streets or roads and built to direct storm water runoff to adjacent vegetated areas;
- Impervious trails built to direct storm water runoff to adjacent vegetated areas, or other non-erodible permeable areas, preferably away from creeks or towards the outboard side of levees; and
- Sidewalks, bicycle lanes, or trails constructed with permeable surfaces.

2.1.2 REDEVELOPMENT PROJECTS

According to the Phase II Permit, redevelopment is defined as land-disturbing activity that results in the creation, addition, or replacement of exterior impervious surface area on a site on which some past development has occurred. The amount of impervious surface added or replaced dictates if a redevelopment project is considered a Small or Regulated project. The amount of impervious surface added or replaced by the project also dictates the amount of stormwater that needs to be treated. The following thresholds are used to determine the amount of post construction stormwater treatment required for a redevelopment project:

- If a redevelopment project results in an increase of more than 50 percent of the impervious surface of the existing development, then the stormwater runoff from the entire project, consisting of all existing, new, and/or replaced impervious surfaces, then the stormwater design volume or flow must meet be managed under these design standards to the extent feasible.
- If a redevelopment project results in an increase of less than 50 percent of the impervious surface of the existing development, then only the stormwater design volume or flow from the created and/or replaced impervious surface of the redevelopment project must be managed under these design standards.

2.1.3 ROAD PROJECTS

Road projects listed in Table 2-3 are considered special projects. Special projects that create 5,000 square feet or more of newly constructed contiguous impervious surface are Regulated Projects and must comply with the post construction design standards in this Manual. If the treatment of runoff from the design storm cannot be infiltrated onsite, then stormwater must be managed following guidance in U.S. EPA's *Managing Wet Weather with Green Infrastructure Municipal Handbook Green Streets* (EPA 833-F-08-009, December 2008) to the extent feasible.

Table 2-3. Road Projects

Type	Description
New Road	Construction of new roads including sidewalks and bicycle lanes built as part of the new roads which create 5,000 square feet or more of impervious surface.
Widening of Existing Roads	This includes roads with additional traffic lanes. — If the project results in an alteration of more than 50 percent of the impervious surface (5,000 square feet or more) of the existing road, then the stormwater design volume or flow from the entire project, consisting of all existing, new, and/or replaced impervious surfaces, must be managed; or — If the project results in an alteration of less than 50 percent (but 5,000 square feet or more) of the impervious surface of the existing road, then only the stormwater design volume or flow from the created and/or replaced impervious surface of the road project must be managed.

3 POST CONSTRUCTION STORMWATER MANAGEMENT REQUIREMENTS

A project applicant, including MTS, must submit a Post Construction Stormwater Management Plan (Plan) to the EHS for review. The Plan must include enough detail depending on the project type and be prepared and stamped by a professional civil engineer, professional geologist or geotechnical engineer. Construction of the proposed project can only begin after the Plan is approved. Worksheets and checklists for Small Projects are provided in Appendix C and applicable worksheets and checklists for Regulated Projects are provided in Appendix D. Each Plan must include the applicable worksheets and checklists for MTS review and approval.

3.1 SMALL PROJECT REQUIREMENTS

The Plan for Small Projects must provide the following information:

- Basic Project Information Cover Sheet
- Site Assessment that summarizes conditions at the project site. This information would be used to plan the project site layout and identify potential sources of pollutants of concern. The following information is required for the Site Assessment:
  - Project location and description
  - Project area size (acreage), including pre- and post-construction impervious surface area
  - Location of point(s) of stormwater runoff discharge from the project site (e.g., storm drain system, receiving waters)
  - Geotechnical conditions[5]
  - Other site considerations and constraints
    - Managing off-site drainage;
    - Existing utilities;
    - Jurisdictional Wetlands and Waters
  - Potential pollutants of concern for stormwater at the project site based on
    - Project location
    - Past land use and activities that have occurred on the project site
    - Land use and activities that are likely to occur in the future
    - Receiving water impairments
- Source Control Measures Checklist. All projects are required to implement source control measures to prevent pollutants from contacting stormwater runoff or prevent discharge of contaminated stormwater runoff from the project site. All projects that include landscape irrigation must implement the landscape irrigation source control measure.
- Site Design Measures Worksheet. Small Projects are required to implement at least one site design measure to the extent technically feasible and calculate the stormwater runoff volume credit using the SWRCB's Post

[5] Geotechnical information is only needed if stormwater mitigation devices that rely on infiltration are being considered.

Construction Stormwater Runoff Calculator (See Appendix E). For the Plan submittal, Small Projects must complete a Site Design Measures Worksheet for each drainage management area (DMA).

- Site Conditions Report prepared by or under the supervision of a licensed professional needs to address and discuss relevant findings of a geotechnical and site evaluation. The Site Conditions Report shall address the following conditions, as appropriate[6], based on the stormwater management measures being considered:
  - Soil type and geology;
  - Groundwater;
  - Existing soil and groundwater contamination;
  - Other geotechnical issues; and
  - Topography.
- Project Site Plan must display the following:
  - Site boundaries;
  - Existing natural hydrological features and significant vegetation;
  - Locations and footprint of existing impervious areas;
  - Proposed locations and footprints of improvements creating new, or replaced impervious surfaces;
  - Existing and proposed site drainage system and connections to off-site drainage; and
  - Proposed locations and footprints of stormwater treatment measures (e.g., site design measures, source control measures) implemented to manage stormwater runoff

3.1.1 SOURCE CONTROL MEASURES

Source control measures apply to both Small and Regulated Projects. Source control measures are practices that can be implemented to avoid water quality impacts by managing pollutants at their source. Source control measures apply to both stormwater and non-stormwater discharges. Non-stormwater discharges are discharges of any substance (e.g., excess irrigation, leaks and drainage from trash dumpsters, cooling water and process wastewater) that is not comprised entirely of stormwater runoff. Any stormwater runoff that is mixed or comingled with non-stormwater flow is considered non-stormwater.

MTS has identified potential sources that require source control measures that must be implemented to the extent technical feasible to mitigate pollutant mobilization in stormwater and non-stormwater runoff from the project site. These sources and measures are summarized in Table 3.1. Implementation of these BMPs would reduce or eliminate pollutants in stormwater runoff at their source through runoff reduction and by keeping pollutants and stormwater segregated. At a minimum, all projects that include landscape irrigation must implement water efficient landscape irrigation design as a source control measure. Irrigation runoff control guidance is detailed in the Landscape Design and Maintenance Plan (WSP 2019) and includes the following:

- Frequently inspect and repair broken water lines.
- Avoid overwatering. Manage irrigation systems to ensure the appropriate amount of water is used and runoff is minimized.
- Use pop-up sprinkler heads in areas of high activity or where there is a chance that pipes may be broken. Consider the use of mechanisms that reduce water flow to sprinkler heads if broken.

[6] For example, if infiltration basins are proposed, the Site Conditions Report shall provide detailed information for all items listed. For BMP strategies that do not incorporate infiltration, then only soil type, geology, topography and depth to groundwater would be required.

Some of the source control measures that are particularly important for MTS maintenance facilities and stations include the measures listed in Table 3.1. BMP fact sheets from the CASQA New Development and Redevelopment BMP Handbook (CASQA 2003) and the Municipal BMP Handbook (CASQA 2003) are provided in Appendix F.

Table 3-1. Source Control Measures

BMP ID No./Name	Source/Activity	Description
SC-10 Non-Stormwater Discharges	Interior floor drains	Keep internal floor drains plugged if they drain to the storm water drainage system
	Drain or wash water from boiler drain lines, condensate drain lines, rooftop equipment, drainage sumps, and other sources	Discharge to the storm drain system, provided that the flow path to the storm drain inlet has been swept of debris, the water is dechlorinated and the water has a pH between 6 and 9.
	Unauthorized non-storm water discharges	Ensure that project plans include appropriately designed areas for washing of transit vehicles and equipment. Unauthorized non-stormwater discharges such as wash water should be conveyed to a sanitary sewer, recycling system or other alternative.
SC-11 Spill Prevention, Control and Cleanup	Accidental spills or leaks	Develop procedures to prevent/mitigate spills to storm drain systems.
SC-21 Vehicle and Equipment Cleaning	Transit vehicle cleaning	Design should incorporate the installation of sumps or drain lines to collect wash water for ultimate conveyance to the sanitary sewer, a holding tank, a process treatment system or an enclosed recycling system.
SC-22 Vehicle and Equipment Repair	Vehicle and equipment repair and maintenance	Design indoor areas for vehicle and equipment repair and maintenance. Provide a centralized location for all liquid cleaning such that solvents and residues stay in one area. Design drainage such that wastewater generated is conveyed to an appropriate treatment control that is connected to a blind sump.
SC-33 Outdoor Storage of Raw Materials	Outdoor storage of equipment or materials	Design outdoor storage areas to contain drainage rather than infiltrate it. Design options include enclosures, secondary containment and imperviious surfaces.

BMP ID No./Name	Source/Activity	Description
SC-41 Building & Grounds Maintenance	Indoor and structural pest control	Install physical barriers for pest control. For example, subterranean termites cannot tunnel through sand barriers. Sand barriers can be designed into crawl spaces under pier and beam foundations and against retaining walls. Metal flashing and metal plates can also be used as a barrier between piers and beams of structures such as decks.
	Fire sprinkler test water	Fire sprinkler systems may contain corrosion inhibitors, fire supresants or antifreeze. Prevent discharge of water from fire sprinkler system maintenance activities to the storm drain system during testing.
SC-43 Parking/Storage Area Maintenance	Maintenance	Conduct regular cleaning by sweeping or vacuuming parking areas prior to the onset of the wet season.
SC-72 Fountain & Pool Maintenance	Ponds, decorative fountains, and other water features	Consider using a vendor to collect all decorative fountain water for offsite disposal. If not possible, never discharge water to a street or storm drain. Instead, discharge to the sanitary sewer if permitted to do so.
SC-73 Landscape Maintenance	Landscape/outdoor pesticide use	Incorporate integrated pest management techniques to the maximum extent practicable. See MTS Landscape Design and Maintenance Plan.
SD-30 Fueling Areas	Fuel dispensing areas	Fuel dispensing area design must comply with Building and Fire Codes and current local agency ordinances and zoning requirements as well as provide protection of water quality. Project plans must be developed for cleaning near fuel dispensers, emergency spill cleanup, containment and leak prevention.
SD-31 Maintenance Bays & Docks	Loading docks	Loading dock areas should be covered or drainage should be designed to preclude urban run-on and runoff. Direct connections into storm drains from depressed loading docks are prohibited.
SD-32 Trash Storage Areas	Refuse areas	Incorporate preventative measures into design such as enclosures, containment structures, and impervious pavements to mitigate spills.
SD-36 Outdoor Processing Areas	Industrial processes	For outdoor processing areas (e.g. painting or coating, sanding, degreasing) design shall include enclosures, secondary containment structures, dead-end sumps, and conveyance to treatment facilities in accordance with conditions established by the local wastewater treatment agency.

Source : CASQA Stormwater BMP Handbook for New Development and Redevelopment and CASQA Municipal BMP Handbook.

3.1.2 SITE DESIGN MEASURES

The purpose of site design measures is to reduce project site runoff. Hydrologic and stormwater management concepts incorporated into site design measures are more integrated with natural topography; reinforce they hydrologic cycle; are more aesthetically pleasing and are often less expensive to build. Site design measures entail locating development on the least sensitive area of a site and help to mitigate the impact on stormwater quality. Implementation of site design measures are required for Small and Regulated projects.

For Small Projects, the developer is required to implement one (1) site design measure. Small Projects do not have to meet numeric sizing criteria for the reduction of the post-project runoff. All projects, however, including Small Projects, must quantify runoff reductions resulting from implementation of site design measures as specified in Section E.12.b.(ii) and Section F.5.g.1.(ii) of the Phase II Permit. The SWRCB developed a Post-Construction Calculator to quantify the stormwater runoff reduction for Small Projects. The Post-Construction Calculator is provided in Appendix E.

The following Site Design Measures listed in the Phase II Permit and applicable to MTS facilities include the following:

- Stream setbacks and buffers
- Soil quality improvement and maintenance
- Tree planting and preservation
- Rooftop and impervious area disconnection
- Porous pavement
- Vegetated swales
- Rain barrels and cisterns

Site Design Measure fact sheets are provided in Appendix G.

STREAM SETBACKS AND BUFFERS

Stream setbacks and buffers are vegetated areas (including trees, shrubs, and herbaceous vegetation) designed to protect a stream system, lake reservoir, or coastal estuarine area by treating sheet flow from adjacent surfaces. These vegetated areas slow down runoff, capture storm water pollutants, allow for some infiltration, and protect erodible banks.

SOIL QUALITY IMPROVEMENT AND MAINTENANCE

Soil quality improvement and maintenance is accomplished through the addition of soil amendments and the creation of a healthy microbial community. Soils with a higher organic content are less likely to erode and provide nutrients which are needed to maintain healthy plants. Soils with more organic content or covered with a compost layer will retain moisture requiring less irrigation. Establishing and maintaining soil quality in the post construction landscape provides pollution prevention by minimizing the need for landscaping chemicals such as pesticides, herbicides and fertilizers. Furthermore, engineered soils allow water to infiltrate and be stored below grade providing low impact development (LID) and hydromodification benefits. An amended soil fact sheets (see Appendix G) from the City of San Diego and San Diego County (2016) provide guidance on mulch planting beds, topsoil layer specifications, and soil amendment organic content and pH.

TREE PLANTING AND PRESERVATION

For stormwater management, trees intercept precipitation which results in a reduction in potential stormwater runoff volumes and flow rates. Trees also absorb and store rainwater which reduces runoff and sediment deposits. Trees are beneficial to water quality in that they provide some pollutant removal through root uptake. Additional environmental benefits include improved air quality, carbon sequestration, reduced heat island effect, and habitat preservation or formation.

When site planning, the developer should preserve existing trees and other vegetation at the project site. For instances where vegetation is designated for ultimate removal, the project designer should temporarily preserve this vegetation for erosion and sediment control.

For tree planting, the project designer should consider and implement if feasible, the following:

- Locate trees based on sun, soil, and moisture requirements.
- Select planting locations to ensure that sight distances and appropriate setbacks are maintained given mature height, size, and rooting depths.
- To help ensure tree survival and canopy coverage, the minimum tree spacing for newly planted trees should consider mature tree spread.
- Concentrate or cluster development on less sensitive areas of the project site. Sensitive areas include:
  - Areas with higher infiltration capacities
  - Mature desirable vegetation
  - Habitat benefits
  - Aesthetic benefits

Stormwater runoff reduction credits are based on the following:

- Number of proposed evergreen and deciduous trees planted
- Square feet under an existing tree canopy that will remain on the property with an average diameter at breast height (DBH) at 4.5 feet above grade is less than 12 inches in diameter
- Square feet under an existing tree canopy that will remain on the property with an average DBH at 4.5 feet above grade is 12 inches in diameter or greater

ROOFTOP AND IMPERVIOUS AREA DISCONNECTION

Rooftop and impervious area disconnection allows a reduction in the volume and rate of runoff from impervious areas. This site design measure retains pollutants from impervious areas such as rooftops and pavement by directing these onsite flows to vegetation or pervious surface areas. Roof runoff controls consist of directing the roof runoff away from paved areas and mitigating flow to the storm drain system through one of several general approaches: cisterns or rain barrels; dry wells or infiltration trenches; pop-up emitters, and foundation planting. For disconnection of impervious areas, site designers should develop a grading plan such that paved areas are graded to drain onto pervious areas such as landscape or a natural area. These design strategies increase the opportunity for infiltration and minimize the sizing requirements for downstream structural treatment.

POROUS PAVEMENT

The design phase presents many opportunities to maximize the permeability of new construction. This includes paving with permeable materials like porous pavement. Porous pavement is a system comprising a load-bearing, durable surface together with an underlying layered structure that temporarily stores water prior to infiltration or drainage to a controlled outlet. The surface can itself be porous such that water infiltrates across the entire surface of the material (e.g., grass and gravel surfaces, porous concrete and porous asphalt), or can be built up of

impermeable blocks separated by spaces and joints, through which the water can drain. Porous pavements can be used in place of traditional concrete or asphalt pavements in many low traffic applications. A high-permeability site plan may allow the reduction or elimination of expensive underground conveyance systems, resulting in significant savings in development costs. Other advantages of porous pavements are that they reduce runoff volume while providing treatment and are unobtrusive.

VEGETATED SWALES

Vegetated swales are open, shallow channels with vegetation covering the side slopes and bottom that collect and slowly convey runoff flow to downstream discharge points. They are designed to remove pollutants by filtration through the vegetation, sedimentation, adsorption to soil particles, and infiltration into the underlying soils (California Department of Transportation 2017). Swales can be natural or manmade. They trap particulate pollutants (suspended solids and trace metals), promote infiltration, and reduce the flow velocity of stormwater runoff.

Vegetated swales should be considered wherever site conditions and climate allow vegetation to be established and where flow velocities will not cause scour. A minimum vegetative cover of approximately 65 percent is required for treatment to occur. Vegetated swales are considered a stormwater treatment strategy for areas that are anticipated to produce pollutants of concern (e.g., roadways, parking lots, maintenance facilities).

The sizing criteria for the vegetated swale is based on the water quality flow which is calculated using the Rational Method and a precipitation rate of 0.2 inches per hour (iph) for San Diego County. The vegetated swale design is typically within a 1 – 2 percent preferred slope with a less than a 6 percent longitudinal slope. Bottom width ranges from two to 12 feet, and the length ranges from 80 to 600 feet. The vegetated swale design requires water quality flow velocities (equal to the flow generated from the 85th percentile storm) to be low enough to keep the hydraulic residence time in the swale greater than five minutes with a Manning's 'n' of 0.24 used for mowed grass at flow depths less than 0.5 foot. The swale should be vegetated with native grasses. For the soil amendment, the vegetated swale can use an aggregate topsoil to promote infiltration of the water quality volume. The downstream end of the vegetated swale can connect to grated inlet structures which would ultimately outlet to adjacent offsite storm drainage systems (California Department of Transportation 2017).

RAIN BARRELS AND CISTERNS

Rain barrels and cisterns are above ground storage vessels with either manually operated valves or permanently open outlets. Impervious surface runoff is temporarily stored and then released for irrigation or infiltration between storms. Roof barrels serve several purposes including mitigating the first flush from the roof which has a high volume, amount of contamination, and thermal load. Consideration must be given to selecting rain barrels that are vector proof and childproof. In addition, some barrels are designed with a bypass valve that filters out grit and other contaminants and routes overflow to a soak-away pit or rain garden. If the cistern has an operable valve, the valve can be closed to store stormwater for irrigation or infiltration between storms. If a cistern is provided with an operable valve and water is stored inside for long periods, the cistern must be covered to prevent mosquitoes from breeding. A cistern system with a permanently open outlet can also provide for metering stormwater runoff. This is a feasible way to mitigate the peak flow increases caused by rooftop and impervious land coverage, especially for the frequent, small storms.

3.2 REGULATED PROJECT REQUIREMENTS

Regulated Projects are required to submit a comprehensive, technical discussion describing compliance with the requirements of this Manual. Regulated Projects are required to implement low impact development (LID) standards to reduce runoff, treat storm water, and provide baseline hydromodification management to the extent

feasible, to meet the Numeric Sizing Criteria for Storm Water Retention and Treatment (see Section E.12.e(ii)(c))[7]. Consideration of LID design standards should begin early in the planning stage as discussed in Section 3.1, Site Assessment. The Post Construction Stormwater Management Plan for a Regulated Project must include the following information:

- Basic Project Information Cover Sheet
- Site Assessment Worksheet. Regulated projects are required to assess and evaluate how site conditions, such as soils, vegetation, and flow paths, will influence the placement of buildings and paved surfaces. The evaluation should be used to meet the goals of capturing and treating runoff and assuring these goals are incorporated into the project design. Guidance on site assessment is available in the Low Impact Development Manual for Southern California: Technical Guidance and Site Planning Strategies (Low Impact Development Center, 2010). Regulated Projects are required to consider optimizing the site layout through the following methods:
  - Define the development envelope and protected areas, identifying areas that are most suitable for development and areas to be left undisturbed.
  - Concentrate development on portions of the site with less permeable soils and preserve areas that can promote infiltration.
  - Limit overall impervious coverage of the site with paving and roofs.
  - Set back development from creeks, wetlands, and riparian habitats.
  - Preserve significant trees.
  - Conform the site layout along natural landforms.
  - Avoid excessive grading and disturbance of vegetation and soils.
  - Replicate the site's natural drainage patterns.
  - Detain and retain runoff throughout the site.
- Source Control Measures Checklist. All projects are required to implement source control measures to prevent pollutants from contacting stormwater runoff or prevent discharge of contaminated stormwater runoff from the project site. All projects that include landscape irrigation must implement the landscape irrigation source control measure.
- Description of drainage management areas (DMAs). To follow the LID principle of managing stormwater through small-scale, decentralized measures, MTS requires every Regulated Project to submit a map or diagram that displays the DMAs. DMAs are designated individual drainage areas within a Regulated Project. DMAs typically follow grade breaks and roof ridge lines and account for each surface type (e.g., landscaping, pervious paving or roofs). Once DMAs are delineated, runoff must be managed using site design, source controls and/or stormwater treatment and baseline hydromodification measures. Implementation of site design measures must be implemented with the objective of achieving infiltration, evapotranspiration and/or harvesting/reuse of the 85th percentile 24-hour storm runoff event. Site design measures are used to reduce the amount of runoff, to the extent feasible, for which retention and runoff is required. Any remaining runoff from impervious DMAs may then be directed to one or more bioretention facilities. Management strategies directed at controlling pollutant sources are discussed in Section 3.1.1. Site design measures are described in Section 3.1.2.
- A Site Conditions Report prepared by or under the supervision of a licensed professional needs to address and discuss relevant findings of a geotechnical and site evaluation. The Site Conditions Report shall address the following conditions, as appropriate, based on the stormwater management measures being considered:

[7] The Office of Water Programs offers a Phase II LID sizing tool to select and size LID BMPs that meet the NPDES sizing requirements for small MS4s. The sizing tool is available at http://www.owp.csus.edu/LIDTool/Start.aspx.

  - Soil type and geology;
  - Groundwater;
  - Existing soil and groundwater contamination;
  - Other geotechnical issues; and
  - Topography.
- Project Site Plan that includes the following:
  - Site boundaries;
  - Existing natural hydrological features and significant vegetation;
  - Locations and footprint of existing impervious areas;
  - Proposed locations and footprints of improvements creating mew, or replaced impervious surfaces;
  - Existing and proposed site drainage system and connections to off-site drainage;
  - All DMAs with unique identifiers; and
  - Proposed locations and footprints of stormwater treatment measures (e.g., site design measures, source control measures, stormwater treatment control measures) implemented to manage stormwater runoff
- Site Design Measures Worksheet. Regulated Projects are required to implement site design measures to the extent technically feasible and calculate the stormwater runoff volume credit using the SWRCB's Post Construction Stormwater Runoff Calculator for each DMA. Regulated Projects must complete a Site Design Measure Worksheet for each DMA as part of the Plan submittal.
- Stormwater Treatment Measure Worksheet. Regulated Projects are required to implement stormwater treatment measures to manage the portion of the stormwater runoff volume not mitigated by site design measures. A Stormwater Treatment Measure Worksheet is required for each DMA and shall be submitted as part of the Plan.

  Bioretention is the preferred stormwater treatment measure unless

  - It is infeasible and an alternative treatment measure equivalent to bioretention is proposed and justified; or
  - A specific exception applies.

  Bioretention facilities are considered a volume-based treatment measure. A discussion on numeric sizing criteria for both volume-based and flow-based stormwater treatment measures is provided in Section 4.
- Operations and Maintenance Plan. The quality of stormwater entering the waters of the state relies heavily on the proper operation and maintenance of stormwater treatment measures. Stormwater management facilities must be periodically inspected to ensure that they function as designed. The inspection will determine the appropriate maintenance that is required for the facility. To ensure that such maintenance is performed, MTS requires the submittal of an Operations and Maintenance Plan. Further details regarding the Operations and Maintenance Plan submittal are provided in Section 5.

4 NUMERIC SIZING CRITERIA

Numeric sizing criteria has been established by the San Diego RWQCB for site design, storm water treatment and baseline hydromodification. The design criteria should be incorporated into newly developed stormwater treatment measures and for retrofit into existing facilities to meet stormwater management objectives. Stormwater treatment measure design depends on the volume and rate of runoff expected, which are affected by the drainage area and configuration, land use, topography, soil characteristics, impervious area, and storm intensity and duration. In general, stormwater treatment measures are designed to treat the flow of smaller, more frequent storm events. Stormwater treatment measure design is based on a specific design storm and must meet either volumetric or flow-based criteria as indicated in Table 4.1.

Table 4-1. Numeric Sizing Criteria

Stormwater Treatment Measure	Type of Numeric Sizing Criteria
Bioretention	Volume-based
Drain Inlet Insert*	Flow-based
Extended Detention Basin	Volume-based
Gravity Separators	Volume-based
Infiltration Basin	Volume-based
Infiltration Trench/Dry Well	Volume-based
Media/Sand Filter	Volume-based
Sidewalk Planter/Flow-Through Planter	Volume-based
Stormwater Filter	Flow-based
Tree-Well Filter/Tree Wells	Volume-based
Vegetated Buffer/Filter Strip	Flow-based
Vegetated Swale	Flow-based

*Includes trash guards, media filter inserts and/or cartridges

4.1 STORMWATER DESIGN VOLUME

The minimum treatment volume for site design measures and volume-based stormwater treatment measures must meet one of the following two criteria:

- Treat the maximized capture storm water volume for the tributary area, based on historical rainfall records, determined using the formula and volume capture coefficients in Urban Runoff Quality Management, WEF Manual of Practice No. 23/ASCE Manual of Practice No. 87 (1998) pages 175-178 (that is, approximately the 85th percentile 24-hour storm runoff event); or
- The volume of annual runoff required to achieve 80 percent or more capture, determined in accordance with the methodology in Section 5 of CASQA's Stormwater Best Management Practice Handbook, New Development and Redevelopment (2003), using local rainfall data.

4.2 STORMWATER DESIGN FLOW

Per the Phase II Small MS4 General Permit, the minimum treatment flow rate for flow-based stormwater treatment measures must meet one of the following two criteria:

- The flow of runoff produced from a rain event equal to at least 0.2 inches per hour intensity[8]; or
- The flow of runoff produced from a rain event equal to at least 2 times the 85th percentile hourly rainfall intensity as determined from local rainfall records.

4.3 POST-CONSTRUCTION STORMWATER RUNOFF REDUCTION CALCULATOR

The primary objective of the post-construction stormwater management requirements is to ensure that a project is reducing pollutant discharges to the maximum extent practicable and preventing stormwater discharges from causing or contributing to a violation of receiving water quality standards. The post-construction requirements emphasize protecting, and where degraded, restoring key watershed processes to create and sustain linkages between hydrology, channel geomorphology, and biological health necessary for a healthy watershed. Maintenance and restoration of watershed processes impacted by stormwater management is necessary to protect water quality and beneficial uses. MTS requires that Small Projects and Regulated Projects use the SWRCB SMARTS Post-Construction Calculator, or equivalent to quantify the runoff reduction resulting from implementation of site design measures. The SWRCB SMARTS Post-Construction Calculator is provided in Appendix E.

4.4 BIORETENTION

Pursuant to the Phase II Permit, after Site Design Measures are identified for low impact development (LID) compliance, any remaining runoff from impervious DMAs must be directed to a bioretention facility. Bioretention facilities are considered as the desired stormwater treatment measure and should be ranked first in priority. If bioretention is considered infeasible, however, then the stormwater treatment measures listed in Table 4-1 shall be evaluated and implemented.

A bioretention facility, which is also considered a low impact design (LID) stormwater treatment measure, is a landscaped shallow depression that captures and filters stormwater runoff (see Figure 4-1). These facilities have a layer of plants and soil where pollutants can be filtered, adsorbed and biodegraded as stormwater percolates through the soil media (Figure 4-2). Once stormwater saturates the media materials and fills the bioretention facility, an underdrain system conveys the treated stormwater to an outlet. Bioretention facilities can remove total suspended solids, nutrients, particulate metals, pathogens and litter. Bioretention removes stormwater pollutants through physical and biological processes, including adsorption, filtration, plant uptake, microbial activity, decomposition, sedimentation and volatilization (US Environmental Protection Agency [EPA], 1999).

[8] MTS suggests using 0.2 iph as the rainfall intensity for determine the stormwater design flow. The design engineer, however, has the option to calculate the design intensity if desired.

Figure 4-1. MTS Bioretention BMPs

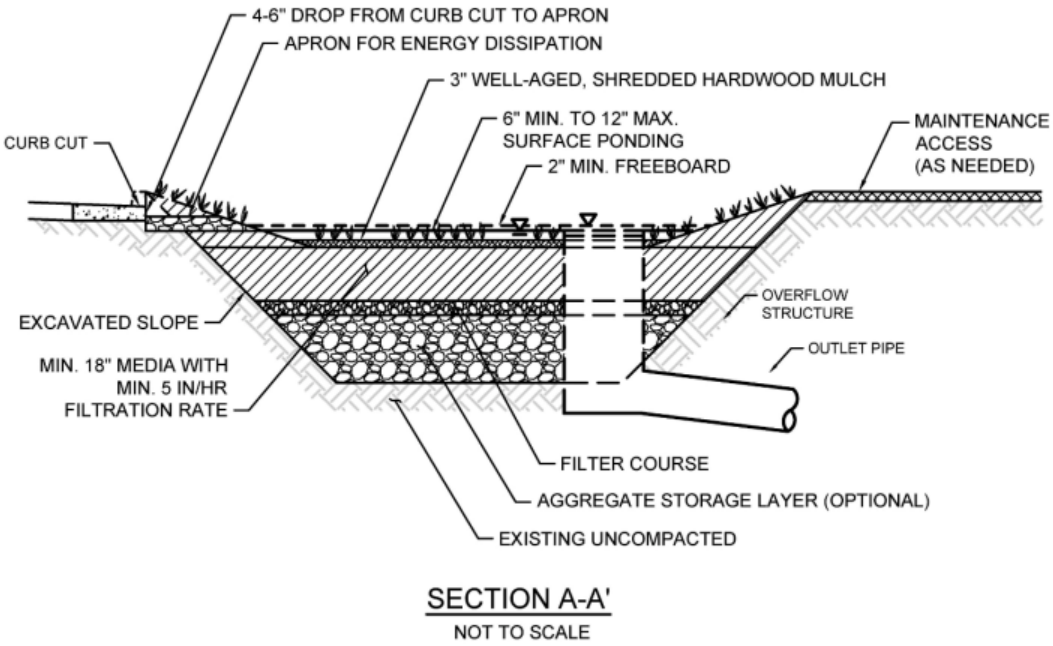

Figure 4-2. Detailed Section of a Bioretention BMP[9]

Bioretention facilities create habitat, improve water quality and include the following features and water quality benefits:

- Planting layer: Facilitates pollutant filtration, adsorption and biodegradation
- Mulch: Facilitates pollutant filtration, adsorption and biodegradation
- Planting Soil: Facilitates pollutant filtration, adsorption and biodegradation
- Gravel: Acts as a high porosity reservoir for treated stormwater
- Underdrain: Conveys treated stormwater to an outlet

4.4.1 STANDARD DESIGN PARAMETERS

Bioretention facilities must incorporate the following design parameters[10]:

- Maximum surface loading rate of 5 inches per hour, based on the flow rates calculated. A sizing factor of 4% of tributary impervious area may be used.
- (2) Minimum surface reservoir volume equal to surface area times a depth of 6 inches.
- (3) Minimum planting medium depth of 18 inches. The planting medium must sustain a minimum infiltration rate of 5 inches per hour throughout the life of the project and must maximize runoff retention and pollutant removal. A mixture of sand (60%-70%) meeting the specifications of American Society for Testing and Materials (ASTM) C33 and compost (30%-40%) may be used.
- Subsurface drainage/storage (gravel) layer with an area equal to the surface area and having a minimum depth of 12 inches.

[9] San Diego County. 2016. County of San Diego BMP Design Manual Appendices. February 2016.
[10] Provision F.5.g.2.d

- Underdrain with discharge elevation at top of gravel layer.
- No compaction of soils beneath the facility, or ripping/loosening of soils if compacted.
- No liners or other barriers interfering with infiltration.
- Appropriate plant palette for the specified soil mix and maximum available water use.
  - A plant list for bioretention facilities is provided in Appendix H.

4.4.2 EQUIVALENT EFFECTIVENESS CRITERIA

MTS will consider an alternative stormwater treatment measure if the Regulated Project developer, including MTS, demonstrates that the alternative measure meets all the following equivalent effectiveness criteria when compared to the bioretention standards referenced in the Phase II Permit[11]:

- Equal or greater amount of runoff infiltrated or evapotranspired
- Equal or lower pollutant concentrations in runoff that is discharged after bioretention
- Equal or greater protection against shock loadings and spills
- Equal or greater accessibility and ease of inspection and maintenance

4.4.3 SPECIAL SITE CONDITIONS

Bioretention standard design parameters may be modified for the following special site conditions. The Regulated Project developer must demonstrate these conditions in their Plan. Although the Phase II Permit allows for the modification of the standard bioretention design parameters, these should not be considered as an exception for implementing bioretention or an alternative stormwater treatment measure.

- Facilities located within 10 feet of structures or other potential geotechnical hazards established by the geotechnical expert for the project may incorporate an impervious cutoff wall between the bioretention facility and the structure or other geotechnical hazard.
- Facilities in areas with documented high concentrations of pollutants in underlying soil or groundwater, facilities located where infiltration could contribute to a geotechnical hazard, and facilities located on elevated plazas or other structures may incorporate an impervious liner and may locate the underdrain discharge at the bottom of the subsurface drainage/storage layer (this configuration is commonly known as a “flow-through planter”).
- Facilities located in areas of highly infiltrative soils or high groundwater, or where connection of underdrain to a surface drain or to a subsurface storm drain are infeasible, may omit the underdrain.
- Facilities serving high-risk areas such as fueling stations, truck stops, auto repairs, and heavy industrial sites may be required to provide additional treatment to address pollutants of concern unless these high-risk areas are isolated from storm water runoff or bioretention areas with little chance of spill migration.

4.4.4 MAINTENANCE

Bioretention maintenance activities are presented in Table 4.2. All vegetation management tasks are included within vegetation repair and are suggested to occur two times per year. Intermittent maintenance includes repair

[11] Provision F.5.g.2.d (a)

of erosion, underdrain system and any structures. Based on average annual rainfall in southern California, sediment removal will be required every 50 years.

Table 4-2. Bioretention Maintenance Activities

Maintenance Activity	Maintenance Frequency
Vegetation Repair	2 times per year
Vegetation Management for aesthetics (optional)	2 times per year
Mulch layer management	2 times per year
Trash and Debris	2 times per year
Intermittent Maintenance	Every 4 years
Underdrain System (if necessary)	Every 4 years
Soil Repair	Every 8 years
Sediment Management	Every 50 years
Inspection and Reporting	Annually

Source: Long-Term Performance and Life Cycle Costs of Stormwater Best Management Practices (2014)

4.5 STORMWATER TREATMENT MEASURES

Stormwater treatment measures improve water quality after construction is complete. MTS has approved stormwater treatment measures for use within their jurisdiction. These stormwater treatment measures must be considered for Regulated Projects, pursuant to Section 1.4 of the MTS Stormwater Management Plan (WSP 2018), to minimize the long-term potential impacts associated with new development and redevelopment. Fact Sheets for alternative stormwater treatment measures are provided in Appendix I. A list of these factsheets is displayed in Table 4-2. Infiltration basins and infiltration trenches would treat and partially contain the on-site impervious area runoff of the DMA. The infiltration basins treat runoff by retaining the stormwater design volume and are typically accepted alternatives to bioretention. The remaining measures, including proprietary design measures, may or may not meet the equivalent effectiveness criteria referenced in Section 4.4.2. The Regulated Project developer must demonstrate in their Plan how a proposed alternative stormwater treatment measure meets all the equivalent effectiveness criteria. Treatment measures that do not meet the criteria may still be used if the Regulated Project fulfills one or more of the exception criteria listed in Section 4.5.1.

Table 4-3. Stormwater Treatment Measures in Lieu of Bioretention

Alternative Measure	Factsheet Source
Drain Inlet Insert	Proprietary
Extended Detention Basin	City of San Diego
Gravity Separators	Proprietary
Infiltration Basin	City of San Diego
Infiltration Trench/Dry Well	San Diego County
Media/Sand Filter	City of San Diego
Sidewalk Planter/Flow-Through Planter	County of San Diego
Stormwater Filter	Proprietary

Alternative Measure	Factsheet Source
Tree-Well Filter/Tree Wells	County of San Diego
Vegetated Buffer/Filter Strip	County of San Diego
Vegetated Swale	City of San Diego

4.5.1 BIORETENTION EXCEPTIONS

The Phase II Permit allows exception to implementation of bioretention facilities. The Regulated Project developer, however, must demonstrate that use of bioretention or a facility of equivalent effectiveness is infeasible, in their Plan. Other types of biotreatment or media filters (such as tree-box-type biofilters or in-vault media filters) may be used for the following categories of Regulated Projects:

- Projects creating or replacing an acre or less of impervious area, and located in a designated pedestrian-oriented commercial district (i.e., smart growth projects), and having at least 85% of the entire project site covered by permanent structures;
- Facilities receiving runoff solely from existing (pre-project) impervious areas; and
- Historic sites, structures or landscapes that cannot alter their original configuration to maintain their historic integrity.

If a Regulated Project meets any of the exceptions listed above, it is still required to implement an alternative stormwater treatment measure. Again, the Regulated Project developer must demonstrate the bioretention exception in their Plan and they must propose an alternative treatment measure for stormwater management at the site.

5 OPERATION AND MAINTENANCE

The objective of maintenance is to ensure that a stormwater treatment measure functions as designed over its useful life. If treatment measures are maintained, their performance generally does not decline with age, assuming their original physical dimensions and influent quality remain constant. The potential, however, does exist for poorly maintained treatment measures to bypass influent, or in extreme cases, contribute pollutant load to the effluent. For example, a detention basin that has an excessive amount of accumulated sediment may bypass a portion of the influent due to lack of storage volume, and in an extreme case, contribute sediment to the effluent due to the creation of a high-energy environment in the sedimentation area from lack of storage volume. Overall, lack or deferred maintenance of treatment measures will negatively affect the effluent water quality from the stormwater treatment measure. To ensure continued effectiveness of stormwater treatment measures, MTS requires the submittal of an Operations and Maintenance Plan as an appendix to the Post Construction Stormwater Management Plan. The Regulated Project developer, his/her designee, or successor is responsible for complying with the Operations and Maintenance Plan. Failure to properly implement the Operations and Maintenance Plan may result in enforcement by MTS. The Operations and Maintenance Plan shall include the items discussed in the following sections.

5.1 BASELINE INFORMATION

Baseline information shall be summarized on the Basic Project Information form in Appendix J.

5.2 MAINTENANCE AGREEMENT MAP

A Maintenance Agreement Map that displays the area bounded in the joint maintenance area shall display the following:

- At a scale of 1-inch equals 200 feet, display boundaries of the project site, major streets and highways, drainage and storm water quality items. The Final Maintenance Agreement Map will include all structures and appurtenances to be constructed and as built will be added to the Maintenance Agreement Map as construction progresses. As-Built Drawings must accompany the final submittal.
- Identify the location of each stormwater treatment measure, sanitary sewer systems, underground utility, and grade breaks for purposes of pollution prevention.
- With a legend, identify locations of items to be maintained by MTS and items that would be maintained by other party referenced in the Agreement for the Regulated Project.

