West Placer

Storm Water Quality Design Manual

April 2016

Revised May 2018

Acknowledgements

Project Sponsors and Funding

Preparation of this document was funded in part from the Cooperative Endangered Species Conservation Fund (Section 6) Planning Grants administered by the California Department of Fish and Wildlife through Agreement No. P1382019. The Agreement is for several work products including this document. Additional funding and in-kind services were provided by the County of Placer, the City of Roseville, the City of Auburn, the City of Lincoln, and the Town of Loomis. In-kind services were provided by the Technical Advisory Committee members. Paid consultants were cbec eco engineering, inc., and CDM Smith.

Steering Committee

Jennifer Byous, Placer County	Jennifer Hanson, City of Lincoln
Rebecca Taber, P.E., Placer County	Gorman Lau, P.E., Larry Walker Associates, representing City of Lincoln
Mary Keller, P.E., CFM, QSD, Placer County	Brit Snipes, Town of Loomis
Candace Rousselet, Placer County	Bernie Schroeder, City of Auburn
Chris Kraft, P.E., City of Roseville	Edgar Medina, City of Auburn

Technical Advisory Committee

Jack Paddon, Williams and Paddon Architects + Planners, Inc.	Harvey Oslick, Wood Rogers, Inc.
Craig Seltenrich, Dudek	Thomas Plummer, Civil Engineering Solutions, Inc.
Ryan O'Keefe, West Park Communities	Steve Fuhrman, Fuhrman Leamy Land Group
Gregg Bates, Dry Creek Conservancy	Ron Enz, McKay & Somps
Ron Wood RFE Engineering, Inc.	

Consultant Team

cbec eco engineering, inc.	CDM Smith
Chris Bowles, PhD, P.E., Melanie Carr, M.S., P.E., Scott Walls, MLA.EP	Stefan Schuster, P.E. Steven Wolosoff, BCES Russell Vadenais, P.E. Nola Mitchell, EIT

Questions or comments about the Manual should be directed to local jurisdiction storm water program staff in the jurisdictional agency where the proposed project is located.

Web Site (download Manual here):

http://www.placer.ca.gov/lowimpactdevelopment

Disclaimer

The contents of this Manual do not necessarily represent the policies of the supporting agencies as identified on the cover page. Although every reasonable effort has been made to ensure the integrity of the document, the supporting agencies do not make any warranty or representation, expressed or implied, with respect to the accuracy or completeness of the information contained herein.

The storm water controls described herein are intended to meet the minimum standard of "reducing the discharge of pollutants from their MS4s to waters of the U.S. to the maximum extent practicable" as required the State Water Resources Control Board Water Quality Order No. 2013-001-DWQ National Pollutant Discharge Elimination System (NPDES) General Permit No. CAS000004 Waste Discharge Requirements for Storm Water Discharges from Small MS4s. Other permit requirements may apply and it is the responsibility of the project owner to ensure compliance with all applicable regulations.

Mention of trade names or commercial products does not constitute endorsement or recommendation of those products.

Table of Contents

Chapter 1 Introduction 1-1

1.1 Regulatory Background .... 1-2 -
1.2 Purpose of this Manual .... 1-3 -
1.3 Use of Outside References .... 1-4 -
1.4 How This Manual Relates to Other Requirements .... 1-5 -
1.5 Manual Revision Process .... 1-5 -

Chapter 2 Projects Subject to Requirements 2-1

2.1 Project Location .... 2-1 -
2.2 Project Categorization .... 2-4 -
2.3 Exclusions .... 2-7 -
2.4 Project Submittal and Approval Process .... 2-8 -

Chapter 3 Pre-Project Site Assessment 3-1

3.1 Site Assessment .... 3-1 -
3.1.1 Soil, Geologic, and Groundwater Characteristics .... 3-2 -
3.1.2 Topography, Hydrology, and Drainage Characteristics .... 3-4 -
3.1.3 Existing Vegetation and Natural Areas .... 3-5 -
3.1.4 Contaminated Soil or Groundwater .... 3-6 -
3.1.5 Existing Improvements and Easements .... 3-6 -

Chapter 4 Site Planning and BMP Selection 4-1

4.1 Small Projects .... 4-1 -
4.2 Regulated Projects .... 4-2 -
4.2.1 Site Plan Layout .... 4-4 -
4.2.2 Source Control Measures .... 4-6 -
4.2.3 Site Design Measures (LID BMP Selection) .... 4-8 -
4.2.4 Storm Water Treatment and Baseline Hydromodification Management 4-10 -
4.3 Hydromodification Management Projects .... 4-12 -
4.4 In Lieu Program .... 4-13 -

Chapter 5 BMP Inspection, Operation and Maintenance 5-1

5.1 Operation and Maintenance Submittal Requirements at the Permitting Stage .... 5-1 -
5.2 Annual Self-Certification Reports .... 5-1 -

Chapter 6 Developing a Post-Construction Storm Water Quality Plan (SWQP) 6-1

Using the SWQP Template (Appendix A) .... 6-2 -
Title Page .... 6-2 -
Section 1 General Project Information .... 6-2 -
Section 2 Requirements for Small Projects .... 6-3 -
Section 3 Requirements for Regulated Projects .... 6-6 -
Section 4 Requirements for Hydromodification Management Projects .... 6-16 -
Section 5 Inspection and Maintenance of Post-Construction BMPs .... 6-21 -
Section 6 Compliance Checklist .... 6-21 -

Glossary

List of Figures

Figure 2-1 Phase II MS4 Permit Regulatory Boundaries .... 2-2 -
Figure 2-2 CARP Regulatory Boundaries .... 2-3 -
Figure 2-3 Project Category Decision Tree .... 2-4 -
Figure 2-4 SWQP Development and Submittal Process .... 2-8 -
Figure 4-1 Site Plan Example .... 4-5 -
Figure 4-2 Selection of Storm Water Treatment/Baseline Hydromodification Controls 4-11

List of Tables

Table 2-1 Project Categories .... 2-5 -
Table 2-2 Special Case Regulated Projects .... 2-6 -
Table 4-1 Selection of Site Design Measures for Small Projects[1] .... 4-2 -
Table 4-2 Selection of Site Design Measures for Regulated Projects[1] .... 4-9 -
Table 6-1 Required SWQP Sections by Project Category .... 6-1 -

Appendices

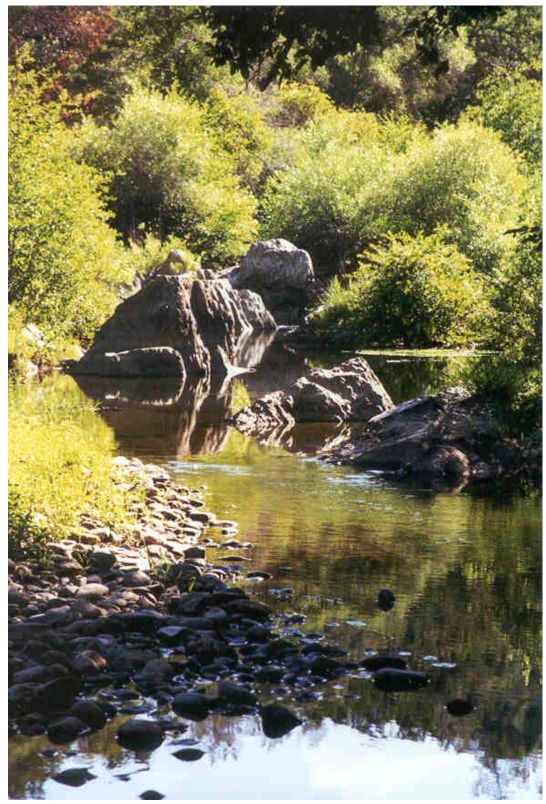
Appendix A .... Automated Template for Post-Construction Storm Water Quality Plan
Appendix B .... Site Design Measures Fact Sheets
Appendix C .... Source Control Measures Selection Table
Appendix D .... SWQP Examples

Chapter 1

Introduction

This Storm Water Quality Design Manual (Manual) has been developed cooperatively between Placer County, the City of Roseville, the City of Lincoln, the City of Auburn, and the Town of Loomis to provide a consistent approach to address storm water management within the West Placer region. For the purposes of this Manual, the West Placer region refers to the areas of Placer County subject to the requirements of this Manual as described in Chapter 2.

As development transforms undeveloped lands with impervious surfaces such as pavement, concrete, buildings, or even compacted soils, the natural infiltration of rainfall into the soil and absorption of rainfall by vegetation is inhibited. This reduction of natural retention of rainfall increases the frequency and intensity of surface runoff which can mobilize and transport sediment and pollutants into our lakes, streams and wetlands. The resulting changes in runoff patterns can also disrupt natural streams through a process known as hydromodification, causing impacts such as increased channel erosion, flooding, loss of habitat, and damage to aquatic ecosystems.



Hydrologic changes caused by development can damage our natural waterways. Photo Credit – Placer County

The State of California, together with local municipalities, have developed storm water management strategies to address the adverse effects of development by implementing regulations and storm water management programs to preserve our waterways and natural hydrologic processes. Storm water permits across the country now include requirements for low impact development (LID) strategies that focus on preserving key elements of a project site's pre-development hydrologic function.

LID is a design strategy where storm water runoff is treated as a valuable resource that can recharge groundwater supplies, protect and enhance natural habitat and biodiversity, and add value to new development or redevelopment projects. Rather than discharging storm water runoff as a waste product, projects are designed to include a diverse set of post-construction storm water controls, or Best Management Practices (BMPs) that infiltrate, evapotranspire, or biotreat storm water runoff. By retaining storm water runoff on-site, downstream receiving waters are provided with protection from increased pollutant loads and alterations of hydrologic functions otherwise impacted by increased impervious surfaces and human activities. By protecting receiving waters, LID strategies help maintain beneficial uses of these resources including potable water sources, recreational uses and fisheries. LID can also add value to new development and redevelopment by integrating storm water management features with landscaping and other improvements rather than the more traditional approach of constructing drainage impact mitigation measures (e.g., detention basins) as disconnected, often fenced off, features.

The intent of this Manual is to promote the following LID goals:

- Minimize adverse impacts of storm water runoff on water quality, biological integrity of receiving waters, and beneficial uses of water bodies.
- Minimize the percentage of impervious surfaces on land development projects and implement mitigation measures to approximately preserve the overall pre-development water balance through infiltration, evapotranspiration, and capture and use of storm water.

By directing storm water to natural or landscaped areas, rather than efficiently conveying it to the nearest water body, we protect our natural water resources.
Photo Credit – Greg Bates

- Minimize pollutant loadings from impervious surfaces such as roof tops, parking lots, and roadways through the use of properly designed, technically appropriate storm water controls, including source control measures or good housekeeping practices, LID planning and design strategies, and treatment control BMPs.
- Guide proper selection, design and maintenance of storm water BMPs to address pollutants generated by land development, minimize post-development surface flows and velocities, assure long-term functionality of BMPs, and avoid vector breeding.

1.1 Regulatory Background

Local storm water regulations originate from federal regulations that began in 1987 when the Clean Water Act (CWA) was amended by the Water Quality Act to formally include storm water runoff. Congress subsequently authorized the U.S. Environmental

Protection Agency (EPA) to administer the National Pollutant Discharge Elimination System (NPDES) program and issue storm water permits to municipalities regulating storm water discharges. In California, this authority was delegated from EPA to the California State Water Resources Control Board (SWRCB) and associated Regional Water Quality Control Boards (RWQCBs).

In addition to storm water regulations, RWQCBs certify that permits under Section 404 of the CWA issued by the U.S. Army Corps of Engineers (Corps) meet state water quality requirements pursuant to Section 401 of the CWA. The 401 certification program provides for protection of the physical, chemical, and biological integrity of waters. Also, pursuant to the Porter-Cologne Water Quality Act, adopted by the state, RWQCBs also regulate activities that impact "Waters of the State," which include certain wetlands and waters not regulated by the Corps.

The Central Valley RWQCB (CVRWQCB) is responsible for issuing NPDES permits and 401 certifications in the West Placer region. NPDES Municipal Separate Storm Sewer System (MS4) Permits require municipalities to implement a variety of programs to prevent pollution, improve and protect storm water quality, reduce storm water runoff, and enhance the ecologic vitality of local creeks and waterways. MS4 Permits also require that municipalities regulate new development and redevelopment projects within their jurisdiction.

1.2 Purpose of this Manual

This Manual provides guidance for projects that are required to comply with CWA regulations and presents LID design standards to reduce runoff, treat storm water, and provide baseline hydromodification management. This Manual is a regulatory compliance tool that addresses the requirements of the SWRCB Water Quality Order No. 2013-001-DWQ, NPDES General Permit No. CAS000004, Waste Discharge Requirements for Storm Water Discharges from Small MS4s (Phase II MS4 Permit).

Consistent with the CWA and the Phase II MS4 Permit, this Manual requires storm water controls to reduce pollutants to the maximum extent practicable (MEP). The MEP standard is an ever-evolving, flexible, and advancing concept, which considers technical and economic feasibility. Interpretation of the MEP standard will be by the jurisdictional agency that has discretion over the project.

The process of developing a Storm Water Quality Plan (SWQP) for new and redevelopment projects is outlined in this Manual and a SWQP Template is provided in Appendix A. The SWQP documents a project's compliance with the Phase II MS4 Permit and provides a standardized format for complete and accurate analyses which will result in more efficient design, review, and project approval.

The following websites are available to view additional information regarding each jurisdiction's storm water program activities:

www.placer.ca.gov/stormwater

www.roseville.ca.us/stormwater

The reader is encouraged to review Section E.12 - Post Construction Storm Water Management Program of the Phase II MS4 Permit which can be found at the following website:

http://www.waterboards.ca.gov/water_issues/programs/stormwater/phase_ii_municipal.shtml

In addition to the Phase II MS4 Permit, this Manual addresses requirements under Placer County Aquatic Resources Program (CARP). The CARP is currently under development and, once the program is approved, this Manual will be updated to incorporate guidance for using LID strategies to minimize impact to aquatic resources. The reader is encouraged to review the draft CARP document, which can be found at the following website:

http://www.placer.ca.gov/~/media/cdr/Planning/PCCP/PolicyDoc2011/Appendix%20M.pdf

1.3 Use of Outside References.

Throughout this Manual, several website references are made to assist the designer with the SWQP development. The following websites provide certain baseline information that is applicable to the understanding and development of the plan:

- Placer County Stormwater Management Manual (SWMM)
  http://www.placer.ca.gov/~/media/dpw/flood%20control/documents/Swmm2004.pdf
- Placer County Planning Division
  http://www.placer.ca.gov/Departments/CommunityDevelopment/Planning.aspx
- Natural Resources Conservation Service Web Soil Survey -
  http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm -
- Natural Resources Conservation Service TR-55 Manual -
  http://www.hydrocad.net/pdf/TR-55%20Manual.pdf -
- California State Water Resources Control Board Database of Registered - Contaminated Sites -
  SWRCB: http://geotracker.waterboards.ca.gov/
- U.S. EPA Brownfields Information -
  EPA Brownfield: http://www.epa.gov/brownfields -

- CA Department of Toxic Substances Control Former Brownfields and Agricultural Sites
  http://www.dtsc.ca.gov/SiteCleanup/Brownfields/

  http://www.dtsc.ca.gov/SiteCleanup/Cortese_List.cfm

- California Stormwater Quality Association - www.casqa.org/resources/bmp-handbooks/ -

- California State Water Resources Control Board Impaired Water Bodies Information www.waterboards.ca.gov/water_issues/programs/water_quality_assessment/#impaired

1.4 How This Manual Relates to Other Requirements

This Manual is intended to satisfy the specific requirements of the Phase II MS4 Permit and CARP, as discussed above. Additional design requirements imposed by other regulations and permits, such as construction and industrial permits, local grading ordinances, CAL Green, California Environmental Quality Act (CEQA), and hydraulic design for flood control, still apply as appropriate. The governing agencies overseeing these regulations may, at their discretion, determine that designs in accordance with this Manual satisfies another requirement. Additionally, coverage under another regulation may trigger the requirement to design in accordance with this Manual. Please check with the local governing agency for specific requirements.

1.5 Manual Revision Process

It is recognized that LID is an emerging field, and that while every effort has been made to ensure that this Manual is complete and accurate, revisions and/or amendments may be necessary. In addition, the Phase II MS4 Permit and CARP are on a 5-year reissuance cycle, which may trigger required updates to this Manual. It is anticipated that Manual revisions will generally coincide with Phase II MS4 Permit revisions following a 5-year revision schedule. The current Phase II MS4 Permit expires in June 2018.

Administrative revisions to improve permit processing and correct problems outside of the next scheduled Phase II MS4 Permit revision shall be authorized cooperatively by the participating jurisdictions' Directors (or their designee responsible for Storm Water compliance). These jurisdiction include the County of Placer, the City of Roseville, the City of Lincoln, the City of Auburn, and the Town of Loomis.

This page intentionally left blank.

Chapter 2

Projects Subject to Requirements

The post-construction storm water control requirements described herein apply to new development and redevelopment projects approved after July 1, 2015. These requirements vary depending on the project's location and the amount of impervious surface that is being created. This chapter introduces a categorization process to define the project type and then determine the corresponding storm water requirements.

2.1 Project Location

The Phase II MS4 Permit compliance boundary defines the areas that are subject to the requirements of this Manual. The boundary encompasses the urbanized areas of western Placer County and projects within this boundary (except the City of Rocklin), as well as major planning project areas under review by the participating jurisdictional agencies. Projects located outside of the Phase II MS4 Permit compliance boundary and planning project areas, but within the CARP compliance boundary will be addressed in a future revision to this Manual upon adoption of the CARP. Projects located outside of the Phase II MS4 Permit, CARP, and planning project area boundaries are not subject to the requirements of this Manual, but may be subject to other post-construction storm water requirements (e.g., construction general permit, industrial general permit). The Phase II MS4 Permit and planning project areas are presented in Figure 2-1 and the CARP compliance areas are presented in Figure 2-2. The union of these areas plus any major planning project areas defines the West Placer region for the purposes of this Manual.

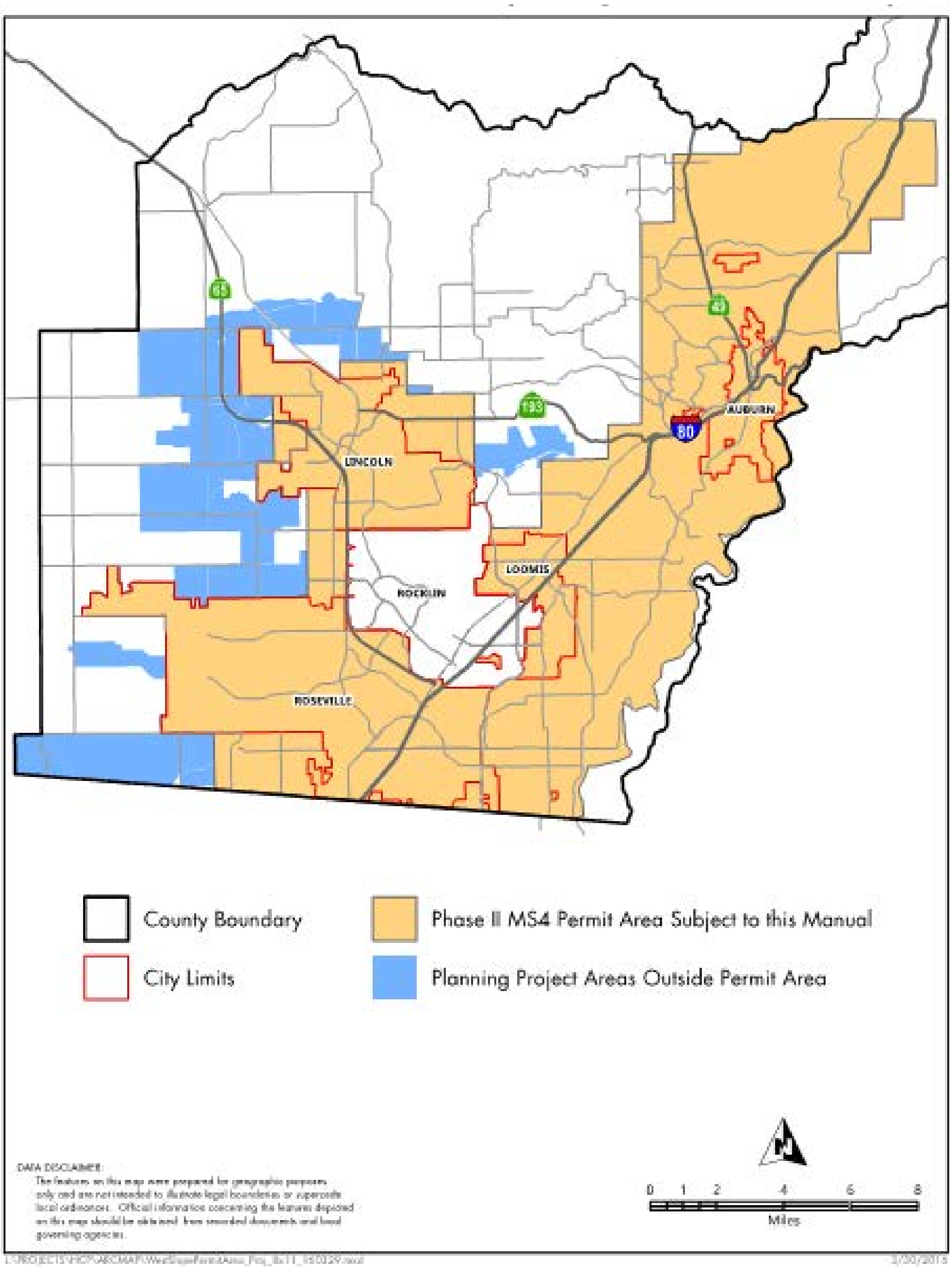
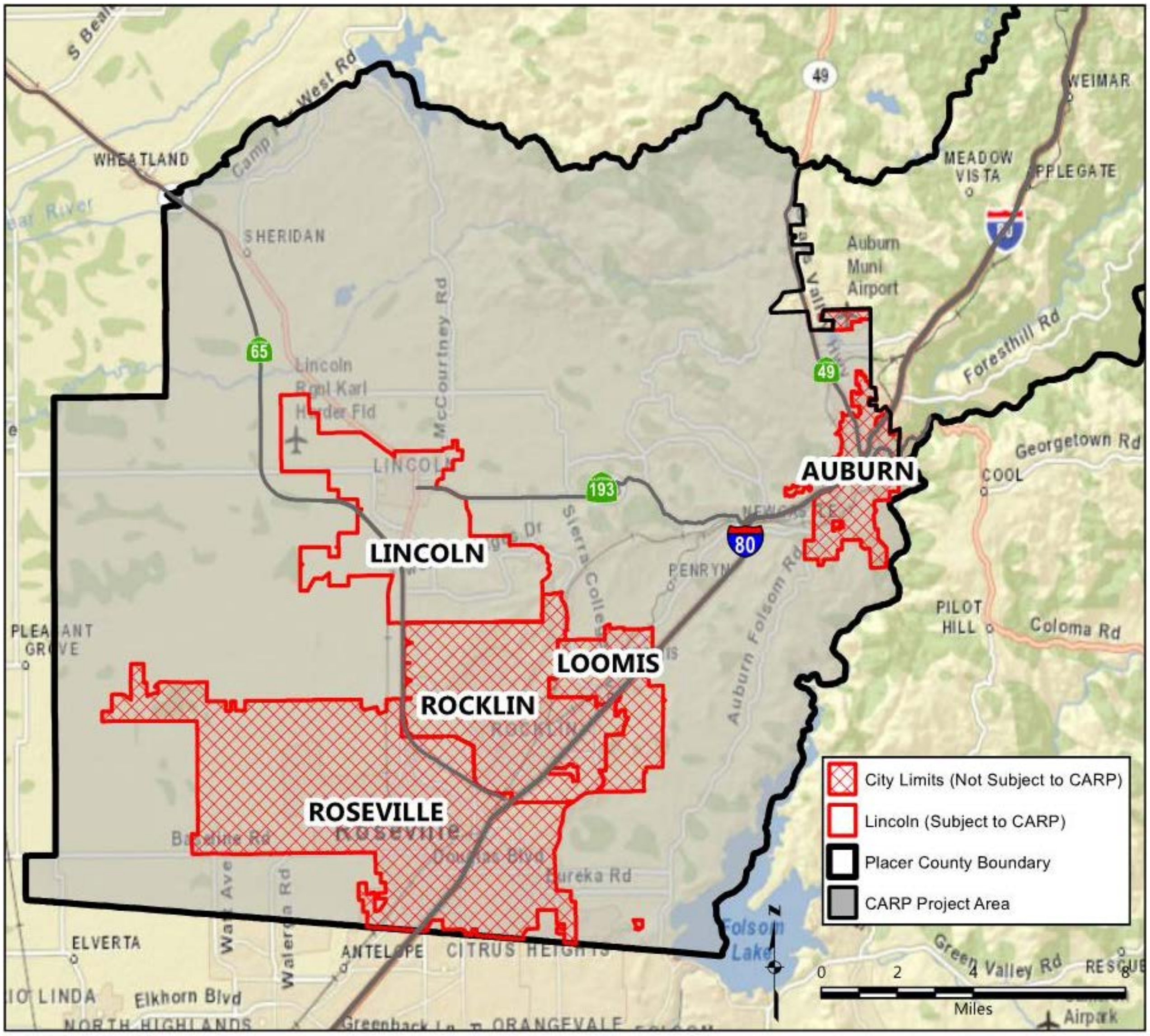


Figure 2-1
Phase II MS4 Permit Regulatory Boundaries

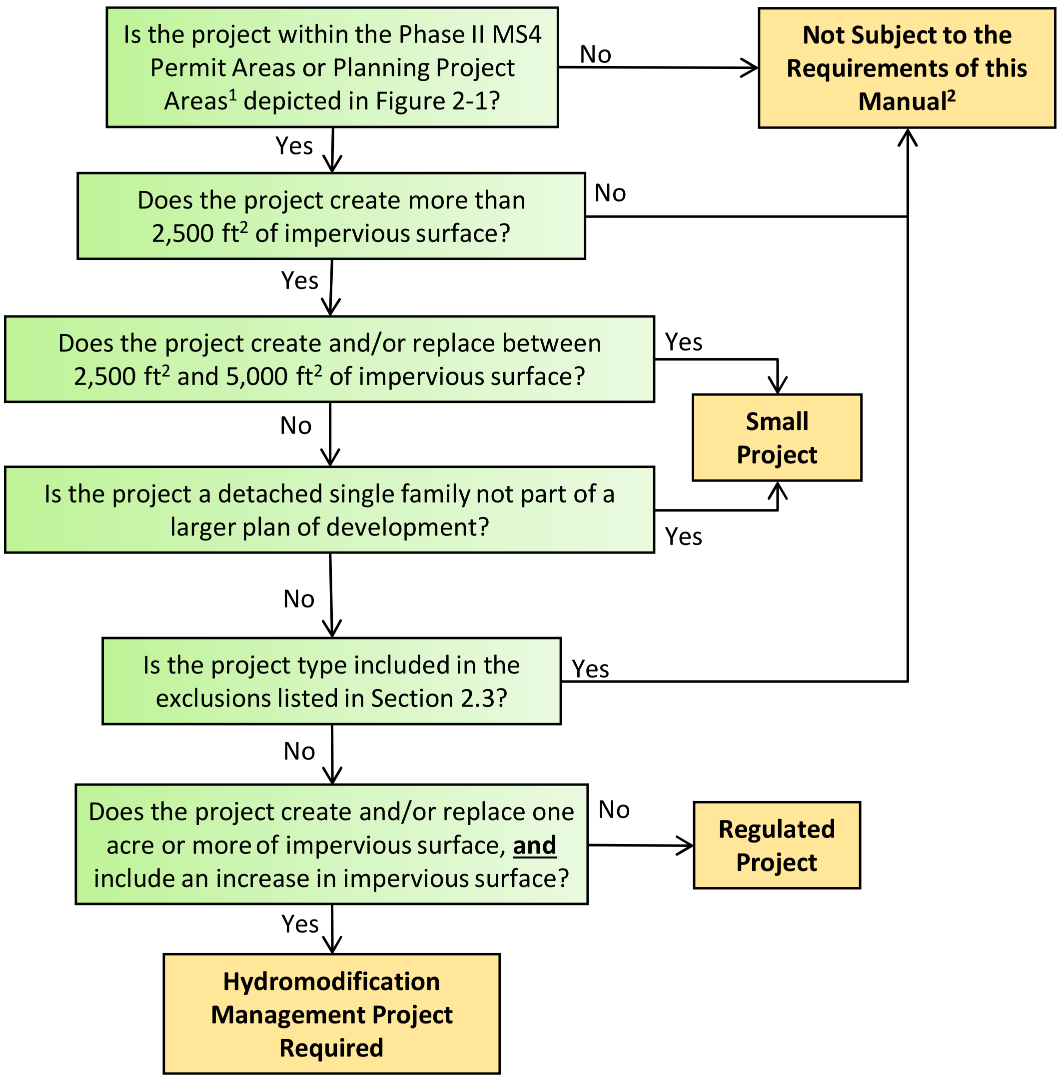


DATA DISCLAIMER:
The features on this map were prepared for geographic purposes only and are not intended to illustrate legal boundaries or supercede local ordinances. Official information concerning the features depicted on this map should be obtained from recorded documents and local governing agencies.
Base map provided by ESRI World Street Map.

Figure 2-2
CARP Regulatory Boundaries

2.2 Project Categorization

The distinction between Small Projects and Regulated Projects is based on the amount of impervious surface that is created or replaced. The decision tree, below, may be used to assist in determining the project category.



1. Future planning projects not shown on Figure 2-1 may be subject to this Manual as determined by the jurisdictional agency.

2. Projects located within the CARP Boundary in Figure 2-2 may be subject to future requirements upon adoption of the CARP. Other SWRCB General Orders (e.g., Construction General Permit, Industrial General Permit) may apply to a project.

Figure 2-3
Project Category Decision Tree

The definitions of the project categories and a summary of the associated storm water requirements are presented in Table 2-1. Supplemental information for special case Regulated Projects is presented in Table 2-2.

Table 2-1 Project Categories

Project Category	Definition	Post Construction Requirements	Reference for Additional Information
Small Projects	All projects that create and/or replace (including projects with no net increase in impervious footprint) more than 2,500 and up to 5,000 square feet of impervious surface, including detached single family homes that create and/or replace 2,500 square feet or more of impervious surface and are not part of a larger plan of development.	Minimum of one Site Design Measure	Section 4.1
Regulated Projects	All projects that create and/or replace 5,000 square feet or more of impervious surface. Includes new development and redevelopment projects on public or private land that fall under the planning and permitting authority of the jurisdictional agency.	Site Assessment and Layout to optimize for capture and treatment of storm water	Chapter 3
		Source Control Measures	Section 4.2.2
		Site Design Measures to the extent technically feasible	Section 4.2.3
		Storm Water Treatment and Baseline Hydromodification Measures	Section 4.2.4
		Operations and Maintenance Plan	Section 5.1

Table 2-2 Special Case Regulated Projects

<table>
<tr><th>Project Category</th><th>Definition</th><th>Post Construction Requirements</th></tr>
<tr><td rowspan="2">Regulated Redevelopment Projects</td><td rowspan="2">Any land-disturbing activity that results in the creation, addition, or replacement of 5,000 square feet or more exterior impervious surface area on a site on which some past development has occurred.</td><td>Where a redevelopment project results in an increase equal to or greater than 50 percent of the impervious surface of a previously existing development, runoff from the entire project, consisting of all existing, new, and/or replaced impervious surfaces, must be treated per the requirements for Regulated Projects to the extent feasible.</td></tr>
<tr><td>Where a redevelopment project results in an increase of less than 50 percent of the impervious surface of a previously existing development, only runoff from the new and/or replaced impervious surface, must be treated per the requirements for Regulated Projects.</td></tr>
<tr><td>Regulated Road Projects and Regulated Linear Underground/ Overhead Projects (LUPs)</td><td>Any of the following types of projects that create 5,000 square feet or more of newly constructed contiguous impervious surface and that are public road projects and/or fall under the building and planning authority of a Permittee:
1. New streets or roads, including sidewalks and bicycle lanes built as part of the new streets or roads.
2. Widening of existing streets or roads with additional traffic lanes.
3. LUPs</td><td>▪ Infiltrate impervious surface runoff onsite from the post-construction 85th percentile 24-hour storm event.

▪ Treatment of runoff that cannot be infiltrated onsite shall follow U.S. EPA guidance regarding green infrastructure to the extent feasible (EPA, 2008).

▪ Where the addition of traffic lanes results in an alteration of equal to or greater than 50 percent of the impervious surface of an existing street or road, runoff from the entire project, consisting of all existing, new, and/or replaced impervious surfaces, must be included in the treatment system design.

▪ Where the addition of traffic lanes results in an alteration of less than 50 percent of the impervious surface of an existing street or road, only runoff from the new, and/or replaced impervious surface must be included in the treatment system design.</td></tr>
</table>

Table 2-2 Special Case Regulated Projects

Project Category	Definition	Post Construction Requirements
Hydromodification Management Projects	Regulated Projects that create and/or replace one acre or more of impervious surface. Projects that do not increase impervious surface area over the pre-project condition are not Hydromodification Management Projects.	Same as for Regulated Projects plus: ▪ Post project runoff shall not exceed estimated pre-project flow rate for the 2-year, 24-hour storm.

2.3 Exclusions

Projects located outside of the West Placer region (Figures 2-1 and 2-2) and projects that create and/or replace less than 2,500 square feet of impervious surface are excluded from the requirements of this Manual. The following additional specific project cases are also excluded:

- Interior remodels;
- Routine maintenance and repair activities that are conducted to maintain original line and grade, hydraulic capacity, and original purpose of facility such as: exterior wall surface replacement, reroofing, and pavement resurfacing within the existing footprint;
- Sidewalks and bicycle lanes 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;
- Sidewalks, bicycle lanes, or trails constructed with permeable surfaces;
- Trenching, excavation and resurfacing associated with LUPs, unless the LUP has a discrete location that has 5,000 square feet of more of newly constructed contiguous impervious surface.
- Pavement grinding, surface treatments, and repaving and/or resurfacing of existing roadways and parking lots;
- Construction of new sidewalks, pedestrian ramps, or bike lanes on existing roadways;

- Emergency redevelopment activities required to protect public health and safety; and,
- Routine replacement of damaged pavement such as pothole repair or - replacement of short, non-contiguous sections of roadway. -

2.4 Project Submittal and Approval Process

Once it is determined that a project is required to incorporate post-construction storm water controls in accordance with this Manual, a Preliminary SWQP is required to be developed and submitted as part of the project entitlement application package and entitlement approval process, followed by a Final SWQP prior to the approval of construction plans/improvement plans or the issuance of a building permit.

The flowchart in Figure 2-4 provides an overview of the SWQP development and submittal process. Each step is summarized below and then described in further detail in the applicable chapters that follow. This process is similar for Small and Regulated Projects; although the SWQP submittal for Small Projects is simpler.

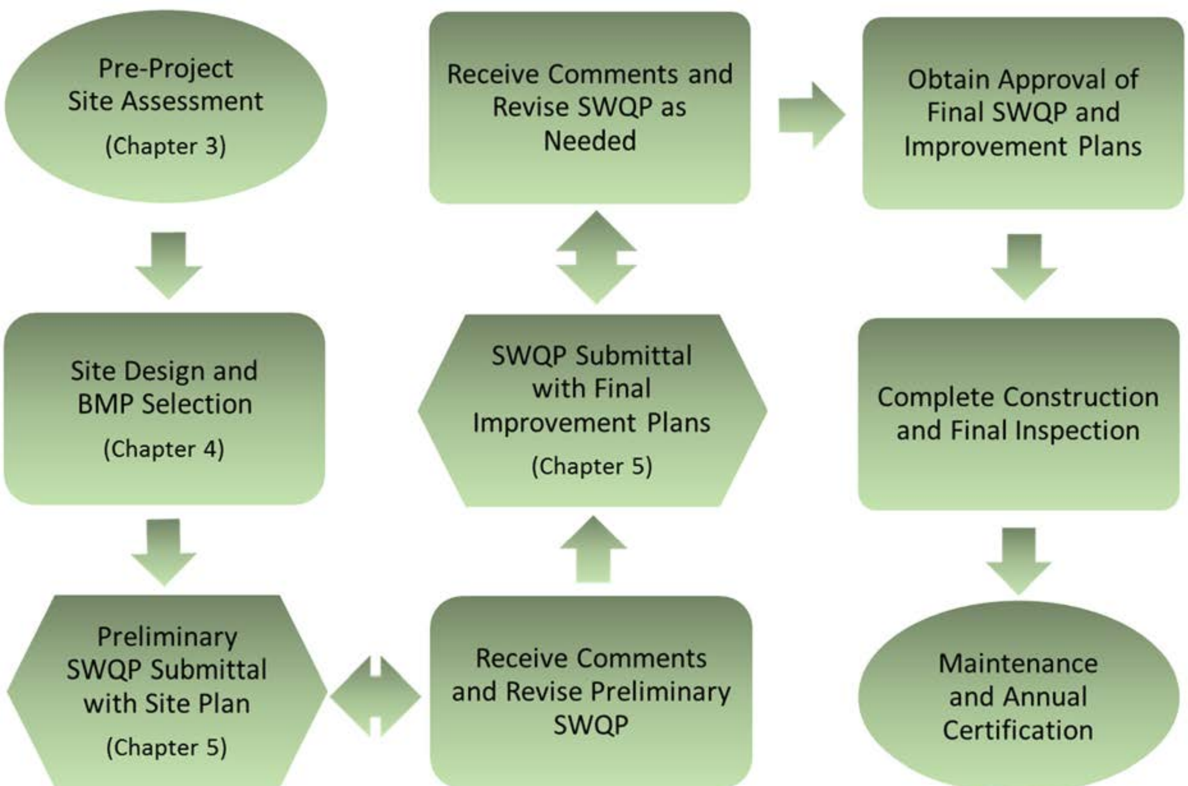


Figure 2-4
SWQP Development and Submittal Process

Detailed guidance for developing a SWQP is provided in the following sections and by using the electronic SWQP Template provided in Appendix A. The SWQP must be submitted as a Preliminary and Final document. The Preliminary SWQP is submitted with the Entitlement Application Package for Tentative Map (or equivalent) while the Final SWQP is submitted with the Final Improvement Plans and Building Permit Application Package (or equivalent). Both the Preliminary and Final SWQP submittals must include all of the forms in the template as required for the determined project category.

The Preliminary SWQP contains a site plan identifying selected BMPs, their locations, tributary drainage areas, preliminary sizing calculations, and preliminary inspection and maintenance documentation.

The Final SWQP includes the Final Improvement Plans showing all BMPs and necessary design details on the appropriate sheets. The BMP Checklist from the SWQP Template must be included on the cover sheet of the Final Improvement Plans. The Final SWQP also includes final sizing calculations, inspection and maintenance schedules and procedures, identification of responsible parties, and all required signatures. The Final SWQP serves as the Project Maintenance Agreement between the owner and the permitting jurisdictional agency and provides permission to access for jurisdictional agency staff to conduct BMP inspections.

SWQP preparation consists of systematically collecting and documenting project specific information that includes the following key components.

General Project Information – Documentation of permitting jurisdictional agency, project name and other identifying information.

Responsible Parties – Project owner and engineer certifications of responsibility and Permission to Access.

Site Assessment – Documentation of existing site conditions and storm water quality management opportunities and constraints. Detailed information on conducting an LID-based site assessment and developing a site layout that supports the retention of storm water runoff on-site is provided in Section 3.

Design Documentation – Project plans showing the location and size of storm water management measures and sizing calculations. Detailed information on the selection of source control measures, site design measures, and storm water treatment and baseline hydromodification measures is provided in Section 4. Design guidance is provided in the SWQP Template (Appendix A) and the BMP Fact Sheets (Appendix B).

