Technical Guidance Document for Water Quality Management Plans

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Prepared for and Submitted by:
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Technical Guidance Document

Section 1 - Introduction

1.1 Purpose of Guidance

The 2010 Municipal Separate Storm Sewer System Permit (MS4 Permit), adopted by the Santa Ana Regional Water Quality Control Board (RWQCB), and issued to San Bernardino County, requires all new development and significant redevelopment projects covered by this Order to incorporate Low Impact Development (LID) Best Management Practices to the maximum extent practicable (MEP). In addition, the Order also requires development of a standard design and post-development best management practice (BMP) guidance for incorporation, where feasible and applicable, of site design/LID, source control, and treatment control BMP (where feasible and applicable) and Hydrologic Conditions of Concern (HCOC) mitigation measures to the MEP on public street, road, highway, and freeway improvement projects ("transportation projects") to reduce the discharge of pollutants to receiving waters. The purpose of this Technical Guidance Document (TGD) for Water Quality Management Plan(s) (WQMP) is to provide direction to project proponents on the regulatory requirements applicable to a private or public development activity, including public works transportation projects, from project conception to completion. This TGD is intended to serve as a living document, which will be updated as needed to remain applicable beyond the current Permit term. Any non-substantive updates to the TGD and Transportation Project BMP Guidance and applicable Template will be provided in the annual report. Future substantive updates shall be submitted to the RWQCB for review and approval, prior to implementation.

1.2 Regulatory Background

The 1972 Federal Water Pollution Control Act and its amendments comprise what is commonly known as the Clean Water Act (CWA). The CWA provides the basis for the protection of all inland surface waters, estuaries, and coastal waters. The federal Environmental Protection Agency (EPA) is responsible for ensuring the implementation of the CWA and its governing regulations (primarily Title 40 of the Code of Federal Regulations) at the state level.

California's Porter-Cologne Water Quality Control Act of 1970 and its implementing regulations established the RWQCB as the agency responsible for implementing CWA and Porter-Cologne requirements in the Santa Ana River Watershed. These requirements include adoption of a Water Quality Control Plan ("Basin Plan") to protect inland freshwaters and estuaries. The Basin Plan identifies the beneficial uses for waterbodies in the Santa Ana River watershed, establishes the water quality objectives required to protect those uses, and provides an implementation plan to protect water quality in the region (RWQCB 1995 and subsequent amendments).

As part of its responsibility to protect beneficial uses of waters in the Santa Ana River Watershed in San Bernardino County, the RWQCB issued permits to regulate discharges from Municipal Separate Storm Sewer System (MS4) facilities within the County.

The jurisdictions covered by this permit include:

San Bernardino County Flood Control District

County of San Bernardino

City of Big Bear Lake

City of Chino

City of Chino Hills

City of Colton

City of Fontana

City of Grand Terrace

City of Highland

City of Loma Linda

City of Montclair

City of Ontario

City of Rancho Cucamonga

City of Redlands

City of Rialto

City of San Bernardino

City of Upland

City of Yucaipa

The first MS4 Permit for these Permittees was issued by the RWQCB in 1990. This permit focused primarily on program development, which included establishment of the Drainage Area Management Plan (now the Municipal Stormwater Management Plan) and implementation of public education and staff training on stormwater quality concerns.

Revised permits were issued in 1996 and 2002. Under these permits the stormwater management requirements applicable to new development and significant redevelopment projects evolved. Accordingly, during these permits the Model WQMP Guidance was revised twice (2000 and 2005) to incorporate increasingly stringent requirements applicable to development activities.

The RWQCB issued the current MS4 Permit on January 29, 2010 (Order No. 2010-0036, NPDES No. CAS618036). This permit contains many new requirements that further increase the complexity and costs associated with the management of stormwater in the permitted area, especially for new development and significant redevelopment projects and public works transportation projects. To address these new regulatory mandates, the MS4 Permit program has again revised the Model WQMP Guidance. This updated TGD replaces all previous guidance applicable to development projects within the Santa Ana River Watershed.

1.3 Stormwater Management

Development activities typically change pre-development hydrologic conditions by altering drainage patterns and increasing impervious area. Impervious areas include streets, walkways, driveways, rooftops, and parking lots which traditionally not only do not infiltrate stormwater runoff, but instead increase the rate and volume of runoff of precipitation during storm events. The traditional approach to storm drain design associated with a development activity focused on capturing and transporting stormwater runoff off-site in the most efficient manner to protect people and property from potential flood damage. Urban constructed drainage systems, comprised of street gutters, catch basins, belowground storm drain piping, detention basins, and open or closed channels (i.e., the MS4) have functioned to convey runoff from completed developments to the nearest receiving water.

Stormwater runoff mobilizes pollutants on land surfaces and carries them downstream via the MS4 to storm drain systems where impacts to receiving water quality may occur. In addition, increased runoff volume from development activities can cause erosion in downstream waters further impacting water quality. Accordingly, over a number of years stormwater management has evolved from simply managing the quantity of runoff from a development site to managing both the quantity and quality of the runoff to reduce impacts to downstream receiving waters.

The recently adopted MS4 Permit for San Bernardino County includes significant changes to the requirements for managing the quantity and quality of runoff from urban developments. These requirements include the incorporation of LID practices to maintain the pre-development hydrology of a development site to the maximum extent practicable.

1.3.1 Low Impact Development

LID principles are increasingly being applied in urban environments as a strategy to reduce receiving water impacts from stormwater runoff. A typical LID definition is:

> "…*a stormwater management strategy that emphasizes conservation and the use of existing natural site features integrated with distributed, small-scale stormwater controls to more closely mimic natural hydrologic patterns in residential, commercial and industrial setting*."[Washington State University Puget Sound Action Team as reported in Green Infrastructure for Los Angeles: Addressing Urban Runoff and Water Supply through LID, 2009]

Accordingly, the San Bernardino County Stormwater Program defines LID as "*a stormwater management and land development strategy that combines a hydrologically functional site design with pollution prevention measures to compensate for land development impacts on hydrology and water quality. LID techniques mimic the site pre-development site hydrology by using site design techniques that store, infiltrate, evapotranspire, bio-filter or detain runoff close to its source*".

1.3.2 Goals of LID

The primary goal of LID is to preserve the pre-development hydrology of a project site. Changes in runoff characteristics that result in increased post-development runoff can be reduced through the use of structural and nonstructural BMPs that store, infiltrate, evaporate, and detain runoff. The desired outcome of the use of these BMPs is to mimic the local watershed's natural hydrologic functions to the maximum extent practicable. There are many site design techniques that may be deployed on a project site to allow the site to function in a manner similar to how it functioned prior to development. With the incorporation of LID practices, downstream waters that ultimately receive stormwater runoff from developed sites will experience fewer negative impacts and have in-stream flows that more closely approximate pre-development runoff conditions.

1.3.3 Benefits of LID

The benefits of implementing LID practices can be significant. Examples include:

- *Maintain pre-development hydrology* – Maintaining the pre-development hydrology reduces the volume of water that must be conveyed offsite, which not only reduces erosion and sedimentation impacts, but ultimately reduces downstream flood control requirements.

- *Water quality benefits* – Pollutant loads carried by stormwater runoff can be greatly reduced through retention of stormwater and pollutants onsite and use of BMPs that biofilter pollutants onsite, thus reducing pollutants that would normally be discharged directly to the storm drain system.

- *Groundwater recharge* – LID emphasizes infiltration of runoff onsite which has the potential to increase local water supply availability from groundwater sources.

- *Aesthetic appeal* - LID involves the use of site design practices that minimize the footprint of proposed developments which increases preservation of open space.

1.4 WQMP Guidance Revision

The 2010 MS4 Permit significantly changed the requirements applicable to development activities by substantially changing how LID practices are incorporated into developments. Specifically, as stated in the Permit:

> *"This Order requires project proponents to first consider preventative and conservation techniques (e.g., preserve and protect natural features to the maximum extent practicable) prior to considering mitigative techniques (structural treatment, such as infiltration systems). The mitigative measures should be prioritized with the highest priority for BMPs that remove storm water pollutants and reduce runoff volume, such as infiltration, then other BMPs, such as harvesting and use, evapotranspiration and biotreatment should be considered. To the maximum extent practicable, these LID BMPs must be implemented at the project site. The Regional Board recognizes that site conditions, including site soils, contaminant plumes, high groundwater levels, etc., could limit the applicability of infiltration and other LID BMPs at certain project sites. Where LID BMPs are not feasible at the project site, more traditional, but equally effective control measures should be implemented. This Order provides for alternatives and in-lieu programs where the preferred LID BMPs are infeasible* (RWQCB Order No. 2010-0036, NPDES No. CAS618036, Section II.G.6).*"*

To address these requirements, this document replaces the existing 2005 Model WQMP Guidance for the Santa Ana River Watershed (revised in May 2012) in its entirety. Key changes to the WQMP Guidance include:

- Revised HCOC performance criteria based on MS4 Permit requirements to conduct hydrologic analysis for only the 2-year storm event (2005 Guidance also required analysis of 1-year and 5-year storm events)
- More detailed description of LID site design considerations including preventative principles (e.g. minimizing impervious area) and mitigative lot level hydrologic source controls (e.g. residential rooftop downspout disconnection)
- New approach to BMP selection and evaluation, whereby LID BMPs are evaluated according to the hierarchy specified in the 2010 MS4 Permit
- Updated tables of pollutant removal effectiveness for BMPs that treat and release runoff to the MS4
- New required calculations to demonstrate that planned LID BMPs are capable of capturing runoff from the water quality design storm event (Design Capture Volume or "DCV")

- New approach to determine if implementation of a BMP type is not feasible, including initial site screening factors (e.g. high groundwater conditions) and detailed assessment of project specific feasibility (e.g. infiltration basin in poorly draining soils)
- Inclusion of a Transportation Guidance specific to certain types of public works transportation projects. Application of this Guidance to transportation projects results in documentation that is functionally equivalent to the WQMP prepared for new development or significant re-development projects.

1.5 Guidance Applicability

All proponents of development projects are required to use this TGD and associated Template to obtain the necessary approvals for implementation of proposed new development and significant re-development activities and proposed transportation projects. Project submittal requirements vary depending on the type of project as well as whether the project proponent is a private entity or public agency. The following sections provide additional information regarding the applicability of this TGD.

1.5.1 Priority Projects

Table 1-1 defines development activities classified as Priority Projects. This TGD establishes requirements for project proponents (both private and public agency project proponents) to meet the minimum County-wide stormwater management requirements applicable to Priority Projects. In general terms, the project proponent shall incorporate infiltration LID BMP to the MEP; and use biotreatment and harvest and use BMP for the remainder of the DCV.

The project proponent should consult the Local Implementation Plan (LIP) established for the jurisdiction within which the project is proposed, as requirements may be applicable for non-priority /non-category projects. The LIP provides information regarding how the WQMP development process is implemented within the local jurisdiction and identifies any additional WQMP development requirements, i.e., in addition to the requirements identified in this document.

No building or grading permits will be issued to Priority Projects by any local jurisdiction without an approved final project-specific WQMP.

1.5.2 Transportation Projects

Transportation projects that are part of a new development or significant re-development project implemented by a private developer are subject to the requirements applicable to Priority Projects (e.g., see Section 1.5 and Table 1-1 Priority Project Category No. 2), regardless of whether the roads remain private or are dedicated to public right-of-way after the development is complete.

Table 1-1. Priority Projects[(1)]

Category No.	Project Type
1	All significant re-development[1] projects - defined as the addition or replacement of 5,000 or more square feet (sq. ft) of impervious surface on an already developed site subject to discretionary approval of the permitting jurisdiction. In addition: Re-development does not include: Routine maintenance activities that are conducted to maintain original line and grade, hydraulic capacity, original purpose of the facility, or emergency redevelopment activity required to protect public health and safety. Where re-development results in an increase of less than 50% of the impervious surfaces of a previously existing developed site, and the existing development was not subject to WQMP requirements, the numeric sizing criteria discussed in Section 4 applies only to the addition or replacement, and not to the entire developed site. Where re-development results in an increase of 50% or more of the impervious surfaces of a previously existing developed site, the numeric sizing criteria discussed in Section 4 applies to the entire development.
2	New development projects that create 10,000 sq. ft. or more of impervious surface (collectively over the entire project site) including commercial, industrial, residential housing subdivisions (i.e., detached single family home subdivisions, multi-family attached subdivisions or townhomes, condominiums, apartments, etc.), mixed-use, and public projects. This category includes development projects on public and private land, which fall under the planning and building authority of the permitting jurisdiction.
3	New development or significant re-development[1] of automotive repair shops (with SIC[2] Codes 5013, 5014, 5541, 7532-7534, 7536-7539) where the project creates, adds and/or replaces 5,000 square feet or more of impervious surface.
4	New development or significant re-development[1] of restaurants (with SIC[2] Code 5812) where the land area of development is 5,000 sq. ft. or more.
5	All hillside developments of 5,000 sq. ft. or more which are located on areas with known erosive soil conditions or where the natural slope is 25% or more.
6	Developments of 2,500 sq. ft. of impervious surface or more adjacent to (within 200 feet) or discharging directly into environmentally sensitive areas or waterbodies listed on the CWA Section 303(d) list of impaired waters[(3)].
7	Parking lots of 5,000 sq. ft. or more exposed to stormwater. A parking lot is defined as land area or facility for the temporary parking or storage of motor vehicles.
8	New development or significant re-development[1] of Retail Gasoline Outlets that are either 5,000 sq. ft. or more, or have a projected average daily traffic of 100 or more vehicles per day.
	Non-Priority / Non-Category Projects may be required by the local jurisdiction to implement applicable site design LID and LIP requirements.

[(1)] – As defined by RWQCB Order R8-2010-0036
[(2)] - For SIC codes, see: www.osha.gov/oshstats/sicser.html
[(3)] – See Section 3 for additional information regarding impaired waters

Public works transportation projects not part of a Priority Project may be subject to the requirements of the Transportation Project BMP Guidance, which describes the stormwater management requirements applicable to selected categories of transportation projects. The Transportation Project BMP Guidance is incorporated into this document as Appendix A. Similar to a Priority Project; it is recommended that a project proponent also consult the LIP for the local jurisdiction in which the public works transportation project is planned to determine if any additional local requirements apply to the proposed project.

1.6 How to Use this Guidance

This TGD provides project planning, site design, BMP selection and evaluation, and project implementation guidance for Priority Projects and transportation projects. Given varying site conditions throughout the County, it is not practical for this document to address every potential site design issue that may arise during project conception and design. Furthermore, this TGD does not supersede any local regulations that affect local development requirements. While not an all-encompassing document, the TGD does provide detailed discussion of LID BMP selection, evaluation, and feasibility analysis so that project proponents will understand what must be incorporated into Priority Projects and road projects to meet County-wide stormwater management requirements.

The TGD is applicable to new development and re-development projects and includes a WQMP Template (Appendix B) that is to be used by all project proponents of Priority Projects. Careful adherence to the methods, calculations, and requirements incorporated into this Template will increase the likelihood that a complete application for project approval is submitted.

The Transportation Project BMP Guidance (Appendix A) also includes a Template that is to be used by all project proponents of public works road projects. For road projects, compliance with the Transportation Project BMP Guidance establishes the documentation that is functionally equivalent to the WQMP documentation prepared for Priority Projects. In addition, usage of the Transportation Project BMP Guidance and Template will increase the likelihood that the project file for a planned road project is complete.

Finally, this document and its accompanying appendices should be used to identify the minimum requirements applicable to private or public development activities or public works transportation projects. The information contained herein should be used to facilitate discussions between the project proponent and responsible agencies for issuing approvals and permits for the proposed development activities.

In addition, each jurisdiction under the MS4 Permit has adopted a LIP that provides information specific to the local area where the development activity is planned. The LIP should be consulted and used along with this TGD to prepare documentation applicable to the proposed project.

Section 2 – WQMP Development Process

2.1 Introduction

Use of this Guidance should begin in the earliest possible stages of project conception when a development site or transportation project is first evaluated to determine how to best utilize the site to optimize both its development potential and ability to incorporate LID concepts given the location and characteristics of the property and the area. Ideally, preparation of the documentation to support the planned project should be a multi-disciplinary effort involving planning, architecture, engineering, geotechnical expertise, and landscape architecture. Teams comprised of diverse disciplines can best evaluate how to apply LID practices from project conception through design and construction.

The process for developing a WQMP for a Priority Project, or the functionally equivalent documentation for a transportation project requires the systematic completion of a number of steps before a project can receive the necessary approvals and permits for construction. The following sections provide an overview of the key steps applicable to proposed projects. Subsequent sections of this TGD for WQMP and its appendices describe each step in more detail.

2.2 Process Overview

Figure 2-1 shows the overall process applicable to Priority Projects and public works transportation projects, including where additional information may be obtained in this document. The project proponent should consult the LIP for the jurisdiction in which the project is located. The LIP provides jurisdiction-specific requirements applicable to WQMP development and transportation projects. At a minimum, all local jurisdictions within the County of San Bernardino shall implement the following process for a proposed project:

- *Select Appropriate Guidance* - If this is a public works transportation project, Appendix A provides Guidance applicable to the proposed project. The remaining sections of this document (Sections 3 through 9) do not apply.
- *Establish Priority Project Type*: Table 1-1 identifies Priority Projects subject to WQMP development requirements.
- *Complete Project Evaluation Requirements*: Perform California Environmental Quality Act (CEQA) review, Watershed Action Plan (WAP) analysis and assess local site conditions and jurisdictional requirements for project (see Section 3).
- *Develop Site Design:* This step involves planning the project using preventative LID site design principles to minimize the impact of development (see Section 5).

- *Establish Project-Specific Performance Criteria:* Based on information developed during project evaluation and site design, the project proponent establishes LID and HCOC performance criteria.

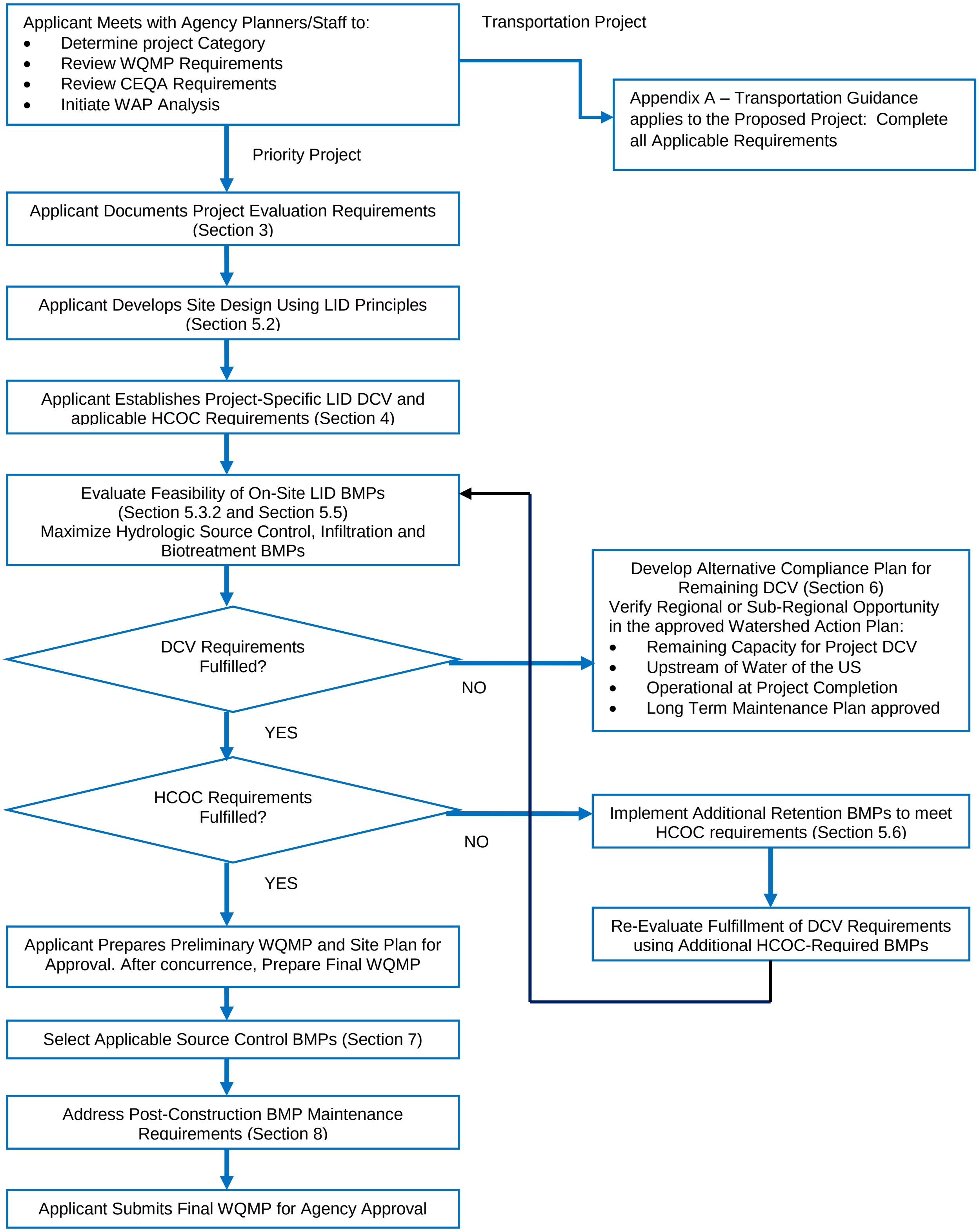

Figure 2-1. WQMP Development Process Flowchart

Section 4 provides guidelines for computing the project design capture volume (DCV) for LID and pre- and post-development hydrologic factors (runoff volume, time of concentration, and peak runoff velocity) for HCOC performance criteria.

2.3 Working with Your Local Jurisdiction

This TGD for WQMP identifies requirements for completion of a WQMP for Priority Projects or functionally equivalent document for transportation projects that satisfies County-wide MS4 Permit requirements. However, nothing in this TGD supersedes any local development requirements.

2.3.1 Getting Started

The first step in the approval process for a proposed project is to determine the applicability of WQMP requirements. If the proposed project is a public works transportation project, then the requirements established in Appendix A – Transportation Project BMP Guidance may apply. The Transportation Guidance provides all necessary information regarding its applicability, use and required documentation. If the project falls within one of the categories listed in Table 1-1, then it is classified as a Priority Project, and all requirements described in subsequent sections of this TGD must then be addressed.

Ultimately, the project proponent should consult the local LIP and, if needed, local stormwater management personnel to verify project approval requirements. It is the responsibility of the project proponent to determine stormwater management requirements applicable to the proposed project. Project proponents must also consult the WAP for the project location, to ensure that WQMP development is aligned with any watershed based plans.

Once it is determined that a project requires a WQMP, the project proponent should work through each step described in this TGD. The WQMP Template provided in Appendix B will guide the process and dictate the types of information and analyses required to complete the WQMP application.

2.3.2 Resource Information

The primary focus of this document is to provide sufficient baseline information for Priority Projects to guide project proponents through the development of the WQMP application. A secondary focus is to provide guidance for application of site design/LID-based BMPs, source control and treatment control BMPs (where applicable to project) to public works transportation projects (i.e., Appendix A). Regardless of the focus, this document is not intended to be an exhaustive source of information about LID BMPs, especially with regards to LID design practices or criteria. Where appropriate in various sections, links to additional specific reference materials are provided. However, prior to starting preparation of the WQMP, it is recommended that the project proponent become familiar with the LID literature, especially as it relates to commonly accepted engineering practices. Recommended source material for transportation projects is provided in the Transportation Project BMP Guidance (Appendix A). Key source materials for new development and re-development projects include:

- Final Draft Model Water Quality Management Plan (WQMP), Orange County (CA) Stormwater Program, March 22, 2011.
- Final Draft Technical Guidance Document for the Preparation of Conceptual/Preliminary and/or Project WQMPs, Orange County (CA) Stormwater Program, March 22, 2011.
- Final Draft Technical Guidance Document Appendices, Orange County (CA) Stormwater Program, March 22, 2011.
- San Bernardino County Watershed Action Plan, San Bernardino County Stormwater Program, January 29, 2011.
- California State Water Resources Control Board and Low Impact Development Center. Low Impact Development Manual for Southern California: Technical Guidance and Site Planning Strategies. 2009.
- Center for Watershed Protection. Better Site Design: A Handbook for Changing Development Rules in Your Community. 1998.
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- Maryland Department of Environmental Resource Programs and Planning Division. Low-Impact Development Design Strategies -An Integrated Design Approach (June 1999) Prince George's County, 1999; http://www.co.pg.md.us/Government/DER/PPD/pgcounty/lidmain.htm.
- American Society of Civil Engineers (ASCE). National Stormwater Best Management Practices (BMP) Database, Version 1.0.
- Urban Water Resources Research Council of ASCE Wright Water Engineers. National Stormwater Best Management Practices Database, 2001.
- Bay Area Stormwater Management Agencies Association (BASMAA). Start at the Source (Detailed discussion of permeable pavements and alternative driveway designs presented), 1999.
- Schueler, Thomas R. and Holland, Heather K. Center for Watershed Protection. The Practice of Watershed Protection, 2000.
- Urban Runoff Quality Management, American Society of Civil Engineers (ASCE) Manual and Report on Engineering Practice No. 87/Water Environment Federation (WEF) Manual of Practice No.23, 1998.

2.4 Preliminary WQMP Submittal

Local jurisdictions shall require the submittal of a preliminary project-specific WQMP application for review early in the project development process to ensure compliance with all jurisdictional requirements applicable to development projects (Permit Section XI.D.3). A Preliminary WQMP may be used by the local jurisdiction during the land use entitlement process or as part of a project application for discretionary project approval. The level of detail and content of the preliminary WQMP submittal depends to a large degree on the nature of the project and local jurisdictional requirements.

The LIP applicable to the project area provides specific information regarding preliminary WQMP submittal process. This document should be consulted prior to initiating development of the WQMP.

2.5 Final WQMP Submittal

A completed Final WQMP shall fully address site design measures, LID BMPs, hydromodification controls, source control BMPs, and treatment control BMPs (where applicable to the project) to address pollutants or hydrologic conditions of concern. If the project proponent has demonstrated the infeasibility of use of the aforementioned BMPs, and is participating in an alternative compliance plan such as a contribution to an in-lieu fund (if available) or mitigation program, the WQMP must describe and document the Project's participation. The Final WQMP, when prepared for submittal for approval, must be certified by the owner, and must include elements agreed upon at Preliminary WQMP acceptance and any revisions proposed.

The Final WQMP must be consistent with the Preliminary WQMP. If there are any substantial differences, the local jurisdiction must make a determination that the differences do not diminish the effectiveness of the BMPs to mitigate or address the project's potential impacts to water quality. Furthermore, any changes must not result in any new environmental impacts not previously disclosed in the local jurisdiction's circulated environmental document(s). If the changes diminish the project's ability to mitigate or address its water quality impacts, or result in previously undisclosed environmental impacts, the local jurisdiction should require that the project be subject to further environmental review.

The completed WQMP is to be submitted to the local jurisdiction for review and approval. Any changes to WQMP elements agreed upon at the Preliminary WQMP phase shall be noted within the WQMP submitted for final approval. Local jurisdiction staff will review the submittal for acceptance and approval. Reviews will be documented by the local jurisdiction. Additional information and submittals may be necessary for final approval. It is the responsibility of the project proponent to provide the additional information for consideration by the local jurisdiction.

Section 3 – Project Evaluation

3.1 Introduction

The purpose of this section is to describe the site and project information requirements needed to determine applicable LID and HCOC performance criteria and select and evaluate runoff capture in proposed BMPs. This information includes site-specific data as well as regional watershed or jurisdictional plans or requirements. Project evaluation involves several key steps, including:

- Assess site conditions
- Determine pollutants of concern (POC)
- Determine HCOC
- Identify requirements associated with a regional watershed or local jurisdiction that may affect project planning

Table 3-1. Key Sources of Information for use in Completing a WQMP Project Evaluation

Source	Key Information and Intended Use(s)
Watershed Geodatabase (*http://sbcounty.permitrack.com/WAP/*)	Downstream receiving waterbodies, downstream HCOC, NRCS soil properties, ecologically sensitive areas
RWQCB TMDL Webpage (*http://www.waterboards.ca.gov/santaana/water_issues/programs/tmdl/index.shtml*)	Downstream adopted TMDLs, planned TMDLs, and 303(d) listed impairments for Santa Ana River Watershed receiving waterbodies
NRCS Web Soil Survey (*http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm*)	General soil and geologic properties
NPDES Permit No. CAS618036 (Order No. R8-2010-0036) for San Bernardino County Permittees within the Santa Ana Watershed Region (*http://www.waterboards.ca.gov/santaana/board_decisions/adopted_orders/orders/2010/10_036_SBC_MS4_Permit_01_29_10.pdf*)	Basis for project evaluation guidance, regulatory background for WQMP requirements
County of San Bernardino Hydrology Manual (*http://www.sbcounty.gov/dpw/floodcontrol/pdf/HydrologyManual.pdf*) and Addendum (*http://www.sbcounty.gov/dpw/floodcontrol/pdf/20100412_addendum.pdf*)	Storm event characterization, runoff and HCOC analyses

Several key references are necessary to develop the information required for project evaluation, as summarized in Table 3-1. In addition, information will need to be obtained from project planning documents, information searches and field surveys as necessary for assessing topography, soil characteristics, drainage patterns, and potential environmental concerns. Section 3 of the WQMP Template includes forms to insert information that describes the site location and drainage features, hydrologic characteristics, and regional watershed.

3.2 Site Assessment

Information gathered through site assessment facilitates computations of selected LID and HCOC BMPs performance relative to the criteria including runoff volume, time of concentration, peak runoff as well as computations of runoff capture of various proposed BMPs.

The review of existing information and the collection of site-specific measurements also identifies conditions that could prohibit the use of specific types of LID BMPs. Site assessments must include available information regarding site slope, soil type, geotechnical conditions, and local groundwater conditions, and how potential site layout and site design concepts can be adapted to these conditions as discussed below. In addition, soil and infiltration testing may be necessary to determine if stormwater infiltration is feasible and to determine the appropriate design infiltration rates for infiltration-based BMPs.

The County of San Bernardino Stormwater Management Program (Program) has completed an on-line watershed Geodatabase (*http://sbcounty.permitrack.com/wap*), including HCOC map, that will be a valuable tool in the project evaluation process. This web-based tool includes site assessment related data information as well as helpful links to background regulatory and technical documents. These components include information such as:

- GIS layers that include land use, topography, drainage subwatersheds, soils, and other groundwater data, etc.
- Delineation of existing channels that are engineered, hardened, and maintained as well as soft-armored or unarmored waterbodies that may be vulnerable to hydromodification
- GIS layers that include known sensitive species, protected habitat areas, and potential stormwater recharge areas

3.2.1 Project Location

The location of a project is important to establish what local jurisdictional conditions and requirements apply to the project and to understand where the project is located in relation to downstream receiving waters.

The project location is also used to obtain information needed for several important calculations necessary for completion of a WQMP. Site coordinates are used to identify the design storm depth to be used in determining LID and HCOC performance criteria from NOAA Atlas isohyet maps (*http://hdsc.nws.noaa.gov/hdsc/pfds/sa/sca_pfds.html*).

The project location includes the climatic region of the site; valley, mountain, or desert. The climatic region for the project site characterizes distinct rainfall patterns that occur in these regions, which influences several WQMP calculations, as described below:

- Calculation of the DCV to meet LID performance criteria relies on a coefficient that is a function of the climatic region. The coefficients for each climatic region are shown in Table 3-2.
- Extrapolation of the 2-year return period, 1-hour rainfall hourly rainfall for sites with sub-hourly time of concentration for use in estimating peak runoff rate for HCOC performance criteria uses a slope that is a function of climatic region. The San Bernardino County Hydrology Manual provides intensity duration curves on a log-log scale to extrapolate sub-hourly rainfall intensity. The log-log slope of the extrapolated curve is different for different climatic regions (Table 3-2).
- Estimation of the necessary flow-through capacity to treat the portion of the DCV that is not retained on-site for sizing of flow-based BMPs (LID biotreatment BMPs with discharge or non-LID treatment BMPs). This process is described in Section 5.4.4.2.
- The project location is also the starting point in compiling other information such as topographic, soils, hydrology, and groundwater data, which vary spatially across San Bernardino County. These information types are discussed in the following sections.

Table 3-2. Coefficients for WQMP Development Influenced by Climatic Region

Variables	Valley	Mountain	Desert
Coefficient used in P_6 Method	1.4807	1.909	1.2371
Log-Log slope for extrapolating sub-hourly rainfall intensity	0.6	0.7	0.7

3.2.2 Site Topography and Hydrography

Site topography needs to be assessed to evaluate surface drainage patterns, high and low points, and identify slopes. Hydrographic calculations necessary for estimating pre- and post-development time of concentration rely upon two key variables that require understanding of the existing and proposed site topography and drainage patterns including the length of the flowpath from the furthest upstream point of a site to its outlet (use longest flowpath if more than one exists) and the difference in elevation along the longest flowpath (see Section 4.2.2). The use of the San Bernardino County Hydrology Manual time of concentration nomograph (Appendix C-1) requires these data inputs.

Selection of site design LID BMPs require an understanding of how stormwater runoff flows at a project site to be able to evaluate potential areas for siting LID BMPs, including impervious area dispersion, runoff capture, retention, or treatment and release. Selection of BMPs must also consider the location and elevation of existing drainage structures to ensure appropriate connections to the local MS4 system.

Preliminary assessment data can be collected through visual observations, but a topographic survey is required to provide sufficient detail for 1-foot contours.

The pre- and post-development topography and post-developed conveyance features may require delineation of multiple drainage management areas (DMAs), which may be routed to a single or multiple discharge points from the project site to the MS4. DMAs are portions of a site that drain to the same BMPs and/or conveyance facility. Projects that require phasing of construction activities should delineate separate DMAs for each phase of the development project. The networking of DMAs, on-site conveyance, and discharge points must be shown in the site plan and in a simple schematic format as shown in Form 3-1 of the WQMP Template.