The Maintenance Agreement Map and the Maintenance Agreement (see Section 5.6) will be kept on file in the EHS office. All Maintenance Agreements are also listed in a Microsoft Excel spreadsheet for tracking inspection and maintenance terms and conditions associated with stormwater treatment measures.

5.3 OPERATION, INSPECTION AND MAINTENANCE REQUIREMENTS

All BMPs should be inspected on an annual basis at a minimum. In addition, all BMPs should be inspected after a significant precipitation event to ensure the facility is draining appropriately and to identify any damage that occurred because of the increased runoff. This section of the Operations and Maintenance Plan should include the following:

- Identify inspection procedures and frequencies
- Identify maintenance triggers and activities
  - Sediment removal
  - Trash removal
  - Vegetation repair
  - Erosion repair
- Identify vector control triggers and response
- Identify field equipment
  - Protective clothing and boots.
  - Safety equipment (vest, hard hat, gloves).
  - Communication equipment.
  - Camera and tape measure
  - Plumbing snake and thin rod
  - Operation and Maintenance Manual for the site including stormwater management facility location maps.
  - Clipboard.
  - Stormwater Facility Maintenance Inspection Forms
  - Manhole Lid Remover
  - Shovel and metal rake.
- Inspection forms for each type of stormwater treatment measure. The form should include the following information:
  - Name of inspector
  - Inspection date and time
  - Approximate days since the last rainfall.
  - The reason for the inspection
  - Inspection results and required corrective actions

5.4 SPILL PLAN

Potentially dangerous (e.g., fuel, chemicals, hazardous materials) substances found during inspection of a stormwater treatment measure must be managed following a Spill Plan. The Spill Plan shall be developed to ensure the safety of all persons, halt the spread of the substance whenever possible (if determined to be non-hazardous) and documentation of events. The following elements are required in the Spill Plan:

- Procedures that effectively address hazardous and non-hazardous spills;
- Equipment and materials required for cleanup of spills;
- Description of appropriate spill response personnel;
- Emergency notification procedures including phone and agency/persons to contact; and
- Identification of downstream storm drain and receiving waters.

5.5 TRAINING

Personnel responsible for inspection, operation and maintenance shall receive appropriate training. Include information about required operation and maintenance training. The training shall include:

- Good Housekeeping/Pollution Prevention procedures;
- Maintenance procedures for routine, restoration and rehabilitation work;
- Spill identification, response and cleanup procedures; and
- Safety.

5.6 JOINT USE MAINTENANCE AGREEMENT

A Joint Use and Maintenance Agreement (Agreement) or modification of an existing Agreement is required in situations where the stormwater treatment measure is owned by MTS and MTS staff are required to access the property to inspect and maintain the stormwater treatment measure(s). The Agreement delineates the duties and responsibilities of the different parties identified in the Agreement as it relates to the portions of the Regulated Project within the boundary of the Maintenance Agreement Map, also referred to as the Joint Maintenance Area.

The property owner is responsible to ensure inspection, maintenance and proper operation of the stormwater treatment measure. For stormwater treatment measures on leased property, the tenant is responsible for on-going maintenance in accordance with applicable terms and conditions in the lease agreement.

During early project design phases, MTS will determine if access by MTS staff would be required. Access conditions would be required if MTS will assume all or part of the responsibilities for operations and maintenance of the stormwater treatment measure. If required, access conditions would be added to the Agreement and the Post-Construction Storm Water Project Manager would be notified.

MTS may require performance bonds for construction during the structural treatment measure establishment phase. For vegetative-based treatment measures such as bioretention facilities, a bond that is extended one year after project acceptance by MTS may be required to ensure proper maintenance of the vegetation during the plant establishment phase.

5.7 OPERATION AND MAINTENANCE VERIFICATION PROGRAM

Per Provision F.5.g.3 of the Phase II Permit, MTS is required to implement an Operations and Maintenance Verification Program for all stormwater treatment measures. The O&M Verification Program will include, at a minimum, any legally enforceable agreement or mechanism that assigns the O&M responsibility for the installed BMPs to MTS or other entities implementing storm water treatment measures and hydromodification management controls within MTS right-of-way. The Phase II Permit requires MTS to develop a database or equivalent table with the following information:

- Name and address of the project;
- Specific description of the location (or a map showing the location) of the installed treatment system(s) and hydromodification control(s) (if any);
- Date(s) that the treatment system(s) and hydromodification controls (if any) is/are installed;
- Description of the type and size of the treatment system(s) and hydromodification control(s) (if any) installed;
- Responsible operator(s) of each treatment system and hydromodification control (if any);

- Dates and findings of inspections (routine and follow-up) of the treatment system(s) and hydromodification control(s) (if any) by MTS; and
- Any problems and corrective or enforcement actions taken.

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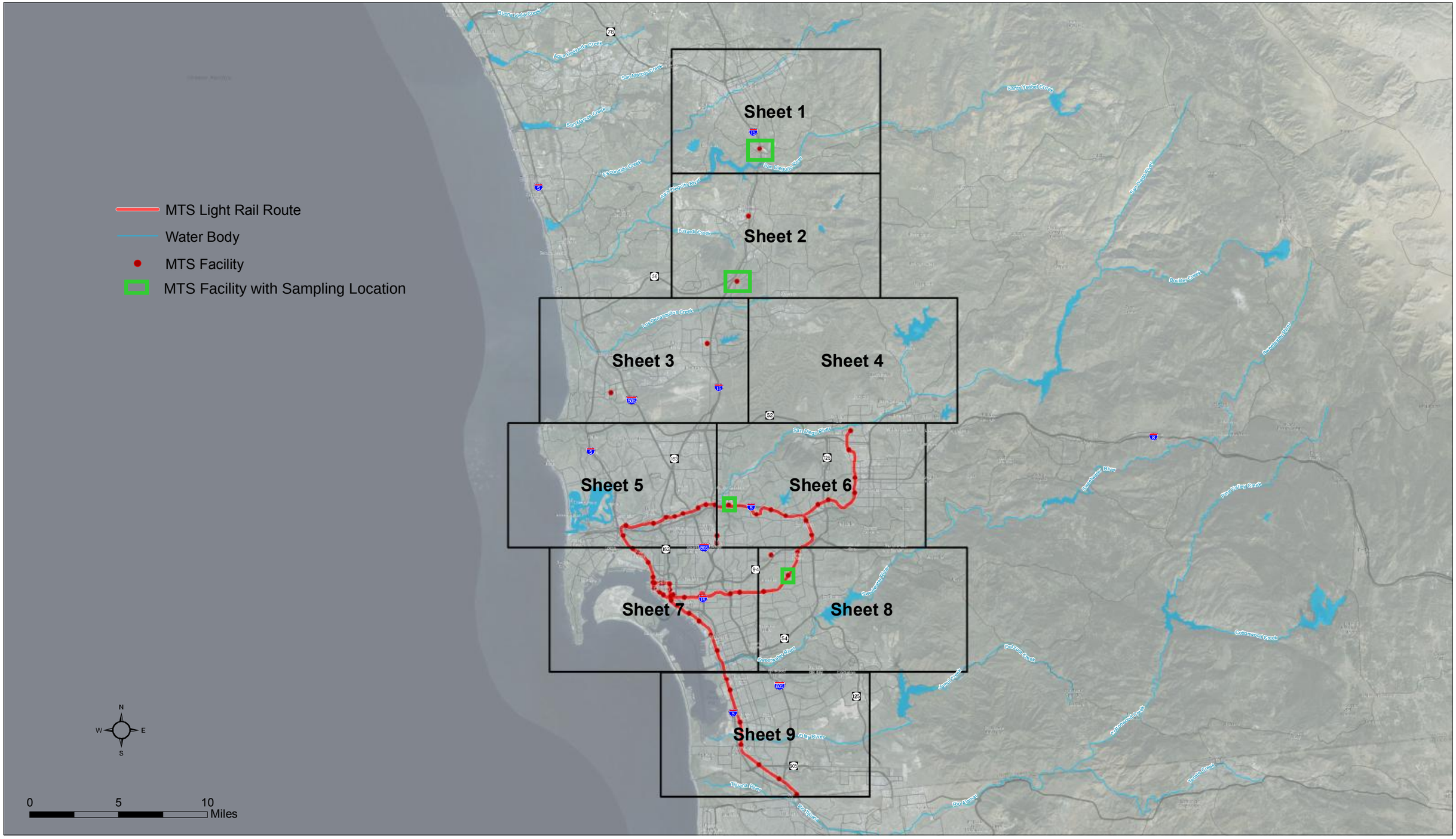
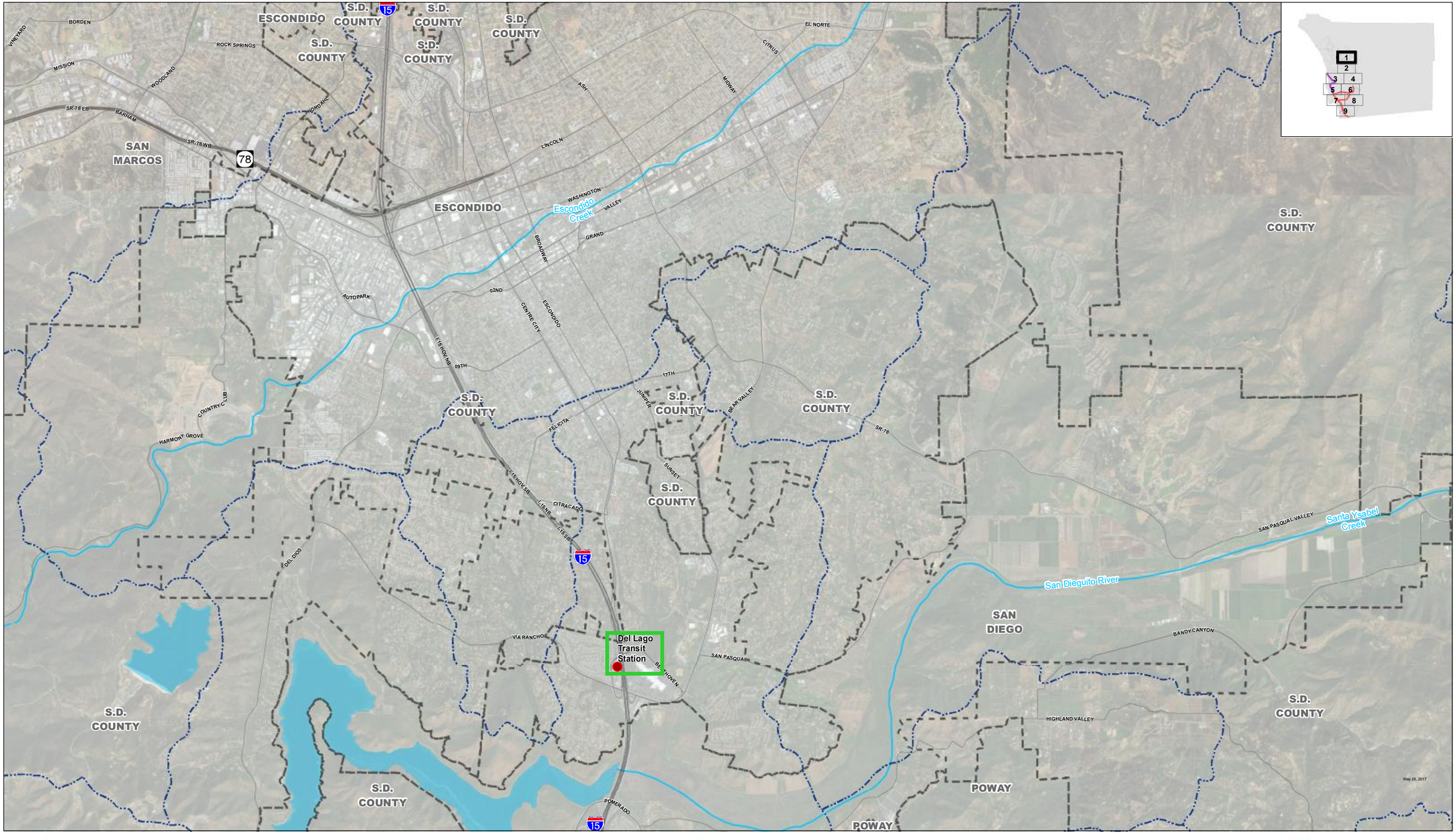
APPENDIX

A MTS JURISDICTIONAL MAP



MS4 JURISDICTIONAL BOUNDARY MAP - SHEET INDEX

SAN DIEGO METROPOLITAN TRANSIT SYSTEM



0 2,000 4,000 Feet

1 inch = 4,000 feet

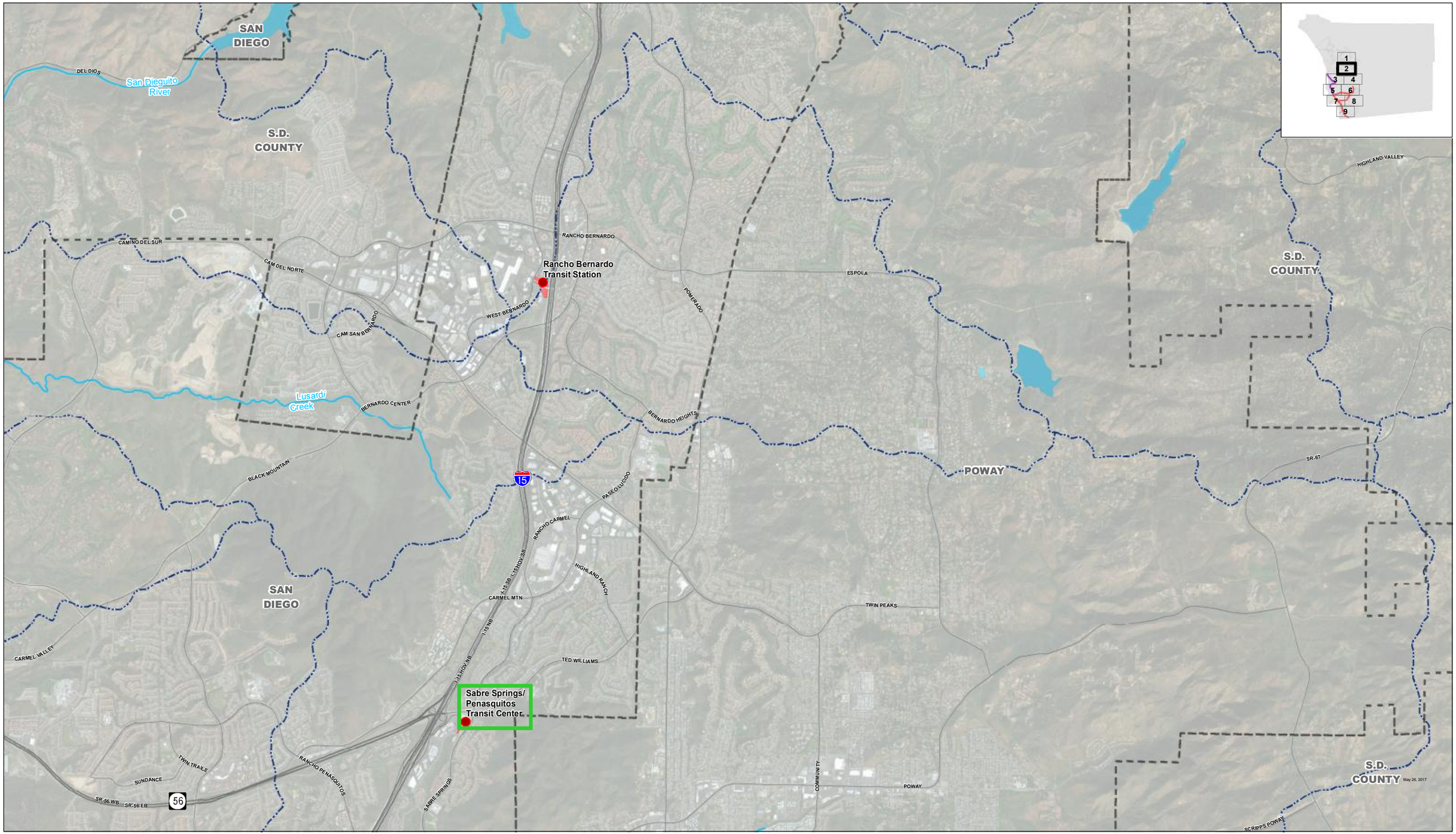
Legend

MTS Facility

Hydrologic Basin Units

WSP | PARSONS BRINCKERHOFF

MTS Metropolitan Transit System



0 2,000 4,000 Feet

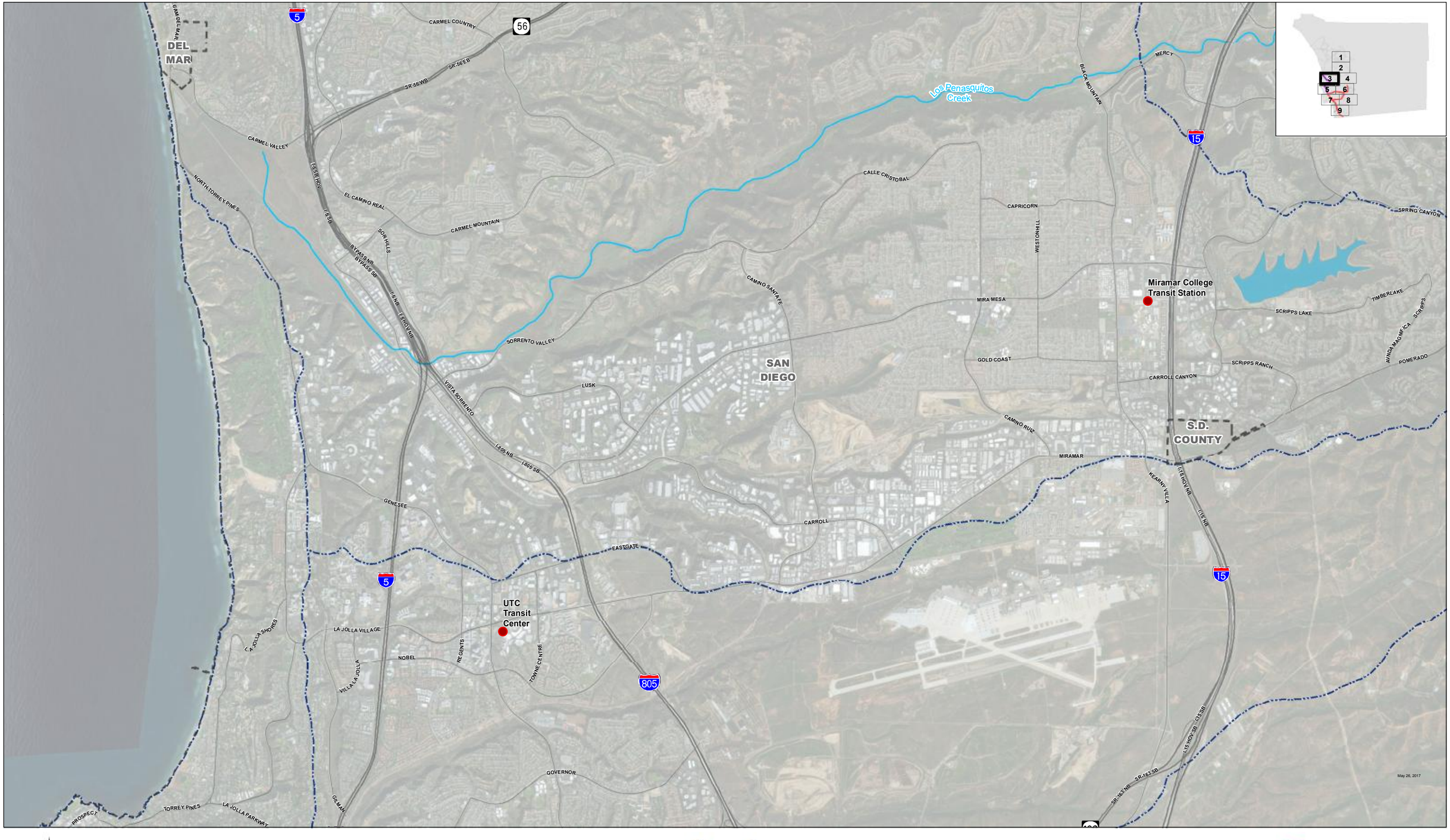
1 Inch = 4,000 feet

Legend

MTS Facility | MTS Property | Hydrologic Basin Units

MTS Metropolitan Transit System

WSP | PARSONS BRINCKERHOFF



1 inch = 4,000 feet

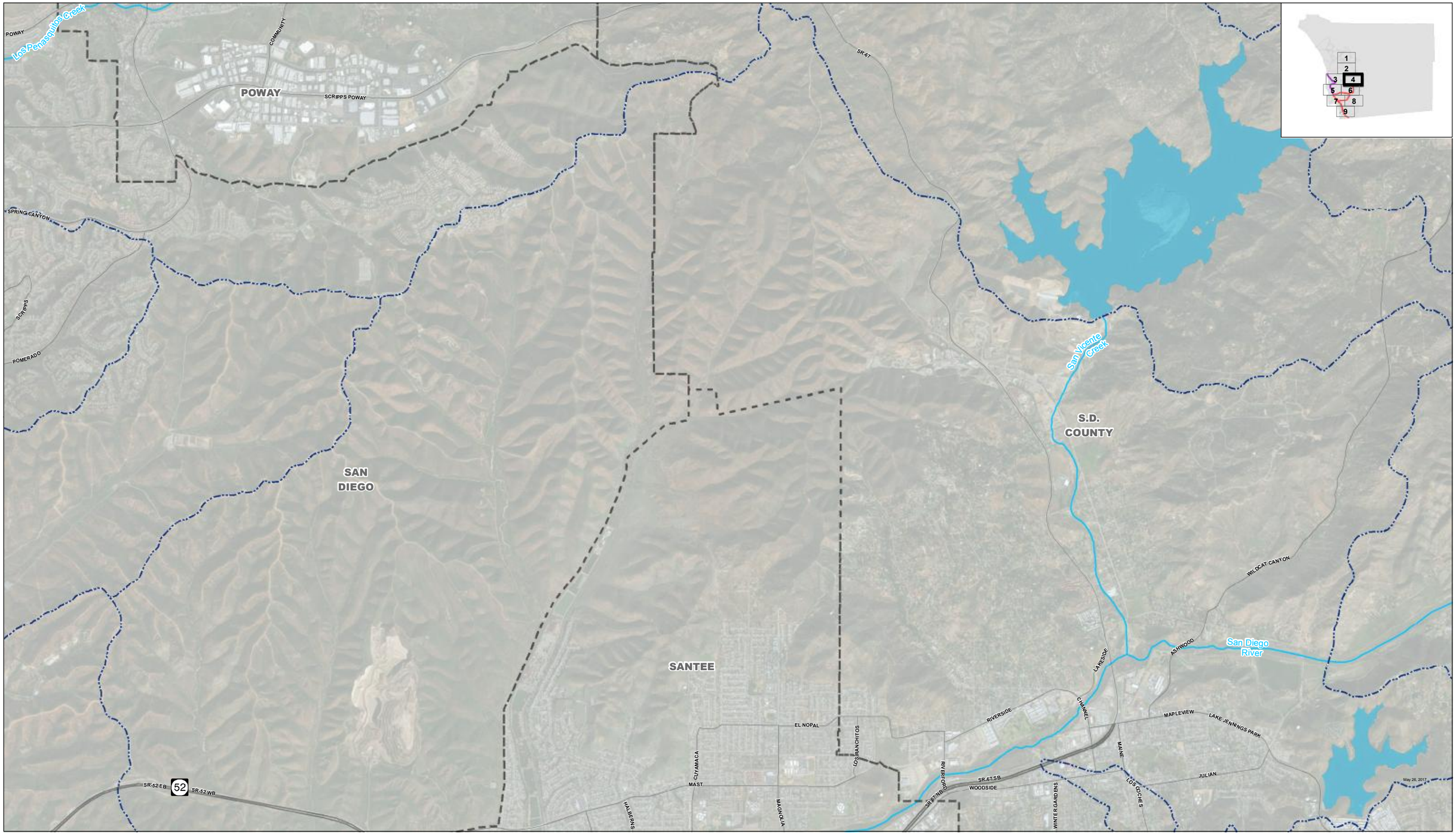
Legend

MTS Facility

Hydrologic Basin Units

MTS Metropolitan Transit System

WSP | PARSONS BRINCKERHOFF



0 2,000 4,000 Feet

1 inch = 4,000 feet

Legend

Hydrologic Basin Units

MTS Metropolitan Transit System

WSP | PARSONS BRINCKERHOFF

0 2,000 4,000 Feet

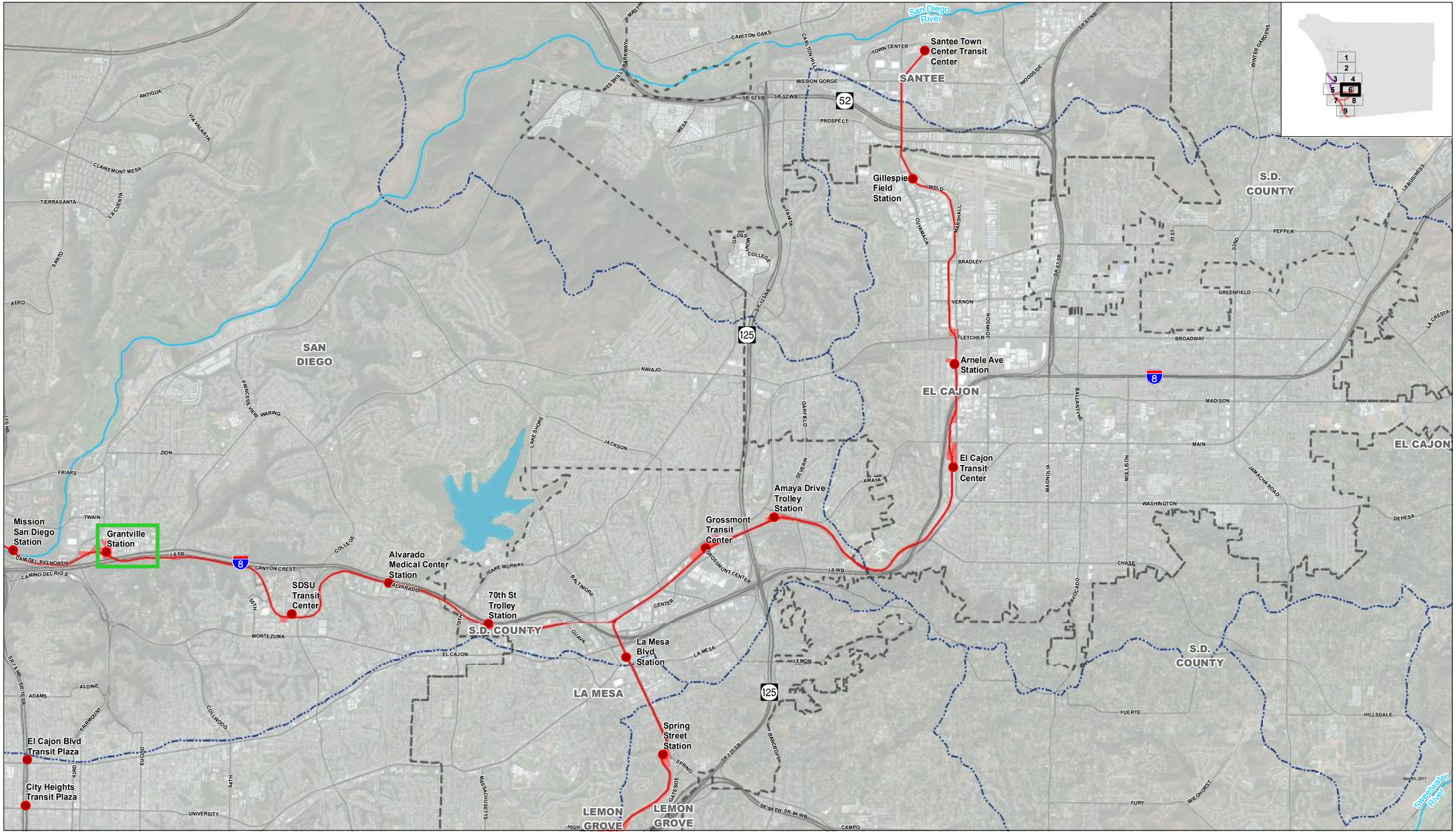
1 inch = 4,000 feet

Legend

MTS Facility — MTS Light Rail Route — MTS Property — Hydrologic Basin Units

MTS Metropolitan Transit System

WSP | PARSONS BRINCKERHOFF



0 2,000 4,000 Feet

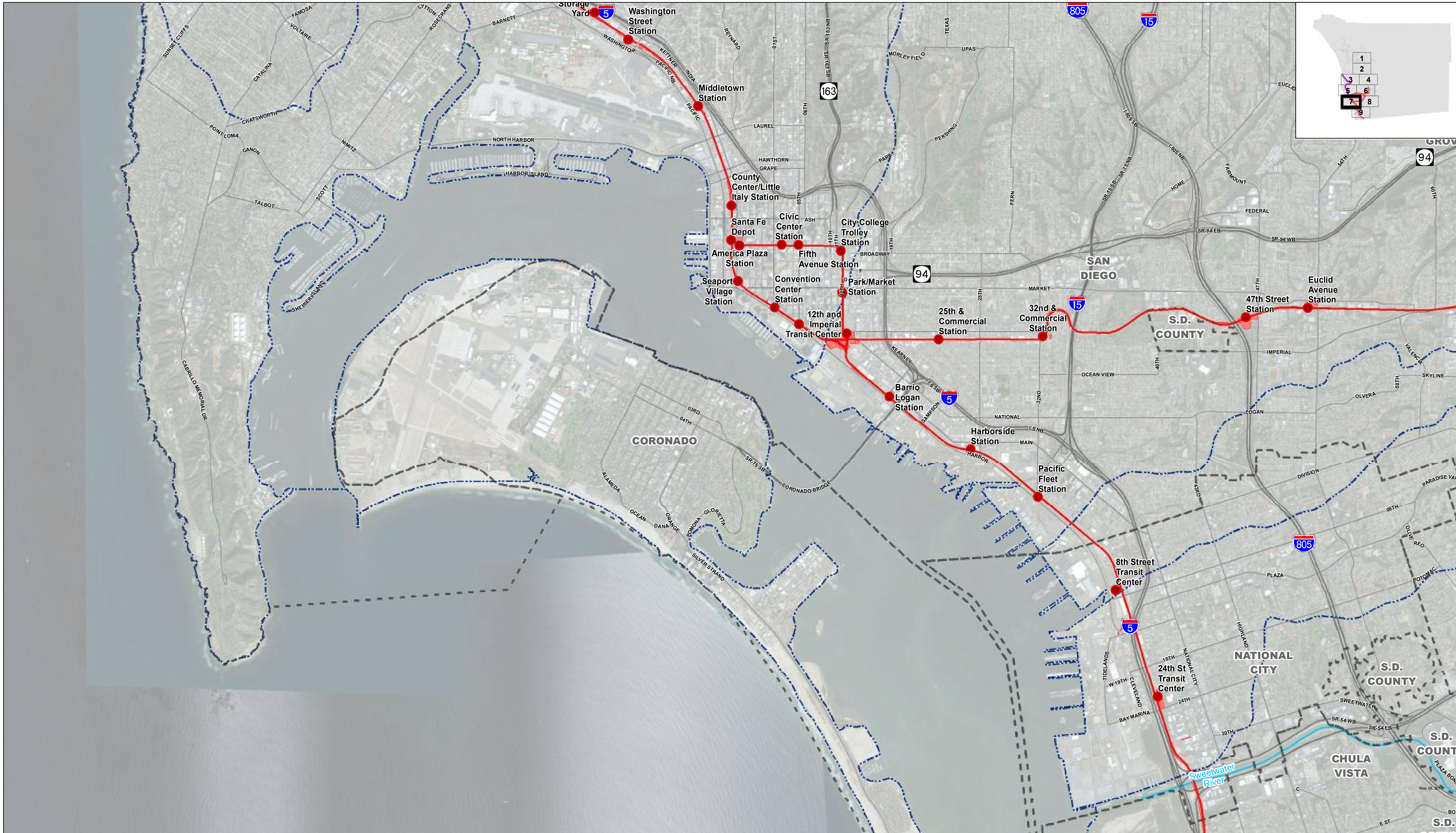
1 inch = 4,000 feet

Legend

MTS Facility — MTS Light Rail Route — MTS Property — Hydrologic Basin Units

MTS Metropolitan Transit System

WSP | PARSONS BRINCKERHOFF



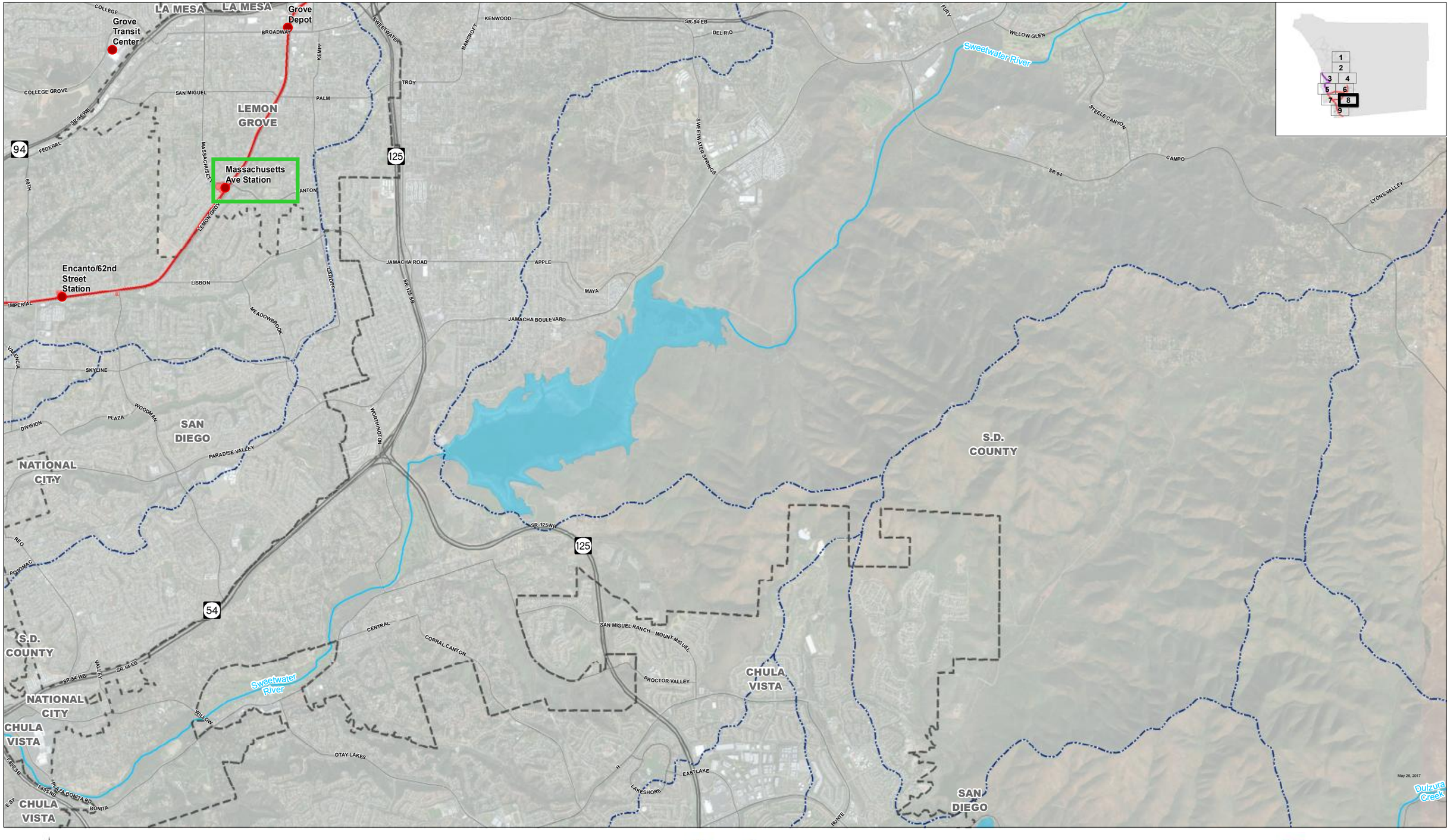
1 inch = 4,083 feet

Legend

MTS Facility — MTS Light Rail Route — MTS Property — Hydrologic Basin Units

MTS Metropolitan Transit System

WSP | PARSONS BRINCKERHOFF



0 2,000 4,000 Feet

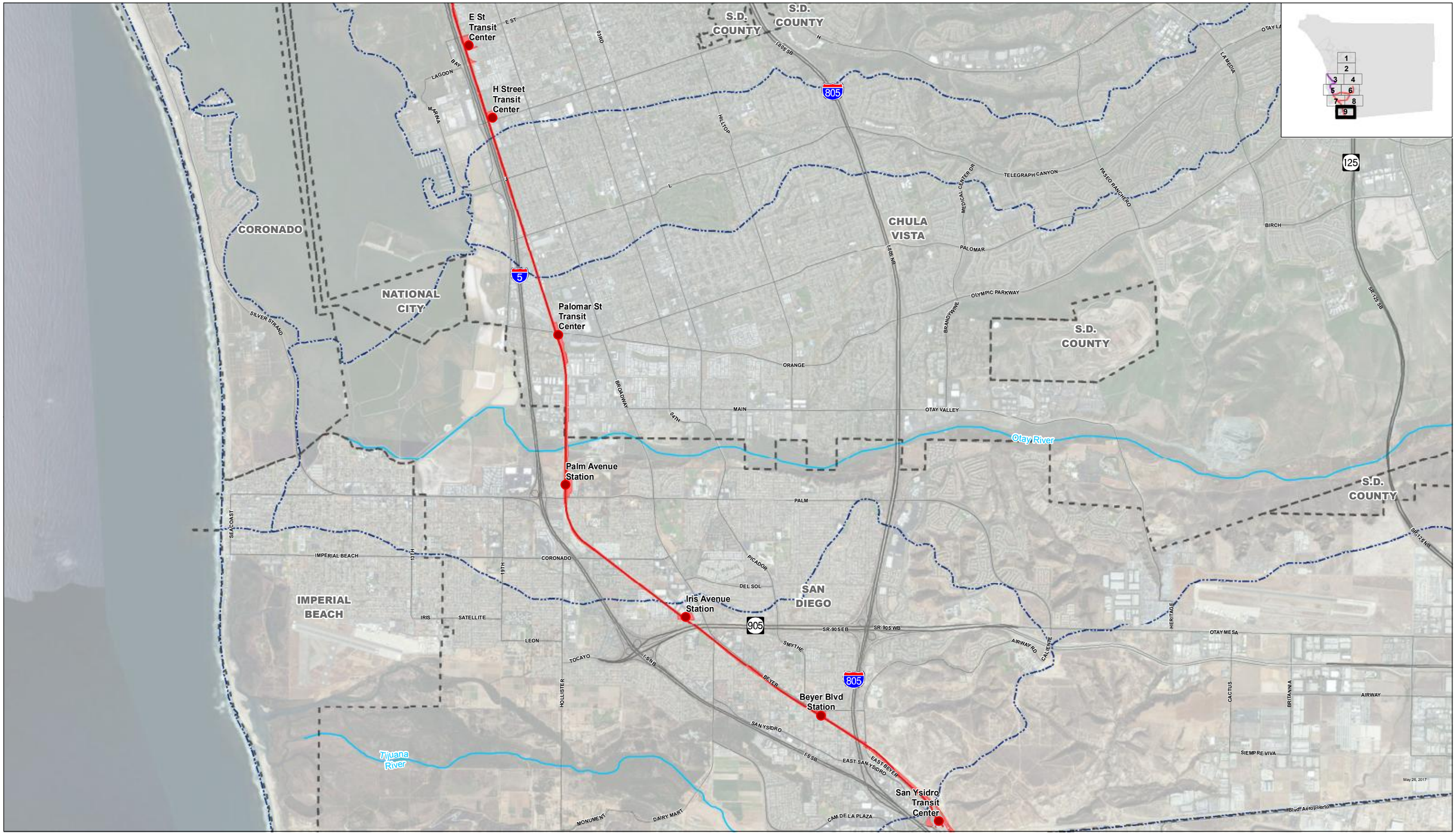
1 Inch = 4,000 feet

Legend

MTS Facility — MTS Light Rail Route — MTS Property — Hydrologic Basin Units

MTS Metropolitan Transit System

WSP | PARSONS BRINCKERHOFF



0 2,000 4,000 Feet

1 Inch = 4,000 feet

Legend

MTS Facility — MTS Light Rail Route — MTS Property — Hydrologic Basin Units

MTS Metropolitan Transit System

WSP | PARSONS BRINCKERHOFF

APPENDIX

B STORMWATER REQUIREMENTS CHECKLIST

Metropolitan Transit System
1225 Imperial Avenue, Suite 1000
San Diego, CA 92101

Stormwater Requirements Checklist

Construction Requirements

1. Will the project create a land disturbance that is greater than or equal to 1 acre?

☐ Yes; Stormwater Pollution Prevention Plan (SWPPP) is required. Skip question 2, go to Post Construction Requirements

☐ No; go to next question

2. Will the project create a land disturbance of less than 1 acre?

☐ Yes; Water Pollution Control Plan (WPCP) is required. Go to Post Construction Requirements

Post Construction Requirements

1. Will the project create/replace ≥2,500 ft^2 impervious surface?

☐ Yes; go to next question

☐ No; project is exempt from Post Construction Requirements. Comply with Construction Requirements and sign and date the checklist.