Operations and Maintenance (O&M) Documentation – O&M Plan listing BMP-specific inspection and O&M requirements. See the BMP Fact Sheets in Appendix B for guidance on O&M requirements.

This page intentionally left blank.

Chapter 3

Pre-Project Site Assessment

During the early planning stages of any project, a thorough site assessment can provide valuable information for planning the layout of site improvements. Developing a site layout considering storm water management to the extent feasible can provide substantial reductions in cost and improve the effectiveness of the project's storm water control measures. Consideration of terrain, required buffer areas, and other natural features can lead to efficient location of BMPs. Additionally, a site layout that keeps clean flows separated from contaminated flows can reduce the need for, and size of, downstream treatment controls. To the extent feasible, projects can be configured to direct storm water runoff from impervious surfaces to landscaped or natural areas, rather than to convey it directly to a discharge location, which may require a structural BMP.

3.1 Site Assessment

A site assessment must be completed for all Regulated Projects and considered for Small Projects during the earliest stages of project planning to appropriately plan the site layout for the capture and treatment of storm water runoff. The incorporation of storm water features is more effective, and often less costly, when site conditions such as soils, vegetation, and drainage characteristics are considered when determining the placement of buildings, paved areas, drainage facilities and other improvements. Site assessments consist of collecting and evaluating data from a variety of sources including, but not limited to, surveys, topographic maps, geotechnical investigations, groundwater records, and site-specific measurements and field observations. The site assessment should evaluate the following key site characteristics:

A careful evaluation of a site's pre-developed condition is key to minimizing the impacts of development.
Photo Credit – Placer County

- Soil, Geologic, and Groundwater Characteristics;
- Topography, Hydrology, and Drainage Characteristics;
- Existing Vegetation and Natural Areas;

- Contaminated Soil or Groundwater;
- Existing Improvements and Easements; and.
- Opportunities and constraints for preserving or enhancing existing natural resources.

The subsections below provide reference information and guidance for evaluating each key site characteristics and incorporating the results into the layout of improvements and the development of a site plan.

3.1.1 Soil, Geologic, and Groundwater Characteristics

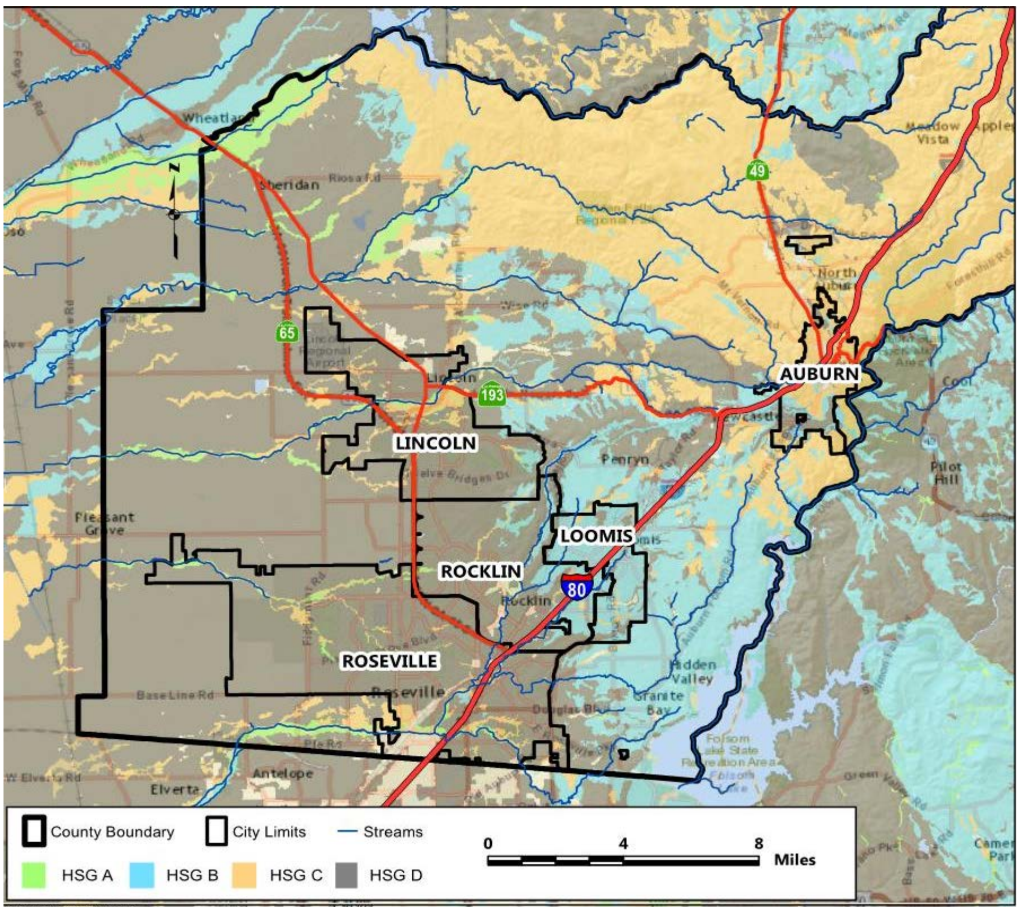
Soil and geologic characteristics and information are necessary for determining the feasibility of infiltrating storm water runoff on a site and will assist in identifying appropriate locations for proposed improvements and the required storm water management measures. Where feasible, buildings, pavement, and other impervious surfaces should be located in areas where soils have lower infiltration rates while infiltration facilities should be installed in more permeable soil areas where there is an average separation of 10 feet between the bottom elevation of the infiltrating BMP and the groundwater surface elevation. At no time shall the separation between the bottom elevation of the infiltrating BMP and the seasonal high groundwater surface elevation be less than 5 feet.

Some information regarding soil types and their potential suitability for infiltrating storm water can be obtained from the United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) Web Soil Survey (WSS) at the following website:

http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm

Soils are categorized into one of four Hydrologic Soil Groups (HSGs) A, B, C or D based on their capacity to percolate water. Type A soils are well drained and highly permeable, while Type D soils consist of low permeability materials such as clays that infiltrate water very slowly. A soils map illustrating the HSGs and their general locations in West Placer region is provided in Figure 3-1. As shown, much of the region's soils are classified as Types C and D indicating high clay content with slow to very slow infiltration rates. Although not ideal for infiltration, LID measures can still be implemented effectively on sites with HSG C and D soils as long as these constraints are considered during the design process. Ideally, site designs allow infiltration to occur to the maximum extent that the native soil will accept and allow for the safe bypass of overflows. In some cases, native soils can be amended to increase their storage and infiltration capacity by mixing organic mulches and/or sandy materials with the less permeable native soils. Additional information on the use of soil amendments is provided in the Fact Sheet SDM-2 in Appendix B.

The WSS provides planning level information such as soil type, HSG, typical infiltration rates, saturated hydraulic conductivity, typical depth to restrictive layers, and typical depth to groundwater. The Placer County Stormwater Management Manual[1] (SWMM) (Placer County, 1994) provides additional guidance in determining soil infiltration rates based on the HSG and the type and condition of ground cover. This information may be used for pre-project runoff calculations, but a site-specific geotechnical evaluation is recommended to obtain more accurate soil characteristics and infiltration rates for the design of infiltration facilities. It should be noted that saturated hydraulic conductivity can be used for designing infiltration facilities, but a site specific infiltration rate measurement of soils underlying the infiltration facilities is strongly recommended for final design.



DATA DISCLAIMER:
The features on this map were prepared for geographic purposes only and are not intended to illustrate legal boundaries or supercede local ordinances.
Official information concerning the features depicted on this map should be obtained from recorded documents and local governing agencies.
Hydrologic Soil Group (HSG) information provided by NRCS.

Figure 3-1
NRCS Hydrologic Soil Groups

---

[1] The Placer County Stormwater Management Manual is available for download at:

http://www.placer.ca.gov/~/media/dpw/flood%20control/documents/Swmm2004.pdf

A site-specific geotechnical investigation should be conducted under the guidance of a licensed geotechnical, soils, or civil engineer and include digging test pits and conducting infiltration rate measurements in locations where infiltration-based BMPs may be located. Test pits will help confirm the types of soils present onsite, identify soil layers that may impede infiltration, and locate the depth to seasonally high groundwater. Testing should be performed at the soil surface as well as the approximate bottom depth of the infiltration BMP to determine appropriate infiltration rates for design. The infiltration measurement methodology must be selected by an appropriately licensed engineer and applied in a manner that adjusts for the relative influence of sidewall flow in the test configuration to the effectiveness of the sidewall flow in the proposed BMP configuration. The potential for long-term degradation of the infiltration rate and the ability to monitor performance and rehabilitate facilities must also be considered. In many cases, the design rate will be no more than one-half of the adjusted measured rate.

The geological assessment must also evaluate a site’s susceptibility to landslides. Landslides occur when the stability of a slope changes from a stable to an unstable condition due to natural and/or anthropogenic causes. Soil saturation is a primary cause of landslides, and infiltration should be limited in areas of high landslide risk, especially when downhill structures, roads, and infrastructure are at risk of being damaged. LID design in areas prone to landslides, especially those that utilize infiltration, should be carefully considered and must be prepared by a licensed civil or geotechnical engineer.

3.1.2 Topography, Hydrology, and Drainage Characteristics

Site topography, hydrology, and drainage characteristics are also critical factors in developing an appropriate site layout for LID implementation. Clearing, grading, and building should be avoided on slopes greater than 25 percent, and, as discussed above, steep slopes and landslide-prone areas are not recommended for infiltration facilities. The design of storm water conveyance and treatment measures relies on existing, or constructed, grades to direct runoff to the desired locations and provide adequate hydraulic head (pressure) to drive flows through treatment measures.

The topography of upstream and downstream sites should be considered for any potential contribution to the total runoff generated during a storm event. Designing effective LID into new or existing sites requires a careful analysis of the topography and how and where storm water runoff will concentrate and flow. Site assessment of the pre-developed site during a storm event is highly recommended to observe and map areas of natural infiltration, concentration, flow, and offsite discharge points.

For previously developed sites, record, or as-built, drawings should be reviewed if available. In the event that topographic data does not already exist for the site or the accuracy of available data is inadequate, a professional topographic survey should be performed prior to proceeding with project design. The survey should produce a detailed topographic base map of the site with contour lines for each foot of elevation change. The survey should also identify the location and elevation of any existing improvements, utilities, and storm water structures (e.g. curb and gutter, swales, catch basins, storm drain pipe inverts, outfalls). This base map provides the starting point in the development of the site plan.

Hydrologic and drainage characteristics of the site should be identified and assessed including:

- ***Onsite streams and water bodies***: Streams and water bodies should be delineated for the project site to locate setbacks and buffer zones. The presence and extent of receiving waters, wetlands, environmentally sensitive areas (ESAs), and impaired water bodies on the 303(d) list or with established Total Maximum Daily Loads (TMDLs) should be clearly defined (see the SWRCB website below for identification of pertinent water bodies).

  www.waterboards.ca.gov/water_issues/programs/water_quality_assessment

- ***Floodplains and drainage hazards***: Floodplains on the site should be delineated to identify areas where significant flooding may occur. LID principles may be effectively implemented in floodplains, where allowed by the jurisdictional agency, but the impacts of potential flooding on proposed LID improvements should be assessed. Development within the floodplain should be avoided to the extent practicable. Areas of the site with other potential drainage hazards such as erosion and landslides should also be identified.

- ***Drainage areas, flow paths, and run-on/runoff locations:*** For the pre-project condition, define the area(s) within the site that drain to common discharge location(s). For undeveloped sites, these areas are defined by the natural topography of the site. For previously developed sites, any existing drainage improvements must be considered since they can alter the locations of drainage area boundaries.

  The key characteristics of existing flow paths include locations, direction of flow, and capacity. It is also critical to identify all locations where storm water might enter a site (run-on) and where it discharges from a site.

3.1.3 Existing Vegetation and Natural Areas

LID design strategies include the preservation or enhancing the quality of existing native, and other high quality vegetation to the maximum extent practicable. The designer should identify existing natural and environmentally sensitive areas on the site and consider how these areas can be preserved and integrated into the site design. Avoiding sensitive areas and preserving natural open space may reduce the need for other permits and provides opportunities for reducing the amount of storm water runoff that needs to be treated. Storm water runoff can sometimes be directed to these areas for infiltration and irrigation. Preservation of existing trees and other vegetation that help intercept rainfall and reduces runoff. Where vernal pools are present, it may be necessary to maintain natural runoff quantities to these sensitive areas.

3.1.4 Contaminated Soil or Groundwater

If a site is influenced by contaminated soils and/or groundwater, special consideration of LID design needs to be made. Infiltration of storm water runoff in areas with contaminated soils and/or groundwater should be avoided to prevent mobilization and dispersion of the pollutants. Sites must be reviewed to ascertain if there is a potential that contamination is present. Redevelopment sites must be investigated for underground storage tanks and other potential sources of contamination. If soil and/or groundwater contamination is suspected, LID implementation must avoid further infiltration of storm water runoff and focus on flow-through type treatment devices.

As part of the Preliminary SWQP, the site must be evaluated for the presence of contamination. The SWRCB maintains a database of registered contaminated sites through their Geotracker® program. Sites with soil contamination (brownfields) and former agriculture sites are managed by EPA and the California Department of Toxic Substances Control. For preliminary investigation of site contamination, the websites for these agencies can be accessed as follows:

- SWRCB: http://geotracker.waterboards.ca.gov/
- EPA Brownfield: http://www.epa.gov/brownfields
- California Department of Toxic Substances Control:

  http://www.dtsc.ca.gov/SiteCleanup/Brownfields/

  http://www.dtsc.ca.gov/SiteCleanup/Cortese_List.cfm

3.1.5 Existing Improvements and Easements

Existing improvements from previous on-site development, adjacent properties, public infrastructure, and underground or overhead utilities must be identified and evaluated when planning the site layout. If available, as-built or record drawings should be reviewed and compared to actual site conditions to verify site features such as buildings and structures, parking lots, roads, drainage systems, landscaped areas.

Previously developed sites may have existing underground utilities, including storm water conveyance/detention, sanitary sewers, and/or gas lines, as well as underground or overhead electrical and/or communications lines. Locations of utilities, whether below ground or overhead, must be noted on the site plan so that any conflicts with storm water, or other improvements may be readily identified.

All easement encumbrances for existing or proposed utilities should also be identified and shown on the site plan as they may indicate a future utility, road, or other structure that may conflict with LID features.

Existing improvements and easements can constrain storm water management alternatives.
Photo Credit – Placer County

Chapter 4

Site Planning and BMP Selection

Selection of an effective set of integrated storm water control measures, or BMPs, can be challenging. Each site is unique, and the application of BMPs will vary depending on site characteristics and proposed use of the site. The storm water management requirements vary depending on the different project categories (i.e., Small, Regulated, Hydromodification Management Projects). This chapter provides a step-wise process for selecting complementary BMPs to complete an effective and integrated design.

This chapter is organized by project categories as described in Chapter 2. Information in the corresponding subsection(s) below provides guidance for selection of BMPs that are appropriate for the site and project type.

4.1 Small Projects

For Small Projects, a site plan showing the layout of improvements and storm water control measures is required to demonstrate consideration of the following:

- Define the development envelope and protected areas, identifying areas that are most suitable for development and areas to be landscaped, or left undisturbed, and used for infiltration. (Sections 3.1.1 through 3.1.4).
- Minimize overall impervious coverage (paving and roofs) of the site.
- Set back development from creeks, wetlands, and riparian habitats in accordance with local ordinances. (Sections 3.1.2 and 3.1.3)
- Preserve significant trees and native vegetation. (Section 3.1.3).
- Conform the site layout along natural landforms. (Section 3.1.2).
- Avoid excessive grading and disturbance of vegetation and soils and stabilize disturbed areas.
- Replicate the site's natural drainage patterns. (Section 3.1.2).

Implementation of one or more Site Design Measure, listed in Table 4-1, is required to reduce project site runoff. The Site Design Measure(s) must be included on the site plan and final improvement plans that are submitted with the building permit application.

Note that some of the Site Design Measures for Small Projects are required to be designed by an appropriately qualified professional engineer licensed in the State of California.

Fact Sheets in Appendix B provide detailed descriptions and design requirements for each Site Design Measure listed.

Additional guidance for incorporating the required storm water measures into Small Projects is provided in Chapter 6 and the SWQP Template in Appendix A.

Table 4-1 Selection of Site Design Measures for Small Projects[1]

Small Projects must incorporate at least one Site Design Measure	Fact Sheet (Appendix B)	Selection Considerations
Adjacent/On-Site Stream Setbacks and Buffers	SDM-1	Applicable for sites with streams on, or directly adjacent to the property.
Soil Quality Improvement and Maintenance	SDM-2	Consult a qualified professional before using in areas of high groundwater, soil or groundwater contamination, or slopes greater than 10 percent.
Tree Planting and Preservation	SDM-3	Irrigation requirements Defensible space for wildfire
Rooftop and Impervious Area Disconnection	SDM-4	Roof drain discharge must be at least six (6) feet from a basement and at least two (2) feet from a crawl space or structural foundation.
Porous Pavement	SDM-5	Consult a professional engineer before using in areas of high groundwater, soil or groundwater contamination, or slopes greater than 10 percent.
Vegetated Swales	SDM-6	Consult a professional engineer before using in areas of high groundwater, soil or groundwater contamination, or slopes greater than 10 percent.
Rain Barrels and Cisterns	SDM-7	Operation and Maintenance requirements

1. The Phase II MS4 Permit also allows the use of green roofs. This Site Design Measure has been omitted from this Manual as a practice that may not be suitable due to the climate of the region and water conservation requirements. However, project applicants may propose green roofs as a Site Design Measure for consideration on a case-by-case basis.

4.2 Regulated Projects

This section provides guidance for site design considerations and selection and layout of storm water control measures for Regulated Projects. The approach consists of applying information from the site assessment to lay out improvements and BMPs to reduce storm water runoff volumes and pollutant concentrations. This information is intended as a reference source for the development of SWQPs for Regulated Projects which are required to be completed by an appropriately qualified professional engineer licensed in the State of California.

Requirements for Regulated Projects include the following:

- Completing a site assessment to evaluate local conditions and identify LID - opportunities and constraints, -
- Developing a site layout that incorporates LID storm water management strategies,
- Implementing Site Design Measures to reduce surface runoff by infiltration, evapotranspiration, and/or harvesting and use as close to its source as possible,
- Implementing Storm Water Treatment and Baseline Hydromodification Measures using bioretention-based facilities or facilities of demonstrated equivalent effectiveness,
- Implementing biotreatment/media filters for special case exceptions to - bioretention or facility of demonstrated equivalent effectiveness, -
- Implementing hydromodification management measures to control post-project runoff rates (required for projects that create or replace more than one (1) acre of impervious surface and result in a net increase in impervious area), and
- Maintaining and implementing an O&M Plan.

For maximum effectiveness, the BMPs listed above should be designed to work together in an integrated system. BMPs can be designed in series to provide multiple treatment steps for pollutant removal and volume reduction. Pretreatment, which refers to design features that provide settling of large particles before storm water enters a storm water treatment facility, is important to ensure proper operation of the facility and reduce the long-term maintenance burden. Perhaps the most common example is a sediment trap placed upstream of another BMP to remove bulk coarse solids in a location that is easily accessed for maintenance upstream from a facility that provides further treatment and runoff reduction. By reducing sediment loads entering a bioretention facility or other infiltration-based facility, pretreatment protects the engineered planting media and/or underlying soil from being occluded prematurely and maintains the infiltration rate of the facility. Another example is installing an oil/water separator upstream of another BMP to remove potential hazardous materials prior to infiltrating runoff. The Phase II MS4 Permit requires that additional treatment steps be considered in high-risk areas such as fueling stations, truck stops, auto repairs, and heavy industrial sites to protect groundwater quality.

The completed SWQP for Regulated Projects provides a multi-layered approach to protect water quality and downstream water bodies. The following sections describe the site planning and BMP selection processes that must be used to develop an effective, integrated SWQP.

4.2.1 Site Plan Layout

The results of the site assessment are used to develop the layout of improvements and site plan, which is submitted with the Preliminary SWQP (see Figure 4-1 for an example). A list with the information required to be included on the site plan is provided in Chapter 6 under the Form 3-4 guidance. The site plan, together with the SWQP, documents consideration of the following items:

- Define the development envelope and protected areas, identifying areas that are most suitable for development and areas to be left undisturbed. (Sections 3.1.2 through 3.1.4)
- Concentrate development on portions of the site with less permeable soils and preserve areas that can promote infiltration. (Section 3.1.1)
- Minimize overall impervious coverage (paving and roofs) of the site.
- Set back development from creeks, wetlands, and riparian habitats in accordance with local ordinances. (Sections 3.1.2 and 3.1.3)
- Preserve significant trees. (Section 3.1.3)
- Conform the site layout along natural landforms. (Section 3.1.2)
- Avoid excessive grading and disturbance of vegetation and soils.
- Replicate the site's natural drainage patterns. (Section 3.1.2)
- Detain and retain runoff throughout the site.

4.2.1.1 Drainage Management Areas

As the proposed new or replaced impervious surfaces are laid out, the associated drainage management areas (DMAs) are defined and identified on the site plan. DMAs are the tributary areas within the project site that drain to a common location where BMPs can be implemented to reduce and treat storm water runoff. DMAs must be carefully defined for each BMP that receive storm water runoff (from both pervious and impervious surfaces) so that they may be appropriately designed. Ideally, DMAs are defined and identified by separating areas that may drain pervious and impervious surfaces. However, depending on the project site grading, it may not be possible to completely separate pervious and impervious surfaces when defining and identifying DMAs. If multiple types of surfaces are present in a DMA, an appropriate composite storm water runoff coefficient must be used. The placement of BMPs and identification of DMAs is typically an iterative process as alternative layouts and storm water management strategies are developed.

As described previously, LID storm water management strategy can involve implementation of various BMP combinations in series. Generally, upstream BMPs, or Site Design Measures, are smaller, distributed measures that function to slow and reduce runoff. Downstream BMPs, or Storm Water Treatment and Baseline Hydromodification Measures, function to remove pollutants from the remaining runoff and provide additional runoff flow and volume control. In some cases, DMAs that discharge to separate upstream BMPs must be combined for the design of BMPs located further downstream in the site's drainage system.

The site plan provided in Figure 4-1 presents an example of a new development project consisting of an office building, driveway, and parking lot. The site was separated into four discrete DMAs. DMA 1 consists of the western portion of the office building roof, DMA 2 consists of the eastern portion of the office building roof, DMA 3 consists of a paved driveway, and DMA 4 consists of a paved parking lot.

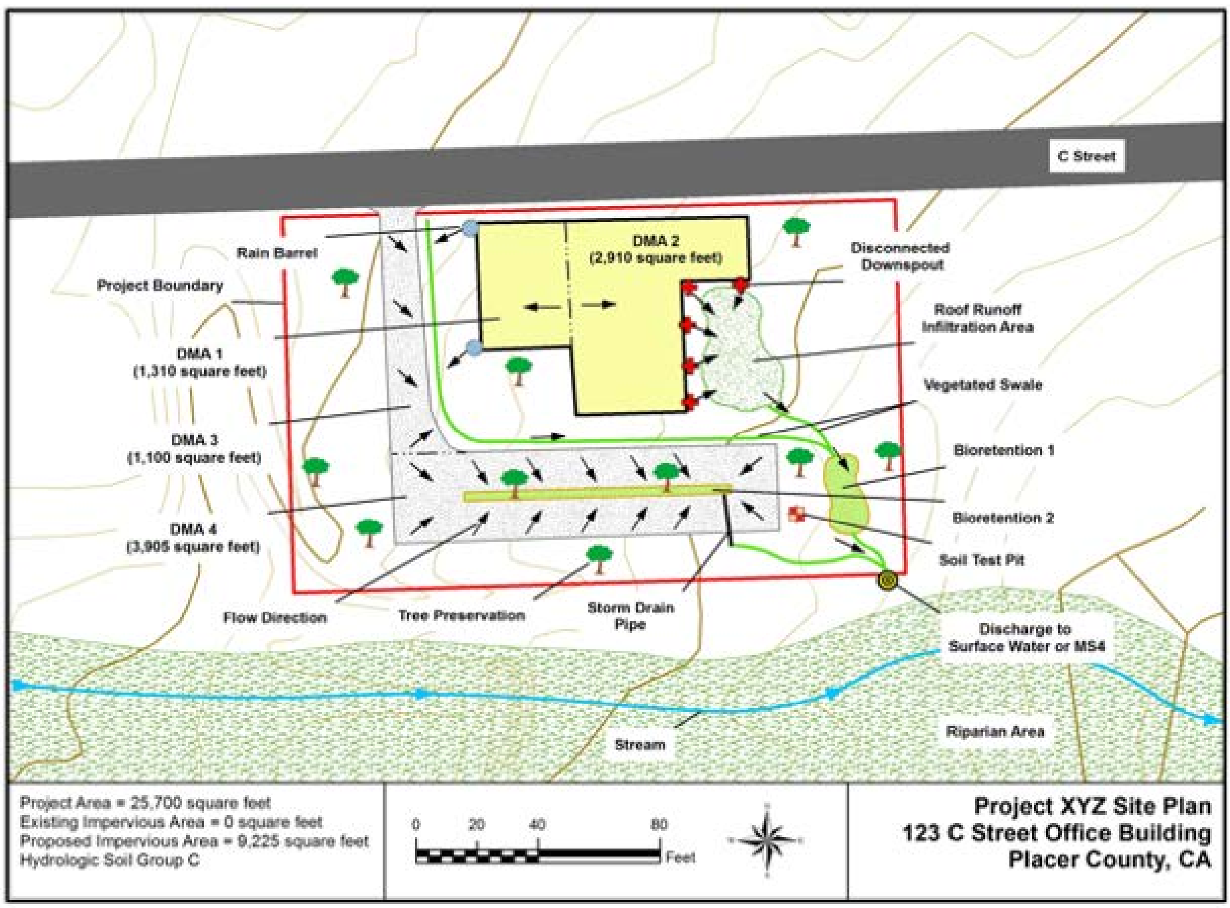


Figure 4-1
Site Plan Example

Site Design Measures and storm water treatment/baseline hydromodification BMPs (bioretention) to manage runoff from each DMA are also included in Figure 4-1. Roof runoff from DMA 1 discharges to two rain barrels. The rain barrels overflow to a vegetated swale which discharges to a bioretention BMP during larger storm events. Roof downspouts from DMA 2 discharge away from the building to a natural depression where infiltration occurs. The natural depression area overflows into a vegetated swale which conveys runoff to a bioretention BMP. Driveway runoff from DMA 3 slopes towards a vegetated swale which also conveys runoff to a bioretention BMP during larger storm events. In this example, DMAs 1, 2, and 3 all discharge to the same bioretention BMP which would need to be designed to treat flows from all three DMAs. Parking lot runoff from DMA 4 flows to a separate bioretention BMP (parking lot landscaped area) which contains two existing trees to be preserved. Treated storm water and overflow from both bioretention BMPs is combined at a single discharge point and released offsite into the municipal storm drain system or natural drainage way.

4.2.2 Source Control Measures

After properly assessing a site and refining the layout, source control measures are implemented to reduce the potential for storm water runoff and pollutants from coming into contact with one another. The goal of source control measures is to KEEP CLEAN WATER CLEAN.

Source control measures can include both structural and operational measures. Structural source control measures include a physical or structural component for controlling the pollutant source such as installing an efficient irrigation system to prevent overspray and off-site runoff or covering trash enclosures or fuel dispensing operations. Operational source control measures involve practices such as storm water management training, trash management and litter control practices, and general good housekeeping practices. When properly implemented, source control measures are effective in preventing pollutants from entering storm water runoff and are typically less expensive than other types of storm water BMPs.

Regulated Projects with potential pollutant-generating activities and sources are required to implement applicable structural and/or operational source control measures. Selection of source control measures must be based on an assessment of potential pollutant generating activities or sources that are anticipated to occur at the site. Depending on the site operations and activities, typical pollutants of concern that can be mobilized and transported by storm water runoff may include, but are not limited to, microbial pathogens (bacteria and viruses), metals, nutrients, toxic organic compounds, suspended solids/sediment, trash and debris, and oil and grease. Some examples of source control measures include trash enclosures, street or parking lot sweeping, and proper materials storage practices.

In some areas, downstream water bodies may be impaired, or subject to TMDL requirements (Chapter 3). In these situations, the pollutant(s) of concern must be identified along with any additional actions that may be required to control potential releases of the pollutant(s).

The Source Control Measures Selection Table (Appendix C) shall be used as a guideline to identify and select source control measures for inclusion in the SWQP. In some cases, multiple source control measures will be used in combination. The table does not include all possible pollutant generating project characteristics/activities that may warrant the consideration of source control measures and additional operational or structural source control measures may be required.

The California Stormwater Quality Association (CASQA) Storm Water BMP Handbooks, or an accepted equivalent reference document, provide recommended guidance for design of source control measures. CASQA has published several storm water BMP handbooks for various project applications and settings, and the source control measures identified in Appendix C reference fact sheets in one or more of these handbooks. The identification codes in the table correspond to the CASQA fact sheets which can be referenced for more information on each source control measure. The CASQA Storm Water BMP Handbooks are available for purchase at:

www.casqa.org/resources/bmp-handbooks/

4.2.3 Site Design Measures (LID BMP Selection)

Distributed Site Design Measures, such as this cistern, can provide significant reductions in site runoff.
Photo Credit – U.S. EPA

Site Design Measures are generally small-scale, distributed BMPs that are intended to reduce and treat surface runoff volumes by managing storm water as close to its source as possible. Site Design Measures often incorporate vegetation which can further reduce runoff through evapotranspiration. These storm water controls are critical for maintaining a site's predevelopment hydrology, which is a primary goal of LID.

Regulated Projects are required to incorporate the Site Design Measures listed in Table 4-3 to the extent technically feasible with the objective of retaining the impervious runoff volume generated by the post-construction 85th percentile, 24-hour storm event by means of infiltration, evapotranspiration, and/or harvesting and use. Typical feasibility considerations are included in the table, but technical feasibility can vary based on a wide variety of site specific conditions that must be evaluated and determined by a professional engineer. Technical feasibility also requires approval by the jurisdictional agency.

If Site Design Measures applied are demonstrated to completely treat and retain the impervious runoff from the post-construction 85th percentile, 24-hour storm event, then no additional downstream BMPs are required. This determination is made during the development of the SWQP (Appendix A). The Site Design Measure Fact Sheets (Appendix B) provide detailed descriptions and design requirements for each measure listed in Table 4-2.

Table 4-2 Selection of Site Design Measures for Regulated Projects[1]

Regulated Projects must incorporate Site Design Measures to the Extent Technically Feasible	Fact Sheet (Appendix B)	Feasibility Considerations
Stream Setbacks and Buffers	SDM-1	▪ Applicable for sites with streams on or directly adjacent to the property.
Soil Quality Improvement and Maintenance	SDM-2	▪ Not suitable in areas of high groundwater, soil or groundwater contamination, or slopes greater than 10 percent.
Tree Planting and Preservation	SDM-3	▪ Irrigation requirements ▪ Defensible space for wildfire
Rooftop and Impervious Area Disconnection	SDM-4	▪ Roof drain discharge must be at least six (6) feet from a basement and at least two (2) feet from a crawl space or structural foundation.
Porous Pavement	SDM-5	▪ Not suitable in areas of high groundwater, soil or groundwater contamination, or slopes greater than 10 percent. ▪ Not ideal for sites with infiltration rates less than 0.5 in/hr. ▪ Not suitable in areas with heavy equipment or traffic loads. ▪ Sediment deposition will cause clogging.
Vegetated Swales	SDM-6	▪ Not suitable in areas of high groundwater, soil or groundwater contamination, or slopes greater than 10 percent.
Rain Barrels and Cisterns	SDM-7	▪ Must be emptied to re-establish storage volume between storm events.

1. The Phase II MS4 Permit also allows the use of green roofs. This Site Design Measure has been omitted from this Manual as a practice that may not be suitable due to the climate of the region and water conservation requirements. However, project applicants may propose green roofs as a Site Design Measure which will be evaluated on a case-by-case basis.

4.2.4 Storm Water Treatment and Baseline Hydromodification Management

Bioretention can be integrated into a site's landscaping to provide water quality and aesthetic benefits while also reducing project costs.
Photo Credit – Greg Bates

After implementation of Site Design Measures, remaining runoff that is not retained by the Site Design Measures must be directed to storm water treatment/baseline hydromodification facilities sized to manage the remaining portion of the post-construction 85th percentile, 24-hour storm event runoff. These treatment facilities, also known as bioretention facilities, are designed to infiltrate, evapotranspire, and/or bioretain the remaining storm water similar to the LID principles of the Site Design Measures. Depending on site characteristics, infiltrating or non-infiltrating flow-through bioretention facilities are typically used to meet this requirement. Infiltrating systems are preferred, and the use of flow-through systems with impervious liners to prevent infiltration is only permitted in several specific cases. These specific circumstances include shallow groundwater conditions, the existence of underlying groundwater or soil contamination, when infiltration creates the potential for geotechnical hazards, or when the facility is located on an elevated plaza or other structure. Bioretention facilities provide pollutant removal through several mechanisms including sedimentation, filtration, and biological processes. Additionally, they reduce runoff volumes and peak flow rates to mitigate the potential hydromodification effects of development.

The determination of which type of storm water treatment/baseline hydromodification control measure(s) to implement can be made using the following flow chart in Figure 4-2. As shown, infiltrating bioretention BMPs are required in the majority of cases. Once the appropriate storm water treatment BMP(s) is (are) selected, refer to the corresponding Fact Sheet (Appendix B) for further design considerations and allowable variations.

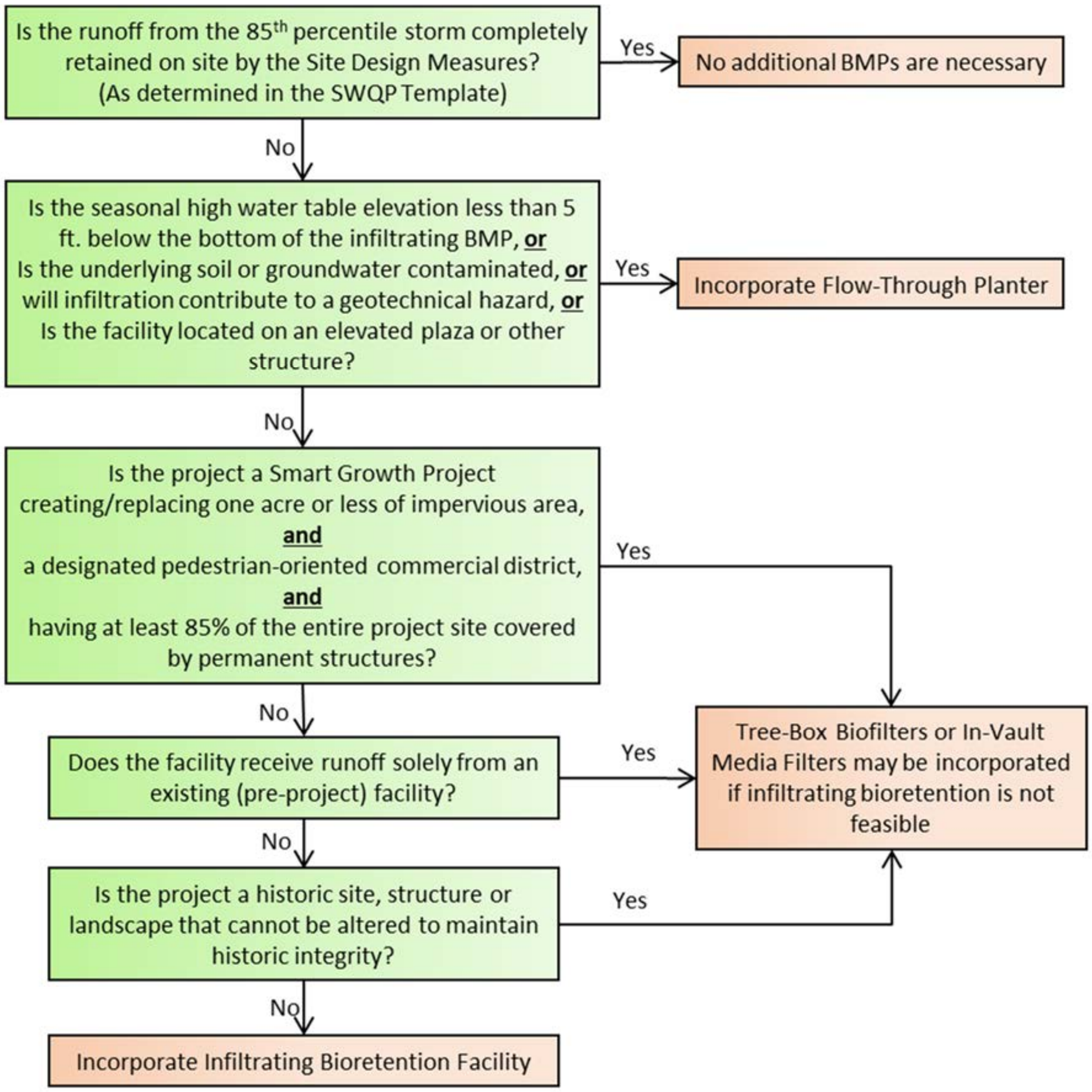


Figure 4-2
Selection of Storm Water Treatment/Baseline Hydromodification Controls

Alternative storm water treatment and baseline hydromodification facilities may be proposed by the designer if the designer can demonstrate that the proposed facility meets all of the following measures of equivalent effectiveness criteria when compared to bioretention facilities:

- Equal or greater amount of storm water runoff infiltrated or evapotranspired for alternatives to infiltrating bioretention facilities
- Equal or greater rate of storm water treatment for flow-through facilities

- Equal or lower pollutant concentrations in storm water runoff that is discharged after biotreatment
- Equal or greater protection against shock loadings and spills
- Equal or greater accessibility and ease of inspection and maintenance

Proposed alternative storm water treatment and baseline hydromodification facilities will be reviewed on a case-by-case basis by the jurisdictional agency.

4.3 Hydromodification Management Projects

The term “hydromodification” is used to define the changes that occur to the natural hydrologic systems of streams and watersheds and how they have the potential to disrupt the natural balances within the watershed. Hydromodification resulting from land development has the potential to create impacts such as excessive erosion, sediment transport and deposition, stream bed instability, loss of habitat, pollutant loading, and damage to the overall ecosystem in downstream reaches of watershed systems. The dynamics of development projects have historically decreased groundwater recharge, increased runoff volume and peak flow frequencies, and altered the natural hydraulic loading of the receiving water (creek system) hydrology. Most LID principles incorporated into this Manual begin to address and minimize these impacts. In the event that storm water runoff reductions do not meet post-construction condition requirements, as demonstrated with the runoff reduction calculator (made part of the Storm Water Template – Appendix A), additional hydromodification treatment measures are required for Regulated Projects creating and/or replacing one acre or more of impervious surface that create a net increase in impervious surface.

The required performance standard for hydromodification control consists of maintaining post-project runoff at or below pre-project flow rates for the 2-year, 24-hour storm event. If this standard can be achieved through the implementation of Site Design Measures and storm water treatment/baseline hydromodification controls (as referenced in Section 4.2 above), then no further storm water controls are required. If post-construction peak flows do not meet this standard, then additional storage capacity with flow control at the discharge point must be incorporated into the design.

For hydromodification management projects in sensitive environmental locations, and/or larger sized projects with complex hydrologic characteristics, the jurisdictional agency may require an alternative approach to using the template forms. In these cases, additional hydrologic modeling analyses, such as a HEC-1 or HEC-HMS discrete storm analysis, may be required to compare pre- and post-project discharge rates for compliance. In these cases, the Section 4 form should be replaced with model results documentation showing that post-construction runoff is less than or equal to the pre-construction runoff rate for a 2-year, 24-hour storm event.

BMP selection for hydromodification controls should be based on the amount of additional storage needed. Additional storage capacity for hydromodification management can be provided by either increasing the size of the control measures (e.g., Site Design Measures or storm water treatment and baseline hydromodification facilities) that are already incorporated in the design or by adding separate structures such as detention basins or vaults.