The pre- and post- development project site will be, as necessary, divided into distinct Drainage Areas (DA). A Drainage Area is the area of the Project site that drains to a specific outlet. If the Project site has two outlets then the site will, by definition, have two DAs. Each DA will be further subdivided into Drainage Management Areas (DMAs) based on land cover type and HSG. If a DA has three distinct land cover types, then the DA will have three DMAs that must be accounted for in the calculations. By definition, the sum of the areas of the DMAs will total the area of the DA, and the sum of the areas of the DA will total the Project site area listed in Item 2 of Form 2.1-1 of the WQMP Template. Projects that require phasing of construction activities should delineate separate DMAs for each phase of the development project. The networking of DAs and DMAs, on-site conveyance, and discharge points must be shown in the site plan and in a simple schematic format as shown in Form 3-1 of the WQMP Template.

3.2.3 Soils and Geologic Conditions

Characterization of soil conditions is required to determine a project site's suitability to infiltrate stormwater runoff. If it is determined that infiltration is feasible, then soils data is necessary to estimate the percolation rate for determining the retention volume that can be achieved with proposed BMPs. Initial review of general soils data such as from the National Resources Conservation Service (NRCS) as well as site-specific soil information assessments conducted onsite are required to understand the characteristics and ability of soils to infiltrate runoff. Section 5.3.2 describes criteria for determining conditions under which infiltration BMPs are not considered feasible as a result of soils and geologic condition and therefore not required to be considered in WQMP as a result of soil characteristics and other factors.

The NRCS categorizes soil types as hydrologic soil group (HSG) A, B, C, or D, with the capacity to percolate water greatest in type A soils and lowest in type D soils. The San Bernardino County Hydrology Manual incorporates the HSG in estimating of both runoff volume and peak runoff from a drainage area, which are HCOC performance criteria (see Section 5.4.2).

Geologic assessments are required to evaluate and consider the project site's depth to water table, depth to bedrock, and susceptibility to landslides. Understanding the soils and geologic conditions is critical for design considerations such as placement of buildings and impervious surfaces.

3.2.4 Groundwater Considerations

Site assessment relative to groundwater characteristics includes an evaluation of groundwater levels. Several types of LID BMPs are prohibited from consideration for sites overlying a seasonal high groundwater table. Similarly, project sites overlying areas groundwater or soil contamination limit or prohibit the consideration of LID BMPs that rely on infiltration for inclusion in WQMP. Section 5.3.2 describes criteria for determining if infiltration BMPs are prohibited as a result of groundwater characteristics.

3.2.5 Environmental Concerns

Identification of sensitive areas on a project site is required since these areas potentially fall under the regulatory purview of other agencies such as the Army Corps of Engineers or California State Department of Fish and Game (DFG). For instance, a proposed project may lie within a conservation or mitigation easement area identified in a Multiple Species Habitat Conservation Plan (MSHCP) that has identified key species and associated habitats. Sensitive or restricted areas may also include wetlands and floodplains. A site assessment also requires review of existing or historical vegetative plant communities and invasive species. Other concerns that may impact the placement of LID BMPs may include contaminated soil and groundwater or buried storage tanks.

3.2.6 Existing Development and Utilities

A clear understanding of site conditions requires knowledge of existing development conditions and utilities since they may limit the placement of LID BMPs and affect site design. For redevelopment projects, existing as-built plans are valuable documents to review to compare against actual site conditions when identifying site features such as buildings and structures, parking lots, roads, landscaped areas, and underground utilities.

In addition, the quality of existing land cover is an important factor in developing a WQMP. The San Bernardino County Hydrology Manual incorporates a 'quality of cover' rating system in estimating of both runoff volume and peak runoff from a DMA, which are HCOC performance criteria (see Sections 4.2.1 and 4.2.3).

Setting a pre-developed quality of cover rating requires field investigation and use of best professional judgment. Vegetation at a site can change dramatically between the wet and dry seasons, therefore assessments of quality of cover that take place toward the end of the dry and beginning of the wet season require observation of plants in a dormant state. These plants still provide similar soil stabilization benefits as during the growing season.

3.3 Pollutants of Concern

Site assessments involve identification of specific pollutants of concern that could be expected from implementation of the Priority Project. Urban runoff mobilizes pollutants that have accumulated on surfaces of developed sites and has the potential to impact the receiving waters downstream of the development site. Typical urban runoff pollutants of concern include microbial pathogens (bacteria and viruses), metals, nutrients, toxic organic compounds, suspended solids/sediment, trash and debris, and oil and grease. Specifically pollutants include:

- ***Pathogens (Bacteria Indicators/ Virus)*** – Bacteria and viruses are ubiquitous microorganisms that thrive under certain environmental conditions. Their proliferation is typically caused by the transport of animal or human fecal wastes from the watershed. Water, containing excessive bacteria and viruses, can alter the aquatic habitat and create a harmful environment for humans and aquatic life. Also, the decomposition of excess organic waste causes increased growth of undesirable organisms in the water.
- ***Metals*** – The primary source of metal pollution in stormwater is typically commercially available metals and metal products, as well as emissions from brake pad and tire tread wear associated with driving. Primary metals of concern include cadmium, chromium, copper, lead, mercury, and zinc. Lead and chromium have been used as corrosion inhibitors in primer coatings and cooling tower systems. Metals are also raw material components in non-metal products such as fuels, adhesives, paints, and other coatings. At low concentrations naturally occurring in soil, metals may not be toxic. However, at higher concentrations, certain metals can be toxic to aquatic life. Humans can be impacted from contaminated groundwater resources, and bioaccumulation of metals in fish and shellfish.

Environmental concerns, regarding the potential for release of metals to the environment, have already led to restricted metal usage in certain applications.

- ***Nutrients*** – Nutrients are inorganic substances, such as nitrogen and phosphorus. Excessive discharge of nutrients to water bodies and streams causes eutrophication, where aquatic plants and algae growth can lead to excessive decay of organic matter in the water body, loss of oxygen in the water, release of toxins in sediment, and the eventual death of aquatic organisms. Primary sources of nutrients in urban runoff are fertilizers and eroded soils.
- ***Organic Compounds*** – Organic compounds are carbon-based. Commercially available or naturally occurring organic compounds are found in solvents and hydrocarbons. Organic compounds can, at certain concentrations, indirectly or directly constitute a hazard to life or health. When rinsing off objects, toxic levels of solvents and cleaning compounds can be discharged to storm drains. Dirt, grease, and grime retained in the cleaning fluid or rinse water may also adsorb levels of organic compounds that are harmful or hazardous to aquatic life. Sources of organic compounds may include waste handling areas and vehicle or landscape maintenance areas.
- ***Pesticides / Herbicides*** – Pesticides and herbicides are organic compounds used to destroy and/or prevent insects, rodents, fungi, weeds, and other undesirable pests. Pesticides and herbicides can be washed off urban landscapes during storm events.
- ***Sediments / Suspended Solids*** – Sediments are solid materials that are eroded from the land surface. Sediments can increase turbidity, clog fish gills, reduce spawning habitat, lower survival rates of young aquatic organisms, smother bottom dwelling organisms, and suppress aquatic vegetation growth.
- ***Trash and Debris*** – Trash (such as paper, plastic, polystyrene packing foam, and aluminum materials) and biodegradable organic matter (such as leaves, grass cuttings, and food waste) are general waste products on the landscape. The presence of trash and debris may have a significant impact on the recreational value of a water body and aquatic habitat. Trash also impacts water quality by increasing biochemical oxygen demand.
- ***Oil and Grease*** – Oil and grease in water bodies decreases the aesthetic value of the water body, as well as the water quality. Primary sources of oil and grease are petroleum hydrocarbon products, motor products from leaking vehicles, esters, oils, fats, waxes, and high molecular-weight fatty acids.

3.3.1 Land Use and Potential Pollutants of Concern

The WQMP must identify all pollutants that are expected to be generated from the proposed project. Site-specific conditions must also be considered as potential pollutant sources, such as legacy pesticides or nutrients in site soils as a result of past agricultural practices or hazardous materials in site soils from industrial uses. Hazardous material sites that have been remediated and do not pose a current threat, and will not pose a future threat to stormwater quality, are not considered a pollutant of concern. Table 3-3 provides guidance for determining expected pollutants of concern and lists those pollutants that are typically associated with the project categories and land use types. The selection of BMPs that involve treatment and release of runoff from the site to downstream waters must effectively mitigate associated pollutants of concern for a proposed project.

Table 3-3. Pollutants of Concern for Project Categories and Land Uses

Priority Project Categories and/or Project Features		General Pollutant Categories							
	Pathogens (Bacterial / Virus)	Metals	Nutrients / Noxious Aquatic Plants	Organic Compounds	Pesticides / Herbicides	Sediments / Total Suspended Solids / pH	Trash & Debris	Oxygen Demanding Compounds	Oil & Grease
Detached Residential Development	E	N	E	E(1)	E	E	E	E(1)	E
Attached Residential Development	E	N	E	E(1)	E	E	E	E	E(2)
Commercial / Industrial Development	E(3)	E	E(1)	E(1,4)	E	E(1)	E	E(1)	E
Automotive Repair Shops	N	E	N	E(1,3,4)	E	N	E	E(1)	E
Restaurants (>5,000 ft^2)	E	E(2)	E(1)	E(1)	E	E(1)(2)	E	N	E
Hillside Development (>5,000 ft^2)	E	N	E	E(1)	E	E	E	E	E
Parking Lots (>5,000 ft^2)	E(5)	E	E(1)	E(3)	E	E(1)	E	E(1)	E
Retail Gasoline Outlets	N	E	N	E(3)	E	N	E	E(1)	E

E = Expected to be a concern in stormwater runoff
N = Not expected to be a concern in stormwater runoff
(1) Expected pollutant if landscaping exists on-site; otherwise not expected.
(2) Expected pollutant if the project includes uncovered parking areas; otherwise not expected
(3) Including petroleum hydrocarbons
(4) Including solvents
(5) Bacterial indicators are routinely detected in pavement runoff

3.3.2 Expected Pollutants of Concern

The WQMP must list all identified pollutants of concern that are expected to be generated by the project and compare this with the list of pollutants for which the receiving waters are impaired. To identify pollutants of concern in receiving waters, each project proponent shall reference Table 3-3 and Table 3-4 to determine if any pollutants expected to be generated by the project are also listed as causing impairments of downstream receiving waters for the project.

3.3.3 Receiving Water Impairments and TMDLs

For each of the proposed project discharge points, the Priority Project proponent shall identify the proximate receiving water for each point of discharge and all downstream receiving waters, using the HCOC Map and Watershed Geodatabase developed for the WAP. For all downstream receiving waters identified, determine if they are listed on the most recent list of CWA Section 303(d) impaired water bodies or have an effective, adopted or planned TMDL. Table 3-4 lists the current impaired receiving water bodies. Project proponent shall check with the RWQCB and State Water Resources Control Board for updates to the 303(d) list of impaired water bodies with adopted TMDLs within the Santa Ana River Watershed Region (http://www.waterboards.ca.gov/water_issues/programs/tmdl/). For identified pollutants of concern that are causing an impairment in receiving waters, the Project WQMP shall incorporate LID BMPs that fully retain stormwater, or provide medium or high effectiveness in reducing pollutants prior to release, if on-site retention is infeasible.

Table 3-4. Summary of Impairments to Receiving Waterbodies (2010) in San Bernardino County

Water Body	Pollutant								
	Pathogens (Bacterial Indicators / Virus)	Metals	Nutrients	Sedimentation / Siltation	Noxious Aquatic Plants	Total Suspended Solids (TSS)	Chemical Oxygen Deman	pH	Polychlorinated biphenyls
Big Bear Lake		X	X		X				X
Chino Creek Reach 1A	X		X						
Chino Creek Reach 1B	X		X				X		
Chino Creek Reach 2	X							X	
Cucamonga Creek, Reach 1	X	X							
Cucamonga Creek, Reach 2								X	
Grout Creek			X						
Knickerbocker Creek	X								

Lytle Creek	X								
Mill Creek (Prado Area)	X		X			X			
Mill Creek Reach 1	X								
Mill Creek Reach 2	X								
Mountain Home Creek	X								
Mountain Home Creek, East Fork	X								
Prado Park Lake	X		X						
Rathbone (Rathbun Creek)		X	X	X					
Santa Ana River, Reach 3	X	X							
Santa Ana River, Reach 4	X								
Summit Creek			X						

For identified pollutants of concern that are causing an impairment in receiving waters, the Project WQMP shall incorporate LID BMPs that fully retain stormwater, or provide medium or high effectiveness in reducing pollutants prior to release, if on-site retention is infeasible.

3.4 Hydrologic Conditions of Concern

A WQMP is required to address the potential for causing or contributing to HCOC from project development. Conditions that demonstrate a project does not have the potential to cause or contribute to a downstream HCOC are found in Permit Section XI.E.5.d.ii. In addition, if your project meets one of the following criteria indicated below, you do not need to address Hydromodification at this time.

Additional HCOC Exemption Criteria:

1. Sump Condition: All downstream conveyance channels to an adequate sump (for example, Prado Dam, Santa Ana River, or other Lake, Reservoir or naturally erosion resistant feature) that will receive runoff from the project are engineered and regularly maintained to ensure design flow capacity; no sensitive stream habitat areas will be adversely affected; or are not identified on the Co-Permittees Hydromodification Sensitivity Maps.
2. Pre = Post: The runoff flow rate, volume and velocity for the post-development condition of the Priority Development Project do not exceed the pre-development (i.e, naturally occurring condition) for the 2-year, 24-hour rainfall event utilizing latest San Bernardino County Hydrology Manual.
    a. Submit a substantiated hydrologic analysis to justify your request.
3. Diversion to Storage Area / Controlled Release Point: The DMAs drain to water storage areas which are considered as controlled release points and utilized for water conservation.

   a. See Appendix F for the HCOC Exemption Area Map and the on-line Watershed Geodatabase (*http://sbcounty.permitrack.com/wap*) for reference.

4. Less than One Acre: The Priority Development Project disturbs less than one acre. The Co-permittee has the discretion to require a Project Specific WQMP to address HCOCs on projects less than one acre on a case by case basis. The project disturbs less than one acre and is not part of a common plan of development.
5. Built Out Area: The contributing watershed area to which the project discharges has an impervious area percentage greater than 90 percent.
   a. See Appendix F for the HCOC Exemption Map and the on-line Watershed Geodatabase (*http://sbcounty.permitrack.com/wap*) for reference.

3.4.1 Susceptibility of Receiving Waters to Hydromodification Impacts

New development typically results in an increased proportion of impervious surfaces on the project site, or conversely reduction in the proportion of porous or pervious surface at the project site, and changes to the drainage network. Common changes to the hydrologic regime resulting from development include increased runoff volume and velocity, reduced infiltration, increased flow frequency, flow duration, peak flow, and faster time to reach peak flow. If the project covers pre-developed natural sediment source areas with impervious surfaces, or otherwise modifies these sediment source areas, the amount of sediment available for transport in downstream flows may be reduced. Storm runoff could fill this sediment-carrying capacity by eroding a downstream channel, resulting in excessive erosion, excessive sedimentation, or both, in downstream reaches. These changes have the potential to adversely impact downstream channels and habitat integrity. A change to the hydrologic regime would be considered an HCOC if the change would have a significant adverse impact on downstream natural channels and habitat integrity, alone or in conjunction with impacts of other projects.

3.4.2 Expected Hydrologic Conditions of Concern

As part of the development of a WAP for the County of San Bernardino (an MS4 Permit requirement), an HCOC Map and Watershed Geodatabase has been developed that delineates existing unarmored or soft-armored drainages in the permitted area that are vulnerable to geomorphology changes due to hydromodification. Initial mapping of HCOC in the Santa Ana River watershed was included in the WAP Phase 1 document, submitted to the RWQCB on January 29, 2011. Once the WAP is approved, the HCOC identified in the Watershed Geodatabase will provide the basis for determining if a proposed project is located upstream of a waterbody that requires protection from hydromodification.

If the proposed project is determined to have the potential to cause or contribute to a downstream HCOC, then the WQMP must address both LID and HCOC performance criteria (see Sections 4.3.1 and 4.3.2). Section 5.5 provides guidance on selection and evaluation of BMPs for addressing HCOC performance criteria. Conversely, if the project is not within a region upstream of a HCOC, then only LID performance criteria (see Section 4.3.1) and associated BMP selection and evaluation steps apply.

3.5 Regional Stormwater Management

Regional efforts to manage watersheds in an integrated manner are underway in San Bernardino County through the development of a WAP. Section XI.B.1 of the MS4 Permit states that:

> *The Permittees shall develop an integrated watershed management approach to improve integration of planning and approval processes with water quality and quantity control measures. Management of the water quality and hydrologic impacts of urbanization will be more effective whether managed on a per site, sub-regional, or regional basis, if coordinated within the WAP.*

Therefore, in some project locations, the WAP may designate sub-regional and/or regional LID BMPs that provide effective water quality and quantity management when on-site LID BMPs are ineffective at achieving LID DCV and HCOC requirements. Under such circumstances, the Project proponent will need to demonstrate, through their infeasibility analysis, that the use of regional BMPs is more effective based on all of the following criteria:

- The sub-regional/regional LID BMPs is sited and designed such that it will provide greater overall benefit than would be achieved by on-site LID BMPs, including combined considerations of pollutant loading, hydrologic loading, groundwater recharge, potable water demand, and Smart Growth goals.
- The sub-regional/regional LID BMPs are located such that runoff from the project would be conveyed to the BMPs prior to discharge to any Waters of the US. However, stormwater runoff from an individual project may be conveyed to a regional treatment system via receiving waters if the pollutants in the runoff have been controlled on-site using LID techniques to the MEP and beneficial uses of the receiving water have not been impacted.
- The sub-regional/regional LID BMPs are sufficiently sized to retain or biotreat runoff from the project in addition to runoff from other upstream drainage areas.
- The sub-regional/regional LID BMPs will be adequately maintained for the life of the project and the sub-regional/regional BMPs will be constructed and operational to serve the project once the project is complete.

To participate in an approved regional LID BMP, the project WQMP must also include an analysis to verify that the criteria used to demonstrate greater effectiveness in a regional LID BMP are maintained throughout the watershed at the time of project completion. For example, if more development occurs within the watershed than estimated, then the capacity of the regional LID BMPs may not be sufficient to mitigate the DCV of a development project.

The use of regional or sub-regional BMPs could require multiple jurisdictions and project proponents within a watershed to develop a watershed-based management strategy to be implemented on a jurisdictional basis. The WAP will identify regional opportunities and a framework for implementation. There may be multiple implementation scenarios among various jurisdictions that will need to be worked out on a case by case basis. As an example of implementing LID on a regional basis, several individual developments potentially in conjunction with other agencies could propose a project that incorporates LID BMPs to address stormwater runoff from all the developments collectively. Examples of regional BMPs would be the use of a regional infiltration basin, regional wetland, or groundwater injection and/or recharge facility as a total project or in conjunction with distributed swales and bioretention areas within the developments or at the regional site.

Section 4 – Project-Specific Performance Criteria

Performance criteria must be established for each Priority Project requiring a WQMP. MS4 Permit Section XI.D.6 prescribes performance criteria for managing the LID water quality control volume and Section X1.E.5 prescribes criteria for projects that have potential to cause a HCOC. The computed performance criteria are the basis for determining the extent of LID and hydromodification BMPs needed for a proposed project. Although the requirements for LID and HCOC are stated independently in the MS4 Permit, and the Project WQMP must also demonstrate compliance with each requirement (LID and HCOC) separately, these provisions overlap significantly and some best management practices may fulfill a portion of one or more of each of the requirements.

The following instructions address LID performance criteria (Section 4.1) separately from HCOC mitigation requirements (Section 4.2). Section 4.3 provides example case studies for implementing these concepts.

For non-Priority / non-Category projects, the Project proponent is not required to address HCOC mitigation requirements. However, they may be required to implement source and site control BMPs and other LIP requirements, as determined by the local jurisdiction. The proponent will complete the applicable sections and forms in the WQMP template (typically, Sections 1, 2 and 3 and Forms 4.1-1, 4.1-2 and 4.1-3) as directed by the local jurisdiction.

The Project site will be, as necessary, divided into distinct Drainage Areas (DA). A Drainage Area is the area of the Project site that drains to a specific outlet. For example, if the Project site has two outlets then the site will, by definition, have two DAs. Each DA will be further subdivided into Drainage Management Areas (DMAs) based on land cover type and HSG. For example, if the DA has three distinct land cover types, then the DA will have three DMAs that must be accounted for in the calculations. By definition, the sum of the areas of the DMAs will total the area of the DA, and the sum of the areas of the DA will total the Project site area listed in Item 2 of Form 2.1-1 of the WQMP Template.

If the Project site has two or more runoff outlets, the Project proponent will complete the HCOC and DCV analysis for each corresponding DA (using the applicable forms).

4.1 LID Performance Criteria

The combined runoff capture from the Project's proposed BMPs must equal or exceed volume-based BMP performance criteria (MS4 Permit Section XI.D.6). Volume-based performance criteria are used as the measure of the overall effectiveness of the LID BMPs. The MS4 Permit requires that volume-based LID BMPs be evaluated first. Flow-based BMPs may only be used after on-site retention and infiltration and volume-based biotreatment BMPs have been implemented to the MEP.

Implementation of BMPs shall follow the LID BMP hierarchy of use (Figure 5-1). The Project Proponent shall evaluate and incorporate LID site design components, hydrologic source controls (HSC), harvest and use BMPs, retention and infiltration BMPs, and, finally, biotreatment BMPs to mitigate the DCV associated with each individual DA on the project site. Section 5.5 provides guidance on the determination of the feasibility and optimization of BMP implementation. If the combination of hydrologic source controls (HSC), retention and infiltration, and harvest and use BMPs are unable to mitigate the entire DCV, then biotreatment BMPs may be implemented by the project proponent for the balance of the DCV. If flow-based biotreatment BMPs are used, then they must be sized to provide sufficient capacity for effective treatment of the remainder of the volume-based performance criteria that cannot be achieved with retention BMPs (TGD for WQMP Section 5.4.4.2). Under no circumstances shall any portion of the DCV be released from the site without effective mitigation and/or treatment.

Section XI.D.6.a of the MS4 Permit includes four alternatives for computing the design capture volume for development of sizing for proposed LID features and other BMPs, if necessary. Of the four, the Program has selected the following criterion for use:

> *The volume of annual runoff produced from a 24-hour, 85th percentile storm event determined as the maximum capture storm water volume for the area, from the formula recommended in Urban Runoff Quality Management, WEF Manual of Practice No. 23/ASCE Manual of Practice No. 87 (1998).*

This alternative was selected for use because of its ease of application, effective management of spatial variability in rainfall by using NOAA isohyetal maps, and status as the prescribed method used for WQMPs prepared since 2005. For the purposes of preparing this WQMP, the 24-hour, 85th percentile storm event shall be equivalent to the calculated DCV, as follows.

This alternative employs two regression equations to convert watershed imperviousness to a runoff coefficient and convert average rainfall event depth (based on a 6-hour inter-event time to identify distinct storm events) to a maximized water quality capture volume (WEF/ASCE, 1998). The maximized water quality capture volume is referred to as the DCV and this term will be used throughout the San Bernardino County WQMP. Computation of the DCV for a potential project involves five steps as shown below:

- Step 1 – Compute the area, in square feet, for each Project Site DA
- Step 2 – Compute the DA runoff coefficient as a function of DA imperviousness (i), using the following regression equation (ASCE and WEF, 1998):

$$C = 0.858 * i^3 – 0.78 * i^2 + 0.774 * i + 0.04$$

- Step 3 – Identify the 2-year, 1-hour rainfall depth for the DA from the NOAA Atlas 14 isohyet map. The following webpage can be used to extract interpolated point rainfall from NOAA Atlas 14 isohyets:

  http://hdsc.nws.noaa.gov/hdsc/pfds/sa/sca_pfds.html

- Step 4 – Compute the P6 mean storm rainfall depth in inches for the DA by multiplying the 2 year, 1-hr rainfall depth by the appropriate coefficient (a_1) for the San Bernardino County climatic region (Valley = 1.4807, Mountain = 1.909, or Desert = 1.2371):

$$P_6 = P_{2yr,1hr} * a_1$$

- Step 5 – Calculate the design capture volume (DCV), in cubic feet, as a function of the total DA, in square feet; the runoff coefficient (C), the P6 rainfall depth, in inches; and the regression constant to account for drawdown time (a_2 = 1.582 for 24-hr drawdown, or 1.963 for 48-hr drawdown). Drawdown time is the maximum amount of time that runoff can be stored in a BMP to ensure sufficient capacity to treat subsequent storm events. The following equation computes the DCV:

$$DCV = DA * C * a_2 * P_6 / 12$$

Section 5.3.1 describes specific preventative site design principles that reduce the amount of runoff generated from a project site. Accordingly, computation of a DA's DCV using the P_6 method shown above requires input of post-developed imperviousness, which may be lower than traditional values as a result of the implementation of site design LID principles.

4.2 HCOC Performance Criteria

Not all potential projects will need to address HCOCs as discussed in Section 3.4. MS4 Permit Section XI.E.5d specifies conditions that would result in a project having the potential to cause an HCOC (see discussion in Section 3.4). If the project has potential to cause a HCOC, as determined in the project evaluation step, performance criteria to assess the effectiveness of a WQMP in mitigating HCOC impacts from the project involve comparing pre-development site hydrology with post-development site hydrology. MS4 Permit Section XI.E.5d provides specific metrics of compliance with the MS4 Permit requirements for HCOC, as follows:

- Post-development runoff volume, time of concentration, and peak flow velocity for the 2-year frequency storm does not exceed that of the pre-development condition by more than five percent.

To determine the proposed project's drainage characteristics, the project engineer must compute pre- and post-development hydrology for a 24-hour design storm event with a 2-yr return period. Each of the following hydrologic variables (runoff volume, time of concentration and peak flow velocity) must be demonstrated to not have changed by more than five percent as a result of the proposed development activity. The LID BMPs included in the WQMP will contribute to meeting HCOC requirements. The volume of runoff retained in LID BMPs serves to reduce the volume computed for the post-developed condition for a 2-year, 24-hour storm event. LID BMPs will also substantially affect the post-developed condition runoff hydrograph, including the time of concentration and peak runoff. HCOC performance criteria for time of concentration and peak runoff require matching of pre- and post- developed conditions within five percent. Longer time of concentration and lower peak runoff generally results in lower concern for hydromodification impacts. It may not be physically possible for a project to implement BMPs consistent with LID provisions of the MS4 Permit without increasing the time of concentration of a site and reducing peak runoff by more than five percent. Therefore, it is interpreted that the five percent post-developed hydrology matching criteria only applies to decreases in time of concentration and increases in peak runoff.

The governing document for discrete hydrologic analysis in San Bernardino County is the San Bernardino County Hydrology Manual (SBCFCD, 1986). The following sections provide guidance for conducting calculations, using Forms 4.2-2 through 4.2-5 of the WQMP Template, for each of the HCOC performance criteria. Additional details are also available in the San Bernardino County Hydrology Manual in the following sections:

- Runoff volume - Section J for drainage areas less than 10 acres or Section E for drainage areas greater than 10 acres;
- Time of concentration - Section D.3 for drainage areas less than 640 acres or Section E for drainage areas greater than 640 acres;
- Peak flowrate - Section D.1 for drainage areas less than 640 acres or Section E for drainage areas greater than 640 acres.

As an alternative for performing the manual calculations on each of these forms, a project proponent may, with the approval of the reviewing jurisdiction, replace Forms 4.2-3 through 4.2-5 by computer software analysis based on the San Bernardino County Hydrology Manual.

4.2.1 Runoff Volume

The method prescribed in the San Bernardino County Hydrology Manual for estimating runoff volume from a design storm event uses an empirical factor, the runoff curve number (CN), for estimating the portion of rainfall depth that is converted to runoff. High curve numbers indicate a high fraction of rainfall is expected to become runoff, as is the case for impervious surfaces such as pavement or rooftop areas, where a CN of 98 is assumed. Conversely, low CNs are assigned to areas designated as a natural land cover type with well drained soils, where the capacity for rainfall to percolate to groundwater is greater.

In the first step for calculating runoff volume, the project site is divided into DAs, which are further subdivided into DMAs based on land cover type and HSG. For each defined land cover type and HSG within a delineated DMA, determine the appropriate CN using Figure C-3 of the San Bernardino County Hydrology Manual (see Appendix C-2). Each column in Form 4.2-3 (WQMP Template) is used to represent the unique land cover type and HSG of each DMA (for projects with numerous DMAs, it may be necessary to incorporate additional columns into Form 4.2-3). Using the DMA areas and corresponding CNs, compute an area-weighted average CN for the entire project site (CN_{site}), using the following equation:

$$CN_{DA} = \sum_n [\ CN_{DMA} * Area_{DMA}\ ] / Area_{DA}$$

The area weighted CN for the site is then converted to a soil storage capacity (*S*) and initial abstraction (I_a) using the following equations;

$$S = (\ 1000 / CN_{DA}\ ) - 10$$

$$I_a = 0.2 * S$$

The initial abstraction is the depth of rainfall that is not available for surface runoff, by way of hydrologic processes such as infiltration, interception, or depression storage. In order to convert this estimate of initial abstraction to a runoff volume it is necessary to determine the design rainfall depth. The 2-year return period, 24-hour rainfall depth ($P_{2yr,24hr}$) for the project site is extracted using the NOAA Atlas 14 isohyetals found on their webpage (*http://hdsc.nws.noaa.gov/hdsc/pfds/sa/sca_pfds.html*). Runoff volume (*V*) from the site is then computed for both pre- and post- developed conditions using the following equation:

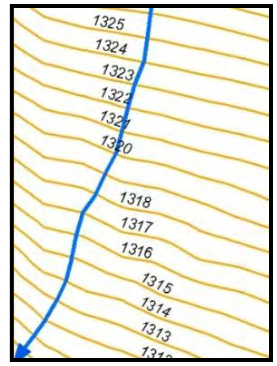
$$V = 1/12 * Area_{site} * (\ P_{2yr,24hr} - I_a\ )^2 / (\ P_{2yr,24hr} - I_a + S\ )$$

The above process shall be completed for both pre-development site conditions and post-development site conditions. A comparison of the runoff volume estimates using pre- and post-developed weighted CNs determines the runoff volume reduction necessary to achieve the HCOC performance criteria. The following equation computes the volume reduction that must be achieved using a combination of LID and hydromodification mitigation BMPs:

$$V_{HCOC} = 0.95 * V_{Post\text{-}developed} - V_{Pre\text{-}developed}$$

4.2.2 Time of Concentration

The time of concentration is the time after the beginning of rainfall when all points in a drainage area are contributing to discharge point(s). It is a measure of the timing of a hydrologic response to a rainfall event. The San Bernardino County Hydrology Manual determines the time of concentration for a project site by using a nomograph (Appendix C-1). Information needed to use the nomograph includes:



- Length of the longest flowpath across the site (see example flowpath for an undeveloped site to the right)
- Change in elevation along the longest flowpath across the site (in example to the right: 1326'-1310' = 16')
- Land cover type and percent imperviousness (undeveloped land cover also requires an assessment of the quality of cover – see section 3.2.6)

The nomograph is limited to DA that are less than 10 acres and with a maximum flowpath length of 1,000 feet. If the site is greater than 10 acres and/or has multiple DA, an additional step (described below) is needed to determine the total time of concentration. For each DA (must be less than 10 acres) the initial DA time of concentration is determined using the nomograph in Appendix C-1. The travel time from each DA outlet to the site discharge point is estimated using the Manning's channel flow velocity equation, shown below:

$$V_{ft/sec} = 1.49 * R^{(2/3)} * S^{(1/2)} / n \ ; \ R = A / P$$

Where n is a coefficient determined by the roughness of the channel bottom, R is the hydraulic radius, which equals the cross sectional flow area in ft^2 *(A)* divided by the wetted perimeter in ft *(P),* and S is the slope of the channel bottom.

The additional travel time from a DA outlet to the project site outlet is then simply the length of the channel ($L_{channel}$) in ft divided by the velocity of flow (*V)* in feet per second, as show in the equation below:

$$T_{minutes} = L_{channel} / (V \ ft/sec * 60 \ sec/min)$$

The time of concentration (T_c) is the sum of the initial DA time of concentration and the travel time to the site discharge point. For sites with multiple DA, the total time of concentration is equal to the longest of the DA-specific times of concentration. Comparison of the time of concentration estimates for pre- and post-developed conditions determines the additional time of concentration ($T_{c\text{-}HCOC}$) that must be provided to achieve HCOC performance criteria:

$$T_{c,HCOC} = 0.95 * T_{c,Pre\text{-}developed} - T_{c,Post\text{-}developed}$$

4.2.3 Peak Runoff

Performance criteria for peak flow velocity are developed to be protective of the downstream waterbody. Velocity in the receiving water or MS4 conveyance facilities just downstream of the discharge point will change with the type, size, and slope of receiving MS4 conveyance facilities prior to reaching the HCOC segment. In addition, inputs of runoff from other drainage areas affect downstream velocity. Thus, peak runoff (cfs) serves as a better criterion for maintaining pre-developed peak flow velocity downstream than the peak velocity at the project's discharge point. New conveyance facilities associated with a development must still comply with local flood control sizing requirements, which include design criteria based on flow velocity.

The San Bernardino County Hydrology Manual uses a form of the Rational Method to estimate peak flow (Q_p) from a DA. The equation is shown below:

$$Q_p = 0.9 * (I - F_m) * DA, \mathit{ft}^2 / 43{,}560\ \mathit{ft^2/acre}\ ;\ \ F_m = a_p * F_p$$

This form of the Rational Method estimates effective rainfall for runoff generation by subtracting the depth of rain expected to be infiltrated (F_m), referred to as the maximum loss rate. The sections below provide information regarding variables used in this equation.

Maximum Loss Rate

The variable F_m is equal to the infiltration capacity of soils on the project site (F_p) multiplied by the pervious fraction of the total site area (a_p). The site design determines the pervious fraction of the project site. The infiltration capacity of pervious areas is identified by using a nomograph in the San Bernardino County Hydrology Manual (Appendix C-3). Data needed to use the nomograph include pervious area CN and antecedent moisture conditions (AMC). For estimating peak runoff for HCOC performance criteria, AMC II is assumed for all portions of the area under the MS4 Permit.