2. Does the project create/replace ≥5,000 ft^2 impervious surface?

☐ Yes; this is a Regulated project. Comply with Construction Requirements, Regulated Project Requirements and sign and date the checklist.

☐ No; this is a Small Project. Go to question 3.

3. Is the project an interior remodel; routine maintenance or repair, i.e. roof replacement; pothole repair; exterior wall surface replacement; pavement grinding and resurfacing of existing roadway; bicycle lane or sidewalk built as part of new streets or roads and built to direct storm water runoff to adjacent vegetated areas; impervious trail built to direct storm water runoff to adjacent vegetated areas, or other non-erodible permeable areas; sidewalk, bicycle lane, or trail constructed with a permeable surface; or construction of a new sidewalk, pedestrian ramp, or bike lane on existing roadway?

☐ Yes; project is exempt from Post Construction Requirements. Comply with Construction Requirements and sign and date the checklist.

☐ No; this is a Small Project. Comply with Construction Requirements, Small Project Requirements and sign and date the checklist.

Small Project

- ☐ SWPPP or WPCP
- ☐ Submit a Post Construction Stormwater Management (PCSM) Plan to MTS that is prepared by a certified professional. Reference guidance in the MTS Post Construction Storm Water Management Manual. The PCSM Plan must include the following:
  - ☐ Site Assessment
  - ☐ Source Control Measures
  - ☐ At least one Site Design Measure
  - ☐ Stormwater Runoff Calculations
  - ☐ Water efficient landscape irrigation design, if applicable, per the MTS Landscape Design and Maintenance Plan

Regulated Project

- ☐ SWPPP or WPCP
- ☐ Submit a Post Construction Stormwater Management (PCSM) Plan to MTS that is prepared by a certified professional. Reference guidance in the MTS Post Construction Storm Water Management Manual. The PCSM Plan must include the following:
  - ☐ Site Assessment
  - ☐ Source Control Measures
  - ☐ Site Design Measures
  - ☐ Stormwater Runoff Calculations
  - ☐ Treatment Measures
  - ☐ Operations & Maintenance Plan
  - ☐ Water efficient landscape irrigation design, if applicable, per the MTS Landscape Design and Maintenance Plan

Name of Owner or Agent (*Please Print)* **Title**

Signature **Date**

APPENDIX

C SMALL PROJECT WORKSHEETS AND CHECKLISTS

BASIC PROJECT INFORMATION COVER SHEET

Project Name

Project Location
[Street Address if available, or intersection and/or APN]

Owner or Developer Information
Name of Owner or Developer
Title, if applicable
Company or Affiliation
Address
Telephone Number
Email Address

Licensed Professional Certification
Name of Owner or Developer
Title, if applicable
Company or Affiliation
Address
Telephone Number
Email Address

[Licensed geotechnical engineer, professional civil engineer, or professional geologist]

Stamp and Signature

SITE ASSESSMENT WORKSHEET

Project Type
[Examples: Routine Maintenance, Roads, Parking Lot, New Development, Redevelopment, Small Project]

Project Description

GENERAL PROJECT SITE INFORMATION

Latitude: _____ Longitude: _____

Total Project Area (ft^2) _____ Total Existing Impervious Area (ft^2) _____

New Impervious Area (ft^2) _____ Replaced Impervious Area (ft^2) _____

Post-Project Impervious Area (ft^2) _____

Receiving Water(s) _____

Describe location(s) of discharge from the project site

Describe Environmentally Sensitive Areas, if applicable and Watershed.

Pollutants of Concern

Post-Project Land Use Type(s) _____

Describe expected pollutant-generating activities

Pre-Project _____

Post-Project _____

Identify pollutants of concern

SOURCE CONTROL MEASURES CHECKLIST

Describe source control measures to be implemented for each potential pollutant generating activity or source present at the project site. If a potential pollutant generating activity or source is not present at the site, indicate it as "N/A"

Interior floor drains
Drain or wash water from boiler drain lines, condensate drain lines, rooftop equipment, drainage sumps, and other sources
Unauthorized non-storm water discharges
Accidental spills or leaks
Transit vehicle cleaning
Vehicle and equipment repair and maintenance
Outdoor storage of equipment or materials
Indoor and structural pest control
Fire sprinkler test water
Parking/Storage Area Maintenance
Ponds, decorative fountains, and other water features
Landscape/outdoor pesticide use
Fuel dispensing areas

SOURCE CONTROL MEASURES CHECKLIST

Describe source control measures to be implemented for each potential pollutant generating activity or source present at the project site. If a potential pollutant generating activity or source is not present at the site, indicate it as "N/A"

Loading docks
Refuse areas
Industrial processes

SITE DESIGN MEASURES WORKSHEET

Small Projects are required to implement one site design measure and quantify the stormwater runoff volume credit using the SWRCB Post-Construction Calculator. The Post-Construction Calculator is provided in Appendix D.

For the proposed project, identify the following information

Proposed Site Design Measure	**Stormwater Runoff Volume Credit (ft^3)**
· Stream setbacks and buffers	
· Soil quality improvement and maintenance	
· Tree planting and preservation	
· Rooftop and impervious area disconnection	
· Porous pavement	
· Vegetated Swale	
· Rain barrels and cisterns	
Total Stormwater Runoff Volume Credit (ft^3)	

A printout of the Post-Construction Calculator results must be submitted with the Project Post Construction Stormwater Management Plan.

APPENDIX

D REGULATED PROJECT WORKSHEETS AND CHECKLISTS

BASIC PROJECT INFORMATION COVER SHEET

Project Name

Project Location
[Street Address if available, or intersection and/or APN]

Owner or Developer Information
Name of Owner or Developer
Title, if applicable
Company or Affiliation
Address
Telephone Number
Email Address

Licensed Professional Certification
Name of Owner or Developer
Title, if applicable
Company or Affiliation
Address
Telephone Number
Email Address

[Licensed geotechnical engineer, professional civil engineer, or professional geologist]

Stamp and Signature

SITE ASSESSMENT WORKSHEET

Project Type
[Examples: Routine Maintenance, Roads, Parking Lot, New Development, Redevelopment, Small Project]

Project Description

GENERAL PROJECT SITE INFORMATION

Latitude: _____ Longitude: _____

Total Project Area (ft^2) _____ Total Existing Impervious Area (ft^2) _____

New Impervious Area (ft^2) _____ Replaced Impervious Area (ft^2) _____

Post-Project Impervious Area (ft^2) _____

Receiving Water(s) _____

Describe location(s) of discharge from the project site

Describe Environmentally Sensitive Areas, if applicable and watershed.

Pollutants of Concern

Post-Project Land Use Type(s) _____

Describe expected pollutant-generating activities

Pre-Project _____

Post-Project _____

Identify pollutants of concern

SOURCE CONTROL MEASURES CHECKLIST

Describe source control measures to be implemented for each potential pollutant generating activity or source present at the project site. If a potential pollutant generating activity or source is not present at the site, indicate it as "N/A"

Interior floor drains
Drain or wash water from boiler drain lines, condensate drain lines, rooftop equipment, drainage sumps, and other sources
Unauthorized non-storm water discharges
Accidental spills or leaks
Transit vehicle cleaning
Vehicle and equipment repair and maintenance
Outdoor storage of equipment or materials
Indoor and structural pest control
Fire sprinkler test water
Parking/Storage Area Maintenance
Ponds, decorative fountains, and other water features
Landscape/outdoor pesticide use
Fuel dispensing areas

SOURCE CONTROL MEASURES CHECKLIST

Describe source control measures to be implemented for each potential pollutant generating activity or source present at the project site. If a potential pollutant generating activity or source is not present at the site, indicate it as "N/A"

Loading docks
Refuse areas
Industrial processes

SITE DESIGN MEASURES WORKSHEET

Regulated Projects are required to implement site design measures and quantify the stormwater runoff volume credit using the SWRCB Post-Construction Calculator. The Post-Construction Calculator is provided in Appendix D.

For the proposed project, identify the following information

Proposed Site Design Measure	**Stormwater Runoff Volume Credit (ft^3)**
· Stream setbacks and buffers	
· Soil quality improvement and maintenance	
· Tree planting and preservation	
· Rooftop and impervious area disconnection	
· Porous pavement	
· Vegetated Swale	
· Rain barrels and cisterns	
Total Stormwater Runoff Volume Credit (SDM_{credit})	

A printout of the Post-Construction Calculator results must be submitted with the Project Post Construction Stormwater Management Plan.

DRAINAGE MANAGEMENT AREA (DMA) WORKSHEET AND NARRATIVE DESCRIPTION

In addition to a map or diagram that displays the DMAs, Regulated Projects shall complete this worksheet and submit it with the Post-Construction Stormwater Management Plan.

DMA No.	Area (ft^2)	Existing Impervious Area (ft^2)	Post-Project Impervious Area (ft^2)	DMA SDV (ft^3)	SDMcredit (ft^3)	ADJUSTED DMA SDV (ft^3)

Drainage Management Area Narrative Descriptions

DMA [name], totaling x,xxx square feet, drains [description of area]. DMA [name] drains to [Self-Retaining DMA name or stormwater treatment measure (STM) name]. [Describe notable or exceptional characteristics or conditions.]

DMA [name], totaling x,xxx square feet, drains [description of area]. DMA [name] drains to [Self-Retaining DMA name or STM name]. [Describe notable or exceptional characteristics or conditions.]

DMA [name], totaling x,xxx square feet, drains [description of area]. DMA [name] drains to [Self-Retaining DMA name or STM name]. [Describe notable or exceptional characteristics or conditions.]

DMA [name], totaling x,xxx square feet, drains [description of area]. DMA [name] drains to [Self-Retaining DMA name or STM name]. [Describe notable or exceptional characteristics or conditions.]

STORMWATER TREATMENT MEASURE (STM) WORKSHEET AND NARRATIVE DESCRIPTIO

Complete this worksheet describing how the remaining runoff is being managed for each DMA in which proposed site design measures did not fully manage the SDV. It the Total Stormwater Runoff Volume for the DMA equals or exceeds the Adjusted DMA SDV, then design for stormwater management is complete. If the Total Stormwater Runoff Volume for the DMA is less that the Adjusted DMA SDV, redesign site measures and stormwater control treatment measures until the entire SDV for the DMA is achieved. Complete this series of calculatios for each DMA.

DMA No.	ADJUSTED DMA SDV (ft^3)	DRAINS TO (BIORETENTION OR STM)	BIORETENTION OR STM SDV (ft^3)	ADJUSTED DMA SDV (ft^3)	STM SDV (ft^3)	TOTAL STORMWATER RUNOFF VOLUME MANAGED (ft^3)

Stormwater Treatment Measure Narrative Description
Describe and provide justification for any variations to the bioretention facility for the site-specific conditions.

Describe and provide justification if an alternative stormwater treatment measure is proposed in lieu of bioretention.

Describe and provide justification for any exceptions to the requirments for bioretention. Identify and describe the proposed biotreatment or media filter system that will be used in lieu of bioretention.

APPENDIX

E POST CONSTRUCTION STORMWATER CALCULATOR

Post-Construction Water Balance Calculator

User may make changes from any cell that is orange or brown in color (similar to the cells to the immediate right). Cells in green are calculated for you.		(Step 1a) If you know the 85th percentile storm event for your location enter it in the box below	(Step 1b) If you can not answer 1a then select the county where the project is located (click on the cell to the right for drop-down): This will determine the average 85th percentile 24 hr. storm event for your site, which will appear under precipitation to left.	*SACRAMENTO*
			(Step 1c) If you would like a more percise value select the location closest to your site. If you do not recgonize any of these locations, leave this drop-down menu at location. The average value for the County will be used.	**SACRAMENTO FAA ARPT**

Project Information		*Runoff Calculations*		
Project Name:	***Optional***	(Step 2) Indicate the Soil Type (dropdown menu to right):	***Group C Soils***	**Low infiltration. Sandy clay loam. Infiltration rate 0.05 to 0.15 inch/hr when wet.**
Waste Discharge Identification (WDID):	***Optional***	(Step 3) Indicate the existing **dominant** non-built land Use Type (dropdown menu to right):	***Wood & Grass: <50% ground cover***	
Date:	***Optional***	(Step 4) Indicate the proposed **dominant** non-built land Use Type (dropdown menu to right):	***Lawn, Grass, or Pasture covering more than 75% of the open space***	
Sub Drainage Area Name (from map):	***Optional***		**Complete Either**	

Runoff Curve Numbers					**Sq Ft**	**Acres**	**Acres**
Existing Pervious Runoff Curve Number		**82**	*(Step 5) Total Project Site Area:*			5.00	**5.00**
Proposed Development Pervious Runoff Curve Number		**74**	*(Step 6) Sub-watershed Area:*			5.00	**5.00**
Design Storm			*Percent of total project :*		**100%**		
Based on the County you indicated above, we have included the 85 percentile average 24 hr event - P85 (in)^ for your area.	**0.62**	**in**					
The Amount of rainfall needed for runoff to occur (Existing runoff curve number -P from existing RCN (in)^)	**0.44**	**In**	***(Step 7) Sub-watershed Conditions***		**Complete Either**		**Calculated Acres**
P used for calculations (in) (the greater of the above two criteria)	**0.62**	**In**	Sub-watershed Area (acres)		**Sq Ft**	**Acres**	**5.00**
^Available at www.cabmphandbooks.com			Existing Rooftop Impervious Coverage			**0**	**0.00**
			Existing Non-Rooftop Impervious Coverage			**0**	**0.00**
			Proposed Rooftop Impervious Coverage			**0**	**0.00**
			Proposed Non-Rooftop Impervious Coverage			**0**	**0.00**

			Credits	**Acres**	**Square Feet**
			Porous Pavement	**0.00**	**0**
			Tree Planting	**0.00**	**0**
Pre-Project Runoff Volume (cu ft)	**247**	**Cu.Ft.**	Downspout Disconnection	**0.00**	**0**
Project-Related Runoff Volume Increase w/o credits (cu ft)	**0**	**Cu.Ft.**	Impervious Area Disconnection	**0.00**	**0**
			Green Roof	**0.00**	**0**
			Stream Buffer	**0.00**	**0**
			Vegetated Swales	**0.00**	**0**
Project-Related Volume Increase with Credits (cu ft)	**0**	**Cu.Ft.**	**Subtotal**	**0.00**	**0**
			Subtotal Runoff Volume Reduction Credit	**0 Cu. Ft.**	

You have achieved your minimum requirements	***(Step 9) Impervious Volume Reduction Credits***	**Volume (cubic feet)**
	Rain Barrels/Cisterns	**0 Cu. Ft.**
	Soil Quality	**0 Cu. Ft.**
	Subtotal Runoff Volume Reduction	**0 Cu. Ft.**
	Total Runoff Volume Reduction Credit	**0 Cu. Ft.**

Porous Pavement Credit Worksheet

Please fill out a porous pavement credit worksheet for each project sub-watershed.

For the PROPOSED Development:

Proposed Porous Pavement	Runoff Reduction*	Fill in either Acres or SqFt		
		In SqFt.	In Acres	Equivalent Acres
Area of **Brick without Grout** on less than 12 inches of base with at least 20% void space over soil	0.45			0.00
Area of **Brick without Grout** on more than 12 inches of base with at least 20% void space over soil	0.90			0.00
Area of **Cobbles** less than 12 inches deep and over soil	0.30			0.00
Area of **Cobbles** less than 12 inches deep and over soil	0.60			0.00
Area of **Reinforced Grass Pavement** on less than 12 inches of base with at least 20% void space over soil	0.45			0.00
Area of **Reinforced Grass Pavement** on at least 12 inches of base with at least 20% void space over soil	0.90			0.00
Area of **Porous Gravel Pavement** on less than 12 inches of base with at least 20% void space over soil	0.38			0.00
Area of **Porous Gravel Pavement** on at least 12 inches of base with at least 20% void space over soil	0.75			0.00
Area of **Poured Porous Concrete or Asphalt Pavement** with less than 4 inches of gravel base (washed stone)	0.40			0.00
Area of **Poured Porous Concrete or Asphalt Pavement** with 4 to 8 inches of gravel base (washed stone)	0.60			0.00
Area of **Poured Porous Concrete or Asphalt Pavement** with 8 to 12 inches of gravel base (washed stone)	0.80			0.00
Area of **Poured Porous Concrete or Asphalt Pavement** with 12 or more inches of gravel base (washed stone)	1.00			0.00

*=1-Rv**

Return to Calculator

**Using Site Design Techniques to meet Development Standards for Stormwater Quality (BASMAA 2003)

**NCDENR Stormwater BMP Manual (2007)

Tree Planting Credit Worksheet

Please fill out a tree canopy credit worksheet for each project sub-watershed.

Tree Canopy Credit Criteria	Number of Trees Planted	Credit (acres)
Number of proposed evergreen trees to be planted (credit = number of trees x 0.005)*	0	0.00
Number of proposed deciduous trees to be planted (credit = number of trees x 0.0025)*		0.00
	Square feet Under Canopy	
Square feet under an existing tree canopy, that will remain on the property, with an average diameter at 4.5 ft above grade (i.e., diameter at breast height or DBH) is LESS than 12 in diameter.		0.00
Square feet under an existing tree canopy that will remain on the property, with an average diameter at 4.5 ft above grade (i.e., diameter at breast height or DBH) is 12 in diameter or GREATER.		0.00
Please describe below how the project will ensure that these trees will be maintained.		

Return to Calculator

* credit amount based on credits from Stormwater Quality Design Manual for the Sacramento and South Placer Regions

Downspout Disconnection Credit Worksheet

Please fill out a downspout disconnection credit worksheet for each project subwatershed. If you answer yes to all questions, all rooftop area draining to each downspout will be subtracted from your proposed rooftop impervious coverage.

Downspout Disconnection Credit Criteria					
Do downspouts and any extensions extend at least six feet from a basement and two feet from a crawl space or concrete slab?				○ Yes	◉ No
Is the area of rooftop connecting to each disconnected downspout 600 square feet or less?				○ Yes	◉ No
Is the roof runoff from the design storm event fully contained in a raised bed or planter box or does it drain as sheet flow to a landscaped area large enough to contain the roof runoff from the design storm event?				○ Yes	◉ No
The Stream Buffer and/or Vegetated Swale credits **will not** be taken in this sub-watershed area?				○ Yes	◉ No
Percentage of existing	0.00	Acres	of rooftop surface has disconnected downspouts		
Percentage of the proposed	0.00	Acres	of rooftop surface has disconnected downspouts	50	
				Return to Calculator	

Impervious Area Disconnection Credit Worksheet

Please fill out an impervious area disconnection credit worksheet for each project sub-watershed. If you answer yes to all questions, all non-rooftop impervious surface area will be subtracted from your proposed non-rooftop impervious coverage.

Non-Rooftop Disconnection Credit Criteria	Response
Is the maximum contributing impervious flow path length less than 75 feet or, if equal or greater than 75 feet, is a storage device (e.g. French drain, bioretention area, gravel trench) implemented to achieve the required disconnection length?	(●) Yes ( ) No
Is the impervious area to any one discharge location less than 5,000 square feet?	(●) Yes ( ) No
The Stream Buffer credit **will not** be taken in this sub-watershed area?	(●) Yes ( ) No

Percentage of existing	0.00	Acres non-rooftop surface area disconnected	
Percentage of the proposed	0.00	Acres non-rooftop surface area disconnected	70

Return to Calculator

Green Roof Credit Worksheet

Please fill out a greenroof credit worksheet for each project sub-watershed. If you answer yes to all questions, 70% of the greenroof area will be subtracted from your proposed rooftop impervious coverage.

Green Roof Credit Criteria	Response
Is the roof slope less than 15% or does it have a grid to hold the substrate in place until it forms a thick vegetation mat?	(•) Yes ( ) No
Has a professional engineer assessed the necessary load reserves and designed a roof structure to meet state and local codes?	(•) Yes ( ) No
Is the irrigation needed for plant establishment and/or to sustain the green roof during extended dry periods, is the source from stored, recycled, reclaimed, or reused water?	(•) Yes ( ) No
Percentage of existing 0.00 Acres rooftop surface area in greenroof	
Percentage of the proposed 0.00 Acres rooftop surface area in greenroof	

Return to Calculator

Stream Buffer Credit Worksheet

Please fill out a stream buffer credit worksheet for each project sub-watershed. If you answer yes to all questions, you may subtract all impervious surface draining to each stream buffer that has not been addressed using the Downspout and/or Impervious Area Disconnection credits.

Stream Buffer Credit Criteria				Response
Does runoff enter the floodprone width* or within 500 feet (whichever is larger) of a stream channel as sheet flow**?				○ Yes ◉ No
Is the contributing overland slope 5% or less, or if greater than 5%, is a level spreader used?				○ Yes ◉ No
Is the buffer area protected from vehicle or other traffic barriers to reduce compaction?				○ Yes ◉ No
Will the stream buffer be maintained in an ungraded and uncompacted condition and will the vegetation be maintained in a natural condition?				○ Yes ◉ No
Percentage of existing	0.00	Acres	impervious surface area draining into a stream buffer:	
Percentage of the proposed	0.00	Acres	impervious surface area that will drain into a stream buffer:	
Please describe below how the project will ensure that the buffer areas will remain in ungraded and uncompacted condition and that the vegetation will be maintained in a natural condition.				

Return to Calculator

* floodprone width is the width at twice the bankfull depth.
** the maximum contributing length shall be 75 feet for impervious area

Vegetated Swale Credit Worksheet

Please fill out a vegetated swale worksheet for each project subwatershed. If you answer yes to all questions, you may subtract all impervious surface draining to each stream buffer that has not been addressed using the Downspout Disconnection credit.

Vegetated Swale Credit Criteria

Have all vegetated swales been designed in accordance with Treatment Control BMP 30 (TC-30 - Vegetated Swale) from the California Stormwater BMP Handbook, New Development and Redevelopment (available at www.cabmphandbooks.com)?	○ Yes ◉ No
Is the maximum flow velocity for runoff from the design storm event less than or equal to 1.0 foot per second?	○ Yes ◉ No

Percentage of existing	0.00	Acres of impervious area draining to a vegetated swale	
Percentage of the proposed	0.00	Acres of impervious area draining to a vegetated swale	

Return to Calculator

Rain Barrel/Cistern Credit Worksheet

Please fill out a rain barrel/cistern worksheet for each project sub-watershed.

Rain Barrel/Cistern Credit Criteria	Response
Total number of rain barrel(s)/cisterns	
Average capacity of rain barrel(s)/cistern(s) (in gallons)	
Total capacity rain barrel(s)/cistern(s) (in cu ft) [1]	0

[1] accounts for 10% loss

Return to Calculator

Please fill out a soil quality worksheet for each project sub-watershed.

	Response
Will the landscaped area be lined with an impervious membrane?	
Will the soils used for landscaping meet the ideal bulk densities listed in Table 1 below?[1]	○ Yes ◉ No
If you answered yes to the question above, and you know the area-weighted bulk density within the top 12 inches for soils used for landscaping (in g/cm^3)* , fill in the cell to the right and skip to cell G11. If not select from the drop-down menu in G10.	1.3
If you answered yes to the question above, but you do not know the exact bulk density, which of the soil types in the drop down menu to the right best describes the top 12 inches for soils used for landscaping (in g/cm^3).	Sandy loams, loams
What is the average depth of your landscaped soil media meeting the above criteria (inches)?	12
What is the total area of the landscaped areas meeting the above criteria (in acres)?	2.97

Return to Calculator

Table 1

Sands, loamy sands	<1.6
Sandy loams, loams	<1.4
Sandy clay loams, loams, clay loams	<1.4
Silts, silt loams	<1.3
Silt loams, silty clay loams	<1.1
Sandy clays, silty clays, some clay loams (35-45% clay)	<1.1
Clays (>45% clay)	<1.1

[1] USDA NRCS. "Soil Quality Urban Technical Note No.2-Urban Soil Compaction". March 2000. http://soils.usda.gov/sqi/management/files/sq_utn_2.pdf

* To determine how to calculate density see: http://www.globe.gov/tctg/bulkden.pdf?sectionID=94

Porosity (%) 50.94%

Mineral grains in many soils are mainly quartz and feldspar, so 2.65 a good average for particle density. To determine percent porosity, use the formula: Porosity (%) = (1-Bulk Density/2.65) X 100

APPENDIX

F SOURCE CONTROL FACT SHEETS

Non-Stormwater Discharges SC-10

Description

Non-stormwater discharges (NSWDs) are flows that do not consist entirely of stormwater. Some non-stormwater discharges do not include pollutants and may be discharged to the storm drain if local regulations allow. These include uncontaminated groundwater and natural springs. There are also some non-stormwater discharges that typically do not contain pollutants and may be discharged to the storm drain with conditions. These include: potable water sources, fire hydrant flushing, air conditioner condensate, landscape irrigation drainage and landscape watering, emergency firefighting, etc. as discussed in Section 2.

However there are certain non-stormwater discharges that pose an environmental concern. These discharges may originate from illegal dumping of industrial material or wastes and illegal connections such as internal floor drains, appliances, industrial processes, sinks, and toilets that are illegally connected to the nearby storm drainage system through on-site drainage and piping. These unauthorized discharges (examples of which may include: process waste waters, cooling waters, wash waters, and sanitary wastewater) can carry substances such as paint, oil, fuel and other automotive fluids, chemicals and other pollutants into storm drains.

Non-stormwater discharges will need to be addressed through a combination of detection and elimination. The ultimate goal is to effectively eliminate unauthorized non-stormwater discharges to the stormwater drainage system through implementation of measures to detect, correct, and enforce against illicit connections and illegal discharges of

Objectives
■ *Cover*
■ *Contain*
■ *Educate*
■ *Reduce/Minimize*
■ *Product Substitution*

Targeted Constituents	
Sediment	
Nutrients	✓
Trash	
Metals	✓
Bacteria	✓
Oil and Grease	✓
Organics	✓

Minimum BMPs Covered	
Good Housekeeping	✓
Preventative Maintenance	
Spill and Leak Prevention and Response	✓
Material Handling & Waste Management	
Erosion and Sediment Controls	
Employee Training Program	✓
Quality Assurance Record Keeping	✓

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pollutants on streets and into the storm drain system and downstream water bodies.

Approach

Initially the Discharger must make an assessment of non-stormwater discharges to determine which types must be eliminated or addressed through BMPs. The focus of the following approach is the elimination of unauthorized non-stormwater discharges. See other BMP Fact Sheets for activity-specific pollution prevention procedures.

General Pollution Prevention Protocols

- Implement waste management controls described in SC-34 Waste Handling and Disposal.

- Develop clear protocols and lines of communication for effectively prohibiting non-stormwater discharges, especially those that are not classified as hazardous. These are often not responded to as effectively as they need to be.

- Stencil or demarcate storm drains, where applicable, to prevent illegal disposal of pollutants. Storm drain inlets should have messages such as "Dump No Waste Drains to Stream" or similar stenciled or demarcated next to them to warn against ignorant or unintentional dumping of pollutants into the storm drainage system.

- Manage and control sources of water such as hose bibs, faucets, wash racks, irrigation heads, etc. Identify hoses and faucets in the SWPPP, and post signage for appropriate use.

Non-Stormwater Discharge Investigation Protocols

Identifying the sources of non-stormwater discharges requires the Discharger to conduct an investigation of the facility at regular intervals. There are several categories of non-stormwater discharges:

- Visible, easily identifiable discharges, typically generated as surface runoff, such as uncontained surface runoff from vehicle or equipment washing; and

- Non-visible, (e.g., subsurface) discharges into the site drainage system through a variety of pathways that are not obvious.

The approach to detecting and eliminating non-stormwater discharges will vary considerably, as discussed below:

Visible and identifiable discharges

- Conduct routine inspections of the facilities and of each major activity area and identify visible evidence of unauthorized non-stormwater discharges. This may include:

  - ✓ Visual observations of actual discharges occurring;

- ✓ Evidence of surface staining, discoloring etc. that indicates that discharges have occurred;
- ✓ Pools of water in low lying areas when a rain event has not occurred; and
- ✓ Discussions with operations personnel to understand practices that may lead to unauthorized discharges.

- □ If evidence of non-stormwater discharges is discovered:
  - ✓ Document the location and circumstances using Worksheets 5 and 6 (Section 2 of the manual), including digital photos;
  - ✓ Identify and implement any quick remedy or corrective action (e.g., moving uncovered containers inside or to a proper location); and
  - ✓ Develop a plan to eliminate the discharge. Consult the appropriate activity-specific BMP Fact Sheet for alternative approaches to manage and eliminate the discharge.
- □ Consult the appropriate activity-specific BMP Fact Sheet for alternative approaches to manage and eliminate the discharge. Make sure the facility SWPPP is up-to-date and includes applicable BMPs to address the non-stormwater discharge.

Other Illegal Discharges (Non visible)

Illicit Connections

- □ Locate discharges from the industrial storm drainage system to the municipal storm drain system through review of "as-built" piping schematics.
- □ Isolate problem areas and plug illicit discharge points.
- □ Locate and evaluate discharges to the storm drain system.
- □ Visual Inspection and Inventory:
  - ✓ Inventory and inspect each discharge point during dry weather.
  - ✓ Keep in mind that drainage from a storm event can continue for a day or two following the end of a storm and groundwater may infiltrate the underground stormwater collection system.
  - ✓ Non-stormwater discharges are often intermittent and may require periodic inspections.

Review Infield Piping

- □ A review of the "as-built" piping schematic is a way to determine if there are any connections to the stormwater collection system.

- Inspect the path of loading/unloading area drain inlets and floor drains in older buildings.

- Never assume storm drains are connected to the sanitary sewer system.

Monitoring for investigation/detection of illegal discharges

- If a suspected illegal or unknown discharge is detected, monitoring of the discharge may help identify the content and/or suggest the source. This may be done with a field screening analysis, flow meter measurements, or by collecting a sample for laboratory analysis. Section 5 and Appendix D describe the necessary field equipment and procedures for field investigations.

- Investigative monitoring may be conducted over time. For example if, a discharge is intermittent, then monitoring might be conducted to determine the timing of the discharge to determine the source.

- Investigative monitoring may be conducted over a spatial area. For example, if a discharge is observed in a pipe, then monitoring might be conducted at accessible upstream locations in order to pinpoint the source of the discharge.

- Generally, investigative monitoring requiring collection of samples and submittal for lab analysis requires proper planning and specially trained staff.

Smoke Testing

Smoke testing of wastewater and stormwater collection systems is used to detect connections between the two piping systems. Smoke testing is generally performed at a downstream location and the smoke is forced upstream using blowers to create positive pressure. The advantage to smoke testing is that it can potentially identify multiple potential discharge sources at once.

- Smoke testing uses a harmless, non-toxic smoke cartridges developed specifically for this purpose.

- Smoke testing requires specialized equipment (e.g., cartridges, blowers) and is generally only appropriate for specially trained staff.

- A Standard Operating Procedure (SOP) for smoke testing is highly desirable. The SOP should address the following elements:

  - ✓ Proper planning and notification of nearby residents and emergency services is necessary since introducing smoke into the system may result in false alarms;

  - ✓ During dry weather, the stormwater collection system is filled with smoke and then traced back to sources;

- ✓ Temporary isolation of segments of pipe using sand bags is often needed to force the smoke into leaking pipes; and
- ✓ The appearance of smoke in a waste vent pipe, at a sewer manhole, or even the base of a toilet indicates that there may be a connection between the sanitary and storm water systems.

- Most municipal wastewater agencies will have necessary staff and equipment to conduct smoke testing and they should be contacted if cross connections with the sanitary sewer are suspected. See SC-44 Drainage System Maintenance for more information.

Dye Testing

- Dye testing is typically performed when there is a suspected specific pollutant source and location (i.e., leaking sanitary sewer) and there is evidence of dry weather flows in the stormwater collection system.
- Dye is released at a probable upstream source location, either the facility's sanitary or process wastewater system. The dye must be released with a sufficient volume of water to flush the system.
- Operators then visually examine the downstream discharge points from the stormwater collection system for the presence of the dye.
- Dye testing can be performed informally using commercially available products in order to conduct an initial investigation for fairly obvious cross-connections.
- More detailed dye testing should be performed by properly trained staff and follow SOPs. Specialized equipment such as fluorometers may be necessary to detect low concentrations of dye.
- Most municipal wastewater agencies will have necessary staff and equipment to conduct dye testing and they should be contacted if cross connections with the sanitary sewer are suspected.

TV Inspection of Drainage System

- Closed Circuit Television (CCTV) can be employed to visually identify illicit connections to the industrial storm drainage system. Two types of CCTV systems are available: (1) a small specially designed camera that can be manually pushed on a stiff cable through storm drains to observe the interior of the piping, or (2) a larger remote operated video camera on treads or wheels that can be guided through storm drains to view the interior of the pipe.
- CCTV systems often include a high-pressure water jet and camera on a flexible cable. The water jet cleans debris and biofilm off the inside of pipes so the camera can take video images of the pipe condition.

- CCTV units can detect large cracks and other defects such as offsets in pipe ends caused by root intrusions or shifting substrate.
- CCTV can also be used to detect dye introduced into the sanitary sewer.
- CCTV inspections require specialized equipment and properly trained staff and are generally best left to specialized contractors or municipal public works staff.

Illegal Dumping

- Substances illegally dumped on streets and into the storm drain systems and creeks may include paints, used oil and other automotive fluids, construction debris, chemicals, fresh concrete, leaves, grass clippings, and pet wastes. These wastes can cause stormwater and receiving water quality problems as well as clog the storm drain system itself.
- Establish a system for tracking incidents. The system should be designed to identify the following:
  - ✓ Illegal dumping hot spots;
  - ✓ Types and quantities (in some cases) of wastes;
  - ✓ Patterns in time of occurrence (time of day/night, month, or year);
  - ✓ Mode of dumping (abandoned containers, "midnight dumping" from moving vehicles, direct dumping of materials, accidents/spills);
  - ✓ An anonymous tip/reporting mechanism; and
  - ✓ Evidence of responsible parties (e.g., tagging, encampments, etc.).
- One of the keys to success of reducing or eliminating illegal dumping is increasing the number of people at the facility who are aware of the problem and who have the tools to at least identify the incident, if not correct it. Therefore, train field staff to recognize and report the incidents.

Once a site has been cleaned:

- Post "No Dumping" signs with a phone number for reporting dumping and disposal.
- Landscaping and beautification efforts of hot spots may also discourage future dumping, as well as provide open space and increase property values.
- Lighting or barriers may also be needed to discourage future dumping.
- See fact sheet SC-11 Spill Prevention, Control, and Cleanup.

Inspection

- Regularly inspect and clean up hot spots and other storm drainage areas where illegal dumping and disposal occurs.
- Conduct field investigations of the industrial storm drain system for potential sources of non-stormwater discharges.
- Pro-actively conduct investigations of high priority areas. Based on historical data, prioritize specific geographic areas and/or incident type for pro-active investigations.

Spill and Leak Prevention and Response

- On paved surfaces, clean up spills with as little water as possible. Use a rag for small spills, a damp mop for general cleanup, and absorbent material for larger spills. If the spilled material is hazardous, then the used cleanup materials are also hazardous and must be sent to a certified laundry (rags) or disposed of as hazardous waste.
- Never hose down or bury dry material spills. Sweep up the material and dispose of properly.
- Use adsorbent materials on small spills rather than hosing down the spill. Remove the adsorbent materials promptly and dispose of properly.
- For larger spills, a private spill cleanup company or Hazmat team may be necessary.
- See SC-11 Spill Prevention Control and Cleanup.

Employee Training Program

- Training of technical staff in identifying and documenting illegal dumping incidents is required. The frequency of training must be presented in the SWPPP, and depends on site-specific industrial materials and activities.
- Consider posting a quick reference table near storm drains to reinforce training.
- Train employees to identify non-stormwater discharges and report discharges to the appropriate departments.
- Educate employees about spill prevention and cleanup.
- Well-trained employees can reduce human errors that lead to accidental releases or spills. The employee should have the tools and knowledge to immediately begin cleaning up a spill should one occur. Employees should be familiar with the Spill Prevention Control and Countermeasure Plan. Employees should be able to identify work/jobs with high potential for spills and suggest methods to reduce possibility.
- Determine and implement appropriate outreach efforts to reduce non-permissible non-stormwater discharges.

- Conduct spill response drills annually (if no events occurred) in order to evaluate the effectiveness of the plan.
- When a responsible party is identified, educate the party on the impacts of his or her actions.

Quality Assurance and Record Keeping

Performance Evaluation

- Annually review internal investigation results; assess whether goals were met and what changes or improvements are necessary.
- Obtain feedback from personnel assigned to respond to, or inspect for, illicit connections and illegal dumping incidents.
- Develop document and data management procedures.
- A database is useful for defining and tracking the magnitude and location of the problem.
- Report prohibited non-stormwater discharges observed during the course of normal daily activities so they can be investigated, contained, and cleaned up or eliminated.
- Document that non-stormwater discharges have been eliminated by recording tests performed, methods used, dates of testing, and any on-site drainage points observed.
- Annually document and report the results of the program.
- Maintain documentation of illicit connection and illegal dumping incidents, including significant conditionally exempt discharges that are not properly managed.
- Document training activities.

Potential Limitations and Work-Arounds

Some facilities may have space constraints, limited staffing and time limitations that may preclude implementation of BMPs. Provided below are typical limitations and recommended "work-arounds."

- Many facilities do not have accurate, up-to-date 'as-built' plans or drawings which may be necessary in order to conduct non-stormwater discharge assessments.
  - ✓ Online tools such as Google Earth™ can provide an aerial view of the facility and may be useful in understanding drainage patterns and potential sources of non-stormwater discharges
  - ✓ Local municipal jurisdictions may have useful drainage systems maps.