Follow the procedures outlined in Chapter 6 and the SWQP Template to determine the additional storage volume needs to select the preferred alternative. If relatively little additional storage is needed, then increasing the capacity of the Site Design and/or storm water treatment measures is likely to be the preferred alternative. For larger additional storage requirements, separate detention facilities are recommended.

4.4 In Lieu Program

Storm water management requirements must be met to the MEP standard as specified in this Manual and within and on the project site. If the storm water management goals specified in this Manual cannot be fully met on the project site due to feasibility constraints, then an In Lieu Project may be identified to satisfy the remaining requirements. All projects that utilize the In Lieu program require review and approval by the CVRWQCB in addition to the jurisdictional agency.

The In Lieu program provides two options:

Option 1- In Lieu Projects

A separate LID, or other environmental protection/enhancement, project may be selected from the list of pre-approved projects developed by the jurisdictional agency, and approved by the CVRWQCB. If an In Lieu Project option is chosen, the jurisdictional agency will identify the In Lieu Project in the Conditions of Approvals to ensure that the requirement is documented in case the property and/or project is sold. The pre-approved list of In Lieu Projects may be amended periodically on a case-by-case basis with approval from both the CVRWQCB and jurisdictional agency.

In Lieu Projects should treat the same type of pollutants that are generated by the untreated portion of the new development or redevelopment project. For example; if the untreated portion of the new development or redevelopment site is roadway, then the In Lieu Project selected should treat runoff from a roadway.

In Lieu Projects should be located within the same jurisdiction or unincorporated area in which the new development or redevelopment project causing the impact is located. Projects located in other areas may be approved on a case-by-case basis. Projects that have the potential to cause a significant impact to a particular water body, as determined by the jurisdictional agency, either because of the size of the project or the sensitivity of the water body, will need to choose an In Lieu Project in the same watershed, if feasible.

In Lieu Projects must be completed within two years of the completion of the qualifying new development or redevelopment project. If additional time is needed to complete the In Lieu Project, an extension may be requested and approved on a case-by-case basis. To compensate for long-term water quality and hydromodification impacts downstream of the project, penalties, in the form of additional fees or additional treatment areas, may be imposed on projects requiring time extensions by the jurisdictional agency.

Option 2 - In Lieu Fee

An In Lieu Fee may be paid toward the completion of a larger project from the pre-approved list. The amount of the In Lieu Fee will be calculated based on the treatment and/or volume capture not achieved on the project site, including maintenance costs, times a multiplier.

Chapter 5

BMP Inspection, Operation and Maintenance

Structural BMPs required for Regulated Projects must *meet manufacturers' or designer's recommendation for operation and maintenance* to ensure that the facilities are functioning as designed and do not create health and safety hazards.

To support these requirements, owners of Regulated Projects must provide specific operations and maintenance (O&M) related information with the SWQP during the project permitting process and submit annual self-certification reports documenting that the O&M activities are performed and BMPs are functioning properly.

5.1 Operation and Maintenance Submittal Requirements at the Permitting Stage

The following items are required to be included in the SWQP for all Regulated Projects:

- A signed statement from the project owner accepting responsibility for inspection and O&M activities for all structural BMPs at the project site until such responsibility is legally transferred to another entity.
- A signed statement from the project owner granting access to all representatives of the jurisdictional agency for the sole purpose of performing O&M inspections of the installed treatment systems(s), and hydromodification control(s) if any. Alternatively, this requirement is considered satisfied if an easement dedication or irrevocable offer of dedication is made to the jurisdictional agency providing equivalent access.
- A list of all structural BMPs on the project site and their specific inspection and O&M requirements. BMP-specific inspection and O&M requirements are included on the respective Fact Sheets (Appendix B). It is the responsibility of the project owner to review these requirements and develop a detailed site-specific O&M Plan to document these requirements and include it with the SWQP.
- A copy of any maintenance agreements that modify the BMP O&M responsibilities for the project.

5.2 Annual Self-Certification Reports

In addition to the above items, which are required at the permitting phase, Annual Self-Certification Reports must be submitted by the responsible party for the life of the project. In accordance with the Phase II MS4 Permit, the Annual Self-Certification Reports must include, at a minimum, the following information:

- Dates and findings of field observations to determine the effectiveness of the structural BMPs in removing pollutants of concern from storm water runoff and/or reducing hydromodification impacts as designed.
- Long-term plan for conducting regular maintenance of BMPs including the frequency of such maintenance.

Chapter 6

Developing a Post-Construction Storm Water Quality Plan (SWQP)

This chapter, in conjunction with the SWQP Template in Appendix A, provides project applicants, project owners, and design professionals with supplemental guidance for developing a SWQP for the various project categories defined herein.

The SWQP Template also provides planning and design review staff with a standardized submittal format to streamline the project review and approval process. In some cases, if the applicant wishes to propose alternative storm water control measures, supplemental documentation is required to be submitted to demonstrate equivalent performance per the listed criteria.

The SWQP for Regulated Projects must outline project compliance with the requirements of this Manual and include a signed certification statement by a registered professional engineer and project owner accepting responsibility for its development and implementation. SWQPs for Small Projects do not require a professional engineer's certification, however; some storm water control measures may require engineered designs. A copy of the Final SWQP shall be available at the project site for the duration of construction and then stored with the project approval documentation and improvement plans in perpetuity.

The SWQP development process begins with identifying the Project Category (see Chapter 2) and completing the corresponding sections in the SWQP template. Table 6-1 below lists the sections in the SWQP that must be completed for each Project Category.

Table 6-1 Required SWQP Sections by Project Category

Project Category	Required SWQP Sections
Small Projects	Sections 1 and 2
Regulated Projects, Regulated Redevelopment Projects, Regulated Road Projects, and Regulated LUPs	Sections 1, 3, 5 and 6
Regulated Hydromodification Management Projects	Sections 1, 3 through 6

For Small Projects, the project owner may prepare the SWQP. If the SWQP is prepared by the project owner, then the project owner takes the responsibility for ensuring the proper design of any storm water control measures that are included in the project. For Regulated Projects, a California licensed professional engineer is required to prepare, sign, and stamp the SWQP. Storm water control measures described in this Manual must be designed by, or under the supervision of, a qualified California licensed Professional Engineer with other specialist as may be needed.

Using the SWQP Template (Appendix A)

The SWQP Template is an automated Microsoft Excel-based tool that is provided in electronic format. The user proceeds through a series of pages by opening the workbook tabs which are labeled to indicate which form they contain. Required information is entered in the shaded gray cells, while other cells will self-populate, to complete the form. Each section below provides supporting information and guidance on completing the associated forms in the SWQP Template. Other more detailed reference information is provided in the preceding Chapters of this manual and in the BMP fact sheets in Appendix B.

Title Page

The title page identifies the project, project owner, and individual or consulting firm responsible for the preparation of the SWQP. It also lists the jurisdictional agency with approval authority for the project and responsibility for implementing the requirements of the Phase II MS4 Permit.

Project identification information such as Building or Grading Permit Numbers may vary among the jurisdictional agencies and should be included as appropriate for the specific project.

The SWQP preparation date is added by the preparer and the approval date is added by the approving jurisdictional agency to the cover as they become available.

Section 1 General Project Information

Section 1 documents basic information pertaining to the project and identifies the individual(s) responsible for the development and implementation of the SWQP. The Project Category is identified here.

There are two forms to be completed in Section 1 as follows:

Form 1-1 Project Identification and Owner's Certification

Form 1-1 supplements information provided on the title page with additional detail including the project address and a brief description of the project. For larger or more complex projects, sheets may be added to describe the project.

The project owner's signature is required to certify responsibility for proper implementation of the SWQP. For Regulated Projects, the project owner signature also provides permission to access to all representatives of the jurisdictional agency for the sole purpose of performing O&M inspections of the installed treatment system(s) and hydromodification control(s), if any.

For Regulated Projects, a California licensed professional civil engineer is required to sign and stamp the SWQP. The professional engineer is responsible for designing all of the storm water control measures for the project site and developing the SWQP per the requirements set forth in the Phase II MS4 Permit and this Manual.

Form 1-2 Project Category

Form 1-2 identifies the project category. Determine the appropriate category by first quantifying the size of the newly created and/or replaced impervious surface and using the decision tree in Figure 2-3. Once the project category is determined, check the appropriate box on the form.

For redevelopment projects, determine the percent increase of impervious surface and check the appropriate box. The percent increase calculation must include both newly created and replaced surfaces.

Use the form to indicate if the project is a road or linear underground/overhead project (LUP) that creates 5,000 ft^2 or more of newly constructed contiguous impervious surface or is a public road project and/or falls under the building and planning authority of a jurisdictional agency.

After determining and checking the appropriate project category, enter the total new and/or replaced impervious surface area for the project.

Section 2 Requirements for Small Projects

Owners of Small Projects are required to complete the forms in Section 1 and 2 of the SWQP Template. The forms in Section 2 guide the development of the project layout, as discussed in Chapter 4, and incorporate one or more of the Site Design Measures listed in Table 4-1. Section 2 includes two forms to address these requirements.

Form 2-1 LID Site Assessment and Layout Documentation

The goal of the site assessment is to develop the site in a way that minimizes impacts to the site hydrology and other environmental functions and processes. The form lists a series of considerations that should be made when developing the layout. For each item, check the appropriate box to indicate that it has been considered and appropriately incorporated or that it is not applicable (N/A) and provide a brief explanation (use a separate sheet if necessary). To complete this form, develop and attach the site plan that illustrates the proposed site layout. The site plan may consist of a preliminary, or conceptual level design drawing, and it is a key requirement of the Preliminary SWQP described in Section 2.

Ensure that the following items, at a minimum, are included in the site plan:

- Site boundary
- Topographic data with one-foot contours (five foot contour intervals may be used for steeper sites)
- Existing natural hydrologic features (e.g., depressions, watercourses, wetlands, riparian corridors)
- Environmentally-sensitive areas and areas to be preserved
- Proposed locations and footprints of improvements creating new or replaced impervious surfaces
- Proposed site drainage with flow directions and site run-on and discharge locations
- Proposed Site Design Measures to reduce runoff

Form 2-2 Runoff Reduction Calculator Site Design Measures on Small Projects

This form is used to identify one or more Site Design Measures to implement on Small Projects and calculate the associated storm water runoff reduction. After identifying the Site Design Measure(s), enter the associated dimensions and quantity information into the form to calculate the storm water runoff reduction and effective treated impervious area. There is no minimum runoff reduction required for Small Projects. Design guidance for Site Design Measures is provided in the Fact Sheets in Appendix B. The equations, variables and units that are used to calculate the Site Design Measure volume reductions (V_r) are presented below for reference.

Adjacent/On-Site Stream Setbacks and Buffers

$$V_r = \left(\frac{1\ ft}{12\ in}\right) \times A_{imp} \times V_{85}$$

A_{imp} (ft^2) - Impervious drainage area discharging to the buffer
V_{85} (in) – Runoff volume from the 85th percentile, 24-hour design storm

Soil Quality Improvement and Maintenance

$$V_r = (A_{pond} \times D_{pond}) + (A_{sa} \times D_{sa} \times \eta)$$

A_{pond} (ft^2) – Ponding area over soil improvement area
D_{pond} (ft) – Ponding depth over soil improvement area
A_{sa} (ft^2) – Surface area of improved soils
D_{sa} (ft) – Depth, or thickness, of improved soil layer
η - Porosity of amended soil

Tree Planting and Preservation

$$V_r = [(218 \times n_e) + (109 \times n_d) + A_{tc}] * V_{85} * \left(\frac{1\,ft}{12\,in} \right)$$

n_e – Number of new evergreen trees
n_d – Number of new deciduous trees
A_{tc} (ft^2) – A_{tc} (ft^2) – Canopy area of existing trees to remain on the property
V_{85} (in) – Runoff volume from the 85th percentile, 24-hour design storm

Rooftop and Impervious Area Disconnection

$$V_r = \left(\frac{1\,ft}{12\,i\bar{A}} \right) \times A_{imp} \times V_{85}$$

A_{imp} (ft^2) - Impervious rooftop or other area draining to pervious infiltration area
V_{85} (in) – Runoff volume from the 85th percentile, 24-hour design storm

Porous Pavement

$$V_r = A_{res.} \times D_{res} \times \eta_{\ gg} \times C$$

A_{res} (ft^2) – Area of underlying gravel storage layer
D_{res} (ft) – Depth of underlying gravel storage layer
η_{agg} – Porosity of aggregate
C – Efficiency factor (See table in Fact Sheet SDM-5)

Vegetated Swales

$$V_r = \left(\frac{1\,ft}{12\,in} \right) \times A_{imp} \times V_{85}$$

A_{imp} (ft^2) - Impervious rooftop or other area draining to swale
V_{85} (in) – Runoff volume from the 85th percentile, 24-hour design storm

Rain Barrels and Cisterns

$$V_r = 0.5 \times N \times V_a$$

N - Number of rain barrels and/or cisterns
V_a (ft^3) - Volume of each rain barrel and/or cistern

Form 2-2 includes storm water runoff reduction calculations that are equivalent to those in the SWRCB's SMARTS Runoff Reduction Calculator. The volume reductions calculated by these methods are dependent on the Site Design Measure(s) being designed per the requirements in the respective Fact Sheets in Appendix B.

In order to calculate runoff reductions, Form 2-2 requires the project elevation, which is inserted at the top of the form. The form then calculates the impervious runoff volume generated by the design storm. A table is included as a footnote to the form showing the design storm depths that correspond to the elevation of the project. Corresponding runoff volumes are calculated using a runoff coefficient of 0.9 for impervious surfaces.

Section 3 Requirements for Regulated Projects

This section addresses the requirements for Regulated Projects. The forms in this section are used to document project characteristics and to facilitate the selection and design of storm water control measures. Projects in this category are required to implement the following storm water control measures to the maximum extent practicable:

- LID site assessment to appropriately plan the layout of improvements for capturing and retaining storm water runoff;
- Source control measures to mitigate potential pollutant generating activities and sources that are anticipated at the site;
- Site Design Measures to infiltrate, evapotranspire, and/or harvest and use the impervious runoff from the post-construction 85^{th} percentile, 24-hour storm runoff event; and
- Storm Water Treatment and Baseline Hydromodification Measures to infiltrate, evapotranspire, and/or bioretain remaining runoff from impervious surfaces, if necessary, after implementation of Site Design Measures.

Section 3 contains seven forms to address each of the above requirements.

Form 3-1 Site Location and Hydrologic Features

Enter the project specific information to document the site location and elevation to calculate the 85th percentile, 24-hour design storm depth. For reference, the table below provides the 85th percentile, 24-hour design storm depths for three elevation increments within the West Placer region.

85th Percentile, 24-Hour Design Storm Depth
Elevation <500 feet = 0.9 inch
Elevation 500-1,000 feet = 1.0 inch
Elevation 1,000-1,500 feet = 1.1 inch

Identify the ultimate receiving waters and provide a general description of their location and distance in relation to the project site.

If the receiving waters are listed as impaired on the state 303(d) list, identify the pollutant(s) of concern. Refer to SWRCB website for the most current information:

www.waterboards.ca.gov/water_issues/programs/water_quality_assessment/#impaired

For phased projects, the form clarifies requirements for defining DMAs and incorporating storm water control measures as each phase is developed.

This form is also used to define the project's DMAs, as described in Chapter 4. For projects with more than one DMA, a conceptual level schematic should be developed showing the DMAs that have been defined for the project and their hydrologic connections to the site discharge location(s). The conceptual DMA diagram in this form should be referenced when laying out DMAs and conveyances in the project's site plan as required in Form 3-2.

Form 3-2 LID Site Assessment and Layout Documentation

A site assessment must be conducted as early as possible in the project planning process to appropriately plan the site layout for the capture and treatment of storm water runoff. The goal is to develop a site layout that minimizes impacts to site hydrology and other environmental systems, functions, and processes.

The form lists a series of considerations that should be evaluated when developing the site layout. For each item, check the appropriate box to indicate that it has been considered and appropriately incorporated, or that it is not applicable (N/A) and provide a brief explanation (use a separate sheet if necessary). To complete this form, develop and attach a site plan that illustrates the proposed site layout. The site plan may consist of a preliminary or conceptual level design drawing, but it is a key requirement of the Preliminary SWQP described in Section 2.

Ensure that the following items are included in the site plan:

- Site boundary
- Soil types and areal extents, test pit and infiltration test locations
- Topographic data with 1-foot contours (5-foot contour intervals may be used for steeper sites)
- Existing natural hydrologic features (e.g., depressions, watercourses, wetlands, riparian corridors)
- Environmentally-sensitive areas and areas to be preserved
- Proposed locations and footprints of improvements creating new, or replaced, impervious surfaces
- Potential pollutant sources areas
- DMAs for the proposed BMPs that will receive storm water runoff
- Existing and proposed site drainage network with flow directions and site run-on and discharge locations
- Proposed design features and surface treatments used to minimize imperviousness and reduce runoff
- Proposed locations and footprints of treatment and hydromodification management facilities
- Design features for managing authorized non-storm water discharges
- Areas of soil and/or groundwater contamination
- Existing utilities and easements
- Maintenance areas

Form 3-3 Source Control Measures

Source control measures are required on all Regulated Projects to prevent onsite pollutants from being mobilized and transported by storm water runoff. The goal of source control is to keep clean water clean. For each item listed in the form, check the box for activities and sources that may occur on the project and use the Source Control Measures Selection Table (Appendix C) to identify permanent structural, and/or operational source control measures. Add project specific descriptions of how each measure will be implemented on the project and attach additional pages if necessary. Be sure to describe any special features, materials, or methods of construction that will be used to implement the source control measures. The identification codes in the table correspond to the CASQA fact sheets which can be referenced for more information on each source control measure. The CASQA Storm Water BMP Handbooks are available for purchase at:

www.casqa.org/resources/bmp-handbooks/

Form 3-4 Runoff Reduction Calculator for Site Design Measures on Regulated Projects

On Regulated Projects, Site Design Measures must be implemented, to the extent technically feasible, to infiltrate, evapotranspire, and/or harvest and use the impervious surface runoff from the post-construction 85th percentile, 24-hour storm event.

For each DMA, identify the Site Design Measure(s) for implementation and enter the associated dimensions and quantity information into the form to calculate the resulting runoff reduction and the effective treated impervious area. Design guidance for Site Design Measures in provided in the Fact Sheets in Appendix B. The equations, variables and units that are used to calculate the Site Design Measure volume reductions (V_r) are presented below for reference.

Adjacent/On-Site Stream Setbacks and Buffers

$$V_r = \left(\frac{1\,ft}{12\,in}\right) \text{ x } A_{imp} \text{ x } V_{85}$$

A_{imp} (ft^2) - Impervious drainage area discharging to the buffer
V_{85} (in) – Runoff volume from the 85th percentile, 24-hour design storm

Soil Quality Improvement and Maintenance

$$V_r = (A_{pond} \text{ x } D_{pond}) + (A_{sa} \text{ x } D_{sa} \text{ x } \eta$$

A_{pond} (ft^2) – Ponding area over soil improvement area
D_{pond} (ft) – Ponding depth over soil improvement area
A_{sa} (ft^2) – Surface area of improved soils
D_{sa} (ft) – Depth, or thickness, of improved soil layer
η - Porosity of amended soil

Tree Planting and Preservation

$$V_r = [(218 x n_e) + (109 x n_d) + A_{tc}] * V_{85} * \left(\frac{1\,ft}{12\,in}\right)$$

n_e – Number of new evergreen trees
n_d – Number of new deciduous trees
A_{tc} (ft^2) – Canopy area of existing trees to remain on the property
V_{85} (in) – Runoff volume from the 85th percentile, 24-hour design storm

Rooftop and Impervious Area Disconnection

$$V_r = \left(\frac{1\,ft}{12\,in}\right) \times A_{imp} \times V_{85}$$

A_{imp} (ft^2) - Impervious rooftop or other area draining to pervious infiltration area
V_{85} (in) – Runoff volume from the 85th percentile, 24-hour design storm

Porous Pavement

$$V_r = A_{res} \times D_{res} \times \eta_{agg} \times C$$

A_{res} (ft^2) – Area of underlying gravel storage layer
D_{res} (ft) – Depth of underlying gravel storage layer
η_{agg} – Porosity of aggregate
C – Efficiency factor (0.5 recommended)

Vegetated Swales

$$V_r = \left(\frac{1\,ft}{12\,in}\right) \times A_{imp} \times V_{85}$$

A_{imp} (ft^2) - Impervious rooftop or other area draining to swale
V_{85} (in) – Runoff volume from the 85th percentile, 24-hour design storm

Rain Barrels and Cisterns

$$V_r = 0.5 \times N \times V_a$$

N - Number of rain barrels and/or cisterns
V_a (ft^3) - Volume of each rain barrel and/or cistern

Form 3-4 includes runoff reduction calculations that are equivalent to those in the SWRCB's SMARTS Runoff Reduction Calculator. The volume reductions calculated by these methods are dependent on the Site Design Measure(s) being designed per the requirements in the respective Fact Sheets in Appendix B.

Form 3-4 calculates the impervious runoff volume generated by the design storm using a runoff coefficient of 0.9 for impervious surfaces.

The form calculates the effective treated impervious area by dividing the runoff reduction by the depth of runoff produced by the 85th percentile, 24-hour design storm depth.

If the post-construction 85th percentile, 24-hour storm event runoff from all impervious surfaces in a DMA is treated, no additional storm water control measures are required for that DMA. If there is untreated impervious area remaining, then Storm Water Treatment and Baseline Hydromodification Measures are required.

Form 3-5 Computation of Water Quality Design Criteria for Storm Water Treatment and Baseline Hydromodification Measures

After implementation of Site Design Measures, any remaining storm water runoff for each DMA must be directed to one or more facilities designed to infiltrate, evapotranspire, and/or bioretain these remaining storm water flows. This form calculates the target Water Quality Volumes and Flows (WQV and WQF, respectively) using the tributary drainage area sizes and characteristics and local rainfall statistics. If all impervious area requiring treatment is treated by Site Design Measures, this form will return a zero value for WQV and WQF as no additional downstream BMPs are required. The Unit WQV referenced in the form is based on the site elevation and a 48 hr. drawdown time as follows:

Project Elevation (ft. above mean sea level)	Unit Water Quality Volume (WQV) (inches)
Over 1,000 ft.	0.9
500 ft – 1,000 ft.	0.75
Under 500 ft	0.65

Storm water runoff entering a site from adjacent properties (run-on) becomes the responsibility of the owner. When entering the DMA sizes in this form, all offsite areas that may contribute run-on flows to the treatment facility must be included.

For DMAs containing multiple types of land cover, the form requires the user to enter a composite, area-weighted, runoff coefficient representing the DMA. The composite runoff coefficient can be calculated as:

$$C_w = \frac{\sum_{j=1}^{n} C_j A_j}{\sum_{j=1}^{n} A_j}$$

- C_W = weighted runoff coefficient
- C_j = runoff coefficient for area j
- A_j (ft^2) = area for land cover j
- n = number of distinct land covers

The equations, variables, and units that are used to calculate the WQV and WQF are presented below for reference.

Water Quality Volume (WQV)

$$WQV\ (ft^3) = \left(\frac{1\ ft}{12\ in}\right) \times A \times R_c \times WQV_u$$

A (ft^2) – Tributary Area to BMP
R_c – Runoff coefficient
WQV_U (in) - Unit Water Quality Volume

Water Quality Flow (WQF)

$$WQF(ft^3/s) = \left(\frac{1\ ft}{12\ in}\right) \times \left(\frac{1\ hr}{3600\ s}\right) \times A \times i_u \times R_c$$

WQF (ft^3/s) = $A_{untreated}$ * I_u * (1ft/12in) * (1hr/3600s)

A (ft^2) – Tributary Area to BMP
i_u (in/hr) – Uniform Rainfall Intensity = 0.2 in/hr
R_c – Runoff coefficient

Form 3-6 Infiltrating Bioretention Measures

Form 3-6 is a sizing tool for volume-based, infiltrating bioretention facilities. Enter the dimensions and other required design parameters for each bioretention facility to calculate volume reductions and determine if the required performance criteria have been achieved. The form is intended to be used in conjunction with the bioretention BMP Fact Sheet(s) in Appendix B which provide additional design guidance.

The following inputs must be determined by the designer and entered into the appropriate cells:

- DMA ID No. – Previously defined DMAs for the Site Design Measures should be combined if they are draining to a single bioretention measure. Enter a unique identifier for the combined DMAs.
- Water Quality Volume (WQV) – If multiple DMAs are combined, as described above, the WQVs for each DMA must be summed.
- Surface Loading Rate (R_{surf})(in/hr)
- BMP Surface Area (top of BMP)(SA_{top}) (ft^2)
- Infiltration rate of soils underlying the BMP (use field measurement at the level where infiltration will occur)(in/hr).
- Maximum ponding depth (d_{max}) (ft)
- Infiltrating surface area (bottom of BMP) (SA_{bottom}) (ft^2)

- Planting media depth (d_{media}) (ft)
- Planting media porosity (n_{media})
- Gravel depth (d_{gravel}) (ft)
- Gravel porosity (η_{gravel})
- Total Treated Flow Rate for Project (Q_{total})(ft^3/s) – Enter the total sum of all treated flows from all DMAs

Calculated values in Form 3-6 include the following:

Ponding depth (d_{pond}) (ft) – This is determined by comparing the depth of water infiltrated within the drawdown time and the maximum ponding depth. The lesser value is taken as the ponding depth.

Retention Volume (V_d) (ft^3) – This is the total runoff volume reduction achieved by the bioretention measure. Retention volume is calculated as follows:

$$V_r = SA_{bottom} \times \left[d_{pond} + d_{media} \times \eta_{media} + d_{gravel} \times \eta_{gravel} + \left(\frac{1\,ft}{12\,in}\right) \times T_f \times I\ X\ 0.5\right]$$

The time of filling (Tf) represents the amount of time typically required for the bioretention measure to fill after the initial onset of rain. A value of 3 hours is assumed and is incorporated into the calculation.

A safety factor of 0.5 is applied to the field measured infiltration rate (I) to account for the degradation of this rate as the facility ages.

Untreated Volume ($V_{untreated}$) (ft^3) – This is the difference between the WQV and retention volume. The retention volume must be greater than or equal to the WQV for each DMA so that “Yes” can be checked as the final item to complete the form.

Treated Flow Rate ($Q_{treated}$) (ft^3/s) – This is the volumetric treatment rate achieved by the bioretention facility. The treated flow rate is calculated as follows:

$$Q_{treated} = \left(\frac{1\,ft}{12\,in}\right) \times \left(\frac{1\,hr}{3600\,s}\right) \times R_{surf} \times SA$$

If an alternative to bioretention is proposed, the designer must submit separate documentation to demonstrate that the proposed facility meets all of the following measures of equivalent effectiveness criteria when compared to bioretention facilities:

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

Form 3-7 Flow-Through Planters, Tree Box and Media Filters

This form provides a tool for flow-based sizing of biotreatment and filtration facilities. Enter the dimensions and other required design parameters for each biotreatment facility to calculate volume reductions and determine if the required performance criteria have been achieved. The form is intended to be used in conjunction with the Fact Sheets found in Appendix B for flow-through facilities to help determine the required dimensions of the structure.

The following inputs must be determined by the designer and entered into the appropriate cells:

- DMA ID No. – Previously defined DMAs for the Site Design Measures should be combined if they are draining to a single treatment measure. Enter a unique identifier for the combined DMAs.
- Water Quality Flow (WQF) – If multiple DMAs are combined, as described above, the WQFs for each DMA must be summed.
- Surface loading rate (R_{surf}) (in/hr) – A maximum of 5 in/hr is allowed.
- Maximum ponding depth (d_{max}) (ft)
- Soil/media surface area (SA) (ft^2)
- Soil/media depth (d_{media}) (ft)
- Soil/media porosity (η_{media})
- Gravel depth (d_{gravel}) (ft)
- Gravel porosity (η_{gravel})

- Total Treated Flow Rate for Project (Q_{total})(ft^3/s) – Enter the total sum of all treated flows from all DMAs

Calculated values in Form 3-7 include the following:

Detention Volume (V_d) – This is the volume of storm water runoff detained by the flow-through facility for filtration and discharge. Detention volume is calculated as follows:

$$V_d = SA \times \left[d_{pond} + d_{media} \times \eta_{media} + d_{gravel} \times \eta_{gravel} + \left(\frac{1ft}{12in}\right) \times R_{surf} \times T_f \right]$$

The time of filling (Tf) represents the amount of time typically required for the bioretention measure to fill after the initial onset of rain. A value of 3 hours is assumed and is incorporated into the calculation.

Treated Flow Rate ($Q_{treated}$) (ft^3/s) – This is the volumetric treatment rate achieved by the flow-through planter or filter. The treated flow rate is calculated as follows:

$$Q_{treated} = \left(\frac{1ft}{12in}\right) \frac{1\,hr}{3600s} \times R_{surf} \times SA$$

Untreated Flow Rate ($Q_{untreated}$) (ft^3/s) – This is the difference between the WQF and the treated flow rate. The treated flow rate must be greater than or equal to the WQF for each DMA so that “Yes” can be checked as the final item to complete the form.

Form 3-7 also provides a line item for entering the treated flow rate for proprietary devices that do not follow the design approach specified in this form. For proprietary devices, the treated flow rate is entered and the product specifications and design documentation must be included in the SWQP to justify and document the flow rates used.

If an alternative to flow-through planters or tree box or media filters is proposed, the designer must demonstrate that the proposed facility meets all of the following measures of equivalent effectiveness criteria when compared to flow-through planters or tree box or media filters:

- Equal or greater rate of storm water treatment
- Equal or lower pollutant concentrations in storm water runoff that is discharged after biotreatment
- Equal or greater protection against shock loadings and spills
- Equal or greater accessibility and ease of inspection and maintenance

Section 4 Requirements for Hydromodification Management Projects

This section covers the additional requirements for Hydromodification Management Projects. Projects in this category must meet the same requirements as other Regulated Projects and also confirm that post-construction peak runoff rates are less than or equal to the pre-construction peak runoff rate for a 2-yr, 24-hr storm event.

This section incorporates the hydrology methods in Section V of the Placer County SWMM. There are three forms in this section which are used to determine the pre-project peak flows and demonstrate compliance.

For projects in sensitive environmental locations, such as those discharging to impaired waters or wetlands, and/or larger sized projects (> 200 acres) with ponding, where flow routing through sub-basins is required, or other projects with complex hydrologic characteristics, the jurisdictional agency may require an alternative approach to using the template forms. In these cases additional hydrologic modeling analyses, such as a HEC-1 or HEC-HMS discrete storm analysis may be required to compare pre- and post-project discharge rates for compliance. In these cases, the Section 4 forms should be replaced with model results documentation showing that post-construction runoff is less than or equal to the pre-construction runoff rate for a 2-yr, 24-hr storm event.

Hydromodification DMAs

The hydromodification analysis is performed at the project outlet points and requires that outlet level DMAs be defined for the project outlet points. These outlet level DMAs may be different than the previously defined DMAs used for BMP design, and will typically consist of combinations of these previously defined DMAs.

Form 4-1 Peak Runoff Response Time

Complete the form utilizing the reference information in the Placer County SWMM to calculate peak runoff response time for each outlet level DMA. The following inputs must be determined by the designer and entered into the appropriate cells:

- Length of longest overland flow path (L_o) (ft) – A maximum value of 100 feet is recommended since storm water runoff will typically concentrate and form rivulets or small gullies within this distance rather than staying in a sheet flow type regime.
- Slope of overland flow path (S_o) (ft/ft)
- Manning's roughness coefficient for the overland flow surface (n_o)
- Hydrologic soil group (HSG)
- Current Land Cover Type(s)

- Pervious Area Condition
- Infiltration Rate (I)(in/hr) – The rates for the newly define outlet level DMA are required to be entered. These may vary from the infiltration rates for the previously developed DMAs used for BMP design.
- Length of collector flow path (L_c)(ft)
- Cross-sectional area of collector flow facility (ft^2)(A)
- Wetted perimeter of collector flow facility (ft) (P)
- Manning's roughness coefficient for collector flow facility (n_c)
- Slope of collector flow facility (S_c)(ft/ft)

Calculated values in Form 4-1 include the following:

Overland flow response time (T_o)(min) – This is the response time of the overland flow areas for each DMA.

$$T_o = \left(\frac{0.355(nL)^\wedge 0.6}{\text{So}^\wedge 0.3}\right)$$

Channel flow velocity (V) (ft/s) – This is used to calculate the response time of the flow conveyances for each DMA and is calculated using Manning's equation as follows:

$$V = \frac{1.49}{n_c} \times \left(\frac{A}{P}\right)^{2/3} \times S^{0.5}$$

Collector flow facility response time (T_c) (min) – This is the response time of the flow conveyances for each DMA.

$$T_c = \left(\frac{1\ min}{60\ s}\right) \times \frac{L_c}{V}$$

Total response time (T_t) (min) – This is combined overland and collector flow response time.

$$T_t = T_c + T_o$$

Form 4-2 Hydromodification Target for Peak Runoff

Form 4-2 computes the peak pre- and post-construction storm water runoff rates for each outlet level DMA. This form also provides a comparison of the pre-project peak flows to the post-project peak flows and requires flow control at the BMP discharges to be modified, if necessary, to meet the hydromodification management performance criteria.

The following inputs must be determined by the designer and entered into the appropriate cells:

- Drainage Area (A) (ft^2) – This is the total area of each outlet level DMA including pervious and impervious surfaces.
- Impervious Area (A_i)(ft^2) – This is the total impervious area of each outlet level DMA.
- Rainfall depth (P_r) (in) – This is the depth of the 2-yr, 24-hour storm event with a duration equal to the total response time calculated in Form 4-1.
- Total Pre-Project Peak Runoff (ft^3/s) – This is the combined total of the pre-project peak runoff rates for each DMA.

Calculated values in Form 4-2 include the following:

Unit peak runoff (q) ($ft^3/s/acre$)

$$q = 60 \times P_2 \times \frac{1}{T_t}$$

Infiltration factor (F_i) ($ft^3/s/acre$)

$$F_i = \text{Infiltration Rate (I)} * \left(1 + \frac{1}{1.3 \times 0.0005 \times Site\ Elevation}\right)$$

Peak Runoff (Q_p) (ft^3/s)

$$Q_p = A \times q - F_i \times (A - A_i)$$

Form 4-3 Detention Volumes for Hydromodification Management

Form 4-3 is used to demonstrate whether the combined detention capacity of the project's Site Design Measures and Storm Water Treatment and Baseline Hydromodification Measures is sufficient to meet the hydromodification requirements. The NRCS TR-55 Manual is utilized and referenced for information to complete this form and is available at the following website:

http://www.hydrocad.net/pdf/TR-55%20Manual.pdf

The following inputs must be determined by the designer and entered into the appropriate cells:

- Land cover and hydrologic condition
- Curve number (CN)
- Precipitation depth (P_2) (in) – This if the depth of the 2-yr, 24-hr storm event.

- Equalization factor *(V_s/V_r)* – The ratio of storage capacity to runoff volume. This is determined by using the attenuation factor and the nomograph in Figure 6-1 of the NRCS TR-55 Manual for Type 1A rainfall distribution.
- Site Design Measure volume (ft^3) – This is the combined volume of all Site Design Measures within each of the outlet level DMA.
- Bioretention volume (ft^3) – This is the combined volume of all bioretention facilities within each of the outlet level DMA.
- Flow-Through Detention Volume (ft^3) - This is the combined volume of all flow-through treatment facilities within each of the outlet level DMA.
- Supplemental volume (ft^3) – This is the volume of any additional detention facilities that have been incorporated into the outlet level DMA to meet the hydromodification management performance criteria.

Calculated values in Form 4-3 include the following:

Post-development soil storage capacity (S) (in)

$$S = \frac{1000}{\text{CN}} - 10$$

Post-development runoff volume (V_{runoff}) (ft^3)

$$V_{runoff} = (\frac{1ft}{12in} \times A \times \frac{(P_2 - 0.2 \times S)^2}{P_2 + 0.8 \times S}$$

Attenuation factor ($q_{out/in}$) – The ratio of the target outflow rate (pre-development peak discharge) to the peak inflow rate (post-development peak discharge).

$$Ø_{\text{out/in}} = \frac{Ø\text{re} - devlopment\, \text{Q}_\text{p}}{Øost - devlopment\, \text{Q}_\text{p}}$$

Runoff detention capacity required to achieve hydromodification management performance criteria ($D_{hydromod}$)(ft^3)

$$D_{hydromod} = \frac{V_s}{V_r} \times V_{\text{runoff}}$$

Combined Detention Volume (ft^3) – This is the combined volume of all Site Design Measures, bioretention facilities, and any supplemental volume in each outlet level DMA.

The combined detention volume must be greater than or equal to the required runoff detention capacity to achieve hydromodification management performance criterial so that "Yes" can be checked as the final item to complete the form.

Section 5 Inspection and Maintenance of Post-Construction BMPs

An O&M Verification Program will be implemented for all structural storm water control measures. Project owners must provide a signed statement, prior to Improvement Plan or Grading Permit approval, accepting responsibility for O&M requirements until the responsibility is legally transferred to another entity. A signed statement must also be provided that grants access to all representatives of the jurisdictional agency for the sole purpose of performing O&M inspections of the installed treatment systems(s) and hydromodification control(s) if any.

Form 5-1 BMP Inspection and Maintenance

For Regulated Projects, the Final SWQP serves as a Maintenance Agreement and Permission to Access Agreement unless the jurisdictional agency has a separate mechanism in place such as the City of Roseville. The City of Roseville requires a separate agreement according to its ordinance. The Final SWQP is recorded with the property ownership documentation to ensure that the maintenance responsibilities and access agreement are transferred to the subsequent owner(s) upon sale of the property.

For all BMPs included in the SWQP, assess the site-specific conditions and reference the Fact Sheets in Appendix B to develop BMP inspection and maintenance requirements and complete Form 5-1. For proprietary BMPs, reference the standard inspection and maintenance documents for the product. SWQPs are required to include a detailed O&M Plan for all BMPs (attach O&M Plan) and a signed certification statement accepting responsibility for its implementation.

Section 6 Compliance Checklist

The purpose of this section is to provide and mechanism for ensuring that all of the storm water control measures identified in the SWQP are also included on the approved Improvement Plans and will be constructed with the project.

Form 6-1 Post-Construction Storm Water BMPs

List each BMP included in the SWQP and the corresponding plan sheet number on the Improvement Plans. Create a copy of Form 6-1 and include it on the cover of the Improvement Plans.

This page intentionally left blank.

Glossary

Baseline Hydromodification Management Measures – Storm water control measures designed to mitigate hydromodification on Regulated Projects that are not Hydromodification Management Projects.

Best Management Practices (BMPs) – Methods, measures, or practices designed and selected to reduce or eliminate the discharge of pollutants to surface waters from point and non-point source discharges including storm water. BMPs include structural, which are permanent, and non-structural controls and operation and maintenance procedures, which when implemented prevents, controls, removes, or reduces pollution from entering surface waters.

Bioretention – Post-construction storm water treatment BMP that treats storm water runoff vertically through an engineered soil filter media and vegetation and retains storm water runoff on-site through infiltration or evapotranspiration.

Bioswale – Shallow channels lined with grass and used to convey and store runoff.

Brownfields - Sites with soil contamination.

Buffer – A forested or otherwise vegetated are located between water bodies such as streams, wetlands, and lakes that provides a permanent barrier against runoff from development, agriculture, construction, and other land uses. Buffers are designed to filter pollutants in storm water runoff before the pollutants reach surface waters.

California Environmental Quality Act (CEQA) Approval – Formal approval of a proposed project under CEQA (California environmental legislation that establishes procedures for conducting an environmental analysis for all projects in California [California Public Resources Code, Section 21000, et. seq.]).

California State Water Resources Control Board (SWRCB) - The state-level entity that regulates storm water runoff and treatment in California.