Rainfall Intensity

The rainfall intensity variable (I) in the Rational Method equation is intended to represent the 2 year return period peak intensity for duration equal to the time of concentration for the project site. Because most project sites will have a time of concentration that is less than one hour, it is necessary to extrapolate NOAA Atlas 14 information for sub-hourly durations. The San Bernardino County Hydrology Manual employs an intensity-duration curve plotted on a Log-Log scale to perform the extrapolation (Appendix C-4). Project sites within the valley use a Log-Log slope of 0.6, while project sites in the Mountain or Desert climatic regions use a Log-Log slope of 0.7. Alternatively, the following equation can be used to estimate the rainfall intensity (I) for duration equal to the time of concentration (T_c);

$$I = 10 \wedge [\text{LOG } I_{2yr,\,1hr} - S_{log\text{-}log} * \text{LOG } (T_c / 60)]$$

Confluence Analysis

For project sites with more than one DA, estimation of peak runoff requires a Rational Method confluence analysis. If the time of concentration from all of the DA to the site discharge point were equal, then the peak runoff would simply be the sum of DA peak runoff estimates. When differences in time of concentration exist among DA, routed to same site discharge point, the peak runoff at the site discharge point (*Outlet* Q_p) is less than the sum of DA peak runoff rates due to different timing of runoff response from each upstream DA. The San Bernardino County Hydrology Manual provides a confluence analysis method for estimating peak runoff at the site discharge point (confluence of multiple DA) for two potential scenarios:

- DA with highest peak runoff has the longest time of concentration (sum of the initial DA time of concentration and the travel time to the site discharge point). Assuming DA-B has a higher peak runoff and longer time concentration than DA-A, peak runoff at the project site outlet is estimated using the following equation (subscripts indicate the DA reference ID):

$$\text{Outlet } Q_p = Q_2 + [\ Q1 * (\ I_2 - F_{m1}\ ) / (\ I_1 - F_{m1}\ )\ ]$$

- The DA with the highest peak runoff has the shortest time of concentration (sum of the initial DA time of concentration and the travel time to the site discharge point). Assuming DA-B has a higher peak runoff and shorter time concentration than DA-A, peak runoff at the project site outlet is estimated using the following equation (subscripts indicate the DA reference ID):

$$\text{Outlet } Q_p = Q_2 + [\ Q1 * (\ I_2 - F_{m1}\ ) / (\ I_1 - F_{m1}\ )\ ] * (\ T_{c2} / T_{c1}\ )$$

Comparison of the peak runoff estimates for pre- and post- developed conditions determines the peak runoff reduction necessary to achieve HCOC performance criteria ($Q_{p\text{-}HCOC}$). The following equation computes the peak runoff reduction needed with a combination of LID and hydromodification BMPs:

$$\text{Outlet } Q_{p\text{-HCOC}} = 0.95 * \text{Outlet } Q_{p,\text{Post-developed}} - \text{Outlet } Q_{p,\text{Pre-developed}}$$

4.3 Case Studies

Two case studies are presented to demonstrate the methodology for evaluating LID and HCOC performance criteria.

The first case study presents a 15-acre site with vacant land cover (Figure 4-1). Figure 4-1 also shows the site layout for Case Study 1 after construction. The proposed project will consist of a large commercial facility and parking lot. It was determined that there were no HCOCs associated with the proposed project.

The second Case Study presents a 6.7-acre site with vegetated land cover and canopy, as shown in Figure 4-2. Figure 4-2 also shows the site layout for Case Study 2 after construction. The site will consist of a low-density residential community with 15 dwelling units, a small pocket park, and an area reserved to preserve existing vegetation and drainage features. The project site is delineated into two hydrologically distinct DA, referred to as DA-A (2.8 acres) and DA-B (3.9 acres). Performance criteria are applied separately for each DA. This proposed project must address HCOC due to conditions in the downstream water body.

Figure 4-1. Case Study 1: Pre- (left) and Post- (right) Developed Site

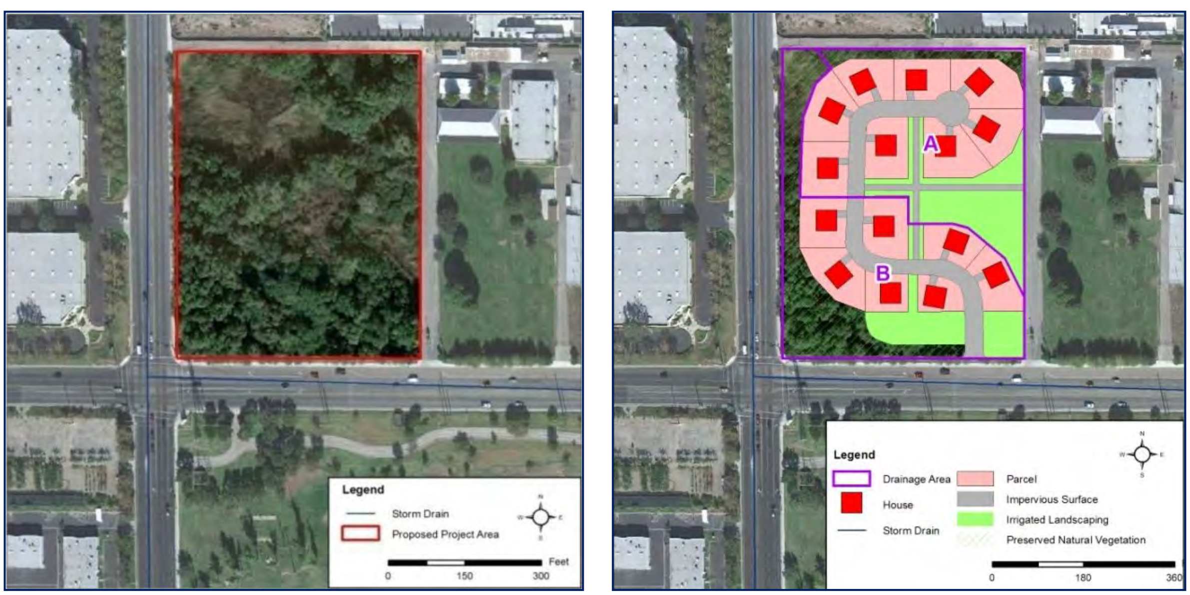


Figure 4-2. Case Study 2: Pre- (left) and Post- (right) Developed Site Layout

4.3.1 Case Studies - LID Performance Criteria

The calculations for the LID Performance Criteria are shown below for Case Study 1 and for each of the two DAs of Case Study 2. Table 4-1 provides the parameters required to perform DCV calculations for each case study sites. Section 4.1 provides a step by step description of how these parameters are used to compute the DCV using the P_6 method. The NOAA Precipitation Frequency Data Server indicates the site has a 2-year, 24-hour storm precipitation of 2.88 inches and 2-year, 1-hour precipitation of 0.63 in/hr (*http://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html?bkmrk=ca*).

Table 4-1. Key Parameters for Calculation of LID DCV for both Case Studies

Parameter	Case Study 1	Case Study 2, DA-A	Case Study 2, DA-B
Area (acres)	15	2.8	3.9
Pre-developed land classification	Undeveloped, unvegetated	Undeveloped, vegetated	Undeveloped, vegetated
Pre-developed imperviousness (%)	0%	0%	0%
Post-developed land classification	Commercial	Residential	Residential
Post-developed imperviousness (%)	70%	33%	29%
2-year, 1 hr precipitation (in)	0.63	0.63	0.63
Climatic Region	Valley	Valley	Valley
BMP Drawdown time (hrs)	48	48	48

Computation of LID DCV for Case Study 1

- **Step 1** – Project site – single drainage area (DA) of approximately 15 acres.

  $DA = 15 \text{ acre} * 43{,}560 \text{ ft}^2/\text{acre} = 653{,}400 \text{ ft}^2$

- **Step 2** – Post-developed runoff coefficient was calculated using the following equation:

  $C = 0.858 * (70\%)^3 – 0.78 * (70\%)^2 + 0.774 * (70\%) +0.04 = 0.49$

- **Step 3** – The 2-year, 1-hour rainfall depth for the project site was determined to be 0.63 in. using the NOAA Atlas 14 isohyet map.

- **Step 4** – The project site is located in the Valley climatic region and therefore, converting 2-year, 1-hour rain to the P_6 average storm depth is:

  $P_6 = 1.4807 * 0.63 = 0.93$ inches

- **Step 5** –Using the parameters obtained from the previous steps, the DCV for a 48-hour drawdown, was calculated as follows:

  $DCV = 653{,}400 \text{ ft}^2 * 0.49 * 0.93\text{in} / 12\text{in/ft} *1.963$

  $DCV = 48{,}708 \text{ ft}^3$

Computation of LID DCV for Case Study 2

- **Step 1** – Project site – two drainage areas: DA-A is approximately 2.8 acres, and DA-B is approximately 3.9 acres.

  DA-A = 2.8 acre *43,560 ft^2/acre = 121,968 ft^2

  DA-B = 3.9 acre *43,560 ft^2/acre = 169,884 ft^2

- **Step 2** – Post-developed runoff coefficient was calculated for DA-A using the following equation:

  $C = 0.858 * (33\%)^3 – 0.78 * (33\%)^2 + 0.774 * (33\%) +0.04 = 0.24$

  and for DA-B:

  $C = 0.858 * (29\%)^3 – 0.78 * (29\%)^2 + 0.774 * (29\%) +0.04 = 0.22$

- **Step 3** – The 2-year, 1-hour rainfall depth for the project site was determined to be 0.63 in. using the NOAA Atlas 14 isohyet map.

- **Step 4** – The project site is located in the Valley climatic region and therefore, converting 2-year, 1-hour rain to the P_6 average storm depth is:

  $P_6 = 1.4807 * 0.63 = 0.93$ inches

- **Step 5** –Using the parameters obtained from the previous steps, the DCV for a 48-hour drawdown for DA-A is calculated below:

  DCV-A = 121,968 ft^2 * 0.24 * 0.93in / 12in/ft *1.963

  DCV-A = 4,453ft^3

  and for DA-B:

  DCV-B = 169,884 ft^2 * 0.22 * 0.93in / 12in/ft *1.963

  DCV-B = 5,686ft^3

4.3.2 Case Studies - HCOC Performance Criteria

The hydrology analysis needed to demonstrate HCOC performance criteria was completed for Case Study 2, a low-density residential development with potential to cause or contribute to a downstream HCOC, using the methods described in Section 4.2. Case Study 2 consists of two hydrologically distinct DAs, and calculations were performed for each DA. Calculations of site-specific HCOC performance criteria for runoff volume, time of concentration, and peak runoff are shown below for this case study.

Runoff Volume

Runoff volume is calculated separately for each defined DA. Table 4-2 summarizes the parameters used in calculating the runoff volume. The entire site overlies the Merrill soil series, with a C HSG.

Table 4-2. Case Study 2 Calculation of Area-Weighted Curve Number

Land Cover	Units	DA-A		DA-B	
		Pre-developed	Post-developed	Pre-developed	Post-developed
Open Brush with Good Cover	CN	75	75	75	75
	Area (sq. ft)	92,129	9,917	126,848	39,518
Open Brush with Fair Cover	CN	77	77	77	77
	Area (sq. ft)	30,710	0	42,283	0
Residential Landscaping	CN	69	69	69	69
	Area (sq. ft)	0	72,540	0	80,984
Pavement	CN	98	98	98	98
	Area (sq. ft)	0	22,382	0	21,628
Rooftop	CN	98	98	98	98
	Area (sq. ft)	0	18,000	0	27,000
Area-weighted CN	CN	76	79	76	79

Case Study 2 - Runoff Volume Calculation

- **Step 1** - Calculate Site CN (see Table 4-2). Calculations of the CN for the pre-developed site assume 75 percent Open Brush with Good Cover (75) and 25 percent Open Brush with Fair Cover (77).

  Site CN_{pre} = [(75 * 218,977) + (77 * 72,993)] / 291,970 = 76

  DA-A CN_{post} = [(75 * 9,917) + (69 * 72,540) + { 98 * (22,382 + 18,000) }] / 122,839 = 79

  DA-B CN_{post} = [(75 * 39,518) + (69 * 80,984) + { 98 * (21,628 + 27,000) }] / 169,131 = 79

- **Step 2** - Calculate Soil Storage Capacity (*S*) and Initial Abstraction (I_a)

  DA-A & DA-B (Pre-developed) $S_{A/Bpre}$ = 1,000 / 76 – 10 = 3.2 ; I_{pre} = 0.2 * 3.2 = 0.64 in

  DA-A (Post-developed) S_{APost} = 1,000 / 79 – 10 = 2.7; I_{APost} = 0.2 * 2.7 = 0.53 in

  DA-B (Post-developed) S_{BPost} = 1,000 / 79 – 10 = 2.7; I_{BPost} = 0.2 * 2.7 = 0.53 in

- **Step 3.** Compute pre-development and post-development runoff volume and calculate required volume reduction to meet HCOC performance criteria.

  DA-A

  Pre-developed: V_{APre} = 1/12 * 122,839 * (2.88 – 0.64)^2 / (2.88 – 0.64 + 3.2) = 9,442 ft^3

  Post-developed: V_{APost} = 1/12 * 122,839 * (2.88 – 0.53)^2 / (2.88 – 0.53 + 2.7) = 11,194 ft^3

  Volume reduction: $\mathbf{V_{A\text{-}HCOC}}$ = 0.95 * 11,194 – 9,442 = **1,193 ft^3**

  DA-B

  Pre-developed: V_{BPre} = 1/12 * 169,131 * (2.88 – 0.64)^2 / (2.88 – 0.64 + 3.2) = 13,000 ft^3

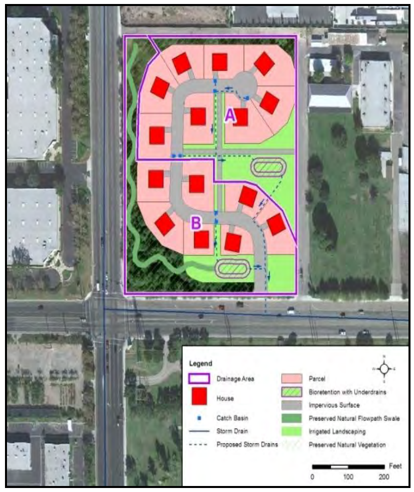
  Post-developed: V_{BPost} = 1/12 * 169,131 * (2.88 – 0.53)^2 / (2.88 – 0.53 + 2.7) = 15,413 ft^3

  Volume reduction: $\mathbf{V_{B\text{-}HCOC}}$ = 0.95 * 15,413 – 13,000 = **1,642 ft^3**

Case Study 2 – Time of Concentration Calculation

Step 1 – Estimate longest flow length

Use GIS elevation data to estimate the maximum flow length and change in elevation for each of the DA for pre- and post- developed site conditions.



Step 2 – The total area of the case study is less than 10 acres. Therefore, the nomograph in Appendix C-1 provided the time of concentration for each DA. The nomograph requires the predominant land cover type for each DA. Parameters used in the nomograph and time of concentration results are shown below:

DMA	Landuse	Flow Length (ft)	Change in elevation (ft)	Time of Concentration (min)
Pre-developed	Undeveloped Good Cover	669	2	40
Post-developed DA A	Single-Family Residential	911	2	20
Post-developed DA B	Single-Family Residential	1000	2	21

Case Study 2 – Peak Runoff Calculation

- **Step 1** – Use nomograph in Appendix C-3 to calculate infiltration capacity of soils, F_p, for each DA assuming AMC II for both pre- and post- developed conditions. Multiply resulting F_p with pervious fraction (a_p) in project to calculate depth of rain to be infiltrated, F_m. Do this for all pervious areas and sum all F_m values to obtain total F_m value for each DA.

Compute DA infiltration depth, F_m	DA-A		DA-B	
	Pre-developed	Post-developed	Pre-developed	Post-developed
Surface Description:	Open Brush			
Pervious Area CN	76	75	76	75
Antecedent Moisture Condition	2	2	2	2
Infiltration Capacity F_p (in/hr)	0.44	0.46	0.44	0.46
Pervious Fraction a_p	1	0.08	1	0.23
Infiltration depth (in)	0.44	0.04	0.44	0.11
Surface Description:	Residential Landscaping (only in post-developed condition)			
Pervious Area CN		69		69
Antecedent Moisture Condition		2		2
Infiltration Capacity F_p (in/hr)		0.56		0.56
Pervious Fraction a_p		0.59		0.48
Infiltration depth (in)		0.33		0.27
Total Depth of Infiltration F_m (in/hr)	0.44	0.37	0.44	0.38

- **Step 2 –** Calculate rainfall intensity for each DA for duration equal to the time of concentration under pre- and post- developed conditions by extrapolating from the 2-year, 1-hr rainfall intensity for the site. For Case Study 2, the 2-year, 1-hr rainfall intensity is 0.63 in/hr. Due to the site being located in the Valley climatic region, extrapolation used a Slog-log of 0.6.

DA-A

Pre-developed: I_{APre} = 10^[LOG 0.63 – 0.6 * LOG (40 / 60)] =0.80

Post-developed: I_{APost} = 10^[LOG 0.63 – 0.6 * LOG (20 / 60)] = 1.22

DA-B

Pre-developed: I_{BPre} = 10^[LOG 0.63 – 0.6 * LOG (40 / 60)] =0.80

Post-developed: I_{BPost} = 10^[LOG 0.63 – 0.6 * LOG (21 / 60)] = 1.18

Case Study 2 – Peak Runoff Calculation (cont.)

- **Step 3** – Calculate peak runoff for each DA**.**

  DA-A

  Pre-developed: $Q_{p,APre}$ = 0.9 * (0.8 – 0.44) * 122,839 ft^2 / 43,560 ft^2/acre = 0.91 cfs

  Post-developed: $Q_{p,APost}$ = 0.9 * (1.22 – 0.37) * 122,839 ft^2 / 43,560 ft^2/acre = 2.16 cfs

  DA-B

  Pre-developed: $Q_{p,BPre}$ = 0.9 * (0.8 – 0.44) * 169,131 ft^2 / 43,560 ft^2/acre = 1.26 cfs

  Post-developed: $Q_{p,BPost}$ = 0.9 * (1.18 – 0.38) * 169,131ft^2 / 43,560 ft^2/acre = 2.81 cfs

- **Step 4** – A confluence analysis is needed to compute peak runoff because the site is divided into hydrologically independent DA. For pre-developed conditions, it is assumed both DA have the same time of concentration and therefore the values are added together:

  $Q_{p,pre}$ = 0.91 + 1.26 = 2.17 cfs

  For post-developed conditions, DA-B has a greater peak runoff and time of concentration then DA-A, therefore peak runoff at the project site discharge point is calculated as follows:

  $Q_{p,post}$ = 2.81 + 2.16 * (1.18 – 0.37) / (1.22 – 0.37) = 4.87 cfs

- **Step 5** –The pre-developed peak runoff is subtracted from the post-developed peak runoff to calculate the required peak runoff reduction to meet HCOC performance criteria:

  $Q_{p\text{-}HCOC}$ = 0.95 * 4.88 – 2.17 = 2.47 cfs

Section 5 – Low Impact Development BMP Evaluation and Selection

5.1 Introduction

The extent to which LID practices may be incorporated into a Priority Project can be determined once the project proponent has a clear understanding of project conditions based on the information developed under Section 3, and the applicable performance criteria determined as described in Section 4. Using this information, LID practices are selected and evaluated to meet the minimum performance criteria feasible. If it is not feasible to fully meet the performance criteria utilizing BMPs, as described in this Section, a Project Proponent must then evaluate and propose an Alternative Compliance approach as described in Section 6.

LID practices may be divided into two general categories:

- **Preventive measures** are site planning, design and construction practices that focus on minimizing the amount of land disturbed and retaining, to the maximum extent practicable, the natural drainage characteristics of the site. Consideration of preventive measures begins early in the project planning phase, when the layout of the project site is being contemplated. The extent to which such measures are incorporated into the project site dictate to a large degree the extent to which additional mitigative measures will be required to meet the performance criteria. Maximizing preventative measures will reduce additional mitigation requirements, resulting in a more cost effective project.
- **Mitigative measures**, if required, are structural BMPs that manage impacts from stormwater runoff and provide pollutant reduction. Categories of mitigative BMPs that must be considered in order of priority are: (1) infiltration BMPs; (2) BMPs that harvest and use runoff (e.g., rain barrels, cisterns, etc); and (3) vegetated BMPs that promote evapotranspiration (e.g., bioretention, biofiltration, and biotreatment).

Table 5-1 summarizes how preventive and mitigative measures interrelate and how WQMP development addresses each category. The following sections describe requirements for incorporation of both categories into the planning and design of a project.

The purpose of this section is to provide guidance for preparing site designs and drainage plans, selecting and sizing BMPs applicable to the project as prescribed in the MS4 Permit, and evaluating the conformance of the proposed BMPs with project-specific LID performance criteria. Final construction documents prepared during project design are the appropriate place to establish construction phase requirements that will then be enforced during construction. Furthermore, detailed requirements for stormwater quality protection during construction are covered under the Sections X.B and XIV of the MS4 Permit. Establishing appropriate post-construction measures and mechanisms for ensuring that they will be implemented are discussed in Section 8.

Table 5-1. Application of LID Practices to Development Phases

Project Development Phase	LID Practice	
	Preventive Measures	**Mitigative Measures**
Site Planning and layout	Preserve natural infiltration capacity Preserve existing drainage patterns Protect existing vegetation and sensitive areas	Not applicable, but extensive application of preventive measures will reduce the mitigative measures required below
Site and Project Design	Minimize impervious area Disconnect impervious areas	Infiltration BMPs Capture/Use BMPs Vegetated BMPs
Construction	Minimize construction footprint Minimize unnecessary compaction Minimize removal of native vegetation	Re-vegetate disturbed areas
Post-Construction	Implement source control BMPs Restore original soils and use appropriate vegetation	Maintain BMPs appropriately

Source: Adapted from SoCal LID manual (original source: Low Impact Development Center, Inc.)

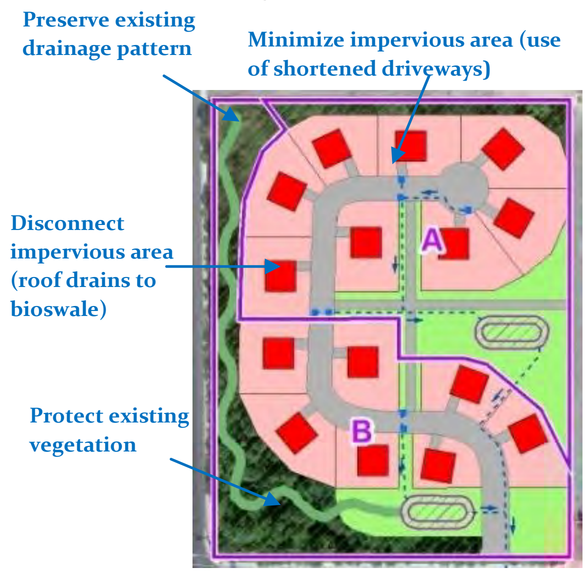
5.2 Selection of LID Preventive Measures

Consistent with the MS4 Permit, the LID practices incorporated into a project-specific WQMP should promote the following principles, where feasible:

- Incorporate landscape designs that promote water retention and evapotranspiration, such as through soil development and grading techniques, and incorporation of water conservation elements such as use of native plants;
- Include permeable surface designs in parking lots and areas with low traffic;
- Allow natural drainage systems for street construction and catchments (with no drainage pipes), and allow grassy swales and ditches;
- Require parking lots to drain to landscaped areas to provide treatment, retention, or infiltration;
- Reduce curb requirements where adequate drainage, conveyance, treatment and storage are available to allow stormwater to drain into landscaped areas;
- Incorporate rainwater harvesting and use;
- Allow building of narrow streets and provide alternatives to minimum parking requirements;
- Consider vegetated landscape as an integral element of streets, parking lots, playgrounds and buildings as a stormwater treatment and retention system; and

- Consider and facilitate application of landform grading techniques and revegetation as an alternative to traditional approaches, particularly in areas susceptible to erosion and sediment loss such as hillside development projects.

Case Study 2 Application of Preventative Site Design Principles



Extensive application of preventive measures throughout the development will reduce the number and size of mitigative BMPs required to meet WQMP requirements. The earlier in the project development phase that preventive measures are considered, the easier it will be to incorporate them.

Preventive measures are incorporated into all phases of a project. Initially, these measures are considered during the planning phase to identify ways to reduce the project footprint, minimize land disturbance and maintain the pre-development hydrological function of a new development site, or, at a minimum, to maintain the existing hydrologic function of a site being redeveloped.

Preventive measures must also be considered and included during both the construction and post-construction phases of the project. Unless carefully anticipated and prescribed in construction document requirements, construction activity can reduce the benefits incorporated during earlier phases, such as by disturbing or compacting naturally infiltrating soils in an area that was set aside for preservation. It is vital that the project incorporate revegetation requirements to cover exposed soils and allow for the site to maximize stormwater retention as quickly as possible following completion of construction activities.

The following sections provide additional information regarding the key elements associated with the incorporation of preventive measures into the various phases of a project – from conception to completion.

5.2.1 Site Planning and Design Practices

Preventive measures associated with site planning and design will be considered together as the practicability of a particular design may be determined by site plan characteristics. Table 5-2 summarizes the key elements that should be considered during the site planning and design phases.

Preventive measures apply to both new development and significant redevelopment projects. However, it is recognized that the ability to incorporate preventive measures into an existing developed site undergoing redevelopment can be more difficult. Attention to specific types of preventive measures, such as minimizing new impervious area and disconnecting existing impervious areas can provide substantial stormwater management benefits.

Table 5-2. LID Preventive Measures for Consideration During Site Planning and Design Phases

LID - Preventive Measures	Project Phase	
	Planning	**Design**
Maximize natural infiltration capacity	▪ Avoid locating constructed elements on highly permeable areas ▪ Cluster constructed elements in the least permeable areas	▪ Use alternative permeable or porous building materials where allowed by code
Preserve existing drainage patterns and increase time of concentration	▪ Avoid channelization of natural drainages ▪ Where channel engineering is necessary, include sinuosity to increase time of concentration ▪ Establish setbacks and buffer areas from natural waterbodies ▪ Retain natural depressions in project area	▪ Avoid channelization of natural streams ▪ Where channel engineering is necessary: ▪ Include mild slopes, ▪ Increase channel roughness to increase time of concentration ▪ Use pervious channel linings to increase infiltration
Protect existing vegetation and sensitive areas	▪ At the outset, establish areas within project site that should remain undisturbed ▪ Establish setbacks and buffer zones around sensitive areas ▪ Incorporate rather than eliminate established vegetation throughout site layout	▪ Design site layout to protect sensitive areas
Minimize impervious area	▪ Reduce footprint by: ▪ Building vertically rather than horizontally ▪ Reducing road and sidewalk widths to MEP ▪ Clustering constructed elements to preserve open space ▪ Minimizing lot setbacks to reduce driveway lengths	▪ Install sidewalks only one side of private roadways ▪ Use alternative permeable or porous building materials where allowed by code ▪ Reduce overall parking lot size by creating smaller parking spaces for compact cars
Disconnect impervious areas	▪ Plan site layout and mass grading to allow runoff to be directed to permeable areas, e.g., natural retention areas, open spaces, medians, parking islands, planter boxes ▪ Avoid channelization of natural on-site streams	▪ Incorporate permeable areas throughout project site to accept runoff ▪ Design roof downspouts to drain to pervious areas ▪ Use alternative permeable or porous building materials where allowed by code
Integrated with planning	▪ Incorporate preventive measures that are consistent with the Watershed Action Plan ▪ Determine if any approved regional BMP projects are constructed downstream and included in WAP, prior to site design planning	▪ Use all design requirements included in the Watershed Action Plan for watershed based BMPs

Source: Adapted from SoCAL LID manual (original source: Low Impact Development Center, Inc)

The following sections provide a description of each preventive measure listed in Table 5-2. For additional information and links to additional technical resources, consult the *Low Impact Development Manual for Southern California: Technical Guidance and Site Planning Strategie*s (*www.casqa.org/LID/SoCalLID/tabid/218/Default.aspx*), or Maryland Department of Resource Programs and Planning Division. Low-Impact Development Design Strategies -An Integrated

Design Approach (*http://www.co.pg.md.us/Government/DER/PPD/pgcounty/lidmain.htm*), or Orange County, CA stormwater program guidance documents (*http://www.waterboards.ca.gov/rwqcb8/water_issues/programs/stormwater/oc_permit.shtml*).

5.2.1.1 Maximize Natural Infiltration Capacity

Taking advantage of a site's natural infiltration and water storage capacity decreases the volume of stormwater runoff generated and the need for BMPs that mitigate project impacts. Accordingly, when developing the footprint for constructed elements of a proposed project, areas where infiltration could be maximized should be preserved. Typically, these areas include:

- Hydrologic Soil Groups A or B
- Mild slopes or depressions
- Undeveloped portions of an existing site undergoing redevelopment

Selecting areas to maximize infiltration must consider geotechnical hazards that could be created by infiltration in inappropriate locations, such as near structures, which may cause structural failure, or in and around steep slopes, which may cause slope destabilization.

5.2.1.2 Preserve Existing Drainage Patterns and Increase Time of Concentration

A project site should be evaluated to determine how rainfall naturally moves through or is stored on the site. To the extent practicable, the natural drainage flow-through and storage characteristics should be incorporated into the project layout. Preserving these features will help maintain the site's pre-development hydrologic characteristics, including the time of concentration, runoff velocity, and peak flow volume. In addition to preserving natural features, the project site should be evaluated to determine where site grading could add additional depressions that can provide on-site storage of stormwater runoff.

5.2.1.3 Protect Existing Vegetation and Sensitive Areas

Vegetative cover (extent, depth and density) provides additional storage volume during rainfall events. Soils with undisturbed vegetation have a much higher capacity to store and infiltrate runoff than disturbed soils or vegetation. Every effort should be made to minimize soil and vegetation disturbance (including existing trees) to retain on-site storage capacity.

Projects should avoid sensitive areas, including wetlands, streams, floodplains, and intact wooded areas. Not only do federal, state and local laws already limit development in these areas or require compliance with significantly more stringent regulatory requirements, impacts to these areas can greatly impact the pre-development hydrologic characteristics of a site.

5.2.1.4 Minimize Impervious Areas

Increased imperviousness is associated with increased environmental impacts to downstream receiving waters, including the creation of hydrologic conditions of concern. Accordingly, projects site plans should minimize impervious areas, which will greatly reduce the amount of BMPs needed to mitigate potential downstream impacts. Table 5-2 includes several example techniques for reducing imperviousness. The extent to which some of these techniques may be employed in the local area (e.g., minimum road widths) is dependent on existing codes and ordinances, which should be carefully consulted in coordination with the local jurisdiction.

5.2.1.5 Disconnect Impervious Areas

Disconnection of impervious areas so that stormwater runoff is directed to on-site pervious surfaces rather than off-site streets and storm drains increases the time of concentration, reduces the peak discharge rate from the site, and maximizes opportunities for on-site infiltration. Careful application of this preventive measure can greatly reduce the need for other BMPs. Care must be taken to ensure that runoff to pervious areas for on-site infiltration does not create geotechnical hazards or cause impacts to adjacent properties. The extent to which disconnection practices may be employed on the project site may be dependent on existing codes and ordinances, which should be carefully consulted.

5.2.1.6 Integrate with Watershed Planning

Regional efforts to manage watersheds in an integrated manner are underway in San Bernardino County through the development of a Watershed Action Plan. This planning effort may influence requirements applicable to site planning and design.

5.2.2 Construction Practices

Project proponents should thoroughly evaluate how the planned construction activity will be staged and phased, and the construction activities allowed or specified throughout the planning and design phases of a project. Table 5-3 summarizes the construction practices that should be considered when incorporating preventive measures into the project during site planning and design. For example, if minimizing land disturbance is a key element of the project plan, then it is important to consider how construction activities, including siting of staging and laydown areas, can be performed without impacting areas where no disturbance is desired. In addition, during construction the following preventive measures should be considered:

- Minimize size of construction easements;
- Locate material storage areas and stockpiles within area being developed;
- Limit ground disturbance in areas not requiring grading;
- Delineate access routes for heavy equipment; and
- Delineate areas to remain undisturbed.

Table 5-3. LID Preventive Measures for Consideration During Construction

LID - Preventive Measures	Example Practices to Minimize Construction Impacts
Maximize natural infiltration capacity	Minimize construction footprint Minimize unnecessary compaction of soils
Preserve existing drainage patterns and increase time of concentration	Minimize construction footprint
Protect existing vegetation and sensitive areas	Ensure sensitive areas are protected during construction phase
Minimize impervious areas	Minimize unnecessary soil compaction (may require geotechnical analysis to determine minimum level of compaction to provide structural stability)
Disconnect impervious areas	N/A

Source: Adapted from SoCal LID manual (original source: Low Impact Development Center, Inc.)

5.2.3 Post-Construction

Post-construction revegetation of disturbed areas is an important preventive measure. Revegetation of disturbed areas that will not be landscaped should occur immediately after completion of construction activity to protect exposed soils and maximize on-site stormwater retention. Considerations include:

- Incorporation of native vegetation, wherever possible;
- Restoration of disturbed areas using native soils which were stockpiled during the construction phase;
- Storage or maintenance of stockpiled soils in a manner that maintains the viability of the flora and fauna within the soil, to the maximum extent practicable;
- Firescaping the site, e.g., through selection of appropriate vegetation for planting and application of California requirements for establishment of required buffer zones around structures; and
- Application of xeriscape landscaping principles, as appropriate.

In addition to the implementation of appropriate re-vegetation techniques, proper implementation of source control BMPs and post-construction BMP management are also required elements of any project regardless of their relationship to LID practices. These requirements are discussed in Sections 7 and 8.