- Video surveillance cameras are commonly used to secure the perimeter of industrial facilities against break-ins and theft. These surveillance systems may also be useful for capturing illegal dumping activities. Minor, temporary adjustments to the field of view of existing surveillance camera systems to target known or suspected problem areas may be a cost-effective way of capturing illegal dumping activities and identifying the perpetrators.

Potential Capital Facility Costs and Operation & Maintenance Requirements

Facilities

- Capital facility cost requirements may be minimal unless cross-connections to storm drains are detected.
- Indoor floor drains may require re-plumbing if cross-connections are detected.
- Leaky sanitary sewers will require repair or replacement which can have significant costs depending on the size and industrial activity at the facility.

Maintenance (including administrative and staffing)

- The primary effort is for staff time and depends on how aggressively a program is implemented.
- Costs for containment, and disposal of any leak or discharge is borne by the Discharger.
- Illicit connections can be difficult to locate especially if there is groundwater infiltration.
- Illegal dumping and illicit connection violations requires technical staff to detect and investigate them.

Supplemental Information

Permit Requirements

The IGP authorizes certain Non-Storm Water Discharges (NSWDs) provided BMPs are included in the SWPPP and implemented to:

- Reduce or prevent the contact of authorized NSWDs with materials or equipment that are potential sources of pollutants;
- Reduce, to the extent practicable, the flow or volume of authorized NSWDs;
- Ensure that authorized NSWDs do not contain quantities of pollutants that cause or contribute to an exceedance of a water quality standards (WQS); and,

- Reduce or prevent discharges of pollutants in authorized NSWDs in a manner that reflects best industry practice considering technological availability and economic practicability and achievability."

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Spill Prevention, Control & Cleanup SC-11

Description

Many activities that occur at an industrial or commercial site have the potential to cause accidental spills. Preparation for accidental spills, with proper training and reporting systems implemented, can minimize the discharge of pollutants to the environment.

Spills and leaks are one of the largest contributors of stormwater pollutants. Spill prevention and control plans are applicable to any site at which hazardous materials are stored or used. An effective plan should have spill prevention and response procedures that identify hazardous material storage areas, specify material handling procedures, describe spill response procedures, and provide locations of spill clean-up equipment and materials. The plan should take steps to identify and characterize potential spills, eliminate and reduce spill potential, respond to spills when they occur in an effort to prevent pollutants from entering the stormwater drainage system, and train personnel to prevent and control future spills. An adequate supply of spill clean-up materials must be maintained onsite.

Objectives
■ *Cover*
■ *Contain*
■ *Educate*
■ *Reduce/Minimize*
■ *Product Substitution*

Targeted Constituents	
Sediment	
Nutrients	
Trash	
Metals	✓
Bacteria	
Oil and Grease	✓
Organics	✓

Minimum BMPs Covered	
Good Housekeeping	
Preventative Maintenance	
Spill and Leak Prevention and Response	✓
Material Handling & Waste Management	
Erosion and Sediment Controls	
Employee Training Program	✓
Quality Assurance Record Keeping	✓

Approach

General Pollution Prevention Protocols

- ☐ Develop procedures to prevent/mitigate spills to storm drain systems.
- ☐ Develop and standardize reporting procedures, containment, storage, and disposal activities, documentation, and follow-up procedures.
- ☐ Establish procedures and/or controls to minimize spills and leaks. The procedures should address:
  - ✓ Description of the facility, owner and address, activities, chemicals, and quantities present;

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- ✓ Facility map of the locations of industrial materials;
- ✓ Notification and evacuation procedures;
- ✓ Cleanup instructions;
- ✓ Identification of responsible departments; and
- ✓ Identify key spill response personnel.

- ☐ Recycle, reclaim, or reuse materials whenever possible. This will reduce the amount of process materials that are brought into the facility.

Spill and Leak Prevention and Response

Spill Prevention

- ☐ Develop procedures to prevent/mitigate spills to storm drain systems. Develop and standardize reporting procedures, containment, storage, and disposal activities, documentation, and follow-up procedures.

- ☐ If illegal dumping is observed at the facility:
  - ✓ Post "No Dumping" signs with a phone number for reporting illegal dumping and disposal. Signs should also indicate fines and penalties applicable for illegal dumping.
  - ✓ Landscaping and beautification efforts may also discourage illegal dumping.
  - ✓ Bright lighting and/or entrance barriers may also be needed to discourage illegal dumping.

- ☐ Store and contain liquid materials in such a manner that if the container is ruptured, the contents will not discharge, flow, or be washed into the storm drainage system, surface waters, or groundwater.

- ☐ If the liquid is oil, gas, or other material that separates from and floats on water, install a spill control device (such as a tee section) in the catch basins that collects runoff from the storage tank area.

Preventative Maintenance

- ☐ Place drip pans or absorbent materials beneath all mounted taps, and at all potential drip and spill locations during filling and unloading of tanks. Any collected liquids or soiled absorbent materials must be reused/recycled or properly disposed.

- ☐ Store and maintain appropriate spill cleanup materials in a location known to all near the tank storage area; and ensure that employees are familiar with the site's spill control plan and/or proper spill cleanup procedures.

- ☐ Sweep and clean the storage area monthly if it is paved, *do not hose down the area to a storm drain.*

- ☐ Check tanks (and any containment sumps) daily for leaks and spills. Replace tanks that are leaking, corroded, or otherwise deteriorating with tanks in good condition. Collect all spilled liquids and properly dispose of them.

- ☐ Label all containers according to their contents (e.g., solvent, gasoline).

- ☐ Label hazardous substances regarding the potential hazard (corrosive, radioactive, flammable, explosive, poisonous).

- ☐ Prominently display required labels on transported hazardous and toxic materials (per US DOT regulations).

- ☐ Identify key spill response personnel.

Spill Response

- ☐ Clean up leaks and spills immediately.

- ☐ Place a stockpile of spill cleanup materials where it will be readily accessible (e.g., near storage and maintenance areas).

- ☐ On paved surfaces, clean up spills with as little water as possible.

  - ✓ Use a rag for small spills, a damp mop for general cleanup, and absorbent material for larger spills.

  - ✓ If the spilled material is hazardous, then the used cleanup materials are also hazardous and must be sent to a certified laundry (rags) or disposed of as hazardous waste.

  - ✓ If possible use physical methods for the cleanup of dry chemicals (e.g., brooms, shovels, sweepers, or vacuums).

- ☐ Never hose down or bury dry material spills. Sweep up the material and dispose of properly.

- ☐ Chemical cleanups of material can be achieved with the use of adsorbents, gels, and foams. Use adsorbent materials on small spills rather than hosing down the spill. Remove the adsorbent materials promptly and dispose of properly.

- ☐ For larger spills, a private spill cleanup company or Hazmat team may be necessary.

Reporting

- Report spills that pose an immediate threat to human health or the environment to the Regional Water Quality Control Board or local authority as location regulations dictate.
- Federal regulations require that any oil spill into a water body or onto an adjoining shoreline be reported to the National Response Center (NRC) at 800-424-8802 (24 hour).
- Report spills to 911 for dispatch and clean-up assistance when needed. Do not contact fire agencies directly.
- Establish a system for tracking incidents. The system should be designed to identify the following:
  - ✓ Types and quantities (in some cases) of wastes;
  - ✓ Patterns in time of occurrence (time of day/night, month, or year);
  - ✓ Mode of dumping (abandoned containers, "midnight dumping" from moving vehicles, direct dumping of materials, accidents/spills);
  - ✓ Clean-up procedures; and
  - ✓ Responsible parties.

Employee Training Program

- Educate employees about spill prevention and cleanup.
- Well-trained employees can reduce human errors that lead to accidental releases or spills:
  - ✓ The employee should have the tools and knowledge to immediately begin cleaning up a spill should one occur; and
  - ✓ Employees should be familiar with the Spill Prevention Control and Countermeasure Plan.
- Employees should be educated about aboveground storage tank requirements. Employees responsible for aboveground storage tanks and liquid transfers should be thoroughly familiar with the Spill Prevention Control and Countermeasure Plan and the plan should be readily available.
- Train employees to recognize and report illegal dumping incidents.

Other Considerations (Limitations and Regulations)

- State regulations exist for facilities with a storage capacity of 10,000 gallons or more of petroleum to prepare a Spill Prevention Control and Countermeasure (SPCC) Plan (Health & Safety Code Chapter 6.67).
- State regulations also exist for storage of hazardous materials (Health & Safety Code Chapter 6.95), including the preparation of area and business plans for emergency response to the releases or threatened releases.
- Consider requiring smaller secondary containment areas (less than 200 sq. ft.) to be connected to the sanitary sewer, prohibiting any hard connections to the storm drain.

Requirements

Costs (including capital and operation & maintenance)

- Will vary depending on the size of the facility and the necessary controls.
- Prevention of leaks and spills is inexpensive. Treatment and/or disposal of contaminated soil or water can be quite expensive.

Maintenance (including administrative and staffing)

- Develop spill prevention and control plan, provide and document training, conduct inspections of material storage areas, and supply spill kits.
- Extra time is needed to properly handle and dispose of spills, which results in increased labor costs.

Supplemental Information

Further Detail of the BMP

Reporting

Record keeping and internal reporting represent good operating practices because they can increase the efficiency of the facility and the effectiveness of BMPs. A good record keeping system helps the facility minimize incident recurrence, correctly respond with appropriate cleanup activities, and comply with legal requirements. A record keeping and reporting system should be set up for documenting spills, leaks, and other discharges, including discharges of hazardous substances in reportable quantities. Incident records describe the quality and quantity of non-stormwater discharges to the storm sewer. These records should contain the following information:

- Date and time of the incident;
- Weather conditions;
- Duration of the spill/leak/discharge;

- Cause of the spill/leak/discharge;
- Response procedures implemented;
- Persons notified; and
- Environmental problems associated with the spill/leak/discharge.

Separate record keeping systems should be established to document housekeeping and preventive maintenance inspections, and training activities. All housekeeping and preventive maintenance inspections should be documented. Inspection documentation should contain the following information:

- Date and time the inspection was performed;
- Name of the inspector;
- Items inspected;
- Problems noted;
- Corrective action required; and
- Date corrective action was taken.

Other means to document and record inspection results are field notes, timed and dated photographs, videotapes, and drawings and maps.

Aboveground Tank Leak and Spill Control

Accidental releases of materials from aboveground liquid storage tanks present the potential for contaminating stormwater with many different pollutants. Materials spilled, leaked, or lost from tanks may accumulate in soils or on impervious surfaces and be carried away by stormwater runoff.

The most common causes of unintentional releases are:

- Installation problems;
- Failure of piping systems (pipes, pumps, flanges, couplings, hoses, and valves);
- External corrosion and structural failure;
- Spills and overfills due to operator error; and
- Leaks during pumping of liquids or gases from truck or rail car to a storage tank or vice versa.

Storage of reactive, ignitable, or flammable liquids should comply with the Uniform Fire Code and the National Electric Code. Practices listed below should be employed to enhance the code requirements:

- Tanks should be placed in a designated area.
- Tanks located in areas where firearms are discharged should be encapsulated in concrete or the equivalent.
- Designated areas should be impervious and paved with Portland cement concrete, free of cracks and gaps, in order to contain leaks and spills.
- Liquid materials should be stored in UL approved double walled tanks or surrounded by a curb or dike to provide the volume to contain 10 percent of the volume of all of the containers or 110 percent of the volume of the largest container, whichever is greater. The area inside the curb should slope to a drain.
- For used oil or dangerous waste, a dead-end sump should be installed in the drain.
- All other liquids should be drained to the sanitary sewer if available. The drain must have a positive control such as a lock, valve, or plug to prevent release of contaminated liquids.
- Accumulated stormwater in petroleum storage areas should be passed through an oil/water separator.

Maintenance is critical to preventing leaks and spills. Conduct routine inspections and:

- Check for external corrosion and structural failure.
- Check for spills and overfills due to operator error.
- Check for failure of piping system (pipes, pumps, flanges, coupling, hoses, and valves).
- Check for leaks or spills during pumping of liquids or gases from truck or rail car to a storage facility or vice versa.
- Visually inspect new tank or container installation for loose fittings, poor welding, and improper or poorly fitted gaskets.
- Inspect tank foundations, connections, coatings, and tank walls and piping system. Look for corrosion, leaks, cracks, scratches, and other physical damage that may weaken the tank or container system.
- Frequently relocate accumulated stormwater during the wet season.

- Periodically conduct integrity testing by a qualified professional.

Vehicle Leak and Spill Control

Major spills on roadways and other public areas are generally handled by highly trained Hazmat teams from local fire departments or environmental health departments. The measures listed below pertain to leaks and smaller spills at vehicle maintenance shops.

In addition to implementing the spill prevention, control, and clean up practices above, use the following measures related to specific activities:

Vehicle and Equipment Maintenance

- Perform all vehicle fluid removal or changing inside or under cover to prevent the run-on of stormwater and the runoff of spills.
- Regularly inspect vehicles and equipment for leaks, and repair immediately.
- Check incoming vehicles and equipment (including delivery trucks, and employee and subcontractor vehicles) for leaking oil and fluids. Do not allow leaking vehicles or equipment onsite.
- Always use secondary containment, such as a drain pan or drop cloth, to catch spills or leaks when removing or changing fluids.
- Immediately drain all fluids from wrecked vehicles.
- Store wrecked vehicles or damaged equipment under cover.
- Place drip pans or absorbent materials under heavy equipment when not in use.
- Use absorbent materials on small spills rather than hosing down the spill.
- Remove the adsorbent materials promptly and dispose of properly.
- Promptly transfer used fluids to the proper waste or recycling drums. Don't leave full drip pans or other open containers lying around.
- Oil filters disposed of in trashcans or dumpsters can leak oil and contaminate stormwater. Place the oil filter in a funnel over a waste oil recycling drum to drain excess oil before disposal. Oil filters can also be recycled. Ask your oil supplier or recycler about recycling oil filters.
- Store cracked batteries in a non-leaking secondary container. Do this with all cracked batteries, even if you think all the acid has drained out. If you drop a battery, treat it as if it is cracked. Put it into the containment area until you are sure it is not leaking.

Vehicle and Equipment Fueling

- Design the fueling area to prevent the run-on of stormwater and the runoff of spills:

  Cover fueling area if possible.

  Use a perimeter drain or slope pavement inward with drainage to a sump.

  Pave fueling area with concrete rather than asphalt.

- If dead-end sump is not used to collect spills, install an oil/water separator.
- Install vapor recovery nozzles to help control drips as well as air pollution.
- Discourage "topping-off" of fuel tanks.
- Use secondary containment when transferring fuel from the tank truck to the fuel tank.
- Use absorbent materials on small spills and general cleaning rather than hosing down the area. Remove the absorbent materials promptly.
- Carry out all Federal and State requirements regarding underground storage tanks, or install above ground tanks.
- Do not use mobile fueling of mobile industrial equipment around the facility; rather, transport the equipment to designated fueling areas.
- Keep your Spill Prevention Control and Countermeasure (SPCC) Plan up-to-date.
- Train employees in proper fueling and cleanup procedures.

Industrial Spill Prevention Response

For the purposes of developing a spill prevention and response program to meet the stormwater regulations, facility managers should use information provided in this fact sheet and the spill prevention/response portions of the fact sheets in this handbook, for specific activities.

The program should:

- Integrate with existing emergency response/hazardous materials programs (e.g., Fire Department).
- Develop procedures to prevent/mitigate spills to storm drain systems.
- Identify responsible departments.

- Develop and standardize reporting procedures, containment, storage, and disposal activities, documentation, and follow-up procedures.
- Address spills at municipal facilities, as well as public areas.
- Provide training concerning spill prevention, response and cleanup to all appropriate personnel.

References and Resources

California's Nonpoint Source Program Plan. http://www.swrcb.ca.gov/nps/index.html.

Clark County Storm Water Pollution Control Manual. Available online at: http://www.co.clark.wa.us/pubworks/bmpman.pdf.

King County Storm Water Pollution Control Manual. Available online at: http://dnr.metrokc.gov/wlr/dss/spcm.htm.

Orange County Stormwater Program, Best Management Practices for Industrial/Commercial Business Activities. Available online at: http://ocwatersheds.com/documents/bmp/industrialcommercialbusinessesactivities

Santa Clara Valley Urban Runoff Pollution Prevention Program. http://www.scvurppp.org.

The Stormwater Managers Resource Center. http://www.stormwatercenter.net/.

Vehicle and Equipment Cleaning SC-21

Description

Wash water from vehicle and equipment cleaning activities performed outdoors or in areas where wash water flows onto the ground can contribute toxic hydrocarbons and other organic compounds, oils and greases, nutrients, phosphates, heavy metals, and suspended solids to stormwater runoff. Use of the procedures outlined below can prevent or reduce the discharge of pollutants to stormwater during vehicle and equipment cleaning.

Approach

Reduce potential for pollutant discharge through source control pollution prevention and BMP implementation. Successful implementation depends on effective training of employees on applicable BMPs and general pollution prevention strategies and objectives

General Pollution Prevention Protocols

- If possible, use properly maintained off-site commercial washing and steam cleaning businesses whenever possible. These businesses are better equipped to handle and properly dispose of the wash waters.
- Use dry cleaning methods to remove debris and sweep area; avoid washing with water when possible.
- Good housekeeping practices can minimize the risk of contamination from wash water discharges.
- Use biodegradable, phosphate-free detergents for washing vehicles as appropriate
- Emphasize the connection between the storm drain system and runoff, help reinforce that vehicle and equipment washing activities affect local water quality through storm drain stenciling programs.

Objectives
■ *Cover*
■ *Contain*
■ *Educate*
■ *Reduce/Minimize*
■ *Product Substitution*

Targeted Constituents	
Sediment	✓
Nutrients	✓
Trash	
Metals	✓
Bacteria	
Oil and Grease	✓
Organics	✓

Minimum BMPs Addressed	
Good Housekeeping	✓
Preventative Maintenance	✓
Spill and Leak Prevention and Response	✓
Material Handling & Waste Management	✓
Erosion and Sediment Controls	
Employee Training Program	✓
Quality Assurance Record Keeping	✓

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- ☐ Map on-site storm drain locations to avoid discharges to the storm drain system.
- ☐ Designate specific wash area with clarifier or place wash areas away from storm drain connections.

Good Housekeeping

- ☐ Mark the area clearly as a wash area by:
  - ✓ Posting signs stating that only washing is allowed in wash area; and
  - ✓ Providing information on how washing is to be done.
- ☐ Provide trash containers in wash area.
- ☐ Have all vehicle and equipment washing done in areas designed to collect and hold the wash and rinse water or effluent generated. Recycle, collect or treat wash water effluent prior to discharge to the sanitary sewer system.
- ☐ If washing/cleaning must occur on-site, consider washing vehicles and equipment inside the building or on an impervious surface to control the targeted constituents by directing them to the sanitary sewer.
- ☐ If washing must occur on-site and outdoor:
  - ✓ Use designated paved wash areas. This area must be covered or bermed to collect the wash water and graded to direct the wash water to a treatment or disposal facility.
  - ✓ Do not conduct oil changes and other engine maintenance in the designated washing area. Perform these activities in a place designated for oil change and maintenance activities.
  - ✓ Cover the wash area when not in use to prevent contact with rain water.
- ☐ Do not permit steam cleaning wash water to enter the storm drain system.
- ☐ If possible, conduct pressure and steam cleaning at appropriate off-site areas to avoid generating runoff with high pollutant concentrations.

Preventative Maintenance

- ☐ Install sumps or drain lines to collect wash water for treatment.
- ☐ Use hoses with nozzles that automatically turn off when left unattended.
- ☐ Perform routine inspections of drain lines, holding tanks, and hoses and repair leaks immediately.

- Perform routine inspection and maintenance of wash water recycling and treatment systems.

Spill Response and Prevention Procedures

- Keep the spill prevention and control plan up-to-date.
- Have an emergency plan, equipment, and trained personnel ready at all times to deal immediately with major spills.
- Collect all spilled liquids and properly dispose of them.
- Store and maintain appropriate spill cleanup materials in a location known to all near the designated wash area.

Material Handling and Waste Management

- Collect all wash water from vehicle and equipment cleaning operations. Consider treating and reusing or discharging wash waters to a sanitary sewer system.
- Large quantities of wash waters may require treatment at the facility. Treatment using a process treatment system (e.g., holding tank, filtration system, and related appurtenances) will require engineering and capital expenditures.
- Collect and treat small amounts of wash water at the facility and either recycle or discharge to the sanitary sewer system or collect and dispose of as an industrial waste.
- Discharge wash waters into sanitary sewer only after contacting local sewer authority to find out if pretreatment is required.

Employee Training Program

- Train employees on proper cleaning and wash water disposal procedures and conduct “refresher” courses on a regular basis.
- Train staff on proper maintenance measures for the wash area.
- Train employees and contractors on proper spill containment and cleanup. The employee should have the tools and knowledge to immediately begin cleaning up a spill should one occur.
- Use a training log or similar method to document training.

Quality Assurance and Record Keeping

- Keep accurate maintenance/inspection logs that document the minimum BMP activities performed for vehicle and equipment cleaning activities and improvement actions.

- Keep accurate logs of spill response actions that document what was spilled, how it was cleaned up, and how the waste was disposed.

- Establish procedures to complete logs and file them in the central office.

Other Facility-Specific Considerations

- Some municipalities may require pretreatment and monitoring of wash water discharges to the sanitary sewer.

- Steam cleaning can generate significant pollutant concentrations requiring that careful consideration be given to the environmental impacts and compliance issues related to the condensate wastewater generated.

Potential Limitations and Work-Arounds

Some facilities may have space constraints, limited staffing and time limitations that may preclude implementation of certain BMPs. Provided below are typical limitations and recommended "work-arounds":

- Most car washing best management practices are inexpensive, and rely more on good housekeeping practices (where vehicles are washed, planning for the collection of wash water) than on expensive technology. However, the construction of a specialized area for vehicle washing can be expensive. Also, for facilities that cannot recycle their wash water, the cost of pre-treating wash water through either structural practices or planning for collection and hauling of contaminated water to sewage treatment plants can be cost-prohibitive.

- A potential work-around is to use properly maintained off-site commercial washing and steam cleaning businesses whenever possible.

Potential Capital Facility Costs and Operation & Maintenance Requirements

Facilities

- Many facilities will already have indoor covered areas where vehicle and equipment cleaning takes place and will require no additional capital expenditures for providing cover.

- Capital investments will be required at some sites if systems to collect and recycle/treat and properly discharge wash water are not in place. The cost associated with these investments will vary depending on the size of the washing facility and local regulations regarding effluent wash water.

Maintenance

- Perform wash and collection system inspections and repair.

- Sweep washing areas frequently to remove solid debris.

- Repair berms and dikes as necessary.
- Inspect and maintain sumps, oil/water separators, and on-site treatment/recycling units.

Supplemental Information

Designated Cleaning Areas

- Washing operations outside should be conducted in a designated wash area having the following characteristics:
  - ✓ Paved with Portland cement concrete
  - ✓ Covered and bermed to prevent contact with stormwater and contain wash water
  - ✓ Sloped for wash water collections
  - ✓ Drainage system for wash water to the sanitary or recycle treatment process waste sewer, or to a dead-end sump equipped with an oil/water separator if necessary.

References and Resources

Orange County Stormwater Program, Best Management Practices for Industrial/Commercial Business Activities. Available online at: http://ocwatersheds.com/documents/bmp/industrialcommercialbusinessesactivities.

Oregon Department of Environmental Quality, 2013. *Industrial Stormwater Best Management Practices Manual- BMP 8 Vehicle, Pavement and Building Washing*. Available online at: http://www.deq.state.or.us/wq/wqpermit/docs/IndBMP021413.pdf.

Sacramento Stormwater Management Program. *Best Management Practices for Industrial Storm Water Pollution Control*. Available online at: http://www.msa.saccounty.net/sactostormwater/documents/guides/industrial-BMP-manual.pdf.

Sacramento County Environmental Management Stormwater Program: Best Management Practices –Vehicle Washing. Available online at: http://www.emd.saccounty.net/EnvHealth/Stormwater/Stormwater-BMPs.html.

Santa Clara Valley Urban Runoff Pollution Prevention Program. http://www.scvurppp-w2k.com/.

US EPA. National Pollutant Discharge Elimination System – Stormwater Menu of BMPs - Municipal Vehicle and Equipment Washing. Available online at: http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=132.

Vehicle and Equipment Cleaning SC-21

Washington State Department of Ecology, 2012 .*Vehicle and Equipment Washwater Discharges Best Management Practices Manual.* Publication no. WQ-R-95-056. Available online at: https://fortress.wa.gov/ecy/publications/publications/95056.pdf.

Vehicle and Equipment Repair SC-22

Description

Vehicle or equipment maintenance and repair are potentially significant sources of stormwater pollution, due to use of harmful materials and wastes during maintenance and repair processes. Engine repair and service (e.g., parts cleaning), replacement of fluids (e.g., oil change), and outdoor equipment storage and parking (leaking vehicles) can impact water quality if stormwater runoff from areas with these activities becomes polluted by a variety of contaminants. Implementation of the following activities must be done where applicable to prevent or reduce the discharge of pollutants to stormwater from vehicle and equipment maintenance and repair activities.

Approach

The BMP approach is to reduce the potential for pollutant discharges through source control pollution prevention and BMP implementation. Successful implementation depends on effective training of employees on applicable BMPs and general pollution prevention strategies and objectives. General pollution prevention protocols are presented followed by applicable minimum BMPs as required by the Industrial General Permit.

General Pollution Prevention Protocols

- ☐ Designate a vehicle maintenance area designed to prevent stormwater pollution.
- ☐ Minimize contact of stormwater with outside operations through berming and appropriate drainage routing.
- ☐ Keep accurate maintenance logs to evaluate materials removed and improvements made.
- ☐ Switch to non-toxic chemicals for maintenance when possible.
- ☐ Choose cleaning agents that can be recycled.
- ☐ Use drop cloths and drip pans.

Objectives
■ *Cover*
■ *Contain*
■ *Educate*
■ *Reduce/Minimize*
■ *Product Substitution*

Targeted Constituents	
Sediment	
Nutrients	
Trash	
Metals	✓
Bacteria	
Oil and Grease	✓
Organics	✓

Minimum BMPs Covered	
Good Housekeeping	✓
Preventative Maintenance	✓
Spill and Leak Prevention and Response	✓
Material Handling & Waste Management	✓
Erosion and Sediment Controls	
Employee Training Program	✓
Quality Assurance Record Keeping	✓

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- Minimize use of solvents. Clean parts without using solvents whenever possible, or use water-based solvents for cleaning.
- Recycle used motor oil, diesel oil, and other vehicle fluids and parts whenever possible.

Operational Protocols

General

- Move maintenance and repair activities indoors whenever feasible.
- Place curbs around the immediate boundaries of process equipment.

Good Housekeeping

- Store idle equipment under cover
- Use a vehicle maintenance area designed to prevent stormwater pollution - minimize contact of stormwater with outside operations through berming and appropriate drainage routing.
- Avoid hosing down your work areas. If work areas are washed, collect and direct wash water to sanitary sewer. Use dry sweeping if possible.
- Paint signs on storm drain inlets to indicate that they are not to receive liquid or solid wastes.
- Post signs at sinks to remind employees not to pour wastes down drains.
- Clean yard storm drain inlets(s) regularly and especially after large storms.
- Do not pour materials down storm drains.
- Cover the work area to limit exposure to rain.
- Place curbs around the immediate boundaries of process equipment.
- Build a shed or temporary roof over areas where parked cars await repair or salvage, especially wrecked vehicles. Build a roof over vehicles kept for parts.

Preventive Maintenance and Repair Activities

- Provide a designated area for vehicle maintenance.
- Inspect vehicles and equipment for leaks regularly and repair immediately.
- Make sure incoming vehicles are checked for leaking oil and fluids. Do not allow leaking vehicles or equipment on-site without correcting the source of the leak and cleaning up any spill.
- Keep equipment clean; don't allow excessive build-up of oil and grease.

- Perform all vehicle fluid removal or changing inside or under cover if possible to prevent the run-on of stormwater and the runoff of spills.

- Use a tarp, ground cloth, or drip pans beneath the vehicle or equipment to capture all spills and drips if temporary work is being conducted outside. Collected drips and spills must be disposed, reused, or recycled properly.

- It is important to sweep the maintenance area weekly, if it is paved, to collect loose particles, and wipe up spills with rags and other absorbent material immediately. Do not hose down the area to a storm drain.

- Establish standard procedures to prevent spillage/leakage of fluids including:

  - ✓ Keep a drip pan under the vehicle while you unclip hoses, unscrew filters, or remove other parts. Use a drip pan under any vehicle that might leak while working on it to keep splatters or drips off the shop floor.

  - ✓ Promptly transfer used fluids to the proper waste or recycling drums. Do not leave drip pans or other open containers lying around.

  - ✓ Keep drip pans or containers under vehicles or equipment that may drip during repairs.

  - ✓ Do not change motor oil or perform equipment maintenance in non-appropriate areas.

- Drain oil and other fluids first if the vehicle or equipment is to be stored outdoors. Elevate and tarp stored vehicles and equipment.

- Monitor parked vehicles closely for leaks. Pans should be placed under any leaks to collect the fluids for proper disposal or recycling.

- Mechanics should clean vehicle parts without using liquid cleaners wherever possible to reduce waste.

- Steam cleaning and pressure washing may be used instead of solvent parts cleaning. The wastewater generated from steam cleaning must be discharged to an on-site oil water separator that is connected to a sanitary sewer or blind sump. Non-caustic detergents should be used instead of caustic cleaning agents, detergent-based or water-based cleaning systems in place of organic solvent degreasers, and non-chlorinated solvent in place of chlorinated organic solvents for parts cleaning. Refer to SC21 for more information on steam cleaning.

- Fifth-wheel bearings on trucks require routine lubrication. Typically chassis grease is applied to the fifth-wheel bearing at rates that result in grease dripping off of the bearing into the environment. To address this concern the following options are available:

  - ✓ Use specialized lubricants with good adhesion (e.g., stay in place) properties. Carefully follow manufacturer's label regarding the use of adhesive lubricant for

truck fifth-wheels. Typically this means applying no more than 8 oz. of grease. No visible extrusion of lubricant from the fifth-wheel bearing when truck and trailer are connected should be present.

- ✓ Use on-board truck or on-board trailer automatic lubrication systems. If these systems apply lube thinner than National Grease Lubrication Institute #2, equipment for collection of used lubricant is needed to prevent excess lubricant from dripping off the truck.
- ✓ Use plastic or Teflon plates instead of grease or other lubricants. Carefully follow manufacturer's instructions for installation and operation.

- ☐ Use one of the following for lubricating vehicle-trailer coupling:
  - ✓ Specialized adhesive lubricants;
  - ✓ Grease-free fifth wheel slip plates (e.g., plastic or Teflon coatings); and
  - ✓ On-Board automatic lubricating systems.

Spill and Leak Prevention and Response Procedures

- ☐ Keep your spill prevention and control plan up-to-date.
- ☐ Place an adequate stockpile of spill cleanup materials where it will be readily accessible.
- ☐ Clean leaks, drips, and other spills with as little water as possible. Use rags for small spills, a damp mop for general cleanup, and dry absorbent material for larger spills. Use the following three-step method for cleaning floors:
  - ✓ Clean spills with rags or other absorbent materials;
  - ✓ Sweep floor using dry absorbent material; and
  - ✓ Mop the floor.

  Mop water may be discharged to the sanitary sewer via a toilet or sink.
- ☐ Remove the adsorbent materials promptly and dispose of properly when using adsorbent materials on small spills.

Material Handling and Waste Management

- ☐ Designate a special area to drain and replace motor oil, coolant, and other fluids, where there are no connections to the storm drain or the sanitary sewer, and drips and spills can be easily cleaned up.
- ☐ Drain all fluids immediately from wrecked vehicles. Ensure that the drain pan or drip pan is large enough to contain drained fluids (e.g., larger pans are needed to contain antifreeze, which may gush from some vehicles).

- Do not pour liquid waste to floor drains, sinks, outdoor storm drain inlets, or other storm drains or sewer connections.
- Do not put used or leftover cleaning solutions, solvents, and automotive fluids and in the sanitary sewer.
- Collect leaking or dripping fluids in drip pans or containers. Fluids are easier to recycle if kept separate.
- Promptly transfer used fluids to the proper waste or recycling drums. Do not leave drip pans or other open containers lying around.
- Place oil filter in a funnel over a waste oil recycling drum to drain excess oil before disposal since municipalities prohibit or discourage disposal of these items in solid waste facilities.
- Oil filters can also be recycled. Ask your oil supplier or recycler about recycling oil filters. Oil filters disposed of in trashcans or dumpsters can leak oil and contaminate stormwater.
- Store cracked batteries in a non-leaking secondary container and dispose of properly at recycling or household hazardous waste facilities.

Employee Training Program

- Train employees and contractors in the proper handling and disposal of engine fluids and waste materials.
- Employees should have the tools and knowledge to immediately begin cleaning up a spill should one occur.
- Conduct annual training to ensure that employees are familiar with the facility's spill control plan and/or proper spill cleanup procedures (You can use reusable cloth rags to clean up small drips and spills instead of disposables; these can be washed by a permitted industrial laundry. Do not clean them at home or at a coin-operated laundry business).
- Use a training log or similar method to document training.

Quality Assurance and Recordkeeping

- Keep accurate maintenance logs to evaluate materials removed and improvements made.
- Establish procedures to collect and file maintenance logs in the central office.

Other Facility-Specific Considerations

Parts Cleaning

Vehicle and equipment maintenance facilities often must clean parts as a part of day-today operations. The following activities should be considered:

- Clean vehicle parts without using liquid cleaners wherever possible to reduce waste.
- Steam cleaning and pressure washing may be used instead of solvent parts cleaning.
- Wastewater generated from steam cleaning must be discharged to an on-site oil water separator that is connected to a sanitary sewer or blind sump.
- Use non-caustic detergents instead of caustic cleaning agents, detergent-based or water-based cleaning systems in place of organic solvent degreasers, and non-chlorinated solvent in place of chlorinated organic solvents for parts cleaning. Refer to SC21 for more information on steam cleaning.

Potential Limitations and Work-Arounds

- Some facilities may have space constraints and time limitations that may preclude all work from being conducted indoors.
  - ✓ Designate specific areas for outdoor activities.
  - ✓ Require employees to understand and follow preventive maintenance and spill and leak prevention BMPs.
- It may not be possible to contain and clean up spills from vehicles/equipment brought on-site after working hours.
  - ✓ Provide a designated area for afterhours deliveries.
  - ✓ Install spill kits.
- Drain pans (usually 1 ft. x 1 ft.) are generally too small to contain antifreeze
  - ✓ Purchase or fabricate large drip pans (3 ft. x 3 ft.) with sufficient volume to contain expected quantities of liquids based on equipment/vehicle specifications.
- Dry floor cleaning methods may not be sufficient for some spills.
  - ✓ Use three-step method instead.
- Identification of engine leaks may require some use of solvents.
  - ✓ Minimize the use of solvents and use drip pans to collect spills and leaks.
- Prices for recycled materials and fluids may be higher than those of non-recycled materials.

- Some facilities may be limited by a lack of providers of recycled materials, and by the absence of businesses to provide services such as hazardous waste removal, structural treatment practice maintenance, or solvent equipment and solvent recycling.

Potential Facilities and Maintenance Requirements

Facilities Requirements

- For facilities that already have covered areas where maintenance takes place, have berms or other means to retain spills and leaks, and/ have other appropriate constructed systems for containment, there may not need to be any significant new capital investment. Capital costs will likely be required at some sites if adequate cover and containment facilities do not exist and can vary significantly depending upon site conditions.

Maintenance Requirements

- Most of the operations and maintenance activity associated with implementing this BMP are integrally linked to routine operations as previously described. Therefore, significant additional operations and maintenance efforts are not likely to be required.

- For facilities responsible for pre-treating their wastewater prior to discharging, the proper functioning of structural treatment system is an important maintenance consideration. Routine cleanout of oil and grease is required for the devices to maintain their effectiveness, usually at least once a month. During periods of heavy rainfall, cleanout is required more often to ensure pollutants are not washed through the trap. Sediment removal is also required on a regular basis to keep the device working efficiently.

- It is important to sweep the maintenance area weekly, if it is paved, to collect loose particles, and wipe up spills with rags and other absorbent material immediately. Do not hose down the area to a storm drain.

Supplemental Information

Waste Reduction

Parts are often cleaned using solvents such as trichloroethylene, 1,1,1-trichloroethane or methylene chloride. Many of these cleaners are harmful and must be disposed of as a hazardous waste. Cleaning without using liquid cleaners (e.g., wire brush) whenever possible reduces waste. Prevent spills and drips of solvents and cleansers to the shop floor. Do all liquid cleaning at a centralized station so the solvents and residues stay in one area. Locate drip pans, drain boards, and drying racks to direct drips back into a solvent sink or fluid holding tank for reuse. Reducing the number of solvents makes recycling easier and reduces hazardous waste management costs. Often, one solvent can perform a job as well as two different solvents.

- Clean parts without using liquid cleaners whenever possible to reduce waste.

- Prevent spills and drips of solvents and cleansers to the shop floor.

- Do all liquid cleaning at a centralized station so the solvents and residues stay in one area.
- Locate drip pans, drain boards, and drying racks to direct drips back into a solvent sink or fluid holding tank for reuse.

Recycling

Separating wastes allows for easier recycling and may reduce treatment costs. Keep hazardous and non-hazardous wastes separate, do not mix used oil and solvents, and keep chlorinated solvents (e.g., 1,1,1-trichloroethane) separate from non-chlorinated solvents (e.g., kerosene and mineral spirits).

Many products made of recycled (i.e., refined or purified) materials are available. Engine oil, transmission fluid, antifreeze, and hydraulic fluid are available in recycled form. Buying recycled products supports the market for recycled materials.

- Recycling is always preferable to disposal of unwanted materials.
- Separate wastes for easier recycling. Keep hazardous and non-hazardous wastes separate, do not mix used oil and solvents, and keep chlorinated solvents separate from non-chlorinated solvents.
- Label and track the recycling of waste material (e.g., used oil, spent solvents, batteries).
- Purchase recycled products to support the market for recycled materials.

Safer Alternatives

If possible, eliminate or reduce the amount of hazardous materials and waste by substituting non-hazardous or less hazardous material:

- Use non-caustic detergents instead of caustic cleaning for parts cleaning.
- Use detergent-based or water-based cleaning systems in place of organic solvent degreasers. Wash water may require treatment before it can be discharged to the sewer.
- Replace chlorinated organic solvents with non-chlorinated solvents. Non-chlorinated solvents like kerosene or mineral spirits are less toxic and less expensive to dispose of properly. Check list of active ingredients to see whether it contains chlorinated solvents.
- Choose cleaning agents that can be recycled.

References and Resources

Orange County Stormwater Program, Best Management Practices for Industrial/Commercial Business Activities. Available online at: http://ocwatersheds.com/documents/bmp/industrialcommercialbusinessesactivities.

Oregon Department of Environmental Quality, 2013. *Industrial Stormwater Best Management Practices Manual- BMP 8 Vehicle, Pavement and Building Washing*. Available online at: http://www.deq.state.or.us/wq/wqpermit/docs/IndBMP021413.pdf.