California Stormwater Quality Association (CASQA) – Statewide association of municipalities, storm water quality managers, and other interested parties. Publisher of the California Stormwater Best Management Practices Handbooks, available at www.cabmphandbooks.com. Successor to the Storm Water Quality Task Force (SWQTF).

Check Dam – Structures constructed of a non-erosive material, such as suitably sized aggregate, wood, gabions, riprap, or concrete, used to slow water to allow sedimentation, filtration, evapotranspiration, and infiltration into the underlying native soil. Check dams can be employed in practices such as dry and enhanced grass swales.

Clean Water Act (CWA) – (33 U.S.C. 1251 et seq.) The Federal Water Pollution Control Act.

Common/Larger Plan of Development or Sale – A contiguous area, plan area, specific plan, subdivision or any other project site that has evaluated storm water management and may be phased in the future or where multiple, distinct construction activities may be taking place at different times under one plan.

Conveyance System – Any channel, swale, gutter, or pipe for collecting and directing storm water.

Curb Cuts – Curb openings that allow storm water runoff to enter landscaped areas, vegetated swales, planters, rain gardens, and other BMP features.

Design Engineer – Engineer responsible for preparing the SWQP for Regulated Projects, site design, and site plan.

Design Storm – A synthetic rainstorm based on historic rainfall data. For purposes of this Manual, the design storm is defined as the volume of runoff produced from the 85th percentile, 24-hour storm event. In the West Placer County Phase II MS4 Permit area, the 85th percentile, 24-hour storm event varies with elevation as follows:

Elevation	85th Percentile 24 Hour Storm Depth (Inches)
< 500 ft.	0.9
500 – 1,000 ft.	1.0
1,000 – 1,500 ft.	1.1

Detached Single-family Home Project – The building of one single new house or the addition and/or replacement of impervious surface associated with one single existing house, which is not part of a larger plan of development.

Storm Water Detention – The practice of temporarily storing peak storm water flows in basins, ponds, vaults, within berms, or in depressed areas and controlling the discharge rates into the storm drain system or receiving water. The detention process allows sediment and associated pollutants to settle out of the runoff.

Development – Any construction, rehabilitation, redevelopment, or reconstruction of any public or private residential project (whether single-family, multi-unit or planned unit development); industrial, commercial, retail and other non-residential projects, including public agency projects; or mass grading for future construction. It does not include routine maintenance to maintain original line and grade, hydraulic capacity, or original purpose of facility, nor does it include emergency construction activities required to immediately protect public health and safety.

Direct Discharge – A discharge that is routed directly to waters of the United States by means of a pipe, channel, or ditch (including a municipal separate storm sewer system), or through surface runoff.

Directly Connected Impervious Area (DCIA) or Surface – Any impervious surface which drains directly into the storm drain system without first allowing flow through a pervious area (e.g., lawn).

Discharger – Any responsible party or site owner or operator within the Permittees' jurisdiction whose site discharges storm water or non-storm water runoff.

Disconnected Pavement – An impervious area that drains through a pervious area prior to discharge to the storm drain system.

Drainage Management Area (DMA) – A discrete area within a project site that contributes all precipitation falling within its boundaries to a single common outflow point, and is defined for the purpose of siting and designing storm water control measures in accordance with the Phase II MS4 Permit.

Drawdown Time – The time required for a storm water detention or infiltration BMP to drain and return to the dry-weather condition. For detention BMPs, drawdown time is a function of basin volume and outlet orifice size. For infiltration BMPs, drawdown time is a function of basin volume and infiltration rate.

Environmentally Sensitive Area (ESA) – A designated area that requires special protection because of its landscape, wildlife, and/or historical value.

Erosion – The physical detachment of soil due to wind or water. Often the detached fine soil fraction becomes a pollutant transported storm water runoff. Erosion occurs naturally, but can be accelerated by land disturbance and grading activities such as farming, development, road building, and timber harvesting.

Evapotranspiration (ET) – The general uptake and release of water by vegetation to the atmosphere.

Existing Road Project – Proposed redevelopment street/road project that will modify or redevelop an existing transportation surface in a manner that increases the surface footprint or impervious area of the roadway.

Filter Strip – Bands of closely-growing vegetation, usually grass, planted between pollution sources and downstream receiving water bodies.

Filtration Rate – The rate at which fluid passes through a porous medium (or media).

Flow-Based Treatment Control Measures – Storm water quality treatment measures that rely on flow capacity to treat storm water. These measures remove pollutants from a moving stream of water through filtration, infiltration, adsorption, and/or biological processes (e.g., vegetated swales and filter strips).

Flow-Through Planters – Structural landscaped reservoirs placed on impervious surfaces used to collect, filter, and temporarily store storm water runoff, allowing pollutants to settle and filter out as the water percolates through the planter soil until flowing through to an approved conveyance.

Green Roof – Conventional rooftops that include a thin covering of vegetation allowing the roof to function more like a vegetated surface. The layer thickness varies between 2-6 inches and consists of vegetation, waterproofing, insulation, fabrics, growth media, and other synthetic components.

Green Street – A Green Street uses a natural systems approach to reduce storm water flow, improve water quality, reduce urban heating, enhance pedestrian safety, reduce carbon footprints, and beautify neighborhoods. Green Street features include vegetated curb extensions, sidewalk planters, landscaped medians, vegetated swales, permeable paving, and street trees. (EPA, 2009)

Groundwater – Water that is underground in cracks and spaces in soil, sand, and rocks. The layers of soil, sand, and rocks are also known as aquifers.

Groundwater Recharge – The replenishment of existing natural water bearing subsurface layers of porous stone, sand, gravel, silt or clay via infiltration.

Hydrograph – Runoff flow rate plotted as a function of time.

Hydrologic Cycle – The movement of rainfall from the atmosphere to the land surface, to receiving waters and then back to the atmosphere through evaporation.

Hydrologic Soil Group – A soil classification system created by the National Resource Conservation Service (formerly Soil Conservation Service) based on the ability to convey and store water; divided into four groups:

- A – well drained sands and gravel, high infiltration capacity, high leaching potential and low runoff potential;
- B – Moderately drained fine to coarse grained soils, moderate infiltration capacity, moderate leaching potential and moderate runoff potential;
- C – Fine grained, low infiltration capacity, low leaching potential and high runoff potential;

- D – Clay soils, very low infiltration capacity, very low leaching potential and very high runoff potential.

Typical Infiltration Rates

Soil Type (Hydrologic Soul Group)	Infiltration Rate (in/hr.)
A	1.00 – 8.3
B	0.5 – 1.00
C	0.17 – 0.27
D	0.02 – 0.10
Infiltration rates shown represent the range covered by multiple sources, e.g., ASCE, BASMAA, etc.	

Hydrology – The science dealing with the waters of the earth, their distribution on the surface and underground, and the cycle involving evaporation, precipitation, and flow to the seas.

Hydromodification – Modification of hydrologic pathways (precipitation, surface runoff, infiltration, groundwater flow, return flow, surface-water storage, groundwater storage, evaporation and transpiration) that results in negative impacts to watershed health and functions. Hydromodification results in an artificially altered rate of natural channel erosion and sedimentation processes.

Impaired Water Body – A waterbody (i.e., stream reaches, lakes, waterbody segments) with chronic or recurring monitored violations of the applicable numeric and/or narrative water quality criteria. An impaired water is a water that has been listed on the California 303(d) list or has not yet been listed but otherwise meets the criteria for listing. A water is a portion of a surface water of the state, including ocean, estuary, lake, river, creek, or wetland. The water currently may not be meeting state water quality standards or may be determined to be threatened and have the potential to not meet standards in the future. The State of California's 303(d) list can be found at http://www.swrcb.ca.gov/quality.html.

Impervious Surface – A surface covering or pavement of a developed parcel of land that prevents the land's natural ability to absorb and infiltrate rainfall/storm water.

Infiltration – The entry of water into the soil. Infiltration rate (or infiltration capacity) is the maximum rate at which a soil in a given condition will absorb water.

Jurisdictional Agency – The municipal agency/agencies with approval authority for private and public projects that fall under the requirements of the Phase II MS4 Permit.

Linear Underground/Overhead Projects (LUPs) – Include, but are not limited to, any conveyance, pipe, or pipeline for the transportation of any gaseous, liquid (including water and wastewater for domestic municipal services), liquescent, or slurry substance; any cable line or wire for the transmission of electrical energy; any cable line or wire for communications (e.g., telephone, telegraph, radio, or television messages); and associated ancillary facilities. Construction activities associated with LUPs include, but are not limited to, (a) those activities necessary for the installation of underground and overhead linear facilities (e.g., conduits, substructures, pipelines, towers, poles, cables, wires, connectors, switching, regulating and transforming equipment, and associated ancillary facilities); and include, but are not limited to, (b) underground utility mark-out, potholing, concrete and asphalt cutting and removal, trenching, excavation, boring and drilling, access road and pole/tower pad and cable/wire pull station, substation construction, substructure installation, construction of tower footings and/or foundations, pole and tower installations, pipeline installations, welding, concrete and/or pavement repair or replacement, and stockpile/borrow locations.

Low Impact Development (LID) – A sustainable practice that benefits water supply and contributes to water quality protection. Unlike traditional storm water management, which collects and conveys storm water runoff through storm drains, pipes, or other conveyances to a centralized storm water facility, LID takes a different approach by using site design and storm water management to maintain the site’s pre-development runoff rates and volumes. The goal of LID is to approximate a site’s pre-development hydrology by using design techniques that infiltrate, filter, store, evaporate, and detain storm water runoff close to the source of rainfall.

Maximum Extent Practicable (MEP) – The minimum required performance standard for implementation of municipal storm water management programs to reduce pollutants in storm water. Clean Water Act § 402(p)(3)(B)(iii) requires that municipal permits "shall require controls to reduce the discharge of pollutants to the maximum extent practicable, including management practices, control techniques and system, design and engineering methods, and such other provisions as the Administrator or the State determines appropriate for the control of such pollutants." MEP is the cumulative effect of implementing, evaluating, and making corresponding changes to a variety of technically appropriate and economically feasible BMPs, ensuring that the most appropriate controls are implemented in the most effective manner. This process of implementing, evaluating, revising, or adding new BMPs is commonly referred to as the iterative process.

Municipal Separate Storm Sewer System (MS4) – The regulatory definition of an MS4 (40 CFR 122.26(b)(8)) is "a conveyance or system of conveyances (including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, man-made channels, or storm drains): (i) Owned or operated by a state, city, town, borough, county, parish, district, association, or other public body (created to or pursuant to state law) including special districts under state law such as a sewer district, flood control district or drainage district, or similar entity, or an Indian tribe or an authorized Indian tribal organization, or a designated and approved management agency under section 208 of the Clean Water Act that discharges into waters of the United States. (ii) Designed or used for collecting or conveying storm water; (iii) Which is not a combined sewer; and (iv) Which is not part of a Publicly Owned Treatment Works (POTW) as defined at 40 CFR 122.2."

In practical terms, operators of MS4s can include municipalities and local sewer districts, state and federal departments of transportation, public universities, public hospitals, military bases, and correctional facilities. The Storm Water Phase II Rule added federal systems, such as military bases and correctional facilities by including them in the definition of small MS4s.

National Pollutant Discharge Elimination System (NPDES) – A national program for issuing, modifying, revoking and reissuing, terminating, monitoring and enforcing permits, and imposing and enforcing pretreatment requirements, under sections 307, 402, 318, and 405 of the Clean Water Act.

Natural Resources Conservation Service (NRCS) – NRCS provides technical expertise and conservation planning for farmers, ranchers and forest landowners wanting to make conservation improvements to their land.

Non-Storm water Discharge – Any discharge to a storm drain that is not composed entirely of storm water. Certain non-storm water discharges are authorized per the NPDES Municipal Stormwater Permits.

Open Space – Pervious area within the project that is subtracted from the total project area to reduce the area used in sizing treatment and LID BMPs. For LID implementation, open space includes, but is not limited to, natural storage reservoirs, drainage corridors, buffer zones for natural water bodies, and flood control detention basins.

Operations and Maintenance (O&M) – Continuing activities required to keep storm water management facilities and their components functioning in accordance with design objectives.

Outfall – A point source, as defined by 40 CFR 122.2, at the point where an MS4 discharges to waters of the United States and does not include open conveyances connecting two MS4s, or pipes, tunnels or other conveyances which connect segments of the same stream or other waters of the United States and are used to convey waters of the United States.

Peak Discharge Rate – The maximum instantaneous rate of flow (volume of water passing a given point over a specific duration, such as cubic feet per second) during a storm, usually in reference to a specific design storm event.

Permeable – Soil or other material that allows the infiltration or passage of water or other liquids.

Permeable or Pervious Pavement – Asphalt or concrete rendered porous by the aggregate structure surfaces that allow water to pass through voids in the paving material and/or between paving units while providing a stable, load-bearing surface. An important component to permeable pavement is the reservoir base course, which provides stability for load-bearing surfaces and underground storage for runoff.

Permittee/Permittees – Municipal agency/agencies and non-traditional small MS4s that are named in and subject to the requirements of the Phase II MS4 Permit.

Phase II MS4 Permit - SWRCB Water Quality Order No. 2013-001-DWQ, NPDES General Permit No. CAS000004, Waste Discharge Requirements for Storm Water Discharges from Small MS4s.

Placer County Aquatic Resources Program (CARP) – A multidisciplinary approach for identifying, classifying, ranking, and protecting the aquatic resources of western Placer County. Broadly defined, aquatic resources are those now regulated by the U.S. Army Corps of Engineers, CVRWQCB, the California Department of Fish and Game, and the City of Lincoln and Placer County General Plans.

Placer County Conservation Plan (PCCP) – A Placer County-proposed solution to coordinate and streamline the permitting process by allowing local entities to issue state and federal permits. The proposed PCCP is a Habitat Conservation Plan (HCP) under the Federal Endangered Species Act and a Natural Community Conservation Plan (NCCP) under the California Natural Community Conservation Planning Act.

Placer County Stormwater Management Manual (SWMM) – A guidance manual produced by the Placer County Flood Control District and Water Conservation District to provide consistent, specific guidance and requirements for storm water management, including regulation of the development process, to achieve storm water management objectives.

Pollutant – Those substances defined in CWA §502(6) (33.U.S.C. §1362(6)) and incorporated by reference into California Water Code §13373.

Porosity – Ratio of pore volume to total solids volume.

Project Owner – Owner of a parcel proposed for development or redevelopment.

Rain Event or Storm Event – Any rain event greater than 0.1 inch in 24 hours except where specifically stated otherwise.

Rain Garden – A lot-level bioretention cell designed to receive and detain, infiltrate, and filter storm water runoff, typically used for discharge from roof leaders.

Rainwater Harvesting – The practice of intercepting, conveying, and storing rainwater for future use. Captured rainwater is typically used for outdoor non-potable water uses such as irrigation and pressure washing, or in the building to flush toilets or urinals or other uses that do not require potable water.

Receiving Water – Surface water that receives regulated and unregulated discharges from activities on land.

Recharge – The infiltration and movement of surface water into the soil, past the vegetation root zone, to the zone of saturation or water table.

Reconstruction – The removal and replacement of paving material down to subgrade.

Redevelopment – 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. Redevelopment does not include trenching, excavation and resurfacing associated with LUPs; pavement grinding and resurfacing of existing roadways; construction of new sidewalks, pedestrian ramps, or bike lanes on existing roadways; or routine replacement of damaged pavement such as pothole repair or replacement of short, non-contiguous sections of roadway.

Regional Water Quality Control Board (RWQCB) – California RWQCBs are responsible for implementing pollution control provisions of the Clean Water Act and California Water Code within their jurisdiction.

Regulated Project – Refers to projects subject to the new and redevelopment standards in Section E.12 in the Phase II MS4 Permit.

Regulated Small MS4 – A Small MS4 that discharges to a water of the United States or to another MS4 regulated by an NPDES permit and has been designated as regulated by the SWRCB or RWQCB under criteria provided in the Phase II MS4 Permit.

Retention – The practice of holding storm water in ponds or basins and allowing it to slowly infiltrate to groundwater. Some portion will evaporate. Also see infiltration.

Retrofitting – Improving pollution and/or flow control at existing developments and facilities to protect or restore beneficial uses and watershed functions.

Riparian Areas – Plant communities contiguous to and affected by surface and subsurface hydrologic features of perennial or intermittent waterbodies. Riparian areas have one or both of the following characteristics: 1) distinctively different vegetative species than adjacent areas, and 2) species similar to adjacent areas but exhibiting more vigorous or robust growth forms. Riparian areas are usually transitional between wetland and upland.

Runoff – Water flowing across the land that does not infiltrate the soil, but drains into surface or groundwater, or when rainfall exceeds the infiltration capacity of the land.

Run-on – Storm water surface flow or other surface flow that enters property that did not originate onsite.

Setback – The minimum distance that design elements must be placed from other elements. For example, houses usually have front, side, and rear yard setbacks from streets and other buildings.

Site Design Measure – Typically small, distributed structural or non-structural measures that aim to reduce the volume of storm water runoff close to the source of the rainfall.

Soil Amendment – Minerals and organic material added to soil to increase its capacity for absorbing moisture and sustaining vegetation.

Source Control – Land use or site planning practices, or structural or non-structural measures, that aim to prevent pollution of runoff by reducing the potential for contact with runoff at the source of pollution. Source control measures minimize the contact between pollutants and urban runoff.

Storm Water – Storm water is generated when precipitation from rain and snowmelt events flows over land or impervious surfaces and does not percolate into the ground. As storm water flows over the land or impervious surfaces, it accumulates debris, chemicals, sediment or other pollutants that could adversely affect water quality if the storm water is discharged untreated.

Storm Water Management – The process of collecting, conveying, storing, treating, and disposing of storm water to ensure control of the magnitude and frequency of runoff to minimize the hazards associated with flooding and the impact on water quality caused by manmade changes to the land.

Storm Water Quality Plan (SWQP) – The SWQP documents a project's compliance with the Phase II MS4 Permit and provides a standardized application form that produces complete and accurate submittals which result in more efficient reviews and project approvals.

Surface Loading Rate (Rsurf) – A hydraulic loading factor, expressed in terms of flow over surface area, representing the flow rate of storm water runoff over the surface area of the treatment measure (i.e. a bioretention cell).

Swale – A shallow storm water channel that can be vegetated with some combination of grasses, shrubs, and/or trees designed to slow, filter, and often infiltrate storm water runoff.

Total Maximum Daily Loads (TMDLs) – The maximum amount of a pollutant that can be discharged into a water body from all sources (point and nonpoint) and still meet water quality standards. Under CWA section 303(d), TMDLs must be developed for all water bodies that do not meet water quality standards even after application of technology-based controls, more stringent effluent limitations required by a state or local authority, and other pollution control requirements such as BMPs.

Treatment – The application of engineered systems that use physical, chemical, or biological processes to remove pollutants. Such processes include, but are not limited to, filtration, gravity settling, media absorption, biodegradation, biological uptake, chemical oxidation, and ultraviolet light radiation.

Treatment Control Measure – Any engineered system designed to remove pollutants by simple gravity settling of particulate pollutants, filtration, biological uptake, media absorption, or any other physical, biological, or chemical process.

Tributary Area – The physical area that drains to a specific BMP or drainage feature.

Underdrain – A perforated pipe used to assist the draining of soils in some LID applications that have impaired infiltration.

Urban Runoff – Any runoff from urbanized areas that enters the MS4 including storm water and dry weather flows from a drainage area that reaches a receiving water body or subsurface. During dry weather, urban runoff may be comprised of groundwater base flow and/or nuisance flows, such as excess irrigation water.

Vegetated Filter Strip – Gently sloping, densely vegetated areas that treat runoff as sheet flow from adjacent impervious areas. They function by slowing runoff velocity and filtering out suspended sediment and associated pollutants, and by providing some infiltration into underlying soils. Also known as buffer strips and grassed filter strips.

Vegetated Swale – A long and narrow, trapezoidal or semicircular channel, planted with a variety of trees, shrubs, and grasses or with a dense mix of grasses. Storm water runoff from impervious surfaces is directed through the swale, where it is slowed and in some cases infiltrated, allowing pollutants to settle out. Check dams are often used to create small ponded areas to facilitate infiltration.

Volume-Based Treatment Control Measures – Storm water quality treatment measures that rely on volume capacity to treat storm water runoff. These measures detain or retain runoff and treat it primarily through settling or infiltration. Examples: detention and infiltration basins, porous pavement and storm water planters (bioretention).

Water Quality Flow (WQF) – For storm water treatment BMPs that depend on flow-through processes, such as filtration, to work, the flow rate of water that must be passed through the facility to achieve maximum extent practicable pollutant removal.

Water Quality Volume (WQV) – For storm water treatment BMPs that depend on detention to work, the volume of water that must be detained to achieve maximum extent practicable pollutant removal.

Water Table – Subsurface water level defined by the level below which all the spaces in the soil are filled with water; the entire region below the water table is called the saturated zone.

Web Soil Survey (WSS) – An interactive, internet-based soils database developed and administered by NRCS.

Wet Season (Rainy Season) – For the West Placer region, the calendar period beginning October 1 and ending April 30. Note: This differs from the California Department of Fish and Wildlife's wet weather definition, which is October 15 – April 15.

Appendix A

Automated Template for Post-Construction Storm Water Quality Plan

(Provided in Electronic Format Only)

http://www.placer.ca.gov/lowimpactdevelopment

Appendix B
BMP Fact Sheets

STREAM SETBACK AND BUFFERS

Fact Sheet SDM-1

Also known as: Aquatic buffers, riparian setbacks

DESCRIPTION

Stream setbacks and buffers are vegetated areas that exist or are established along a stream system, lake, reservoir, or wetland area where development is restricted or prohibited. They consist of trees, shrubs, and herbaceous vegetation that separates and physically protects aquatic ecosystems and habitats from future disturbance or encroachment. Stream setbacks and buffers can either be preserved natural areas or engineered BMPs specifically designed to treat stormwater runoff before it enters a stream, shore, or wetland.

Stream zone avoidance in south Placer County.
Source: Placer County Conservation Plan

ADVANTAGES

- Can be used as part of a treatment train with other BMPs.
- Can provide high level water quality treatment with proper design.
- Limits development in floodplain areas.
- Improves aesthetics.
- Improves quality of aquatic ecosystems and habitats.
- Serves as foundation for present or future greenways.

LIMITATIONS

- A minimum stream setback and buffer width of 500 feet is required to obtain stormwater runoff reduction credits.
- Restrictions on available space for development.
- Potential establishment of nuisance species.
- Not suitable for treating point-source stormwater discharges (i.e. end of pipe).
- Can be difficult to delineate and demarcate stream setback and buffer widths.
- Natural stream shifts may alter stream setback and buffer widths.

KEY DESIGN FEATURES

The ability of a particular stream setback and buffer to function effectively depends on how well the buffer is planned or designed. In general, the following guidelines should be followed (for more information see *The Architecture of Urban Stream Buffers*, *The Practice of Watershed Protection: Article*):

- Maintain the stream setback and buffer in an ungraded and uncompacted condition.
- Protect the stream setback and buffer from vehicular traffic to reduce compaction.
- The contributing overland slope should be 5% or less unless a level spreader is used.
- Adopt a vegetative target based on predevelopment plant community.
- Expand the width of the middle zone to pick up wetlands, slopes and larger streams.
- Use clear and measurable criteria to delineate the origin and boundaries of the buffer.

STREAM SETBACK AND BUFFERS

Fact Sheet SDM-1

Photo Source: USGS

- The number and conditions or stream and buffer crossings should be limited.
- The use of buffer for stormwater runoff treatment should be carefully prescribed.
- Buffer boundaries should be visible before, during, and after construction
- Buffer education and enforcement are needed to protect buffer integrity.

A minimum stream setback and buffer width of 500 feet is required to obtain runoff volume reduction credits.
However, smaller stream setbacks and buffers may be required by local jurisdictions even if runoff volume reduction credits are not obtainable. For areas within the West Placer County Phase II MS4 Permit boundary, local ordinances should be reviewed to determine required stream setback widths at a particular site.

SIZING DESIGN GOALS AND REQUIREMENTS

The Post-Construction S orm Water Quality Plan (SWQP) Form 3-4 should be used to calculate the retention volume (V_{ret}) of the Stream Setback and Buffer. This value is then used to calculate the area of impervious surface treated, and determine if other site design measures are necessary to capture the 85th percentile, 24-hour design storm for Regulated Projects. The equation for determining V_{ret} is as follows:

$$V_{ret} = A_{imp} * V_{85} * (1/12)$$

Where:

V_{ret} = stormwater retention olume (^{3});
A_{imp} = impervious area draining to the stream setback (^{2}); and
V_{85} = Runoff volume from 85th percentile, 24-hour design storm (in)

RUNOFF REDUCTION CREDIT REQUIREMENTS

- A minimum stream setback and buffer width of 500 feet is required to obtain runoff volume reduction credits.

INSPECTION AND MAINTENANCE REQUIREMENTS

A maintenance plan shall be provided with the SWQP. The maintenance plan shall include recommended maintenance practices, state the parties responsible for maintenance and upkeep, specify the funding source for ongoing maintenance, and provide a site specific inspection checklist. At a minimum, maintenance shall include the following:

- Establish and manage distinctions of allowable and unallowable uses in each buffer zone.
- Clearly identify buffer boundaries and maintain clear signs or markers defining buffer extents.
- Inspect newly established vegetation semi-annually to determine if landscape maintenance is needed (reseeding, irrigation, trimming, weed removal, etc.).
- Inspect disturbed and revegetated slopes semi-annually for erosion and repair as needed.
- Inspect trails, paths, and bridges annually for erosion or structural issues and repair as necessary.

REFERENCES

Schueler, T. 2000. The Architecture of Urban Stream Buffers, The Practice of Watershed Protection: Article 39. Center for Watershed Protection, Ellicott City, MD. Pages 225-233. Available for download at: http://www.cwp.org/online-watershed-library/cat_view/63-research/70-watershed

Stormwater Center, Aquatic Buffers Fact Sheet: Buffer Zones. Available online at: http://www.stormwatercenter.net/Assorted%20Fact%20Sheets/Tool3_Buffers/BufferZones.htm

U.S. Environmental Protection A ency. Aquatic Bu er Model Ordinance. Available online at: http://www.epa.gov/polwaste/nps/upload/2002_09_19_NPS_ordinanceuments_Buffer_model_ordinance1. pdf

SOIL QUALITY IMPROVEMENT AND MAINTENANCE

Fact Sheet SDM-2

Also known as: Soil amendments, engineered soils

DESCRIPTION

The quality of existing soils on a project site can be improved by implementing soil amendments that alter the physical, chemical, and biological characteristics of the soil. Soil amendments can help restore disturbed soils by increasing organic matter content and reducing compaction. Amendments can also make soils with high clay content (i.e. hydrologic soil groups [HSG] C and D) more suitable to receive and filter/infiltrate site runoff. Soil amendments consist of humus such as compost and aged manure; fibrous materials such as peat, wood chips, and hardwood bark; inorganic materials such as vermiculite and perlite; and other soil conditioners and fertilizers as appropriate. The practice can increase infiltration rates, plant survival rates and health, enhance root growth, provide erosion stabilization, and decrease need for irrigation and fertilization.

Photo Source: U.S. EPA

ADVANTAGES

- Improves soil infiltration rates.
- Reduces surface runoff quantities and erosion.
- Improves soil filtration capabilities and pollutant removal.
- Enhances plant survival rates and health.
- Decreases need for landscape irrigation and fertilization.

LIMITATIONS

- Not recommended for slopes steeper than 3:1.
- Could result in increased water table elevations, lateral groundwater flows and other conditions that may create unwanted seepage or flooding at down gradient locations.

KEY DESIGN FEATURES

The type, mix, and amounts of soil amendments will vary from site to site in response to the local soil conditions and type of desired vegetation. Existing soils must be sampled and analyzed to determine soil characteristics and identify appropriate amendment types and quantities. Soil amendments should consist primarily of compost mixed with other materials as necessary. Detailed material and testing specifications or compost are provided in the Low Impact Development Center's Soil Amendment – Compost Specifications.

Before soil amendments are applied, use a rototiller, soil ripper, or other equipment to loosen existing soils to the desired depth. Loosening soils below the depth of the amended soil layer will further improve infiltration. Design depths of soil amendment areas range from 6 inches minimum to several feet. Soil amendments should then be applied over the loosened soil area and incorporated into the existing soil until fully mixed. The amended soil should then be watered thoroughly and allowed to settle for at least one week prior to final grading. Seeding and planting should be performed immediately after final grading is complete.

SOIL QUALITY IMPROVEMENT AND MAINTENANCE

Fact Sheet SDM-2

SIZING DESIGN GOALS AND REQUIREMENTS

A qualified Geotechnical Engineer, Geologist, or Hydrogeologist should be consulted for the implementation of this Site Design Measure. The Post-Construction Storm Water Quality Plan (SWQP) Form 3-4 should be used to calculate the retention volume (V_{ret}) of the soil quality improvement and maintenance area. This value is then used to calculate the area of impervious surface treated, and determine if other site design measures are necessary to capture the 85th percentile, 24-hour design storm for Regulated Projects. The equation for determining V_{ret} is as follows:

$$\mathbf{V_{ret} = (A_{pond} * D_{pond}) + (A_{sa} * D_{sa} * n)}$$

Where:

V_{ret} = stormwater retention olume (^{3});
A_{pond} = ponding area (^{2});
D_{pond} = ponding depth (ft);
A_{sa} = soil amendment area (^{2});
D_{sa} = depth of amended soil (ft); and
n = porosity of amended soil

Soil quality improvement and maintenance areas must meet the ideal bulk densities provided in Table 1 below. Soil porosity (n) in the above equation is calculated as follows:

$$\mathbf{n = 1 - (\rho_{sa} / 2.65\ g/cm^3)}$$

Where:

n = porosity of amended soil; and
ρ_{sa} = bulk density of amended soil (g/cm^3)

Table 1. Ideal Bulk Densities or Amended Soils (grams/cm^3)

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

Data source: USDA NRCS

INSPECTION AND MAINTENANCE REQUIREMENTS

A maintenance plan shall be provided with the SWQP. The maintenance plan shall include recommended maintenance practices, state the parties esponsible for maintenance and upkeep, specify the funding source for ongoing maintenance, and provide a site specific inspection check ist. At a minimum, maintenance shall include the following:

- Soil should be planted and mulched after installation. No part of the site should have bare soil exposed.
- Compaction of amended soils should be avoided.
- Amended soils should be inspected annually for signs of compaction, waterlogging, loss of vegetated cover, or erosion.
- Corrective actions include application of additional amendments and mechanical aeration.

REFERENCES

Low Impact Development Center, Inc. 2003. Soil Amendment - Compost Specification. Available online at: http://www.lowimpactdevelopment.org/epa03/soilamend.htm

Low Impact Development Center, Inc. 2010. Low Impact Development Manual for Southern California: Technical Guidance and Site Planning Strategies. Available online at: https://www.casqa.org/sites/default/files/downloads/socallid-manual-final-040910.pdf

U.S. Environmental Protection Agency. 2007. The Use of Soil Amendments for Remediation, revitalization, and Reuse. Available online at: http://nepis.epa gov/Exe/ZyPDF.cgi/60000LQ7.PDF?Dockey=60000LQ7.PDF

TREE PLANTING AND PRESERVATION

Fact Sheet SDM-3

Also known as: Interceptor Trees

DESCRIPTION

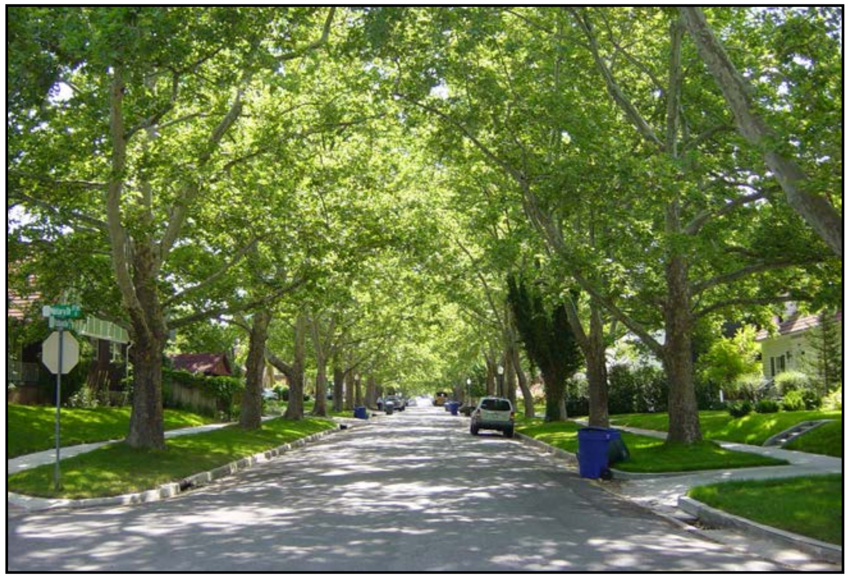


Photo Source: wfrc.org

Tree planting and preservation involves planting of now trees and preservation of existing trees to reduce stormwater runoff volumes from a new development or redevelopment site. Trees intercept rain water on their leaves and branches before it lands on impervious surface below, allowing rain water to evaporate or run down the branches and trunk of the tree where it readily infiltrates into the soil. Trees absorb infiltrated runoff through their roots and further reduce stormwater runoff by means of transpiration. Trees also provide shade over impervious surfaces which reduces the "heat island" effects of urban areas. Tree planting and preservation should be implemented on residential lots, throughout landscape corridors, in commercial and industrial parking lots, and along street frontages.

ADVANTAGES

- Reduces stormwater runoff volumes and the amount of pollutants entering downstream BMPs and the storm drain system.
- Enhances aesthetic value.
- Provides shade to cool pavement and reduces surface runoff temperatures.
- Aids in removal of air pollutants and noise reduction.
- Trees required by the permitting agency may be counted as interceptor trees.
- Establishes habitat for birds and other pollinators like butterflies and bees.
- Extends life of asphalt paving.

LIMITATIONS

- Great care must be exercised when work is conducted near existing trees to be preserved.
- New and existing trees may require irrigation.
- New and existing trees must have adequate setback from buildings, structures, and utilities
- Incorrect tree selection can result in high irrigation costs and pest infestation.
- Runoff reductions are dependent on the canopy area over the impervious surfaces created by the project.

KEY DESIGN FEATURES

- Appropriate new trees must be selected according to site and soil characteristics. Refer to the Local Landscape Design Guidelines for more information.
- Involve an arborist in the design process.
- Fire safety must be a consideration in areas with increased risk of fire hazard.

- Consider the future size/canopy and root zone of the fully-grown mature species when locating trees on the site, providing proper clearance from building foundations, pavement and overhead/underground utilities Ideally, provide a setback of 10 to 15 feet from the expected 10-year canopy to overhead lines.
- Utilize approved root barriers when trees are planted in near proximity to infrastructure, per the local permitting agency standards.
- Evergreen trees provide the greatest benefit to water quality due to their retention of leaves throughout the rainy season.
- Install irrigation systems according to local specifications.
- Do not install grass or turf within 24 inches of the tree trunk.
- Use mulch around the base of newly planted trees to reduce irrigation needs and protect bare soils from erosion. Consult an Arborist or nursery on appropriate amounts and types.

SIZING DESIGN GOALS AND REQUIREMENTS

The Post-Construction Storm Water Quality Plan (SWQP) Form 3-4 should be used to calculate the retention volume associated with tree planting and preservation. This value is then used to calculate the area of impervious surface treated, and determine if other site design measures are necessary to capture the 85th percentile, 24-hour design storm for Regulated Projects. The equation or determining V_{ret} is as follows:

$$V_{ret} = ((n_e * 218) + (n_d * 109) + A_{tc}) * (V_{85} * 1 \text{ ft}/12\text{in})$$

Where:

V_{ret} = stormwater retention olume (^{3});
n_e = number of new evergreen trees;
n_d = number of new deciduous trees;
A_{tc} = canopy area of existing trees to remain on the property (ft^2)
V_{85} = runoff volume from the 85th percentile, 24-hour design storm (in)

INSPECTION AND MAINTENANCE REQUIREMENTS

A maintenance plan shall be provided with the SWQP. The maintenance plan shall include recommended maintenance practices, tate the parties esponsible for maintenance and upkeep, specify the funding source for ongoing maintenance, and provide a site specific inspection checkl t. At a minimum, maintenance shall include the following:

- Irrigate as necessary to establish and maintain trees.
- Remove fallen leaves and debris annually to prevent materials from being transported in stormwater runoff
- Prune dead vegetation f om trees on a regular basis.
- Minimize the use of chemical fertilizers and pesticides.
- Maintain lawn and turf at least 24 inches from trunk of tree.
- Remove and replace dead trees as needed.

REFERENCES

Placer County Planning Services Division. 2013. Placer County Landscape Design Guidelines. Available online at: http:// ww.placer.ca.gov/~/media/cdr/Planning/documents/DesignGuides/Landscape%20 Design%20Guidelines.pdf

Sacramento County, et al. 2014. Stormwater Quality Design Manual for the Sacramento Region. Available online at: http:// ww.beriverfriendly.net/docs/files/Ma ter%20Stormwater%20Quality%20Manual%202014_FINAL_W%20 APPEND_W%20COVER.pdf

ROOFTOP AND IMPERVIOUS AREA DISCONNECTION

Fact Sheet SDM-4

Including: Downspout Disconnection, pavement Disconnection, and Flowpath Disconnection.

OVERVIEW

Rooftop disconnection. Source: LID Center

Rooftop and impervious area disconnection are techniques that reduce the volume of stormwater delivered to storm drains or receiving waters by disconnecting the runoff from these areas and redirecting it to permeable locations that promote soil filtration and runoff filtration. This can be accomplished by configuring roof gutter downspouts and impervious areas (e.g., driveways, pathways, small parking areas, and patios) to discharge runoff into landscaped areas, rain barrels and cisterns, or designed stormwater management areas such as vegetated swales, stream buffers, amended soil areas, and bioretention cells.

This Fact Sheet is organized to include separate sections for rooftop disconnection, and impervious area disconnection. Details on specific stormwater management strategies discussed herein, including stream setbacks and buffers, soil quality improvement and maintenance, porous pavement, vegetated swales, rain barrels and cisterns, and bioretention, can be found in other Fact Sheets included in this manual.

ROOFTOP DISCONNECTION

Roof drains and downspouts can be disconnected from the storm drain system by routing discharge to vegetated areas or into subsurface infiltration systems. The two rooftop disconnection methods discussed in this Fact Sheet include splash blocks and bubble-up emitters which both provide means of dissipating flow energy and spreading flows over the pervious area. Rooftop drainage is also ideal for harvest/reuse applications; refer to the Rain Barrels and Cisterns Fact Sheet for more information.

SPLASH BLOCK

Splash blocks are a low tech and cost efficient option to hard piped downspout systems. Existing downspouts can easily be retrofitted using splash blocks that reduce the velocity and impact of runoff discharging from downspouts. This reduces soil erosion and promotes infiltration.

ADVANTAGES

- Reduces peak flow rates and total runoff volumes.
- Directs runoff away from foundations and structures.
- Simple to implement in retrofit applications.
- Reduces the size of downstream BMPs.

LIMITATIONS

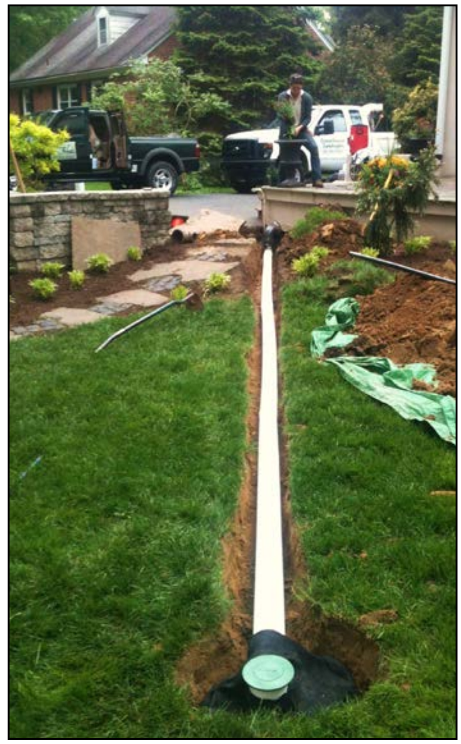
- Adjacent buildings and overflow requirements need to be considered in design.
- Only appropriate for sites with pervious areas near downspouts.
- If groundwater exists within two feet of the ground surface, seasonal fluctuations may result in periods of decreased infiltration and/or standing water.
- Runoff reduction credits cannot be claimed for rooftop disconnection if credits for stream setbacks and buffers or vegetated swales are being claimed in the same sub-watershed areas (DMA).