5.3 Selection of LID Mitigative Measures and BMPs

5.3.1 Hierarchy of BMP Types

A large suite of BMPs is effective at managing a wide spectrum of pollutants. The MS4 Permit requires that BMPs that use on-site retention be prioritized over BMPs that may result in some release of runoff to the MS4 system. Specifically, higher priority type BMPs (e.g., retention) must be evaluated for feasibility (see Section 5.4), selected and sized to capture the maximum feasible portion of the DCV, before attempting to address the remaining volume with the next lower control (e.g., biotreatment). Section 5.3.2 describes site-specific conditions that would require or allow for a project WQMP to determine that it is not feasible to consider retention and infiltration BMPs, and proceed to evaluate biotreatment BMPs.

Figure 5-1 provides a flowchart showing the BMP selection and evaluation process that must be followed in developing a WQMP. The following sections provide guidance on the selection of specific BMPs and methods for evaluating conformance with project–specific performance criteria. General steps involved in BMP selection and evaluation are summarized below:

- Step 1 - <u>Incorporate hydrologic source control into site design</u>
  The first step in the process is to consider hydrologic source control (HSC). HSC is a class of BMPs integrated with site design that retain stormwater runoff and reduce the volume (and potentially the rate) of stormwater discharge to the downstream system (e.g. impervious area dispersion). If the volume of runoff retained by HSC in a DA is greater than or equal to the DCV for the DA, the DA is considered to be self-retaining and no additional BMPs are required to treat discharges from the drainage area to meet LID requirements. Otherwise, the volume retained by HSC is subtracted from the DCV to estimate the remaining volume for sizing LID infiltration BMPs. However, the excess volume retained by the HSC could be used to provide additional volume mitigation that may be required to meet HCOC performance criteria.
- Step 2 – <u>Evaluate on-site retention and infiltration BMPs</u>

  The next step is to determine the feasibility of retention and infiltration BMPs (Sections 5.3.2.1 and 5.5.1). If on-site retention and infiltration is infeasible the project proponent shall proceed to Step 3.
- Step 3 – <u>Evaluate harvest and use BMPs</u>

  The next step is to determine the feasibility of harvest and use BMPs (Sections 5.3.2.2 and 5.5.4). If implementation of harvest and use BMPs is infeasible the project proponent shall proceed to Step 4.
- Step 4 – <u>Re-Evaluate and Optimize suite of BMPs to maximize on-site retention of DCV</u>

  If individual retention and infiltration, and/or harvest and use BMP are feasible, but unable to treat the entire DCV, evaluate the use of combinations of BMPs, including HSC BMPs, to maximize on-site retention of the DCV. If no combination of BMP can mitigate the entire DCV, implement the single BMP type, or combination of BMP types, that maximizes on-site retention of the DCV, and proceed to Step 5.
- Step 5 – <u>Evaluate BMPs for biotreatment of pollutants of concern</u>

  If it is infeasible to fully infiltrate the DCV on the project site, then biotreatment BMPs must be selected and implemented to mitigate the entire remaining DCV (Sections 5.3.2.4

and 5.5.5). Biotreatment BMPs with medium to high pollutant removal effectiveness must be selected to address the project pollutants of concern (POC) that cause impairment of downstream receiving waters. If the combination of retention and infiltration, harvest and use, and biotreatment is insufficient to capture and treat the full DCV, proceed to Step 6.

- Step 6 – Determine alternative compliance strategies

  Lastly, if it is infeasible to fully infiltrate, retain or biotreat the DCV on the project site, then Section 6 provides guidance for identifying alternative compliance approaches.

5.3.2 General Feasibility Criteria for Use of Required LID BMPs

Prior to BMP selection, the WQMP must substantiate whether any or all BMPs are feasible to consider for use on a particular site, or whether use of one or more BMP types would result in violations of statutory requirements. The WQMP must include justification for any infeasibility determination. The following subsections describe specific conditions that would make the use of a specific BMP type infeasible for consideration when developing a project WQMP.

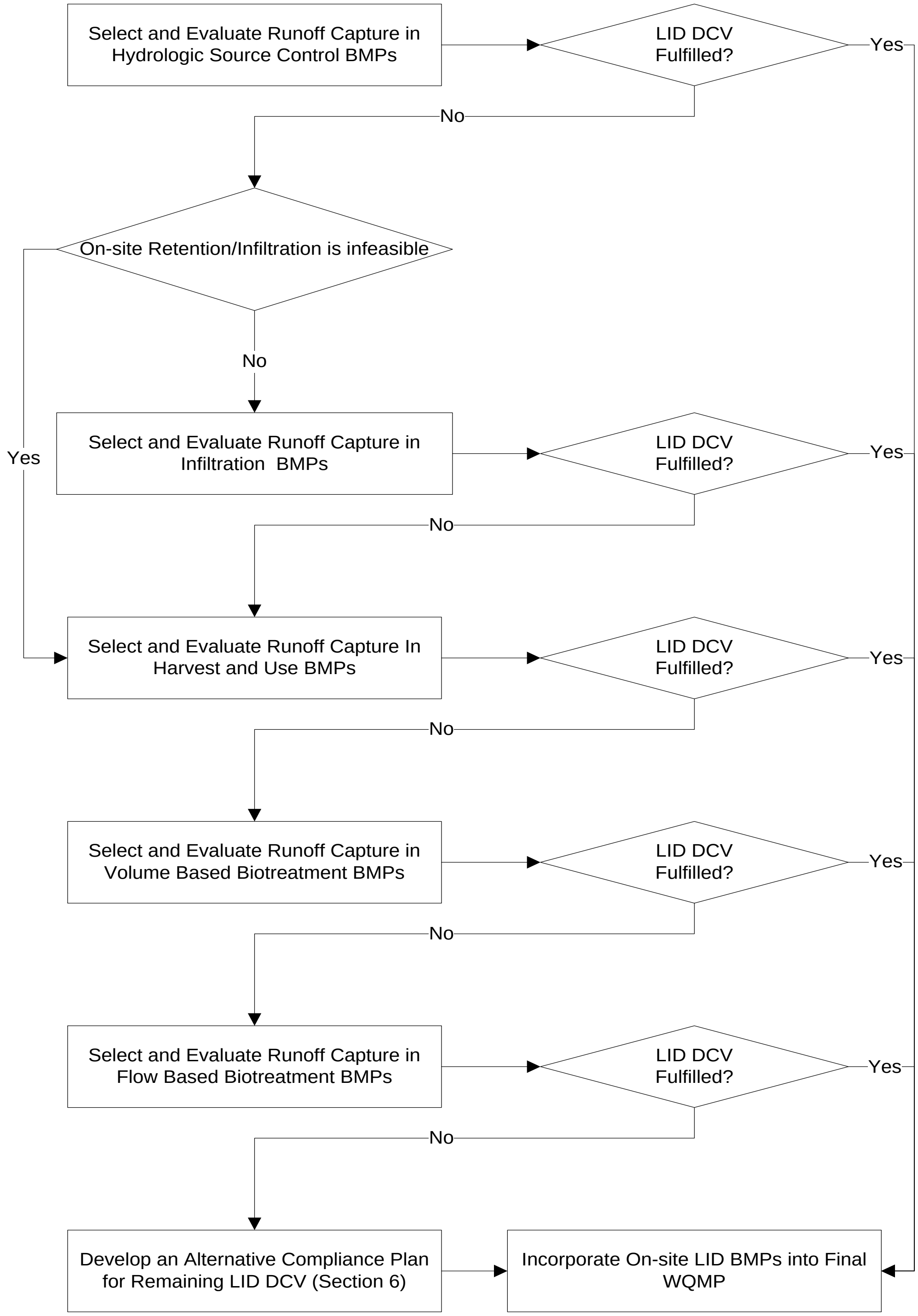


Figure 5-1 On-site LID BMP Selection and Evaluation Flowchart

5.3.2.1 Infiltration BMPs

All projects retaining and infiltrating runoff shall implement source control and pollutant prevention control BMPs, to the MEP, in order to protect groundwater quality. Conditions that would prohibit the use of infiltration BMPs for a specific project WQMP are listed below:

- Stormwater infiltration would result in significant risks to drinking water quality and groundwater quality that cannot be reasonably and technically mitigated. Factors that may pose a risk to groundwater quality that cannot be mitigated include:
    - Seasonally high groundwater is less than 10 feet below the designed bottom of the infiltration facility for aquifers managed for water quality or with significant connectivity to aquifers managed for groundwater quality.
    - Seasonally high groundwater is less than 5 feet below the designed bottom of the infiltration facility for aquifers not managed for groundwater quality and without significant connectivity to aquifers managed for groundwater quality.
    - Horizontal distance to a water supply well is less than 100 feet.
    - Infiltration of stormwater from project land uses would result in significant risks to drinking water quality and groundwater quality that cannot be reasonably and technically mitigated through methods such isolation of sources and/or pre-treatment of runoff prior to infiltration.
- For Brownfield sites or adjacent sites, stormwater infiltration would result in a significant risk of mobilizing or moving contamination that cannot be reasonably and technically avoided, as documented by a site-specific or available watershed study with sufficient resolution to positively identify areas where stormwater infiltration should not be conducted. The documenting study shall have sufficient resolution to positively identify areas where stormwater infiltration should be restricted.
- Where a groundwater pollutant plume (man-made or natural) is under the site or in close proximity, and stormwater infiltration would result in a significant risk of causing or contributing to plume movement that cannot be reasonably and technically avoided, as documented by a site-specific study or available watershed study. The documenting study shall have sufficient resolution to positively identify areas where stormwater infiltration should be restricted.
- Projects constructing fueling operations, large commercial parking lots, areas of industrial or light industrial activity, areas subject to high vehicular traffic (25,000 or more daily volume), car washes, fleet storage areas, nurseries, or any other land use or activity with a high threat to water quality, unless adequate pretreatment is provided.
- Infiltration of runoff into Class V injection wells or drywells, in projects occupied by vehicular repair or maintenance activities, such as auto body repair, automotive repair, new and used car dealerships, specialty repair shops (e.g. transmission and muffler repair) or any facility that performs vehicular repair work.
- Stormwater infiltration would result in significantly increased risks of geotechnical hazards such as liquefaction or landslides that cannot be reasonably and technically mitigated as documented by a geotechnical professional or available watershed study. The

documenting study shall have sufficient resolution to positively identify areas of expansive clays or other conditions, which would prohibit stormwater infiltration.

- Infiltration of site runoff would create a nuisance or pollution as defined in Water Code Section 13050 (*http://www.leginfo.ca.gov/cgi-bin/displaycode?section=wat&group=13001-14000&file=13050-13051*).
- Infiltration of runoff would violate downstream water rights.

Certain factors may limit the potential benefit that infiltration BMPs can have or limit the extent to which infiltration is beneficial. While these factors eliminate the requirement to consider BMPs with a primary purpose of infiltration, these factors shall not prevent the ability of the project proponent to consider some level of *incidental* infiltration, if desired, as part of an integrated stormwater management design.

Infiltration is not required to be considered if any of the following conditions are met:

- Project is located in D soils per the watershed Geodatabase *and* the site geotechnical investigation confirms presence of soil characteristics, which support categorization as D soils. For small projects (residential projects under 10 acres in size and comprised of less than 30 dwelling units; commercial projects less than 5 acres in size, and industrial projects less than 2 acres in size), the geotechnical investigation shall not be required to include infiltration testing to confirm mapped categorization as D soils; other sources of data such as bore logs, soils reports and other related information from the site, or from other sites in the immediate vicinity obtained for other purposes may be used.
- The measured infiltration rate after accounting for soil amendments is less than 0.3 inches per hour in the vicinity of proposed BMPs. Infiltration measurement shall include protocols that account for the effect of soil amendments. Soil amendments would not be expected to increase the effective infiltration rate of a soil if the limiting horizon for infiltration lies below the amended zone (in this case, it would increase storage, but not infiltration rate). Soil amendments would be expected to effectively increase infiltration rates if the limiting horizon for infiltration occurs near the proposed bottom of the infiltration basin and the entire depth of this layer can be amended.
- Reduction of runoff to pre-developed conditions would be partially or fully inconsistent with watershed-scale management strategies and/or would impair the beneficial uses of the receiving water. The allowable level of runoff reduction must be documented in a site-specific study or watershed plan, and it must be demonstrated that infiltration BMPs would exceed the allowable level of runoff reduction.
- Increase in infiltration to pre-developed conditions would be partially or fully inconsistent with watershed-scale management strategies and/or would cause impairments to downstream beneficial uses, such as change of seasonality of ephemeral washes. The level of allowable increase in infiltration must be documented in a site-specific study or watershed plan, and it must be demonstrated that stand-alone infiltration BMPs would

exceed the allowable level of increase in infiltration or what level could be infiltrated as a partial consideration.

In the event that any of these conditions apply, infiltration BMPs are not required, but may be considered as an option. Biotreatment BMPs (where employed) should be designed to promote incidental infiltration where possible.

5.3.2.2 Harvest and Use BMPs

A single ‘yes’ answer to any of the following questions indicates that harvest and use shall not be considered because harvest and use would conflict with codes and/or ordinances or is impractical:

- Does use of harvested water for the type of demand on the project violate codes or ordinances in effect at the time of project application?
- Would harvest and use of runoff violate downstream water rights?
- Is recycled water planned for use to serve the project site non-potable demand?

5.3.2.3 Evapotranspiration BMPs

In general, evapotranspiration (ET) would not be expected to cause a risk that would exclude its use from any project.

Green roofs, brown roofs, and blue roofs may be considered wherever they are consistent with applicable codes and ordinances. However, the use of these BMPs is presently considered above and beyond the MEP; and, therefore, these BMPs are encouraged but not required to be considered in assessing feasibility. Green roofs, brown roofs, and blue roofs are considered to be beyond the MEP for the following technical, economical, and societal reasons:

- The increased use of irrigation water and plant life requiring water is inappropriate to the direction of state legislation (AB1881) mandating landscaping water efficiency.
- Long term data regarding maintenance of a green roof, in a Mediterranean climate prone to high winds and fire hazard is not readily available.
- The practical limitations of requiring individual homeowners and small business owners to irrigate and maintain a green roof are untested.
- The majority of current building codes and the fire code do not specifically address green roof construction, and it is unknown how this requirement may conflict with other building code provisions or upcoming mandatory solar requirements.
- Studies of cost-benefit and cost-effectiveness of green roofs have often not considered costs of additional structural requirements, which may comprise a large portion of green roof costs.
- Although green roofs have been encouraged in several locations across the country, there are no known locations in the US where implementation of greenroofs has been required in an implemented permit in order to meet the MEP standard.

Where green roofs, brown roofs and blue roofs are selected as an option, consideration should be given for overall water demands which may increase as a result of an increase in the amount of area potentially requiring irrigation during the dry periods. However, for a project with very high density, green roofs could provide almost complete treatment for the water quality design storm (sidewalks and minor surface areas would also need treatment) and, for some projects, could provide a cost-saving when other benefits (heating and cooling reductions, etc.) are factored in.

5.3.2.4 Biotreatment BMPs

In general, biotreatment BMPs would not be expected to cause a risk that would exclude their use from any project. However, biotreatment BMPs shall be designed to prevent or limit incidental infiltration for projects where use of infiltration BMPs would be prohibited (see Section 5.3.2.1).

5.4 Evaluation of LID BMPs

When evaluating the effect of proposed BMPs on the post-development hydrologic condition, it is necessary to calculate the runoff capture provided by all volume mitigation BMPs proposed in the WQMP. This section provides methodologies for estimating runoff capture for specific BMPs designed to infiltrate, harvest and use, evapotranspire, and/or biotreat runoff. The BMPs include:

- Hydrologic Source Control (HSC) BMPs – Impervious area dispersion, localized on-lot infiltration, green/brown/blue roof, street trees, and residential rain barrels/cisterns
- Infiltration BMPs - Infiltration trench, infiltration basin, bioretention with no underdrain, drywell, permeable pavement, and underground infiltration
- Harvest and Use BMPs – Cisterns and underground detention
- Biotreatment BMPs – Bioretention with underdrain, vegetated swale, vegetated filter strip, dry extended detention basin, wet detention basin, constructed wetland, and proprietary biotreatment.

5.4.1 Hydrologic Source Control

HSC BMPs are differentiated from retention and biotreatment classes of BMPs by their higher level of integration within a site. They are not sized according to engineering design criteria, and they do not typically result in a distinct facility. Consequently, they are usually regarded as site design practices, as opposed to structural BMPs. On-site retention of runoff in HSC BMPs reduces the portion of the DCV that must be addressed in downstream BMPs. HSC BMPs that are considered to retain runoff include:

- Impervious area dispersion
- Localized on-lot infiltration
- Green / brown roof
- Blue roof

- Street trees
- Residential rain barrels/cisterns

5.4.1.1 Impervious Area Dispersion

Impervious area dispersion refers to the practice of routing runoff from impervious areas, such as rooftops, walkways, and patios onto the surface of adjacent pervious areas. Rooftop downspout disconnection is an example of commonly used impervious area dispersion BMPs. Runoff is dispersed uniformly via splash block or dispersion trench and soaks into the ground as it moves slowly across the surface of pervious areas. The retention volume provided by downspout dispersion is a function of the ratio of impervious to pervious area (Table 5-4).

5.4.1.2 Localized on-lot infiltration

Localized on-lot infiltration refers to the practice of collecting runoff from small distributed areas within a DA and diverting it to a dedicated on-site infiltration area where it can be infiltrated or evapotranspired. This technique can include disconnecting downspouts and draining sidewalks and patios into french drains, trenches, small rain gardens, or other surface depressions. Localized on-lot infiltration shall meet infiltration infeasibility screening criteria to be considered for use (see Section 5.3.2.1). The retention volume provided by localized on-lot infiltration is equal to the storage volume provided by surface ponding and the pore space within an amended soil layer or gravel trench (Table 5-4).

5.4.1.3 Evapotranspiration: Green, brown, or blue roofs

Green roofs are also known as ecoroofs, roof gardens, or vegetated roof covers. Green roofs are roofing systems that provide a layer of soil/vegetative cover over a waterproofing membrane. There are two types of green roofing systems; extensive (a light weight system); and intensive (a heavier system that allows for larger plants but requires additional maintenance). A green roof mimics pre-development conditions by limiting the impervious area created by development. Green roofs filter, absorb, and evapotranspire precipitation to help mitigate the delivery of excess runoff to the local storm water conveyance systems and the effects of urbanization on water quality.

Brown roofs are essentially a sub-type of green roof designed to maximize biodiversity. Brown roofs typically utilize natural soil and locally available substrates to create a protected biodiverse habitat for specific species of local flora and fauna. Rather than landscaping the roof during construction, plants are left to germinate and grow on their own in the native soils, thus the “brown” (i.e., initially unvegetated) designation. Hand-seeding may be implemented where self-colonization via airborne seeds is unlikely.

Table 5-4 - Estimation Methods for On-site Retention BMPs

BMP Type	Runoff Volume Calculation	Variables	Fact Sheet Reference for Design Details
Impervious area dispersion	$V_{ret} = DA_{imp} * R_{perv:imperv} * 0.5/12$	DA_{imp} = *impervious drainage area* (ft^2) $R_{perv:imperv}$ = *ratio of pervious to impervious area*	Orange County Technical Guidance Document (TGD) for Project WQMPs Appendix XIV[1]
Localized on-lot infiltration	$V_{ret} = (SA_{pond} * d_{pond}) +$ $(SA_{matrix} * d_{matrix} * n_{matrix})$	SA_{pond} = *surface area for ponding water* (ft^2) d_{pond} = *depth of ponding water (ft)* SA_{matrix} = *surface area of amended soil / gravel* (ft^2) d_{matrix} = *depth of amended soil / gravel (ft)* n_{matrix} = *porosity of amended soil / gravel*	Orange County TGD for Project WQMPs Appendix XIV[1]
Green / Brown roofs	$V_{ret} = E_{daily,\ wet\ season} * A_{rooftop} * T_{drawdown}/24$ *or* *fully self-retaining if* $d_{matrix} = 3/R_{BMP,\ roof}$	*dmatrix = depth of soil layer for roof BMP (ft)* *RBMP:roof = ratio of BMP area to total roof area* *Edaily,wetseason = wet season daily evaporation (in/day)* *Tdrawdown* *Arooftop – rooftop area for evapotranspiration BMPs*	Orange County TGD for Project WQMPs Appendices IX and XIV[1]
Blue roof	$V_{ret} = E_{daily,\ wet\ season} * A_{rooftop} * T_{drawdown}/24$	$E_{daily,wetseason}$ = *wet season daily evaporation (in/day)* $T_{drawdown}$ = *drawdown time for stored runoff (hrs), default is 96 hours* *Arooftop – rooftop area for evapotranspiration BMPs*	Orange County TGD for Project WQMPs Appendix XIV[1]
Street trees	$V_{ret} = n_{trees} * IA_{canopy} * d_{int} / 12$	n_{trees} = *number of street trees* IA_{canopy} = *average impervious area under tree canopy after 4 years growth* (ft^2) d_{int} = *rain depth retained by canopy interception (in)*	Orange County TGD for Project WQMPs Appendix XIV[1]
Residential rain barrels / cisterns	$V_{ret} = n_{barrels} * S_{barrel} / 2$	$n_{barrels}$ = *number of residential rain barrels / cisterns* S_{barrel} = *volume of residential rain barrels / cisterns* (ft^3)	Orange County TGD for Project WQMPs Appendix XIV[1]
Infiltration basin	$V_{ret} = P_{design} / 12 * SA_{inf} * (T_{drawdown} + T_{fill})$	P_{design} = *design percolation rate (in/hr), field measured infiltration divided by safety factor* SA_{inf} = *infiltrating surface area* (ft^2) $T_{drawdown}$ = *drawdown time for stored runoff (hrs), default is 48 hours*[1] T_{fill} = *duration of storm when infiltration is occurring as basin is filling (hrs), default is 3 hours*	Riverside County LID BMP Manual[2] Orange County TGD for Project WQMPs Appendix XIV[1]

[1] A 48-hour drawdown time is utilized for infiltration basin sizing, which is consistent with the current DCV calculation methodology in Form 4.2-1 of the WQMP Template

Table 5-4 (cont.) - Estimation Methods for On-site Retention BMPs

BMP Type	Runoff Volume Calculation	Variables	Fact Sheet Reference for Design Details
Infiltration trench	$V_{ret} = (P_{design} / 12 * SA_{inf} * T_{fill}) +$ $(SA_{ponded} * d_{ponded}) +$ $(SA_{gravel} * d_{gravel} * n_{gravel})$ where $d_{ponded} < T_{drawdown} * P_{design} / 12$	P_{design} = design percolation rate (in/hr), field measured infiltration divided by safety factor $SA_{inf, ponded,gravel}$ = surface area (ft^2) of trench bottom, gravel layer, and surface ponding $T_{drawdown}$ = drawdown time for stored runoff (hrs), default is 48 hours T_{fill} = duration of storm when infiltration is occurring as basin is filling (hrs), default is 3 hours $d_{ponded,gravel}$ = depth (ft) of ponding and gravel layers n_{gravel} = porosity of gravel layer	Riverside County LID BMP Manual[2] Orange County TGD for Project WQMPs Appendix XIV[1]
Bioretention with no underdrain	$V_{ret} = (P_{design} / 12 * SA_{inf} * T_{fill}) +$ $(SA_{ponded} * d_{ponded}) +$ $(SA_{soil} * d_{soil} * n_{soil}) +$ $(SA_{gravel} * d_{gravel} * n_{gravel})$ where $d_{ponded} < T_{drawdown} * P_{design} / 12$	P_{design} = design percolation rate (in/hr), field measured infiltration divided by safety factor $SA_{inf,ponded,soil,gravel}$ = surface area (ft^2) of bioretention bottom, soil and gravel layers, and surface ponding $T_{drawdown}$ = drawdown time for stored runoff (hrs), default is 48 hours T_{fill} = duration of storm when infiltration is occurring as basin is filling (hrs), default is 3 hours $d_{ponded,gravel}$ = depth (ft) of ponding and gravel layers n_{gravel} = porosity of gravel layer	Riverside County LID BMP Manual[2] Orange County TGD for Project WQMPs Appendix XIV[1]
Drywell / Permeable pavement / Underground infiltration	$V_{ret} = (P_{design} / 12 * SA_{inf} * T_{fill}) +$ $(SA_{resevoir} * d_{resevoir} * n_{aggregate})$ where $d_{resevoir} < T_{drawdown} * P_{design} / 12$	P_{design} = design percolation rate (in/hr), field measured infiltration divided by safety factor $SA_{inf,reservoir}$ = surface area (ft^2) of reservoir for drywell or permeable pavement, include weep holes for drywell SA_{inf} $T_{drawdown}$ = drawdown time for stored runoff (hrs), default is 48 hours T_{fill} = duration of storm when infiltration is occurring as basin is filling (hrs), default is 3 hours $d_{reservoir}$ = depth (ft) of drywell $n_{aggregate}$ = porosity of aggregate , if none then 1.0	Riverside County LID BMP Manual[2] Orange County TGD for Project WQMPs Appendix XIV[1]

1) http://www.waterboards.ca.gov/rwqcb8/water_issues/programs/stormwater/oc_permit.shtml
2) http://rcflood.org/NPDES/LIDBMP.aspx

A green or brown roof can be considered to be fully self-retaining if it meets criteria for soil depth as shown in Table 5-4. By fully retaining water from the roof, the LID DCV should be recomputed to account for the reduction in imperviousness equal to the area of the roof routed into the BMP.

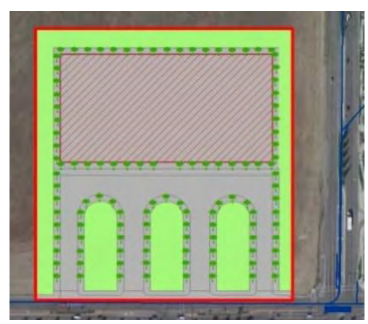
Blue roofs, also known as rooftop detention systems, serve as a rooftop storage designed to reduce runoff peak flows and volumes. Captured stormwater, up to the design depth, is held on the rooftop until the water either evaporates or is slowly metered out via flow restriction valves. With sufficent waterproofing blue roofs can be implemented on existing structures, given that the roof and building are of sufficient structural integrity to support the weight for the ponded water. As blue roofs lack vegetation, they require significantly less maintenance than green or brown roofs. Blue roofs should not be designed to hold standing water longer than 96 hours in order to mitigate vector hazards, and therefore it is not possible for these BMPs to be fully self retaining. Instead, volume retention is equal to the wet season evaporation over a 96 hour period (Table 5-4).

5.4.1.4 Street Trees

By intercepting rainfall, trees located in street medians, shoulders, and parking lots, can provide several aesthetic and stormwater benefits including peak flow control, increased infiltration and evapotranspiration, and runoff temperature reduction. The volume of precipitation intercepted by the canopy reduces the treatment volume required for downstream BMPs. Shading reduces the heat island effect as well as the temperature of adjacent impervious surfaces, over which stormwater flows, and reducing the heat transferred to downstream receiving waters. Tree roots also strengthen the soil structure and provide infiltrative pathways, simultaneously reducing erosion potential and enhancing infiltration.

Case Study 1 Application of Street Trees HSC

- Project with 114 street trees
- IA_{canopy} = 1,000 ft^2
- $V_{ret} = n_{trees} * IA_{canopy} * 0.05 / 12 = 475$ ft^3



The retention volume provided by street trees via canopy interception is dependent on the tree species, time of year, and maturity. To compute the retention depth, the expected impervious area covered by the full tree canopy (IA_{canopy}) after 4 years of growth must be computed. The maximum retention depth credit for canopy interception is 0.05 inches over the impervious area covered by the canopy at 4 years of growth (Table 5-4).

5.4.1.5 Residential Rain Barrels/Cisterns

Rain barrels / cisterns are above ground storage vessels that capture runoff from roof downspouts during rain events and detain that runoff for later uses such as irrigating landscaped areas. The temporary storage of roof runoff reduces the runoff volume from a property and may reduce the peak runoff velocity for small, frequently occurring storms. In addition, by reducing the amount of storm water runoff that flows overland into a storm water conveyance system (storm drain inlets and drain pipes), fewer pollutants are transported through the conveyance system into the offsite storm drain system and receiving waters. The use of the detained water for irrigation purposes leads to the conservation of potable water and the recharge of groundwater.

Retention volume from residential rain barrels/cisterns can be approximately estimated as half of the storage capacity provided, which assumes the storage is half-empty at the beginning of a storm event (Table 5-4).

5.4.2 Infiltration BMPs

Infiltration BMPs are BMPs that capture, store and infiltrate stormwater runoff. These BMPs are engineered to store a specified volume of water and have no design surface discharge (underdrain or outlet structure) until this volume is exceeded. These types of BMPs may also lose some water to evapotranspiration, but are characterized by having their most dominant volume losses due to infiltration.

As discussed in Section 5.3.2.1, certain conditions related to soils and groundwater make it infeasible to infiltrate runoff at a project site. Form 4.3-1 of the WQMP Template facilitates the determination of whether a project site meets one or more criteria that would prohibit, or make infeasible, any implementation of infiltration BMPs. Appendix D provides a more detailed set of guidelines to determine the feasibility of infiltrating runoff at a project site due to soil or groundwater conditions. Unless the project site meets one or more of these criteria that would deem infiltration infeasible, then infiltration BMPs must be evaluated for retention of the LID DCV.

The first step in evaluating infiltration BMP potential is to assess the infiltration rate of soils underlying the project site. For infeasibility analysis, small projects may rely only on regional soils data mapping (*http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm*) instead of on-site infiltration testing required, because on-site infiltration tests would constitute an unreasonable economic burden. The definitions for small projects are categorized based on land use as follows:

- Residential properties less than 10 acres and consisting of less than 30 dwelling units
- Commercial/institutional properties must be less than 5 acres and less than 50,000 SF building footprint,

- Industrial properties must be less than 2 acres and less than 20,000 SF building footprint. For larger projects, field measurements are required as specified in Appendix D.

Infiltration BMPs have the potential to fail over time when not adequately designed or maintained. Based on experience from numerous studies and published information, an appropriate factor of safety applied to infiltration testing results is mandatory. The infiltration rate will decline between maintenance cycles as the BMP surface becomes occluded and particulates accumulate in the infiltrative layer. Monitoring of actual facility performance has shown that the full-scale infiltration rate is typically far lower than the rate measured by small-scale testing. It is important that adequate conservatism is incorporated in the selection of design infiltration rates. The methodology for estimating an appropriate infiltration factor of safety is provided in Appendix D. The infiltration safety factor is estimated based on ratings of low, medium, or high concern for the following criteria:

- Infiltration assessment method
- Soil texture classification
- Variability of soil across site
- Depth to groundwater or impervious layer
- Tributary area size
- Level of pretreatment / Expected influent sediment load
- Redundancy of treatment
- Compaction during construction

The field measured infiltration rate is divided by the infiltration safety factor to obtain the design infiltration rate. The design safety factor must be 2.0 or greater (cannot be less than 2.0) and less than 9. A safety factor greater than 9 can be used at the discretion of the design engineer.

Some infiltration BMPs may be considered "Class V Injection Wells" under the federal Underground Injection Control (UIC) Program regulated in California by U.S. EPA Region 9. The project proponent must assess whether a UIC permit is required (*http://www.epa.gov/region9/water/groundwater/uic-classv.html*).

The following sections describe BMPs that can be used to retain runoff on-site. The methods for estimating the runoff volume retained from each BMP type, including specific equations and references for design details, are provided in Table 5-4.

5.4.2.1 Infiltration basin

An infiltration basin consists of an earthen basin constructed in naturally pervious soils with a flat bottom. An energy dissipating inlet must be provided, along with an emergency spillway to control excess flows. A forebay settling basin or separate treatment control measure must be provided as pretreatment. An infiltration basin allows retained runoff to percolate into the underlying soils in 48 hours or less. The bottom of an infiltration basin is typically vegetated with dryland grasses or vegetative ground cover. Other types of vegetation are permissible if they can survive periodic inundation and long inter-event dry periods.

The retention volume provided by an infiltration basin is a function of the infiltrating surface area on the basin bottom and the depth of water that is percolated and stored in the basin over the course of the storm and infiltrated within 48 hours after the basin is filled (see Table 5-4).

5.4.2.2 Infiltration trench

An infiltration trench is a long, narrow, rock-filled trench with no outlet other than an overflow outlet. Runoff is stored in the void space between stones and infiltrates through the bottom and sides of the trench. Pretreatment is important for limiting amounts of coarse sediment entering the trench which can clog and render the trench ineffective.

Retention volume provided by an infiltration trench is a function of the infiltrating surface area on the trench bottom and the depth of water that is either percolated over the course of the storm or stored within the BMP for percolation into underlying soils following the storm (Table 5-4). The volume of water that is stored in the trench includes both pore water in the trench gravel layer as well as up to one foot of allowable ponding above the gravel layer. Allowable ponding is limited by the requirement to drawdown ponded water within 48 hours following a storm event.

5.4.2.3 Bioretention with no Underdrain

Bioretention stormwater treatment facilities are shallow landscaped depressions that capture and filter stormwater runoff. These facilities function as a soil and plant-based filtration device that removes pollutants through a variety of physical, biological, and chemical treatment processes. The facilities normally consist of a ponding area, mulch layer, planting soils, and plants. As stormwater passes down through the planting soil, pollutants are filtered, adsorbed, and biodegraded by the soil and plants.

Retention volume provided by a bioretention BMP with no underdrain is a function of the infiltrating surface area on the bioretention bottom and the depth of water that is either percolated over the course of the storm or stored within the BMP for percolation into underlying soils following the storm (Table 5-4). The volume of water that is stored in a bioretention area includes pore water in the amended soil and gravel layers as well as up to 1.5 ft of allowable ponding above the ammended soil layer. Allowable ponding is limited by the requirement to draw down ponded water within 48 hours following a storm event. The pore water can be stored for extended periods of time, which is necessary to support plants.

5.4.2.4 Drywell

Drywells are similar to infiltration trenches in their design and function, but generally have a greater depth to footprint area ratio and can be installed at relatively large depths. A drywell is a subsurface storage facility designed to temporarily store and infiltrate runoff, primarily from rooftops or other impervious areas with low pollutant loading. A drywell may be either a small excavated pit filled with aggregate or a prefabricated storage chamber or pipe segment. Drywells can be used to reduce the volume of runoff from roofs. While roofs are generally not a significant source of stormwater pollutants, they can be a major contributor of runoff volumes. Therefore, drywells can indirectly enhance water quality by reducing the DCV that must be treated by other, downstream stormwater management facilities. Note: A drywell is considered a "Class V Injection Wells" under the federal Underground Injection Control (UIC) Program regulated in California by U.S. EPA Region 9.