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Outdoor Storage of Raw Materials SC-33

Objectives

- Cover
- Contain
- Educate
- Reduce/Minimize

Description

Raw materials, by-products, finished products, containers, and material storage areas exposed to rain and/or runoff can pollute stormwater. Stormwater can become contaminated when materials wash off or dissolve into water or are added to runoff by spills and leaks. Improper storage of these materials can result in accidental spills and the release of materials. To prevent or reduce the discharge of pollutants to stormwater from material delivery and storage, pollution prevention and source control measures, such as minimizing the storage of hazardous materials on-site, enclosing or covering materials, storing materials in a designated area, installing secondary containment, conducting regular inspections, preventing stormwater runon and runoff, and training employees and subcontractors must be implemented.

Targeted Constituents

Sediment	✓
Nutrients	✓
Trash	✓
Metals	
Bacteria	
Oil and Grease	✓
Organics	✓
Oxygen Demanding	✓

Approach

Pollution Prevention

- Employee education is paramount for successful BMP implementation.
- Minimize inventory of raw materials.
- Keep an accurate, up-to-date inventory of the materials delivered and stored on-site.
- Try to keep chemicals in their original containers, and keep them well labeled.

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SC-33 Outdoor Storage of Raw Materials

Suggested Protocols

General

- Store all materials inside. If this is not feasible, then all outside storage areas should be covered with a roof, and bermed, or enclosed to prevent stormwater contact. At the very minimum, a temporary waterproof covering made of polyethylene, polypropylene or hypalon should be used over all materials stored outside.
- Cover and contain the stockpiles of raw materials to prevent stormwater from running into the covered piles. The covers must be in place at all times when work with the stockpiles is not occurring. (applicable to small stockpiles only).
- If the stockpiles are so large that they cannot feasibly be covered and contained, implement erosion control practices at the perimeter of your site and at any catch basins to prevent erosion of the stockpiled material off site,
- Keep liquids in a designated area on a paved impervious surface within a secondary containment.
- Keep outdoor storage containers in good condition.
- Keep storage areas clean and dry.
- Design paved areas to be sloped in a manner that minimizes the pooling of water on the site, particularly with materials that may leach pollutants into stormwater and/or groundwater, such as compost, logs, and wood chips. A minimum slope of 1.5 percent is recommended.
- Secure drums stored in an area where unauthorized persons may gain access to prevent accidental spillage, pilferage, or any unauthorized use.
- Cover wood products treated with chromated copper arsenate, ammonical copper zinc arsenate, creosote, or pentachlorophenol with tarps or store indoors.

Raw Material Containment

- Do not store chemicals, drums, or bagged materials directly on the ground. Place these items in secondary containers if applicable.
- Prevent the run-on of uncontaminated stormwater from adjacent areas as well as runoff of stormwater from the stockpile areas, by placing a curb along the perimeter of the area. The area inside the curb should slope to a drain. Liquids should be drained to the sanitary sewer if allowed. The drain must have a positive control such as a lock, valve, or plug to prevent release of contaminated liquids.
- Tanks should be bermed or surrounded by a secondary containment system.
- Release accumulated stormwater in petroleum storage areas prior to the next storm. At a minimum, water should pass through an oil/water separator and, if allowed, discharged to a sanitary sewer.

Inspection

- Conduct regular inspections of storage areas so that leaks and spills are detected as soon as possible.
- Conduct routine inspections and check for external corrosion of material containers. Also check for structural failure, spills and overfills due to operator error, failure of piping system.
- Check for leaks or spills during pumping of liquids or gases from truck or rail car to a storage facility or vice versa.
- Visually inspect new tank or container installations for loose fittings, poor welding, and improper or poorly fitted gaskets.
- Inspect tank foundations, connections, coatings, and tank walls and piping system. Look for corrosion, leaks, cracks, scratches, and other physical damage that may weaken the tank or container system.

Training

- Employees should be well trained in proper material storage.
- Train employees and contractors in proper techniques for spill containment and cleanup.

Spill Response and Prevention

- Refer to SC-11, Spill Prevention, Control & Cleanup.
- Keep your Spill Prevention Control and countermeasure (SPCC) plan up-to-date, and implement accordingly.
- Have spill cleanup materials readily available and in a known location.
- Cleanup spills immediately and use dry methods if possible.
- Properly dispose of spill cleanup material.
- Have employees trained in spill containment and cleanup present during loading/unloading of dangerous waste, liquid chemicals and other potentially hazardous materials.

Other Considerations

- Storage sheds often must meet building and fire code requirements. Storage of reactive, ignitable, or flammable liquids must comply with the Uniform Fire Code and the National Electric Code.
- Space limitations may preclude storing some materials indoors.
- Some municipalities require that secondary containment areas (regardless of size) be connected to the sanitary sewer, prohibiting any hard connections to the storm drain. Storage sheds often must meet building and fire code requirements.
- The local fire district must be consulted for limitations on clearance of roof covers over containers used to store flammable materials.

SC-33 Outdoor Storage of Raw Materials

Requirements

Costs

- Costs will vary depending on the size of the facility and the necessary controls. They should be low except where large areas may have to be covered.

Maintenance

- Accurate and up-to-date inventories should be kept of all stored materials.
- Berms and curbs may require periodic repair and patching.
- Parking lots or other surfaces near bulk materials storage areas should be swept periodically to remove debris blown or washed from storage area.
- Sweep paved storage areas regularly for collection and disposal of loose solid materials, do not hose down the area to a storm drain or conveyance ditch.
- Keep outdoor storage areas in good condition (e.g. repair roofs, floors, etc. to limit releases to runoff).

Supplemental Information

Further Detail of the BMP

Raw Material Containment

Paved areas should be sloped in a manner that minimize the pooling of water on the site, particularly with materials that may leach pollutants into stormwater and/or groundwater, such as compost, logs, and wood chips. A minimum slope of 1.5 percent is recommended.

- Curbing should be placed along the perimeter of the area to prevent the runon of uncontaminated stormwater from adjacent areas as well as runoff of stormwater from the stockpile areas.
- The storm drainage system should be designed to minimize the use of catch basins in the interior of the area as they tend to rapidly fill with manufacturing material.
- The area should be sloped to drain stormwater to the perimeter where it can be collected or to internal drainage alleyways where material is not stockpiled.
- If the raw material, by-product, or product is a liquid, more information for outside storage of liquids can be found under SC-31, Outdoor Container Storage.

Examples

The “doghouse” design has been used to store small liquid containers. The roof and flooring design prevent contact with direct rain or runoff. The doghouse has two solid structural walls and two canvas covered walls. The flooring is wire mesh about secondary containment. The unit has been used successively at Lockheed Missile and Space Company in Sunnyvale.

References and Resources

King County Stormwater Pollution Control Manual - http://dnr.metrokc.gov/wlr/dss/spcm.htm

Model Urban Runoff Program: A How-To-Guide for Developing Urban Runoff Programs for Small Municipalities. Prepared by City of Monterey, City of Santa Cruz, California Coastal Commission, Monterey Bay National Marine Sanctuary, Association of Monterey Bay Area Governments, Woodward-Clyde, Central Coast Regional Water Quality Control Board. July 1998 (Revised February 2002 by the California Coastal Commission).

Orange County Stormwater Program
http://www.ocwatersheds.com/StormWater/swp_introduction.asp

San Diego Stormwater Co-permittees Jurisdictional Urban Runoff Management Program (URMP)
http://www.projectcleanwater.org/pdf/Model%20Program%20Municipal%20Facilities.pdf

Building & Grounds Maintenance SC-41

Description

Stormwater runoff from building and grounds maintenance activities can be contaminated with toxic hydrocarbons in solvents, fertilizers and pesticides, suspended solids, heavy metals, abnormal pH, and oils and greases. Utilizing the protocols in this fact sheet will prevent or reduce the discharge of pollutants to stormwater from building and grounds maintenance activities by washing and cleaning up with as little water as possible, following good landscape management practices, preventing and cleaning up spills immediately, keeping debris from entering the storm drains, and maintaining the stormwater collection system.

Approach

Reduce potential for pollutant discharge through source control pollution prevention and BMP implementation. Successful implementation depends on effective training of employees on applicable BMPs and general pollution prevention strategies and objectives.

General Pollution Prevention Protocols

- Switch to non-toxic chemicals for maintenance to the maximum extent possible.
- Choose cleaning agents that can be recycled.
- Encourage proper lawn management and landscaping, including use of native vegetation.
- Encourage use of Integrated Pest Management techniques for pest control.
- Encourage proper onsite recycling of yard trimmings.
- Recycle residual paints, solvents, lumber, and other material as much as possible.

Objectives
■ *Cover*
■ *Contain*
■ *Educate*
■ *Reduce/Minimize*
■ *Product Substitution*

Targeted Constituents	
Sediment	✓
Nutrients	✓
Trash	
Metals	✓
Bacteria	✓
Oil and Grease	
Organics	

Minimum BMPs Covered	
Good Housekeeping	✓
Preventative Maintenance	
Spill and Leak Prevention and Response	✓
Material Handling & Waste Management	✓
Erosion and Sediment Controls	
Employee Training Program	✓
Quality Assurance Record Keeping	✓

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- Clean work areas at the end of each work shift using dry cleaning methods such as sweeping and vacuuming.

Good Housekeeping

Pressure Washing of Buildings, Rooftops, and Other Large Objects

- In situations where soaps or detergents are used and the surrounding area is paved, pressure washers must use a water collection device that enables collection of wash water and associated solids. A sump pump, wet vacuum or similarly effective device must be used to collect the runoff and loose materials. The collected runoff and solids must be disposed of properly.

- If soaps or detergents are not used, and the surrounding area is paved, wash runoff does not have to be collected but must be screened. Pressure washers must use filter fabric or some other type of screen on the ground and/or in the catch basin to trap the particles in wash water runoff.

- If you are pressure washing on a grassed area (with or without soap), runoff must be dispersed as sheet flow as much as possible, rather than as a concentrated stream. The wash runoff must remain on the grass and not drain to pavement.

Landscaping Activities

- Dispose of grass clippings, leaves, sticks, or other collected vegetation as garbage, or by composting. Do not dispose of collected vegetation into waterways or storm drainage systems.

- Use mulch or other erosion control measures on exposed soils. See also SC-40, Contaminated and Erodible Areas, for more information.

Building Repair, Remodeling, and Construction

- Do not dump any toxic substance or liquid waste on the pavement, the ground, or toward a storm drain.

- Use ground or drop cloths underneath outdoor painting, scraping, and sandblasting work, and properly dispose of collected material daily.

- Use a ground cloth or oversized tub for activities such as paint mixing and tool cleaning.

- Clean paintbrushes and tools covered with water-based paints in sinks connected to sanitary sewers or in portable containers that can be dumped into a sanitary sewer drain. Brushes and tools covered with non-water-based paints, finishes, or other materials must be cleaned in a manner that enables collection of used solvents (e.g., paint thinner, turpentine, etc.) for recycling or proper disposal.

- Use a storm drain cover, filter fabric, or similarly effective runoff control mechanism if dust, grit, wash water, or other pollutants may escape the work area and enter a catch basin. This is particularly necessary on rainy days. The containment device(s) must be in place at the beginning of the work day, and accumulated dirty runoff and

solids must be collected and disposed of before removing the containment device(s) at the end of the work day.

- If you need to de-water an excavation site, you may need to filter the water before discharging to a catch basin or off-site. If directed off-site, you should direct the water through hay bales and filter fabric or use other sediment filters or traps.
- Store toxic material under cover during precipitation events and when not in use. A cover would include tarps or other temporary cover material.

Mowing, Trimming, and Planting

- Dispose of leaves, sticks, or other collected vegetation as garbage, by composting or at a permitted landfill. Do not dispose of collected vegetation into waterways or storm drainage systems.
- Use mulch or other erosion control measures when soils are exposed.
- Place temporarily stockpiled material away from watercourses and drain inlets, and berm or cover stockpiles to prevent material releases to the storm drain system.
- Consider an alternative approach when bailing out muddy water: do not put it in the storm drain; pour over landscaped areas.
- Use hand weeding where practical.

Fertilizer and Pesticide Management

- Do not use pesticides if rain is expected.
- Do not mix or prepare pesticides for application near storm drains.
- Use the minimum amount needed for the job.
- Calibrate fertilizer distributors to avoid excessive application.
- Employ techniques to minimize off-target application (e.g., spray drift) of pesticides, including consideration of alternative application techniques.
- Apply pesticides only when wind speeds are low.
- Fertilizers should be worked into the soil rather than dumped or broadcast onto the surface.
- Irrigate slowly to prevent runoff and then only as much as is needed.
- Clean pavement and sidewalk if fertilizer is spilled on these surfaces before applying irrigation water.

Inspection

- Inspect irrigation system periodically to ensure that the right amount of water is being applied and that excessive runoff is not occurring. Minimize excess watering and repair leaks in the irrigation system as soon as they are observed.

Building & Grounds Maintenance SC-41

Spill Response and Prevention Procedures

- Keep your Spill Prevention Control and Countermeasure (SPCC) Plan up-to-date.
- Place a stockpile of spill cleanup materials, such as brooms, dustpans, and vacuum sweepers (if desired) near the storage area where it will be readily accessible.
- Have employees trained in spill containment and cleanup present during the loading/unloading of dangerous wastes, liquid chemicals, or other materials.
- Familiarize employees with the Spill Prevention Control and Countermeasure Plan.
- Clean up spills immediately.

Material Handling and Waste Management

- Follow all federal, state, and local laws and regulations governing the use, storage, and disposal of fertilizers and pesticides and training of applicators and pest control advisors.
- Use less toxic pesticides that will do the job when applicable. Avoid use of copper-based pesticides if possible.
- Dispose of empty pesticide containers according to the instructions on the container label.
- Use up the pesticides. Rinse containers, and use rinse water as product. Dispose of unused pesticide as hazardous waste.
- Implement storage requirements for pesticide products with guidance from the local fire department and County Agricultural Commissioner. Provide secondary containment for pesticides.

Employee Training Program

- Educate and train employees on pesticide use and in pesticide application techniques to prevent pollution.
- Train employees and contractors in proper techniques for spill containment and cleanup.
- Be sure the frequency of training takes into account the complexity of the operations and the needs of individual staff.

Quality Assurance and Record Keeping

- Keep accurate logs that document maintenance activities performed and minimum BMP measures implemented.
- Keep accurate logs of spill response actions that document what was spilled, how it was cleaned up, and how the waste was disposed.
- Establish procedures to complete logs and file them in the central office.

Potential Capital Facility Costs and Operation & Maintenance Requirements

Facilities

- Additional capital costs are not anticipated for building and grounds maintenance. Implementation of the minimum BMPs described above should be conducted as part of regular site operations.

Maintenance

- Maintenance activities for the BMPs described above will be minimal, and no additional cost is anticipated.

Supplemental Information

Fire Sprinkler Line Flushing

Site fire sprinkler line flushing may be a source of non-stormwater runoff pollution. The water entering the system is usually potable water, though in some areas it may be non-potable reclaimed wastewater. There are subsequent factors that may drastically reduce the quality of the water in such systems. Black iron pipe is usually used since it is cheaper than potable piping, but it is subject to rusting and results in lower quality water. Initially, the black iron pipe has an oil coating to protect it from rusting between manufacture and installation; this will contaminate the water from the first flush but not from subsequent flushes. Nitrates, poly-phosphates and other corrosion inhibitors, as well as fire suppressants and antifreeze may be added to the sprinkler water system. Water generally remains in the sprinkler system a long time (typically a year) and between flushes may accumulate iron, manganese, lead, copper, nickel, and zinc. The water generally becomes anoxic and contains living and dead bacteria and breakdown products from chlorination. This may result in a significant BOD problem and the water often smells. Consequently dispose fire sprinkler line flush water into the sanitary sewer. Do not allow discharge to storm drain or infiltration due to potential high levels of pollutants in fire sprinkler line water.

References and Resources

City of Seattle, Seattle Public Utilities Department of Planning and Development, 2009. *Stormwater Manual Vol. 1 Source Control Technical Requirements Manual.*

Kennedy/Jenks Consultants, 2007. *The Truckee Meadows Industrial and Commercial Storm Water Best Management Practices Handbook*. Available online at: http://www.cityofsparks.us/sites/default/files/assets/documents/env-control/construction/TM-I-C_BMP_Handbook_2-07-final.pdf.

Orange County Stormwater Program, Best Management Practices for Industrial/Commercial Business Activities. Available online at: http://ocwatersheds.com/documents/bmp/industrialcommercialbusinessesactivities.

Sacramento Stormwater Management Program. *Best Management Practices for Industrial Storm Water Pollution Control*. Available online at:

http://www.msa.saccounty.net/sactostormwater/documents/guides/industrial-BMP-manual.pdf.

US EPA, 1997. *Best Management Practices Handbook for Hazardous Waste Containers*. Available online at: http://www.epa.gov/region6/6en/h/handbk4.pdf.

Ventura Countywide Stormwater Management Program Clean Business Fact Sheets. Available online at: http://www.vcstormwater.org/documents/programs_business/building.pdf.

Parking Area Maintenance SC-43

Description

Parking lots can contribute a number of substances, such as trash, suspended solids, hydrocarbons, oil and grease, and heavy metals that can enter receiving waters through stormwater runoff or non-stormwater discharges. The protocols in this fact sheet are intended to prevent or reduce the discharge of pollutants from parking areas and include using good housekeeping practices, following appropriate cleaning BMPs, and training employees.

BMPs for other outdoor areas on site (loading/unloading, material storage, and equipment operations) are described in SC-30 through SC-33.

Approach

The goal of this program is to ensure stormwater pollution prevention practices are considered when conducting activities on or around parking areas to reduce potential for pollutant discharge to receiving waters. Successful implementation depends on effective training of employees on applicable BMPs and general pollution prevention strategies and objectives.

General Pollution Prevention Protocols

- ☐ Encourage advanced designs and maintenance strategies for impervious parking lots. Refer to the treatment control BMP fact sheets in this manual for additional information.
- ☐ Keep accurate maintenance logs to evaluate BMP implementation.

Good Housekeeping

- ☐ Keep all parking areas clean and orderly. Remove debris, litter, and sediments in a timely fashion.
- ☐ Post "No Littering" signs and enforce anti-litter laws.

Objectives
■ *Cover*
■ *Contain*
■ *Educate*
■ *Reduce/Minimize*
■ *Product Substitution*

Targeted Constituents	
Sediment	✓
Nutrients	
Trash	✓
Metals	✓
Bacteria	
Oil and Grease	✓
Organics	✓

Minimum BMPs Covered	
Good Housekeeping	✓
Preventative Maintenance	✓
Spill and Leak Prevention and Response	✓
Material Handling & Waste Management	
Erosion and Sediment Controls	
Employee Training Program	✓
Quality Assurance Record Keeping	✓

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- ☐ Provide an adequate number of litter receptacles.
- ☐ Clean out and cover litter receptacles frequently to prevent spillage.

Preventative Maintenance

Inspection

Have designated personnel conduct inspections of parking facilities and stormwater conveyance systems associated with parking facilities on a regular basis.

- ☐ Inspect cleaning equipment/sweepers for leaks on a regular basis.

Surface Cleaning

- ☐ Use dry cleaning methods (e.g., sweeping, vacuuming) to prevent the discharge of pollutants into the stormwater conveyance system if possible.
- ☐ Establish frequency of public parking lot sweeping based on usage and field observations of waste accumulation.
- ☐ Sweep all parking lots at least once before the onset of the wet season.
- ☐ Dispose of parking lot sweeping debris and dirt at a landfill.
- ☐ Follow the procedures below if water is used to clean surfaces:
  - ✓ Block the storm drain or contain runoff.
  - ✓ Collect and pump wash water to the sanitary sewer or discharge to a pervious surface. Do not allow wash water to enter storm drains.
- ☐ Follow the procedures below when cleaning heavy oily deposits:
  - ✓ Clean oily spots with absorbent materials.
  - ✓ Use a screen or filter fabric over inlet, then wash surfaces.
  - ✓ Do not allow discharges to the storm drain.
  - ✓ Vacuum/pump discharges to a tank or discharge to sanitary sewer.
  - ✓ Dispose of spilled materials and absorbents appropriately.

Surface Repair

- ☐ Check local ordinance for SUSMP/LID ordinance.
- ☐ Preheat, transfer or load hot bituminous material away from storm drain inlets.
- ☐ Apply concrete, asphalt, and seal coat during dry weather to prevent contamination from contacting stormwater runoff.
- ☐ Cover and seal nearby storm drain inlets where applicable (with waterproof material or mesh) and manholes before applying seal coat, slurry seal, etc. Leave covers in

place until job is complete and all water from emulsified oil sealants has drained or evaporated. Clean any debris from these covered manholes and drains for proper disposal.

- Use only as much water as necessary for dust control during sweeping to avoid runoff.
- Catch drips from paving equipment that is not in use with pans or absorbent material placed under the machines. Dispose of collected material and absorbents properly.

Spill Response and Prevention Procedures

- Keep your Spill Prevention Control and Countermeasure (SPCC) Plan up-to-date.
- Place a stockpile of spill cleanup materials where it will be readily accessible or at a central location.
- Clean up fluid spills immediately with absorbent rags or material.
- Dispose of spilled material and absorbents properly.

Employee Training Program

- Provide regular training to field employees and/or contractors regarding cleaning of paved areas and proper operation of equipment.
- Train employees and contractors in proper techniques for spill containment and cleanup.
- Use a training log or similar method to document training.

Quality Assurance and Record Keeping

- Keep accurate maintenance logs that document minimum BMP activities performed for parking area maintenance, types and quantities of waste disposed of, and any improvement actions.
- Keep accurate logs of spill response actions that document what was spilled, how it was cleaned up, and how the waste was disposed.
- Establish procedures to complete logs and file them in the central office.

Potential Capital Facility Costs and Operation & Maintenance Requirements

Facilities

- Capital investments may be required at some sites to purchase sweeping equipment, train sweeper operators, install oil/water/sand separators, or implement advanced BMPs. These costs can vary significantly depending upon site conditions and the amount of BMPs required.

Maintenance

- Sweep and clean parking lots regularly to minimize pollutant transport into storm drains from stormwater runoff.
- Clean out oil/water/sand separators regularly, especially after heavy storms.
- Maintain advanced BMPs such as vegetated swales, infiltration trenches, or detention basins as appropriate. Refer to the treatment control fact sheets for more information.

Supplemental Information

Advanced BMPs

Some parking areas may require advanced BMPs to further reduce pollutants in stormwater runoff, and a few examples are listed below. Refer to the Treatment Control Fact Sheets and the New Development and Redevelopment Manual for more information.

- When possible, direct sheet runoff to flow into biofilters (vegetated strip and swale) and/or infiltration devices.
- Utilize sand filters or oleophilic collectors for oily waste in low quantities.
- Arrange rooftop drains to prevent drainage directly onto paved surfaces.
- Design lot to include semi-permeable hardscape.

References and Resources

City of Seattle, Seattle Public Utilities Department of Planning and Development, 2009. *Stormwater Manual Vol. 1 Source Control Technical Requirements Manual.*

California Stormwater Quality Association, 2003. *New Development and Redevelopment Stormwater Best Management Practice Handbook*. Available online at: https://www.casqa.org/resources/bmp-handbooks/new-development-redevelopment-bmp-handbook.

Kennedy/Jenks Consultants, 2007. *The Truckee Meadows Industrial and Commercial Storm Water Best Management Practices Handbook*. Available online at: http://www.cityofsparks.us/sites/default/files/assets/documents/env-control/construction/TM-I-C_BMP_Handbook_2-07-final.pdf.

Orange County Stormwater Program, Best Management Practices for Industrial/Commercial Business Activities. Available online at: http://ocwatersheds.com/documents/bmp/industrialcommercialbusinessesactivities.

Pollution from Surface Cleaning Folder, 1996, 2003. Bay Area Stormwater Management Agencies Association. Available online at: http://basmaa.org/Portals/0/documents/pdf/Pollution%20from%20Surface%20Cleaning.pdf.

Sacramento Stormwater Management Program. *Best Management Practices for Industrial Storm Water Pollution Control*. Available online at: http://www.msa.saccounty.net/sactostormwater/documents/guides/industrial-BMP-manual.pdf.

The Storm Water Managers Resource Center, http://www.stormwatercenter.net.

US EPA. *Post-Construction Stormwater Management in New Development and Redevelopment*. BMP Fact Sheets. Available online at: http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=min_measure&min_measure_id=5.

Fountain & Pool Maintenance SC-72

Description

The primary pollutant of concern in municipal swimming pool water is chlorine or chloramine used as a disinfectant. This water, if discharged to the storm drain system, can be toxic to aquatic life. In lakes, lagoons, and fountains, the pollutants of concern are chemical algaecides that are added to control algae mainly for aesthetic reasons (visual and odor). Following the procedures noted in this fact sheet will reduce the pollutants in this discharge.

Approach

Pollution Prevention

- Prevent algae problems with regular cleaning, consistent adequate chlorine levels, and well-maintained water filtration and circulation systems.
- Manage pH and water hardness to minimize corrosion of copper pipes.

Suggested Protocols

Pools and Fountains

- Do not use copper-based algaecides. Control algae with chlorine or other alternatives, such as sodium bromide.
- Do not discharge water to a street or storm drain when draining pools or fountains; discharge to the sanitary sewer if permitted to do so. If water is dechlorinated with a neutralizing chemical or by allowing chlorine to dissipate for a few days (do not use the facility during this time), the water may be recycled/reused by draining it gradually onto a landscaped area. Water must be tested prior to discharge to ensure that chlorine is not present.
- Prevent backflow if draining a pool to the sanitary sewer by maintaining an "air gap" between the discharge line and the sewer line (do not seal the connection between the hose and sewer line). Be sure to call the local wastewater treatment plant for further guidance on flow rate restrictions, backflow prevention, and handling special cleaning waste (such as acid wash). Discharge flows should be kept to the low levels typically possible through a garden hose. Higher flow rates may be prohibited by local ordinance.
- Provide drip pans or buckets beneath drain pipe connections to catch leaks. This will be especially pertinent if pool or spa water that has not been dechlorinated is pumped through piping to a discharge location.

Objectives

- Contain
- Educate
- Reduce/Minimize
- Product Substitution

Targeted Constituents

Sediment	☑
Nutrients	☑
Trash	☑
Metals	
Bacteria	☑
Oil and Grease	
Organics	☑
Oxygen Demanding	☑

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- Never clean a filter in the street or near a storm drain.
- Rinse cartridge filters onto a dirt area, and spade filter residue into soil.
- Backwash diatomaceous earth filters onto dirt. Dispose of spent diatomaceous earth in the garbage. Spent diatomaceous earth cannot be discharged to surface waters, storm drainage systems, septic systems, or on the ground.
- If there is not a suitable dirt area discharge filter backwash or rinsewater to the sanitary sewer if permitted to do so by the local sewering agency.

Lakes and Lagoons

- Reduce fertilizer use in areas around the water body. High nitrogen fertilizers can produce excess growth requiring more frequent mowing or trimming, and may contribute to excessive algae growth.
- To control bacteria, discourage the public from feeding birds and fish (i.e. place signs that prohibit feeding of waterfowl).
- Consider introducing fish species that consume algae. Contact the California Department of Fish and Game for more information on this issue.
- Mechanically remove pond scum (blue-green algae) using a 60 micron net.
- Educate the public on algae and that no controls are necessary for certain types of algae that are beneficial to the water body.
- Control erosion by doing the following:
  - Maintain vegetative cover on banks to prevent soil erosion. Apply mulch or leave clippings to serve as additional cover for soil stabilization and to reduce the velocity of stormwater runoff.
  - Areas should be designed (sloped) to prevent runoff and erosion and to promote better irrigation practices.
  - Provide energy dissipaters (e.g. riprap) along banks to minimize potential for erosion.
  - Confine excavated materials to surfaces away from lakes. Material must be covered if rain is expected.
- Conduct inspections to detect illegal dumping of clippings/cuttings in or near a lake. Materials found should be picked up and properly disposed of.
- Avoid landscape wastes in and around lakes should be avoided by either using bagging equipment or by manually picking up the material. Collect trash and debris from within water bodies where feasible
- Provide and maintain trash receptacles near recreational water bodies to hold refuse generated by the public.

- Increase trash collection during peak visitation months (generally June, July and August).

Training

- Train maintenance personnel to test chlorine levels and to apply neutralizing chemicals.
- Train personnel regarding proper maintenance of pools, ponds and lakes.

Spill Response and Prevention

- Refer to SC-11, Spill Prevention, Control & Cleanup
- Have spill cleanup materials readily available and in a known location.
- Cleanup spills immediately and use dry methods if possible.
- Properly dispose of spill cleanup material.

Other Considerations

- Managers of pools located in sensitive areas or adjacent to shorelines should check with the appropriate authorities to determine if code requirements apply.
- Cleanup activities at lakes and lagoons may create a slight disturbance for local aquatic species. If the lake is recognized as a wetland, many activities, including maintenance, may be subject to regulation and permitting.

Requirements

Costs

- The maintenance of pools and lakes is already a consideration of most municipal public works departments. Therefore the cost associated with this BMP is minimal and only reflects an increase in employee training and public outreach.

Maintenance

Not applicable

Supplemental Information

Further Detail of the BMP

When dredging is conducted, adhere to the following:

- Dredge with shovels when laying/maintaining pipes.
- To determine amount to dredge, determine rate of volume loss due to sediments.
- For large lakes, dredge every 10 years.
- When dredging small lakes, drain lake.
- When dredging large lakes, use vacuum equipment.
- After dredging test sediment piles for proper disposal. Dredged sediment can be used as fill, or may have to be land filled.

References and Resources

King County Stormwater Pollution Control Manual. Best Management Practices for Businesses. 1995. King County Surface Water Management. July. On-line: http://dnr.metrokc.gov/wlr/dss/spcm.htm

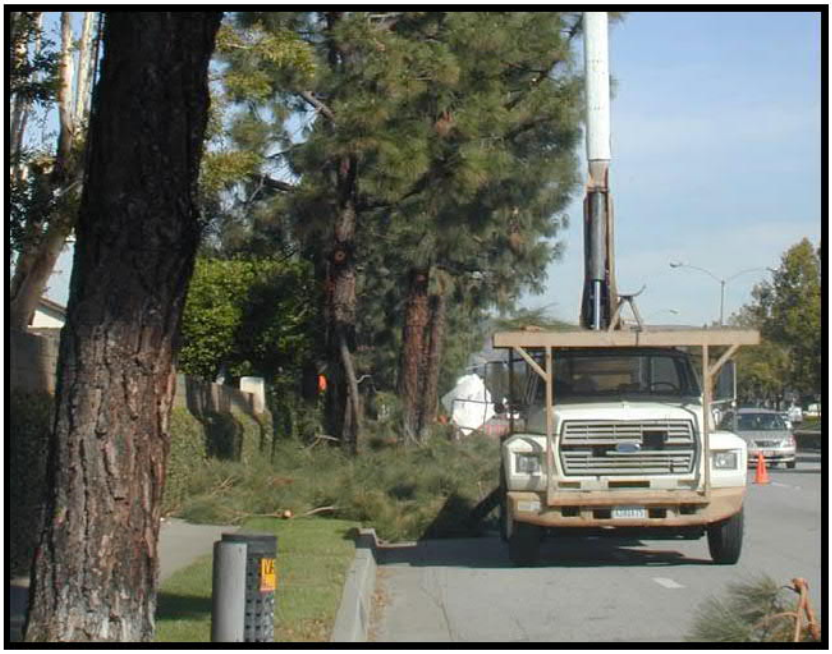
Los Angeles County Stormwater Quality. Public Agency Activities Model Program. On-line: http://ladpw.org/wmd/npdes/public_TC.cfm

Model Urban Runoff Program: A How-To Guide for Developing Urban Runoff Programs for Small Municipalities. Prepared by City of Monterey, City of Santa Cruz, California Coastal Commission, Monterey Bay National Marine Sanctuary, Association of Monterey Bay Area Governments, Woodward-Clyde, Central Coast Regional Water Quality Control Board. July. 1998.

Orange County Stormwater Program
http://www.ocwatersheds.com/StormWater/swp_introduction.asp

Santa Clara Valley Urban Runoff Pollution Prevention Program. Maintenance Best Management Practices for the Construction Industry. Brochures: Landscaping, Gardening, and Pool; Roadwork and Paving; and Fresh Concrete and Mortar Application. June 2001.

Landscape Maintenance SC-73



Objectives

- Contain
- Educate
- Reduce/Minimize
- Product Substitution

Targeted Constituents

Sediment	☑
Nutrients	☑
Trash	☑
Metals	
Bacteria	
Oil and Grease	
Organics	
Oxygen Demanding	☑

Description

Landscape maintenance activities include vegetation removal; herbicide and insecticide application; fertilizer application; watering; and other gardening and lawn care practices. Vegetation control typically involves a combination of chemical (herbicide) application and mechanical methods. All of these maintenance practices have the potential to contribute pollutants to the storm drain system. The major objectives of this BMP are to minimize the discharge of pesticides, herbicides and fertilizers to the storm drain system and receiving waters; prevent the disposal of landscape waste into the storm drain system by collecting and properly disposing of clippings and cuttings, and educating employees and the public.

Approach

Pollution Prevention

- Implement an integrated pest management (IPM) program. IPM is a sustainable approach to managing pests by combining biological, cultural, physical, and chemical tools.
- Choose low water using flowers, trees, shrubs, and groundcover.
- Consider alternative landscaping techniques such as naturescaping and xeriscaping.
- Conduct appropriate maintenance (i.e. properly timed fertilizing, weeding, pest control, and pruning) to help preserve the landscapes water efficiency.

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- Consider grass cycling (grass cycling is the natural recycling of grass by leaving the clippings on the lawn when mowing. Grass clippings decompose quickly and release valuable nutrients back into the lawn).

Suggested Protocols

Mowing, Trimming, and Weeding

- Whenever possible use mechanical methods of vegetation removal (e.g mowing with tractor-type or push mowers, hand cutting with gas or electric powered weed trimmers) rather than applying herbicides. Use hand weeding where practical.
- Avoid loosening the soil when conducting mechanical or manual weed control, this could lead to erosion. Use mulch or other erosion control measures when soils are exposed.
- Performing mowing at optimal times. Mowing should not be performed if significant rain events are predicted.
- Mulching mowers may be recommended for certain flat areas. Other techniques may be employed to minimize mowing such as selective vegetative planting using low maintenance grasses and shrubs.
- Collect lawn and garden clippings, pruning waste, tree trimmings, and weeds. Chip if necessary, and compost or dispose of at a landfill (see waste management section of this fact sheet).
- Place temporarily stockpiled material away from watercourses, and berm or cover stockpiles to prevent material releases to storm drains.

Planting

- Determine existing native vegetation features (location, species, size, function, importance) and consider the feasibility of protecting them. Consider elements such as their effect on drainage and erosion, hardiness, maintenance requirements, and possible conflicts between preserving vegetation and the resulting maintenance needs.
- Retain and/or plant selected native vegetation whose features are determined to be beneficial, where feasible. Native vegetation usually requires less maintenance (e.g., irrigation, fertilizer) than planting new vegetation.
- Consider using low water use groundcovers when planting or replanting.

Waste Management

- Compost leaves, sticks, or other collected vegetation or dispose of at a permitted landfill. Do not dispose of collected vegetation into waterways or storm drainage systems.
- Place temporarily stockpiled material away from watercourses and storm drain inlets, and berm or cover stockpiles to prevent material releases to the storm drain system.
- Reduce the use of high nitrogen fertilizers that produce excess growth requiring more frequent mowing or trimming.

- Avoid landscape wastes in and around storm drain inlets by either using bagging equipment or by manually picking up the material.

Irrigation

- Where practical, use automatic timers to minimize runoff.
- Use popup sprinkler heads in areas with a lot of activity or where there is a chance the pipes may be broken. Consider the use of mechanisms that reduce water flow to sprinkler heads if broken.
- Ensure that there is no runoff from the landscaped area(s) if re-claimed water is used for irrigation.
- If bailing of muddy water is required (e.g. when repairing a water line leak), do not put it in the storm drain; pour over landscaped areas.
- Irrigate slowly or pulse irrigate to prevent runoff and then only irrigate as much as is needed.
- Apply water at rates that do not exceed the infiltration rate of the soil.

Fertilizer and Pesticide Management

- Utilize a comprehensive management system that incorporates integrated pest management (IPM) techniques. There are many methods and types of IPM, including the following:
  - Mulching can be used to prevent weeds where turf is absent, fencing installed to keep rodents out, and netting used to keep birds and insects away from leaves and fruit.
  - Visible insects can be removed by hand (with gloves or tweezers) and placed in soapy water or vegetable oil. Alternatively, insects can be sprayed off the plant with water or in some cases vacuumed off of larger plants.
  - Store-bought traps, such as species-specific, pheromone-based traps or colored sticky cards, can be used.
  - Slugs can be trapped in small cups filled with beer that are set in the ground so the slugs can get in easily.
  - In cases where microscopic parasites, such as bacteria and fungi, are causing damage to plants, the affected plant material can be removed and disposed of (pruning equipment should be disinfected with bleach to prevent spreading the disease organism).
  - Small mammals and birds can be excluded using fences, netting, tree trunk guards.
  - Beneficial organisms, such as bats, birds, green lacewings, ladybugs, praying mantis, ground beetles, parasitic nematodes, trichogramma wasps, seed head weevils, and spiders that prey on detrimental pest species can be promoted.
- Follow all federal, state, and local laws and regulations governing the use, storage, and disposal of fertilizers and pesticides and training of applicators and pest control advisors.

- Use pesticides only if there is an actual pest problem (not on a regular preventative schedule).
- Do not use pesticides if rain is expected. Apply pesticides only when wind speeds are low (less than 5 mph).
- Do not mix or prepare pesticides for application near storm drains.
- Prepare the minimum amount of pesticide needed for the job and use the lowest rate that will effectively control the pest.
- Employ techniques to minimize off-target application (e.g. spray drift) of pesticides, including consideration of alternative application techniques.
- Fertilizers should be worked into the soil rather than dumped or broadcast onto the surface.
- Calibrate fertilizer and pesticide application equipment to avoid excessive application.
- Periodically test soils for determining proper fertilizer use.
- Sweep pavement and sidewalk if fertilizer is spilled on these surfaces before applying irrigation water.
- Purchase only the amount of pesticide that you can reasonably use in a given time period (month or year depending on the product).
- Triple rinse containers, and use rinse water as product. Dispose of unused pesticide as hazardous waste.
- Dispose of empty pesticide containers according to the instructions on the container label.

Inspection

- Inspect irrigation system periodically to ensure that the right amount of water is being applied and that excessive runoff is not occurring. Minimize excess watering, and repair leaks in the irrigation system as soon as they are observed.
- Inspect pesticide/fertilizer equipment and transportation vehicles daily.

Training

- Educate and train employees on use of pesticides and in pesticide application techniques to prevent pollution. Pesticide application must be under the supervision of a California qualified pesticide applicator.
- Train/encourage municipal maintenance crews to use IPM techniques for managing public green areas.
- Annually train employees within departments responsible for pesticide application on the appropriate portions of the agency's IPM Policy, SOPs, and BMPs, and the latest IPM techniques.

- Employees who are not authorized and trained to apply pesticides should be periodically (at least annually) informed that they cannot use over-the-counter pesticides in or around the workplace.
- Use a training log or similar method to document training.

Spill Response and Prevention

- Refer to SC-11, Spill Prevention, Control & Cleanup
- Have spill cleanup materials readily available and in a know in location
- Cleanup spills immediately and use dry methods if possible.
- Properly dispose of spill cleanup material.