KEY DESIGN FEATURES

- Sites should be evaluated to ensure that splash blocks won't have negative impacts.
- Rain water must be directed away from foundations and footings.
- Do not compact soils in areas where infiltration of storm water is planned.
- Downspouts must extend at least six feet from a basement and two feet from a crawl space or concrete slab.
- The area of rooftop connecting to each downspout must be 600 square feet or less.
- Downspouts should not be directed to paved areas or across sidewalks.
- Landscaped areas receiving roof water should be adequately sized to prevent runoff or erosion. An impervious:pervious ratio of 2:1 should be applied.
- Flow spreaders should be implemented downstream of splash blocks for sites with steep slopes.

BUBBLE-UP EMITTER

Bubble-up emitters function very much like splash blocks, but allow for roof drainage to be discharged into vegetated areas that are not directly adjacent to the building. Downspouts are connected to underground pipes then released through a valve that opens with water pressure.



Bubble-up emi er installation.
Photo Source: green-weaver.com

ADVANTAGES

- Reduces peak flow rates and total runoff volumes.
- Directs runoff away from foundations and structures.
- Can discharge to vegetated areas not adjacent to buildings.
- Reduces the size of downstream BMPs.

LIMITATIONS

- Overflow requirements need to be considered in design.
- Increased maintenance and cost over splash blocks.
- Runoff reduction credits cannot be claimed for rooftop disconnection if credits for stream setbacks and buffers or vegetated swales are being claimed in the same sub-watershed areas (DMA).

KEY DESIGN FEATURES

- The area of rooftop connecting to each downspout should be 600 square feet or less.
- Landscaped areas receiving roof water should be adequately sized to prevent runoff or erosion. An impervious:pervious ratio of 2:1 should be applied.
- Overflow systems and backflow prevention should be incorporated into design.
- Piping and valves must be able to convey the design storm event.

ROOFTOP AND IMPERVIOUS AREA DISCONNECTION

Fact Sheet SDM-4

IMPERVIOUS AREA DISCONNECTION

Impervious Area Disconnection.
Photo Source: City of Kitchener, ON

Disconnecting impervious areas involves routing runoff from paved areas such as roads, parking lots, pathways, courtyards, and patios to adjoining vegetated areas as sheet flow. As the sheet flow passes over vegetated areas it is filtered by the soil and infiltrated thereby reducing the volume of stormwater discharged to receiving waters or the storm drain system. Examples of vegetated areas to accept sheet flow runoff include vegetated swales, stream buffers, amended soil areas, and bioretention cells. Another alternative for disconnecting impervious surfaces involves implementation of pervious pavement; refer to the Pervious Pavement Fact Sheet for more information. In general, curb and gutter should be avoided to reduce concentrated flows from impervious surfaces. However, curb cuts can be effectively implemented to direct runoff from roads and parking lots into permeable stormwater management areas. Level spreaders should be considered for energy dissipation and promotion of sheet flow to the pervious areas. This technique works well for retrofitting existing sites at a relatively low cost. Care must be taken to provide adequate clearances between vegetated infiltration areas and building foundations and paved surfaces.

ADVANTAGES

- Reduces peak flow rates and total runoff volumes.
- Eliminates need for stormwater conveyance infrastructure.
- Promotes groundwater recharge and is aesthetically pleasing.
- Reduces the size of downstream BMPs.

LIMITATIONS

- Soil permeability may limit use of existing vegetated areas.
- Not suitable for sites with high concentrations of oil & grease or potential spills.
- Could result in increased water table elevations, lateral groundwater flows and other conditions that may create unwanted seepage or flooding at down gradient locations.
- Runoff reduction credits cannot be claimed for impervious area disconnection if credits for stream setbacks and buffers are being claimed in the same sub-watershed areas (DMA).

KEY DESIGN FEATURES

- The area of impervious surface discharging to a single vegetated area must be 5,000 square feet or less.
- The size of the pervious area receiving runoff should be at least 50% of the contributing impervious area (i.e. use a impervious:pervious ratio of 2:1).
- The maximum contributing impervious fl w length should be less than 75 feet. If equal or greater than 75 feet, a storage device (e.g. French drain, bioretention a ea, gravel trench) should be implemented as a buffer prior to discharging to the impervious area.
- Water barriers may be required when infiltrating adjacent to paved surfaces in order to prevent undermining of pavement and baserock.
- If flow is to be introduced through curb cuts, place pavement slightly above the elevation of the the pervious area. Curb cuts should be at least 12 inches wide to prevent clogging.

ROOFTOP AND IMPERVIOUS AREA DISCONNECTION

Fact Sheet SDM-4

SIZING DESIGN GOALS AND REQUIREMENTS

The Post-Construction Storm Water Quality Plan (SWQP) Form 3-4 should be used to calculate the retention volume (V_{ret}) associated with rooftop and impervious area disconnection. This value is then used to calculate the area of impervious surface treated, and determine if other site design measures are necessary to capture the 85th percentile, 24-hour design storm for Regulated Projects. The equation for determining V_{ret} is as follows:

$$V_{ret} = A_{imp} * V_{85} * (1/12)$$

Where:

V_{ret} = stormwater retention volume (ft^3);

A_{imp} = impervious drainage area (ft^2); and

V_{85} = Runoff volume from the 85th percentile, 24-hour design storm (in)

RUNOFF REDUCTION CREDIT REQUIREMENTS

- Downspouts and any extensions must extend at least six feet from a basement and two feet from a crawl space or concrete slab.
- The area of rooftop connecting to each disconnected downspout must be 600 square feet or less.
- Roof runoff from the design storm must be fully contained in a landscaped area.
- The impervious area discharging to an impervious disconnection area must be than 5,000 square feet or less.
- The maximum contributing impervious flow path length for impervious area disconnection must be less than 75 feet or, if equal or greater than 75 feet, a storage device (e.g. French drain, bioretention area, gravel trench) is required to achieve the required disconnection length.
- Credits for roof runoff and impervious area disconnection cannot be obtained if stream setbacks and buffers are used within the same Drainage Management Area.
- Credits for roof runoff disconnection cannot be obtained if vegetated swales are used within the same Drainage Management Area.

REFERENCES

Low Impact Development Center, Inc. 2010. Low Impact Development Manual for Southern California: Technical Guidance and Site Planning Strategies. Available online at: https://www.casqa.org/sites/default/files/downloads/socallid-manual-final-040910.pdf

Sacramento County, et al. 2014. Stormwater Quality Design Manual for the Sacramento Region. Available online at: http://www.beriverfriendly.net/docs/files/Ma ter%20Stormwater%20Quality%20Manual%202014_FINAL_W%20 APPEND_W%20COVER.pdf

POROUS PAVEMENTS

Fact Sheet SDM-5

Also known as: Pervious pavement and permeable pavement.

DESCRIPTION

Porous Pavement is a system comprised of a load-bearing, durable surface coupled with an underlying drainage layer that temporarily stores water prior to infiltration or drainage to a controlled outlet. The surface can be porous such that water infiltrates across the entire surface of the material, or it can be constructed of impermeable blocks separated by spaces and joints, through which the water can drain. There are many types of porous pavement including pervious concrete and asphalt, modular block, reinforced grass, cobblestone block, and gravel.

Pemeable pavement. Source: EPA

Porous pavement is well-suited for low trafficroadways, parking lots, walking paths, sidewalks, playgrounds, plazas, tennis courts, and other similar uses. It has been widely applied in retrofit situations where existing standard pavements are replaced. Porous pavements should not be used in industrial and commercial applications where pavement areas are used for material storage or the potential for surface clogging is increased due to high traffic of construction vehicles.

ADVANTAGES

- Reduces peak flow rates and total runoff volumes.
- Significant flow attenuation and improvement in water quality.
- Can replace existing pavements eliminating the need or additional land.
- Roof runoff can be piped into the subsurface storage area directly, which would increase the level of flow attenuation.
- Sometimes more attractive than traditional pavement.
- Reduces size of downstream BMPs.

LIMITATIONS

- Can become clogged if improperly installed or maintained and may require replacement.
- Use should be limited level areas such as parking lots and other lightly trafficked or non-trafficked areas.
- Not suitable for areas of slope instability where infiltrated stormwater may cause failure.
- Not suitable in locations that can negatively impact building foundation or footings.
- Not suitable for sites with high concentrations of oil & grease or potential spills.
- Not suitable in industrial and commercial applications where pavement areas are used for material storage or high traffic of construction vehicles.
- High groundwater may slow infiltration, create standing water in the subsurface storage layers and destabilize pavement and/or result in seepage to the surface.

POROUS PAVEMENTS

Fact Sheet SDM-5

KEY DESIGN FEATURES

Source: NACTO

There are several types of porous pavement available, including pervious concrete, pervious asphalt, modular block, reinforced grass, cobblestone block, and gravel. The applicability of each porous pavement type should be carefully evaluated based on land uses and site characteristics. For detailed information and design guidance on all porous pavement types, refer to the Stormwater Quality Design Manual for the Sacramento Region. General siting and design recommendations for all porous pavement are as follows:

- Consult a geotechnical engineer to determine what types of porous pavement are suitable for the expected traffic load speed, and volume.
- Consult a geotechnical engineer to determine set back from building, or use 10 feet.
- Determine site soil type and permeability before selecting porous pavement as a runoff reduction strategy.
- Porous pavements are generally not suitable for sloped areas. Low points should be carefully evaluated and underdrains must placed appropriately to avoid flooding.
- May be used over soils with low permeability in selected situations if underdrain is provided.
- Underdrains should tie into an open landscape area or treatment control measure to quickly relieve the water pressure in the pavement section and prolong the pavement life.
- Access ports should be provided for underdrain systems to allow for routine inspection and cleaning
- Address seasonal shrink/swell in sites with expansive subgrade. Use the expansion index test (ASTM D4828) to provide insight as to degree of surface deformation in choosing paving sections.
- Consider opportunities for directing runoff from impervious surfaces across porous pavement to achieve runoff volume reduction credits. See the Rooftop and Impervious Area Disconnection fact Sheet included in this manual.
- Select the porous pavement type based on the type of anticipated pedestrian traffic; most types of porous pavement can be designed to be Americans with Disabilities Act (ADA) compliant.
- A water barrier or interceptor drain will be required where porous material abuts regular asphalt/concrete pavement and there is concern about water infiltrating the regular pavement sub-base. The water barrier should run down the 12-inch deep excavation and 12 inches under the drain rock.
- For manufactured products, check the manufacturer's specifications or any additional siting considerations.

SIZING DESIGN GOALS AND REQUIREMENTS

The Post-Construction S orm Water Quality Plan (SWQP) Form 3-4 should be used to calculate the retention volume (V_{ret}) for porous pavement areas. This value is then used to calculate the area of impervious surface treated, and determine if other site design measures are necessary to capture the 85th percentile, 24-hour design storm for Regulated Projects. The equation for determining V_{ret} is as follows:

$$\mathbf{V_{ret} = A_{res} * D_{res} * n_{agg} * C}$$

Where:

V_{ret} = stormwater retention olume (^{3});
A_{res} = area of permeable storage reservoir (^{2});
D_{res} = depth of permeable storage reservoir (ft);
n_{agg} = porosity of aggregate; and
C = efficiency actor

Efficiency factors for different types of porous pavements are provided in Table 1

below. **Table 1. Porous Pavement Efficiency actors**

Pervious Concrete or Asphalt (15% void space)	0.60
Modular Block Pavement (20% void space)	0.75
Reinforced Grass Pavement	1.00
Cobblestone Block Pavement (8% void space)	0.40

Source: Urban Drainage and Flood Control District, Denver, CO, Urban Storm Drainage Criteria Manual Volume 3 – Best Management Practices, September, 1999 (Rev. June, 2002)

INSPECTION AND MAINTENANCE REQUIREMENTS

A maintenance plan shall be provided with the SWQP. The maintenance plan shall include recommended maintenance practices, state the parties responsible for maintenance and upkeep, specify the funding source for ongoing maintenance, and provide a site specific inspection checklist. At a minimum, maintenance shall include the following:

- Post signs identifying porous pavement areas.
- Keep landscaped areas well-maintained and prevent soil from being transported onto the pavement.
- Clean the surface using vacuum sweeping machines.
- If routine cleaning does not restore infiltration rates, then reconstruction of part of the porous pavement may be required.
- For modular and cobblestone block, periodically add joint material (sand) to replace material that has been transported or removed.
- Monitor regularly to ensure that the paving surface drains properly after storms.
- Do not seal or repave with impermeable materials.
- Inspect the surface annually for deterioration.
- Reinforced grass requires mowing and periodic reseeding to fill in bare spots.
- Clean out underdrain systems at regular intervals.
- Inspect outlets annually and maintain as needed.

REFERENCES

Low Impact Development Center, Inc. 2010. Low Impact Development Manual for Southern California: Technical Guidance and Site Planning Strategies. Available online at: https://www.casqa.org/sites/default/files/d wnloads/socallid-manual-final-040910.pd

Santa Clara Valley Urban Runoff Pollution Prevention Program. 2012. Pervious Pavement, Stormwater Control for Small Projects. Available online at: http://scvurppp-w2k.com/pdfs/1213/BASMAA_Pervious_Paving_Fact_Sheet_082312_ APPROVED_online_ver.pdf

Urban Drainage and Flood Control District, Denver, CO, Urban Storm Drainage Criteria Manual Volume 3 – Best Management Practices, September, 1999 (Rev. June, 2002). http://udfcd.org/criteria-manual

VEGETATED SWALE

Fact Sheet SDM-6

Also known as: Bioretention Swale, Treatment Swale, and Grassed Swale

DESCRIPTION

Grassed swale. Photo Source: EPA

Vegetated swales are essentially bioretention cells that are configured as linear channels, but are typically not designed with an engineered soil matrix and underlying gravel layer below the vegetation layer to accommodate additional treatment, storage, and infiltration. They function as a soil and plant-based filtration and infiltration feature that removes pollutants through a variety of natural physical, biological, and chemical treatment processes. Vegetated swales are open, shallow channels with vegetation covering the side slopes and bottom that collect and slowly convey stormwater runoff to downstream discharge points. They are designed to treat runoff through vegetation filtration, biological uptake, evapotranspiration, and or infiltration into the underlying soils. They trap particulate pollutants (suspended solids and trace metals), promote infiltration, and reduce the flow velocity of storm water runoff.

Vegetated swales can serve as part of a storm water drainage system and can replace curbs, gutters and storm sewer systems. They are best suited to capture runoff from small impervious areas and should not be implemented in areas with highly contaminated runoff. They can be used as part of treatment train approach and are effective at providing pretreatment for other BMPs.

ADVANTAGES

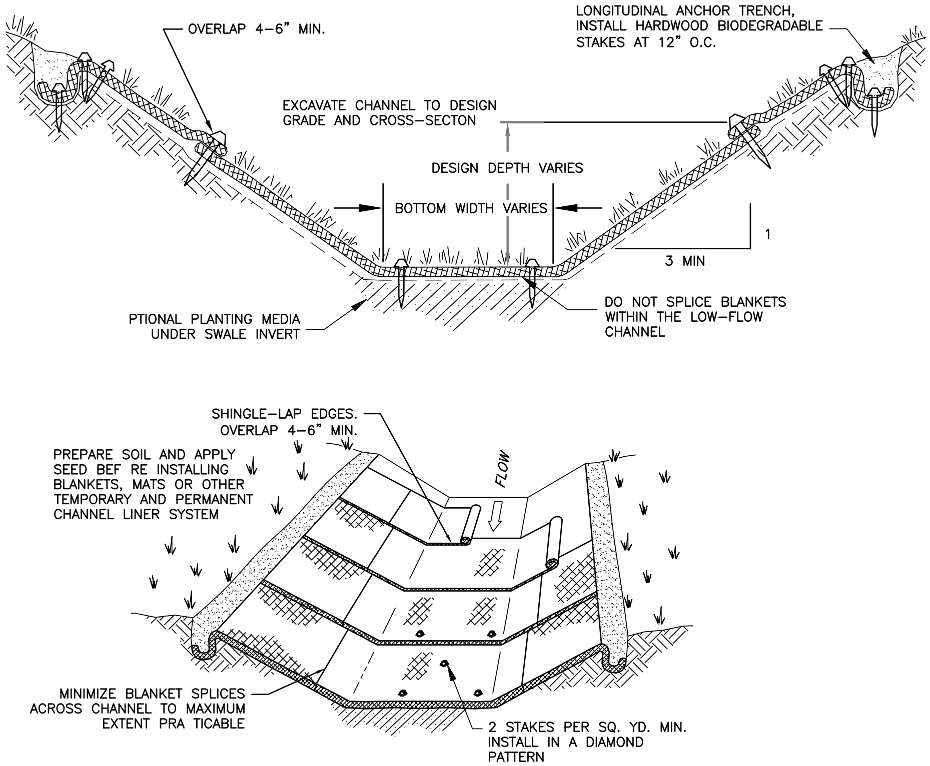
- Reduces peak flow rates and total runoff volumes.
- Provides effective pretreatment for downstream BMPs by trapping, filtering, and infiltrating particulates and associated pollutants.
- Can serve as a cost-effective alternative to traditional curb and gutter.
- Can be integrated into landscape design to improve aesthetic appeal.

LIMITATIONS

- Can be difficult to avoid channelization, which may cause erosion and limit infiltration potential.
- Not suitable for steep slopes.
- May not be appropriate for industrial sites or locations where spills may occur.
- Best suited for small drainage areas with low flow rates.
- A thick vegetative cover is needed for these features to function properly.

KEY DESIGN FEATURES

In order to receive runoff volume reduction credits, vegetated swales must be designed in accordance with Treatment Control BMP 30 (TC-30) from the California Stormwater BMP Handbook, New Development and Redevelopment. Key design elements are summarized below:



VE ETATED SWALE TYPICAL INSTALLATION

- Maximum flow velocity from the design storm event shall not exceed 1.0 foot per second.
- Vegetated swales should be designed so that the water level does not exceed 2/3rds the height of the grass or 4 inches, whichever is less, at the design treatment rate.
- Longitudinal slopes between 0.5% and 2.5% are recommended.
- Provide sufficient length to achieve a desired treatment contact time of 10 minutes. Regardless of contact time, the swale should not be less than 100 feet in length.
- Implement check dams for longitudinal slopes > 2.5% as a means to reduce slopes and promote infiltration. Space as required to maintain maximum longitudinal bo   om slope < 2.5%.
- Implement entrance/outlet energy dissipation measures to limit erosion and promote retention.
- Do not compact soils beneath vegetated swales.
- Trapezoidal channels are normally recommended but other configurations, such as parabolic, can also provide substantial water quality improvement and may be easier to mow than designs with sharp breaks in slope.
- Swales constructed in cut are preferred, or in fill areas that are far enough from an adjacent slope to minimize the potential for gopher damage. Do not use side slopes constructed of fill, which are prone to structural damage by gophers and other burrowing animals.
- A diverse selection of low growing, plants that thrive under the specific site, climatic, and watering conditions should be specified. Vegetation whose growing season corresponds to the wet season are preferred. Drought tolerant vegetation should be considered especially for swales that are not part of a regularly irrigated landscaped area.
- The width of the swale should be determined using Manning's Equation,   at the peak of the design storm, and a value of 0.25 for Manning's n.

- If flow is to be introduced through curb cuts, place pavement slightly above the elevation of the the vegetated areas. Curb cuts should be at least 12 inches wide to prevent clogging.
- Swales must be vegetated in order to provide adequate treatment and reduction of runoff. It is important to maximize water contact with vegetation and the soil surface. For general purposes, select fine, close-growing, water-resistant grasses. Refer to the Placer County Landscape Design Guidelines for more information.
- If possible, divert runoff (other than necessary irrigation) during the period of vegetation establishment. Where runoff diversion is not possible, cover graded and seeded areas with suitable erosion control materials. Diverted runoff must be managed and retained onsite to avoid violation of the Phase II MS4 permit.
- Swales used as primary stormwater conveyance facilities (i.e. without high flow bypass) must be designed according to requirements in the Placer County Stormwater Management Manual. These swales will not qualify for volume reduction credits unless the design criteria specified above are also satisfied.

SIZING DESIGN GOALS AND REQUIREMENTS

The Post-Construction Storm Water Quality Plan (SWQP) Form 3-4 should be used to calculate the retention volume (V_{ret}) associated with vegetated swales. This value is then used to calculate the area of impervious surface treated, and determine if other site design measures are necessary to capture the 85th percentile, 24-hour design storm for Regulated Projects. The equation or determining V_{ret} is as follows:

$$\mathbf{V_{ret} = A_{imp} * V_{85} * (1/12)}$$

Where:

V_{ret} = stormwater retention olume (^{3});
A_{imp} = impervious area draining to vegetated swale (^{2}); and
V_{85} = Runoff volume from the 85th percentile, 24-hour design storm (in)

RUNOFF REDUCTION CREDIT REQUIREMENTS

- Vegetated swales must be 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).
- The maximum flow velocity for runoff from the design storm event must be less than or equal to 1.0 foot per second.

INSPECTION AND MAINTENANCE REQUIREMENTS

A maintenance plan shall be provided with the SWQP. The maintenance plan shall include recommended maintenance practices, state the parties esponsible for maintenance and upkeep, specify the funding source for ongoing maintenance, and provide a site specific inspection checklist. At a minimum, maintenance shall include the following:

- Inspect on a semi-annual basis to assess slope integrity, soil moisture, vegetati e health, soil stability, compaction, erosion, ponding, and sedimentation.
- Mow at least once per year, but do not cut grass shorter than the design flow depth because the effectiveness of the vegetation in reducing flow velocity and pollutant removal may be reduced. Grass cuttings should be removed from the swale and composted.
- Remove accumulated sediment when it is 3” deep or higher than the turf to minimize potential concentrated flows and sediment resuspension.
- Irrigate only as necessary to prevent vegetation from dying.
- Integrated pest management should be used for pest control. The designer should ideally select vegetation that does not require fertilizers.

- Reseed periodically to maintain dense turf.
- Remove trash or obstructions th t cause standing water.
- Prevent off-street parking or other activities that can cause rutting or soil compaction.

REFERENCES

California Department of Transportation (Caltrans). 2010. Treatment BMP Technology Report. CTSW-RT-09-239.06. Available online at: http://www.dot.ca.gov/hq/env/stormwater/pdf/CTSW-RT-09-239-06.pdf

California Stormwater Quality Association (CASQA). 2003. California Stormwater BMP Handbook – New Development and Redevelopment. BMP Factsheet TC-30: Vegetated Swale. Available online at: http://www.cabmphandbooks.com/Documents/Development/TC-30.pdf

County of San Diego. 2007. Low Impact Development Handbook. Available online at: http://www.sdcounty.ca.gov/dplu/docs/LID-Handbook.pdf

Placer County Planning Services Division. 2013. Placer County Landscape Design Guidelines. Available online at: http://www.placer.ca.gov/~/media/cdr/Planning/documents/DesignGuides/Landscape%20Design%20Guidelines.pdf

U.S. Environmental Protection Agency, Post-Construction Stormwater Management in New Development and Redevelopment. BMP Fact Sheets. Available online at: http://water.epa.gov/polwaste/npdes/swbmp/PostConstruction-Stormwater-Management-in-New-Development-and-Redevelopment.cfm

RAIN BARRELS AND CISTERNS

Fact Sheet SDM-7

Also known as: Rainwater Harvesting, and Rainwater Collection

DESCRIPTION

Source: EPA

Rainwater harvesting is the practice of collecting, conveying, and storing rainfall for future indoor and outdoor use such as landscape irrigation, toilet flushing, and vehicle washing. The purpose of this harvesting is to collect high quality runoff to offset potable water demands while simultaneously reducing stormwater runoff volumes. Rooftop runoff is the stormwater most often harvested for use because it typically contains lower pollutant loads than surface runoff and provides accessible locations for collection. However, runoff from other clean impervious surfaces, such as driveways, walkways, and patios, may also be harvested effectively.

Rainwater harvesting typically utilizes rain barrels or cisterns:

- Rain barrels are small containers, typically ranging from 50 to 100 gallons installed adjacent to individual downspouts to capture rainwater runoff from roofs. Rain barrels are inexpensive, easy to install and maintain, and well suited to small-scale sites.
- Cisterns are typically much larger than rain barrels, ranging from 200 gallons for small installations to 10,000 gallons or more for large facilities. They can be installed above or below ground, or even on the roof, depending upon site conditions

The irrigation of harvested rainwater may utilize a simple gravity system for small systems or use pumps for larger systems. The pump and wet well should be automated with a rainfall sensor to provide irrigation only during periods when required infiltration rates can be realized.

ADVANTAGES

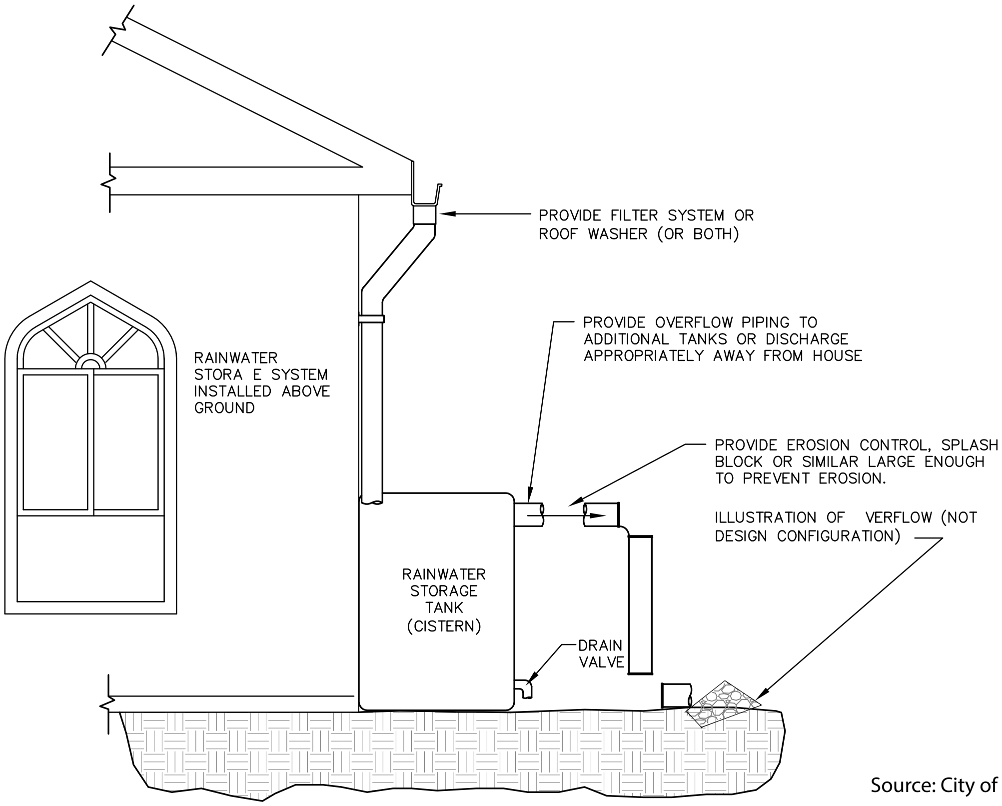
- Applicable with limited space constraints and under all soil conditions.
- Reduces runoff volumes and peak flows while disconnecting impervious surfaces.
- Does not add additional pollutants to runoff.
- Cisterns can be combined with pervious parking areas.
- Helps reduce demand on municipal treated water supplies.
- Can be retrofitted into existing property.

LIMITATIONS

- Rain barrels have limited storage capacity.
- Stored runoff must be used between storm events to maintain storage capacity.
- Does not provide water quality treatment.
- May require a system of pumps and valves to fill containers and reuse stored water.
- Irrigation systems may be expensive to operate and maintain.
- Inadequate maintenance can result in mosquito breeding and/or algae production.
- May require building permits. Contact the governing agency for requirements.
- Reuse of harvested rainwater may involve regulatory obstacles.
- May require screening or landscaping to improve aesthetics.

RAIN BARRELS AND CISTERNS

Fact Sheet SDM-7



Source: City of Salinas

KEY DESIGN FEATURES

- Site storage tanks underground, indoors, on roofs, or adjacent to buildings, outside of existing utility easement and County right-of-way.
- Make tanks water tight to avoid ponding or saturation of soils within 10’ of building foundations.
- Locate rain barrels or above ground cisterns with gravity distribution systems up-gradient from irrigated areas.
- Locate underground cisterns in native, rather than fill soil for stability.
- Roof surfaces shall not include copper or materials treated with fungicides or herbicides.
- Roof gutters must be fully screened and installed at continuous grade.
- Containers must be opaque, water tight, vented, completely covered and screened.
- Pretreat runoff to remove debris, dust, leaves, and other debris. Use leaf and mosquito screens (1 mm mesh size), first-flush diverter, or in-tank filter.
- Use settling compartment for tanks over 2,500 gallons.
- Use a water pump for underground cisterns. Indoor systems usually require a pump, pressure tank, back-up water supply line and backflow preventer.
- Overflow device must be equal in size to the total of all inlets and must lead to an approved discharge location with approved air gap.
- Install safety labels (non-potable, vector hazard, drowning hazard icons).
- Refer to local ordinances for siting and size constraints.
- Both rain barrels and above-ground cisterns must be sited in a stable, flat area. Rain barrels and cisterns may not block the path of travel for fire safety access.
- Overflow locations, which can include bioretention units, additional rain barrels or cisterns, or a discharge point to the storm drain system, must be designed to both direct outflow away from building foundations and prevent nuisance flows to adjacent properties.
- Tanks should be opaque and placed in a cool or shaded area to avoid algal growth.

RAIN BARRELS AND CISTERNS

Fact Sheet SDM-7

SIZING DESIGN GOALS AND REQUIREMENTS

The Post-Construction S orm Water Quality Plan (SWQP) Form 3-4 should be used to calculate the retention olume (V_{ret}) associated with rain barrels and cisterns. This value is then used to calculate the area of impervious surface treated, and determine if other site design measures are necessary to capture the 85th percentile, 24-hour design storm for Regulated Projects. The equation or determining V_{ret} is as follows:

Photo Source: City of Portland

$$V_{ret} = N * Va * 0.5$$

Where:

V_{ret} = stormwater retention volume (ft^3);
N = number of rain barrels and/or cisterns; and
V_a = average volume of rain barrels and/or cisterns (ft^3)

INSPECTION AND MAINTENANCE REQUIREMENTS

A maintenance plan shall be provided with the SWQP. The maintenance plan shall include recommended maintenance practices, state the parties responsible for maintenance and upkeep, specify the funding source for ongoing maintenance, and provide a site specific inspection checklist. Maintenance requirements for rainwater harvesting systems vary according to use. At a minimum, maintenance shall include the following:

- Perform regular inspections every six months during the spring and fall seasons for the following:
  - Confirm that all the parts, pumps, and valves are operable and not leaking;
  - Keep leaf screens, roof gutters, and downspouts free of leaves and other debris;
  - Check screens and patch holes or gaps;
  - Clean and maintain first flush diverters and filters, especially those on drip irrigation systems;
  - Inspect and clean storage tank lids, paying special attention to vents and screens on inflow and outflow spigots; and
  - Replace damaged system components as needed.
- Clean tanks annually with a non-toxic cleaner, such as vinegar and dispose of wash water in a sink, bathtub or sewer cleanout.
- Flush cisterns annually to remove sediment. For buried structures, vacuum removal of sediments is required.
- Test all backflow prevention assemblies or proper function annually.
- Regular use of the water stored in systems between rain events is critical to ensure that storage is available for the next storm event.

REFERENCES

California Stormwater Quality Association (CASQA). 2003. California Stormwater BMP Handbook – New Development and Redevelopment. BMP Factsheet TC-12: Retention/Irrigation. Available online at: https://www.casqa.org/sites/ default/files/BMPHandboo s/TC-12.pdf

Low Impact Development Center, Inc. 2010. Low Impact Development Manual for Southern California: Technical Guidance and Site Planning Strategies. Available online at: https://www.casqa.org/sites/default/files/d wnloads/socallid-manual-final-040910.pdf

San Francisco Public Utilities Commission, et al. 2010. San Francisco Stormwater Design Guidelines. Appendix A, Stormwater BMP Fact Sheets. Available online at: http://www.sfwater.org/Modules/ShowDocument.aspx?documentID=2779

Santa Clara Valley Urban Runoff pollution Prevention Program. 2012. Rain Barrels and Cisterns, Stormwater Control for Small Projects. Available online at: http://www.scvurppp-w2k.com/pdfs/1213/BASMAA_Rain_Barrel_Fact_Sheet_082312_APPROVED_online_ver.pdf

BIORETENTION

Fact Sheet TR-1

Bioretention facilities, also known as rain gardens and stormwater planters, are planted depressions that slow, treat, and infiltrate stormwater to improve water quality and manage hydromodification. They can be located in a variety of settings such as along roadsides or incorporated into a site's landscaping but should be designed by a qualified professional. Bioretention cells receive runoff from roofs and other impervious surfaces and provide treatment through settling, filtration, and biological processes as stormwater ponds and percolates through planting soil media and into a subsurface gravel storage bed. Runoff volume is reduced by evapotranspiration and, if conditions are suitable, by infiltration into the underlying soils and groundwater. Bioretention facilities are effective at removing a variety of pollutants including trash, sediment, metals, nutrients, bacteria and hydrocarbons. Bioretention areas are usually designed to allow shallow ponding, with an overflow outlet to prevent flooding during heavy storms. The overflow can be directed to a storm drain system or to another BMP.

Roadside bioretnetion. Sou ce: sitephocus.com

Two general types of bioretention facilities are allowable in the Permit including infiltrating bioretention and flow-through planters. Flow-through planters are used in locations not suitable for infiltration and include impermeable liners and an underdrain pipe to collect the treated water and discharge it to the municipal storm drain or other appropriate location.

ADVANTAGES

- Protects and improves water quality by removing pollutants from stormwater runoff.
- Reduces surface runoff volumes and attenuates peak flows.
- Wide range of scales and site applicability.
- Attractive and relatively easy and inexpensive to install and maintain.
- Improves air quality and reduces heat island effects.
- Increases groundwater recharge.
- Creates habitat and increases biodiversity.

LIMITATIONS

- Infiltration of stormwater can negatively impact structural foundations and increase other geological hazards. Locations shall be approved by a licensed Geotechnical Engineer.
- High groundwater can slow infiltration ates or even seep into bioretention cells and discharge as surface water. An average 10 ft. separation, and a minimum of 5 ft., between the bottom of the BMP and groundwater is recommended.
- Contaminants in soil and groundwater can be mobilized by infiltrating water.
- Existing infrastructure such as underground utilities and drainage infrastructure may constrain bioretention design.
- Vegetation requires maintenance and can look overgrown or weedy; seasonally it may appear dead.

KEY DESIGN FEATURES

The design of bioretention facilities involves many considerations and planning activities should be started at the earliest possible stage of a projects. It is critical that the facilities achieve the required performance standards while also protecting public health and safety, infrastructure and property. Bioretention design should begin during the site assessment and layout phase when determining building and parking locations and footprints and before the site grading plan is prepared. For infiltration type planters, consult a licensed geotechnical engineer about site suitability.


LID vegetated swale parking lot. Shellito Indoor Pool, Roseville. Photo: Greg Bates

The key design features and considerations for bioretention facilities include the following:

1. Topography: In appropriate conditions and with careful design, bioretention facilities an be located on slopes by incorporating check dams, terracing, or other methods to pond the water. Infiltration on slopes can create, or increase, the potential for downgradient seepage, landslides, and other geotechnical hazards. Infiltration is generally not recommended on slopes exceeding 10 percent.

2. Adjacent structures: Where bioretention facilities are located next to structures such as curb and gutter, sidewalks, buildings, additional structural support may be required between the adjacent road or parking surface and bioretention soil media. Vertical cutoff walls or impervious liners should be considered to keep stormwater from migrating into structural fill or road base materials. In expansive (C, D) soils, locate stormwater planters far enough from structures to avoid damage to foundations (as determined by a structural or geotechnical engineer). 10 feet is a typical rule-of-thumb.

   Subsurface utilities should not be located within the bioretention facility and utility trenches should be isolated from the infiltrating areas to prevent the formation of preferential flow paths along trenches, migration of backfill materials, and flooding of utility vaults.

3. Inlet design: Inlets can include a variety of structures and configurations including curb cuts, open channels, and pipes. The design must provide the width and geometry needed to direct flows into the facility and its elevation must provide adequate hydraulic head for filtration and storage volume. To prevent stormwater runoff from eroding the soil surface as it enters the facility, a concrete splash pad or rock energy dissipater (3”-5” -size rounded rock, 6” depth) should be placed at the inlets.

4. Overflow: Provisions to bypass flows that exceed the design ponding depth must be included in bioretention designs. Overflow systems should be located near the entrance of the bioretention facility to prevent scouring of the system and mobilization of the mulch layer. Overflow provisions shall not impact structures. Overflow structures may consist of a raised overflow structure connected via pipe to an approved discharge point, or a surface conveyance route (e.g., curb cuts, open channel, or pipe). Overflow structures must be sized to convey peak flood flows, per Placer County SWMM requirements, and include provisions for clogging. Elevations must be set to provide storage of the required water quality volume.

5. Surface ponding: A minimum design depth of 6 inches is required for surface ponding to provide additional stormwater storage capacity, with a maximum depth of 12 inches. Ensure that the design does not allow ponding to persist for longer than 72 hours for vector control.

6. Aggregate layer: A minimum 12-inch thick layer of ¾-inch washed aggregate below the planting media increases the facility's water storage capacity and promotes positive drainage through the underdrain system. A 3-inch layer of smaller aggregate (washed pea gravel) between the planting media and ¾-inch aggregate layer can omit the need for filter fabric, which is known to cause clogging.

7. Bioretention soil media: A minimum 18-inch thick mixture of 60-70 percent sand meeting the specifications of the American Society for Testing and Materials (ASTM) C33 and 30-40 percent compost may be used to provide filtration of runoff while supporting heathy plant growth. It may be possible in some cases to use native soil or to amend the native soil so that it is suitable. Use of native soil will depend on the evaluation of the criteria in "Section 3 - Si e Assessment" as well as consideration of structural needs and may require evaluation by a licensed Geotechnical Engineer.

8. Mulch: If the area will be mulched, initial excavation depth must anticipate the total combined media depth, to avoid having to reduce soil depth during construction to accommodate mulch at final grades. If mulch is used as a top dressing avoid wood chips or other material that will float and potentially clog overflow structures. Mulch should not be installed just before or during the rainy season.

9. Underdrain: An underdrain system should be included with the discharge elevation at the top of the aggregate layer to convey runoff not infiltrated into the native soil to the stormwater system or other appropriate discharge point. The underdrain may be eliminated in areas of high groundwater, rapidly infiltrating soils or where connection of the underdrain to a surface discharge point or to a subsurface storm drain are infeasible. The perforations in the underdrain must be directed down or else water flowing through the planting media into the gravel layer will immediately be collected and discharged through the underdrain. Maintenance access and cleanout ports should be provided so that underdrain system can be routinely inspected and cleaned as needed.

10. Liners: Facilities 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 aggregate layer.

11. Plants: A list of native plant species for the Sacramento Valley is provided in the table below. Use a variety of trees, shrubs and herbaceous plant materials. Native grass meadows are especially effective at controlling and treating storm water over a large area. Choose moisture-tolerant plants for the bottom of a bioretention swale or basin. Choose plants that can tolerate both fluctuating water conditions and drought conditions for the side edges. Guidance on planting and general landscape design is provided in the Placer County Landscape Design Guidelines (Placer County Planning Services Division, 2013).