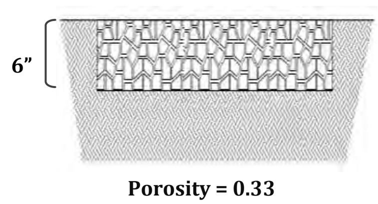
Retention volume provided by a drywell is a function of the infiltrating surface area into soils underlying and surrounding the drywell and the depth of water that is either percolated over the course of the storm or stored within the BMP for percolation into soils following the storm (Table 5-4). Volume retention is estimated similarly to an infiltration trench; however, there is not surface ponding to account for when evaluating drywells. The same equation is used to estimate retention in permeable pavement and underground infiltration BMPs.

5.4.2.5 Permeable Pavement

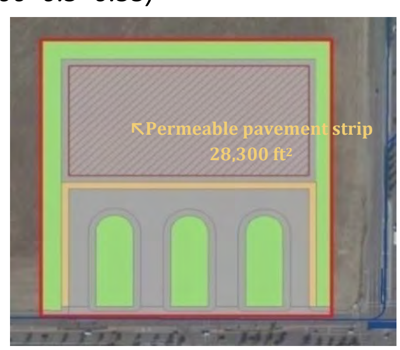
Permeable pavement BMPs contain small voids that allow water to pass through to a gravel base. Permeable pavement comes in a variety of forms, including modular paving systems (concrete pavers, grass-pave, or gravel-pave) or poured in place pervious pavement (porous concrete, permeable asphalt). All permeable pavements treat stormwater and remove sediments and metals to some degree within the pavement pore space and gravel base.

Case Study 1 Application of Permeable Pavement Infiltration

- Field measured infiltration = 3 in/hr
- Infiltration safety factor = 3.0
- $V_{ret} = (P_{design} / 12 * SA_{inf} * T_{fill}) + (SA_{resevoir} * d_{resevoir} * n_{aggregate})$
- $V_{ret} = (1*28,300*3/12) + (28,300*0.5*0.33) = 11,745\ ft^3$



Cross-Section (not to scale)



While conventional pavement results in increased rates and volumes of stormwater and non-stormwater runoff, properly constructed and maintained porous pavement BMPs allow stormwater to percolate through the pavement and enter the soil below.

This facilitates groundwater recharge while providing the structural and functional features needed for the roadway, parking lot, or sidewalk. The paving surface, subgrade, and installation requirements of permeable pavements are more complex than those for conventional asphalt or concrete surfaces. For permeable pavement BMPs to function properly over an expected life span of 15 to 20 years, they must be properly sited, carefully designed and installed, and periodically maintained. Failure to protect paved areas from construction-related sediment loads can result in their premature clogging and failure.

Retention volume provided by permeable pavement is a function of the infiltrating surface area into underlying soils and the depth of water that is either percolated over the course of the storm or stored within the BMP for percolation into soils following the storm (Table 5-4). Volume retention is estimated using the same equation as used for drywells and undergound infiltration.

5.4.2.6 Underground Infiltration

Underground infiltration BMPs typically include a vault or chamber with an open bottom that is used to store runoff and infiltrate the runoff into the subsurface soils and aquifer. A number of vendors offer proprietary products that allow for similar or enhanced rates of infiltration and subsurface storage while offering durable prefabricated structures. There are many varieties of proprietary infiltration BMPs that can be used for roads and parking lots, parks and open spaces, single and multi-family residential, or mixed-use and commercial uses.

Retention volume provided by underground infiltration is a function of the surface area infiltrating into underlying soils and the depth of water that is either percolated over the course of the storm or stored within the BMP for percolation into soils following the storm (Table 5-4). Volume retention is estimated using the same equation as used for drywells and permeable pavement.

5.4.3 Harvest and Use BMPs

Harvest and use BMPs are BMPs that capture and store stormwater runoff for later on-site use. These BMPs are engineered to store a specified volume of water and have no design surface discharge until this volume is exceeded. The use of captured water used should comply with codes and regulations and should not result in runoff to storm drains or receiving waters (except indirectly via the sanitary sewer/municipal wastewater treatment system). Uses of captured water may potentially include irrigation demand, indoor non-potable demand, industrial process water demand, or other demands. This document provides guidance for irrigation use. Use of harvested stormwater for other non-potable demands shall be evaluated on a case-by-case basis by local jurisdictions. Harvest and use BMPs involve either above ground (cisterns) or below ground storage of harvested water for subsequent on-site use as follows:

- Cisterns are large rain barrels. While rain barrels are less than 100 gallons (see Section 5.4.1.5 for information on small residential rain barrels as HSC), cisterns range from 100 to more than 10,000 gallons in capacity. Cisterns collect and temporarily store runoff from rooftops for later use as irrigation and/or other non-potable uses. The following components are generally required for installing and utilizing a cistern: (1) pipes that divert rooftop runoff to the cistern, (2) an overflow for when the cistern is full, (3) a pump (unless the site is designed such that the water can be distibuted to the use by gravity such as drip irrigation systems), and (4) a distribution system to supply the intended end uses.

- Underground detention facilities are subsurface tanks, vaults, or oversized pipes that store stormwater runoff. Similar to cisterns, underground detention facilities can store water for later use as irrigation and/or other non-potable uses.

Volume retention from implementation of harvest and use BMPs is a function of the wet season irrigation demand for landscaped areas on the project site. The Inland Empire Landscape Alliance Model Water Ordinance includes a formula for estimating a project's annual Estimated Applied Water Use (EAWU) based on the landscaped area in square feet (LA), daily reference evaporation ($ETo_{wet\text{-}day}$), landscape coefficient (K_L), and irrigation efficiency (IE), as follows:

$$EAWU_{wet\text{-}day} = [\ LA * ETo_{wet\text{-}day} / 12 * K_L\ ] / IE$$

To calculate harvested water irrigation demand, monthly reference ET data was averaged to obtain a daily wet season ET of approximately 0.1 in/day based on several CIMIS stations in the vicinity of the Permit area. For planning level assessments of harvest and use potential, a landscape coefficient of 0.7 shall be used for active turf areas, and 0.35 for conservation landscaping (Orange County TGD Appendix X.2.5.2, (*http://www.waterboards.ca.gov/rwqcb8/water_issues/programs/stormwater/oc_permit.shtml*). For the MS4 Permit area, an assumption of 0.9 shall be used. Potential to harvest and use is typically a small fraction of the DCV in most potential projects given the low irrigation demand during the wet season. Sections 5.3.2.2 and 5.5.5 describe infeasibility criteria for harvest and use BMPs.

5.4.4 Biotreatment BMPs

Mitigative BMPs must be selected based on a hierarchy of controls (infiltration first, then harvest and use) and sized to capture the maximum feasible portion of the DCV. The portion of the DCV that is not retained is referred to as unmet. The first three categories of mitigative

BMPs (HSC, infiltration, and harvest and use) consist of BMPs that, if used properly, retain runoff on-site and therefore all pollutants in captured runoff are removed from discharges to the MS4. After evaluating HSC, infiltration, and harvest and use, vegetative BMPs that promote evapotranspiration, including bio-retention, biofiltration and biotreatment (collectively termed biotreatment BMPs), should be considered. Biotreatment BMPs do not retain all runoff on-site. While biotreatment BMPs can be designed to maximize evapotranspiration and retention, a portion of the unmet volume would be treated and subsequently discharged to the MS4. Consequently, selection of biotreatment BMPs for evaluation must consider the pollutants of concern for the project.

Biotreatment BMPs are a broad class of structural BMPs that treat stormwater using a suite of treatment mechanisms characteristic of biologically active systems to remove both suspended and dissolved pollutants in urban storm water runoff. All biotreatment BMPs include treatment mechanisms that employ soil microbes and plants. Biotreatment BMPs may be either flow-based (limited storage) or volume-based (storage a key design component) and be designed to treat and discharge urban stormwater runoff to a downstream conveyance system. Biotreatment BMPs should be designed to maximize infiltration and evapotranspiration even though they will result in discharge of runoff.

Table 5-5 provides ratings of pollutant removal effectiveness (low, medium, and high) for different types of biotreatment BMPs that employ different unit operations and processes (UOPs) to remove pollutants. At a minimum, WQMPs that rely upon biotreatment BMPs must include at least one BMP type that is given a medium or high rating for the pollutant of concern for the entire unmet volume. The performance ratings in this table are based on observed effluent quality, observed differences between influent and effluent quality (magnitude and significance), and the assumed UOPs provided by each BMP. In order for a BMP to achieve the level of performance anticipated by this table, the BMP must:

- Be designed to industry-adopted standards based on the criteria contained in the BMP Fact Sheets referenced in the table and additional requirements for biotreatment provided in Appendix E.
- Include the assumed UOPs listed in this table. BMPs not found on this list may be acceptable if they incorporate similar UOPs.

Operations and maintenance of biotreatment BMPs should emphasize preservation of hydraulic function and the promotion of robust biological processes. Biotreatment BMPs typically utilize “soft” infrastructure (e.g., vegetative slope stabilization as opposed to rip rap slope stabilization) and therefore require an adaptive approach to maintenance and performance enhancement, more typical of landscape maintenance than maintenance of hard infrastructure.

Note that while biotreatment BMPs promote and depend upon vegetation for effective performance, plant growth may damage facility infrastructure elements such as fencing, curbs, etc. This hazard can be mitigated by incorporating root barriers and/or through regular maintenance.

Biotreatment BMPs can be divided into two sub-categories:

- Volume-based biotreatment incorporating a significant amount of storage, maximizing evapotranspiration and infiltration, and delaying outflow of the remaining retained volume; and
- Flow-based biotreatment in which temporary storage is minimal, evapotranspiration and/or infiltration is limited to incidental losses, and most of the runoff is discharged following treatment by the combination of physical and biological processes inherent in the BMP design.

5.4.4.1 Volume-based biotreatment

Biotreatment achieved from implementing volume-based biotreatment BMPs is a function of the depth of water that is either treated over the course of the storm or stored within the BMP for evapotranspiration, infiltration and release following the storm (Table 5-6). Runoff stored in pore spaces, if applicable, can be detained for extended periods of time, which may be necessary to support the vegetation and maximize any potential infiltration. The outflow from the bioretention underdrains is sized to allow for 48 hour drawdown in retained water following a storm event. Allowable retention is limited by the requirement to drawdown retained water within 48 hours following a storm event in order to restore retention volume for a subsequent storm event. Several types of volume-based biotreatment BMPs may be considered when developing a Project WQMP, including:

- Bioretention / Planter Box with underdrains - Bioretention stormwater treatment facilities are shallow landscaped depressions that capture and filter stormwater runoff. The incorporation of an underdrain system that releases treated stormwater runoff changes the BMP from an on-site retention category to a biotreatment category. Use of underdrains is necessary in areas with low permeability native soils or steep slopes. The underdrain system routes the treated runoff not otherwise infiltrated or evapotranspirated to the storm drain system rather than depending entirely on infiltration or ET. These facilities function as a soil and plant-based filtration device that removes pollutants through a variety of physical, biological, and chemical treatment processes. The facilities normally consist of a ponding area, mulch layer, planting soils, and plants. As stormwater passes down through the planting soil, pollutants are filtered, adsorbed, biodegraded, and sequestered by the soil and plants. The volume of water that is stored includes pore water in the ammended soil and gravel layers (for bioretention areas) as well as up to 1.5 ft of allowable ponding above the amended soil layer.

Table 5-5. Relative Treatment Performance Ratings of Biotreatment BMPs

Unit Operations and Process	Assumed Principal Unit Operations and Processes Provided	Pathogens (Bacteria/Virus)	Metals	Nutrients: Nitrogen	Nutrients: Phosphorus	Sediment / Total Suspended Solids	Organic Compounds	Pesticides / Herbicides	Trash and Debris	Oil and Grease
Bioretention system	Particulate Settling Size Exclusion Inert Media Filtration Sorption / Ion Exchange Microbial Competition / Predation Biological Uptake	M	H	L	L	H	M	M	H	H
Bioretention system with internal water storage zone and nutrient sensitive media design	Bioretention UOPs, <u>plus</u>: Microbially Mediated Transformations (if designed with internal water storage zone)	M	H	M	M	H	M	M	H	H
Dry extended detention basin	Particulate Settling Size Exclusion Floatable Capture Vegetative Filtration (with low-flow channel)	L	L	L	M	M	L	L	H	M
Dry extended detention basin with vegetated sand filter outlet structure	Dry extended detention basin UOPs, <u>plus</u>: Inert Media Filtration	M	M	L	M	H	L	L	H	M
Vegetated Swale	Vegetative Filtration Sorption/Ion Exchange	L	M	L	L	M	M	M	M	M
Vegetated Filter Strip	Vegetative Filtration Sorption/Ion Exchange	L	M	L	L	M	M	M	L	M
Wet detention basins and constructed stormwater wetlands	Particulate Settling Size Exclusion Floatable Capture Sorption/Ion Exchange Microbially Mediated Transformations Microbial Competition/ Predation Biological Uptake Solar Irradiation	M	H	M	H	H	M	M	H	H
Proprietary Biotreatment and Treatment Control	Varies by product.	Expected performance should be based on evaluation of unit processes provided by BMP and available testing data. Approval is based on the discretion of the reviewing agency.								

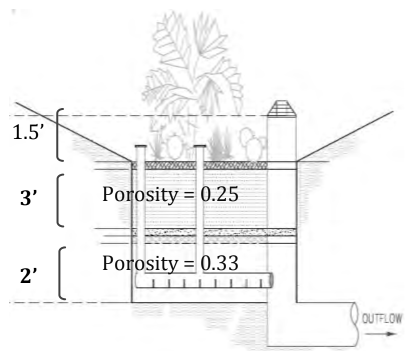
L = Low Effectiveness M = Medium Effectiveness H = High Effectiveness

<u>**Sources:**</u> Strecker, E.W ., W.C Huber, J.P. Heaney, D. Bodine, J.J. Sansalone, M.M. Quigley, D. Pankani, M. Leisenring, and P. Thayumanavan, "Critical assessment of Stormwater Treatment and Control Selection Issues." Water Environment Research Federation, Report No. 02-SW-1. ISBN 1-84339-741-2. 290pp
International Stormwater Best Management Practices (BMP) Database

Biotreatment volume calculation is similar to bioretention without underdrains, but applies a higher design percolation rate to account for infiltration into an amended soil layer and not underlying soils.

Case Study 2 Application of Bioretention with Underdrains

- Amended soil design percolation = 2.5 in/hr
- Surface area of each bioretention cell = 2,000 ft^2
- $V_{biotreated} = (P_{design}/12 * SA_{inf} * T_{fill}) + (SA_{ponded} * d_{ponded}/2) + (SA_{soild} * d_{soil} * n_{soil}) + (SA_{gravel} * d_{gravel} * n_{gravel})$
- Vret = (2.5/12 * 2,000 * 3) + (2,000 * 1.5/2) + (2,000 * 3.0 * 0.25) + (2,000 * 2.0 * 0.33) = 5,570 ft^3 in each cell



- Constructed wetland - A constructed wetland is a system consisting of a sediment forebay and one or more permanent micro-pools with aquatic vegetation covering a significant portion of the basin. Constructed treatment wetlands typically include components such as an inlet with energy dissipation, a sediment forebay for settling out coarse solids and to facilitate maintenance, shallow sections (1 to 2 feet deep) planted with emergent vegetation, deeper areas or micro pools (3 to 5 feet deep), and a water quality outlet structure. The interactions between the incoming stormwater runoff, aquatic vegetation, wetland soils, and the associated physical, chemical, and biological unit processes are a fundamental part of constructed wetlands. Biotreated volume is a function of the HRT for the facility (default is 48 hours for capture of frequent storms in the wet season), which is used to determine sizing criteria for wetland and outflow facilities.

- Wet detention basin – Wet detention basins are constructed, naturalistic ponds with a permanent or seasonal pool of water (also called a "wet pool" or "dead storage"). Aquascape facilities, such as artificial lakes, are a special form of wet pool facility that can incorporate innovative design elements to allow them to function as a stormwater treatment facility in addition to an aesthetic water feature. Wet ponds require base flows to exceed or match losses through evaporation and/or infiltration, and they must be designed with the outlet positioned and/or operated in such a way as to maintain a permanent pool. Wet ponds can be designed to provide extended detention of incoming flows using the volume above the permanent pool surface. Biotreated volume is a function of the HRT for the facility (default is 48 hours for capture of frequent storms in the wet season), which is used to determine sizing criteria for wetland and outflow facilities.

- Dry extended detention basin (DEDB) - DEDBs are basins whose outlets have been designed to detain stormwater runoff to allow particulates and associated pollutants to settle out. DEDBs do not have a permanent pool, but are designed to drain completely between storm events. They can also be used to provide hydromodification and/or flood control by modifying the outlet control structure and providing additional detention storage. The slopes, bottom, and forebay of DEDBs are typically vegetated. Considerable stormwater volume reduction can occur in DEDBs when they are located in permeable soils and are not lined with an impermeable barrier.

5.4.4.2 Flow-based biotreatment

Flow based biotreatment BMPs do not provide for significant storage of runoff, and therefore the treatment capacity must be sufficient to address the entire runoff hydrograph. Since the shape of the runoff hydrograph is not defined in the P_6 method for determining BMP performance criteria, an alternative approach was employed to evaluate the effectiveness of flow-based biotreatment BMPs. Section XI.D.6.a of the MS4 Permit allows for demonstration of 80 percent of long-term average annual runoff for sizing of BMPs included in a WQMP. This method was not selected for use in developing site-specific performance criteria for WQMPs in San Bernardino County. However, the basis for allowing for multiple methods to estimate site-specific performance criteria is so that application of either method will result in BMPs sized to capture and treat equivalent volumes of runoff. Accordingly, a BMP that is capable of capturing 80 percent of long-term average annual runoff capture is comparable to the capture of a single design storm as determined using the P_6 method.

The runoff treatment effectiveness of flow-based biotreatment BMPs was evaluated using a simplified continuous daily simulation analysis of long-term rainfall, runoff, and BMP performance. For each storm event in the period of record a mass balance of precipitation, runoff, treatment, and overflow was accounted using a hypothetical 1 acre impervious catchment. Precipitation is converted to runoff (BMP inflow) by subtracting estimated depth of depression storage (assumed to be 0.06 inches for the WQMP guidance development). Overflow of the flow-based treatment occurred when the runoff inflow exceeded the treatment capacity of the BMP. Flow-based BMPs can be designed to route higher flows, but with insufficient contact time with vegetation to provide biotreatment of pollutants. Aggregating results from each event provides an estimate of long term annual average capture. The long-term simulation was run for the same hypothetical 1 acre impervious catchment with varying treatment capacities to develop a relationship between on-site treatment capacity and long-term average annual runoff capture. To account for different rainfall patterns in each

Table 5-6. Estimation methods for biotreatment BMPs

BMP Type	Runoff Volume Calculation	Variables	Fact Sheet Reference for Design Details
Constructed wetland / Extended wet detention / Dry extended detention	$V_{biotreated} = (S_{forebay} + S_{basin}) + \{ T_{fill} * (V_{forebay} + V_{basin}) / T_{drawdown} \}$ *where* $Q_{out} = (V_{forebay} + V_{basin}) / (T_{drawdown} * 3600)$	$S_{forebay,basin}$ = storage volume in forebay and main basin (ft^3), approximated by equation for volume of a rectangular frustam (Template Form 4.3-7 Item 8) $T_{drawdown}$ = drawdown time for stored runoff (hrs), default is 48 hours T_{fill} = duration of storm when biotreatment is occurring as basin is filling (hrs), default is 3 hours Q_{out} = capacity of outflow (cfs)	Riverside County LID BMP Manual Orange County TGD for Project WQMPs Appendix XIV
Bioretention with underdrain / Planter Box	$V_{biotreated} = (P_{design} / 12 * SA_{inf} * T_{fill}) + (SA_{ponded} * d_{ponded}/2) + (SA_{soil} * d_{soil} * n_{soil}) + (SA_{gravel} * d_{gravel} * n_{gravel})$ *where* $d_{ponded} \leq T_{drawdown} * P_{design} / 12$	P_{design} = design percolation rate into amended soil layer (in/hr), default 2.5 in/hr $SA_{amended\ soil}$ = surface area (ft^2) of amended soil layer of bioretention area and surface ponding $T_{drawdown}$ = drawdown time for stored runoff (hrs), default is 48 hours T_{fill} = duration of storm when biotreatment is occurring as basin is filling (hrs), default is 3 hours $d_{ponded,soil,gravel}$ = depth (ft) of ponding and gravel layers, zero ponding for planter box $n_{amended\ soil,\ gravel}$ = porosity of amended soil and gravel layer	Riverside County LID BMP Manual Orange County TGD for Project WQMPs Appendix XIV
Bioswale / Vegetated filter strip	$b = (Q_{design} * n / (1.49 * d^{1.67} * S^{0.5})$ *where* $b_{filter\ strip} \geq Q_{design} / 0.005$	b = bottom width (ft) of bioswale / vegetated filter strip Q_{design}= design flow capacity (cfs) as determined from Figure 5-2 n = Manning's roughness coefficient d = depth of flow (ft), vegetated filter strip not to exceed 1", bioswale not to exceed 2" if mowed or 4" if not mowed S = slope in direction of flow	Riverside County LID BMP Manual Orange County TGD for Project WQMPs Appendix XIV

climatic region in San Bernardino County, this analysis was conducted for two rainfall gauges that are representative of different climatic regions of the Valley (Carbon Canyon COOP 041520) and Mountain (Camp Angelus COOP 041369). The results of these continuous simulation models (Figure 5-2) were interpreted to estimate the treatment capacity needed to achieve the unmet volume after incorporating in the project, to the extent feasible, higher priority LID.

Once the necessary treatment capacity for sizing flow-based BMPs is determined from Figure 5-2, the Manning's equation shall be used to estimate bioswale sizing criteria to allow for a minimum of 10 minutes hydraulic residence time (HRT) and 100 feet length (Table 5-6). Table 5-6 shows the form of the Manning's equation to be used in evaluating flow-based BMPs as well as fact sheets to use in developing BMPs designs. Flow-based biotreatment BMPs include:

- Bioswale - Bioswales are open, shallow channels with low-lying vegetation covering the side slopes and bottom that collect and slowly convey runoff flow to downstream discharge points. Bioswales provide pollutant removal through settling and filtration in the vegetation (usually grasses) lining the channels. In addition to conveying storm water runoff, they provide the opportunity for volume reduction through infiltration and evapotranspiration, and reduce the flow velocity. Where soil conditions allow, volume reduction in bioswales can be enhanced by adding a gravel drainage layer underneath the swale allowing additional flows to be retained and infiltrated. Where slopes are shallow and soil conditions limit or prohibit infiltration, an underdrain system or low flow channel for dry weather flows may be required to minimize ponding and convey treated and/or dry weather flows to an acceptable discharge point. An effective bioswale achieves uniform sheet flow through a densely vegetated area for a period longer than 10 minutes. The vegetation in the swale can vary depending on its location within the project area, and is generally the choice of the designer, subject to the design criteria outlined in this section.

- Vegetated filter strip - Vegetated filter strips are designed to treat sheet flow runoff from adjacent impervious surfaces or intensive landscaped areas such as golf courses. Filter strips decrease runoff velocity, filter out total suspended solids and associated pollutants, and provide some infiltration into underlying soils. While some assimilation of dissolved constituents may occur, filter strips are generally more effective in trapping sediment and particulate-bound metals, nutrients, and pesticides. Filter strips are more effective when the runoff passes through the vegetation and thatch layer in the form of shallow, uniform flow. Biological and chemical processes may help break down pesticides, uptake metals, and utilize nutrients that are trapped in the filter.

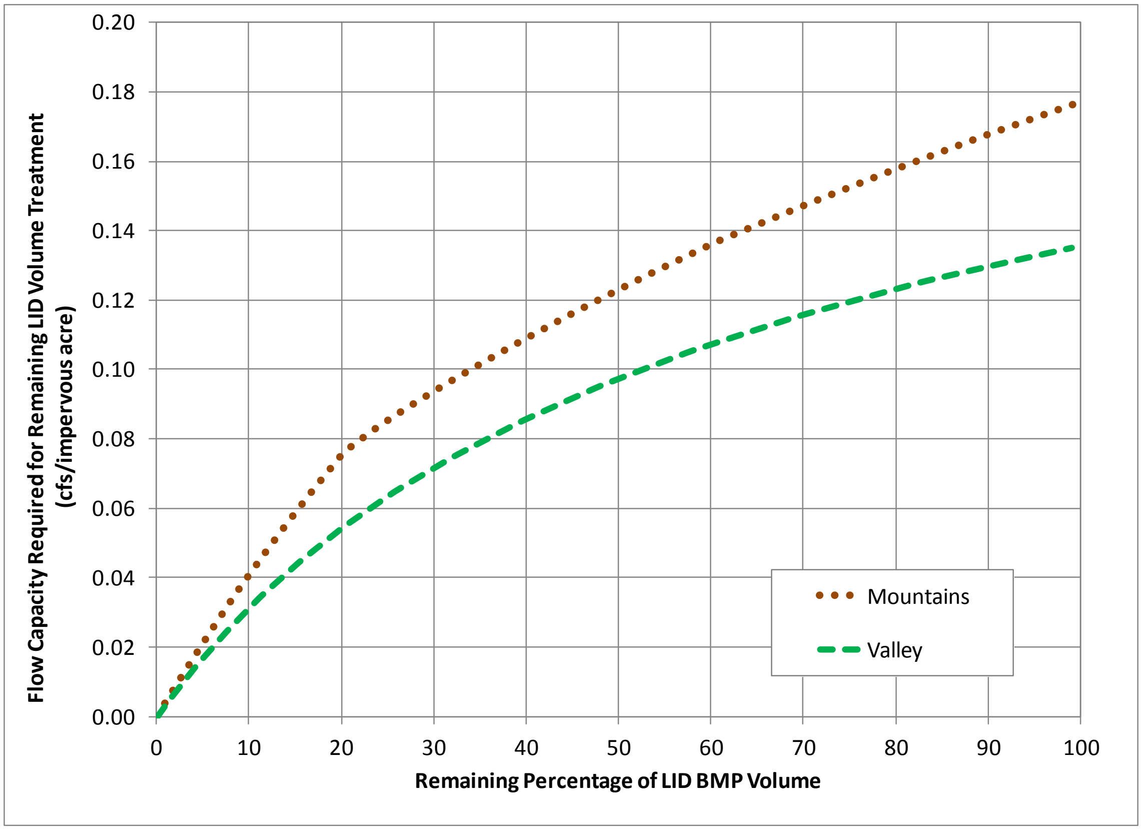


Figure 5-2. Nomograph for Determining Flow-based BMP Capacity Requirement to meet Remaining Unmet DCV

- Proprietary biotreatment - Proprietary biotreatment devices are devices that are manufactured to mimic natural systems such as bioretention areas by incorporating plants, soil, and microbes engineered to provide treatment at higher flow rates or volumes and with smaller footprints than their natural counterparts. Incoming flows are typically filtered through a planting media (mulch, compost, soil, plants, microbes, etc.) and either infiltrated or collected by an underdrain and delivered to the storm water conveyance system. Tree box filters are an increasingly common type of proprietary biotreatment device that are installed at curb level and filled with a bioretention type soil. For low to moderate flows they operate similarly to bioretention systems and are bypassed during high flows. Tree box filters are highly adaptable solutions that can be used in all types of development and soils but are especially applicable to urban parking lots, street, and roadways.

5.5 WQMP Conformance Analysis

Section 5.3.2 presented general feasibility criteria for determining project conditions that would preclude or restrict the use of one or more types of BMPs. This section describes specific, quantitative analyses to be conducted to determine the extent to which BMPs that are not excluded or limited from consideration can be used to meet the LID performance criteria.

The WQMP shall demonstrate how implementation of the combination of proposed preventive and mitigative measures are expected to achieve retention and/or treatment and release of the DCV. If it can be demonstrated that the DCV can be retained through a combination of infiltration BMPs, no additional analysis is required. Otherwise, the WQMPs must include an infeasibility analysis to objectively determine the amount of runoff that can be retained on-site by infiltration BMPs. The feasibility analysis must also evaluate how much of the DCV can be retained by harvest and use BMPs. If the analyses indicate that it is not feasible to retain the entire DCV through preventive, infiltration and/or harvest and use BMPs, then the Project Proponent must investigate the use of biotreatment BMPs. If the DCV can be retained and/or treated and released with BMPs designed in accordance with the methodologies described in Section 5.4, no additional BMPs are required to achieve the water quality requirement.

BMPs shall be designed to retain, infiltrate and/or biotreat the DCV to the MEP by applying the applicable feasibility criteria in the following subsections. The project proponent shall evaluate and implement BMPs to the MEP using the following hierarchy of priority:

1) Retention and infiltration BMPs
2) Harvest and Use BMPs
3) Volume-based Biotreatment BMPs
4) Flow-based Biotreatment BMPs
5) Alternative Compliance Plan, including off-site BMPs

The methods used to conduct an infeasibility analysis vary for the different types of BMPs under consideration. The following sections describe specific requirements to demonstrate that BMP implementation is infeasible, or that implementation of the BMP to the MEP does not mitigate the full DCV prior to considering other BMP types lower in the hierarchy for demonstrating conformance.

5.5.1 Criteria for MEP Determination

WQMP site designs shall incorporate BMPs to the MEP per the following criteria:

- At least the recommended portion of the site specified in Table 5-7 shall be provided in the site plans for surface plus subsurface BMPs. Local jurisdictions may develop a more stringent table (i.e., greater area required to be provided for BMPs) at their discretion; and

- The site shall be configured such that runoff can be routed to BMPs located in the available area(s) of the site; and
- The site shall be laid out such that BMPs are located over infiltrative soils with the highest percolation capacity as practicable given the constraints of the site, unless infiltration is infeasible for risk-based reasons identified in Section 5.3.2.1, and
- Satisfaction of these criteria shall be documented in exhibits or narrative descriptions.

OR

- A site specific study shall be prepared as part of the Project WQMP that documents that the site cannot be designed to allow at least the recommended percentage of area shown in Table 5-7 for BMPs. The study may consider:
  - Site conditions/constraints (e.g., depth to groundwater, topography, existing utilities)
  - Zoning/code requirements (e.g., target density, accessibility, traffic circulation, health and safety, setbacks, etc.)
  - Economic feasibility

Table 5-7 provides the minimum percentage of a project site that is necessary to demonstrate MEP implementation of on-site retention and infiltration and biotreatment of the DCV using LID BMPs. The project proponent may provide additional area for BMPs, if desired. Table 5-7 is intended to be used as follows:

- If a Project Proponent proposes to demonstrate that it is infeasible to retain and infiltrate the entire DCV on-site, it is necessary to demonstrate that the area within the applicable DA provided for retention and infiltration equals or exceeds the project-type specific minimum effective area criteria listed in Table 5-7
- If the minimum effective area in Table 5-7 is not provided for LID BMPs and the full DCV is not managed on-site, the reviewer shall request that additional area be made available for BMPs in the site design until either the percentage of the site in Table 5-7 is provided or the entire DCV is retained and infiltrated on-site, whichever percentage is less.
- If 1) the Project Proponent has provided the minimum effective area within a DA, and 2) site constraints limit the use of BMPs to a single type, and 3) the specific BMP type is unable to mitigate more than 40% of the DCV, then the Project Proponent may consider that specific BMP to be “infeasible” and shall evaluate a BMP listed lower in the hierarchy for feasibility.

- If the percentage of the site made available for retention and infiltration, harvest and use, and biotreatment BMPs equals or exceeds the project-type specific minimum effective area criteria for BMPs and still does not achieve the DCV, then the unmet portion of the DCV must be addressed in an alternative compliance plan.
- To demonstrate infeasibility of on-site infiltration BMPs, the infiltration factor of safety will be based on project-specific considerations. Section 5.4.2 and Appendix D describe how to compute an infiltration safety factor and apply it in evaluating LID infiltration BMPs for full capture of DCV.

Table 5-7. Minimum Effective Area[1] Required for LID BMPs (surface + subsurface facilities) for Project WQMP to Demonstrate Infeasibility[2] (% of site)

Project Type	New Development	Redevelopment
SF/MF Residential < 7 du/ac	10%	5%
SF/MF Residential 7 – 18 du/ac	7%	3.5%
SF/MF Residential > 18 du/ac	5%	2.5%
Mixed Use, Commercial/Industrial w/ FAR < 1.0	10%	5%
Mixed Use, Commercial/Industrial w/ FAR 1.0 – 2.0	7%	3.5%
Mixed Use, Commercial/Industrial w/ FAR > 2.0	5%	2.5%
Podium (parking under > 75% of project)	3%	1.5%
Zoning allowing development to property lines	2%	1%
Transit Oriented Development[3]	5%	2.5%
Parking	5%	2.5%

[1] "Effective area" is defined as area which 1) is suitable for a BMP (for example, if infiltration is potentially feasible for the site based on infeasibility criteria, infiltration must be allowed over this area) and 2) receives runoff from impervious areas.
[2] Criteria for only required if the Project WQMP seeks to demonstrate that the full DCV cannot be feasibly managed on-site.
[3] Transit oriented development is defined as a development with development center within 1/2 mile of a mass transit center.
Key: du/ac = dwelling units per acre, FAR = Floor Area Ratio = ratio of gross floor area of building to gross lot area, MF = Multi Family, SF = Single Family

Local jurisdictions may choose to develop analogous tables that are more, but not less stringent (i.e., higher areas required to be provided) than Table 5-7 (consult the LIP). Projects that demonstrate BMPs are capable of retaining the full DCV (as documented by the Project WQMP) are not required to demonstrate that they meet these minimum criteria for BMP effective area.

If implementation of biotreatment is determined to be infeasible to control the remaining portion of the DCV, then an alternative compliance approach must be developed per Section

XI.E.10 of the MS4 Permit. Section 6 describes the process of developing an alternative compliance plan.