Other Considerations

- The Federal Pesticide, Fungicide, and Rodenticide Act and California Title 3, Division 6, Pesticides and Pest Control Operations place strict controls over pesticide application and handling and specify training, annual refresher, and testing requirements. The regulations generally cover: a list of approved pesticides and selected uses, updated regularly; general application information; equipment use and maintenance procedures; and record keeping. The California Department of Pesticide Regulations and the County Agricultural Commission coordinate and maintain the licensing and certification programs. All public agency employees who apply pesticides and herbicides in "agricultural use" areas such as parks, golf courses, rights-of-way and recreation areas should be properly certified in accordance with state regulations. Contracts for landscape maintenance should include similar requirements.
- All employees who handle pesticides should be familiar with the most recent material safety data sheet (MSDS) files.
- Municipalities do not have the authority to regulate the use of pesticides by school districts, however the California Healthy Schools Act of 2000 (AB 2260) has imposed requirements on California school districts regarding pesticide use in schools. Posting of notification prior to the application of pesticides is now required, and IPM is stated as the preferred approach to pest management in schools.

Requirements

Costs

Additional training of municipal employees will be required to address IPM techniques and BMPs. IPM methods will likely increase labor cost for pest control which may be offset by lower chemical costs.

Maintenance

Not applicable

Supplemental Information

Further Detail of the BMP

Waste Management

Composting is one of the better disposal alternatives if locally available. Most municipalities either have or are planning yard waste composting facilities as a means of reducing the amount of waste going to the landfill. Lawn clippings from municipal maintenance programs as well as private sources would probably be compatible with most composting facilities

Contractors and Other Pesticide Users

Municipal agencies should develop and implement a process to ensure that any contractor employed to conduct pest control and pesticide application on municipal property engages in pest control methods consistent with the IPM Policy adopted by the agency. Specifically, municipalities should require contractors to follow the agency's IPM policy, SOPs, and BMPs; provide evidence to the agency of having received training on current IPM techniques when feasible; provide documentation of pesticide use on agency property to the agency in a timely manner.

References and Resources

King County Stormwater Pollution Control Manual. Best Management Practices for Businesses. 1995. King County Surface Water Management. July. On-line: http://dnr.metrokc.gov/wlr/dss/spcm.htm

Los Angeles County Stormwater Quality Model Programs. Public Agency Activities http://ladpw.org/wmd/npdes/model_links.cfm

Model Urban Runoff Program: A How-To Guide for Developing Urban Runoff Programs for Small Municipalities. Prepared by City of Monterey, City of Santa Cruz, California Coastal Commission, Monterey Bay National Marine Sanctuary, Association of Monterey Bay Area Governments, Woodward-Clyde, Central Coast Regional Water Quality Control Board. July. 1998.

Orange County Stormwater Program http://www.ocwatersheds.com/StormWater/swp_introduction.asp

Santa Clara Valley Urban Runoff Pollution Prevention Program. 1997 Urban Runoff Management Plan. September 1997, updated October 2000.

United States Environmental Protection Agency (USEPA). 2002. Pollution Prevention/Good Housekeeping for Municipal Operations Landscaping and Lawn Care. Office of Water. Office of Wastewater Management. On-line: http://www.epa.gov/npdes/menuofbmps/poll_8.htm

Fueling Areas SD-30

Photo Credit: Geoff Brosseau

Design Objectives

- Maximize Infiltration
- Provide Retention
- Slow Runoff
- Minimize Impervious Land Coverage
- Prohibit Dumping of Improper Materials
- ☑ Contain Pollutants
- ☑ Collect and Convey

Description

Fueling areas have the potential to contribute oil and grease, solvents, car battery acid, coolant and gasoline to the stormwater conveyance system. Spills at vehicle and equipment fueling areas can be a significant source of pollution because fuels contain toxic materials and heavy metals that are not easily removed by stormwater treatment devices.

Approach

Project plans must be developed for cleaning near fuel dispensers, emergency spill cleanup, containment, and leak prevention.

Suitable Applications

Appropriate applications include commercial, industrial, and any other areas planned to have fuel dispensing equipment, including retail gasoline outlets, automotive repair shops, and major non-retail dispensing areas.

Design Considerations

Design requirements for fueling areas are governed by Building and Fire Codes and by current local agency ordinances and zoning requirements. Design requirements described in this fact sheet are meant to enhance and be consistent with these code and ordinance requirements.

Designing New Installations

Covering

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Fuel dispensing areas should provide an overhanging roof structure or canopy. The cover's minimum dimensions must be equal to or greater than the area within the grade break. The cover must not drain onto the fuel dispensing area and the downspouts must be routed to prevent drainage across the fueling area. The fueling area should drain to the project's treatment control BMP(s) prior to discharging to the stormwater conveyance system. Note - If fueling large equipment or vehicles that would prohibit the use of covers or roofs, the fueling island should be designed to sufficiently accommodate the larger vehicles and equipment and to prevent stormwater run-on and runoff. Grade to direct stormwater to a dead-end sump.

Surfacing

Fuel dispensing areas should be paved with Portland cement concrete (or equivalent smooth impervious surface). The use of asphalt concrete should be prohibited. Use asphalt sealant to protect asphalt paved areas surrounding the fueling area. This provision may be made to sites that have pre-existing asphalt surfaces.

The concrete fuel dispensing area should be extended a minimum of 6.5 ft from the corner of each fuel dispenser, or the length at which the hose and nozzle assembly may be operated plus 1 ft, whichever is less.

Grading/Contouring

Dispensing areas should have an appropriate slope to prevent ponding, and be separated from the rest of the site by a grade break that prevents run-on of urban runoff. (Slope is required to be 2 to 4% in some jurisdictions' stormwater management and mitigation plans.)

Fueling areas should be graded to drain toward a dead-end sump. Runoff from downspouts/roofs should be directed away from fueling areas. Do not locate storm drains in the immediate vicinity of the fueling area.

Redeveloping Existing Installations

Various jurisdictional stormwater management and mitigation plans (SUSMP, WQMP, etc.) define "redevelopment" in terms of amounts of additional impervious area, increases in gross floor area and/or exterior construction, and land disturbing activities with structural or impervious surfaces. The definition of " redevelopment" must be consulted to determine whether or not the requirements for new development apply to areas intended for redevelopment. If the definition applies, the steps outlined under "designing new installations" above should be followed.

Additional Information

- In the case of an emergency, provide storm drain seals, such as isolation valves, drain plugs, or drain covers, to prevent spills or contaminated stormwater from entering the stormwater conveyance system.

Other Resources

A Manual for the Standard Urban Stormwater Mitigation Plan (SUSMP), Los Angeles County Department of Public Works, May 2002.

Model Standard Urban Storm Water Mitigation Plan (SUSMP) for San Diego County, Port of San Diego, and Cities in San Diego County, February 14, 2002.

Model Water Quality Management Plan (WQMP) for County of Orange, Orange County Flood Control District, and the Incorporated Cities of Orange County, Draft February 2003.

Ventura Countywide Technical Guidance Manual for Stormwater Quality Control Measures, July 2002.

Maintenance Bays & Docks SD-31

Design Objectives

- Maximize Infiltration
- Provide Retention
- Slow Runoff
- Minimize Impervious Land Coverage
- ☑ Prohibit Dumping of Improper Materials
- ☑ Contain Pollutants
- Collect and Convey

Description

Several measures can be taken to prevent operations at maintenance bays and loading docks from contributing a variety of toxic compounds, oil and grease, heavy metals, nutrients, suspended solids, and other pollutants to the stormwater conveyance system.

Approach

In designs for maintenance bays and loading docks, containment is encouraged. Preventative measures include overflow containment structures and dead-end sumps. However, in the case of loading docks from grocery stores and warehouse/distribution centers, engineered infiltration systems may be considered.

Suitable Applications

Appropriate applications include commercial and industrial areas planned for development or redevelopment.

Design Considerations

Design requirements for vehicle maintenance and repair are governed by Building and Fire Codes, and by current local agency ordinances, and zoning requirements. The design criteria described in this fact sheet are meant to enhance and be consistent with these code requirements.

Designing New Installations

Designs of maintenance bays should consider the following:

- Repair/maintenance bays and vehicle parts with fluids should be indoors; or designed to preclude urban run-on and runoff.
- Repair/maintenance floor areas should be paved with Portland cement concrete (or equivalent smooth impervious surface).

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- Repair/maintenance bays should be designed to capture all wash water leaks and spills. Provide impermeable berms, drop inlets, trench catch basins, or overflow containment structures around repair bays to prevent spilled materials and wash-down waters form entering the storm drain system. Connect drains to a sump for collection and disposal. Direct connection of the repair/maintenance bays to the storm drain system is prohibited. If required by local jurisdiction, obtain an Industrial Waste Discharge Permit.
- Other features may be comparable and equally effective.

The following designs of loading/unloading dock areas should be considered:

- Loading dock areas should be covered, or drainage should be designed to preclude urban run-on and runoff.
- Direct connections into storm drains from depressed loading docks (truck wells) are prohibited.
- Below-grade loading docks from grocery stores and warehouse/distribution centers of fresh food items should drain through water quality inlets, or to an engineered infiltration system, or an equally effective alternative. Pre-treatment may also be required.
- Other features may be comparable and equally effective.

Redeveloping Existing Installations

Various jurisdictional stormwater management and mitigation plans (SUSMP, WQMP, etc.) define "redevelopment" in terms of amounts of additional impervious area, increases in gross floor area and/or exterior construction, and land disturbing activities with structural or impervious surfaces. The definition of " redevelopment" must be consulted to determine whether or not the requirements for new development apply to areas intended for redevelopment. If the definition applies, the steps outlined under "designing new installations" above should be followed.

Additional Information

Stormwater and non-stormwater will accumulate in containment areas and sumps with impervious surfaces. Contaminated accumulated water must be disposed of in accordance with applicable laws and cannot be discharged directly to the storm drain or sanitary sewer system without the appropriate permit.

Other Resources

A Manual for the Standard Urban Stormwater Mitigation Plan (SUSMP), Los Angeles County Department of Public Works, May 2002.

Model Standard Urban Storm Water Mitigation Plan (SUSMP) for San Diego County, Port of San Diego, and Cities in San Diego County, February 14, 2002.

Model Water Quality Management Plan (WQMP) for County of Orange, Orange County Flood Control District, and the Incorporated Cities of Orange County, Draft February 2003.

Ventura Countywide Technical Guidance Manual for Stormwater Quality Control Measures, July 2002.

Trash Storage Areas SD-32

Description

Trash storage areas are areas where a trash receptacle (s) are located for use as a repository for solid wastes. Stormwater 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 into nearby storm drain inlets, channels, and/or creeks. Waste handling operations that may be sources of stormwater pollution include dumpsters, litter control, and waste piles.

Design Objectives

- Maximize Infiltration
- Provide Retention
- Slow Runoff
- Minimize Impervious Land Coverage
- Prohibit Dumping of Improper Materials
- ☑ Contain Pollutants
- Collect and Convey

Approach

This fact sheet contains details on the specific measures required to prevent or reduce pollutants in stormwater runoff associated with trash storage and handling. Preventative measures including enclosures, containment structures, and impervious pavements to mitigate spills, should be used to reduce the likelihood of contamination.

Suitable Applications

Appropriate applications include residential, commercial and industrial areas planned for development or redevelopment. (Detached residential single-family homes are typically excluded from this requirement.)

Design Considerations

Design requirements for waste handling areas are governed by Building and Fire Codes, and by current local agency ordinances and zoning requirements. The design criteria described in this fact sheet are meant to enhance and be consistent with these code and ordinance requirements. Hazardous waste should be handled in accordance with legal requirements established in Title 22, California Code of Regulation.

Wastes from commercial and industrial sites are typically hauled by either public or commercial carriers that may have design or access requirements for waste storage areas. The design criteria in this fact sheet are recommendations and are not intended to be in conflict with requirements established by the waste hauler. The waste hauler should be contacted prior to the design of your site trash collection areas. Conflicts or issues should be discussed with the local agency.

Designing New Installations

Trash storage areas should be designed to consider the following structural or treatment control BMPs:

- Design trash container areas so that drainage from adjoining roofs and pavement is diverted around the area(s) to avoid run-on. This might include berming or grading the waste handling area to prevent run-on of stormwater.
- Make sure trash container areas are screened or walled to prevent off-site transport of trash.

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- Use lined bins or dumpsters to reduce leaking of liquid waste.
- Provide roofs, awnings, or attached lids on all trash containers to minimize direct precipitation and prevent rainfall from entering containers.
- Pave trash storage areas with an impervious surface to mitigate spills.
- Do not locate storm drains in immediate vicinity of the trash storage area.
- Post signs on all dumpsters informing users that hazardous materials are not to be disposed of therein.

Redeveloping Existing Installations

Various jurisdictional stormwater management and mitigation plans (SUSMP, WQMP, etc.) define "redevelopment" in terms of amounts of additional impervious area, increases in gross floor area and/or exterior construction, and land disturbing activities with structural or impervious surfaces. The definition of " redevelopment" must be consulted to determine whether or not the requirements for new development apply to areas intended for redevelopment. If the definition applies, the steps outlined under "designing new installations" above should be followed.

Additional Information

Maintenance Considerations

The integrity of structural elements that are subject to damage (i.e., screens, covers, and signs) must be maintained by the owner/operator. Maintenance agreements between the local agency and the owner/operator may be required. Some agencies will require maintenance deed restrictions to be recorded of the property title. If required by the local agency, maintenance agreements or deed restrictions must be executed by the owner/operator before improvement plans are approved.

Other Resources

A Manual for the Standard Urban Stormwater Mitigation Plan (SUSMP), Los Angeles County Department of Public Works, May 2002.

Model Standard Urban Storm Water Mitigation Plan (SUSMP) for San Diego County, Port of San Diego, and Cities in San Diego County, February 14, 2002.

Model Water Quality Management Plan (WQMP) for County of Orange, Orange County Flood Control District, and the Incorporated Cities of Orange County, Draft February 2003.

Ventura Countywide Technical Guidance Manual for Stormwater Quality Control Measures, July 2002.

Outdoor Processing Areas SD-36

Description

Outdoor process equipment operations such as rock grinding or crushing, painting or coating, grinding or sanding, degreasing or parts cleaning, landfills, waste piles, wastewater and solid waste treatment and disposal, and others operations may contribute a variety of toxic compounds, oil and grease, heavy metals, nutrients, suspended solids, and other pollutants to the storm conveyance system.

Approach

Outdoor processing areas require a drainage approach different from the typical infiltration/detention strategy. In outdoor process equipment areas, infiltration is discouraged. Containment is encouraged, accompanied by collection and conveyance. Preventative measures include enclosures, secondary containment structures, dead-end sumps, and conveyance to treatment facilities in accordance with conditions established by the applicable sewer agency.

Design Objectives

- Maximize Infiltration
- Provide Retention
- Slow Runoff
- Minimize Impervious Land Coverage
- Prohibit Dumping of Improper Materials
- ☑ Contain Pollutants
- ☑ Collect and Convey

Suitable Applications

Appropriate applications include commercial and industrial areas planned for development or redevelopment.

Design Considerations

Design requirements for outdoor processing areas are governed by Building and Fire codes, and by current local agency ordinances, and zoning requirements.

Designing New Installations

Operations determined to be a potential threat to water quality should consider to the following recommendations:

- Cover or enclose areas that would be the most significant source of pollutants; or slope the area toward a dead-end sump; or, discharge to the sanitary sewer system following appropriate treatment in accordance with conditions established by the applicable sewer agency.
- Grade or berm area to prevent run-on from surrounding areas.
- Do not install storm drains in areas of equipment repair.
- Consider other features that are comparable or equally effective.
- Provide secondary containment structures (not double wall containers) where wet material processing occurs (e.g., electroplating), to hold spills resulting from accidents, leaking tanks, or equipment, or any other unplanned releases (Note:

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if these are plumbed to the sanitary sewer, they must be with the prior approval of the sewering agency.)

Redeveloping Existing Installations

Various jurisdictional stormwater management and mitigation plans (SUSMP, WQMP, etc.) define "redevelopment" in terms of amounts of additional impervious area, increases in gross floor area and/or exterior construction, and land disturbing activities with structural or impervious surfaces. The definition of " redevelopment" must be consulted to determine whether or not the requirements for new development apply to areas intended for redevelopment. If the definition applies, the steps outlined under "designing new installations" above should be followed.

Additional Information

Stormwater and non-stormwater will accumulate in containment areas and sumps with impervious surfaces. Contaminated accumulated water must be disposed of in accordance with applicable laws and cannot be discharged directly to the storm drain or sanitary sewer system without the appropriate permit.

Other Resources

A Manual for the Standard Urban Stormwater Mitigation Plan (SUSMP), Los Angeles County Department of Public Works, May 2002.

Model Standard Urban Storm Water Mitigation Plan (SUSMP) for San Diego County, Port of San Diego, and Cities in San Diego County, February 14, 2002.

Model Water Quality Management Plan (WQMP) for County of Orange, Orange County Flood Control District, and the Incorporated Cities of Orange County, Draft February 2003.

Ventura Countywide Technical Guidance Manual for Stormwater Quality Control Measures, July 2002.

APPENDIX

G SITE DESIGN FACT SHEETS

E.12 HU-1 Cistern

Photo Credit: Water Environment Research Foundation: WERF.org

MS4 Permit Category

Retention

Manual Category

Harvest and Use

Applicable Performance Standards

Pollutant Control
Flow Control

Primary Benefits

Volume Reduction
Peak Flow Attenuation

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

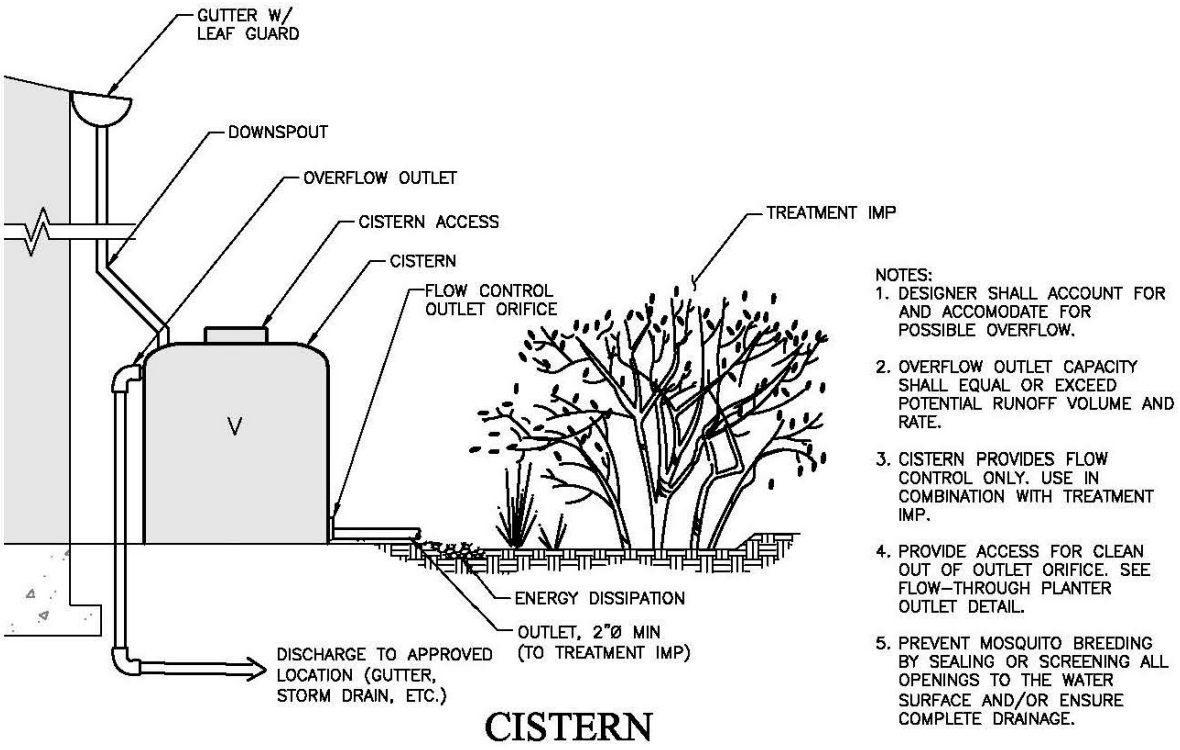


Figure E.12-1 : Typical Section View of a Cistern BMP

Source: 2012 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 the City Engineer 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 if the volume of the facility is adjusted using the percent capture method in Appendix B.4.2. Drawdown time greater than 96 hours may require a vector management plan.
□	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 drawdown/storage meets the pollutant control requirement. Refer to Appendix B for guidance.
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.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.

E.7 SD-B Impervious Area Dispersion

Photo Credit: Orange County Technical Guidance Document

MS4 Permit Category

Site Design

Manual Category

Site Design

Applicable Performance Criteria

Site Design

Primary Benefits

Volume Reduction
Peak Flow Attenuation

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 (SD-F fact sheet) 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

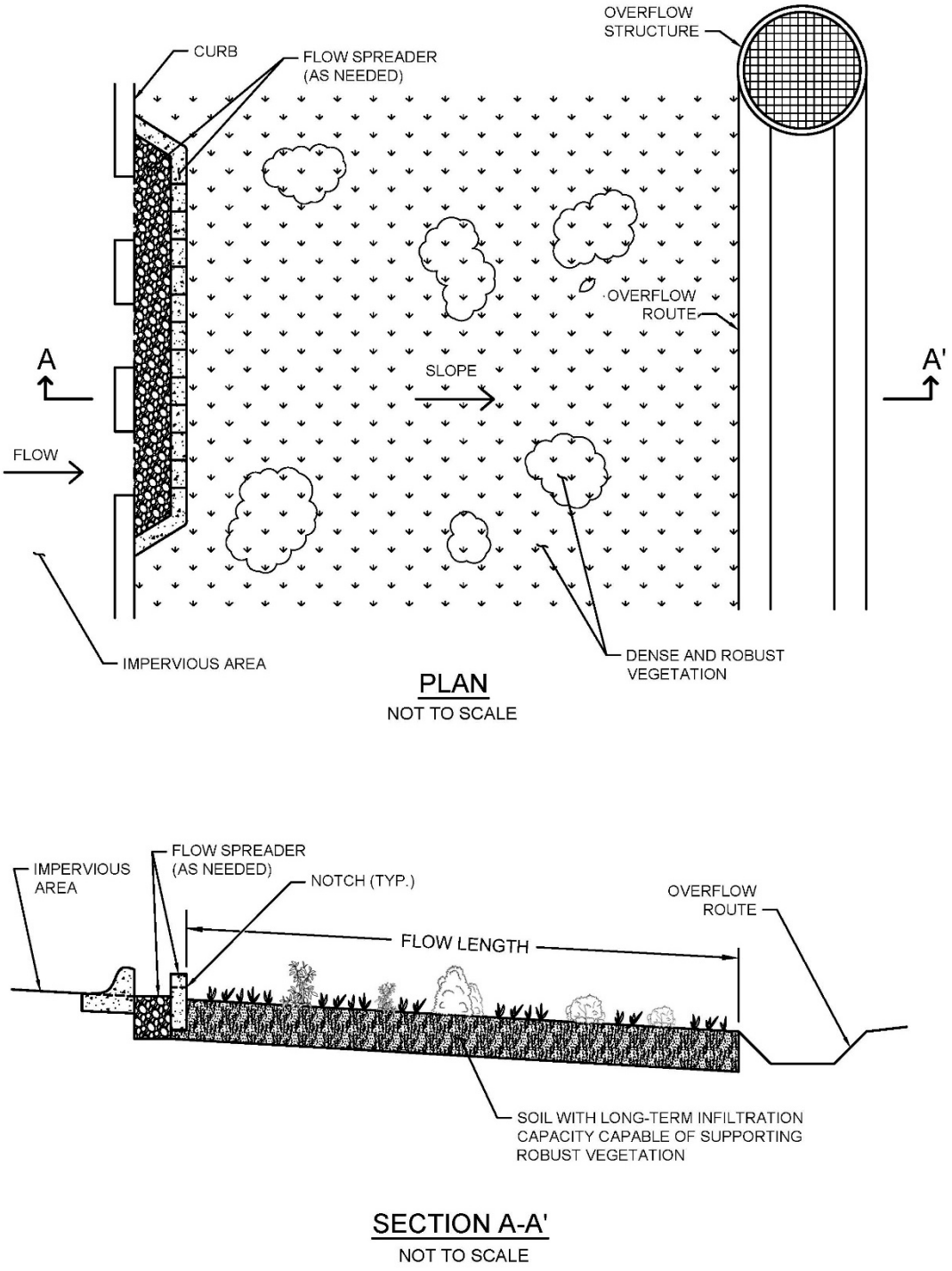


Figure E.7-1 : Typical Plan and Section view of an Impervious Area Dispersion BMP

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 the City Engineer if it is determined to be appropriate:

	Siting and Design	Intent/Rationale
□	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		
□	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.	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". DMA is 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
4. If the top 12 inches uses amended soils in accordance with SD-F, the runoff coefficient (c-factor) for the amended area is 0.1

Conceptual Design and Sizing Approach for Storm Water Pollutant Treatment and Flow Control

DMA is considered to meet both pollutant control and hydromodification flow control requirements if **ALL** of the following criteria are met:

1. All the impervious area within the DMA discharges to the pervious area before the runoff discharges from the DMA.
2. At a minimum, the top 11 inches of the pervious area uses amended soils in accordance with SD-F fact sheet and the pervious area also meets the requirements for dispersion (e.g. slope, inflow velocities, etc.) in SD-B fact sheet.
3. The impervious to pervious area ratio is 1:1.

E.11 SD-F Amended Soils

Photo Credit: Orange County Technical Guidance Document

MS4 Permit Category
Site Design
Manual Category
Site Design
Applicable Performance Standard
Site Design
Primary Benefits
Volume Reduction Peak Flow Attenuation

Description

Amended soils are soils whose physical, chemical, and biological characteristics have been altered from the natural condition to promote beneficial storm water characteristics. Amended soils shall be used as part of SD-B Impervious Area Dispersion, where applicable. Typical storm water management benefits associated with amended soils include:

- **Improved hydrologic characteristics**—amended soils can promote infiltration, decrease runoff rates and volumes, and more effectively filter pollutants from storm water runoff
- **Improved vegetation health**—amended soils provide greater moisture retention, and altered chemical and biological characteristics that can result in healthier plant growth, reduced irrigation demands, and reduced need for fertilization and maintenance
- **Reduced erosion**—amended soils produce healthier plant growth and reduced runoff which results in reduced soil erosion

Design Adaptations for Project Goals

Varying categories of soil amendments have different benefits and applications. Mulch is a soil amendment that is added at grade, rather than mixed into the soil. Mulch reduces evaporation and improves retention. Shavings and compost are common soil amendments that improve biological and chemical properties of the soil. Sand can be used as an amendment to improve the drainage rates of amended soils. Native soil samples may need to be analyzed by a lab to determine the specific soil amendments needed to achieve the desired infiltration, retention, and/or filtration rates.

Important Considerations

Maintenance: Annual maintenance may be required to determine reapplication requirements of amended soils. Amended soils should be regularly inspected for signs of compaction, waterlogging, and unhealthy vegetation.

Limitations: Not all amended soils have the same storm water benefits, the soil amendment used should be suited for the design purpose and design period of the amended area.

Design Criteria and Considerations

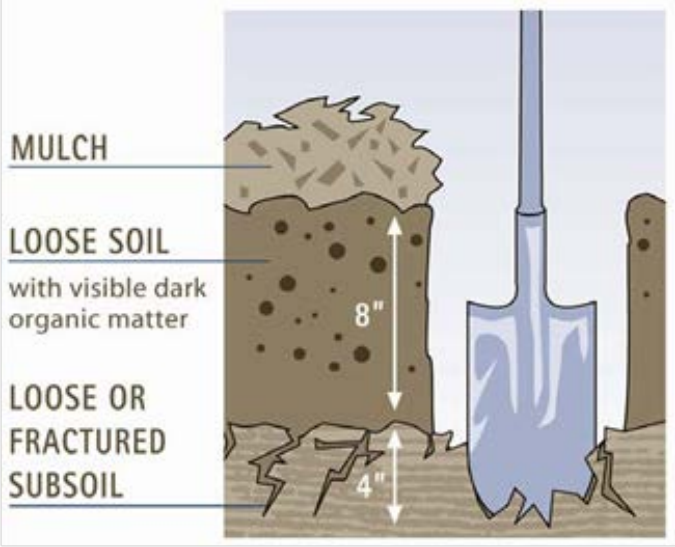
Soil amendments must meet the following design criteria and considerations. Deviations from the below criteria may be approved at the discretion of the City Engineer if appropriate:

	Siting and Design	Intent/Rationale
☐	When mulch is used as an amendment, it is applied at grade over all planting areas to a depth of 3".	Mulch should be applied on top and not mixed into underlying soils
☐	When shavings or compost is used as an amendment, it is rototilled into the native soil to a minimum depth of 6" (12 inches preferred).	If soil is not completely mixed the overall benefit will be reduced.
☐	Compost meets the criteria in Appendix F.3.1.2	If poor quality compost is used, it will have negative impact to water quality.
☐	Soil amendments are free of stones, stumps, roots, glass, plastic, metal, and other deleterious materials.	Large debris in amended soils can cause localized erosion. Trash/harmful materials can result in personal injury or contamination.
☐	Mixing of soils are done prior to planting	Soil mixing before planting results in a more homogeneous mixing and will reduce the stress on plants.
☐	Care is taken around existing trees and shrubs to prevent root damage during construction and soil amendment application.	Preservation of existing established vegetation is an important part of site design and erosion control.
☐	Soil amendments are applied at the end of construction	Soil amendments applied too soon in the construction process may become over compacted reducing effectiveness.
☐	Soil amendments are compatible with planned vegetation	The soil amendments impact the pH and salinity of the soil. Some plants have sensitive pH and/or salinity tolerance ranges.

Conceptual Design and Sizing Approach for Site Design

- When soil amendments are used a runoff factor of 0.1 can be used for DCV calculation for the amended area.
- Amended soils should be used as part of SD-B Impervious Area Dispersion, and to increase the retention volume in infiltration and biofiltration BMPs.

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

A.10 Vegetated Filter Strip

Location: Oak Hills Church, San Antonio, Texas.

Figure A.10-1. Vegetated filter strip.

A.10.1 Design

The design of a vegetated filter strip can be broken down to a nine-step process. Table A.10-1 summarizes the steps, which this chapter describes in more detail.

Table A.10-1. Vegetated filter strip iterative design step process

Design step		Design component/ consideration	General specification
1	**Determine Design Flows**	Runoff flow rates	Refer to chapter 2 of the County SUSMP.
2	**Determine Available Filter Strip Width and Slope (A-92)**	Layout and site configuration	Based on existing site conditions.
3	**Determine Vegetative Cover (A-92)**	Vegetation	Native, drought-tolerant turf grasses (not bunch grasses) should be maintained at a height of no less than 4 inches (see Appendix E).

Design step		Design component/ consideration	General specification
4	**Calculate the Design Flow Depth (A-92)**	Design flow depth	Flow depth should be less than 1 inch to achieve effective water quality improvement.
5	**Calculate the Design Velocity (A-93)**	Design velocity	Velocity should be less than 1 inch to achieve effective water quality improvement.
6	**Calculate the Desired Length (A-93)**	Length and residence time	Filter strip length should provide for a 10-minute hydraulic residence time if substantial water quality improvement is desired.
7	**Design Level Spreader/Energy Dissipater if Needed (A-94)**	Level spreader	A level spreader and energy dissipater must be designed if concentrated flows are present.
8	**Determine if Soils Need to be Amended (A-94)**	Permeability	If additional water quality improvement and infiltration are desired, amend the soil with 2 inches of media.
9	**Specify Signage (A-94)**	Signage regulations	Signage should identify filter strips as stormwater treatment practice and prohibit foot traffic and other activities that could compact or rut filter strip soils.

A.10.1.1 Step 1. Determine the Design Flow Rate

The vegetated filter strip must be sized to fully convey the desired or required design storm volume and flow rates. Chapter 2 of the County SUSMP presents the relevant sizing regulatory requirements.

A.10.1.2 Step 2. Determine Available Filter Strip Width and Slope

Site conditions dictate the available filter strip width and slope. The recommended minimum width is 15 feet with a preferred width of 25 feet. The slope should not exceed 5 percent if possible. A hydraulic residence time of 10 minutes is desired for substantial water quality treatment.

A.10.1.3 Step 3. Determine Vegetative Cover

Vegetation specifications should meet the requirements outlined in the Vegetated Swale section (A.9.1.8).

A.10.1.4 Step 4. Calculate the Flow Depth of the Design Flow

Filter strips should be designed according to the maximum depth of flow and the maximum flow velocity.

Depth of runoff flow generated by the design storm in the filter strip should be limited to less than or equal to 1 inch. The design configuration having the greatest effect on those design standards are the contributing watershed area, longitudinal slope (along the direction of flow), the resistance to flow (Manning's n), and the width and slope of the filter strip. The design flow depth (d) is calculated on the

basis of the width and the slope (parallel to the flow path) using a modified Manning's equation as follows:

$$d = \left[Q_{wq} \times n_{wq} / 1.49 \times w \times s^{0.5} \right]^{0.6}$$

where

d = design flow depth (ft)
Q_{wq} Q_{wq} = water quality design flow rate (cfs)
w = width of strip perpendicular to flow that equals the width of impervious surface contributing to the filter strip (ft)
s = slope (ft/ft) of strip parallel to flow, average over the whole width
n_{wq} = Manning's roughness coefficient (0.025–0.03)

If d is greater than 1 inch, a smaller slope is required, or the filter strip may not provide substantial water quality improvement.

A.10.1.5 Step 5. Calculate the Design Velocity

Maximum design storm flow velocity should be limited to 1 foot per second. The design flow velocity is based on the design flow, design flow depth, and width of the strip as follows:

$$v_{wq} = Q_{wq} / dw$$

where

v_{wq} = water quality design flow velocity (ft/sec)
Q_{wq} = water quality design flow rate (cfs)
d = design flow depth (ft)
w = width of strip perpendicular to flow that equals the width of impervious surface contributing to the filter strip (ft)

A.10.1.6 Step 6. Calculate the Desired Length

Determine the required length (L) to achieve a desired residence time of 10 minutes using this equation:

$$L = 600 v_{wq}$$

where

L = swale length (ft)
v_{wq} = design water quality flow velocity (ft/sec)

If the design parameters as computed in steps 1 through 6 above are not within the recommended standards, an alternative IMP such as a grassed swale should be considered to treat stormwater runoff.

A.10.1.7 Step 7. Design Level Spreader/Energy Dissipater (Optional)

The transition of stormwater runoff from upslope, impervious areas to the vegetated filter strip is critical to the proper function of the integrated management practice (IMP). Flow should not be concentrated and should not cause erosion. Energy dissipaters typically consist of a gravel flow spreader. The gravel flow spreader should have the following characteristics:

- Minimum of 6 inches deep and 12 inches wide
- Surface is a minimum of 1 inch below the surface of the adjacent pavement

Concrete spreaders can also be incorporated for energy dissipation and flow spreading.

A.10.1.8 Step 8. Determine if Soils Need to be Amended (Optional)

If enhanced infiltration is desired, vegetated filter strips can be amended with 2 inches of soil media or plant-derived compost. See the Bioretention section (A.1.1.5) for media specifications. The amendment should be mixed into the native soils to a depth of 6 inches to prevent soil layering.

A.10.1.9 Step 9. Specify Signage

Signs on-site should identify the area as a stormwater IMP, prohibit foot traffic, and instruct maintenance crews to maintain the vegetation at a height between 4 to 6 inches.

A.10.2 Critical Construction Considerations

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

A.10.3 Operations and Maintenance

The primary maintenance requirement of a vegetated filter strip is managing vegetation in the filter strip. Table A.10-2 describes the maintenance activities for vegetated filter strips.

Table A.10-2. Inspection and maintenance tasks

Task	Frequency	Maintenance notes
Mowing	Two to twelve times per year	As needed to maintain aesthetics. Grass height should be a minimum of 2 inches.
Inlet inspection	Once after first major rain of the season, then monthly during the rainy season	Check for sediment accumulation to ensure that flow into the system is as designed. Remove any accumulated sediment.
Miscellaneous upkeep	Twelve times per year	Tasks include trash collection and spot weeding.

A.10.4 References

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

E.6 SD-A Tree

Source: County of San Diego LID Manual

MS4 Permit Category
Site Design
Manual Category
Site Design
Applicable Performance Standard
Site Design
Primary Benefits
Volume Reduction

Description

Trees planted to intercept rainfall and runoff can be used as storm water management measure that provide additional benefits beyond those typically associated with trees, (i.e. 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 system components include:

- Trees of the appropriate species for site conditions and constraints
- Available growing space based on tree species, soil type, water availability, surrounding land uses, and project goals
- Staking and planting requirements (see Standard Drawing: SDL-101)

- Optional suspended pavement design to provide structural support for adjacent pavement without requiring compaction of underlying layers
- As needed root barrier devices; 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 damage.
- Optional tree grates; maximize available space for pedestrian circulation and protect tree roots from compaction.
- Optional shallow surface depression for ponding of excess runoff
- Optional planter box drain

Design Adaptations for Project Goals

Storm water volume credits are only allowed for new trees implemented within the project footprint.

Site design BMP to provide incidental treatment. Trees primarily functions as site design BMPs for incidental treatment. Benefits from trees as a site design BMP are accounted by adjustment factors presented in **Appendix B.2.2**. Trees as a site design BMP are only credited up to 0.25 times the DCV from the project footprint (with a maximum single tree credit volume of 400 ft^3).

Storm water pollutant control BMP to provide treatment. Applicants are allowed to design trees as a pollutant control BMP and obtain credit greater than 0.25 times the DCV from the project footprint (or a credit greater than 400 ft^3 from a single tree). For this option to be approved by the City Engineer, applicant is required to do infiltration feasibility screening (Worksheet C.4-1/Form I-8) and provide calculations supporting the amount of credit claimed from implementing trees within the project footprint. The City Engineer has the discretion to request additional analysis before approving credits greater than 0.25 times the DCV from the project footprint (or a credit greater than 400 ft^3 from a single tree).

Design Criteria and Considerations

Trees must meet the following design criteria and considerations and the requirements of Standard Drawing SDL-101 where applicable. Deviations from the below criteria may be approved at the discretion of the City Engineer 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.	Proper tree placement and species selection minimizes problems such as pavement damage by surface roots and poor growth.

<table>
<tr><th></th><th>Siting and Design</th><th>Intent/Rationale</th></tr>
<tr><td>□</td><td>Location of trees planted along public streets follows local requirements and guidelines. Vehicle and pedestrian line of sight are considered in tree selection and placement.
Unless exemption is granted by the City Engineer the following minimum tree separation distance (from the tree trunk) is followed
<table>
<tr><th>Improvement</th><th>Minimum distance to Tree</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></td><td>Roadway safety for both vehicular and pedestrian traffic is a key consideration for placement along public streets.</td></tr>
<tr><td>□</td><td>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.</td><td>Tree growth can damage utilities and overhead wires resulting in service interruptions. Protecting utilities routed through the planter prevents damage and service interruptions.</td></tr>
<tr><td>□</td><td>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.</td><td>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.</td></tr>
<tr><td>□</td><td>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 mature tree drip line.

Applicant uses soil amendments (SD-F), as necessary. Soil amendments result in healthier plant growth, reduced irrigation demands, and reduced need for fertilization and maintenance</td><td>The minimum soil volume is required to support a healthy tree.

A lower amount of soil volume may be allowed if certified by a landscape architect or agronomist that the installed soil volume will be adequate for health tree growth. The retention credit from the tree must be directly proportional to the soil volume installed for the tree.</td></tr>
</table>

	Siting and Design	Intent/Rationale
□	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.
□	Inlet opening to the tree that is at least 18 inches wide. A minimum 2 inch drop in grade from the inlet to the finish grade of the tree. Grated inlets are allowed for pedestrian circulation. Grates need to be ADA compliant and have sufficient slip resistance.	Design requirement to ensure that the runoff from the tributary area is not bypassed. Different inlet openings and drops in grade may be allowed at the discretion of the City Engineer 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.