12. Pre-treatment: Runoff from industrial sites or locations where spills may occur or areas with excessive erosion or sediment sources should be pre-treated to address pollutants of concern prior to discharging into bioretention systems.

13. Underlying soils: Soils beneath the facility must be protected from compaction during construction activities. If soils have been compacted previously they should be ripped as deeply as necessary to loosen the soils and re-establish natural infiltration rates.

Sacramento Valley Native Plant List. Provided by the California Native Plant Society, Sacramento Valley Chapter, July 2015.

Botanic name	Common name	Height	Dry	Med Water	Wet	Full Sun	Part Shade	Shade	Deciduous/ Evergreen
ANNUAL PLANTS									
Collinsia heterophylla	Chinese Houses	1-2′		X			X		D
Eschscholzia californica	California Poppy	1-1.5′	X	X		X			D
Gilia capitata	Globe gilia	0.5-1′	X	X		X	X		D
GRASSES & GRASS-LIKE PLANTS									
Bouteloua gracilis	Blue gramma grass	1.5-2′	X			X			D
Deschampsia caespitosa	Tufted hair grass	1-2′		X	X		X		E
Elymus glaucus	Blue wildrye	1′	X	X		X			E
Elymus triticoides	Creeping wildrye	1-3′	X	X		X	X		D
Festuca californica 'Serpentine Blue'	Serpentine blue California fescue	2-3′	X	X		X	X		E
Festuca idahoensis	Blue Idaho fescue	1′	X	X		X	X		E
Festuca idahoensis 'Siskiyou Blue'	Siskiyou Blue Idaho fescue	2′		X		X	X		E
Leymus condensatus 'Canyon Prince'	Canyon prince lyme grass	4′	X	X		X	X		E
Leymus triticoides (Elymus triticoides)	Creeping wild rye	1.5-3′	X	X		X	X		E
Melica californica	California melic	1-3′	X				X		D
Muhlenbergia rigens	Deer grass	5′	X	X		X	X		E
Sporobolus airoides	Alkali sacaton	2′		X	X	X	X		D
Stipa cernua	Nodding needlegrass	2′	X			X	X		D
Stipa lepida	Foothill needlegrass	2-3″	X			X	X		D
Stipa pulchra	Purple needlegrass	2′	X				X		D
Carex barbarae	Santa Barbara sedge	1-3′		X	X	X	X	X	E
Carex pansa	California meadow sedge	0.5′	X			X	X		E
Carex praegracilis	Clustered field sedge	1-2′	X	X		X	X		E
Juncus balticus	Baltic rush or wire rush	1-4′		X		X	X		E
Juncus effusus	Common rush	1.5-2′		X	X		X		E
Juncus effusus var. brunneus	Common rush	3-4′		X	X	X	X		E
Juncus effusus var. pacificus	Common rush	2-3′		X		X	X		E
Juncus patens	California gray rush	1.5-2.5′	X	X		X	X		E
Juncus patens 'Carman's Gray'	Carman's California gray rush	1-2′		X	X	X	X		E
Scirpus robustus	Alkali bull rush	5-15′			X	X	X		E
Xerophyllum tenax	Bear grass	2-4′		X		X			D
PERENNIAL PLANTS									
Achillea millefolium	Common Yarrow	1-3′	X	X		X	X		E
Achillea millefolium 'Island Pink'	Island pink common yarrow	2′	X	X			X		
Acmispon glaber (syn. Lotus scoparius)	Deerweed	3′	X			X			E
Aquilegia exima	Serpentine columbine	2′	X	X			X	X	D
Aquilegia formosa	Western columbine	1.5-3′		X	X		X	X	D
Artemisia douglasiana	California mugwort	3-5′	X	X	X	X	X		E
Asarum caudatum	Wild ginger	1′		X	X		X	X	E
Asclepias cordifolia	Purple Milkweed	1-3′	X	X		X	X		D
Asclepias fascicularis	Narrowleaf milkweed	2-3′		X		X	X		D

Sacramento Valley Native Plant List. Provided by the California Native Plant Society, Sacramento Valley Chapter, July 2015.

Botanic name	Common name	Height	Dry	Med Water	Wet	Full Sun	Part Shade	Shade	Deciduous/ Evergreen
PERENNIAL PLANTS CONT.									
Asclepias speciosa	Showy milkweed	3-6′		X		X	X		D
Carex tumulicola	Foothill Sedge	1.5′	X	X		X	X	X	E
Dudleya cymosa	Dudleya, Liveforever	3-6″		X			X	X	E
Epilobium canum	California fuchsia	1-1.5′	X	X					D
Epilobium canum 'Carman's Grey'	Carman's grey California fuchsia	2′	X	X		X	X		D
Epilobium canum 'Catalina'	Tall California fuchsia	1.5-3′	X	X		X	X		D
Epilobium septentrionalis 'Select	Select Mattole California fuchsia	0.25-0.5′		X		X	X		D
Equisetum scirpoides	Dwarf scouring rush	0.5′		X	X	X	X		E
Erigeron glaucus 'Wayne Roderick'	Seaside Daisy	0.5′		X		X	X		E
Erigeron karvinskianus	Mexican daisy, Santa Barbara daisy	1-1.5′		X		X	X		E
Eriodictyon californicum	Yerba Santa	3-6′	X	X		X	X		E
Eriogonum gracile	Wild buckwheat/ Slender	14-16″	X	X		X	X	X	D
Eriogonum grande var rubescens	Red-Flowered buckwheat	1-3′	X			X			E
Eriogonum umbellatum var. polyanthum	Sulfur buckwheat	0.5-1′	X	X		X	X		E
Eriogonum ursinum	Bear Valley buckwheat	0.25-1′	X	x		X	X		E
Eriophyllum lanatum	Woolly sunflower	1-2′	X			X	X		E
Fragaria vesca	Wild strawberry	4-6″		X	X	X	X	E	E
Grindelia stricta venulosa	Coastal gum plant	1-2′	X	X		X	X		E
Helenium bigelovii	Bigelow's sneezeweed	2-3′		X		X	X		D
Heuchera 'Canyon Quartet'	Canyon quartet alum root	1-2′	X	X			X	X	E
Heuchera 'Lillian's Pink'	Lillian's pink alum root	1-2′	X				X	X	E
Heuchera maxima	Island alum root	2-3′	X	X			X	X	E
Heuchera micrantha	Crevice alum root	1-2′	X	X			X	X	E
Heuchera 'Rosada'	Rosada alum root	2-3	X	X			X	X	E
Hibiscus lasiocarpus	Hibiscus	4-6′		X	X	X	X		D
Iris douglasiana	Douglas iris	1-2′	X	X		X	X		E
Iris Pacific Coast Hybrid 'Canyon	White Pacific Coast hybrid iris	1-2′	X	X		X	X		E
Iris Pacific Coast Hybrid 'Dorothea's	Burgundy Pacific Coast hybrid iris	1-2′	X	X		X	X		E
Iris Pacific Coast Hybrid 'Lavender'	Lavender Pacific Coast hybrid iris	1-2′	X	X		X	X		E
Iris Pacific Coast Hybrid 'Purple and	Purple and white Pacific Coast hybrid iris	1-2′	X	X		X	X		E
Iris Pacific Coast Hybrid 'Yellow'	Yellow Pacific Coast hybrid iris	1-2′	X	X		X	X		E
Iris Pacific Coast Iris mixed	Mixed colors Pacific Coast hybrid iris	1-2′	X	X		X	X		E
Lilium pardilinum	Leopard lily	3-8′		X		X	X		D
Linum lewisii	Blue Flax	2-3′	X	X			X	X	D
Lupinus polyphyllus	Streamside lupine	1-3′		X	X		X		D
Mentzelia laevicaulis	Blazing star	2-3′	X			X			D
Mimulus aurantiacus	Sticky monkeyflower	3-5′	X	X		X	X		E
Mimulus aurantiacus 'Verity',	Bush monkeyflower	1-4′		X		X	X		E
Mimulus cardinalis	Scarlet Monkeyflower	1 ½ -3′			X	X	X		D
Monardella odoratissima	Mountain pennyroyal, coyote mint	0.3-2′	X			X			E

Sacramento Valley Native Plant List. Provided by the California Native Plant Society, Sacramento Valley Chapter, July 2015.

Botanic name	**Common name**	**Height**	**Dry**	**Med Water**	**Wet**	**Full Sun**	**Part Shade**	**Shade**	**Deciduous/ Evergreen**
PERENNIAL PLANTS CONT.									
Penstemon azureus	Azure penstemon	0.5-1.5′	X	X		X	X		D
Penstemon heterophyllus	Foothill penstemon	1-3′	X	X		X	X		E
Penstemon heterophyllus 'Margarita BOP'	Margarita BOP foothill penstemon	1.5-2′	X	X		X	X		E
Penstemon spectabilis	Showy penstemon	3-4.5′	X			X	X		E
Phacelia imbricate	Rock Phacelia, Pine Bee Flower	1-2′	X			X			D
Phyla nodiflora	Lippia	2-4"		X			X		D
Potentilla glandulosa	Sticky cinquefoil	1-2′		X		X	X		D
Rubus leucodermis	Western raspberry	3-4′		X			X		D
Rubus parviflorus	Thimbleberry	3-6′		X			X	X	D
Salvia 'Bee's Bliss'	Bee's bliss Sonoma sage	1-1.5	X	X		X	X		E
Salvia sonomensis	Creeping Sage	1′	X			X	X		E
Scrophularia californica	California figwort, Bee Plant	4-6′		X			X		D
Sedum obtusatum	Sierra sedum	0.5′	X	X			X		E
Sisyrinchium bellum	Blue-eyed grass	1′		X	X	X			D
Solidago californica	California goldenrod	1′			X	X	X		D
Solidago Californica 'Cascade Creek'	Cascade Creek California goldenrod	3-4′	X			X	X		D
Symphyotrichum chilense	California aster	2′	X	X	X	X	X		D
Whipplea modesta	Western whipplea	0.25-0.75′		X			X		D
Woodwardia fimbriata	Western chain fern	4-6′		X			X	X	E
Wyethia angustifolia	Narrowleaf mule's ears	20″	X	X		X	X		D
Wyethia mollis	Mountain mule's ears	0.5-2′	X	X			X		D
SHRUBS									
Arctostaphylos bakeri 'Louis	Pink manzanita	5-6′	X	X		X	X		E
Arctostaphylos densiflora 'Howard	McMinn's manzanita	5-8′	X	X		X	X		E
Arctostaphylos densiflora 'Sentinel'	Sentinel manzanita	6-8′	X	X		X	X		E
Arctostaphylos edmundsii 'Carmel Sur'	Carmel Sur manzanita	1-1.5′	X	X		X	X		E
Arctostaphylos 'Emerald Carpet'	Emerald carpet manzanita	1′	X	X		X	X		E
Arctostaphylos glauca	Bigberry manzanita	15′	X	X		X	X		E
Arctostaphylos hookeri 'Wayside'	Wayside Monterey manzanita	4′	X	X		X	X		E
Arctostaphylos 'John Dourley'	John Dourley manzanita	2-4′	X	X		X	X		E
Arctostaphylos manzanita 'Dr. Hurd'	Dr. Hurd's manzanita	10-12′	X	X		X	X		E
Arctostaphylos uva-ursi 'Green	Green Supreme bearberry	1′	X	X		X	X		E
Arctostaphylos uva-ursi 'Massachusetts'	Massachusetts bearberry	1′	X	X		X	X		E
Arctostaphylos uva-ursi 'Pacific Mist'	Pacific Mist bearberry	2-3′	X	X		X	X		E
Arctostaphylos uva-ursi 'Point Reyes'	Pt. Reyes bearberry	1′	X	X		X	X		E
Arctostaphylos uva-ursi 'Radiant'	Radiant bearberry	1′	X	X		X	X		E
Arctostaphylos viscida	Whiteleaf manzanita	4-12′	X			X			E
Atriplex lentiformis	Quail bush	3-10′	X			X			D
Baccharis pilularis	Coyote brush	4-8′	X			X			E
Baccharis pilularis 'Pigeon Point'	Pigeon Point coyote brush	1.5-3′	X	X		X			E

Sacramento Valley Native Plant List. Provided by the California Native Plant Society, Sacramento Valley Chapter, July 2015.

Botanic name	**Common name**	**Height**	**Dry**	**Med Water**	**Wet**	**Full Sun**	**Part Shade**	**Shade**	**Deciduous/ Evergreen**
SHRUBS CONT.									
Calycanthus occidentalis	Western Spicebush	8-15'		X	X		X	X	D
Carpenteria californica	California bush anemone	4-8'	X	X			X	X	E
Carpenteria californica 'Elizabeth'	Dr. McClintock's bush anemone	3-5'	X	X			X	X	E
Ceanothus 'Blue Jeans'	Blue jeans wild lilac	7-9	X			X			E
Ceanothus 'Centennial'	Centennial wild lilac	2'	X			X			E
Ceanothus 'Concha'	Concha wild lilac	6-7'	X			X			E
Ceanothus cuneatus	Buck brush	5-10'	X			X			E
Ceanothus 'Dark Star'	Dark Star wild lilac	5-6'	X			X			E
Ceanothus gloriosus	Pt. Reyes wild lilac	1-1.5'	X			X			E
Ceanothus gloriosus 'Anchor Bay'	Anchor Bay wild lilac	1-1.5'	X			X			E
Ceanothus gloriosus var. exaltatus	Emily Brown's hallelujah bush	1-2	X	X		X	X		E
Ceanothus griseus 'Louis Edmunds'	Louis Edmunds wild lilac	5-6'	X			X			E
Ceanothus griseus var. horizon. 'Yankee Point'	Yankee Point wild lilac	2-3'	X			X			E
Ceanothus griseus var. horizontalis	Carmel creeper wild lilac	1.5-2.5'	X			X			E
Ceanothus integerrimus	Deerbrush wild lilac	3-7'	X			X	X		D
Ceanothus 'Joan Mirov'	Joan Mirov wild lilac	3-6'	X	X		X	X		E
Ceanothus 'Joyce Coulter'	Joyce Coulter wild lilac	2-5'	X			X			E
Ceanothus 'Julia Phelps'	Julia Phelps wild lilac	5-7'	X			X			E
Ceanothus maritimus 'Point Sierra'	Pt. Sierra wild lilac	2-3'	X			X			E
Ceanothus maritimus 'Valley Violet'	Valley Violet wild lilac	2-3	X			X	X		E
Ceanothus 'Owlswood Blue'	Owlswood blue island wild lilac	10'	X	X			X		E
Ceanothus prostratus	Squaw carpet	1'	X	X			X		E
Ceanothus 'Ray Hartman'	Ray Hartman wild lilac	12-20'	X			X			E
Ceanothus thrysifolius repens 'Louis Edmunds'	Louis Edmunds prostrate blue blossom	0,5-2'	X	X		X	X		E
Ceanothus thyrsiflorus	Blue blossom	5-15'	X			X			E
Ceanothus thyrsiflorus 'Skylark'	Skylark compact blue blossom	3-6'	X			X			E
Ceanothus thyrsiflorus 'Snow Flurry'	Snow flurry wild lilac	6-10'	X			X			E
Cercocarpus betuloides	Mountain Mahogany, Birchleaf Mountain Mahogany	10-15'	X			X	X		E
Cercocarpus betuloides var blancheae	Island mountain mahogany	10-12'	X	X		X			E
Cornus stolonifera (syn. C. sericea)	redtwig or western dogwood	7-9'		X	X		X		D
Cornus stolonifera 'Peter's Choice'	redtwig or western dogwood	7-9'		X	X		X		D
Eriogonum fasciculatum (E. f. var. foliolosum)	California buckwheat	1-3	X	X		X			E
Eriogonum giganteum	St. Catherine's lace	3-4'	X	X		X			E
Frangula tomentella	Hoary coffeeberry	6-10'	X	X		X	X		E
Fremontodendron 'Ken Taylor'	Ken Taylor flannel bush	4-6'	X			X			E
Fremontodendron 'Pacific Sunset'	Pacific Sunset flannel bush	12-15'	X			X			E
Fremontodendron 'San Gabriel'	San Gabriel flannel bush	15-20'	X			X			E
Garrya elliptica 'Evie'	Evie coast silktassel	8-15'	X			X			E
Garrya elliptica 'James Roof'	James Roof coast silktassel	8-15'	X			X			E
Heteromeles arbutifolia	Toyon	8-15'	X			X	X		E

Sacramento Valley Native Plant List. Provided by the California Native Plant Society, Sacramento Valley Chapter, July 2015.

Botanic name	Common name	Height	Dry	Med Water	Wet	Full Sun	Part Shade	Shade	Deciduous/ Evergreen
Heteromeles arbutifolia 'Davis Gold'	Yellow berry toyon	8-15'	X			X	X		E
Isomeris arborea	Bladderpod	3-4'	X			X	X		E
Lupinus albifrons	Silver Bush lupine	3-5'	X			X	X		E
Lupinus arboreus	Yellow flowered bush lupine	4-5'	X	X		X			E
Mahonia aquifolium	Oregon grape	3-6'	X	X		X	X		E
Mahonia aquifolium compacta	Compact Oregon grape	2-4'	X	X			X	X	E
Philadelphus lewisii 'Goose Creek'	Double flowered wild philadelphus	4-8'		X	X		X		D
Prunus andersonii	Desert peach	3-6'	X			X			D
Rhamnus californica	Coffeeberry	3-15'	X			X	X		E
Rhamnus californica 'Mound San	Mound San Bruno coffeeberry	4-6'	X			X	X	X	E
Rhamnus californica 'Eve Case'	Eve Case coffeeberry	4-8'	X			X	X		E
Rhamnus californica ssp. tomentella	Coffeeberry	6-15'	X	X		X	X		E
Rhamnus ilicifolia	Holly-leaf Redberry	5-15'	X	X		X	X		E
Rhamnus purshiana	Cascara sagrada	10-15'	X	X		X	X		E
Rhus integrifolia	Lemonade berry	3-10'	X			X			E
Rhus ovata	Sugar bush	4-10'	X			X			E
Ribes aureum var. aureum	Western golden currant (mountain)	3-6'	X	X	X	X	X		D
Ribes aureum var. gracillimum	Golden currant	3-6'	X	X	X	X	X		D
Ribes californicum	Hillside gooseberry	3'		X			X		D
Ribes malvaceum	Chaparral flowering currant	3-4'	X				X		D
Ribes sanguineum	Winter current	3-6'	X	X		X	X		D
Ribes sanguineum var. glutinosum	Flowering currant	3-5'	X	X		X	X		D
Ribes sanguineum var. glutinosum	Claremont flowering currant	3-6'	X	X			X	X	D
Ribes sanguineum 'White Icicle'	White icicle flowering currant	6-8'	X	X			X	X	D
Ribes speciosum	Fuchsia flowering gooseberry	3-6'	X	X		X	X		D
Ribes viburnifolium	Evergreen currant	2-3'	X	X			X	X	E
Rosa californica	California wild rose	3'		X			X	X	D
Salvia apiana	White sage	3-5'	X	X		X			E
Salvia clevelandii	Cleveland's sage	3-5'	X			X			E
Salvia clevelandii 'Allen Chickering'	Allen Chickering Cleveland's sage	3-5 '	X			X			E
Salvia clevelandii 'Whirly Blue'	Whirly blue Cleveland's sage	3-5'	X			X	X		E
Salvia clevelandii 'Winnifred Gilman'	Winnifred Gilman Cleveland's sage	3'	X			X			E
Salvia leucophylla	Purple sage	3-7'	X			X			E
Salvia mellifera	Black sage	3-6'	X			X	X		E
Salvia mellifera 'Terra Seca'	Terra seca black sage	2'	X			X	X		E
Sambucus caerulea	Blue elderberry	6-9'		X		X	X		D
Sambucus mexicana	Mexican elderberry	6-12'	X	X		X	X		D
Spiraea douglasii	Western spiraea	4-5'	X	X		X			D
Styrax redivivus officinalis	Snow drop bush	5-7'	X	X			X		D
Symphoricarpos albus	Snowberry	6-12'		X	X		X	X	D
Trichostema lanatum	Wooly bluecurls	3-4'	X			X			E

Sacramento Valley Native Plant List. Provided by the California Native Plant Society, Sacramento Valley Chapter, July 2015.

Botanic name	Common name	Height	Dry	Med Water	Wet	Full Sun	Part Shade	Shade	Deciduous/ Evergreen
	SHRUBS CONT.								
Viguera parishii	Desert golden eye	1-3’	X			X	X		D
	SHRUBS/TREES								
Cephalanthus occidentalis	Buttonbush (buttonwillow)	3-15’		X	X	X	X		D
Cercis occidentalis	Western redbud	15-25’	X	X		X	X		D
Myrica californica	Pacific wax myrtle	10-30’		X		X			E
Prunus lyonii (P. ilicifolia ssp. lyonii)	Catalina cherry	15-20’	X	X		X			E
Salix exigua (Salix hindsiana)	Coyote willow	6-20’		X		X	X		D
Salix laevigata	Red willow	10-25’		X		X	X		D
Salix lasiolepsis	Arroyo willow	10-20’		X		X			D
Umbellularia californica	California bay	6-50’		X			X		E
	TREES								
Acer circinatum	Vine maple	5-35’		X	X	X	X		D
Acer macrophyllum	Big-leaf maple	30-50’		X	X	X	X		D
Aesculus californica	California buckeye	10-30’	X	X		X	X		D
Arbutus menziesii	Madrone	20-50’	X	X		X	X		E
Calocedrus dedurrens	Incense cedar	50-90’	X	X		X			E
Cornus nuttallii	mountain dogwood	20-50’		X	X		X		D
Cupressus sargentii	Sargent cypress	10-40’	X				X		E
Fraxinus latifolia	Oregon ash	30-40’		X	X	X	X		D
Juglans californica var. hindsii	Northern California black walnut	30-60’	X	X		X			D
Pinus attenuata	Knobcone pine	20-40’`	X	X					E
Pinus jeffreyi	Jeffrey pine	60-120’	X						E
Pinus lambertiana	Sugar	60-200’	X						E
Pinus ponderosa	Ponderosa pine	80-100’	X						E
Pinus sabiniana	Foothill pine	40-80’	X						E
Platanus racemosa	California sycamore	40-60’		X		X			D
Quercus agrifolia	Coast live oak	20-70	X			X			E
Quercus berberidifolia	Scrub oak	6-15’	X			X			E
Quercus douglasii	Blue oak	30-50’	X	X		X	X		D
Quercus durata	Leather Oak	10’	X			X			E
Quercus kelloggii	Black oak	30-80’	X			X			D
Quercus lobata	Valley oak	50-70’	X			X			D
Quercus wislizenii	Interior live oak	30-80’	X	X		X			E
	VINES								
Aristolochia californica	California pipe vine	10-40’	X	X		X	X		D
Clematis ligusticifolia	Western clematis	4-30’		X	X	X	X		D
Clematis sp.	Virgin’s Bower	10-30’	X	X			X		D
Lonicera hispidula	Pink Honeysuckle	8-12'	x	x			x		D
Vitis californica	California wild grape	10-20’	X	X			X		D

SIZING DESIGN GOALS AND REQUIREMENTS

The Post-Construction S orm Water Quality Plan (SWQP) Form 3-5 should be used to calculate the Water Quality Volume (WQV) of bioretention a eas for Regulated Projects. This value is then used to iterati ely determine the necessary bioretention a ea sizing to capture the remainder of the 85th percentile, 24-hour design storm not retained by Site Design Measures. The equation or determining the WQV is as follows:

$$\textbf{WQV = Unit WQV * } A_{imp} \textbf{ * } R_C$$

Where:

WQV	= Water Quality Volume (^{3});
Unit WQV	= design storm based on elevation and drawdown time
A_{imp}	= impervious drainage area untreated by Site Design Measures (^{2});
R_C	and = Runoff Coefficient (default 0.9).

Sites with documented high concentrations of pollu ants in underlying soil or groundwater, sites located where infilt ation ould contribute to a geotechnical hazard, and sites located on elevated plazas or other structures may incorporate an impervious liner and may locate the underdrain discharge at the bo om of the gravel layer to create a "Flow-Through Planter." These Flow-Through Planters must be sized according to Water Quality Flow (WQF) using Form 3-5 and Form 3-7 of the SWQP. The equation or determining the WQF for Flow-Through Planters is as follows:

$$\textbf{WQF = } A_{imp} \textbf{ * } P_F \textbf{ / 43,200}$$

Where:

WQF	= Water Quality Flow (cfs);
A_{imp}	= impervious drainage area untreated by Site Design Measures (^{2}); and
P_F	= fl w based design storm intensity (0.2 inch/hr).

CONSTRUCTION PHASE CONSIDERATIONS

Protection and Excavation

Protecting bioretention areas during all phases of construction is a top priority. In project specifications, and during pre-bid and pre-construction meetings, communicate requirements and expectations to the contractor. From the start of construction, areas should be fenced to define limits and keep heavy equipment out. Erosion and sediment control measures should be placed so that construction sediment and wastes cannot enter the facility. Excavation activities should avoid compacting the facility base and sidewalls and should not take place during wet weather. Inlets should be blocked until construction sediment sources are removed and plants are sufficiently established to hold up to stormwater flows. Plant establishment times will depend on plant species. Storm water directed away from bioretention areas during plant establishment must be managed using temporary BMPs.

Structures and Materials

Structures such as curbs, inlets, checkdams, bypass and underdrain systems and containment walls are critical to facility function. During construction, verify that the elevations of these elements match the design drawings. For example, the raised overflow structures used in bioretention facilities may look like a plan error to contractors not experienced with LID. Clearly communicating design objectives will help avoid uninformed field adjustments.

The bioretention soil mix and aggregate layers are also key components to achieving the desired performance. During pre-bid and pre-construction meetings,   explain the characteristics and purpose of these materials to contractors and follow up by thoroughly reviewing construction material submittals.

INSPECTION AND MAINTENANCE REQUIREMENTS

A maintenance plan shall be provided with the Final SWQP. The maintenance plan shall include recommended maintenance practices,   state the parties responsible for maintenance and upkeep, specify the funding source for ongoing maintenance, with provisions for full replacement when necessary, and provide site specific inspection checklist.

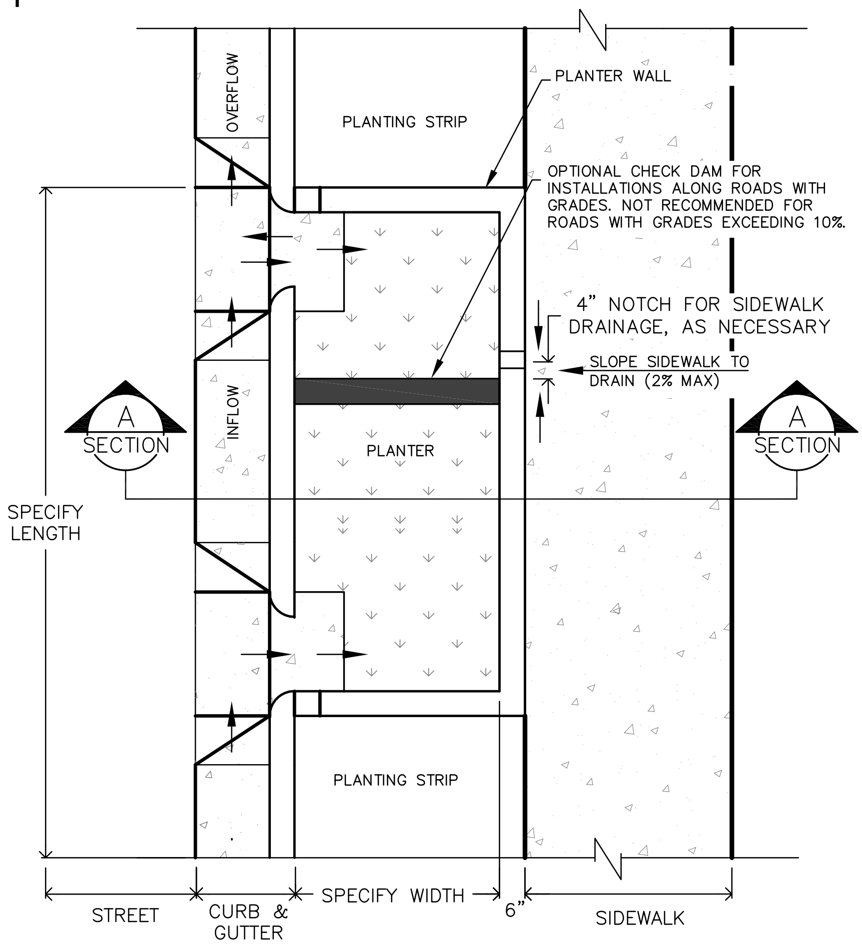
At a minimum the following inspections and maintenance activities should be conducted on an annual basis or more frequently if necessary:

Maintenance Indicator	Required Maintenance Activity
Is litter, excess sediment or debris present in the upstream drainage or in the bioretention facility?	Remove litter, sediment/debris. Inspect the areas upstream of the bioretention acility to make sure the tributary area is properly stabilized.
Is standing water present in the facility for longer than 72 hours a er a storm?	Remove any accumulated sediment and flush d ainage system including underdrain. Remove and replace top few inches of soil. Remove and replace all soil, re-grade and re-plant.
Are dead plants, weeds present?	Remove dead vegetation and eplace as necessary. Pull weeds and trim excess plant growth.
Is erosion occurring within the facility or drainage system?	Repair erosion and stabilize to prevent recurrence
Are holes or voids present in the facility?	Inspect underdrain and replace soil if needed.
Are unwanted rodents or other pests present?	Implement environmentally friendly pest control practices. Do not use pe ticides or herbicides in the bioretention acility.

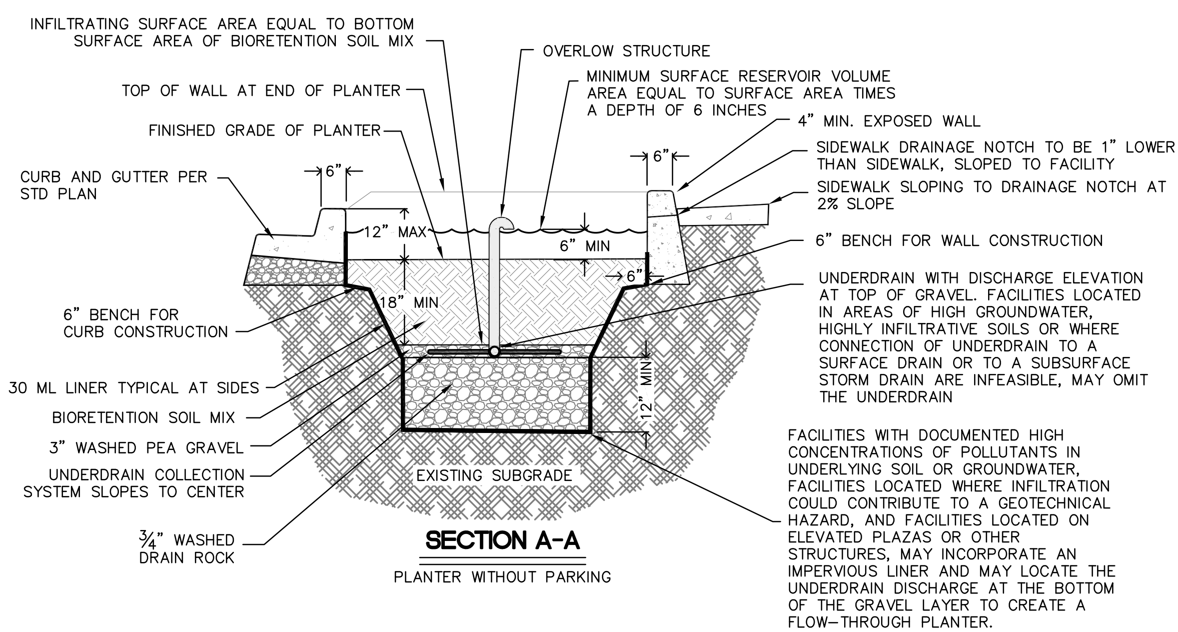
REFERENCES

City of Salinas Department of Engineering and Transportation. 2014. S ormwater Standard Plans (SWSPs). Available online at: http://   ww.ci.salinas.ca.us/services/engineering/engineering.cfm

Placer County Planning Services Division. 2013. Placer County Landscape Design Guidelines. Available online at: http://   ww.placer.ca.gov/~/media/cdr/Planning/documents/DesignGuides/Landscape%20 Design%20Guidelines.pdf



PLAN VIEW



SECTION A-A

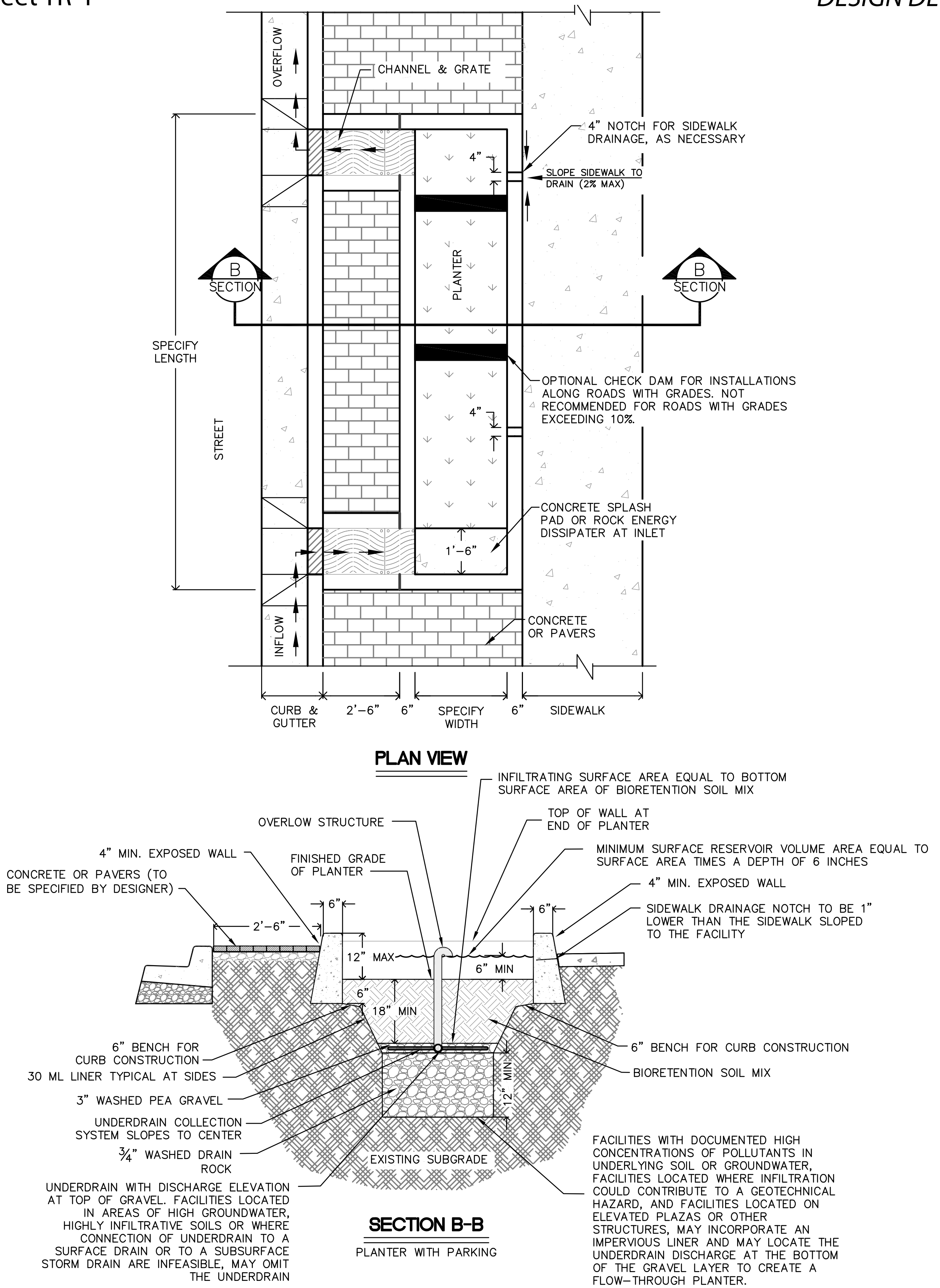
PLANTER WITHOUT PARKING

IN STREET BIORETENTION - WITHOUT PARKING

Plan & Section Views

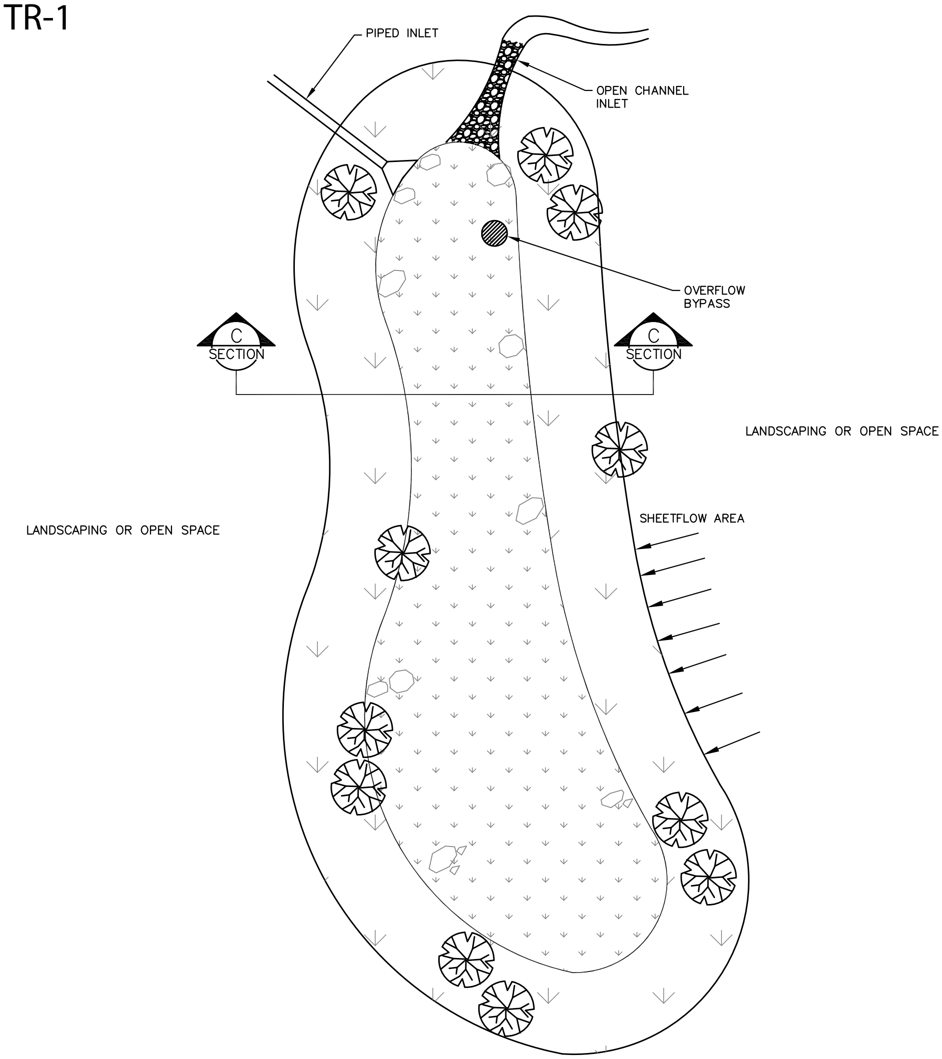
DRAWING NOT TO SCALE

Source: Adapted from City of Salinas

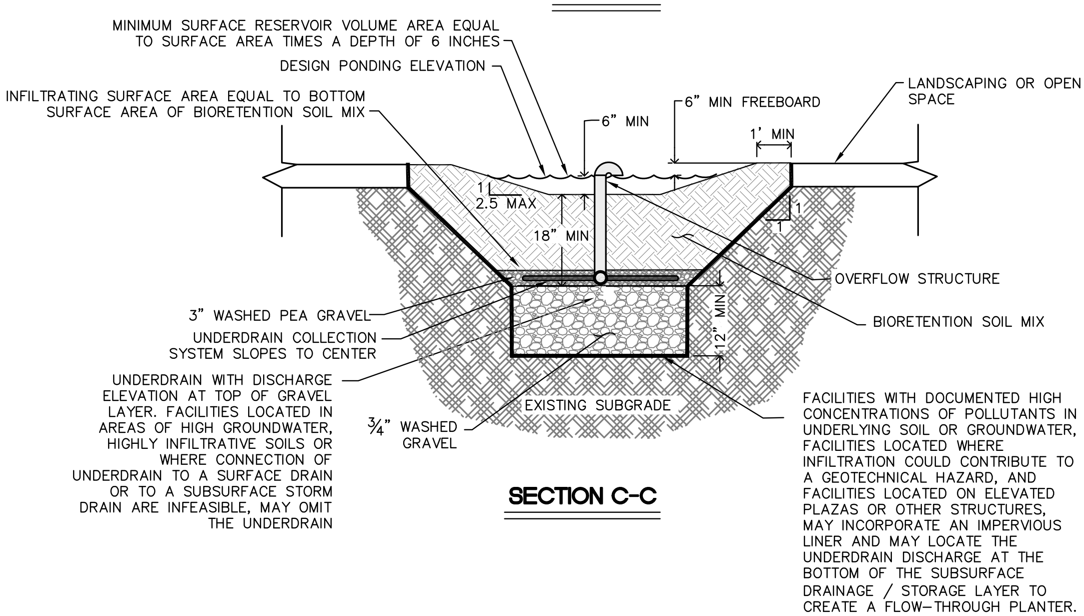


IN STREET BIORETENTION - WITH PARKING
Plan and Section Views

DRAWING NOT TO SCALE
Source: Adapted from City of Salinas



PLAN VIEW



SECTION C-C

BIORETENTION IN LANDSCAPE OR OPEN SPACE AREAS
Plan and Section Views

DRAWING NOT TO SCALE
Source: Adapted from City of Salinas

MEDIA FILTER

Fact Sheet TR-2

DESCRIPTION

Storm water media filters are typically two-chambered including a pretreatment settling basin and a filter consisting of sand, gravel, or other adsorptive filtering media. As storm water flows into the first chamber, large particles settle out, and then finer particles and other pollutants are removed as stormwater flows through the filtering media in the second chamber. There are a number of design variations including the Austin sand fiter, Delaware sand filter, multi-chambered treatment train (MCTT), and manufactured storm water filters. Treated storm water is collected in an effluent chamber or underdrain, and subsequently discharged to a storm water conveyance system or other appropriate location

Photo Source: Portland BES

Manufactured storm water filters are typically underground systems that utilize membranes of various materials or cartridges filled with different types of media to filter stormwater runoff. For cartridge systems, the media used can be inert, such as sand, or adsorptive, such as peat or manufactured media. The effectiveness of these systems depends on the type of membrane or media being implemented, the filter loading rate, and the characteristics of the influent storm water. For some systems, the water chemistry will also determine the effectiveness of the filter in removing dissolved constituents.