If HCOC must be addressed in the project WQMP, additional BMPs or BMP capacity may be required. Section 5.6 describes these additional requirements. If there are no HCOC present, no additional analyses are required.

5.5.2 Hydrologic Source Controls

Section XI.E of the Permit sets forth the RWQCB's intent to advance and promote the use of LID site design techniques and HSC to minimize a development's impact on the hydrologic cycle. Further, the Permit emphasizes the use of LID preventative measures over mitigative measures. Section 5.2 of this TGD identifies the LID preventative measures consistent with the requirements of Section XI.E of the Permit. In addition, the use of LID site design techniques and the on-site retention of runoff in site HSC BMPs reduces the portion of the DCV that must be addressed in downstream BMPs. For large drainage areas, LID tools are a valuable aid in assisting the project proponent to comply with the requirement for the post-development runoff condition to mimic the pre-development runoff condition.

All applicable HSC shall be provided except where they are mutually exclusive with each other, or with BMPs. Mutual exclusivity may result from overlapping BMP footprints such that either would be potentially feasible by itself, but both could not be implemented

Please note that while there are no numeric standards regarding the use of HSC, if a project cannot feasibly meet BMP sizing requirements or cannot fully address HCOCs, feasibility of all applicable HSC must be part of demonstrating that the BMP system has been designed to retain the maximum feasible portion of the DCV.

5.5.3 LID Infiltration BMPs

This section provides criteria that shall be met to demonstrate that infiltration BMPs have been designed to retain stormwater design volume to the MEP.

- Site design allowances for infiltration BMPs shall meet or exceed project-type specific minimum effective area criteria (see Table 5-7). If the full DCV can be mitigated using infiltration BMPs that occupy a footprint smaller than the project-type specific minimum effective area criteria, then no additional area need be used.

- If individual retention and infiltration, and/or harvest and use BMP (Section 5.5.4) are infeasible or unable to treat the entire DCV, evaluate the use of combinations of LID BMPs to maximize on-site retention of the DCV. If no combination of BMP can mitigate the entire DCV, implement the single BMP type, or combination of BMP types, that maximizes on-site retention of the DCV within the minimum effective area in each DA.

- If the full DCV ***cannot*** be mitigated using infiltration BMPs (after optimizing their use) that occupy a footprint greater than or equal to the project-type specific minimum effective area criteria, the Project Proponent may use BMPs that are lower in the hierarchy; and
- If the full DCV ***cannot*** be mitigated using a combination of retention and infiltration, harvest and use, and biotreatment BMPs that occupy a footprint equal to or greater than the project-type specific minimum effective area criteria, then the unmet portion of the DCV must be addressed in an Alternative Compliance Plan (Section 6)

5.5.4 Harvest and Use BMPs

Demonstration that harvest and use BMPs have been designed to retain the DCV to the MEP requires computation of the wet season irrigation demand for landscaped areas on the project site compared with the DCV, per the formula provided in the Inland Empire Landscape Alliance Model Water Ordinance (see Section 5.4.3). If the entire project site landscaped area wet season demand over a 48-hour period is less than 50 percent of the DCV, then use of harvest and use BMPs can be determined to be infeasible.

To simplify WQMP development, Table 5-8 provides estimates of wet season irrigation demand per impervious acre of drainage area that would be needed to exceed the minimum incremental benefit threshold for use of harvest and use BMPs. Certain project types may be required to include harvest and use, where there is a low imperviousness and high irrigation demand, such as schools, institutional campuses, parks or golf courses.

5.5.5 Biotreatment BMPs

This section provides criteria for adding biotreatment BMPs to a WQMP to manage the remaining DCV to the MEP. If retention and infiltration BMPs have been implemented to the MEP (see Section 5.5.3), and there is still remaining DCV requiring mitigation, biotreatment BMPs shall be added to the system. Biotreatment BMPs shall be implemented such that the footprint of the BMP shall provide for sufficient sizing to treat the entire remaining DCV.

Any stormwater DCV that remains after evaluating biotreatment BMPs alone or in combination with on-site retention and/or infiltration shall be considered infeasible to retain or biotreat on-site and alternative compliance obligations shall be computed as described in Section 6.

Table 5-8. Infeasibility Thresholds for Consideration of Harvest and Use BMPs

P_6 Mean Storm Depth (in)	Harvested Water Demand Needed to Equal or Exceed Minimum Benefit Threshold[1] (cfd/impervious acre)
0.70	1,112
0.80	1,271
0.90	1,430
1.00	1,589
1.10	1,748
1.20	1,907
1.30	2,066
1.40	2,225
1.50	2,384
1.60	2,542
1.70	2,701
1.80	2,860
1.90	3,019
2.00	3,178
2.10	3,337
2.20	3,496
2.30	3,655

[1] Projects with 48-hour wet season irrigation demand below these values can determine infeasibility for harvest and use BMPs and consider use of biotreatment BMPs for remaining DCV

5.5.6 Case Study Conformance Analysis

Selection and evaluation of potential BMPs to address the DCV were completed for the two case studies described in Section 4.3 (Figure 5-3). Table 5-9 shows how the DCV for the two case studies is achieved using a variety of BMPs. The commercial case study, located in an area of highly permeable soils, shows that the DCV is retained on-site using a combination of street trees, permeable pavement, and bioretention without underdrains. For the residential case study, assume infeasibility determinations were completed for infiltration (less than 0.3 in/hr design infiltration rate in underlying soils) and harvest and use BMPs (on-site irrigation demand is < 1,000 cfd/impervious acre) types. Therefore, the full DCV from each DA is addressed with biotreatment BMPs, including both bioretention with underdrains (volume-based BMP) and a bioswale (flow-based BMP).

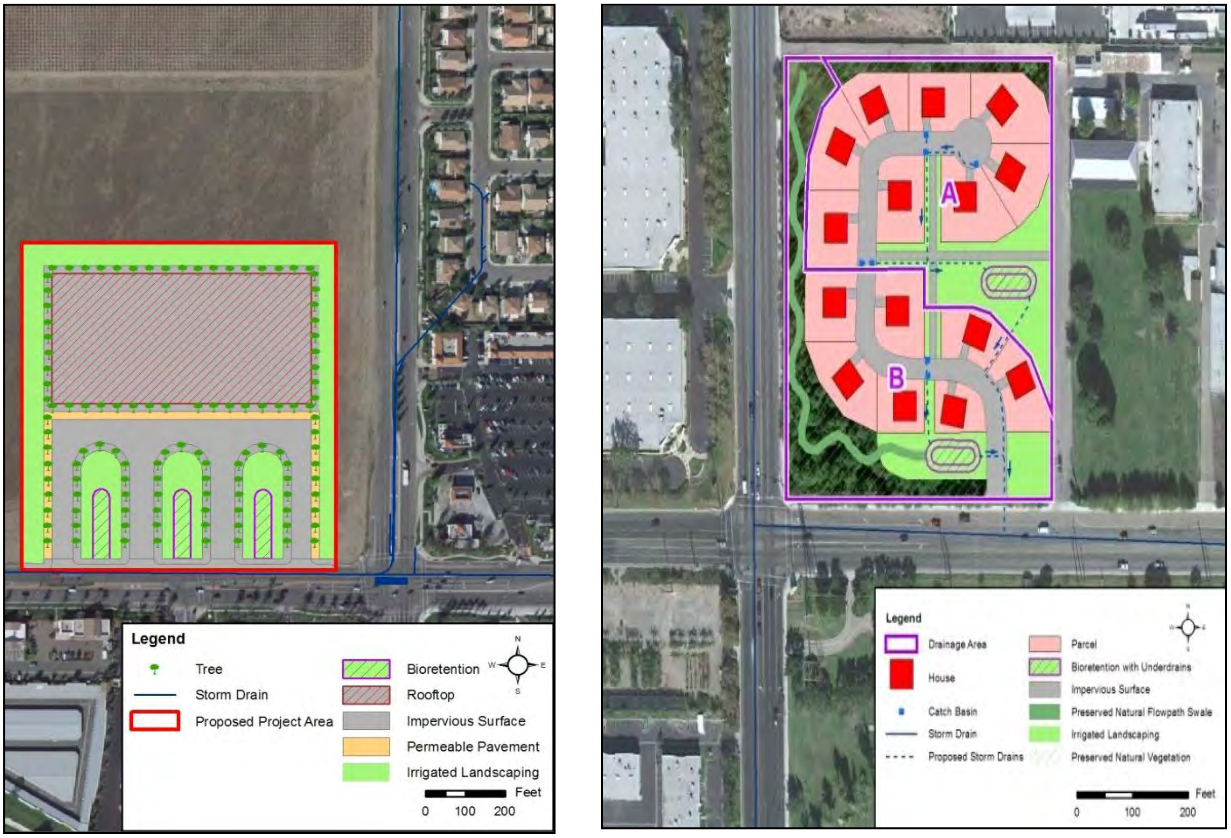


Figure 5-3. WQMP Site Design for Commercial and Residential Case Studies

Table 5-9. Summary of Conformance Analysis for Case Studies

Case Study 1: Commercial project overlying highly permeable soils	Project	Case Study 2: Residential project overlying HSG C soils	DA A	DA B
Design Capture Volume (ft^3)	49,245	Design Capture Volume (ft^3)	4,511	5,638
Retention/Biotreatment in LID BMPs (ft^3)		Retention/Biotreatment in LID BMPs (ft^3)		
Street Trees (ft^3)	475	Bioretention with underdrains	4,905	4,905
Permeable Pavement (ft^3)	18,829	Surplus/(Deficit) Volume Capture (ft^3)	(394)	733
Bioretention without underdrains (ft^3)	30,344	Flow-based biotreatment (cfs)		
Surplus/(Deficit) Volume Capture (ft^3)	(403)	Bioswale	n/a	0.17

5.6 Hydromodification Control

5.6.1 Incorporating Hydromodification into Project WQMPs

Hydromodification control refers to the methods used to address HCOC in a project WQMP. Hydromodification control BMPs range from structural BMPs designed to control flow duration to in-stream measures such as grade control structures. In-stream measures can be desirable where stream channels are already degraded due to hydromodification caused by existing development. There are various alternatives for siting hydromodification control measures, including on-site, in-stream, and regional.

The BMPs included in the WQMP will help contribute to meeting HCOC requirements. The volume of runoff retained by BMPs to meet the water quality DCV will typically serve to reduce the volume computed for the post-developed condition for a 2-year, 24-hour storm event. BMPs will also substantially reduce the post-developed condition runoff hydrograph, including the time of concentration and peak runoff when compared to the potential resulting post-development hydrograph if no BMPs were incorporated. HCOC performance criteria for time of concentration and peak runoff require matching of pre- and post- developed conditions within 5 percent. Inclusion of mitigative BMPs that retain or detain on-site runoff, may make it physically impossible for a project to avoid increasing the time of concentration of a site and reducing peak runoff by more than five percent. These changes to a site's hydrologic regime are less of a concern for downstream HCOCs, as they serve to reduce the frequency of erosive conditions. Therefore, it is interpreted that the five percent post-developed matching criteria only applies to decreases in time of concentration and increases in runoff volume and peak flow rate, which could cause increases in frequency of erosive conditions.

Where necessary, the following steps shall be used to address HCOCs in project WQMP:

- *Step 1:* For a project upstream of non-EHM receiving channels, the WQMP must evaluate the extent to which implementation of BMPs will address runoff volume, time of concentration, and peak flow performance criteria to meet HCOC requirements. If there is still additional HCOC volume reduction needed that is not addressed by BMPs, the project WQMP should consider increasing the size of on-site retention and/or investigate and identify off-site controls to mitigate the additional volume reduction requirements. If additional retention volume can be provided on-site, a revised project layout and preliminary design should be developed to add this volume. If additional volume cannot be provided, then the project shall proceed to Step 2.
- *Step 2:* A site-specific evaluation may be conducted to determine whether an opportunity exists to mitigate potential impacts through in-stream controls. The site-specific evaluation may find that in-stream controls can be feasibly implemented in combination

with on-site and regional volume retention such that the project will not adversely impact downstream erosion and sedimentation cycles, or stream habitat. If in-stream controls can be identified to address the HCOCs, the description and design features must be included in the Project WQMP along with documentation demonstrating that the project and proposed system will not adversely impact downstream erosion and sedimentation cycles, or stream habitat. This approach, including its effectiveness in addressing HCOC and the environmental impacts of any in-stream controls must be analyzed by the local jurisdiction pursuant to CEQA, and the necessary permits from regulatory agencies must be obtained.

- *Step 3:* If the HCOC cannot be feasibly mitigated through one of the above approaches, then the project must participate in an alternative or in-lieu program as described in Section 6.

5.6.2 Hydromodification Control BMPs

5.6.2.1 Detention/Retention Basins

Detention/retention basins are stormwater management facilities that are designed to detain and infiltrate runoff from one or multiple projects or project areas. These basins are typically shallow with flat, vegetated bottoms. Detention/retention basins can be constructed by either excavating a depression or building a berm to create above ground storage. It is clearly advantageous to locate a basin, such that runoff can drain from the project site into the basin by gravity and avoid the need for pumping. Runoff is stored in the basin as well as in the pore spaces of the surface soils.

Detention/retention basins for hydromodification management incorporate outlet structures designed for flow duration control. These basins can also be designed to support flood control and water quality treatment objectives in addition to hydromodification. If underlying soils are not suitable for infiltration, the basin may be designed for flow detention only, with alternative practices to manage increased volumes, such as storage and use, discharge at a rate below the critical rate for adverse impacts, or discharge to a non-susceptible water body. Pretreatment BMPs such as swales, filter strips, and sedimentation forebays minimize fine sediment loading to the basins, thereby reducing maintenance frequencies.

Detention/retention basins should be designed to receive flows from developed areas only, both to optimize design and reduce size, as well as to avoid intercepting coarse sediments from unimproved open spaces that should ideally be passed through to the stream channel. Reduction in coarse sediment loads contributes to downstream channel instability.

For outdoor recreational areas that are undeveloped, but nevertheless impacted and disturbed by these activities, water quality basins are recommended for intercepting runoff, thereby mitigating accelerated erosion and sediment transport from these areas.

5.6.2.2 In-Stream Controls

Hydromodification management can also be achieved by in-stream controls, including drop structures, bed and bank reinforcement, and grade control structures.

- *Drop Structures* - Drop structures are designed to reduce the channel slope, thereby reducing the shear stresses generated by stream flows. These controls can be incorporated as natural appearing rock structures with a step-pool design which allows drop energy to be dissipated in the pools while providing a reduced longitudinal slope between structures.
- *Grade Control Structures* - Grade control structures are designed to maintain the existing channel slope while allowing for minor amounts of local scour. These control measures are often buried and would entail a narrow trench across the width of the stream backfilled with concrete or similar material, as well as the creation of a "plunge pool" feature on the downstream side of the sill by placing boulders and vegetation. A grade control option provides a reduced footprint and impact compared to drop structures, which are designed to alter the channel slope.
- *Bed and Bank Reinforcement* - Channel reinforcement serves to increase bed and bank resistance to stream flows. In addition to conventional techniques such as riprap and concrete, a number of vegetated approaches are increasingly utilized, including products such as vegetated reinforcement mats. This technology provides erosion control with an open-weave material that stabilizes bed and bank surfaces and allows for re-establishment of native plants, which serves to further increase channel stability.

Section 6 – Alternative Compliance Plan

6.1 Introduction

If a Priority Project is not able to fully meet LID requirements based on implementing site design and on-site LID BMPs, nor through participation in available regional/sub-regional LID projects that have been previously identified and approved in the WAP, then a project proponent must develop an alternative compliance plan to address the remainder of the DCV that is neither retained nor treated and released through LID BMPs, either on- or off-site in an approved regional/sub-regional project. Also, some projects may qualify for Water Quality Credits that can be applied to reduce or fully satisfy the remaining DCV that must be treated before evaluating alternative approaches.

These alternative plans may include:

- Implementing on-site treatment control BMPs, sized to treat remaining design capture volume, or
- Implementing off-site watershed-based treatment control BMPs, or
- Contributing to an in-lieu fund, if available, or
- A combination of the above three options, to address all remaining DCV

If treatment control BMPs are used as a complete alternative compliance option, the performance of these BMPs must be compared to unmet LID DCV. The performance assessment must demonstrate that the volume treated by treatment control BMPs must be equal to the DCV for the project, minus any volume retained or treated by LID BMPs incorporated in the project, and that the treatment control BMPs have a medium or high effectiveness rating for removing the Pollutant(s) of Concern (POC) that cause impairment of the receiving water. If a treatment control BMP, or combination of BMPs, can achieve these objectives, the project is considered to be in compliance with the permit requirements and the WQMP can be completed. The WQMP must document the infeasibility analysis demonstrating why the DCV could not be fully met with LID BMPs. However, if the cost of treatment control BMP implementation greatly outweighs the pollution control benefits, a waiver of BMPs may be granted by the local jurisdiction as discussed in Section 6.4, and then the project proponent will be required to participate in an In-lieu fund (if available) or Mitigation Program as described in Section 6.5. The use of on-site treatment control BMPs are required before discharge to receiving waters, unless there are alternative compliance approaches, as identified in the approved WAP, to achieve equivalent or better water quality benefits, and not impair the beneficial uses of receiving waters.

Figure 6-1 is a flow chart illustrating the key steps in developing an alternative compliance plan. The following sections describe water quality credits, treatment control BMPs, waivers, in-lieu funds, mitigation programs, and off-site mitigation.

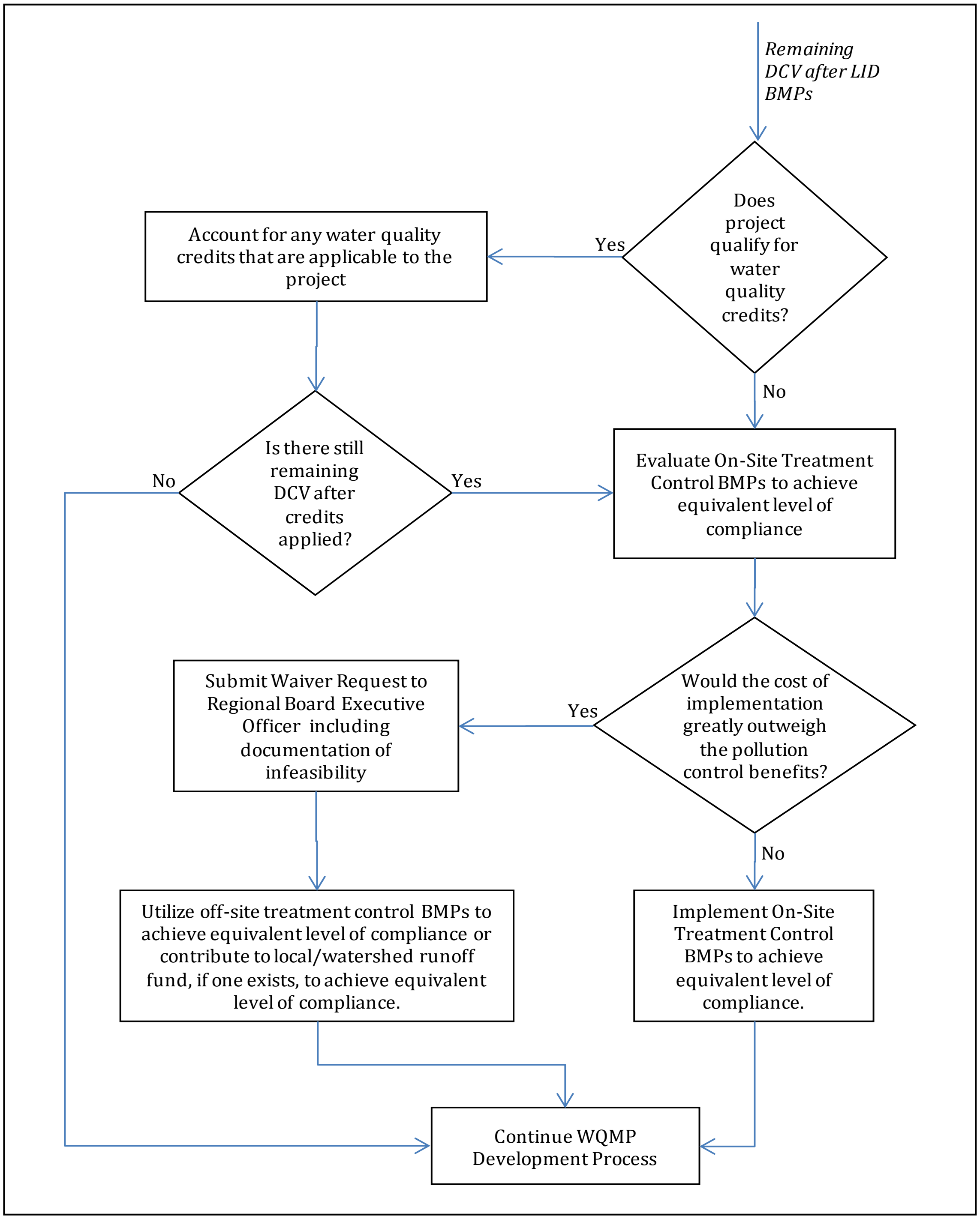


Figure 6-1. Alternative Compliance Plan Flowchart

6.2 Water Quality Credits

6.2.1 Qualifying Projects

For certain types of development projects, LID BMPs may be more difficult to incorporate due to the nature of the development, but the development practices may provide other environmental benefits to communities. For example, infiltration BMPs may not be desirable for a Brownfield re-development site where infiltrated stormwater could cause an adverse impact to groundwater supply, but re-development of the site would be expected to have other environmental benefits such as accelerated site clean-up. Alternatively, a re-development project could be implemented in a way that reduces the overall impervious footprint of the project site rather than increasing it.

Local jurisdictions may develop a water quality credit program that applies to certain types of development projects after they first evaluate the feasibility of meeting LID requirements on-site. If it is not feasible to meet the requirements for on-site LID, project proponents for specific project types can apply credits that would reduce project obligations for selecting and sizing other treatment control BMPs or participating in other alternative programs. Water quality credits can be applied before other alternative programs are evaluated and/or a Waiver request is submitted.

The Permit allows for credits to be applied for hydromodification requirements. Permittee may develop a credit system for hydromodification at a future date and submit this to the Executive Officer for approval.

Projects potentially eligible for consideration for water quality credits include:

- Re-development projects that reduce the overall impervious footprint of the project site;
- Brownfield re-development, meaning re-development, expansion, or reuse of real property which may be complicated by the presence or potential presence of hazardous substances, pollutants or contaminants, and which have the potential to contribute to adverse ground or surface water quality if not redeveloped (*http://www.epa.gov/brownfields/overview/glossary.htm*);
- Higher density development projects which include two distinct categories (credits can only be taken for one category):
- Those with more than seven units per acre of development (lower credit allowance);
- Vertical density developments, for example, those with a Floor to Area Ratio (FAR) of 2, or those having more than 18 units per acre (greater credit allowance);

- Mixed use development, such as a combination of residential, commercial, industrial, office, institutional, or other land uses which incorporate design principles that can demonstrate environmental benefits that would not be realized through single use projects (e.g. reduced vehicle trip traffic with the potential to reduce sources of water or air pollution);
- Transit-oriented developments, such as a mixed use residential or commercial area designed to maximize access to public transportation; similar to above criterion, but where the development center is within one half mile of a mass transit center (e.g. bus, rail, light rail or commuter train station). Such projects would not be able to take credit for both categories, but may have greater credit assigned;
- Developments with dedication of undeveloped portions to parks, preservation areas and other pervious uses;
- Developments in a city center area;
- Developments in historic districts or historic preservation areas;
- Live-work developments, a variety of developments designed to support residential and vocational needs together – similar to criteria to mixed use development; would not be able to take credit for both categories; and
- In-fill projects, the conversion of empty lots and other underused spaces, substantially surrounded by urban uses, into more beneficially used spaces, such as residential or commercial areas, as defined by the local jurisdiction;
- Developments where a regional treatment system has a capacity to treat flows;
- Developments with offsite mitigation or dedications within the same watershed:

This provision does not exempt the project proponent from first conducting the investigations to determine if it is feasible to fulfill the full LID, treatment control, and hydromodification requirements through a combination of site design practices and BMPs consistent with the permit hierarchy.

6.2.2 Applying Water Quality Credits

To determine the amount of credit a project would qualify for, the first step is to calculate the DCV that would need to be satisfied in the absence of any credits. Any credits would then be taken as a reduction to the DCV. For all categories of projects noted above, the remaining volume to be treated or mitigated would be reduced in accordance with portions of the DCV shown in Table 6-1.

Table 6-1. Water Quality Credits for Applicable Project Categories

Project Category	Water Quality Credit (% of DCV) [1]
Redevelopment projects that reduce the overall impervious footprint of the project site	Percentage of site imperviousness reduced
Historic district, historic preservation area, or similar areas	10%
Brownfield re-development	25%
Higher density development, 7 units/acre or more	5%
Higher density development, vertical density	20%
Mixed use development, transit oriented development or live-work development	20%
In-fill development	10%

1) Maximum total of water quality credits for a project is 50 percent

If more than one category applies to a particular project, the credit percentages would be additive. Applicable performance criteria depend on the number of LID water quality credits claimed by the proposed project. Water quality credits can be additive up to a maximum 50 percent reduction from a proposed project's obligation for sizing treatment control BMPs, contributing to an in-lieu fund, or off-site mitigation projects. The water quality credit would be calculated as the DCV of the proposed condition multiplied by the sum of the credit percentages claimed above.

6.3 Treatment Control BMPs

If it is not feasible to meet LID performance criteria through retention and/or biotreatment provided on-site or at a sub-regional/regional scale, then treatment control BMPs shall be provided on-site prior to discharge to receiving waters. Table 6-2 provides ratings of low, medium, and high for pollutant removal effectiveness for different types of treatment BMPs that employ different unit operations and processes (UOP) to remove pollutants. At a minimum, WQMP that rely upon treatment BMPs must include at least one BMP type that is given a medium or high rating for the POC that cause impairments of receiving waters, for the entire unmet volume. The performance ratings in this table are based on observed effluent quality, observed differences between influent and effluent quality (magnitude and significance), and the assumed UOP provided by each BMP. In order for a BMP to achieve the level of performance anticipated by this table, the BMP must:

- Be designed to industry-adopted design standards based on the criteria contained in the BMP Fact Sheets referenced in the table.

- Include the assumed UOP listed in this table. BMPs not found on this list may be acceptable if they incorporate similar UOP.

Table 6-2. Relative Treatment Performance Ratings of Treatment Control BMPss

Unit Operations and Process	Assumed Principal Unit Operations and Processes Provided	Pathogens (Bacteria / Virus)	Metals	Nutrients		Sediments / Turbidity	Organic Compounds	Oil and Grease	Trash and Debris
				Nitrogen	Phosphorus				
Sand Filter (inert)	Size Exclusion Floatable Capture Inert Media Filtration	M	L/M	L	M	H	L	H	H
Sand Filter (specialized Media)	Sand Filter UOPs, plus: Sorption/Ion Exchange	M	M/H	L	M	H	M	H	H
Cartridge Media Filter	Size Exclusion Floatable Capture Inert Media Filtration Sorption/Ion Exchange	M	M	L	M	M	M	H	H
Hydrodynamic Separator	Particulate Settling (coarse only) Size Exclusion Floatable Capture	L	L	L	L	M	L	M	H
Catch Basin Insert	Size Exclusion	L	L	L	L	L	L	M	H

L = Low Effectiveness M = Medium Effectiveness H = High Effectiveness

Sources: Strecker, E.W., W.C. Huber, J.P. Heaney, D. Bodine, J.J. Sansalone, M.M. Quigley, D. Pankani, M. Leisenring, and P. Thayumanavan, "Critical assessment of Stormwater Treatment and Control Selection Issues." Water Environment Research Federation, Report No. 02-SW-1. ISBN 1-84339-741-2. 290pp
International Stormwater Best Management Practices (BMP) Database

Sizing of treatment control BMPs shall be based on the unmet volume after claiming applicable water quality credits, if appropriate. If treatment control BMPs can treat all of the remaining unmet volume and have a medium to high effectiveness for reducing the primary POC causing an impairment of a receiving water, the project is considered to be in compliance; a waiver application and participation in an alternative program is not required.

If the cost of providing treatment control BMPs greatly outweighs the pollution control benefits they would provide, a waiver of treatment control and LID requirements can be requested and alternative compliance approaches must be used to fulfill the remaining unmet volume.

6.4 Waivers

Project proponents can apply for a waiver if it is determined to be infeasible to fulfill the LID performance requirements using either on-site LID practices, through regional LID approaches, through on-site treatment control BMPs, or through watershed approaches contained in the approved WAP. Only those proposed projects that have completed a rigorous feasibility analysis shall be considered for a BMP waiver. A Waiver Request is required if LID BMPs are infeasible and if the cost of treatment control BMPs implementation greatly outweighs the pollution control benefits.

Each local jurisdiction is to use the feasibility criteria described in Section 5.3 or 5.5 to evaluate if Waiver Requests have adequately documented infeasibility. Each jurisdiction will identify in its Local Implementation Plan (LIP) the individual(s) or position(s) that is (are) authorized to review and approve Waivers.

Before a local jurisdiction can approve an alternative compliance plan, a waiver request must be submitted to the local jurisdiction for approval and to the RWQCB Executive Officer in writing 30 days prior to approval by the local jurisdiction. If the RWQCB Executive Officer does not raise an objection to a waiver within 30 days of receiving a WQMP alternative compliance plan, the local jurisdiction may approve the waiver. Before approving a waiver and an alternative compliance plan, the local jurisdiction must determine that the project proponent’s alternative compliance plan meets the criteria described in Sections 5.3 or 5.5.

Project proponents that have been granted a waiver must comply with requirements for the alternative compliance plan proposed by the Project Proponent and approved by the Permittee for the proposed project to mitigate potential negative impacts on the watershed due to the infeasibility of fully implementing LID BMPs.

6.5 In-Lieu Fund

For projects granted a LID BMP Waiver, participation in an In-Lieu fund, if available, may be required. Payment into an In-Lieu fund can be used to address the runoff volume or pollutant load that is not addressed through LID BMPs or other alternative compliance options including treatment control BMPs described above. When an approved In-Lieu fund is available, participation in the program is allowable as long as the net effectiveness of the alternative program is the same or better than the project LID BMPs design capture and/or water quality volume that would be achieved with on-site compliance.

The following section describes a general basis and criteria for developing such programs. However, a specific program with established quantitative criteria and cost basis has not been established. It is expected that the local jurisdictions will develop a specific program and submit this to the RWQCB Executive Officer for future review and approval to allow specific projects to use this approach.

Payment into an In-Lieu fund can be an alternative to on-site treatment control if a waiver has been granted. The amount of the contribution will be based on the unmet difference between the combination of the project LID BMPs design capture and/or water quality volume that would be achieved through full compliance with on-site LID BMPs and the actual LID DCV that can be achieved through the combination of LID practices and treatment control BMPs that can be incorporated in the project. The basis for determining the “value” of the contribution will be determined by additional or future studies by the local jurisdictions.

Certain types of projects may qualify for water quality credits that reduce the LID DCV for the project. The details of the credit program and a description of eligible projects can be found in Section 6.2. Project proponents should determine if a project qualifies for credits and subtract the credited volume from the unmet DCV. If the project can meet the reduced target volume through a combination of LID BMPs or treatment control BMPs, no contribution to an in-lieu fund is required. If there is still an unmet obligation even after applying credits, then a contribution needs to be made to an in-lieu fund.

The In-Lieu fund must be expended for water quality improvement or other related projects. Examples of projects eligible for funding through an in-lieu fund include, but are not limited to:

- Green street projects
- Projects which retrofit existing development areas with LID and other BMPs to reduce existing pollutant loads
- Retrofit incentive programs
- Regional BMP / Sub-Regional BMP
- Stream restoration
- Projects which promote groundwater recharge to increase water supplies
- Other equivalent projects proposed by local jurisdictions

Section 7 – Source Control BMPs

7.1 Introduction

Source control BMPs reduce the potential for stormwater runoff and pollutants from coming into contact with one another. Source control BMPs are defined as any administrative action, structural facility design, usage of alternative materials, and site-specific operation, maintenance, inspection, and compliance activities that eliminate or reduce pollutants in stormwater runoff. Source control BMPs can be separated into non-structural and structural types. Non-structural type BMPs are those which involve a procedure or practice such as stormwater training or trash management and litter control practices, while structural source control BMPs have a physical or structural component to preventing pollutants from contacting stormwater runoff. Structural source control BMPs includes those such as inlet trash racks, trash bin covers, and an efficient irrigation system.

Source control BMPs are required to be incorporated into all new development and significant redevelopment projects, including those identified in an applicable regional watershed or TMDL management plan, unless they do not apply to the proposed project.

Sections 7.2 and 7.3 provide descriptions of non-structural (see Table 7-1) and structural (see Table 7-2) source control BMPs that must be considered when selecting BMPs applicable to the proposed project. The BMPs are numbered for purposes of the San Bernardino County Stormwater Program and Model WQMP.

Section 7.4 includes a Source Control BMPs Selection Worksheet (see Table 7-3), adapted from City of San Diego Countywide Model Standard Urban Stormwater Management Plan, which can assist project proponents in identifying appropriate non-structural and structural source control BMPs based on the potential sources of pollutants associated with the proposed project.

7.2 Non-Structural Source Control BMPs

Table 7-1 lists the non-structural source control BMPs that may be required in new development and significant redevelopment projects. This list can be referenced along with Section 7.4, Table 7-3 to assist in BMP selection when completing the WQMP. For purposes of the San Bernardino County Stormwater Program and the Model WQMP, each non-structural source control BMP is numbered with a WQMP reference identifier (e.g., N1, N2, etc). A cross reference to the California Stormwater Quality Association (CASQA) BMP Handbooks (2003) reference number is included in parentheses (e.g., SC-73), where applicable.