Conceptual Design and Sizing Approach for Site Design and Storm Water Pollutant Control

- Determine the areas where trees can be used in the site design to achieve incidental treatment. Trees reduce runoff volumes from the site. Refer to **Appendix B.2.2**. Document the proposed tree locations in the SWQMP.
- 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:
    - Delineate the DMA (tributary area) to the tree and calculate the associated DCV.
    - Calculate the required diversion flow rate using **Appendix B.1.2** and size the inlet required to convey 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.
        - 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.
        - Then the effective DCV draining to the tree = 820 ft^3 * (0.05/0.10) = 420 ft^3
    - Estimate the amount of storm water treated by the tree by summing the following:
        - Evapotranspiration credit of 0.1 * amount of soil volume installed; and
        - Infiltration credit calculated using sizing procedures in **Appendix B.4**.

E.21 FT-1 Vegetated Swales

Location: Eastlake Business Center, Chula Vista, California; Photo Credit: Eric Mosolgo

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

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)

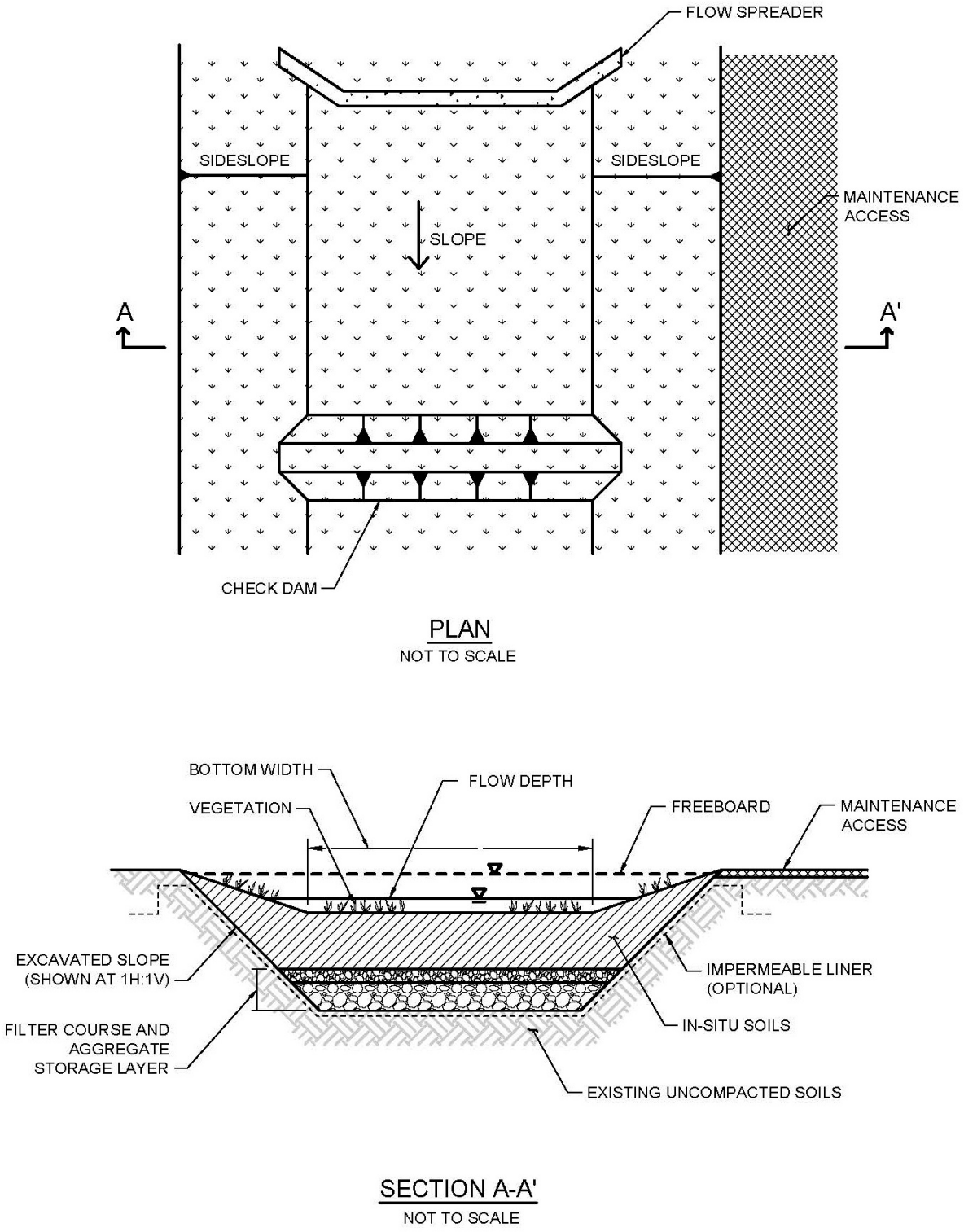


Figure E.21-1 : Typical Plan and Section View of a Vegetated Swale BMP

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 the City Engineer 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 2 inches of freeboard is provided.	Freeboard minimizes risk of uncontrolled surface discharge.

Siting and Design		Intent/Rationale
□	Minimum 100 foot flow length.	Longer flow lengths provide increased pollutant removal via filtration and greater incidental infiltration.
□	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: BSM specification in Appendix F.3; 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.
□	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.

Siting and Design		Intent/Rationale
□	Filter course is washed and free of fines.	Washing aggregate will help eliminate fines that could clog the facility and impede infiltration.
□	To reduce clogging potential, a two-layer filter course (aka choking stone system) is used consisting of one 3" layer of clean and washed ASTM 33 Fine Aggregate Sand overlying a 3" layer of ASTM No 8 Stone (Appendix F.4).	This specification has been developed to maintain permeability while limiting the migration of media material into the stone reservoir and underdrain system.
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.
□	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 8 inches.	Minimum diameter required for maintenance by City crews. For privately maintained BMPs, a minimum underdrain diameter of 6 inches is allowed.
□	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 8-inch diameter and lockable cap is placed, at the farthest, every 300 feet as required based on underdrain length (50 feet is recommended).	Properly spaced cleanouts will facilitate underdrain maintenance. For privately maintained BMPs, cleanout diameter of 6 inches is allowed.

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.

APPENDIX

H BIORETENTION FACILITY PLANT LIST

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.

APPENDIX

I STORMWATER TREATMENT MEASURE FACT SHEETS

FG-LP-0002

NOTES:

1. Filter outlet adapter shall be constructed from stainless steel Type 304.

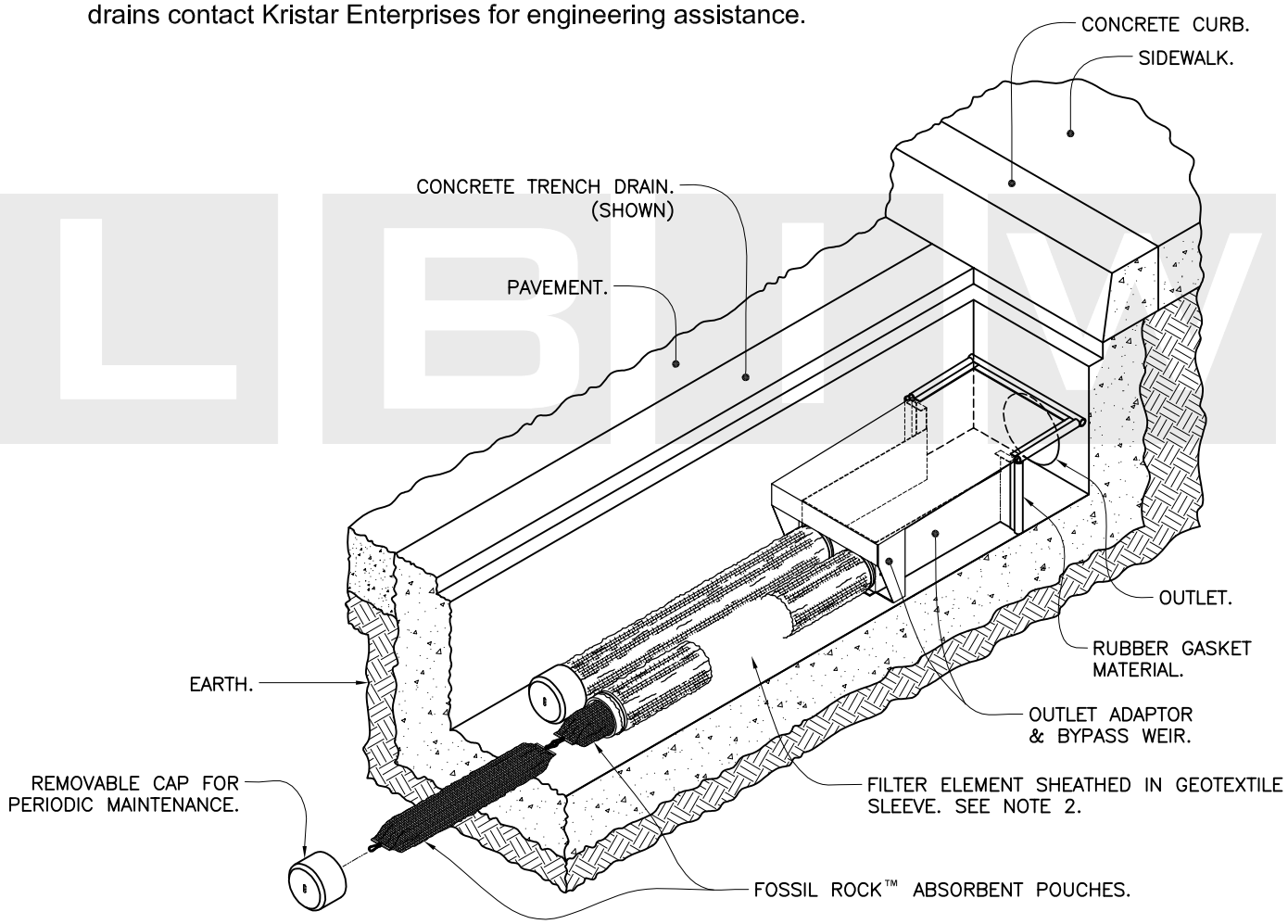
2. Filter element is constructed from polypropylene woven monofilament geotextile surrounding a perforated filter housing. Filter element shall not allow the retention of water between storm events.

3. Filter inserts are supplied with "clip-in" filter pouches utilizing Fossil Rock ™ filter medium for the collection and retention of petroleum hydrocarbons (oils & greases).

4. FloGard® LoPro™ filter inserts and Fossil Rock ™ filter medium pouches must be maintained in accordance with manufacturer recommendations.

5. Outlet adapter can accommodate outlet openings at right angles and/or bottom outlet openings.

6. For alternate outlet adapter configurations used for extremely shallow trench drains contact Kristar Enterprises for engineering assistance.



TITLE

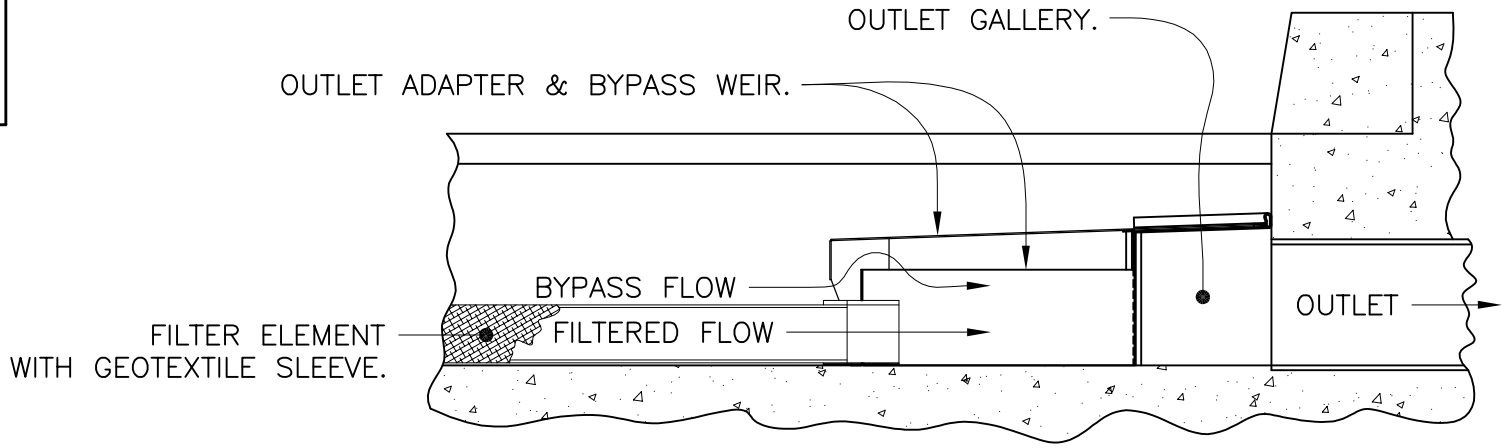
FloGard® LoPro™

TRENCH DRAIN FILTER INSERT

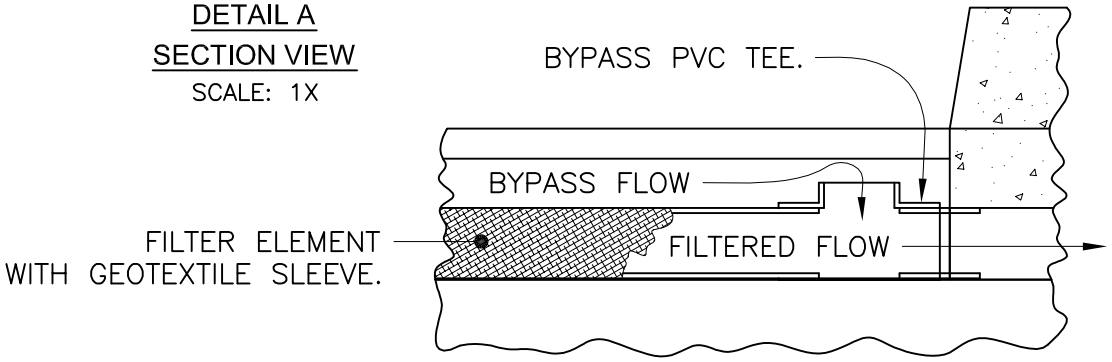
KriStar Enterprises, Inc.
360 Sutton Place, Santa Rosa, CA 95407
Ph: 800.579.8819, Fax: 707.524.8186, www.kristar.com

DRAWING NO.	REV	ECO	DATE	SHEET
FG-LP-0002	E	0059 JPR 12/30/08	JPR 2/21/07	SHEET 1 OF 2

FG-LP-0002



DETAIL A
SECTION VIEW
SCALE: 1X



DETAIL B
SECTION VIEW
ALTERNATE ADAPTER CONFIGURATION
SCALE: 1X

SPECIFIER CHART

MODEL	FILTER TYPE	TRENCH WIDTH "ID" (CLEAR OPENING)	MINIMUM TRENCH DEPTH (FROM BOTTOM OF GRATE)	SOLIDS STORAGE CAPACITY CUBIC FEET **	FILTERED FLOW CUBIC FEET / SECOND **	TOTAL BYPASS CAPACITY CUBIC FEET /SECOND
FG-TDOF3	PIPE *	3.0	6.5	0.1	0.5	0.1
FG-TDOF4	PIPE *	4.0	6.5	0.2	0.5	0.1
FG-TDOF6	PIPE	6.0	6.5	0.4	0.5	0.2
FG-TDOF8	PIPE	8.0	6.5	0.7	0.5	0.3
FG-TDOF10	PIPE	10.0	6.5	0.9	0.5	0.5
FG-TDOF12	PIPE	12.0	6.5	0.9	1.0	0.6
FG-TDOF18	PIPE	18.0	6.5	1.3	1.5	1.1
FG-TDOF24	PIPE	24.0	6.5	1.8	2.0	1.5
FG-TDOA6	PANEL	6.0	4.5	0.4	0.2	0.2
FG-TDOA8	PANEL	8.0	4.5	0.7	0.2	0.3
FG-TDOA10	PANEL	10.0	4.5	0.8	0.3	0.5
FG-TDOA12	PANEL	12.0	4.5	1.0	0.4	0.6
FG-TDOA18	PANEL	18.0	4.5	1.4	0.8	1.1
FG-TDOA24	PANEL	24.0	4.5	1.8	1.1	1.5

* ALTERNATE ADAPTER CONFIGURATION. SEE DETAIL B.
**CAPACITY PER 4-FT. SEGMENT USED.

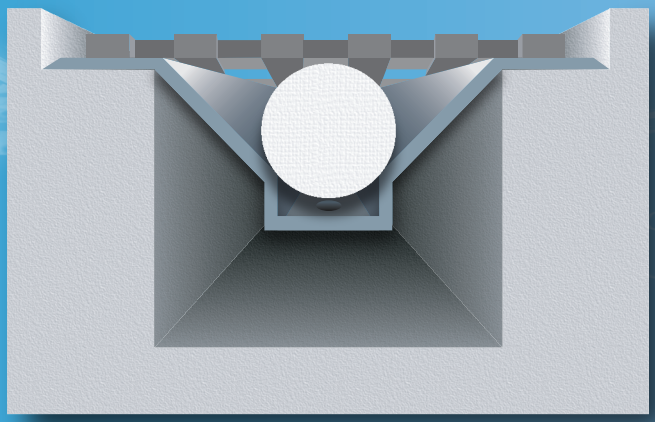
TITLE

FloGard® LoPro™

TRENCH DRAIN FILTER INSERT

KriStar Enterprises, Inc.
360 Sutton Place, Santa Rosa, CA 95407
Ph: 800.579.8819, Fax: 707.524.8186, www.kristar.com

DRAWING NO.	REV	ECO	DATE	
FG-LP-0002	E	0059 JPR 12/30/08	JPR 2/21/07	SHEET 2 OF 2



Trench Grate Filter™

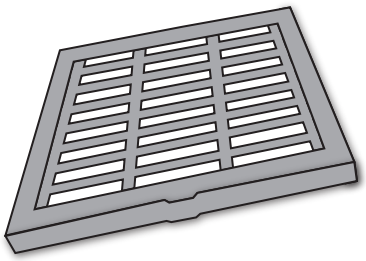
The Trench Grate Filter™ is a specialized inlet filter, designed to prevent nonpoint source runoff pollution and debris from entering grated trench inlets. The filter is adaptable to any size trench inlet and is both easy to install and simple to service. NPDES compliant, the unit excels at hydrocarbon absorption via StormBoom™ Media and is perfect for hydrocarbon rich areas such as gas stations, parking lots, service stations, airports and more!

Trench Grate Filter™ benefits include:

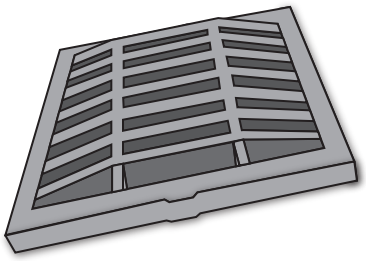
- Adaptable to any size trench catch basin & grate type via mounting kit (if necessary)
- Hydrocarbon filtering via StormBooms™
- Prevents debris from entering trench inlets
- No Rust + High Durability: Made from marine grade fiberglass
- Low Profile Design: Easily installs under the grate and is simple to service
- Versatile: Can be used for gas station aprons, within parking lots & more!
- NPDES Compliant

Trench Grate Types

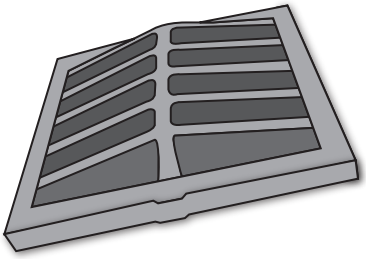
Type A:
Flat Grate



Type B:
Tapered Grate



Type C:
Drop Grate



Suntree Technologies Inc.

798 Clearlake Rd, Suite 2
Cocoa, FL 32922
www.suntreetech.com
info@suntreetech.com
321.637.7552

NPDES | EPA Compliant:

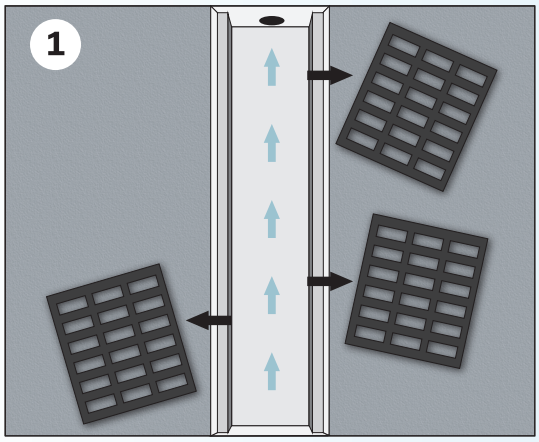
The Trench Grate Filter™ is an integral Best Management Practice and helps to meet associated NPDES | EPA requirements

Sustainable and Versatile Runoff Quality Improvement

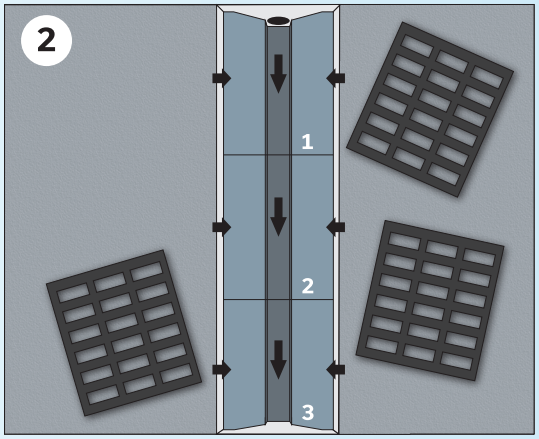
LEED Credits Eligible:

6.2 Stormwater Design / Quality Control

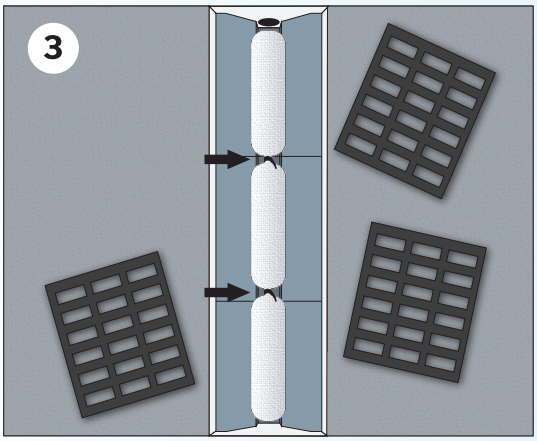
Standard Trench Grate Filter™ Installation Process



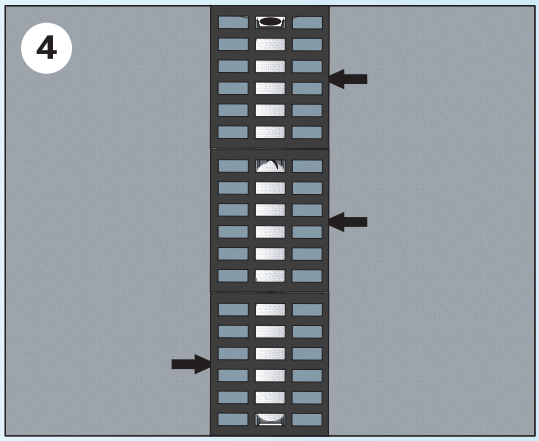
Remove grates from trench catch basin, take notice of flow direction to outflow.



Starting at the trench outflow, install each overlapping filter section, trim to fit as needed.



Install and secure StormBooms™ end to end using supplied zip ties. Trim StormBooms™ as needed to achieve an appropriate fit. Be sure to zip tie any open ends closed.



Replace the trench grates, which will properly secure all StormBooms™ in place. The Trench Grate Filter™ is now ready to tackle the next storm event.

E.24 FT-4 Dry Extended Detention Basin

Location: Rolling Hills Ranch, Chula Vista, California; Photo Credit: Eric Mosolgo

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

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

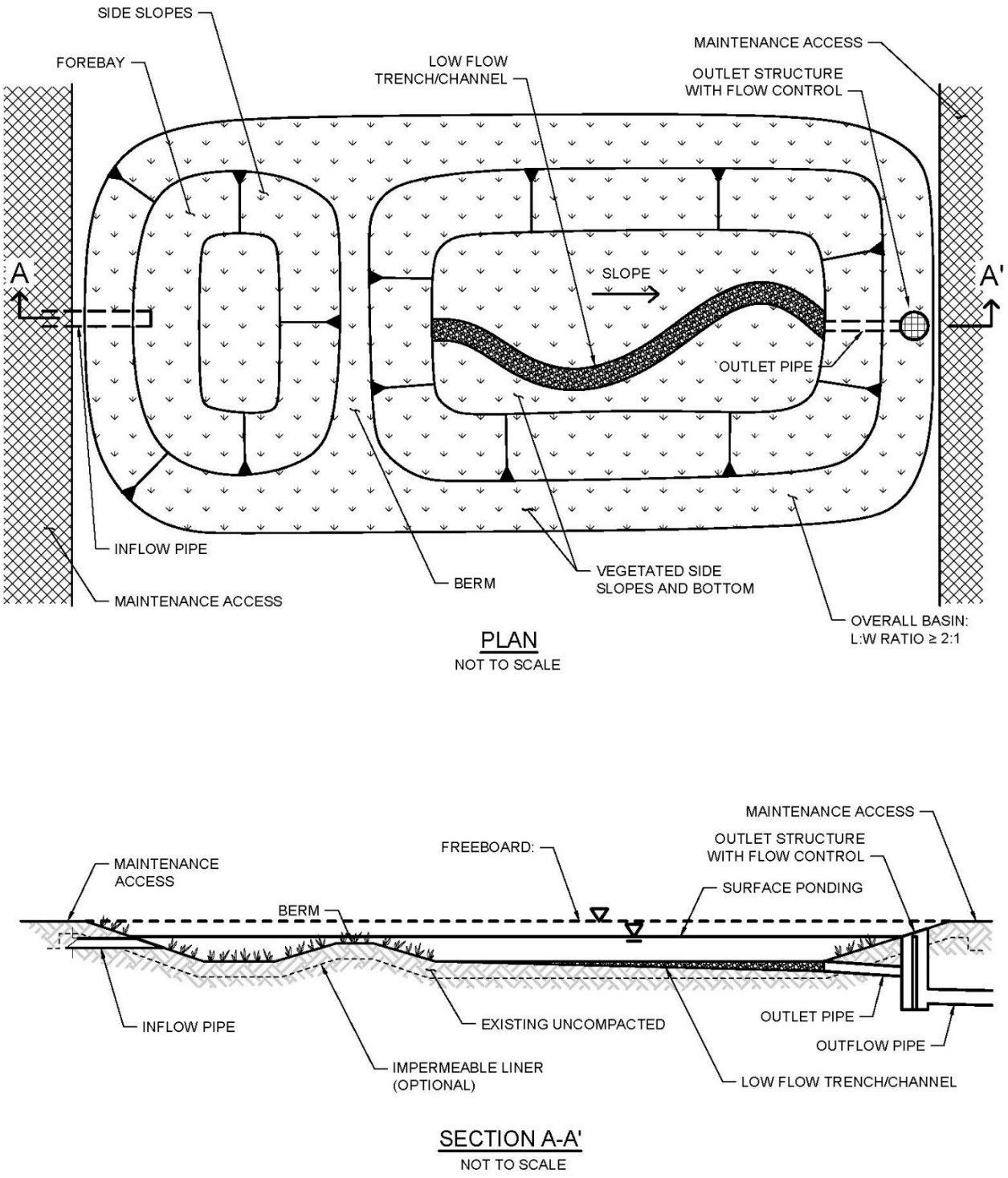


Figure E.24-1 : Typical plan and Section view of a Dry Extended Detention Basin BMP

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 the City Engineer 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 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.

	Siting and Design	Intent/Rationale
□	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.

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.

GRAVITY SEPARATOR STORM WATER TREATMENT DEVICE

1.0 GENERAL

1.1 This item shall govern the furnishing and installation of the Vortechs® by Contech Engineered Solutions LLC, or equivalent, complete and operable as shown and as specified herein, in accordance with the requirements of the plans and contract documents.

1.2 The Contractor shall furnish all labor, equipment and materials necessary to install the storm water treatment device(s) (SWTD) and appurtenances specified in the Drawings and these specifications.

1.3 The manufacturer of the SWTD shall be one that is regularly engaged in the engineering design and production of systems deployed for the treatment of storm water runoff for at least five (5) years and which have a history of successful production, acceptable to the Engineer. In accordance with the Drawings, the SWTD(s) shall be a Vortechs® device or equivalent manufactured by:

Insert Manufacturer's information

1.4 Related Sections

1.4.1 Section 02240: Dewatering
1.4.2 Section 02260: Excavation Support and Protection
1.4.3 Section 02315: Excavation and Fill
1.4.4 Section 02340: Soil Stabilization

1.5 All components shall be subject to inspection by the engineer at the place of manufacture and/or installation. All components are subject to being rejected or identified for repair if the quality of materials and manufacturing do not comply with the requirements of this specification. Components which have been identified as defective may be subject for repair where final acceptance of the component is contingent on the discretion of the Engineer.

1.6 The manufacturer shall guarantee the SWTD components against all manufacturer originated defects in materials or workmanship for a period of twelve (12) months from the date the components are delivered to the owner for installation. The manufacturer shall upon its determination repair, correct or replace any manufacturer originated defects advised in writing to the manufacturer within the referenced warranty period. The use of SWTD components shall be limited to the application for which it was specifically designed.

1.7 The SWTD manufacturer shall submit to the Engineer of Record a "Manufacturer's Performance Certification" certifying that each SWTD is capable of achieving the specified removal efficiencies listed in these specifications. The certification shall be supported by independent third-party research

1.8 No product substitutions shall be accepted unless submitted 10 days prior to project bid date, or as directed by the Engineer of Record. Submissions for substitutions require review and

approval by the Engineer of Record, for hydraulic performance, impact to project designs, equivalent treatment performance, and any required project plan and report (hydrology/hydraulic, water quality, stormwater pollution) modifications that would be required by the approving jurisdictions/agencies. Contractor to coordinate with the Engineer of Record any applicable modifications to the project estimates of cost, bonding amount determinations, plan check fees for changes to approved documents, and/or any other regulatory requirements resulting from the product substitution.

2.0 MATERIALS

2.1 Each stormwater treatment system shall include a circular aluminum "swirl chamber" (or "grit chamber") with a tangential inlet to induce a swirling flow pattern that will accumulate and store settleable solids in a manner and a location that will prevent re-suspension of previously captured particulates.

2.2 Housing unit of stormwater treatment device shall be constructed of pre-cast or cast-in-place concrete, no exceptions. Concrete for precast stormwater treatment systems shall conform to ASTM C 857 and C 858 and meet the following additional requirements

- 2.2.1 The wall thickness shall not be less than 6 inches (152 mm) or as shown on the dimensional drawings. In all cases the wall thickness shall be no less than the minimum thickness necessary to sustain HS20-44 (MS18) loading requirements as determined by a Licensed Professional Engineer.
- 2.2.2 Sections shall have tongue and groove or ship-lap joints with a butyl mastic sealant conforming to ASTM C 990.
- 2.2.3 Cement shall be Type II Portland cement conforming to ASTM C 150.
- 2.2.4 All sections shall be cured by an approved method. Sections shall not be shipped until the concrete has attained a compressive strength of 4,000 psi (28 MPa) or until 5 days after fabrication and/or repair, whichever is the longer.
- 2.2.5 Pipe openings shall be sized to accept pipes of the specified size(s) and material(s), and shall be sealed by the Contractor with a hydraulic cement conforming to ASTM C 595M
- 2.2.6 Brick or masonry used to build the manhole frame to grade shall conform to ASTM C 32 or ASTM C 139 and shall be installed in conformance with all local requirements.
- 2.2.7 Casting for manhole frames and covers shall be in accordance with ASTM A48, CL.35B and AASHTO M105.

2.3 Internal Components and appurtenances shall conform to the following:

- 2.3.1 Internal aluminum plate components shall be aluminum alloy 5052-H32 in accordance with ASTM B 209.
- 2.3.2 Sealant to be utilized at the base of the swirl chamber shall be 60 durometer extruded nitrile butadiene rubber (Buna N) and shall be provided to the concrete precaster for installation.

3.0 PERFORMANCE

3.1 The SWTD shall be capable of achieving an 80 percent average annual reduction of TSS or an 80% reduction of TSS based on a treatment flow rate or calculation as specified by local regulatory requirements unless otherwise stated.

3.2 The SWTD shall have completed field tested following TARP Tier II protocol requirements

3.3 Annual TSS removal efficiency models shall be based on documented removal efficiency performance from full scale laboratory tests based on a particle size gradation defined in Table 1 unless otherwise stated. Annual TSS removal efficiency models shall only be considered valid if they are corroborated by independent third party field testing. Said field testing shall include influent and effluent composite samples from a minimum of ten storms at one location.

3.4 Individual stormwater treatment systems shall have usable sediment storage capacity of not less than the corresponding volume listed in Table 2. The systems shall be designed such that the pump-out volume is less than ½ of the total system volume. The systems shall be designed to not allow surcharge of the upstream piping network during dry weather conditions.

3.5 The stormwater treatment system manufacturer shall furnish documentation which supports all product performance claims and features, storage capacities and maintenance requirements.

3.6 Stormwater treatment systems shall be completely housed within one rectangular structure.

3.7 In order to not restrict the Owner's ability to maintain the stormwater treatment system, the minimum dimension providing access from the ground surface to the sump chamber shall be 16 inches in diameter

TABLE 1
Particle Size Gradation

Percent of Sample	Particle Size Range
27%	>250 micron
11%	150-250 micron
7%	100-150 micron
9%	75-100 micron
4%	63-75 micron
42%	<63 micron

4.0 EXECUTION

4.1 Each Stormwater Treatment System shall be constructed according to the sizes shown on the

Drawings and as specified herein. Install at elevations and locations shown on the Drawings or as otherwise directed by the Engineer.

4.2 Place the precast base unit on a granular subbase of minimum thickness of six inches (152 mm) after compaction or of greater thickness and compaction if specified elsewhere. The granular subbase shall be checked for level prior to setting and the precast base section of the trap shall be checked for level at all four corners after it is set. If the slope from any corner to any other corner exceeds 0.5% the base section shall be removed and the granular subbase material re-leveled.

4.3 Prior to setting subsequent sections place bitumen sealant in conformance with ASTM C 990-91 along the construction joint in the section that is already in place.

4.4 After setting the base and wall or riser sections, prepare to install the swirl chamber (if not installed prior to delivery). Place the butyl mastic sealant vertically on the outside of the swirl chamber starting one inch above the bottom of the swirl chamber and continuing to a height equal to the elevation of the bottom of the upper aperture of the swirl chamber. The butyl mastic sealant should abut the downstream side of the pre-drilled mounting holes that attach the swirl chamber to the long walls of the concrete vault. Next, install the extruded Buna N seal on the bottom edge of the 180 degree downstream section of the swirl chamber by first applying a bead of Sikaflex-1a polyurethane elastomeric sealant into the extruded slot then slide the seal onto the swirl chamber. The extruded seal should extend 3-inches (76 mm) upstream of the mounting holes, toward the inlet end of the vault. Set the swirl chamber into position and keep the seal approximately ½-inch (13 mm) above the floor of the concrete vault. Apply a continuous bead of Sikaflex-1a sealant under the cupped bottom of the seal. Set the circular swirl chamber on the floor of the vault and anchor it by bolting the swirl chamber to the side walls of the concrete vault at the three (3) tangent points and at the inlet tab using HILTI brand stainless steel drop-in wedge anchors or equivalent 3/8-inch (10 mm) diameter by 2-3/4 inch (70 mm) minimum length at heights of approximately three inches (3") (76 mm) off the floor and at fifteen inch (15") (381 mm) intervals to approximately the same height of the butyl mastic sealant (at locations of pre-drilled holes in aluminum components). Apply a continuous bead of Sikaflex-1a sealant to the intersection of the inside bottom edge of the extruded seal and the vault floor.

4.5 If the oil baffle wall (Baffle A) and flow control wall (Baffle B) are not integrally cast-in to riser/wall sections then the Baffle wall panels shall be placed in the formed keyways or between bolted-in-place angle flanges as provided by the manufacturer. Apply non-shrink grout or Sikaflex-1a sealant to each end of Baffle A and Baffle B at the upstream intersection with the side walls of the concrete vault.

4.6 Prior to setting the precast roof section, bitumen sealant equal to ASTM C 990 shall be placed along the top of the oil baffle wall (Baffle A), using more than one layer of mastic if necessary, to a thickness at least 1-inch (25 mm) greater than the nominal gap between the top of the baffle and the roof section. The nominal gap shall be determined either by field measurement or the shop drawings. Do not seal the top of Baffle B unless specified on the shop drawings to do so. After placement of the roof section has compressed the butyl mastic sealant in the gap over Baffle A, finish sealing the gap with an approved non-shrink grout on both sides of the gap using the butyl mastic as a backing material to which to apply the grout. If roof section is "clamshell" or "bathtub" halves, then finish sealing the ends of the Baffle walls by applying non-shrink grout or Sikaflex-1a sealant to each end of Baffle A at the upstream intersection

with the side walls of the concrete vault and to each end of Baffle B at the downstream intersection with the side walls of the concrete vault.

4.7 After setting the precast roof section of the stormwater treatment system, set precast concrete manhole riser sections, to the height required to bring the cast iron manhole covers to grade, so that the sections are vertical and in true alignment with a ¼-inch (6 mm) maximum tolerance allowed. Backfill in a careful manner, bringing the fill up in 6-inch (152 mm) lifts on all sides. If leaks appear, clean the inside joints and caulk with lead wool to the satisfaction of the Engineer. Precast sections shall be set in a manner that will result in a watertight joint. In all instances, installation of Stormwater Treatment Systems shall conform to ASTM specification C 891 "Standard Practice for Installation of Underground Precast Utility Structures".

4.8 Holes made in the concrete sections for handling or other purposes shall be plugged with a nonshrink grout or by using grout in combination with concrete plugs.

4.9 Where holes must be cut in the precast sections to accommodate pipes, do all cutting before setting the sections in place to prevent any subsequent jarring which may loosen the mortar joints. The Contractor shall make all pipe connections.

TABLE 2
Stormwater Treatment Device
Storage Capacities

Vortechs Model	Minimum Sump Storage Capacity (yd^3)/(m^3)
1000	0.7(0.54)
2000	1.2(0.91)
3000	1.8(1.38)
4000	2.4(1.84)
5000	3.2(2.45)
7000	4.0(3.06)
9000	4.8(3.67)
11000	5.6(4.28)
16000	7.1(5.43)

END OF SECTION

E.13 INF-1 Infiltration Basin

Photo Credit:
http://www.stormwaterpartners.com/facilities/basin.html

MS4 Permit Category
Retention
Manual Category
Infiltration
Applicable Performance Standard
Pollutant Control Flow Control
Primary Benefits
Volume Reduction Peak Flow Attenuation

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

Recommended Siting Criteria

Siting Criteria	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.

Siting Criteria	Intent/Rationale
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. Applicant must complete Worksheet C.4-1/Form I-8A; Worksheet C.4-2/Form I-8B and Worksheet C.4-3.