ADVANTAGES

- Protects and improves water quality by removing pollutants from storm runoff.
- Customizable sizing (small footprint).
- Customizable filter media to target key site pollutants.
- May be located underground.
- Does not require irrigation.

LIMITATIONS

- Minimal reduction in runoff volume in comparison to other systems that promote infiltration, evaporation, or evapotranspiration.
- Designs that maintain permanent standing water may create vector concerns
- Confined space training may be required for maintenance on vault systems.
- Failure to maintain media filter may result in clogging and system failure.
- Significant head loss through filters may limit use on flat sites.
- High installation and maintenance costs.

KEY DESIGN FEATURES

Media filters may only be implemented for Regulated Projects that demonstrate use of bioretention facilities to be infeasible. Regulated Projects implementing media filters must meet the following requirements:

1. 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;
2. Facilities receiving runoff solely from existing (pre-project) impervious areas; and

3. Historic sites, structures or landscapes that cannot alter their original configuration in order to maintain their historic integrity.

The performance of any media filter is governed primarily by the following factors which should be carefully evaluated when designing the facility:

- Hydraulic Loading Rate – The application rate of untreated water to the surface of the filter media usually expressed as a flow rate per filter surface area (i.e. gpm/ft^2);
- Filter Media Gradation – A finer media gadation reduces hydraulic conductivity and increases the capture efficiency or fine particulate pollutants. Finer media also has a greater surface area which increases sorption rates for chemically active media. A more homogeneous media gradation increases voids volume in a media bed. Finer media is more susceptible o surface clogging.
- Residence Time - Residence time is a function of media gradation, hydraulic loading rate and the media bed depth and configuration. A longer residence time generally improves pollutant removal performance.
- Media Chemical Properties – Filter media can be inert (i.e. sand) or can be selected to target specific pollutants of concern (i.e. activated carbon for trace organics). Chemically active options may be organic, mineral or synthetic or a combination of types. Media should be selected with consideration of the type and load of pollutants requiring removal.
- Pretreatment – Integrate adequate pretreatment facilities into media filter designs to reduce sediment loading and maintenance frequency. The level of pretreatment required is dependent on the tributary drainage area, but typical pretreatment consists of a sedimentation chambers, hydrodynamic separator, vegetated buffer strips, and vegetated swales.
- Hydraulic Head – Different media filters types have varying hydraulic head requirements that must be considered during design. Certain media filter configurations may not be suitable for flat sites.

SIZING DESIGN GOALS AND REQUIREMENTS

The Post-Construction Storm Water Quality Plan (SWQP) Form 3-5 should be used to calculate the Water Quality Flow (WQF) of media filters for Regulated Projects. This value is then used in Form 3-7 to iteratively determine the necessary media filter sizing to capture the remainder of the 85th percentile, 24-hour design storm not retained by Site Design Measures. The equation or determining the WQF for media filters is as follows:

$$\mathbf{WQF = A_{imp} * P_F / 43,200}$$

Where:

WQF = Water Quality Flow (cfs);
A_{imp} = impervious drainage area untreated by Site Design Measures (ft^2);
P_F and = flow based design storm intensity (0.2 inch/hr).

CONSTRUCTION PHASE CONSIDERATIONS

- Divert flow around the sand filter to protect it from sediment loads during construction. If sediment does enter the facility during construction, the sediment will require removal after the tributary area has been stabilized. Diverted flow must be managed using temporary BMPs.

- Where underdrains are used, ensure that the minimum slope of the pipe is 0.5 (1/2) percent.
- Ensure that the inverts of notches, orifices, or weirs dividing chambers correspond with design elevations to ensure proper function.
- The surface of bed filters should be completely level to promote uniform filtration.
- If precast concrete lids are used, provide lifting rings or threaded sockets to allow easy removal with standard lifting equipment.
- Once construction is complete, stabilize the entire tributary area to the media filter before allowing runoff o enter the unit.

MAINTENANCE CONSIDERATIONS

Media filters may exhibit decreased ettectiveness after a single year of operation, depending on the activities occurring in the drainage area and filter loading. They clog easily when subjected to high sediment loads, and sediment reducing pretreatment practices placed upstream of the filter should be maintained properly to reduce sediment loads into the filter.

Maintenance efforts will need to focus on basic housekeeping practices such as removal of sediment and debris accumulations to prevent clogs and/or ponds of standing water. To minimize the potential for clogging, frequent maintenance and inspection practices are required. Waste sand, gravel, membranes, or filter media must be disposed of properly and in accordance with all applicable laws.

Media filters can become a nuisance due to mosquito or midge breeding if not properly designed and maintained. Installations should dewater completely (recommended 96 hour or less residence time) to prevent creating mosquito and other vector habitats.

AVAILABLE VENDOR PRODUCTS

The names of vendor products listed below are for informational purposes only. Their appearance here is not an endorsement of the products or manufacturers by Placer County.

- BayFilter™
- Fabco Filter Cartridges
- Jellyfish®
- Media Filtration System (MFS)
- Perk Filter™
- Puristorm™
- Up-Flo™
- StormFilter®
- VortFilter™

Photo Source: Contech®

REFERENCES

California Department of Transportation (Calt ans). 2010. Treatment BMP Technology Report. CTSW-RT-09-239.06. Available online at: http://www.dot.ca.gov/hq/env/stormwater/pdf/CTSW-RT-09-239-06.pdf

California Stormwater Quality Association (CASQA). 2003. Cali ornia Stormwater BMP Handbook – New Development and Redevelopment. BMP Fact Sheet TC-40: Media Filter and BMP Fact Sheet MP-40: Media Filter. Available online at: https://www.casqa.org/resources/bmp-handbooks/new-development-redevelopment-bmp-handbook

Low Impact Development Center, Inc. 2010. Low Impact Development Manual for Southern California: Technical Guidance and Site Planning Strategies. Available online at: https://www.casqa.org/sites/default/files/downloads/socallid-manual-final-040910.pdf

Sacramento County, et al. 2014. Stormwater Quality Design Manual for the Sacramento Region. Available online at: http://www.beriverfriendly.net/docs/files/Ma ter%20Stormwater%20Quality%20Manual%202014_FINAL_W%20 APPEND_W%20COVER.pdf

TREE BOX FILTER

Fact Sheet TR-3

DESCRIPTION

Tree box filters are typically manufactured systems that provide biofilt ation and media filtration o treat storm water runoff. Storm water typically flows into a pretreatment chamber to remove large sediment, debris and trash before passing into the biotreatment chamber where physical straining, and biological and chemical reactions in the mulch, root zone, and soil matrix occurs. Tree box filters are similar in concept to bioretention areas in function and application, with the major distinction that a tree box filter has been optimized for high volume/flow treatment, therefore the ratio of impervious area to treatment area is less. A tree box filter takes up little space and may be used on highly developed sites in areas such as landscaping, green space, parking lots and streetscapes.

Photo Source: Oldcastle Stormwater Solutions ™

An underdrain in the tree box filter collects treated storm water to be discharged to the storm water conveyance system or other appropriate location. Manufactured tree box filters typically incorporate a high flow bypass to prevent scouring in the bioretention basin and mobilization of treated pollutants. The overflow can be directed to another treatment system or the municipal storm system.

ADVANTAGES

- Protects and improves water quality by removing pollutants from storm runoff.
- Customizable sizing (small footprint).
- Trees can reduce heat island effects.
- Can be integrated into landscaping and is aesthetically pleasing.
- Customizable vegetation.

LIMITATIONS

- Minimal reduction in runoff volume in comparison to other systems that promote infiltration.
- Designs that maintain permanent standing water may create vector concerns
- Vegetation may develop slowly, though treatment is still provided.
- Confined space training may be required for maintenance.
- Failure to maintain may result in clogging and system failure.
- High installation and maintenance costs.

KEY DESIGN FEATURES

Tree box filters may only be implemented for Regulated Projects that demonstrate use of bioretention facilities to be infeasible. Regulated Projects implementing tree box filters must meet the following requirements:

1. 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;
2. Facilities receiving runoff solely from existing (pre-project) impervious areas; and
3. Historic sites, structures or landscapes that cannot alter their original configuration in order to maintain their historic integrity.

The performance of a tree box filter is governed primarily by the following factors which should be carefully evaluated when designing the facility:

- Hydraulic Loading Rate – The application rate of untreated water to the surface of the filter media usually expressed as a flow rate per filter surface area (i.e. gpm/ft^2);
- Filter Media Gradation – A finer media gradation reduces hydraulic conductivity and increases the capture efficiency or fine particulate pollutants. Finer media also has a greater surface area which increases sorption rates for chemically active media. A more homogeneous media gradation increases voids volume in a media bed. Finer media is more susceptible to surface clogging.
- Residence Time - Residence time is a function of media gradation, hydraulic loading rate and the media bed depth and configuration. A longer residence time generally improves pollutant removal performance.
- Media Chemical Properties – Filter media can be inert (i.e. sand) or can be selected to target specific pollutants of concern (i.e. activated carbon for trace organics). Chemically active options may be organic, mineral or synthetic or a combination of types. Media should be selected with consideration of the type and load of pollutants requiring removal.
- Pretreatment – Integrate adequate pretreatment facilities into media filter designs to reduce sediment loading and maintenance frequency. The level of pretreatment required is dependent on the tributary drainage area, but typical pretreatment consists of a sedimentation chambers, hydrodynamic separator, vegetated buffer strips, and vegetated swales.
- Vegetation – Choose moisture-tolerant plants that can tolerate both fluctuating water conditions and drought conditions. Guidance on planting and general landscape design is provided in the Placer County Landscape Design Guidelines (Placer County Planning Services Division, 2013). Refer to fact sheet TR-1 for more information on recommended plant species.

CONSTRUCTION PHASE CONSIDERATIONS

- Divert flow around the tree box filter to protect it from sediment loads during construction. If sediment does enter the facility during construction, the sediment will require removal after the tributary area has been stabilized. Diverted flow must be managed using temporary BMPs.
- Where underdrains are used, ensure that the minimum slope of the pipe is 0.5 (1/2) percent.
- Once construction is complete, stabilize the entire tributary area to the media filter before allowing runoff to enter the unit.

SIZING DESIGN GOALS AND REQUIREMENTS

The Post-Construction S orm Water Quality Plan (SWQP) Form 3-5 should be used to calculate the Water Quality Flow (WQF) of tree box filters for Regulated Projects. This value is then used in Form 3-7 to iteratively determine the necessary tree box filter sizing to capture the remainder of the 85th percentile, 24-hour design storm not retained by Site Design Measures. The equation for determining the WQF for tree box filters is as follows:

$$\mathbf{WQF = A_{imp} * P_F / 43,200}$$

Where:

WQF = Water Quality Flow (cfs);

A_{imp} = impervious drainage area untreated by Site Design Measures (^{2}); and

P_F = fl w based design storm intensity (0.2 inch/hr).

MAINTENANCE CONSIDERATIONS

Maintenance activities and frequencies are specific to each manufactured product. Semiannual maintenance is typical and should be performed per manufacturer specifivations. Maintenance agreements are available from some manufacturers.

Tree box filters may exhibit decreased effectiveness after a single year of operation, depending on the activities occurring in the drainage area and filter loading. They clog easily when subjected to high sediment loads, and sediment reducing pretreatment practices placed upstream of the filter should be maintained properly to reduce sediment loads into the filter.

Maintenance efforts will need to focus on basic housekeeping practices such as removal of sediment and debris accumulations to prevent clogs and/or ponds of standing water. To minimize the potential or clogging, frequent maintenance and inspection practices are required. Waste sand, gravel, soil, mulch, or filter media must be disposed of properly and in accordance with all applicable laws.

Tree box filters can become a nuisance due to mosquito or midge breeding if not properly designed and maintained. Installations should dewater completely (recommended 72 hour or less residence time) to prevent creating mosquito and other vector habitats.

Photo Source: Contech®

AVAILABLE VENDOR PRODUCTS

The names of vendor products listed below are for informational purposes only. Their appearance here is not an endorsement of the products or manufacturers by Placer County.

- DeepRoot® Silva Cell
- Filterra® Bioretention System
- TreePod® Biofilter
- UrbanGreen™ Biofilter

REFERENCES

Alameda Countywide Clean Water Program. C.3 Stormwater Technical Guidance, A Handbook for Developers, Builders, and Project Applicants, Version 3.1. 2012. Available online at: http://www.fremont.gov/DocumentCenter/Home/ View/885

California Department of Transportation (Calt ans). 2010. Treatment BMP Technology Report. CTSW-RT-09-239.06. Available online at: http://www.dot.ca.gov/hq/env/stormwater/pdf/CTSW-RT-09-239-06.pdf

Low Impact Development Center, Inc. 2010. Low Impact Development Manual for Southern California: Technical Guidance and Site Planning Strategies. Available online at: https://www.casqa.org/sites/default/files/downloads/socallid-manual-final-040910.pdf

Appendix C

Source Control Measures Selection Table

Source Control Measures Selection Table

Potential Pollutant Source or Activity	Source Control Measure and General Implementation Protocols	CASQA BMP Handbook with Additional Information	CASQA Fact Sheet No.
Accidental spills or leaks	**Spill Prevention, Control and Cleanup** ▪ 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. ▪ Recycle, reclaim, or reuse materials whenever possible.	Industrial and Commercial (2014)	SC-11
Interior floor drains	**Non-Stormwater Discharges** ▪ Visually inspect and inventory all interior floor drains. ▪ Do not connect to MS4. Floor drains should discharge to sumps for pumping and disposal or to the sanitary sewer in compliance with local agency requirements. ▪ For redevelopment, identify and disconnect interior floor drains from the MS4. ▪ Isolate problem areas and plug illicit discharge points.	Industrial and Commercial (2014)	SC-10
Parking/Storage Areas and Maintenance	**Parking/Storage Area Maintenance** ▪ Encourage advanced designs and maintenance strategies for impervious parking lots. ▪ Keep accurate maintenance logs to evaluate BMP implementation.	Industrial and Commercial (2014)	SC-43
Indoor and structural pest control	**Building and Grounds Maintenance** ▪ Follow all federal, state, and local laws and regulations governing the use, storage, and disposal of pesticides. ▪ Do not mix, prepare, or apply pesticides near storm drain inlets. ▪ Encourage use of Integrated Pest Management techniques for pest control.	Industrial and Commercial (2014)	SC-41
	Safer Alternative Products ▪ Use less toxic pesticides that will do the job when applicable. Avoid use of copper-based pesticides if possible.	Industrial and Commercial (2014)	SC-35
Pools, spas, ponds, decorative fountains, and other water features	**Mobile Cleaning - Swimming Pools and Spas** ▪ Never discharge wash water or wastewater from cleaning swimming pools and spas to the driveway, street, gutter, or near a storm drain.	Industrial and Commercial (2014)	BG-63

Potential Pollutant Source or Activity	Source Control Measure and General Implementation Protocols	CASQA BMP Handbook with Additional Information	CASQA Fact Sheet No.
	▪ Follow local regulations for draining swimming pools and spas into the sanitary sewer system.		
	Fountains and Pools Maintenance ▪ 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. ▪ Do not use copper-based algaecides. Control algae with chlorine or other alternatives, such as sodium bromide. ▪ Reduce fertilizer use in areas around the water body. High nitrogen fertilizers may contribute to excessive algae growth.	Municipal (2003)	SC-72
Landscaping/outdoor pesticide use	**Building and Grounds Maintenance** ▪ Follow all federal, state, and local laws and regulations governing the use, storage, and disposal of fertilizers and pesticides. ▪ Use non-toxic chemicals to the maximum extent possible. ▪ Encourage use of Integrated Pest Management techniques for pest control. ▪ Encourage proper onsite recycling of yard trimmings. ▪ Do not use pesticides if rain is expected. ▪ Do not mix, prepare, or apply fertilizers and pesticides near storm drain inlets. ▪ Use the minimum amount of fertilizer and pesticides 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.	Industrial and Commercial (2014)	SC-41
	Safer Alternative Products ▪ Use less toxic pesticides that will do the job when applicable. Avoid use of copper-based pesticides if possible.	Industrial and Commercial (2014)	SC-35
	Site Design and Landscape Planning ▪ Integrate and incorporate appropriate landscape planning methodologies into the project design to minimize surface and groundwater contamination from stormwater.	New Development and Redevelopment (2003)	SD-10

Potential Pollutant Source or Activity	Source Control Measure and General Implementation Protocols	CASQA BMP Handbook with Additional Information	CASQA Fact Sheet No.
	Efficient Irrigation ▪ Design and implement irrigation methods that minimize runoff of excess irrigation water into the stormwater conveyance system.	New Development and Redevelopment (2003)	SD-12
Restaurants, grocery stores, and other food service operations	**Food Service Facilities** ▪ Minimize exposure of rain and runoff to outdoor cleaning and storage areas by using cover and containment. ▪ Use good housekeeping to minimize the generation of pollutants. ▪ Make stormwater pollution prevention BMPs a part of standard operating procedures and the employee training program. ▪ Provide employee education materials in the first language of employees.	Industrial and Commercial (2014)	BG-30
	Mobile Cleaning – Food Service Related ▪ Perform dry cleanup before washing with water. ▪ Wash without soaps and solvents. ▪ Keep polluted water out of storm drains. ▪ Dispose of wastewater correctly and legally	Industrial and Commercial (2014)	BG-61
Refuse areas	**Waste Handling and Disposal** ▪ Cover storage containers with leak proof lids. ▪ Cover all waste piles (plastic tarps are acceptable coverage) and prevent stormwater run-on and runoff with a berm. ▪ Recycle materials whenever possible. ▪ Use the entire product before disposing of the container. ▪ Take special care when loading or unloading wastes to minimize losses. Loading systems can be used to minimize spills and fugitive emission losses such as dust or mist. Vacuum transfer systems can minimize waste loss. ▪ Use dry methods when possible (e.g., sweeping, use of absorbents. If water must be used after sweeping, collect water and discharge through grease interceptor to the sanitary sewer.	Industrial and Commercial (2014)	SC-34

Potential Pollutant Source or Activity	Source Control Measure and General Implementation Protocols	CASQA BMP Handbook with Additional Information	CASQA Fact Sheet No.
Industrial Processes	**Non-Stormwater Discharges** ▪ Develop clear protocols and lines of communication for effectively prohibiting non-stormwater discharges, especially those that are not classified as hazardous. ▪ Stencil or demarcate storm drains, where applicable, to prevent ignorant, unintentional, and illegal disposal of pollutants. Storm drain inlets should have messages such as "Dump No Waste Drains to Stream" or similar. ▪ 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.	Industrial and Commercial (2014)	SC-10
Outdoor storage of equipment or materials	**Outdoor Loading/Unloading** ▪ Park tank trucks or delivery vehicles in designated areas so that spills or leaks can be contained. ▪ Limit exposure of material to rainfall whenever possible. ▪ Prevent stormwater run-on. ▪ Check equipment regularly for leaks.	Industrial and Commercial (2014)	SC-30
	Outdoor Liquid Container Storage ▪ Educate employees about pollution prevention measures and goals. ▪ Keep an accurate, up-to-date inventory of the materials delivered and stored onsite. ▪ Try to keep chemicals in their original containers, and keep them well labeled. ▪ Develop an operations plan that describes procedures for loading and/or unloading. ▪ Protect materials from rainfall, run-on, runoff, and wind dispersal.	Industrial and Commercial (2014)	SC-31
	Outdoor Equipment Operations ▪ Perform the activity during dry periods whenever possible. ▪ Install secondary containment measures where leaks and spills may occur. ▪ Use non-toxic chemicals for maintenance and minimize or eliminate the use of solvents. ▪ Connect process equipment area to public sanitary sewer or facility wastewater treatment system. Do not connect drains from secondary containment areas to the storm drain.	Industrial and Commercial (2014)	SC-32

Potential Pollutant Source or Activity	Source Control Measure and General Implementation Protocols	CASQA BMP Handbook with Additional Information	CASQA Fact Sheet No.
Outdoor storage of equipment or materials (cont.)	**Outdoor Storage of Raw Materials** ▪ Emphasize employee education for successful BMP implementation. ▪ Store materials that could contaminate stormwater inside or under permanent cover and bermed to prevent stormwater contact. ▪ Elevate and tarp solid materials such as beams, metal, etc. ▪ Minimize the inventory of raw materials kept outside. ▪ Keep an accurate, up-to-date inventory of the materials delivered and stored on-site. ▪ Stormwater runoff that could potentially be contaminated by materials stored outdoors should be drained to the sanitary sewer. The drain must have a positive control such as a lock, valve, or plug to prevent release of contaminated liquids.	Industrial and Commercial (2014)	SC-33
Vehicle and equipment cleaning	**Vehicle and Equipment Cleaning** ▪ If possible, use properly maintained off-site commercial washing and steam cleaning businesses whenever possible. ▪ Use dry cleaning methods to remove debris and sweep area 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. ▪ 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.	Industrial and Commercial (2014)	SC-21
Vehicle and equipment repair and maintenance	**Vehicle and Equipment Repair** ▪ 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.	Industrial and Commercial (2014)	SC-22

Potential Pollutant Source or Activity	Source Control Measure and General Implementation Protocols	CASQA BMP Handbook with Additional Information	CASQA Fact Sheet No.
	▪ Switch to non-toxic chemicals for maintenance when possible. ▪ Choose cleaning agents that can be recycled. ▪ Use drop cloths and drip pans.		
Fuel dispensing areas	**Vehicle and Equipment Fueling** ▪ Use properly maintained off-site fueling stations whenever possible. ▪ Focus pollution prevention activities on containment of spills and leaks, most of which may occur during liquid transfers.	Industrial and Commercial (2014)	SC-20
Loading docks	**Outdoor Loading/Unloading** ▪ Develop an operations plan that describes procedures for loading and/or unloading. ▪ Conduct loading and unloading in dry weather if possible. ▪ Cover designated loading/unloading areas to reduce exposure of materials to rain. ▪ Consider placing a seal or door skirt between delivery vehicles and building to prevent exposure to rain. ▪ Design loading/unloading area to prevent stormwater run-on, which would include grading or berming the area, and position roof downspouts so they direct stormwater away from the loading/unloading areas. ▪ Pave loading areas with concrete instead of asphalt. ▪ Avoid placing storm drains inlets in the area. ▪ Grade and/or berm the loading/unloading area with drainage to sump; regularly remove materials accumulated in sump.	Industrial and Commercial (2014)	SC-30
Fire sprinkler test water	**Non-Stormwater Discharges** ▪ Develop a plan to eliminate discharge to the storm drain system.	Industrial and Commercial (2014)	SC-10
	Building and Grounds Maintenance ▪ Dispose fire sprinkler line test 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.	Industrial and Commercial (2014)	SC-41
Drain or wash water from boiler drain lines, condensate drain lines, rooftop equipment, drainage sumps, and other sources	**Non-Stormwater Discharges** ▪ Manage and control sources of water from drain lines. ▪ Eliminate discharge of water from drain lines to the storm drain system. ▪ Repair drain line leaks immediately.	Industrial and Commercial (2014)	SC-10

Potential Pollutant Source or Activity	Source Control Measure and General Implementation Protocols	CASQA BMP Handbook with Additional Information	CASQA Fact Sheet No.
Drain or wash water from boiler drain lines, condensate drain lines, rooftop equipment, drainage sumps, and other sources (cont.)	**Building and Grounds Maintenance** ▪ In situations where soaps or detergents are used and the surrounding area is paved, use a water collection device that enables collection of wash water and associated solids for subsequent removal and proper disposal. ▪ 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. ▪ If 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.	Industrial and Commercial (2014)	SC-41
Unauthorized non-storm water discharges	**Non-Stormwater Discharges** ▪ Effectively eliminate unauthorized non-stormwater discharges to the storm water drainage system through implementation of measures to detect, correct, and enforce against illicit connections and illegal discharges of pollutants onto streets and into the storm drain system and downstream water bodies.	Industrial and Commercial (2014)	SC-10
Building and grounds maintenance	**Building and Grounds Maintenance** ▪ 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.	Industrial and Commercial (2014)	SC-41

Appendix D
SWQP Examples

Small Project

Post-Construction
Storm Water Quality Plan

For:

Jones Residence
Placer County

APN: 000-0000-000

Prepared for:

Joe Jones
Owner
Not Applicable - Private Residence
12345 X St
Placer County, CA 99999
999-999-9999

Prepared by:

Stormwater Inc.
12345 Y St
City, CA 99999
999-999-9999

Preparation Date: March 12, 2016

Approval Date:_____________________

Section 1 General Project Information

The undersigned owner of the subject property, is responsible for the implementation of the provisions of this plan, including ongoing operations and maintenance (O&M), consistent with the requirements of the West Placer Storm Water Quality Design Manual and the State of California Phase II Small MS4 General Permit (Order No: 2013-0001-DWQ). If the undersigned transfers its interest in the property, its successors-in-interest shall bear the aforementioned responsibility to implement the SWQP.

For all Regulated Projects (As identified in Form 1-2 below), the undersigned owner hereby grants access to all representatives of the Jurisdictional Agency for the sole purpose of performing O&M inspections of the installed treatment system(s) and hydromodification control(s) if any.

A copy of the final signed and fully approved SWQP shall be available on the subject site for the duration of construction and then stored with the project approval documentation and improvement plans in perpetuity.

Form 1-1 Project Identification and Owner's Certification

Project Site Address:	12345 X St, Placer County, CA 99999		
Owner Name:	Joe Jones		
Title	Owner		
Company	Not Applicable - Private Residence		
Address	12345 X St		
City, State, Zip Code	Placer County, CA 99999		
Email			
Telephone #	999-999-9999		
Signature		Date	
Engineer:*	NA - Small Project	PE Stamp* (Required for all Regulated Projects)	
Title			
Company	Stormwater Inc.		
Address	12345 Y St		
City, State, Zip Code	City, CA 99999		
Email			
Telephone #	999-999-9999		
Signature			
Brief Description of Project: (Attach additional sheets as necessary)	3,000 sq ft residential home.		

* Not required for Small Projects as determined in Form 1-2 below. Project owners are responsible for ensuring that all storm water facilities are designed by an appropriately licensed and qualified professional.

Form 1-2 Project Category

Development Category (Select all that apply)	
[1]**Small Project** – All projects, except LUPs, that create and/or replace between 2,500-5,000 ft^2 of impervious surface or detached single family homes that create and/or replace 2,500 ft^2 or more of impervious surface and are not part of a larger plan of development.	X
[2]Enter total new and/or replaced impervious surface (ft^2)	3000
[3]**Regulated Project** – All projects that create and/or replace 5,000 ft^2 or more of impervious surface.	
[4]**Regulated Redevelopment Project** with equal to, or greater than 50 percent increase in impervious area	
[5]**Regulated Redevelopment Project** with less than 50 percent increase in impervious area	
[6]Enter total pre-project impervious surface (ft^2)	
[7]Enter total new and/or replaced impervious surface (ft^2)	
[8]**Regulated Road or linear underground/overhead project (LUP)** creating 5,000 ft^2 or more of newly constructed contiguous impervious surface.	
[9]Enter total new and/or replaced impervious surface (ft^2)	
[10]**Regulated Hydromodification Management Project** – Regulated projects that create and/or replace 1 acre or more of impervious surface. A project that does not increase impervious surface area over the pre-project condition is not a hydromodification management project.	
[11]Enter total new and/or replaced impervious surface (ft^2)	

Section 2 Small Projects

Form 2-1 Site Assessment and Layout Documentation

	Has this Item been considered in the Site Layout and depicted in the Site Plan?	
	Yes	Not Applicable (Include brief explaination)
Define the development envelope and protected areas, identifying areas that are most suitable for development and areas to be landscaped , or left undisturbed, and used for infiltration.	x	
Minimize overall impervious coverage (paving and roofs) of the site.	x	
Set back development from creeks, wetlands, and riparian habitats in accordance with local ordinances.		No creeks on sites
Preserve significant trees and native vegetation.	x	
Conform site layout along natural landforms.	x	
Avoid excessive grading and disturbance of vegetation and soils and stabilize disturbed areas.	x	
Replicate the site's natural drainage patterns.	x	

Attach a Site Plan that incorporates the applicable considerations above. Ensure that the following items are included in the Site Plan:

Site Boundary
Topographic data with 1 ft. contours (5 ft.contours are acceptable on steeper sites).
Existing natural hydrologic features (depressions, watercourses, wetlands, riparian corridors)
Environmentally sensitive areas and areas to be preserved.
Proposed locations and footprints of improvements creating new, or replaced, impervious surfaces
Proposed site drainage with flow directions and site run-on and discharge locations
Proposed Site Design Measures to reduce runoff

Form 2-2 Runoff Reduction Calculator for Site Design Measures on Small Projects				
[1] Project Site Elevation (ft. above seal level)	500			
Site Design Measure		**Runoff Reduction Parameters**		**Runoff Reduction (ft^3)**
[2] Adjacent/On-Site Stream Setbacks and Buffers	A_{imp} (ft^2)	*impervious drainage area*		0
	V_{85} (in)	*runoff volume from 85th percentile, 24-hour storm*	0.8	
[3] Soil Quality Improvement and Maintenance	A_{pond} (ft^2)	*ponding area*		0
	D_{pond} (ft)	*ponding depth*		
	A_{sa} (ft^2)	*soil amendment area*		
	D_{sa} (ft)	*depth of amended soil*		
	n	*porosity of amended soil*		
[4] Tree Planting and Preservation	n_e	*number of new evergreen trees*	5	137
	n_d	*number of new deciduous trees*	4	
	A_{tc} (ft^2)	*Canopy area of existing trees to remain on the property*	500	
	V_{85} (in)	*runoff volume from 85th percentile, 24-hour storm*	0.8	
[5] Rooftop and Impervious Area Disconnection	A_{imp} (ft^2)	*impervious drainage area*		0
	V_{85} (in)	*runoff volume from 85th percentile, 24-hour storm*	0.8	
[6] Porous Pavement	A_{res} (ft^2)	*area of gravel storage layer*		0
	D_{res} (ft)	*depth of gravel storage layer*		
	n_{agg}	*porosity of aggregate*		
	C	*efficiency factor*		
[7] Vegetated Swales	A_{imp} (ft^2)	*impervious drainage area*		0
	V_{85} (in)	*runoff volume from 85th percentile, 24-hour storm*	0.8	
[8] Rain Barrels and Cisterns	N	*number of rain barrels and/or cisterns*		0
	V_a (ft^3)	*volume of each rain barrel and/or cistern*		
			[9] Total Volume Reduction (ft^3)	**137**
			[10] Effective Treated Impervious Area (ft^2)	**2026**

85th Percentile, 24 Hour Design Storm Depth

Elevation <500 feet = 0.9 inch

Elevation 500-1,000 feet = 1.0 inch

Elevation 1,000-1,500 feet = 1.1 inch

Regulated Project

Post-Construction
Storm Water Quality Plan

For:

Project XYZ
Placer County

Planning Permit No. 1, Improvement Plan No. 1, Grading Permit No. 1, Building Permit No. 1

Lot No. 1

Prepared for:

Joe Jones
President
Development Inc.
XX C St.
Sacramento, CA 99999
999-999-9999

Prepared by:

Development Inc.
XX C St.
Sacramento, CA 99999
999-999-9999

Preparation Date: March 15, 2016

Approval Date:______________________

Section 1 General Project Information

The undersigned owner of the subject property, is responsible for the implementation of the provisions of this plan, including ongoing operations and maintenance (O&M), consistent with the requirements of the West Placer Storm Water Quality Design Manual and the State of California Phase II Small MS4 General Permit (Order No: 2013-0001-DWQ). If the undersigned transfers its interest in the property, its successors-in-interest shall bear the aforementioned responsibility to implement the SWQP.

For all Regulated Projects (As identified in Form 1-2 below), the undersigned owner hereby grants access to all representatives of the Jurisdictional Agency for the sole purpose of performing O&M inspections of the installed treatment system(s) and hydromodification control(s) if any.

A copy of the final signed and fully approved SWQP shall be available on the subject site for the duration of construction and then stored with the project approval documentation and improvement plans in perpetuity.

Form 1-1 Project Identification and Owner's Certification

Project Site Address:	123 C Steet, Placer County, CA 99999		
Owner Name:	Joe Jones		
Title	President		
Company	Development Inc.		
Address	XX C St.		
City, State, Zip Code	Sacramento, CA 99999		
Email	Joe@email.com		
Telephone #	999-999-9999		
Signature		Date	
Engineer:*	Frank T. Storm	PE Stamp* (Required for all Regulated Projects)	
Title	Civil Engineer		
Company	Development Inc.		
Address	XX C St.		
City, State, Zip Code	Sacramento, CA 99999		
Email	Frank@email.com		
Telephone #	999-999-9999		
Signature			
Brief Description of Project: (Attach additional sheets as necessary)	New office building and parking lot.		

* Not required for Small Projects as determined in Form 1-2 below. Project owners are responsible for ensuring that all storm water facilities are designed by an appropriately licensed and qualified professional.

Form 1-2 Project Category	
Development Category (Select all that apply)	
[1]**Small Project** – All projects, except LUPs, that create and/or replace between 2,500-5,000 ft^2 of impervious surface or detached single family homes that create and/or replace 2,500 ft^2 or more of impervious surface and are not part of a larger plan of development.	
[2]Enter total new and/or replaced impervious surface (ft^2)	
[3]**Regulated Project** – All projects that create and/or replace 5,000 ft^2 or more of impervious surface.	X
[4]**Regulated Redevelopment Project** with equal to, or greater than 50 percent increase in impervious area	
[5]**Regulated Redevelopment Project** with less than 50 percent increase in impervious area	
[6]Enter total pre-project impervious surface (ft^2)	0
[7]Enter total new and/or replaced impervious surface (ft^2)	9225
[8]**Regulated Road or linear underground/overhead project (LUP)** creating 5,000 ft^2 or more of newly constructed contiguous impervious surface.	
[9]Enter total new and/or replaced impervious surface (ft^2)	
[10]**Regulated Hydromodification Management Project** – Regulated projects that create and/or replace 1 acre or more of impervious surface. A project that does not increase impervious surface area over the pre-project condition is not a hydromodification management project.	
[11]Enter total new and/or replaced impervious surface (ft^2)	

Section 3 Regulated Projects

Section 3 forms are to be completed for all Regulated Projects.