Table 7-1. Non-Structural Source Control BMPs

WQMP Reference Identifier	Non-Structural Source Control BMPs
N1	Education for Property Owners, Tenants, and Occupants
N2	Activity Restrictions
N3	Landscape Management (CASQA BMP Handbook SC-73)
N4	BMP Maintenance
N5	Title 22 CCR Compliance
N6	Local Water Quality Ordinance Compliance
N7	Spill Contingency Plan (CASQA BMP Handbook SC-11)
N8	Underground Storage Tank Compliance
N9	Hazardous Materials Disclosure Compliance
N10	Uniform Fire Code Implementation
N11	Litter Control (CASQA BMP Handbook SC-60)
N12	Employee Training
N13	Housekeeping of Loading Docks (CASQA BMP Handbook SD-31)
N14	Catch Basin Inspection (CASQA BMP Handbook SC-74)
N15	Vacuum Sweep Private Streets and Parking Lots (CASQA BMP Handbook SC-43, SC-70)
N16	Other Non-structural Measures for Public Agency Projects
N17	Comply with all other applicable NPDES permits

CASQA BMP Handbook for New Development and Redevelopment has source control BMP fact sheets referenced as "SD-##", while factsheets from the CASQA Industrial and Commercial BMP Handbook are designated as "SC-##".

- **(N1) Education for Property Owners, Tenants and Occupants** - For developments with no Property Owners Association (POA)[2] or with POA of less than fifty (50) dwelling units, practical information materials will be provided to the first residents/occupants/tenants on general housekeeping practices that contribute to the protection of stormwater quality. These materials will be initially developed and provided to first residents/occupants/tenants by the developer. Thereafter such materials will be available through the local jurisdiction's stormwater education program. Different materials for residential, office commercial, retail commercial, vehicle-related commercial and industrial uses have been developed.

[2] The term "Property Owners' Association" or POA, as used herein, means a nonprofit corporation or unincorporated association created for the purpose of managing a common interest development [from California Civil Code Sec. 1351 (a)].

- For developments with POA and residential projects of more than fifty (50) dwelling units, project conditions of approval will require that the POA periodically provide environmental awareness education materials, made available by the municipalities, to all members. Among other things, these materials will describe the use of chemicals (including household type) that should be limited to the property, with no discharge of wastes via hosing or other direct discharge to gutters, catch basins and storm drains. Educational materials available from the San Bernardino Stormwater Program and can be downloaded at: http://www.sbcountystormwater.org/gov_out.html
- **(N2) Activity Restrictions** - If a POA is formed, conditions, covenants and restrictions (CCRs) must be prepared by the developer for the purpose of surface water quality protection. An example would be not allowing car washing outside of established community car wash areas in multi-unit complexes. Alternatively, use restrictions may be developed by a building operator through lease terms, etc. These restrictions must be included in the Project WQMP.
- **(N3) Landscape Management (CASQA BMP Handbook SC-73)** - Identify on-going landscape maintenance requirements consistent with applicable local ordinances that may include fertilizer and/or pesticide usage. Statements regarding the specific applicable guidelines must be included in the Project WQMP.
- **(N4) BMP Maintenance** - Identify responsibility for implementation of each non-structural BMP and scheduled cleaning and/or maintenance of all structural BMP facilities.
- **(N5) Title 22 CCR Compliance** - Compliance with Title 22 of the California Code of Regulations (CCR) and relevant sections of the California Health & Safety Code regarding hazardous waste management is enforced by County Department of Environmental Health Services on behalf of the State. The Project WQMP must describe how the proposed development will comply with the applicable hazardous waste management section(s) of Title 22.
- **(N6) Local Water Quality Ordinances** – Comply with any applicable local water quality ordinances. The local jurisdiction, under local water quality ordinances, have authority to ensure clean stormwater discharges from fuel dispensing areas and other areas of concern to public properties.
- **(N7) Spill Contingency Plan (CASQA BMP Handbook SC-11)** – This Plan is prepared by the building operator for use by specified types of building or suite occupancies. The Plan mandates stockpiling of cleanup materials, notification of responsible agencies, disposal of cleanup materials, documentation, etc.

- (**N8) Underground Storage Tank Compliance** – This BMP addresses compliance with State regulations dealing with underground storage tanks, enforced by County Environmental Health Services on behalf of State.

- **(N9) Hazardous Materials Disclosure Compliance** - Compliance with local ordinances for the management of hazardous materials is typically enforced by local fire protection agencies. San Bernardino County, health care agencies, and/or other appropriate agencies (i.e. Department of Toxics Substances Control) are typically responsible for enforcing hazardous materials and hazardous waste handling and disposal regulations.

- **(N10) Uniform Fire Code Implementation** - Compliance with Article 80 of the Uniform Fire Code enforced by the fire protection agency.

- **(N11) Litter Control (CASQA BMP Handbook SC-60)** - For industrial/commercial developments and for developments with POAs, the owner/POA are required to implement trash management and litter control procedures in the common areas aimed at reducing pollution of drainage water. The owner/POA may contract with their landscape maintenance firms to provide this service during regularly scheduled maintenance, which should consist of litter patrol, emptying of trash receptacles in common areas, and noting trash disposal violations by tenants/homeowners or businesses and reporting the violations to the owner/POA for investigation.

- (**N12) Employee Training** – This BMP requires an education program (see N1) as it would apply to future employees of individual businesses. The developer prepares manual(s) for initial purchasers of a business site or for a development that is constructed for an unspecified use, the developer makes a commitment on behalf of POA or future business owner to prepare the training. An example would be a provision to provide training on the proper storage and use of fertilizers and pesticides, or training on the implementation of hazardous spill contingency plans.

- **(N13) Housekeeping of Loading Docks (CASQA BMP Handbook SD-31)** - Loading docks typically found at large retail and warehouse-type commercial and industrial facilities should be kept in a clean and orderly condition through a regular program of sweeping and litter control and immediate cleanup of spills and broken containers. Cleanup procedures should minimize or eliminate the use of water. If wash water is used, it must be disposed of in an approved manner and not discharged to the storm drain system. If there are no other alternatives, discharge of non-stormwater flow to the sanitary sewer may be considered only if allowed by the local sewerage agency through a permitted connection.

- **(N14) Catch Basin Inspection (CASQA BMP Handbook SC-74)** - For industrial/commercial developments and for developments with privately maintained drainage systems, the owner is required to have at least 80 percent of drainage facilities inspected, cleaned and maintained on an annual basis with 100 percent of the facilities included in a two-year period. Cleaning should take place in the late summer/early fall prior to the start of the rainy season. Drainage facilities include catch basins (storm drain inlets) detention basins, retention basins, sediment basins, open drainage channels and lift stations.

- **(N15) Vacuum Sweep Private Streets and Parking Lots (CASQA BMP Handbook SC-43, SC-70)** - Streets and parking lots are required to be swept on a regular frequency based usage and field observations of waste accumulation, using a vacuum assisted sweeper. At a minimum all paved areas of a business shall be swept, in late summer or early fall, prior to the start of the rainy season or equivalent, as required by the governing jurisdiction.
- **(N16) Other Non-structural Measures for Public Agency Projects** - Other non-structural measures shall be implemented and included in the Project WQMP as applicable for new public agency Priority Projects and as required by the local jurisdiction.
- **(N17) Other NPDES Permits, as applicable** – Permittees shall comply with other NPDES permits such as General Industrial permits, etc., to include BMPs that are required as part of a SWPPP.

7.3 Structural Source Control BMPs

Table 7-2 lists the structural source control BMPs that may be required in new development and significant redevelopment projects. These can be referenced with Section 7.4, Table 7-3, to assist in BMP selection for completing the Project WQMP. For purposes of the San Bernardino County Stormwater Program and WQMP Guidance, each structural source control BMP is numbered with a WQMP reference identifier (e.g., S1, S2, etc). A cross reference for the CASQA BMP Handbook Factsheet reference number is included in parentheses, where applicable.

Table 7-2. Structural Source Control BMPs

WQMP Reference Identifier	Structural Source Control BMPs
S1	Provide storm drain system stenciling and signage (CASQA BMP Handbook SD-13)
S2	Design and construct outdoor material storage areas to reduce pollution introduction (CASQA BMP Handbook SD-34)
S3	Design and construct trash and waste storage areas to reduce pollution introduction (CASQA BMP Handbook SD-32)
S4	Use efficient irrigation systems & landscape design, water conservation, smart controllers, and source control (Statewide Model Landscape Ordinance; CASQA BMP Handbook SD-12)
S5	Finished grade of landscaped areas
S6	Protect slopes and channels and provide energy dissipation
S7	Loading Dock areas (CASQA BMP Handbook SD-31)
S8	Maintenance bays (CASQA BMP Handbook SD-31)
S9	Vehicle wash areas (CASQA BMP Handbook SD-33)
S10	Outdoor processing areas (CASQA BMP Handbook SD-36)
S11	Equipment wash areas
S12	Fueling areas (CASQA BMP Handbook SD-30)
S13	Hillside landscaping (CASQA BMP Handbook SD-10)
S14	Wash water control for food preparation areas
S15	Community car wash racks

- **(S1) Provide Storm Drain System Stenciling and Signage (CASQA BMP Handbook SD-13)** - Storm drain stencils are highly visible source control messages, typically placed directly adjacent to storm drain inlets. The stencils contain a brief statement that prohibits the dumping of improper materials into the MS4. Graphical icons, either illustrating anti-dumping symbols or images of receiving water fauna, are effective supplements to the anti-dumping message. Stencils and signs alert the public to the destination of pollutants discharged into stormwater. The following requirements should be included in the project design and shown on the project plans:

  - Provide stenciling or labeling of all storm drain inlets and catch basins, constructed or modified, within the project area with prohibitive language (such as: “No Dumping – Flows to Creek”) and/or graphical icons to discourage illegal dumping.

  - Post signs and prohibitive language and/or graphical icons, which prohibit illegal dumping at public access points along channels and creeks within the project area.

  - Maintain legibility of stencils and signs.

- See CASQA Stormwater Handbook BMP Fact Sheet SD-13 for additional information.

- (**S2) Design Outdoor Hazardous Material Storage Areas to Reduce Pollutant Introduction (SD-34)** - Improper storage of materials outdoors may increase the potential for toxic compounds, oil and grease, fuels, solvents, coolants, wastes, heavy metals, nutrients, suspended solids, and other pollutants to enter the MS4. Where the plan of development includes outdoor areas for storage of hazardous materials that may contribute pollutants to the MS4, the following stormwater BMPs are required:

  - Hazardous materials with the potential to contaminate urban runoff shall either be: (a) placed in an enclosure such as, but not limited to, a cabinet, shed, or similar structure that prevents contact with runoff or spillage to the MS4; or (b) protected by secondary containment structures (not double wall containers) such as berms, dikes, or curbs.
  - The storage area shall be paved and sufficiently impervious to contain leaks and spills.
  - The storage area shall have a roof or awning to minimize direct precipitation and exposure, and collection of stormwater within the secondary containment area.
  - Any stormwater retained within the containment structure must not be discharged to the street or storm drain system.
  - Location(s) of installations of where these preventative measures will be employed must be included on the map or plans identifying BMPs.
  - See CASQA Stormwater Handbook Section 3.2.6 and BMP Fact Sheet SD-34 for additional information.

- **(S3) Trash Enclosures to Reduce Pollutant (CASQA BMP Handbook SD-32)** - Design trash storage areas to reduce pollutant introduction. All trash container areas shall meet the following requirements (limited exclusion: detached residential homes):

  - Paved with an impervious surface, designed not to allow run-on from adjoining areas, designed to divert drainage from adjoining roofs and pavements diverted around the area, screened or walled to prevent off-site transport of trash; and
  - Provide solid roof or awning to prevent exposure to direct precipitation.
  - Connection of trash area drains to the MS4 is prohibited. See CASQA Stormwater Handbook Section 3.2.9 and BMP Fact Sheet SD-32 for additional information.

- **(S4) Use Efficient Irrigation Systems and Landscape Design (CASQA BMP Handbook SD-12)** The Water Conservation in Landscaping Act of 2006, Assembly Bill 1881 (AB 1881), requires adoption of the Model Water Efficient Landscape Ordinance designed to improve public and private landscaping and irrigation practices for new development projects or rehabilitation of significant landscape areas. The ordinance reduces outdoor water waste through improvements in irrigation efficiency and selection of plants requiring less water. The ordinance requires development of water budgets for landscaping, use of recycled water if available, routine irrigation audits, and scheduling of irrigation based on localized climate. For existing landscapes greater than one-acre in size, the water purveyors are required to implement programs, such as irrigation water use analyses, irrigation surveys, and irrigation audits to reduce landscape water use to a level not exceeding the Maximum Applied Water Allowance (MAWA) as specified in the ordinance. Landscape audits are required to be conducted by a certified landscape auditor. Irrigation practices shall also comply with any more stringent local ordinances related to irrigation efficiency. The project proponent should also consult the LIP for the area in which the project is planned for development. In general, the following methods to reduce excessive irrigation runoff shall be considered, and incorporated for all landscaped areas:

- Employing rain shutoff devices to prevent irrigation after precipitation.
- Designing irrigation systems to each landscape area's specific water requirements.
- Using flow reducers or shutoff valves triggered by a pressure drop to control water loss in the event of broken sprinkler heads or lines.
- The timing and application methods of irrigation water shall be designed to minimize the runoff of excess irrigation water into the municipal storm drain system.
- Employing other comparable, equally effective, methods to reduce irrigation water runoff.
- Group plants with similar water requirements in order to reduce excess irrigation runoff and promote surface filtration. Choose plants with low irrigation requirements (for example, native or drought tolerant species). Consider other design features, such as:
- Use mulches (such as wood chips or shredded wood products) in planter areas without ground cover to minimize sediment in runoff.
- Install appropriate plant materials for the location, in accordance with amount of sunlight and climate, and use native plant material where possible and/or as recommended by the landscape architect.
- Leave a vegetative barrier along the property boundary and interior watercourses, to act as a pollutant filter, where appropriate and feasible.

- Choose plants that minimize or eliminate the use of fertilizer or pesticides to sustain growth.

- **(S5) Finished Grade of Landscaped Areas -** All landscape pockets, fingers, setback areas, parkway strips, street medians, etc., shall be finish-graded at a minimum of 1-2 inches below top of curb or sidewalk for increased retention/infiltration of stormwater and irrigation water.

- **(S6) Protect Slopes and Channels** - Project plans should include Source Control BMPs to decrease the potential for erosion of slopes and/or channels. The following design principles should be considered and incorporated and implemented where determined applicable and feasible by the local jurisdiction:

  - Convey runoff safely from the tops of slopes.
  - Avoid disturbing steep or unstable slopes.
  - Avoid disturbing natural channels.
  - Install permanent stabilization BMPs on disturbed slopes as quickly as possible.
  - Vegetate slopes with native or drought tolerant vegetation.
  - Control and treat flows in landscaping and/or other controls prior to reaching existing natural drainage systems.
  - Install permanent stabilization BMPs in channel crossings as quickly as possible, and ensure that increases in runoff velocity and frequency caused by the project do not erode the channel.
  - Install energy dissipaters, such as riprap, at the outlets of new storm drains, culverts, conduits, or channels that enter unlined channels in accordance with applicable specifications to minimize erosion. Energy dissipaters should be installed in such a way as to minimize impacts to receiving waters.
  - On-site conveyance channels should be lined, where appropriate, to reduce erosion caused by increased flow velocity due to increases in tributary impervious area. The first choice for linings should be grass or some other vegetative surface, since these materials not only reduce runoff velocities, but also provide water quality benefits from filtration and infiltration. Irrigation demand of vegetated systems should be considered. If velocities in the channel are large enough to erode grass or other vegetative linings, rock, riprap, concrete soil cement or geo-grid stabilization may be substituted or used in combination with grass or other vegetation stabilization.

- Other design principles which are comparable and equally effective.
- These practices should be implemented, as feasible, consistent with local codes and ordinances. Projects involving an alteration to bed, bank, or channel of a Water of the US may require approval of additional regulatory agencies with jurisdiction over water bodies, (e.g., the U.S. Army Corps of Engineers, the California Regional Water Quality Control Boards and the California Department of Fish and Game).

▪ **(S7) Loading Dock Areas (CASQA BMP Handbook SD-31)** - Loading /unloading dock areas shall include the following:

- Cover loading dock areas, or design drainage to preclude run-on and runoff, unless the material loaded and unloaded at the docks does not have potential to contribute to stormwater pollution, and this use is ensured for the life of the facility.
- Direct connections to the municipal storm drain system from below grade loading docks (truck wells) or similar structures are prohibited. Stormwater can be discharged through a permitted connection to the storm drain system with a treatment control BMP applicable to the use.
- Other comparable and equally effective features that prevent unpermitted discharges to the MS4.
- Housekeeping of loading docks shall be consistent with Housekeeping of Loading Dock Areas (SD-31).
- See CASQA BMP Handbook Section 3.2.8 for additional information.

▪ **(S8) Maintenance Bays (CASQA BMP Handbook SD-31)** - Maintenance bays shall include the following:

- Repair/maintenance bays shall be indoors; or, designed to preclude urban run-on and runoff.
- Design a repair/maintenance bay drainage system to capture all wash water, leaks and spills. Provide impermeable berms, drop inlets, trench catch basins, or overflow containment structures around repair bays to prevent spilled materials and wash-down waters from entering the storm drain system. Connect drains to a sump for collection and disposal. Direct connection of the repair/maintenance bays to the MS4 is prohibited. If there are no other alternatives, discharge of non-stormwater flow to the sanitary sewer may be considered only if allowed by the local sewerage agency through permitted connection.

- Other features which are comparable and equally effective that prevent discharges to the MS4 without appropriate permits.
- See CASQA BMP Handbook Fact Sheet SD-31 for additional information.

▪ **(S9) Vehicle Wash Areas (CASQA BMP Handbook SD-33)** - Projects that include areas for washing /steam cleaning of vehicles shall use the following:

- Self-contained or covered with a roof or overhang.
- Equipped with a wash rack, and with the prior approval of the sewerage agency (Note: Discharge monitoring may be required by the sewerage agency).
- Equipped with a clarifier or other pretreatment facility.
- If there are no other alternatives, discharge of non-stormwater flow to the sanitary sewer may be considered only allowed by the local sewerage agency through permitted connection.
- Other features which are comparable and equally effective that prevent unpermitted discharge, to the MS4.
- See CASQA BMP Handbook Sections 3.2.7 and 3.2.10 and Fact Sheet SD-33 for additional information.

▪ **(S10) Outdoor Processing Areas (CASQA BMP Handbook SD-36)** - Outdoor process equipment operations, such as rock grinding or crushing, painting or coating, grinding or sanding, degreasing or parts cleaning, landfills, waste piles, and wastewater and solid waste handling, treatment, and disposal, and other operations determined to be a potential threat to water quality by the local jurisdiction shall adhere to the following requirements.

- Cover or enclose areas that would be the sources of pollutants; or, slope the area toward a sump that will provide infiltration or evaporation with no discharge; or, if there are no other alternatives, discharge of non-stormwater flow to the sanitary sewer may be considered only allowed by the local sewerage agency through permitted connection.
- Grade or berm area to prevent run-on from surrounding areas.
- Installation of storm drains in areas of equipment repair is prohibited.
- Other features which are comparable or equally effective that prevent unpermitted discharges to the MS4.

- Where wet material processing occurs (e.g. electroplating), secondary containment structures (not double wall containers) shall be provided to hold spills resulting from accidents, leaking tanks or equipment, or any other unplanned releases .

- Some of these land uses (e.g. landfills, waste piles, wastewater and solid waste handling, treatment and disposal) may be subject to other permits including Phase I Industrial Permits that may require additional BMPs.

- See CASQA Stormwater Handbook Section 3.2.5 for additional information.

▪ **(S11) Equipment Wash Areas** - Outdoor equipment/accessory washing and steam cleaning activities shall use the following:

  - Be self-contained or covered with a roof or overhang.

  - Design an equipment wash area drainage system to capture all wash water. Provide impermeable berms, drop inlets, trench catch basins, or overflow containment structures around equipment wash areas to prevent wash -down waters from entering the storm drain system. Connect drains to a sump for collection and disposal. Discharge from equipment wash areas to the MS4 is prohibited. If there are no other alternatives, discharge of non-stormwater flow to the sanitary sewer may be considered, but only when allowed by the local sewerage agency through a permitted connection.

  - Other comparable or equally effective features that prevent unpermitted discharges to the MS4.

▪ **(S12) Fueling Areas (CASQA BMP Handbook SD-30)** - Fuel dispensing areas shall contain the following:

  - At a minimum, the fuel dispensing area must extend 6.5 feet (2.0 meters) from the corner of each fuel dispenser, or the length at which the hose and nozzle assembly may be operated plus 1 foot (0.3 meter), whichever is less.

  - The fuel dispensing area shall be paved with Portland cement concrete (or equivalent smooth impervious surface). The use of asphalt concrete shall be prohibited.

  - The fuel dispensing area shall have an appropriate slope (2 percent - 4 percent) to prevent ponding, and must be separated from the rest of the site by a grade break that prevents run-on of stormwater.

  - An overhanging roof structure or canopy shall be provided. The cover's minimum dimensions must be equal to or greater than the area of the fuel dispensing area in the first item above. The cover must not drain onto the fuel dispensing area and the downspouts must be routed to prevent drainage across the fueling area. The fueling area shall drain to the project's Treatment Control BMP(s) prior to discharging to the MS4.

- See CASQA Stormwater Handbook Section 3.2.11 and BMP Fact Sheet SD-30 for additional information.

- **(S13) Site Design and Landscape Planning (Hillside Landscaping), (CASQA BMP Handbook SD-10)** - Hillside areas that are disturbed by project development shall be landscaped with deep-rooted, drought tolerant plant species selected for erosion control, satisfactory to the local jurisdiction.
- (**S14) Wash Water Controls for Food Preparation Areas** - Food establishments (per State Health & Safety Code 27520) shall have either contained areas or sinks, each with sanitary sewer connections for disposal of wash waters containing kitchen and food wastes. If located outside, the contained areas or sinks shall also be structurally covered to prevent entry of stormwater. Adequate signs shall be provided and appropriately placed stating the prohibition of discharging washwater to the storm drain system.
- **(S15) Community Car Wash Racks** - In complexes larger than 100 dwelling units where car washing is allowed, a designated car wash area that does not drain to a storm drain system shall be provided for common usage. Wash waters from this area may be directed to the sanitary sewer (with the prior approval of the sewerage agency); to an engineered infiltration system; or to an equally effective alternative. Pre-treatment may also be required.

7.4 Selecting Source Control BMPs

Identifying appropriate source control BMPs for a project is critical to reducing the potential for sources of pollutants from contacting stormwater runoff. When completing WQMP Template Form 4.1-1 (Non-Structural Source Control BMPs) and Form 4.1-2 (Structural Source Control BMPs), reference Table 7-3 to complete the WQMP Template form. Table 7-3 presents a worksheet for identifying appropriate non-structural and structural source control BMPs, based on project-specific potential sources of pollutants.

Note: Table 7-3 is intended as an *example* worksheet of how to consider selection of source control BMPs based on project-specific characteristics and does not include all possible project characteristics/activities and corresponding applicable source control BMPs.

Table 7-3. Source Control BMP Selection Worksheet

If Potential Source of Runoff Pollutants will be on the Project Site…	…then WQMP shall include these Source Control BMPs	
Project Characteristic/Activity	**Non-structural BMPs**	**Structural BMPs**
Onsite Storm Drain Inlets	N1 – Education for POA, Tenants, Occupants N2 – Activity Restrictions N4 – BMP Maintenance N12 – Employee Training N14 – Catch Basin Inspection	S1 - Provide Storm Drain Stenciling and Signage
Landscape/ Outdoor Pesticide Use	N1 – Education for POA, Tenants, Occupants N2 – Activity Restrictions N3 – Landscape Management; N4 – BMP Maintenance N12 – Employee Training	S4 – Use Efficient Irrigation Systems and Landscape Design; S5 - BMP S6 – Protect Slopes and Channels S13 – Site Design and Landscape Planning (Hillside Landscaping)
Food Service/Restaurants	N4 – BMP Maintenance N12 – Employee Training	S3 - Design and construct trash and waste storage areas to reduce pollution introduction S14 – Wash Water Controls for Food Preparation Areas
Refuse Areas	N1 – Education for POA, Tenants, Occupants N2 – Activity Restrictions N4 – BMP Maintenance N11 – Litter Control N12 – Employee Training	S3 - Design and construct trash and waste storage areas to reduce pollution introduction
Outdoor Storage of Equipment or Materials	N4 – BMP Maintenance N7 – Spill Contingency Plan N9 – Hazardous Materials Disclosure Compliance N12 – Employee Training	S2- Design Outdoor Materials Storage Areas S10 – Outdoor Processing Areas
Vehicle and Equipment Cleaning	N1 – Education for POA, Tenants, Occupants N2 – Activity Restrictions N4 – BMP Maintenance N12 – Employee Training	S8 – Maintenance Bays & Docks S9 – Vehicle Wash Areas S11 – Equipment Wash Areas S15 – Community Wash Racks
Vehicle/Equipment Repair & Maintenance	N1 – Education for POA, Tenants, Occupants N2 – Activity Restrictions N4 – BMP Maintenance N12 – Employee Training	S8 – Maintenance Bays
Fuel Dispensing Areas	N4 – BMP Maintenance N6 – Local Water Quality Permit Compliance N7 – Spill Contingency Plan ; N8 – Underground Storage Tank Compliance; N9 - Hazardous Materials Disclosure Compliance N12 – Employee Training	S12 – Fueling Areas
Loading Docks	N4 – BMP Maintenance N13 – Housekeeping of Loading Docks; N12 – Employee Training	S7 – Dock Areas
Streets and Parking Lots	N1 – Education for POA, Tenants, Occupants N2 – Activity Restrictions N4 – BMP Maintenance N12 – Employee Training; N15 – Street Sweeping Private Streets and Parking Lots	S1 - Provide Storm Drain Stenciling and Signage

Source: Adapted from San Diego Countywide Model SUSMP Manual, SUSMP Requirements for Development Applications, August 2010.

Section 8 – Post-Construction BMP Requirements

This section includes post-construction requirements for operation and maintenance of BMPs incorporated into an approved Project WQMP, and provides guidance for completing WQMP Template, Form 5-1, BMP Inspection and Maintenance.

Scheduled operation and long term maintenance of BMPs is critical to the function and effectiveness of BMPs. Other post-construction requirements include access agreements between the property owner and local jurisdiction and recordation of the maintenance agreements into the local deed records so that BMP maintenance requirements are disclosed as part any property transfers.

8.1 BMP Maintenance Mechanisms

Alternative mechanisms that may be used to ensure on-going BMP maintenance include:

- **Public entity maintenance**: The local jurisdiction with the responsibility for WQMP approval may approve a WQMP that identifies a public or acceptable quasi-public entity (e.g., the City, the County, County Flood Control District, an existing assessment district, an existing utility district, or a conservation conservancy) as assuming responsibility for operation, maintenance, repair and replacement of the BMP. Unless otherwise acceptable to individual local agencies, public entity maintenance agreements shall ensure estimated costs are front-funded or reliably guaranteed, (e.g., through a trust fund, assessment district fees, bond, letter of credit or similar means). In addition, the local jurisdictions may seek protection from liability by appropriate releases and indemnities.

- The project proponent must demonstrate that it has proposed transfer of the BMP maintenance to another public entity. The project proponent will negotiate maintenance requirements with the entity that it is proposing to accept maintenance responsibilities within its jurisdiction; and negotiate with the resource agencies responsible for issuing permits for the construction and/or maintenance of the facilities. If necessary, the public entity will also demonstrate through the CEQA review or the public entity's public review process that it can accept the maintenance responsibility. The local jurisdiction must be identified as a third party beneficiary empowered to enforce any such maintenance agreement within their respective jurisdictions.

- **Project proponent agreement to maintain stormwater BMP:** The local jurisdiction may enter into a contract with the project proponent obligating the project proponent to maintain, repair and replace the stormwater BMP as necessary into perpetuity. Security or a funding mechanism with a "no sunset" clause may be required.

- **Assessment districts**: The local jurisdiction may approve an assessment district or other funding mechanism created by the project proponent to provide funds for stormwater BMP maintenance, repair and replacement on an ongoing basis. Any agreement with an assessment district shall be subject to the public entity maintenance provisions above.
- **Lease provisions**: In those cases where the local jurisdiction holds title to the land in question, and the land is being leased to another party for private or public use, the local jurisdiction may assure stormwater BMP maintenance, repair and replacement through conditions in the lease.
- **Conditional use permits**: For discretionary projects only, the local jurisdiction may assure maintenance of stormwater BMP through the inclusion of maintenance conditions in the conditional use permit. Security may be required.
- **Alternative mechanisms**: The local jurisdiction may accept alternative maintenance mechanisms if such mechanisms are as protective as those listed above.

8.2 BMP Maintenance Requirements

The following sections describe general requirements that may be applicable to the maintenance of BMPs. Consult the LIP for the jurisdiction in which the project is proposed to determine specific local requirements.

8.2.1 Operation and Maintenance Plan

An Operation and Maintenance Plan (O&M Plan) for the BMPs shall be prepared and included in the Project WQMP. The local jurisdiction requires the O&M Plan be received prior to permit closeout (see Section 8.3) and the issuance of certificates of use and occupancy.

The O&M Plan describes the designated responsible party to manage the stormwater BMPs. It also defines employee training program and duties, operating schedule, maintenance frequency, routine service schedule, specific maintenance activities, copies of resource agency permits, and any other necessary activities.

The final Project WQMP shall require the project proponent or approved maintenance entity to complete and maintain O&M forms to document all maintenance requirements. Parties responsible for the O&M Plan shall retain records for at least 5 years. These documents shall be made available to the local jurisdiction for inspection upon request at any time.

8.2.2 O&M Commitments

At a minimum, the final Project WQMP shall require the inspection and servicing of all structural BMPs on an annual basis. More frequent inspection and servicing requirements may be required by the local jurisdiction.

As part of the maintenance mechanism selected above, the local jurisdiction shall require the inclusion of a copy of an executed access easement that shall be binding on the land throughout the life of the project, until such time that the stormwater BMPs requiring access is replaced, satisfactory to the local agency.

8.2.3 Maintenance Agreements

Maintenance agreements are an effective tool for ensuring long-term maintenance of on-site BMPs. The purpose of a maintenance agreement is to clearly define the responsibilities of each party entering into the agreement. The local jurisdiction may require such an agreement that could include the following:

- **Performance of routine maintenance:** Local jurisdictions often find it easier to have a property owner perform all maintenance according to the requirements of a Design Manual. Other communities require that property owners do aesthetic maintenance (i.e., mowing, vegetation removal) and implement pollution prevention plans, but elect to perform structural maintenance and sediment removal themselves.
- **Maintenance schedules**: Maintenance requirements may vary, but usually local jurisdictions require that all BMP owners perform at least an annual inspection and document the maintenance and repairs performed. An annual report must then be submitted to the local jurisdiction, which may then choose to perform an inspection of the facility.
- **Inspection requirements:** Local jurisdictions may obligate themselves to perform an annual inspection of a BMP, or may choose to inspect when deemed necessary instead. Local agencies may also wish to include language allowing maintenance requirements to be increased if deemed necessary to ensure proper functioning of the BMPs.
- **Access to BMPS**: The agreement should grant permission to a local jurisdiction or its authorized agent to enter onto property to inspect BMPS. If deficiencies are noted, the local stormwater agency will provide a copy of the inspection report to the property owner and provide a timeline for repair of the deficiencies.
- **Failure to maintain:** In the maintenance agreement, the local jurisdiction will repeat the steps available for addressing a failure to maintain situation. Language allowing access to BMPS cited as not properly maintained may be included in the agreement, along with the right to charge any costs for repairs back to the property owner. The local jurisdiction may include deadlines for repayment of maintenance costs, and provide for liens against property up to the cost of the maintenance plus interest.
- **Recording of the Maintenance Agreement:** An important aspect to the recording of the maintenance agreement is that the agreement be recorded into local deed records. This

recordation helps ensure that the maintenance agreement is bound to the property in perpetuity.

- Local jurisdictions may elect to include easement requirements in maintenance agreements. While easement agreements are often secured through a separate legal agreement, recording public access easements for maintenance in a maintenance agreement reinforces a local jurisdiction's right to enter and inspect a BMP. Examples of maintenance agreements may be found at *http://www.stormwatercenter.net/*. Also, consult the LIP to determine if the local jurisdiction has established a Maintenance Agreement form.

8.3 Permit Closeout Requirements

For discretionary projects, the method approved by local jurisdictions for stormwater BMP maintenance shall be incorporated into the project's permit, and shall be consistent with permits issued by resource agencies, if any. Just as with all other aspects of a project's approved plans and designs, the local authority will make a determination whether all requirements of the Project WQMP have been satisfactorily completed prior to close-out of permits and issuance of certificates of use and occupancy.

For projects requiring only ministerial permits, the method approved by local jurisdictions for stormwater BMP maintenance shall be shown on the project plans before the issuance of any ministerial permits. Verification will occur similar to discretionary projects. Local jurisdictions shall not issue construction approvals, permit closeout, and issuance of certificates of use and occupancy prior to receipt of this proof.

In all instances, project proponents shall provide proof of execution of a method (as approved by local jurisdiction) for maintenance, repair, and replacement of BMPs. For all properties, the verification mechanism will include the project proponent's signed statement, as part of the Project WQMP, accepting responsibility for all structural BMP maintenance, repair and replacement or agreeing to an alternative mechanism that is approved by the local authority regarding maintenance, repair and replacement of the structural BMPS.

Local authorities carrying out public projects that are not required to obtain permits shall be responsible for ensuring that stormwater BMP maintenance; repair and replacement requirements are identified prior to the completion of construction and incorporated into the agency's municipal activities program.

Section 9 -References

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Appendix A - Transportation Project BMP Guidance

Transportation Project BMP Guidance
San Bernardino County Municipal Stormwater Management Program

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Tables

Section 1 Introduction

A. Purpose of the Guidance

The federal Clean Water Act (CWA) establishes requirements for the discharge of urban runoff from Municipal Separate Storm Sewer Systems (MS4) under the National Pollutant Discharge Elimination System (NPDES) program. On January 29, 2010, the Santa Ana Regional Water Quality Control Board (RWQCB) issued Permit Order No. R8-2010-0036 ("MS4 Permit") to authorize the discharge of urban runoff from MS4 facilities in San Bernardino County within the Santa Ana River watershed.