Example Schematic Design – Plan and Section View

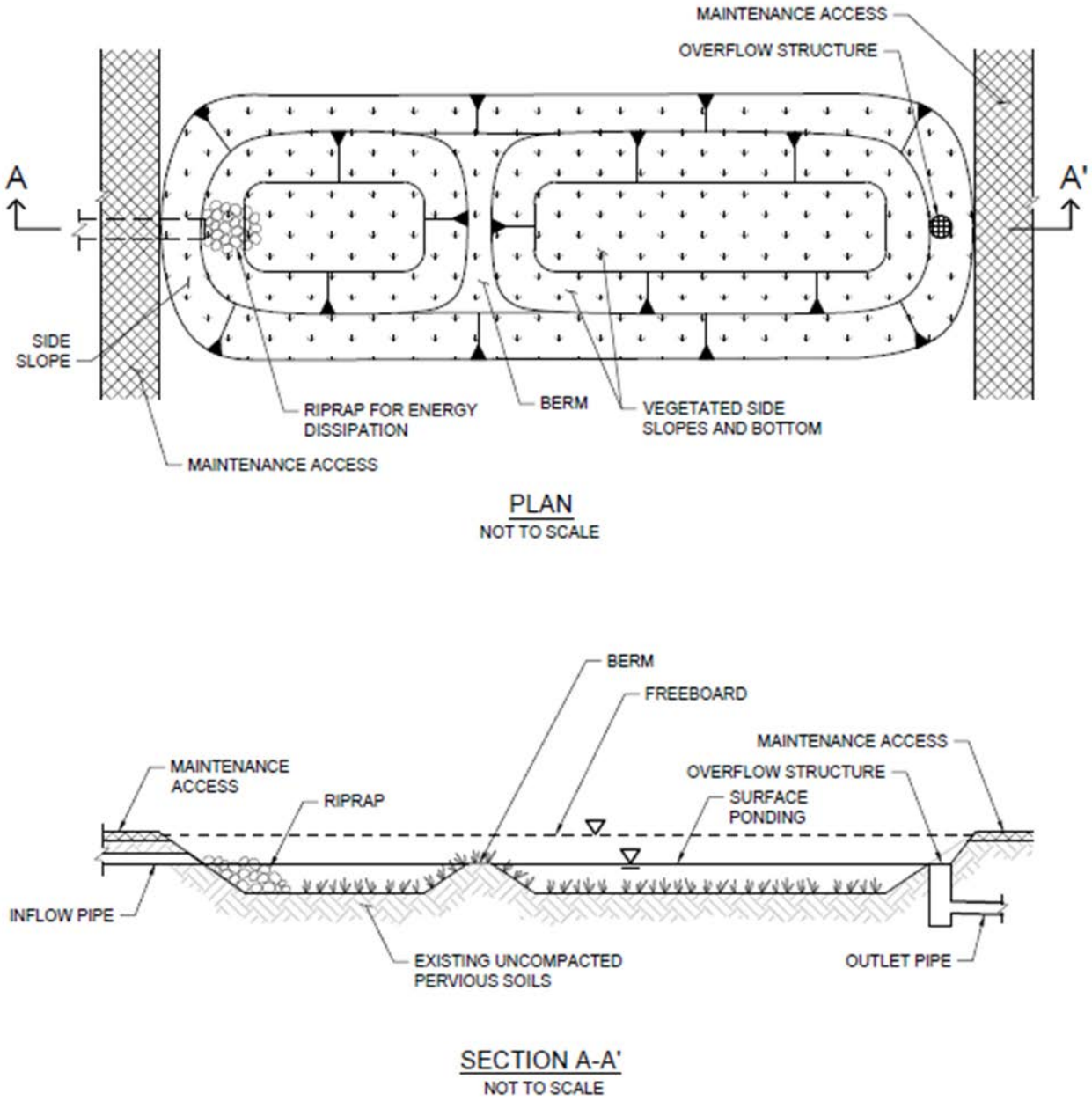


Figure E.13-1 : Typical Plan and Section View of an Infiltration BMP

Recommended BMP Component Dimensions

BMP Component	Dimension	Intent/Rationale
Freeboard	≥ 2 inches	Freeboard minimizes risk of uncontrolled surface discharge.
Ponding Area Side Slopes	3H:1V or shallower	Gentler side slopes are safer, less prone to erosion, able to establish vegetation more quickly and easier to maintain.
Settling Forebay Volume	≥ 25% of facility volume	A forebay to trap sediment can decrease frequency of required maintenance. Equivalent pretreatment BMPs upstream of the infiltration BMP are allowed.

Deviations to the recommended BMP component dimensions may be approved at the discretion of the City Engineer if it is determined to be appropriate.

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 the City Engineer if it is determined to be appropriate:

	Design Criteria	Intent/Rationale
□	Finish grade of the facility is ≤ 2% (0% recommended).	Flatter surfaces reduce erosion and channelization with the facility.
□	Infiltration of surface ponding is limited to a 36-hour drawdown time.	Prolonged surface ponding reduce volume available to capture subsequent storms. The applicant has an option to use a different drawdown time up to 96 hours if the volume of the facility is adjusted using the percent capture method in Appendix B.4.2. A drawdown time greater than 96 hours maybe allowed with implementation of an vector management plan.
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.

	Design Criteria	Intent/Rationale
□	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:

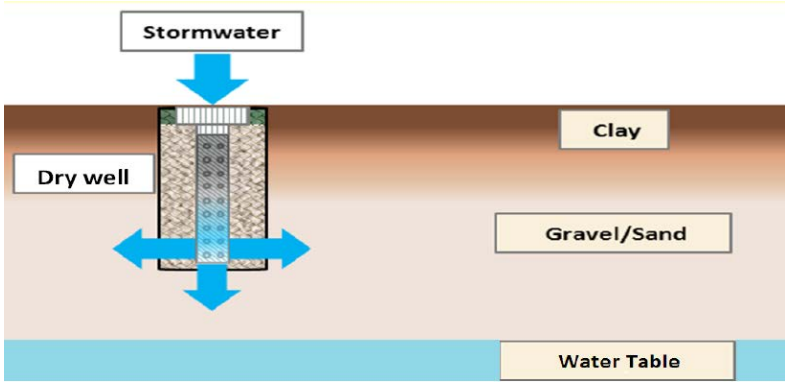
1. Verify that siting and design criteria have been met, including placement and basin area requirements, forebay volume, and maximum slopes for basin sides and bottom.
2. Calculate the DCV per **Appendix B** based on expected site design runoff for tributary areas.
3. Use the sizing worksheet (**Appendix 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.

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.23 FT-3 Sand Filters

Photo Credit: City of San Diego LID Manual

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)

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

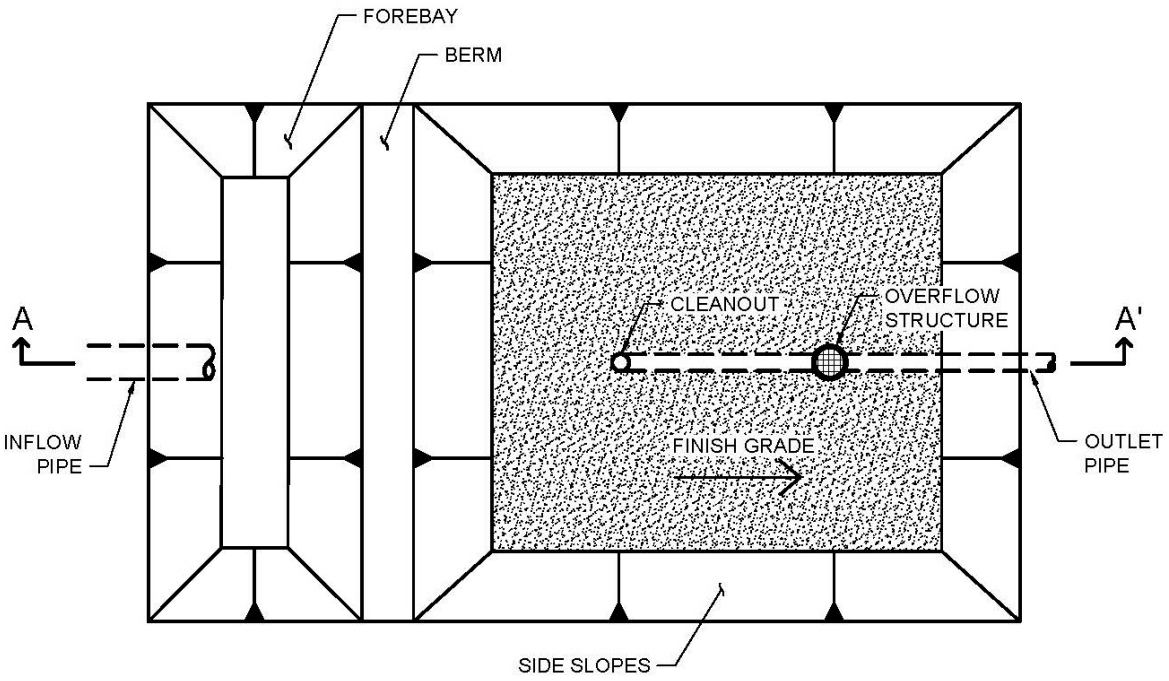


Figure E.23-1 : Typical Plan and Section View of a Sand Filter BMP

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 the City Engineer 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 the City Engineer if the following conditions are met: 1) incorporate design features (e.g. flow spreaders) to minimizing short circuiting of flows in the BMP and 2) incorporate additional design features requested by the City Engineer 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.

	Siting and Design	Intent/Rationale
□	Surface ponding is limited to a 36-hour drawdown time.	Provides required capacity to treat back to back storms. Exception to the 36 hour drawdown criteria is allowed if additional surface storage is provided using the curves in Appendix B.4.2.
□	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.
□	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 8 inches.	Minimum diameter required for maintenance by City crews. For privately maintained BMPs, a minimum underdrain diameter of 6 inches is allowed.

	Siting and Design	Intent/Rationale
□	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.

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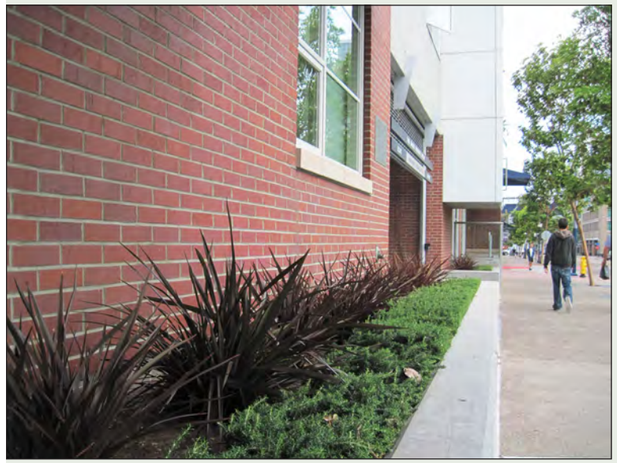
Flow-Through Planters

Description

Flow-through planters are vegetated IMP units that capture, temporarily store, and filter storm water runoff. The vegetation, ponding areas, and soil media in the flow-through planters remove contaminants and retain storm water flows from small drainage areas before directing the treated storm water to an underdrain system. Typically, Flow-through planters are completely contained systems; for this reason, they can be used in areas where geotechnical constraints prevent or limit infiltration or in areas of concern where infiltration should be avoided. Flow-through planters offer considerable flexibility and can be incorporated into small spaces, enhancing natural aesthetics of the landscape.

Treatment Efficiency			
Runoff Volume	Low	Metals	High
Sediment	High	Oil & Grease	High
Nutrients	Medium	Organics	High
Pathogens	High		



Siting and Suitability

Flow-through planters require relatively little space and can be easily adapted for urban retrofits such as building and rooftop runoff catchments or into new street and sidewalk designs. Because flow-through planters are typically fully-contained systems, available space presents the most significant limitation. To ensure healthy vegetation in the planter box, proper plant and media selection are important considerations for accommodating the drought, ponding fluctuations, and brief periods of saturated soil conditions. See Section 3 for details.

Drainage Area: To be less than 0.35 acres and fully stabilized.

Underground Utilities: Complete a utilities inventory to ensure that site development will not interfere with or affect the utilities.

Existing Buildings: Assess building effects (runoff, solar shadow) on the site. When completely contained, building setbacks are less of a concern.

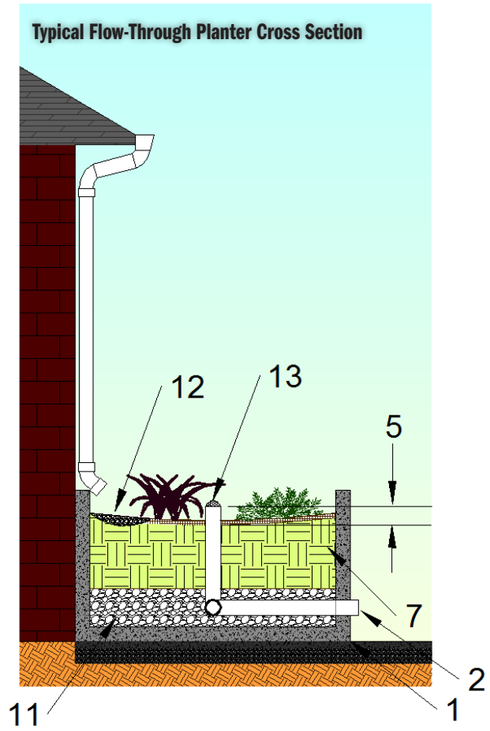
Water Table: Seasonal high water table should be located below the bottom of the planter.

Soil Type: Soils within the drainage area must be stabilized. If flow-through planters are fully contained, local soils must provide structural support.

Areas of Concern: Fully-contained flow-through planters can be used in areas with known soil contamination or in *hot spots*.

Design Considerations & Specifications *(see* Appendices A & G *for details)*

Design Component/ Consideration			General Specification
IMP Function	1	Impermeable liner	Planter boxes are typically contained within a concrete vault.
	2	Underdrain (required)	Underdrain required if subsoil infiltration < 0.5 in/hr. Schedule 40 PVC pipe with perforations (slots or holes) every 6 inches. If design is fully infiltrating, ensure that subgrade compaction is minimized.
	3	Cleanouts/ Observation Wells	Provide 6-inch diameter cleanout ports/observation wells for each underdrain pipe.
	4	Internal Water Storage (IWS)	With careful plant selection, the outlet can be slightly elevated to create a sump for additional moisture retention to promote plant survival and enhanced treatment. Top of IWS should be greater than 18 inches below surface.
	5	Temporary Ponding Depth	Provide 6–18 inches surface ponding (6–12 inches near schools or in residential areas); average ponding depth of 9 inches is recommended.
	6	Drawdown Time	Surface drawdown: 12–96 hrs, Subsurface dewatering: 48 hrs.
Soil Media	7	Soil Media Depth	2–4 feet (deeper for better pollutant removal, hydrologic benefits, and deeper rooting depths).
	8	Soil Media Composition	65% sand, 20% sandy loam, and 15% compost (from vegetation-based feedstock; animal wastes or by-products should not be applied) by volume.
	9	Media Permeability	5 in/hr infiltration rate for the flow-based SUSMP method (1–6 in/hr for alternative designs, as approved by local jurisdiction).
	10	Chemical Analysis	Total phosphorus < 15 ppm, pH 6–8, CEC > 5 meq/100 g soil. Organic Matter Content < 5% by weight.
	11	Drainage Layer	Separate soil media from underdrain with 2 to 4 inches of washed concrete sand (ASTM C33), followed by 2 inches of choking stone (ASTM No. 8) over a 1.5 ft envelope of ASTM No. 57 stone. Additional aggregate storage depth can be provided for hydromodification control.
Routing	12	Inlet/ Pretreatment	Provide stabilized inlets and energy dissipation. Install rock armored forebay, gravel splash pad, or upturn incoming pipes.
	13	Outlet Configuration	Online: All runoff is routed through system—install an elevated overflow structure or weir at the elevation of maximum ponding. Offline: Only treated volume is diverted to system—install a diversion structure or allow bypass of high flows.
Landscape	14	Mulch	Dimensional chipped hardwood or triple shredded, well-aged hardwood mulch 3-inches-deep.
	15	Vegetation	Native, deep rooting, drought tolerant plants.
	16	Multi-Use Benefits	Provide educational signage, artwork, or wildlife habitat.

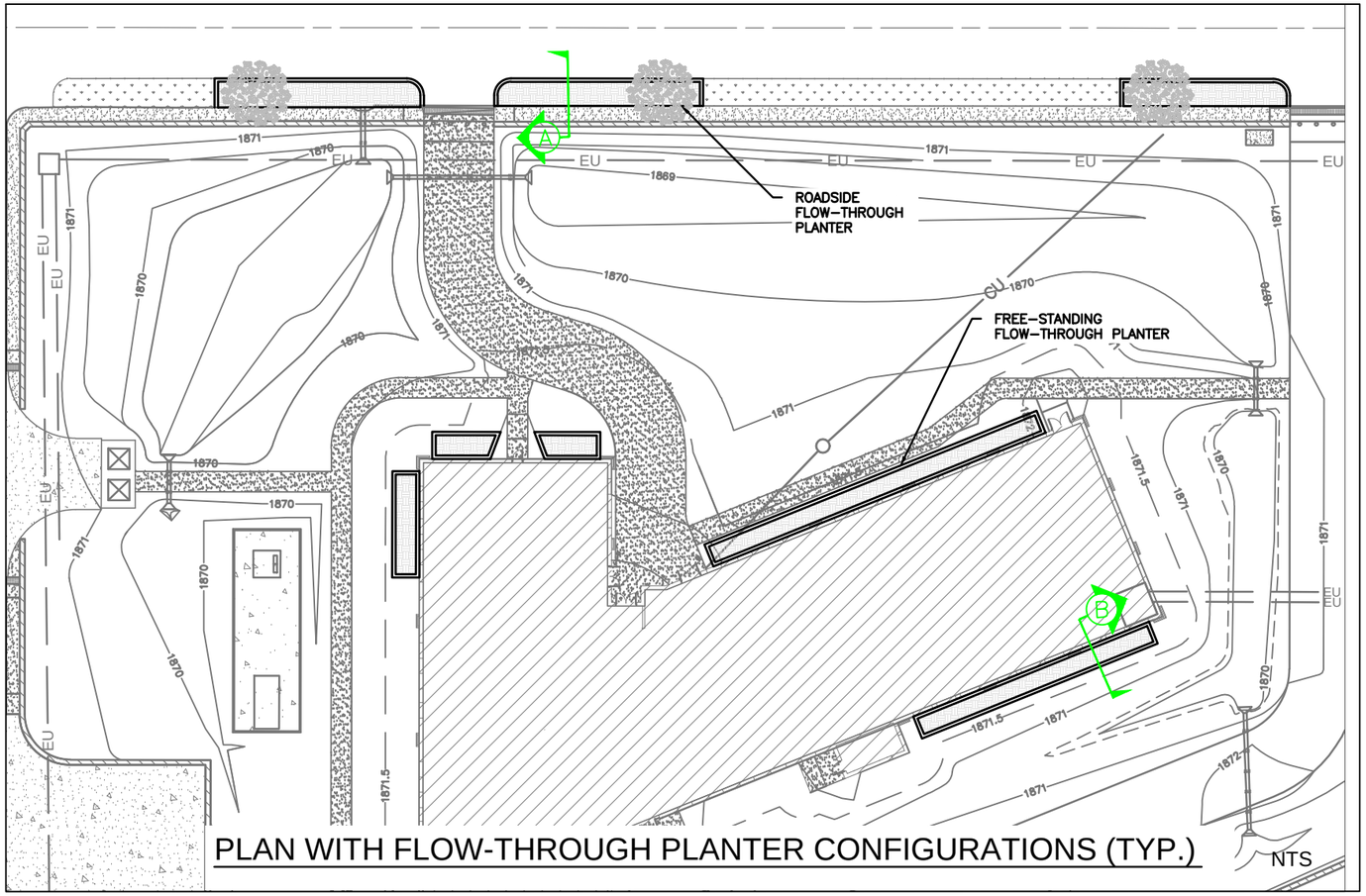


This diagram shows the design elements of a flow-through planter installed for water quality control. Flow-through planters can be used in highly urbanized settings or areas where infiltration is restricted. Additional surface storage or subsurface aggregate storage can be provided for hydromodification control.

Maintenance Considerations *(see* Appendix D *for detailed checklist)*

Task	Frequency	Indicator Maintenance is Needed	Maintenance Notes
Catchment inspection	Weekly or biweekly with routine property maintenance	Excessive sediment, trash, and/or debris accumulation on the surface of bioretention swale	Permanently stabilize any exposed soil and remove any accumulated sediment. Adjacent pervious areas may need to be regraded.
Inlet inspection		Internal erosion or excessive sediment, trash, and/ or debris accumulation	Check for sediment accumulation to ensure that flow into the bioretention swale is as designed. Remove any accumulated sediment.
Litter/leaf removal and misc. upkeep		Accumulation of litter and debris within bioretention swale area, mulch around outlet, internal erosion	Litter, leaves, and debris should be removed to reduce the risk of outlet clogging, reduce nutrient inputs to the bioretention area, and to improve facility aesthetics. Erosion should be repaired and stabilized.
Pruning	1–2 times/year	Overgrown vegetation that interferes with access, lines of sight, or safety	Nutrients in runoff often cause bioretention vegetation to flourish.
Mowing	2–12 times/year	Overgrown vegetation that interferes with access, lines of sight, or safety	Frequency depends on location and desired aesthetic appeal and type of vegetation.
Outlet inspection	1 time/year	Erosion at outlet	Remove any accumulated mulch or sediment.
Mulch removal and replacement	1 time/2–3 years	2/3 of mulch has decomposed	Remove decomposed fraction and top off with fresh mulch to a total depth of 3 inches
Remove and replace dead plants	1 time/year	Dead plants	Within the first year, 10 percent of plants can die. Survival rates increase with time.
Temporary Watering	1 time/2–3 days for first 1–2 months	Until establishment and during severely-droughty weather	Watering after the initial year might be required.
Fertilization	1 time initially	Upon planting	One-time spot fertilization for first year vegetation.

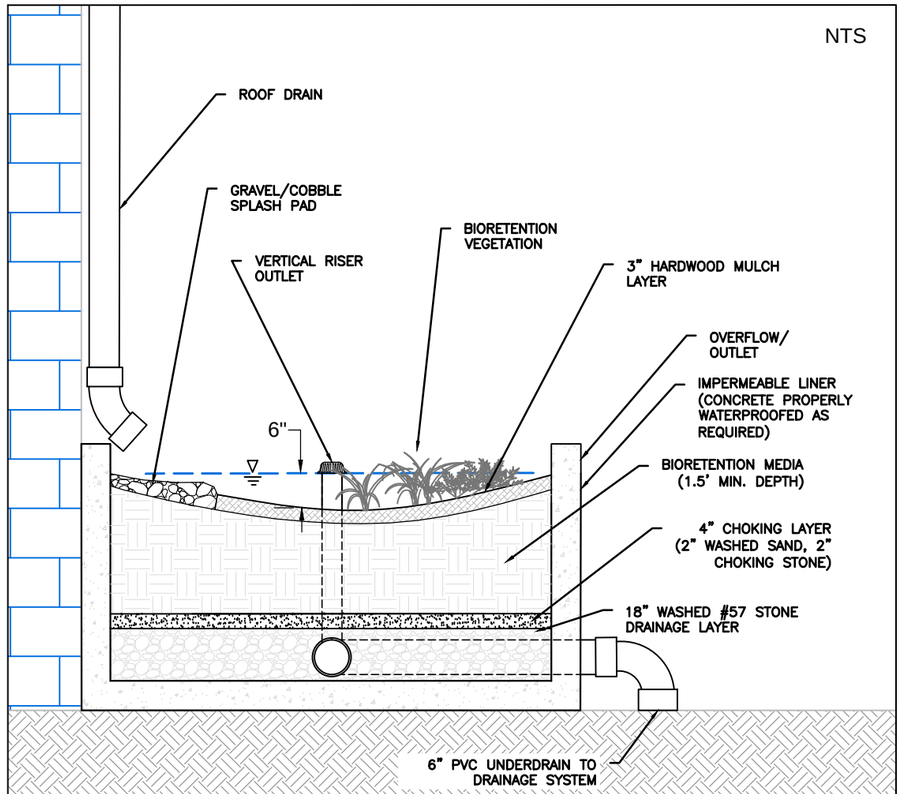
TETRA TECH



PLAN WITH FLOW-THROUGH PLANTER CONFIGURATIONS (TYP.)

NTS

NTS



SECTION B - FREE-STANDING
FLOW-THROUGH PLANTER

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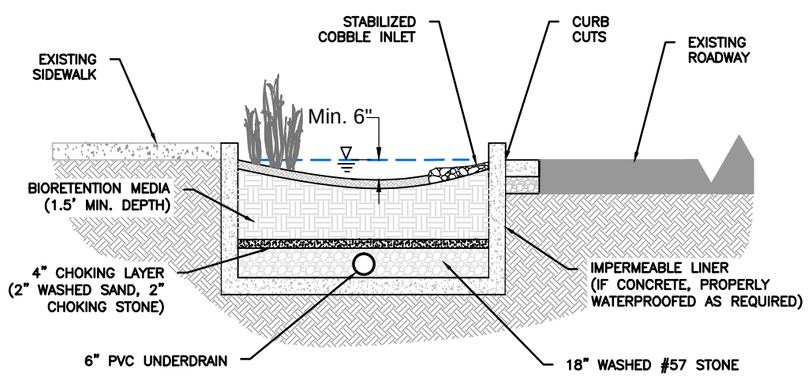

SECTION A - ROADSIDE FLOW-THROUGH PLANTER

SOIL MEDIA SPECIFICATIONS

TEXTURE AND COMPOSITION (BY VOLUME):

SOIL MEDIA SHOULD CONSIST OF A LOAMY SAND CONFORMING TO THE FOLLOWING SPECIFICATIONS:

- 65% SAND
- 20% SANDY LOAM
- 15% COMPOST

ORGANIC MATTER MATERIAL:

MAXIMUM 5% BY WEIGHT IN OVERALL SOIL MEDIA. ORGANIC MATTER SHOULD BASED FROM VEGETATION–BASED FEEDSTOCK AND INCLUDE NO ANIMAL MANURE OR BYPRODUCTS.

INFILTRATION RATES:

5 IN/HR INFILTRATION RATE FOR FLOW–BASED SUSMP METHOD (1–6 IN/HR FOR ALTERNATIVE DESIGNS, AS APPROVED BY LOCAL JURISDICTION.)

pH:

6 TO 8

CATION EXCHANGE CAPACITY (CEC):

GREATER THAN 5 MILLIEQUIVALENTS (MEQ)/100 GRAMS SOIL

PHOSPHORUS:

TOTAL PHOSPHORUS SHOULD NOT EXCEED 15 PPM

REFER TO THE COUNTY OF SAN DIEGO LID HANDBOOK APPENDIX G FOR FURTHER SOIL MEDIA SPECIFICATIONS.

CONSULTANT NAME
STREET NUMBER AND ADDRESS

SAN DIEGO COUNTY

FLOW–THROUGH PLANTERS

___% SUBMITTAL	PROJECT NO.: _____		DATE: _____
DRWN. BY: ____	DSGN. BY: _____	CHKD. BY: _____	SHEET NO.: __OF__

E.22 FT-2 Media Filters

Photo Credit: Contech Stormwater Solutions

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)

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 the City Engineer 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.4.2.
	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:
   (k) Divide the vault volume by the filter surface area.
   (l) Divide the result (a) by the design filter rate.

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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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A.10 Vegetated Filter Strip

Location: Oak Hills Church, San Antonio, Texas.

Figure A.10-1. Vegetated filter strip.

A.10.1 Design

The design of a vegetated filter strip can be broken down to a nine-step process. Table A.10-1 summarizes the steps, which this chapter describes in more detail.

Table A.10-1. Vegetated filter strip iterative design step process

Design step		Design component/ consideration	General specification
1	**Determine Design Flows**	Runoff flow rates	Refer to chapter 2 of the County SUSMP.
2	**Determine Available Filter Strip Width and Slope (A-92)**	Layout and site configuration	Based on existing site conditions.
3	**Determine Vegetative Cover (A-92)**	Vegetation	Native, drought-tolerant turf grasses (not bunch grasses) should be maintained at a height of no less than 4 inches (see Appendix E).

Design step		Design component/ consideration	General specification
4	**Calculate the Design Flow Depth (A-92)**	Design flow depth	Flow depth should be less than 1 inch to achieve effective water quality improvement.
5	**Calculate the Design Velocity (A-93)**	Design velocity	Velocity should be less than 1 inch to achieve effective water quality improvement.
6	**Calculate the Desired Length (A-93)**	Length and residence time	Filter strip length should provide for a 10-minute hydraulic residence time if substantial water quality improvement is desired.
7	**Design Level Spreader/Energy Dissipater if Needed (A-94)**	Level spreader	A level spreader and energy dissipater must be designed if concentrated flows are present.
8	**Determine if Soils Need to be Amended (A-94)**	Permeability	If additional water quality improvement and infiltration are desired, amend the soil with 2 inches of media.
9	**Specify Signage (A-94)**	Signage regulations	Signage should identify filter strips as stormwater treatment practice and prohibit foot traffic and other activities that could compact or rut filter strip soils.

A.10.1.1 Step 1. Determine the Design Flow Rate

The vegetated filter strip must be sized to fully convey the desired or required design storm volume and flow rates. Chapter 2 of the County SUSMP presents the relevant sizing regulatory requirements.

A.10.1.2 Step 2. Determine Available Filter Strip Width and Slope

Site conditions dictate the available filter strip width and slope. The recommended minimum width is 15 feet with a preferred width of 25 feet. The slope should not exceed 5 percent if possible. A hydraulic residence time of 10 minutes is desired for substantial water quality treatment.

A.10.1.3 Step 3. Determine Vegetative Cover

Vegetation specifications should meet the requirements outlined in the Vegetated Swale section (A.9.1.8).

A.10.1.4 Step 4. Calculate the Flow Depth of the Design Flow

Filter strips should be designed according to the maximum depth of flow and the maximum flow velocity.

Depth of runoff flow generated by the design storm in the filter strip should be limited to less than or equal to 1 inch. The design configuration having the greatest effect on those design standards are the contributing watershed area, longitudinal slope (along the direction of flow), the resistance to flow (Manning's n), and the width and slope of the filter strip. The design flow depth (d) is calculated on the

basis of the width and the slope (parallel to the flow path) using a modified Manning's equation as follows:

$$d = \left[Q_{wq} \times n_{wq} / 1.49 \times w \times s^{0.5} \right]^{0.6}$$

where

d = design flow depth (ft)
Q_{wq} Q_{wq} = water quality design flow rate (cfs)
w = width of strip perpendicular to flow that equals the width of impervious surface contributing to the filter strip (ft)
s = slope (ft/ft) of strip parallel to flow, average over the whole width
n_{wq} = Manning's roughness coefficient (0.025–0.03)

If d is greater than 1 inch, a smaller slope is required, or the filter strip may not provide substantial water quality improvement.

A.10.1.5 Step 5. Calculate the Design Velocity

Maximum design storm flow velocity should be limited to 1 foot per second. The design flow velocity is based on the design flow, design flow depth, and width of the strip as follows:

$$v_{wq} = Q_{wq} / dw$$

where

v_{wq} = water quality design flow velocity (ft/sec)
Q_{wq} = water quality design flow rate (cfs)
d = design flow depth (ft)
w = width of strip perpendicular to flow that equals the width of impervious surface contributing to the filter strip (ft)

A.10.1.6 Step 6. Calculate the Desired Length

Determine the required length (L) to achieve a desired residence time of 10 minutes using this equation:

$$L = 600 v_{wq}$$

where

L = swale length (ft)
v_{wq} = design water quality flow velocity (ft/sec)

If the design parameters as computed in steps 1 through 6 above are not within the recommended standards, an alternative IMP such as a grassed swale should be considered to treat stormwater runoff.

A.10.1.7 Step 7. Design Level Spreader/Energy Dissipater (Optional)

The transition of stormwater runoff from upslope, impervious areas to the vegetated filter strip is critical to the proper function of the integrated management practice (IMP). Flow should not be concentrated and should not cause erosion. Energy dissipaters typically consist of a gravel flow spreader. The gravel flow spreader should have the following characteristics:

- Minimum of 6 inches deep and 12 inches wide
- Surface is a minimum of 1 inch below the surface of the adjacent pavement

Concrete spreaders can also be incorporated for energy dissipation and flow spreading.

A.10.1.8 Step 8. Determine if Soils Need to be Amended (Optional)

If enhanced infiltration is desired, vegetated filter strips can be amended with 2 inches of soil media or plant-derived compost. See the Bioretention section (A.1.1.5) for media specifications. The amendment should be mixed into the native soils to a depth of 6 inches to prevent soil layering.

A.10.1.9 Step 9. Specify Signage

Signs on-site should identify the area as a stormwater IMP, prohibit foot traffic, and instruct maintenance crews to maintain the vegetation at a height between 4 to 6 inches.

A.10.2 Critical Construction Considerations

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

A.10.3 Operations and Maintenance

The primary maintenance requirement of a vegetated filter strip is managing vegetation in the filter strip. Table A.10-2 describes the maintenance activities for vegetated filter strips.

Table A.10-2. Inspection and maintenance tasks

Task	Frequency	Maintenance notes
Mowing	Two to twelve times per year	As needed to maintain aesthetics. Grass height should be a minimum of 2 inches.
Inlet inspection	Once after first major rain of the season, then monthly during the rainy season	Check for sediment accumulation to ensure that flow into the system is as designed. Remove any accumulated sediment.
Miscellaneous upkeep	Twelve times per year	Tasks include trash collection and spot weeding.

A.10.4 References

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

E.21 FT-1 Vegetated Swales

Location: Eastlake Business Center, Chula Vista, California; Photo Credit: Eric Mosolgo

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

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)

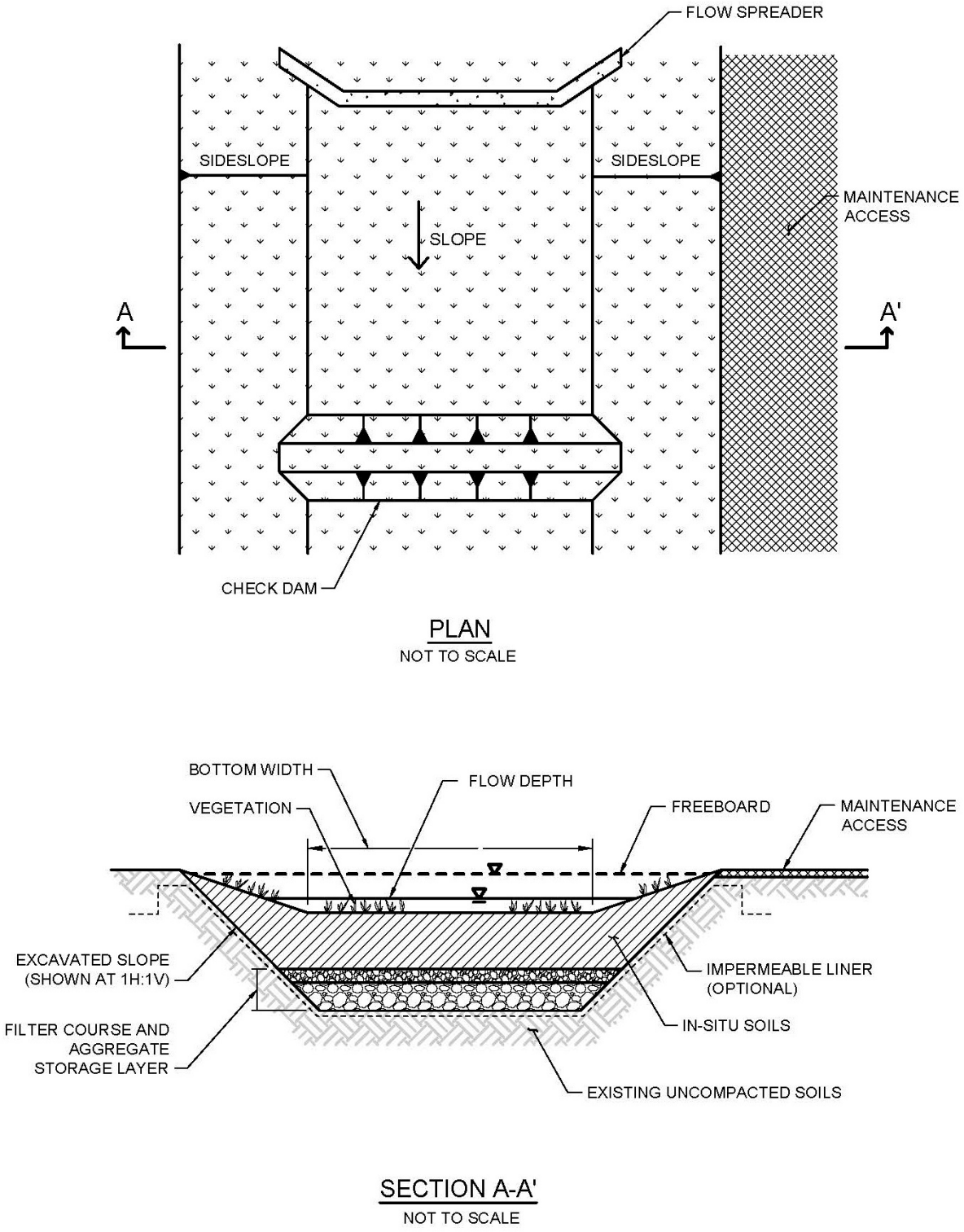

Figure E.21-1 : Typical Plan and Section View of a Vegetated Swale BMP

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 the City Engineer 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 2 inches of freeboard is provided.	Freeboard minimizes risk of uncontrolled surface discharge.

Siting and Design		Intent/Rationale
□	Minimum 100 foot flow length.	Longer flow lengths provide increased pollutant removal via filtration and greater incidental infiltration.
□	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: BSM specification in Appendix F.3; 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.
□	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.

Siting and Design		Intent/Rationale
□	Filter course is washed and free of fines.	Washing aggregate will help eliminate fines that could clog the facility and impede infiltration.
□	To reduce clogging potential, a two-layer filter course (aka choking stone system) is used consisting of one 3" layer of clean and washed ASTM 33 Fine Aggregate Sand overlying a 3" layer of ASTM No 8 Stone (Appendix F.4).	This specification has been developed to maintain permeability while limiting the migration of media material into the stone reservoir and underdrain system.
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.
□	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 8 inches.	Minimum diameter required for maintenance by City crews. For privately maintained BMPs, a minimum underdrain diameter of 6 inches is allowed.
□	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 8-inch diameter and lockable cap is placed, at the farthest, every 300 feet as required based on underdrain length (50 feet is recommended).	Properly spaced cleanouts will facilitate underdrain maintenance. For privately maintained BMPs, cleanout diameter of 6 inches is allowed.

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.

APPENDIX

J OPERATIONS AND MAINTENANCE PLAN BASIC PROJECT INFORMATION FORM

OPERATIONS & MAINTENANCE MANUAL

BASIC PROJECT INFORMATION COVER SHEET

Project Name	
Project Location [Street Address if available, or intersection and/or APN]	
Owner/Operator Information	
Name of Owner	
Person(s) responsible for operating/maintaining stormwater treatment measures	
Company or Affiliation	
Address	
Telephone Number	
Email Address	
Describe method of funding on-going maintenance and operation of stormwater treatment measures	
Stormwater Treatment Measure	
Measure Type:	
Installation Date:	
Design Specifications	
Measure Type:	
Installation Date:	
Design Specifications	
Measure Type:	
Installation Date:	
Design Specifications	

Attach additional sheets if needed.