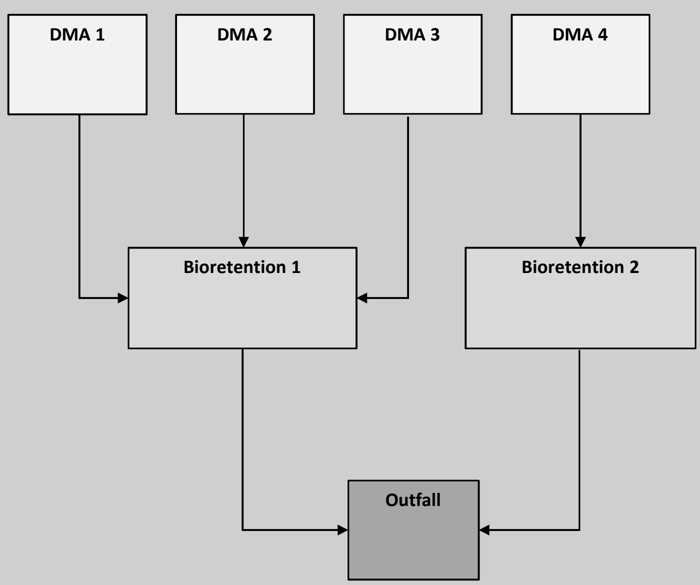
Form 3-1 Site Location and Hydrologic Features

Site coordinates: *Take GPS measurement at approximate center of site*	[1] Latitude	[2] Longitude	[3] Elevation (ft. above sea level)	[4] 85th Percentile, 24 Hour Design Storm Depth (in):
	xx	xx	1200	1.1

[5] Receiving waters *Name of stream, lake or other downstream waterbody to which the site runoff eventually drains*	Folsom Reservoir
[6] 303(d) listed pollutants of concern *Refer to State Water Resources Control Board website* www.waterboards.ca.gov/water_issues/programs/water_quality_assessment/#impaired	Mercury
[7] Is Project going to be phased? *If yes, ensure that the SWQP evaluates each phase with distinct DMAs, requiring LID BMPs to address runoff at time of completion.*	No

[8] *Use this form to show a conceptual schematic depicting DMAs and conveyance features connecting DMAs to the site outlet(s). An example is provided below that can be modified for the proposed project or a drawing clearly showing DMAs and flow routing may be attached.*

Example only
Modify for project specific SWQP
Use separate sheet if necessary

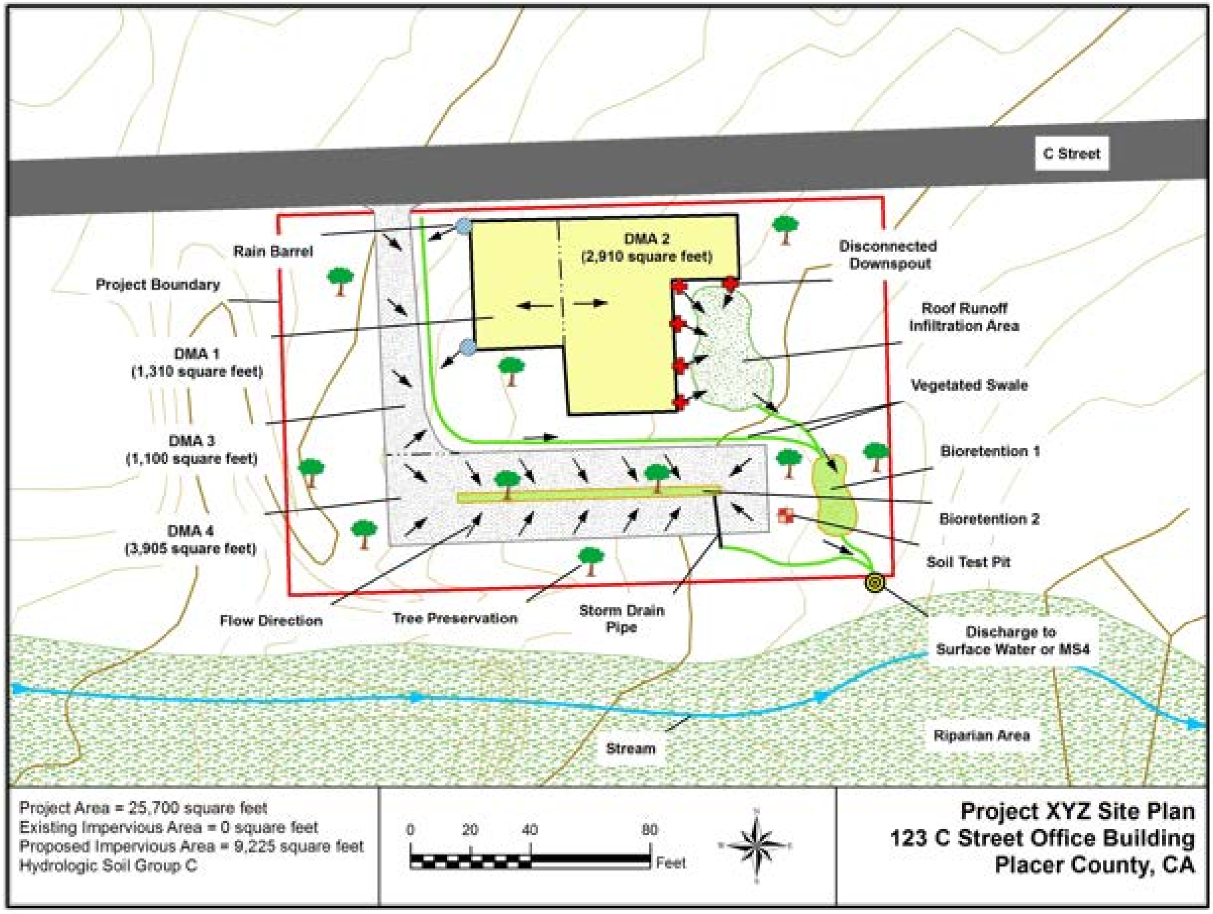


Form 3-2 Site Assessment and Layout Documentation

	Has this Item been considered in the Site Layout and depicted in the Site Plan?	
	Yes	**Not Applicable (Include brief explanation)**
Define the development envelope and protected areas, identifying areas that are most suitable for development areas to be left undisturbed.	X	
Concentrate development on portions of the site with less permeable soils and preserve areas that can promote infiltration.	X	
Limit overall impervious coverage of the site with paving and roofs.	X	
Set back development from creeks, wetlands, and riparian habitats.		NA Existing stream is too close to provide 500 ft setback
Preserve significant trees.	X	
Conform site layout along natural landforms.	X	
Avoid excessive grading and disturbance of vegetation and soils.	X	
Replicate the site's natural drainage patterns.	X	
Detain and retain runoff throughout the site.	X	

Attach a Site Plan that incorporates the applicable considerations above. Ensure that the following items are included in the Site Plan:

Site Boundary
Soil types and areal extents, test pit and infiltration test locations
Topographic data with 1 ft. contours
Existing natural hydrologic features (depressions, watercourses, wetlands, riparian corridors)
Environmentally sensitive areas and areas to be preserved.
Proposed locations and footprints of improvements creating new, or replaced, impervious surfaces
Potential pollutant sources and locations
Entire site divided into separate DMAs with unique identifiers
Existing and proposed site drainage network with flow directions and site run-on and discharge locations
Proposed design features and surface treatments used to minimize imperviousness and reduce runoff
Proposed locations and footprints of treatment and hydromodification management facilities
Design features for managing authorized non-stormwater discharges
Areas of soil and/or groundwater contamination
Existing utilities and easements
Maintenance areas


C Street
Rain Barrel
Project Boundary
DMA 1
(1,310 square feet)
DMA 2
(2,910 square feet)
DMA 3
(1,100 square feet)
DMA 4
(3,905 square feet)
Disconnected
Downspout
Roof Runoff
Infiltration Area
Vegetated Swale
Bioretention 1
Bioretention 2
Soil Test Pit
Flow Direction
Tree Preservation
Storm Drain
Pipe
Discharge to
Surface Water or MS4
Stream
Riparian Area
Project Area = 25,700 square feet
Existing Impervious Area = 0 square feet
Proposed Impervious Area = 9,225 square feet
Hydrologic Soil Group C
0 20 40 80
Feet
Project XYZ Site Plan
123 C Street Office Building
Placer County, CA

Form 3-3 Source Control Measures			
Potential Pollutant Generating Activity or Source	Check One		Describe the source control measures to be implemented for each potential pollutant generating activity or source present on the project as listed in Appendix C and in the CASQA Fact Sheets. Include any special features, materials, or methods of construction that will be used.
	Present	Not Applicable	
Accidental spills or leaks	☑	☐	All materials will be stored inside and properly sealed.
Interior floor drains	☑	☐	Floor drains in basement connect to sanitary sewer.
Parking/storage areas and maintenance	☑	☐	Parking lot to be swept monthly.
Indoor and structural pest control	☑	☐	All materials will be stored inside and properly sealed.
Pools, spas, ponds, decorative fountains, and other water features	☐	☑	
Landscape/outdoor pesticide use	☑	☐	All manufacturer recommendations and regulations will be followed. Minimum amounts will be used.
Restaurants, grocery stores, and other food service operations	☐	☑	
Refuse areas	☑	☐	Trash bins to be closed and locked.
Industrial Processes	☐	☑	
Outdoor storage of equipment or materials	☐	☑	
Vehicle and equipment cleaning	☐	☑	
Vehicle and equipment repair and maintenance	☐	☑	
Fuel dispensing areas	☐	☑	
Loading docks	☐	☑	
Fire sprinkler test water	☑	☐	To be disposed in sanitary sewer.
Drain or wash water from boiler drain lines, condensate drain lines, rooftop equipment, drainage sumps, and other sources	☑	☐	To be disposed in sanitary sewer.
Unauthorized non-storm water discharges	☐	☑	
Building and grounds maintenance	☑	☐	Landscape maintenace to use minimal fertilizers.

The source control measures identified in this table shall be designed consistent with recommendations from the CASQA Stormwater BMP Handbook for New Development and Redevelopment[1], or from another equivalent manual.

[1] California Stormwater BMP Handbook New Development and Redevelopment. California Stormwater Quality Association (CASQA). January 2003.

Form 3-4 Runoff Reduction Calculator for Site Design Measures on Regulated Projects

		[1]DMA ID No.	1		2		3		4	
Site Design Measure	Runoff Reduction Parameters			Runoff Reduction (ft^3)		Runoff Reduction (ft^3)		Runoff Reduction (ft^3)		Runoff Reduction (ft^3)
[2] Adjacent/On-Site Stream Setbacks and Buffers	A_{imp} (ft^2)	*impervious drainage area*		0		0		0		0
	V_{85} (in)	*runoff volume from 85th percentile, 24-hour storm*	1.0		1.0		1.0		1.0	
[3] Soil Quality Improvement and Maintenance	A_{pond} (ft^2)	*ponding area*		0		0		0		
	D_{pond} (ft)	*ponding depth*								
	A_{sa} (ft^2)	*soil amendment area*								
	D_{sa} (ft)	*depth of amended soil*								
	n	*porosity of amended soil*								
[4] Tree Planting and Preservation	n_e	*number of new evergreen trees*		0		0		0	2	36
	n_d	*number of new deciduous trees*								
	A_{tc} (ft^2)	*canopy area of existing trees to remain on the property*								
	V_{85} (in)	*runoff volume from 85th percentile, 24-hour storm*	1.0		1.0		1.0		1.0	
[5] Rooftop and Impervious Area Disconnection	A_{imp} (ft^2)	*impervious drainage area*		0	2910	240		0		0
	V_{85} (in)	*runoff volume from 85th percentile, 24-hour storm*	1.0		1.0		1.0		1.0	
[6] Porous Pavement	A_{res} (ft^2)	*area of gravel storage layer*		0		0		0		0
	D_{res} (ft)	*depth of gravel storage layer*								
	n_{agg}	*porosity of aggregate*								
	C	*efficiency factor*								
[7] Vegetated Swales	A_{imp} (ft^2)	*impervious drainage area*	1310	108		0	1100	91		0
	V_{85} (in)	*runoff volume from 85th percentile, 24-hour storm*	1.0		1.0		1.0		1.0	
[8] Rain Barrels and Cisterns	N	*number of rain barrels and/or cisterns*	10	250		0		0		0
	V_a (ft^3)	*volume of each rain barrel and/or cistern*	50							
[9] Do all Site Design Measures meet the design requirements outlined in the Fact Sheets?				Yes	X	No				
[10] Total Volume Reduction (ft^3)			358		240		91		36	
[11] Effective Treated Impervious Area (ft^2)			3906		2619		990		392	

Form 3-5 Computation of Water Quality Design Criteria for Stormwater Treatment and Baseline Hydromodification Measures

DMA ID No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
[1]Total impervious area requiring treatment	1310	2910	1100	3905																	
[2] Impervious area untreated by Site Design Measures (ft^2) *Item 1 – Form 3-4 Item 11*	0	291	110	3513	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
[3]Additional pervious area draining to BMP (ft^2)	0	800	1200	500																	
[4] Composite DMA Runoff Coefficient (Rc) *Enter area weighted composite runoff coefficient representing entire DMA*	0.90	0.70	0.50	0.80																	
[5] Water Quality Volume (WQV) (ft^3) *WQV = 1/12 * [Item 2 + Item 3) *Item 4] * Unit WQV*	0	57	49	241	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
[6] Water Quality Flow (WQF) (cfs) *WQF = 1/43,200 * [0.2* (Item 2 + Item 3) * Item4]*	0.000	0.004	0.003	0.015	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

DMA ID No.	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43
[1]Total impervious area requiring treatment																					
[2] Impervious area untreated by Site Design Measures (ft^2) *Item 1 – Form 3-4 Item 11*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
[3]Additional pervious area draining to BMP (ft^2)																					
[4] Composite DMA Runoff Coefficient (Rc) *Enter area weighted composite runoff coefficient representing entire DMA*																					
[5] Water Quality Volume (WQV) (ft^3) *WQV = 1/12 * [Item 2 + Item 3) *Item 4] * Unit WQV*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
[6] Water Quality Flow (WQF) (cfs) *WQF = 1/43,200 * [0.2* (Item 2 + Item 3) * Item4]*	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Form 3-6 Volume-Based Infiltrating Bioretention Measures				
[1] **DMA ID No.** *If combining multiple DMAs from Form 3-5, enter a new unique DMA ID No.*	**DMA1-3**	**DMA4**		
[2] WQV (ft^3) *Item 5 in Form 3-5* *If combining multiple DMAs from Form 3-5, enter the sum of their respective WQVs.*	87	262		
[3] Surface Loading Rate *Maximum 5.0 in/hr*	5	5		
[4] BMP Surface Area (ft^2) *Top of BMP*	150	225		
[5] Infiltration rate of underlying soils (in/hr)	0.12	0.12		
[6] Maximum ponding depth (ft) *BMP specific, see BMP design details*	0.5	0.5		
[7] Ponding Depth (ft) *d_{BMP} = Minimum of (1/12 * Item 5 * 48 hrs) or Item 6*	0.5	0.5	-	-
[8] Infiltrating surface area, *SA_{BMP}* (ft^2) *Bottom of BMP*	75	225		
[9] Planting media depth, *d_{media}* (ft)	1.5	1.5		
[10] Planting media porosity	0.30	0.30		
[11] Gravel depth, *d_{media}* (ft) *Only included in certain BMP types*	1.0	1.0		
[12] Gravel porosity	0.30	0.30		
[13] Retention Volume (ft^3) *$V_{retention}$ = Item 8 * [Item7 + (Item 9 * Item 10) + (Item 11 * Item 12) + (1.5* (Item 5 / 12))]*	92.3	276.8	-	-
[14] Untreated Volume (ft^3) *$V_{untreated}$ = Item 2 – Item 13* *If greater than zero, adjust BMP sizing variables and re-compute retention volume*	0	0	0	0
[15] Treated Flow Rate (ft^3/s) $Q_{treated}$ *= 1/43,200*(Item 3 * Item 4)*	0.0174	0.0260	0.0000	0.0000
[16] Total Treated Flow Rate for Project (ft^3/s) *Q_{total} = Sum of Item 15 for all DMAs*	0.043			
[17] **Is WQV for each DMA treated on-site?**	**Yes**	**X**	**No**	

Form 5-1 BMP Inspection and Maintenance

BMP	Inspection Point and Frequency	Maintenance Activity Required
Rain Barrels	Roof drains/Annual	Remove debris
	Barrels/Annual	Repair leaks
	Irrigation piping/Annual	Repair leaks
Veg Swale	Embankments and channel invert/Annual or as needed	Repair erosion problems, remove debris and sediment.
Bioretention facility in parking lot	Inlets and Outlets/Twice a year	Remove debris
	Plants/Monthly	Irrigate, weed control, replace dead plants
	Overflow structure/Twice a year	Remove debris to unclog

Form 6-1 Post-Construction Stormwater BMPs

Following is a summary of all BMPs included in the Project design. This checklist must be included on the cover sheet of the Improvement Plans for all Regulated Projects.

BMP		Plan Sheet Number(s)
Structural Source Controls (list BMPs)	**Refuse bins**	**C3**
	Floor drains	**C6**
Site Design Measures	Stream Setbacks and Buffers	
	Soil Quality Improvement and Maintenance	
	Tree Planting and Preservation	**C4**
	Rooftop and Impervious Area Disconnection	**C4**
	Porous Pavement	
	Vegetated Swales	**C5**
	Rain Barrels and Cisterns	**C2**
Stormwater Treatment and Baseline Hydromodification Measures	Bioretention with Infiltration	**C8 and Detail 1**
	Flow-Through Planters, Tree Box Filters and Media Filters	
Hydromodification Management Measures	Supplemental Detention	

Hydromodification Management Project

Post-Construction
Storm Water Quality Plan

For:

Big Box Store #3
Placer County

Planning Permit No. 2

Prepared for:

Joe Jones
CEO
Big Box Inc
2000000 Baseline Rd
Placer, CA 99999
999-999-9999

Prepared by:

Stormwater Nomore Inc
1 Water Way
Placer, CA 99999
888-888-8888

Preparation Date: March 15, 2016

Approval Date:_____________________

Section 1 General Project Information

The undersigned owner of the subject property, is responsible for the implementation of the provisions of this plan, including ongoing operations and maintenance (O&M), consistent with the requirements of the West Placer Storm Water Quality Design Manual and the State of California Phase II Small MS4 General Permit (Order No: 2013-0001-DWQ). If the undersigned transfers its interest in the property, its successors-in-interest shall bear the aforementioned responsibility to implement the SWQP.

For all Regulated Projects (As identified in Form 1-2 below), the undersigned owner hereby grants access to all representatives of the Jurisdictional Agency for the sole purpose of performing O&M inspections of the installed treatment system(s) and hydromodification control(s) if any.

A copy of the final signed and fully approved SWQP shall be available on the subject site for the duration of construction and then stored with the project approval documentation and improvement plans in perpetuity.

Form 1-1 Project Identification and Owner's Certification

Project Site Address:	2000000 Baseline Rd		
Owner Name:	Joe Jones		
Title	CEO		
Company	Big Box Inc		
Address	2000000 Baseline Rd		
City, State, Zip Code	Placer, CA 99999		
Email	Joe@emailcom		
Telephone #	999-999-9999		
Signature		Date	
Engineer:*	Phillip Waters, P.E.	PE Stamp* (Required for all Regulated Projects)	
Title	Lead Engineer		
Company	Stormwater Nomore Inc		
Address	1 Water Way		
City, State, Zip Code	Placer, CA 99999		
Email	Phil@email.com		
Telephone #	888-888-8888		
Signature			
Brief Description of Project: (Attach additional sheets as necessary)	New big box store and parting lot.		

* Not required for Small Projects as determined in Form 1-2 below. Project owners are responsible for ensuring that all storm water facilities are designed by an appropriately licensed and qualified professional.

Form 1-2 Project Category	
Development Category (Select all that apply)	
[1]**Small Project** – All projects, except LUPs, that create and/or replace between 2,500-5,000 ft^2 of impervious surface or detached single family homes that create and/or replace 2,500 ft^2 or more of impervious surface and are not part of a larger plan of development.	
[2]Enter total new and/or replaced impervious surface (ft^2)	
[3]**Regulated Project** – All projects that create and/or replace 5,000 ft^2 or more of impervious surface.	
[4]**Regulated Redevelopment Project** with equal to, or greater than 50 percent increase in impervious area	
[5]**Regulated Redevelopment Project** with less than 50 percent increase in impervious area	
[6]Enter total pre-project impervious surface (ft^2)	
[7]Enter total new and/or replaced impervious surface (ft^2)	
[8]**Regulated Road or linear underground/overhead project (LUP)** creating 5,000 ft^2 or more of newly constructed contiguous impervious surface.	
[9]Enter total new and/or replaced impervious surface (ft^2)	
[10]**Regulated Hydromodification Management Project** – Regulated projects that create and/or replace 1 acre or more of impervious surface. A project that does not increase impervious surface area over the pre-project condition is not a hydromodification management project.	X
[11]Enter total new and/or replaced impervious surface (ft^2)	392,040

Section 3 Regulated Projects

Section 3 forms are to be completed for all Regulated Projects.

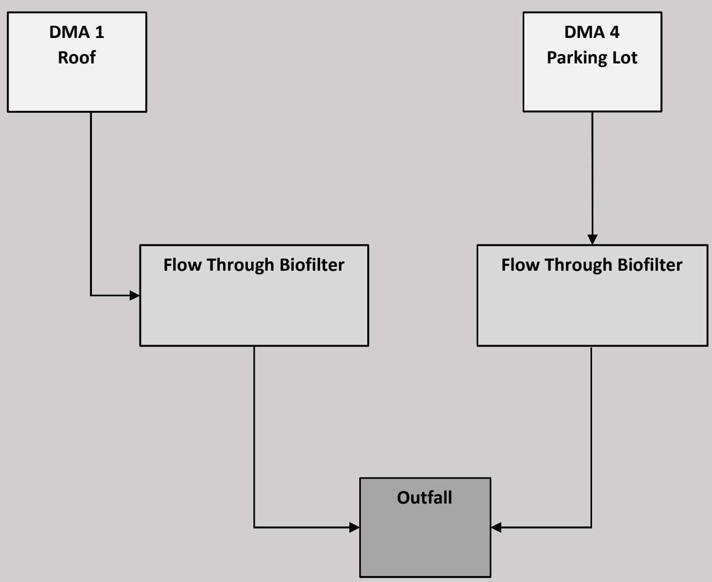
Form 3-1 Site Location and Hydrologic Features

Site coordinates: *Take GPS measurement at approximate center of site*	[1] Latitude	[2] Longitude	[3] Elevation (ft. above sea level)	[4] 85th Percentile, 24 Hour Design Storm Depth (in):
	xx	xx	500	0.9

[5] Receiving waters *Name of stream, lake or other downstream waterbody to which the site runoff eventually drains*	Folsom Lake
[6] 303(d) listed pollutants of concern *Refer to State Water Resources Control Board website* www.waterboards.ca.gov/water_issues/programs/water_quality_assessment/#impaired	Mercury
[7] Is Project going to be phased? *If yes, ensure that the SWQP evaluates each phase with distinct DMAs, requiring LID BMPs to address runoff at time of completion.*	No

[8] *Use this form to show a conceptual schematic depicting DMAs and conveyance features connecting DMAs to the site outlet(s). An example is provided below that can be modified for the proposed project or a drawing clearly showing DMAs and flow routing may be attached.*

Example only
Modify for project specific SWQP
Use separate sheet if necessary



Form 3-2 Site Assessment and Layout Documentation

	Has this Item been considered in the Site Layout and depicted in the Site Plan?	
	Yes	**Not Applicable (Include brief explanation)**
Define the development envelope and protected areas, identifying areas that are most suitable for development areas to be left undisturbed.		NA, previous ag land. All areas are similar
Concentrate development on portions of the site with less permeable soils and preserve areas that can promote infiltration.		NA, conforming to local impervious coverage ordinances
Limit overall impervious coverage of the site with paving and roofs.		NA, no creeks or wetlands nearby
Set back development from creeks, wetlands, and riparian habitats.		NA, no trees or native vegetation present
Preserve significant trees.		NA, site is graded flat from previous use
Conform site layout along natural landforms.		NA, previously graded for ag use.
Avoid excessive grading and disturbance of vegetation and soils.		NA, previously graded flat for ag use.
Replicate the site's natural drainage patterns.	x	
Detain and retain runoff throughout the site.	x	

Attach a Site Plan that incorporates the applicable considerations above. Ensure that the following items are included in the Site Plan:

Site Boundary
Soil types and areal extents, test pit and infiltration test locations
Topographic data with 1 ft. contours
Existing natural hydrologic features (depressions, watercourses, wetlands, riparian corridors)
Environmentally sensitive areas and areas to be preserved.
Proposed locations and footprints of improvements creating new, or replaced, impervious surfaces
Potential pollutant sources and locations
Entire site divided into separate DMAs with unique identifiers
Existing and proposed site drainage network with flow directions and site run-on and discharge locations
Proposed design features and surface treatments used to minimize imperviousness and reduce runoff
Proposed locations and footprints of treatment and hydromodification management facilities
Design features for managing authorized non-stormwater discharges
Areas of soil and/or groundwater contamination
Existing utilities and easements
Maintenance areas


500'x 19'
Biofilter
Building Footprint
(DMA 1)
6 acres
300'x 17'
Biofilter
Parking Lot
(DMA 2)
3 acres
Project Outlet
Legend
Storm Drain
Proposed Project Area
Feet
0
200
400

Form 3-3 Source Control Measures			
Potential Pollutant Generating Activity or Source	Check One		Describe the source control measures to be implemented for each potential pollutant generating activity or source present on the project as listed in Appendix C and in the CASQA Fact Sheets. Include any special features, materials, or methods of construction that will be used.
	Present	Not Applicable	
Accidental spills or leaks	☑	☐	All materials will be stored inside and properly sealed.
Interior floor drains	☑	☐	Floor drains in basement connect to sanitary sewer.
Parking/storage areas and maintenance	☑	☐	Parking lot to be swept monthly.
Indoor and structural pest control	☑	☐	All materials will be stored inside and properly sealed.
Pools, spas, ponds, decorative fountains, and other water features	☐	☑	
Landscape/outdoor pesticide use	☑	☐	All manufacturer recommendations and regulations will be followed. Minimum amounts will be used.
Restaurants, grocery stores, and other food service operations	☐	☑	
Refuse areas	☑	☐	Trash bins to be closed and locked.
Industrial Processes	☑	☐	Lumber processing and storage yard. No direct drains to storm drainage system. Outdoor areas swept daily. Staining activities
Outdoor storage of equipment or materials	☑	☐	All material storage areas are covered with secondary containment.
Vehicle and equipment cleaning	☐	☑	
Vehicle and equipment repair and maintenance	☐	☑	
Fuel dispensing areas	☐	☑	
Loading docks	☑	☐	Drains to sump. Sump is cleaned as needed and materials disposed of at landfill, or in sanitary sewer.
Fire sprinkler test water	☑	☐	To be disposed in sanitary sewer.
Drain or wash water from boiler drain lines, condensate drain lines, rooftop equipment, drainage sumps, and other sources	☑	☐	To be disposed in sanitary sewer.
Unauthorized non-storm water discharges	☐	☑	
Building and grounds maintenance	☑	☐	Landscape maintenace to use minimal fertilizers.

The source control measures identified in this table shall be designed consistent with recommendations from the CASQA Stormwater BMP Handbook for New Development and Redevelopment[1], or from another equivalent manual.

[1] California Stormwater BMP Handbook New Development and Redevelopment. California Stormwater Quality Association (CASQA). January 2003.

Form 3-4 Runoff Reduction Calculator for Site Design Measures on Regulated Projects

		[1] DMA ID No.	1		2		3		4	
Site Design Measure	Runoff Reduction Parameters			Runoff Reduction (ft^3)		Runoff Reduction (ft^3)		Runoff Reduction (ft^3)		Runoff Reduction (ft^3)
[2] Adjacent/On-Site Stream Setbacks and Buffers	A_{imp} (ft^2)	*impervious drainage area*		0		0		0		0
	V_{85} (in)	*runoff volume from 85th percentile, 24-hour storm*	0.8		0.8		0.8		0.8	
[3] Soil Quality Improvement and Maintenance	A_{pond} (ft^2)	*ponding area*		0		0		0		
	D_{pond} (ft)	*ponding depth*								
	A_{sa} (ft^2)	*soil amendment area*								
	D_{sa} (ft)	*depth of amended soil*								
	n	*porosity of amended soil*								
[4] Tree Planting and Preservation	n_e	*number of new evergreen trees*		0		0		0		0
	n_d	*number of new deciduous trees*								
	A_{tc} (ft^2)	*canopy area of existing trees to remain on the property*								
	V_{85} (in)	*runoff volume from 85th percentile, 24-hour storm*	0.8		0.8		0.8		0.8	
[5] Rooftop and Impervious Area Disconnection	A_{imp} (ft^2)	*impervious drainage area*		0		0		0		0
	V_{85} (in)	*runoff volume from 85th percentile, 24-hour storm*	0.8		0.8		0.8		0.8	
[6] Porous Pavement	A_{res} (ft^2)	*area of gravel storage layer*		0		0		0		0
	D_{res} (ft)	*depth of gravel storage layer*								
	n_{agg}	*porosity of aggregate*								
	C	*efficiency factor*								
[7] Vegetated Swales	A_{imp} (ft^2)	*impervious drainage area*		0		0		0		0
	V_{85} (in)	*runoff volume from 85th percentile, 24-hour storm*	0.8		0.8		0.8		0.8	
[8] Rain Barrels and Cisterns	N	*number of rain barrels and/or cisterns*		0		0		0		0
	V_a (ft^3)	*volume of each rain barrel and/or cistern*								
[9] Do all Site Design Measures meet the design requirements outlined in the Fact Sheets?					Yes		No	X		
[10] Total Volume Reduction (ft^3)			**0**		**0**		**0**		**0**	
[11] Effective Treated Impervious Area (ft^2)			**0**		**0**		**0**		**0**	

Form 3-5 Computation of Water Quality Design Criteria for Stormwater Treatment and Baseline Hydromodification Measures

DMA ID No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
[1]Total impervious area requiring treatment	261360	130680																				
[2] Impervious area untreated by Site Design Measures (ft^2) *Item 1 – Form 3-4 Item 11*	261360	130680	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
[3]Additional pervious area draining to BMP (ft^2)	0	0																				
[4] Composite DMA Runoff Coefficient (Rc) *Enter area weighted composite runoff coefficient representing entire DMA*	0.90	0.90																				
[5] Water Quality Volume (WQV) (ft^3) *WQV = 1/12 * [Item 2 + Item 3) *Item 4] * Unit WQV*	14702	7351	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
[6] Water Quality Flow (WQF) (cfs) *WQF = 1/43,200 * [0.2* (Item 2 + Item 3) * Item4]*	1.089	0.545	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

DMA ID No.	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44
[1]Total impervious area requiring treatment																						
[2] Impervious area untreated by Site Design Measures (ft^2) *Item 1 – Form 3-4 Item 11*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
[3]Additional pervious area draining to BMP (ft^2)																						
[4] Composite DMA Runoff Coefficient (Rc) *Enter area weighted composite runoff coefficient representing entire DMA*																						
[5] Water Quality Volume (WQV) (ft^3) *WQV = 1/12 * [Item 2 + Item 3) *Item 4] * Unit WQV*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
[6] Water Quality Flow (WQF) (cfs) *WQF = 1/43,200 * [0.2* (Item 2 + Item 3) * Item4]*	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Form 3-6 Volume-Based Infiltrating Bioretention Measures

[1]**DMA ID No.** *If combining multiple DMAs from Form 3-5, enter a new unique DMA ID No.*				
[2]WQV (ft^3) *Item 5 in Form 3-5* *If combining multiple DMAs from Form 3-5, enter the sum of their respective WQVs.*				
[3]Surface Loading Rate *Maximum 5.0 in/hr*				
[4]BMP Surface Area (ft^2) *Top of BMP*				
[5]Infiltration rate of underlying soils (in/hr)				
[6]Maximum ponding depth (ft) *BMP specific, see BMP design details*				
[7]Ponding Depth (ft) d_{BMP} *= Minimum of (1/12 * Item 5 * 48 hrs) or Item 6*	-	-	-	-
[8]Infiltrating surface area, SA_{BMP} (ft^2) *Bottom of BMP*				
[9]Planting media depth, d_{media} (ft)				
[10]Planting media porosity				
[11]Gravel depth, d_{media} (ft) *Only included in certain BMP types*				
[12]Gravel porosity				
[13]Retention Volume (ft^3) $V_{retention}$ *= Item 8 * [Item7 + (Item 9 * Item 10) + (Item 11 * Item 12) + (1.5* (Item 5 / 12))]*	-	-	-	-
[14]Untreated Volume (ft^3) $V_{untreated}$ *= Item 2 – Item 13* *If greater than zero, adjust BMP sizing variables and re-compute retention volume*	0	0	0	0
[15] Treated Flow Rate (ft^3/s) $Q_{treated}$ *= 1/43,200*(Item 3 * Item 4)*	0.0000	0.0000	0.0000	0.0000
[16]Total Treated Flow Rate for Project (ft^3/s) Q_{total} *= Sum of Item 15 for all DMAs*				
[17]**Is WQV for each DMA treated on-site?**	**Yes**		**No**	**X**

Form 3-7 Flow-Through Planters, Tree Box and Media Filters				
[1]**DMA ID No.** *If combining multiple DMAs from Form 3-5, enter a new unique DMA ID No.*	**DMA 1**	**DMA 2**		
[2]WQF (ft3/s) *Item 6 in Form 3-5* *If combining multiple DMAs from Form 3-5, enter the sum of their respective WQFs.*	1.0890	0.5450		
[3]Surface Loading Rate *Maximum 5.0 in/hr*	5.0	5.0		
[4]Maximum Ponding Depth (ft) *BMP Specific, see BMP design details*	0.5	0.5		
[5]Soil/Media Surface Area (ft^2) *Top of BMP*	9410	4750		
[6]Soil/Media Depth (ft)	1.50	1.50		
[7]Soil/Media porosity	0.30	0.30		
[8]Gravel Depth (ft)	1.00	1.00		
[9]Gravel porosity	0.30	0.30		
[10]Detention Volume (ft^3) *Vd = Item 5 * [Item4 + (Item 6 * Item 7) + (Item 8 * Item 9) + (3* (Item 3 / 12))]*	23,525.00	11,875.00	0.00	0.00
[11]Manufacturers' specified flow rate for proprietary devices (ft3/s) (attach a copy of the product specifications)				
[12] Treated Flow Rate (ft^3/s) $Q_{treated}$ *= 1/43,200*(Item 3 * Item 5) or Item 11*	1.0891	0.5498	0.0000	0.0000
[13]Untreated Flow Rate (ft^3/s) $Q_{untreated}$ *= Item 2 - Item 12* *If greater than zero, adjust BMP sizing variables and re-compute treated flow*	0.0000	0.0000	0.0000	0.0000
[14]Total Treated Flow Rate for Project (ft^3/s) Q_{total} *= Sum of Item 12 for all DMAs*	1.64			
[15] **Is WQF for each DMA treated on-site?**	**Yes**	**X**	**No**	

Section 4
Regulated Hydromodification Management Projects

Form 4-1 Peak Runoff Response Time

(Complete Section 4 forms for Regulated Hydromodification Projects only)

Determine total runoff response time for pre- and post-construction conditions at each project outlet.

Variables	**Pre-construction DMAs to Project Outlet**				**Post-construction DMAs to Project Outlet**			
	1	**2**	**3**	**4**	**1**	**2**	**3**	**4**
[1]Length of longest overland flow path *Not to exceed 100 ft*	100				0			
[2]Slope of overland flow path (ft/ft)	0.0050							
[3]Manning's roughness coefficient for overland flow surface *See Table 5-5 of the Placer County SWMM*	0.4000							
[4]Overland flow response time (min) $(0.355*(\text{Item 1}*\text{Item 3})^{0.6})/(\text{Item 2}^{0.3})$	16	-	-	-	-	-	-	-
[5]Hydrologic Soil Group *Refer to Section 3.1.1. or NRCS Web Soil Survey*	D							
[6]Current Land Cover Type(s) *Select from categories shown in Table 5-3 of the SWMM*	Fallow							
[7]Pervious Area Condition: *Based on the extent of vegetated cover* *Good >75%; Fair 50-75%; Poor <50%* *Attach photos of site to support rating*	Poor							
[8]Infiltration Rate (in/hr) *Refer to Table 5-3 of the SWMM using Items 3, 4, and 5 above or obtain site specific field measurements (See Section 3.1.1)*	0.03							
[9]Length of collector flow (ft)	700				800			
[10]Cross-sectional area of collector flow facility (ft^2)	1.00				7.00			
[11]Wetted perimeter of collector flow facility (ft)	3.50				9.40			
[12]Manning's roughness of collector flow facility	0.0400				0.0100			
[13]Slope of collector flow facility (ft/ft)	0.0050				0.0050			
[14]Channel flow velocity (ft/sec) *$V = (1.49 / \text{Item 12}) * (\text{Item 10}/\text{Item 11})^{0.67} * (\text{Item 13})^{0.5}$*	1.1	-	-	-	8.7	-	-	-
[15]Collector flow facility response time (min) *$T_c = \text{Item 9} / (\text{Item 14} * 60)$*	10.2	-	-	-	1.5	-	-	-
[16]Total runoff response time or T_t (min) *$T_t = \text{Item 4} + \text{Item 15}$*	26.1	-	-	-	1.5	-	-	-

Form 4-2 Hydromodification Target for Peak Runoff

Variables	Pre-construction DMAs to Project Outlet				Post-construction DMAs to Project Outlet			
	1	2	3	4	1	2	3	4
[1] Drainage Area (ft^2) *Sum of all outlet level DMAs should equal total project area.*	392,040				392,040			
[2] Impervious Area (ft^2) *Sum of all outlet level DMAs should equal total project impervious area.*	0				392,040			
[3] Rainfall depth for 2yr storm with duration equal to response time (in) *See Placer County SWMM Table 5-A-1 for elevation of site and duration equal to response time*	0.32				0.13			
[4] Unit peak runoff (cfs/acre) *q = 60/Form 4-1 Item 16 * Item 3*	0.73	-	-	-	5.06	-	-	-
[5] Infiltration factor (cfs/acre) *F_i = Form 4-1 Item 8 * (1 + 1 /(1.3 + 0.0005 * Form 3-1 Item 3))*	0.05	-	-	-	-	-	-	-
[6] Peak runoff from DMAs (cfs) *Q_p = Item 1 * Item 4 – Item 5 * (Item 1 - Item 2)*	6.22	-	-	-	45.95	-	-	-
[7]Total Pre-Project Peak Runof (ft^3/s) *Q_{total} = Sum of Item 6 for all Pre-construction DMAs*	6.22							
[8] Is the total post-project peak runoff equal to or less than the total pre-project peak runoff? *Yes, if Item 7 is greater than or equal to the sum of the Total Treated Flow Rates from Form 3-6 Item 16 and 3-7 Item 12.*	**YES**							

Form 4-3 Detention Volumes for Hydromodification Management

	Post-construction DMAs to Project Outlet			
	1	2	3	4
1 Land cover and hydrologic condition *See NRCD TR-55 Manual Table 2-2 for types*	Industrial			
2 Hydrologic Soil Group *Refer to Section 3.1.1. or NRCS Web Soil Survey*	-	-	-	-
3 Drainage Area (A) (ft^2)	392,040	-	-	-
4 Curve Number (CN) *Use Items 1 and 2 to select curve number from NRCS TR-55 Manual Table 2-2*	98			
5 Post-development soil storage capacity, S (in): *S = (1000 / Item 4) – 10*	0.2	#DIV/0!	#DIV/0!	#DIV/0!
6 Precipitation for 2-yr, 24-hr storm (in) *See Placer County SWMM Table 5-A-1 for elevation of site and 24-hr duration depths*	1.90			
7 Post-developed runoff volume for 2-yr – 24-hour storm, V_{runoff} (ft^3): V_{runoff} *= Item 3 * (1 / 12) * [(Item 6 – 0.2 * Item 5)^2 / (Item 6 + 0.8 * Item 5)]*	54,732	#DIV/0!	#DIV/0!	#DIV/0!
8 Attenuation Factor, $q_{out/in}$ (ratio of target outflow rate to peak inflow rate): $q_{out/in}$ *= Form 4-2 Item 6 Pre-Construction / Form 4-2 Item 6 Post-Construction*	0.14	#DIV/0!	#DIV/0!	#DIV/0!
9 Equalization Factor, Vs/Vr (ratio of storage capacity to runoff volume) *Vs/Vr obtained using Item 8 and nomograph in Figure 6-1 of NRCS TR-55 Manual for Rainfall Type IA*	0.40			
10 Runoff detention capacity to achieve hydromodification management criteria (ft^3) $D_{hydromod}$ *= Item 7 * Item 9*	21893	#DIV/0!	#DIV/0!	#DIV/0!
11 Site Design Measure (SDM) Volume (ft^3): *Sum of Item 10 in Form 3-4 for all SDMs in this DMA.*	0			
12 Bioretention Volume (ft3): *Sum of Item 14 in Form 3-6 for all bioretention measures in this DMA.*	0			
13 Flow-Through Detention Volume (ft3): *Sum of Item 10 in Form 3-7 for all flow-through facilities in this DMA.*	35400			
14 Supplemental Detention Volume (ft^3):	0			
15 Combined Detention Volume in this DMA (ft^3): *Sum of Items 11 through 14*	35,400	-	-	-
16 Is detention capacity to achieve hydromodification management criteria achieved at all project outlets? *Yes, if Item 10 is less than or equal to Item 15. If not provide additional storage capacity*	**Yes**	**X**	**No**	

Form 5-1 BMP Inspection and Maintenance

BMP	Inspection Point and Frequency	Maintenance Activity Required
Biofilters	Inlets and outlets/annually	Remove debris as needed
	Surface of filter bed/annually and after large storms	Remove accumulations to restore filtration rate as needed
	Vegetation	Remove weeds, replace dead plants

Form 6-1 Post-Construction Stormwater BMPs

Following is a summary of all BMPs included in the Project design. This checklist must be included on the cover sheet of the Improvement Plans for all Regulated Projects.

BMP		Plan Sheet Number(s)
Structural Source Controls (list BMPs)	**Loading dock containment**	**C1**
	Refuse area cover	**C2**
	Floor drain sump	**C3**
Site Design Measures	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	
Stormwater Treatment and Baseline Hydromodification Measures	Bioretention with Infiltration	
	Flow-Through Planters, Tree Box Filters and Media Filters	**C5 and D 5**
Hydromodification Management Measures	Supplemental Detention	**C6 and D6**