Generally, the accepted Santa Ana River watershed regional approach to WQMP development for managing transportation projects is to prepare a "functionally equivalent document" (Riverside County Transportation Guidance Document, November 2012) that incorporates site-specific engineering conditions into the BMP-selection analysis in order to manage project runoff to the MEP.

The MS4 Permit requires development of a standard design and post-development Best Management Practices (BMP) guidance to guide application of Low Impact Development (LID) BMPs to the maximum extent practicable (MEP) on transportation projects including public street, road, highway, freeway and bike/pedestrian path improvement projects to reduce the discharge of pollutants to receiving waters. The San Bernardino County MS4 Permittees prepared this Transportation Projects Guidance ("Guidance") to provide guidance to city engineers, planners, MS4 program staff, and transportation project proponents on how to address the MS4 Permit requirements within their jurisdictions. This guidance is largely based upon public street, road, highway, and freeway BMP techniques contained within USEPA's Municipal Handbook, *Managing Wet Weather with Green Infrastructure: Green Streets* (http://water.epa.gov/infrastructure/greeninfrastructure/upload/gi_munichandbook_green_sreets.pdf) and the *Low Impact Development Manual for Southern California* prepared for the Southern California Stormwater Monitoring Coalition, in cooperation with the State Water Resources Control Board, by the Low Impact Development Center. This Guidance also provides links and references to other sources of information regarding the application of LID-based BMPs to Transportation Projects (see Section 6: Resources).

The remaining parts of this section provide information regarding the applicability and appropriate use of this Guidance. Subsequent sections of this document provide detailed information on how to apply this Guidance to applicable projects.

B. NPDES Permit Requirement

The MS4 Permit establishes requirements for the application of LID BMP practices on all new development and significant redevelopment projects. For development activities specific to paved surfaces that will be used for vehicular transportation, the MS4 Permit requires the development of this Guidance by the Principal Permittee (San Bernardino County Flood Control District). Specifically, MS4 Permit Section XI.F.1 states:

"Within 24 months of adoption of this Order, the Principal Permittee, in cooperation with the Co-Permittees, shall develop standard design and post-development BMP guidance to be incorporated into projects for public streets, roads, highways, and freeway improvements to reduce the discharge of pollutants from the projects to the MEP. The draft guidance shall be submitted to the Executive Officer for review and approval and shall meet the performance standards for site design/LID BMPs, source control, and treatment control BMPs as well as the Hydrologic Conditions of Concern (HCOC) criteria. The guidance and BMPs shall address any paved surface used for transportation of automobiles, trucks, motorcycles, and other vehicles, and excludes routine road maintenance activities where the surface footprint is not increased. The guidance shall incorporate principles contained in the USEPA guidance, "Managing Wet Weather with Green Infrastructure: Green Streets" to the MEP and include the following:

a. Guidance specific to new road projects;

b. Guidance specific to projects for existing roads;

c. Size or impervious area criteria that trigger project coverage;

d. Preference for green infrastructure approaches wherever feasible;

e. Criteria for design and BMP feasibility analyses on a project-specific basis."

This Guidance fulfills this MS4 Permit requirement. Accordingly, all jurisdictions subject to the requirements of the MS4 Permit shall implement this Guidance to the extent that it is applicable to their project.

C. Applicability

The effective date of this Guidance is six months after the approval of the Guidance by the Santa Ana RWQCB Executive Officer.

However, transportation projects are implemented to address many needs, ranging from improving the transportation network to support local and regional development to meeting public safety and maintenance needs. Given the vast array of potential activities carried out to develop and manage transportation networks, project proponents should routinely consult this Guidance to evaluate its applicability to a proposed project. **Table 1-1** and **Figure 1-1** summarize Guidance applicability.

Table 1-1. Transportation Project Guidance Applicability

This Guidance applies to the following projects:
• Public Transportation Projects in the area covered by the Santa Ana Region MS4 Permit, which involve the construction of new transportation surfaces or the improvement of existing transportation surfaces • Proposed Road Projects in initial stages of planning and design

This Guidance does not apply to the following projects:

- Transportation Project activities within the transportation corridor that do not modify the transportation surface
- Projects proposing unpaved roadway surfaces (dirt or gravel roads)
- Transportation Projects that have passed the preliminary engineering stages of the design process (i.e., 35 percent or similar) or at any stage past which funding has been secured
- Transportation Projects that have received CEQA approval by the effective date of this Guidance
- Projects that have completed design phases but have not been constructed (shelved projects) do not have to be redesigned to incorporate the requirements of this guidance as long as they have satisfied CEQA approval at the time of design.
- Emergency Projects, as defined by this Guidance (see Section 2)
- Maintenance Projects, as defined by this Guidance (see Section 2)
- Transportation Projects that are part of a private new development or significant redevelopment project and required to prepare a Water Quality Management Plan (WQMP)
- Transportation Projects subject to other MS4 Permit requirements, e.g., California Transportation Department (Caltrans) oversight projects, cooperative projects with an adjoining County or an agency outside the jurisdiction covered by the Santa Ana Region MS4 Permit

Project Type: For projects involving transportation surfaces, the following two key questions should be evaluated before moving forward with the application of this Guidance to your project:

Question 1 - Is this a cost-share transportation project with potential overlapping MS4 Permit requirements?

- Yes, this project is a cost-share with the California Department of Transportation (Caltrans) – Caltrans has its own MS4 Permit requirements to fulfill on transportation projects. The requirements applicable to the project proponent shall be applied to this project, i.e., if you are the project proponent, then this Guidance may apply; see Question 2. If Caltrans is the project proponent, then this Guidance does not apply.

- Yes, this project is a cost-share with a jurisdiction in adjacent Riverside, Orange, or Los Angeles County – The applicability of LID BMP practices to Transportation projects varies with each county, subject to the requirements of their respective MS4 Permits. The requirements applicable to the project proponent shall be applied to this project, i.e., if you are the project proponent, then this Guidance may apply; see Question 2. If another jurisdiction is the project proponent, then this Guidance does not apply.

- Yes, this project is a cost-share with a jurisdiction within San Bernardino County – This Guidance applies uniformly to all jurisdictions subject to the San Bernardino County MS4 Permit. This Guidance may be applicable to the proposed project; see Question 2.

- No, this project does not involve cost-share with another jurisdiction – This Guidance may apply; see Question 2.

Question 2 - Are the proposed transportation surfaces part of a larger development project or activity?

- Yes, new roads and streets will be constructed as part of a larger development activity – This Guidance does not apply. A Water Quality Management Plan (WQMP) is required for these types of projects regardless of whether the roads or streets are private or public after project completion;

consult the Local Implementation Plan (LIP) for the jurisdiction within which the project is planned.

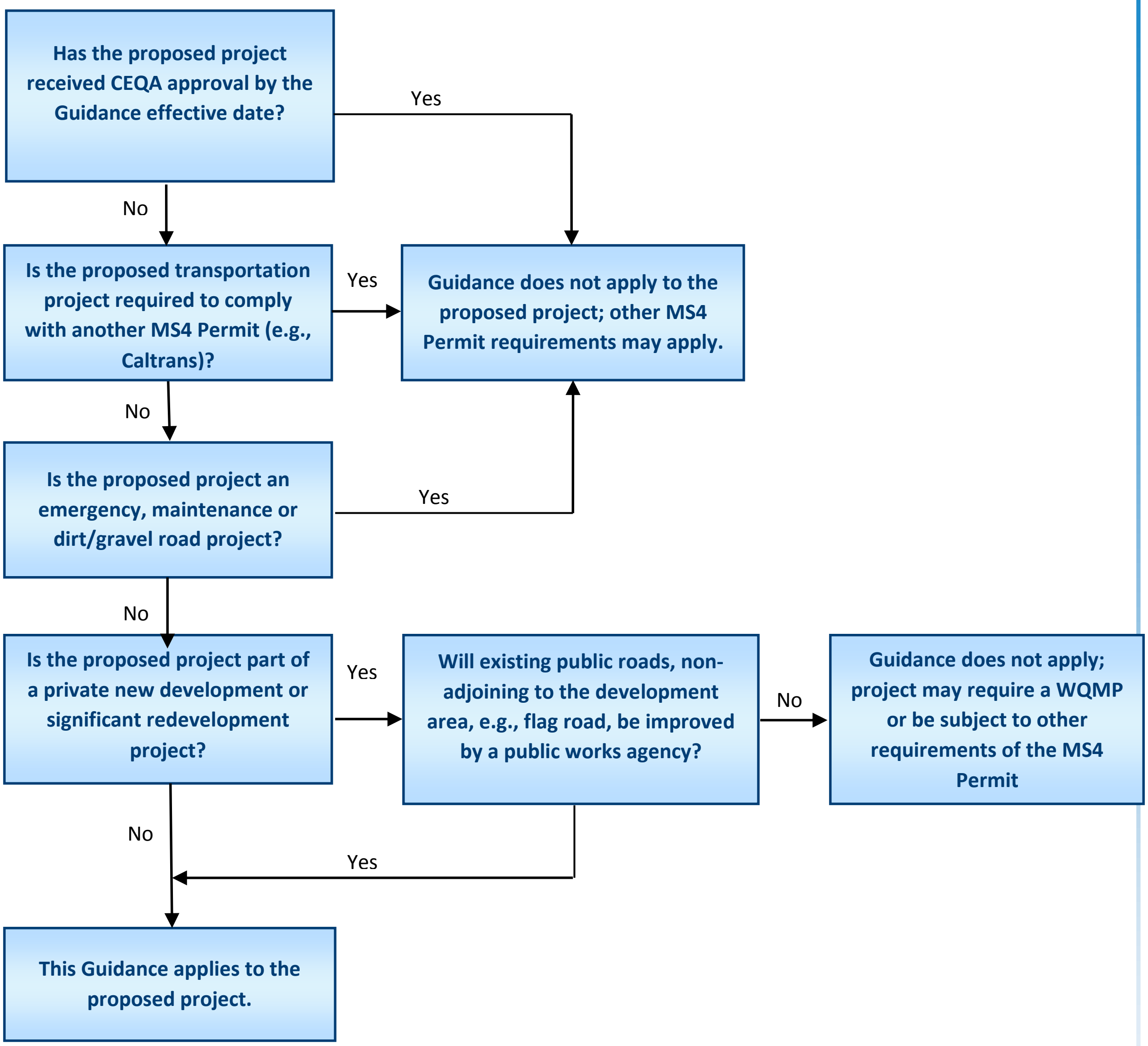
- Yes, existing adjacent roads and streets may be modified as part of the larger development activity - This Guidance does not apply. The WQMP required for the larger development activity will incorporate these adjacent road and street improvements. Consult the LIP for the jurisdiction within which the project is planned.

- Yes, existing non-adjacent roads and streets may be modified as part of the larger development activity - This Guidance may apply.

- No, the proposed project is not part of a larger development activity – This Guidance may apply.

If a finding of "This Guidance may apply" is made for either of the above questions, a project proponent should continue use of this Guidance to ensure compliance with MS4 Permit requirements applicable to transportation projects. If it is determined that this Guidance does not apply to the Transportation Project, this finding, along with the basis for the finding, should be documented in the project file. **Figure 1-1** illustrates the process for determining the applicability of this Guidance to proposed Transportation projects.

Figure 1-1. Applicability of the Transportation Project Guidance to a Proposed Project



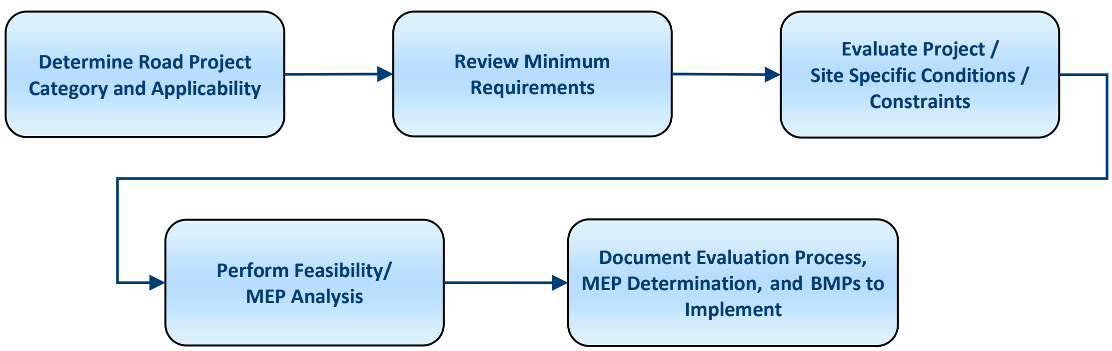
D. Functional Equivalence to WQMP

As stated in the MS4 Permit Order XI.F, the Santa Ana Region MS4 Permit requires the establishment of guidance that facilitates the development of project documents that are functionally equivalent to WQMP documents prepared for new development and significant redevelopment projects. This Guidance establishes minimum Site Design/LID BMPs to reduce the discharge of pollutants and address HCOCs, to the MEP and also includes site specific considerations for application of the Site Design/LID BMPs, to the MEP. For each specific project the feasibility analysis in Section 3 of this Guidance determines what is MEP, within the constraints associated with the project. Depending on the nature of the project and BMPs selected, this Guidance also establishes source control and treatment BMP requirements (e.g., as applicable to infiltration BMPs). HCOC criteria, within the context of pre and post project implementation, are to be considered as part of a project-specific feasibility analysis, but only to the maximum extent space is available, and the maximum extent feasible within the context of meeting other safety-related requirements to move water as quickly as possible off of impervious surfaces.

E. Organization and Use of the Guidance

The extent to which LID BMP practices are applicable to a proposed project is determined by evaluating and determining the project category, project type and site-specific conditions and constraints. Each step in the process of evaluating a proposed project per this Guidance is presented in Figure 1-2.

Figure 1-2. Project Evaluation Steps



The remaining sections of this Guidance describe each step in the process, specifically:

- **Section 2, Transportation Project Categories** – In some cases, this guidance may still not apply to the proposed project. This section further refines Guidance applicability.
- **Section 3, Minimum Requirements** – This section identifies minimum LID BMP requirements applicable to Transportation projects to which this Guidance applies. Minimum requirements will vary depending on the nature, location, and size of the project. The Guidance does establish specific minimum area criteria that trigger project coverage, and Section 3 (a) establishes minimum BMP design principles and techniques that shall be considered for all projects to which the Guidance applies; (b) summarizes site constraints that should be evaluated with each project; and (c) provides project-specific BMP feasibility criteria for consideration to evaluate the feasibility of incorporating green infrastructure elements (LID Principles and BMPs) into the proposed project.

- **Section 4, Source Control BMPs** - This section identifies recommended source control BMPs that should be evaluated for applicability to Transportation projects
- **Section 5, Project Implementation Requirements** – This section describes the minimum documentation requirements applicable to Transportation projects and nexus between the Transportation project evaluation and other permit requirements.
- **Section 6, Resources** – This section includes resources for implementation, including planning and design information to facilitate implementation of LID-based BMPs in Transportation Projects, a Glossary, and Transportation Project BMP Template that should be used as part of the evaluation process for proposed Transportation Projects.

Section 2
Transportation Project Categories

Four categories of Transportation projects have been established for the purposes of this Guidance:

- Category 1 – Emergency Street/Road Projects
- Category 2 – Routine Street/Road Maintenance Projects
- Category 3 – Re-development Street/Existing Road Projects
- Category 4 – New Street/Road Projects

Consistent with MS4 Permit Provisions XI.F.1 and XI.D.4.i, Category 1 or 2 projects (emergency road projects and routine road maintenance activities) are considered exempt from the LID and Source Control BMP implementation requirements contained within this Guidance and the WQMP. The project owner and operator should consult the Local Implementation Plan (LIP) for the jurisdiction within which the project will be built to identify applicable requirements, such as for Category 2 – Maintenance Projects.

This Guidance is only applicable to two categories: Category 3 and 4 (**Table 2-1**). Accordingly, the LID Principles and BMPs applicable to the project type shall be evaluated and incorporated into the project design to the MEP (see Section 3).

Category 3 projects may be subcategorized into capacity improvement, non-capacity improvement, or Class I Bikeway and sidewalk projects (not adjoining an existing road). This sub-categorization may be important for the selection and evaluation of appropriate LID Principles and BMPs for incorporation into the project (see Section 3). If a Transportation project includes adjoining bikeway or sidewalk features, the selection and evaluation of BMPs should consider both the road and the adjoining bikeway/sidewalk features as a single project.

The design of new bridge projects as identified in Category 4 on Table 2-1 below will be evaluated using the following references from the U.S. Department of Transportation, Federal Highway Administration, for design considerations and channel stability assessments:

- Hydraulic Engineering Circular No. 14, *Hydraulic Design of Energy Dissipators for Culverts and Channels*

  http://www.fhwa.dot.gov/engineering/hydraulics/pubs/06086/hec14.pdf

- Publication No. FHWA-HRT-05-072, *Assessing Stream Channel Stability at Bridges in Physiographic Regions*

  http://www.fhwa.dot.gov/publications/research/infrastructure/hydraulics/05072/05072.pdf

Table 2-1. Project Categories and Example Projects[1]

Exempt from Guidance Requirements		Category 3 Re-Development Street/Road Projects	Category 4 New Street/Road Projects
Category 1 Emergency Street/Road Projects	**Category 2 Routine Street/Road Maintenance Projects**		
▪ Emergency road work of any nature that occurs outside the normal planning process	▪ Alteration of the existing road profile within the existing surface footprint ▪ Reconstruction of the road base and asphalt concrete within the existing surface footprint ▪ Bridge replacement or reconstruction ▪ Routine, reactive, or preventive maintenance activities including, seal coat, slurry seal, cape seal, chip seal, full-depth reclamation, hot in-place recycling, cold planning in-place recycling and overlay ▪ Traffic control device improvements to address safety concerns ▪ Seismic enhancement/retrofit projects ▪ Safety enhancement projects that result in the addition of no new transportation surfaces ▪ Median improvement projects, with no new road surface, and/or do not increase the overall median imperviousness by more than 5% ▪ Curb and gutter improvements ▪ Utility cuts	▪ Roadway Capacity Improvement Projects - Lane additions - Bridge capacity improvements - Grade separation projects, where capacity is increased ▪ Non-Capacity Roadway Improvement Projects - Shoulder / parking lane improvements - Turn pocket additions - Signal project that adds a turn lane - Horizontal alignment correction to improve sight distance - Grade separation projects, where no change in capacity - Addition of passing lane - Addition of a turn out - Addition of a bike lane or sidewalk that adjoins an existing roadway	▪ New road, street, and highway projects ▪ New bridge projects

Section 3
Project Evaluation

A. Criteria for Project Coverage

Category 3 or 4 Projects that meet the following criteria shall meet the minimum BMP requirements contained within this section:

1. Residential Street Project

   Residential street projects comprising an entire block length, intersection to intersection, with a minimum length of ¼ mile

2. City Street / Road Project

   City street / road arterial projects (single or multi-lane) extending from arterial intersection to arterial intersection, with a minimum length of ½ mile

3. Highway / Freeway

   Highway / freeway projects with a minimum length of 1 mile. Local grade separation projects that are part of a highway / freeway projects with a minimum length of 1 mile.

Category 3 or 4 Projects that do not meet the project criteria described above are not subject to the BMP requirements described in the sections that follow. This finding should be included in the documentation file associated with the proposed project (see also Section 5.A).

B. Minimum Requirements

Project proponents for Category 3 and 4 Projects that meet the criteria described above shall implement the following design principles to the maximum extent practicable (MEP):

- Conservation of natural areas to the extent feasible
- Minimization of the impervious footprint
- Minimization of disturbances to natural drainage
- Design and construction of pervious areas (medians, parkway strips, roadway setback areas) to receive runoff from new roadway surfaces
- Use of landscaping that minimizes irrigation and runoff, promotes surface infiltration, and minimizes the use of pesticides and fertilizers

To implement these design principles, Category 3 and 4 Projects shall incorporate, to the MEP, the following BMP techniques described within USEPA's Guidance *Managing Wet Weather with Green Infrastructure: Green Streets*:

- Minimizing Street Widths
- Drainage Swales
- Bioretention
- Permeable Pavements
- Sidewalk Trees and Tree Boxes
- Infiltration Basins/Trenches

Project applicants shall refer to the design principles listed below, as well as the sources cited above, for general guidance on road construction or widening projects, with the understanding that these are examples of typical green street design and that final configuration of street profiles, roadway drainage areas, etc. is subject to review and approval by Agency Planning and Engineering staff. The example design drawings also do not usurp the ability of City and County Engineers and Planners to make local land use determinations or to adjust, modify, or reject these guidelines, if the local development condition or traffic safety warrants those actions.

Minimizing Street Widths

a. Plan site layout and street network to respect the existing hydrologic functions of the land (preserve wetlands, buffers, high-permeability soils, etc.) and minimize the impervious area.

b. Minimize street widths while maintaining jurisdictional code requirements for emergency service vehicles, sight distance, and a free flow of traffic. The USEPA Municipal Handbook, *Managing Wet Weather with Green Infrastructure: Green Streets* provides example for additional information. Street widths shall meet minimum requirements of the approving agency.

c. Look for opportunities to eliminate imperviousness within all areas of the proposed project site.

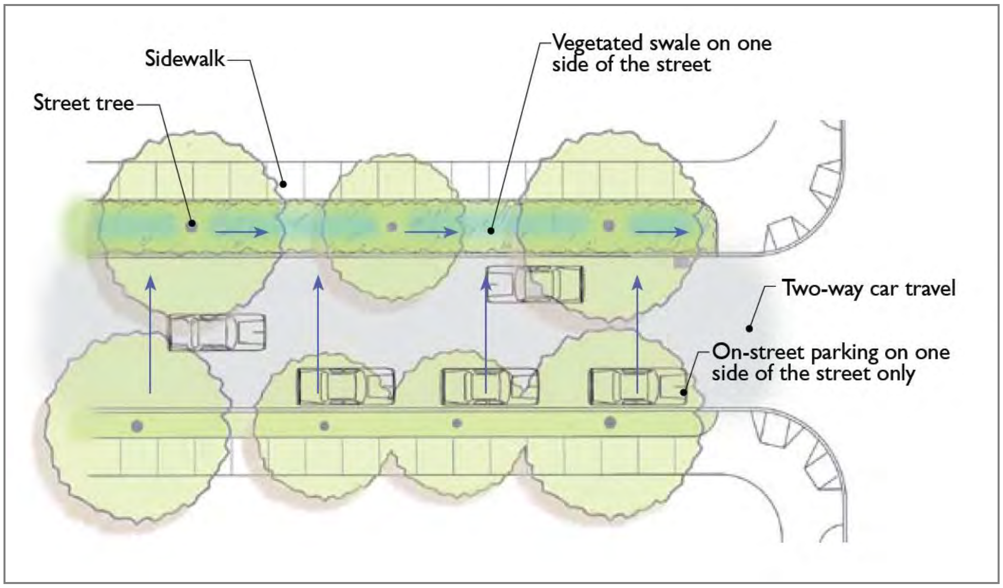
Drainage Swales

a. Plan site drainage using vegetated swales and curb and gutter modifications to accept sheet flow runoff from new or expanded roadway areas and convey it in broad shallow flow to reduce stormwater volume through infiltration, improve water quality through vegetative and soil filtration, and reduce flow velocity by increasing channel roughness. See picture and plan view schematic below.

b. Consider use of vegetated or pervious material swales for site drainage before considering use of hard lined impervious channels.

Green Streets: EPA-833-F-09-002, August 2009, www.epa.gov/greeninfrastructure

c. Identify additional benefits that may be attained from swales through amended soils, bioretention soils, gravel storage areas, underdrains, weirs, and thick diverse vegetation, including, where possible, use of native vegetation.



Plan View of Typical Drainage Swale on Residential Street (source: EPA-833-F-09-002, August 2009, www.epa.gov/greeninfrastructure

Bioretention Curb Extensions, Reverse Parkway Drains, Curb Cuts and Sidewalk Planters

a. Plan site layout using bioretention features such as curb extensions, reverse parkway drains, curb cuts, sidewalk planters, and tree boxes designed to take runoff from the street. See picture and plan view schematic below.

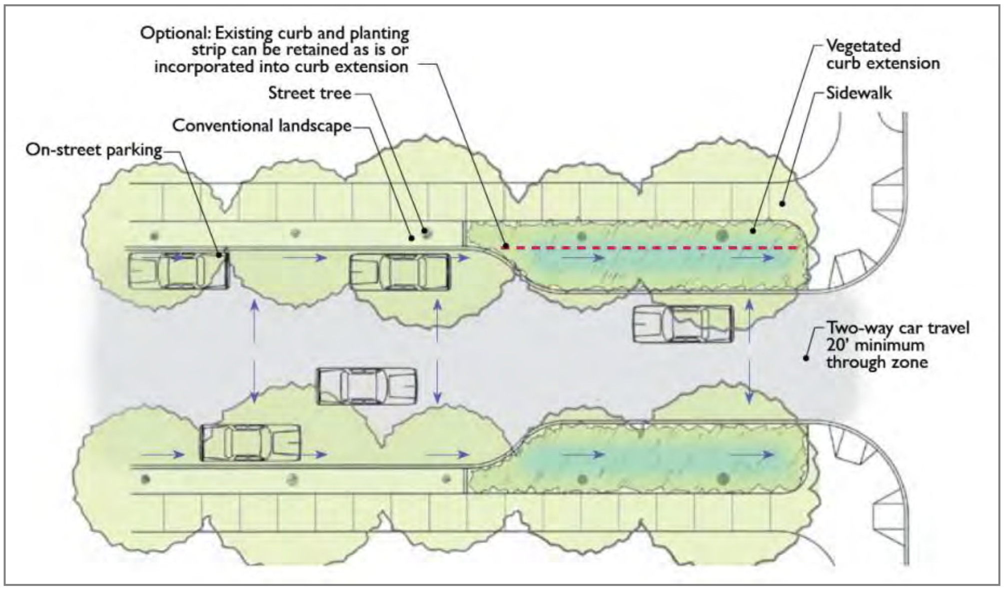
b. Look for opportunities to incorporate site specific bioretention features into specifications and standards.

c. Evaluate street configurations, topography, soil conditions, and space availability for opportunities to incorporate bioretention features.

d. Evaluate existing site utilities for opportunities to incorporate bioretention features as a retrofit.

e. Evaluate and select plants with respect to maintenance requirements and salt tolerance, considering sidewalk interference/buckling and plant height for traffic safety and security. Plants should be selected from the permittee's approved plant list, where one exists.

Green Streets: EPA-833-F-09-002, August 2009, www.epa.gov/greeninfrastructure



Plan View of Typical Bioretention Curb Extension on Residential Street (source: EPA-833-F-09-002, August 2009, www.epa.gov/greeninfrastructure

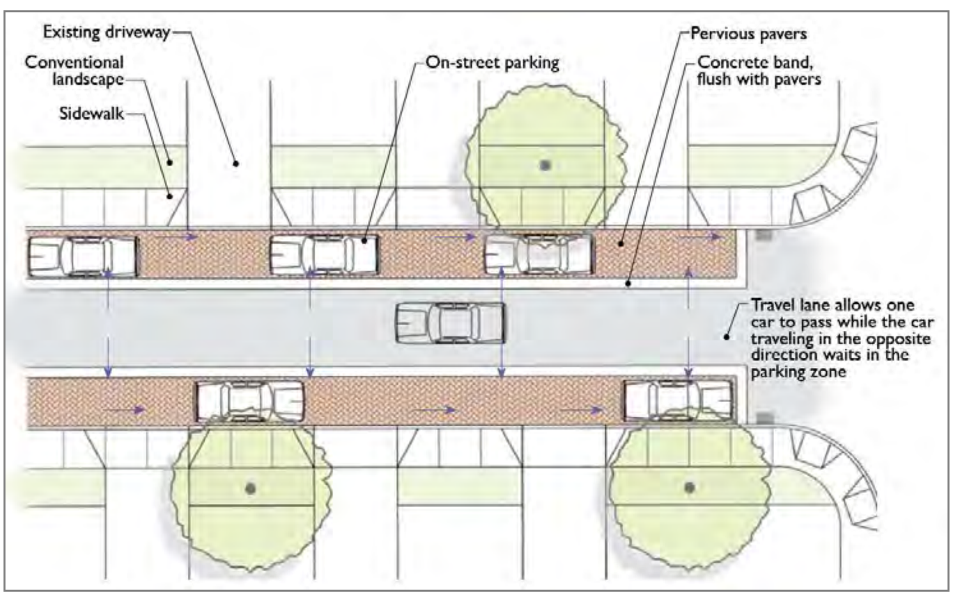
Permeable Pavement

a. Plan site layout with areas for incorporating permeable pavement. See picture and plan view schematic below.

b. Evaluate permeable gutters.

c. Evaluate permeable concrete, permeable asphalt, permeable interlocking concrete pavers, and grid pavers as alternatives to conventional, less pervious concrete and asphalt surfaces.

Green Streets: EPA-833-F-09-002, August 2009, www.epa.gov/greeninfrastructure



Plan View of Typical Permeable Pavement on Residential Street (source: EPA-833-F-09-002, August 2009, www.epa.gov/greeninfrastructure

d. Incorporate an aggregate base to provide structural support, runoff storage, and pollutant removal through filtering and adsorption.

e. In areas with freezing winter conditions, design permeable pavement structures that will always drain and never freeze solid. Make necessary adjustments to snow removal and deicing program implementation, such as adjusting snow plow blade height to prevent scraping the permeable surface, and eliminating the use of sand and other traction fines that will clog the pervious surface.

Sidewalk Trees and Tree Boxes

a. Incorporate tree cover into the site layout. See picture and plan view schematic below.

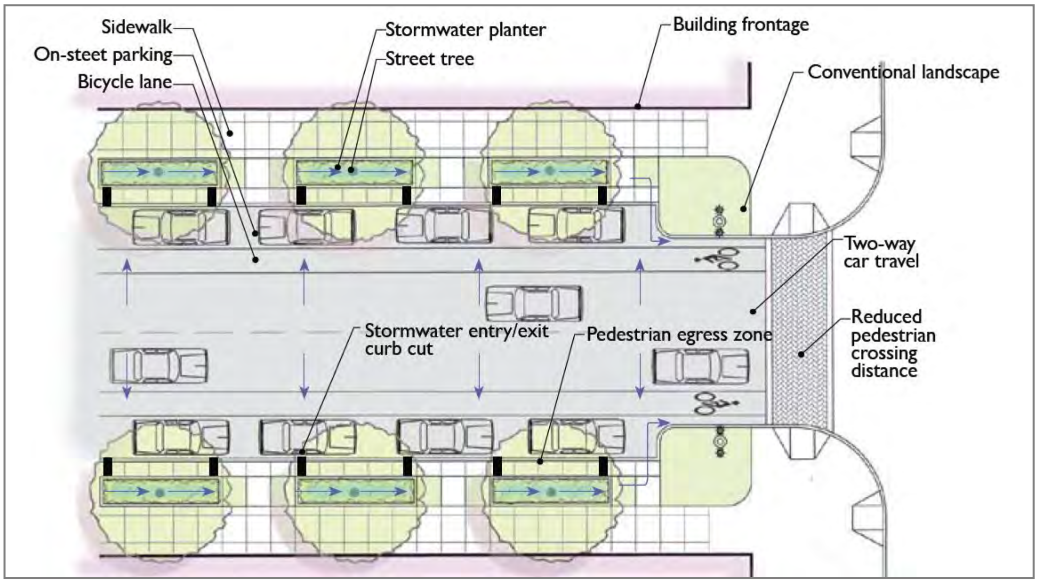
b. Evaluate site opportunities for sidewalk tree features and tree boxes, including catch basin drains or other means of directing surface runoff to them.

c. Provide sufficient uncompacted soil and space for proper tree health and growth via larger tree boxes, structural soils, root paths, or "silva cells" that allow sufficient tree root space.

d. Consider sufficient tree space in the right-of-way while maintaining traffic and pedestrian safety.

e. Evaluate space for trees vs. added construction costs.

Green Streets: EPA-833-F-09-002, August 2009, www.epa.gov/greeninfrastructure



Plan View of Typical Sidewalk Planters and Street Trees on Commercial Street (source: EPA-833-F-09-002, August 2009, www.epa.gov/greeninfrastructure

Infiltration Basins

a. Plan roadway drainage to be directed away from the road surface to infiltration basins. Typical detention or retention basins may be designed as infiltration facilities in some cases, with the ability to store runoff until it gradually exfiltrates through the soil. A 72-hour drawn down is usually recommended.

b. Incorporate infiltration basins, which can have high pollutant removal efficiency and can reduce flows to mimic pre-development hydrologic conditions.

www.casqa.org – Califonia BMP Handbooks

c. Use of infiltration BMPs shall be consistent with the pretreatment of runoff prior to infiltration requirements established by the MS4 Permit for areas subject to high vehicular traffic (25,000 or more average daily traffic).

d. Evaluate appropriate soil conditions for infiltration and site constraints. Groundwater separation should be at least 10 feet from the basin invert to the measured ground water elevation.

e. Evaluate traffic / pedestrian safety and site aesthetics while locating infiltration basins.

f. Reference the county's design criteria for infiltration basins for consistency with these and other design elements. Caltrans also has specific design requirements for infiltration basins in their ROW.

C. Project Specific Conditions/Constraints

The extent to which the BMP techniques described above are applied to a Transportation Project depends on the results of the BMP feasibility analysis completed for each project. All potential BMP techniques described above shall be considered for each project.

Several site conditions and constraints must be considered for implementation of the BMP techniques contained within this guidance. Each project is unique and will have unique conditions and constraints that influence the implementation of the techniques, and affect the feasibility of implementation. These may be internal to the project or may be related to connecting project features to existing sites or to infrastructure within adjoining jurisdictions. Table 3-1 contains example project site constraints to be considered as part of the effort to evaluate the feasibility of implementing the BMP techniques contained within this Guidance (Figure 3-1).

Figure 3-1. Potential Project Constraints

- Regulatory Requirements
  - TMDL/Impaired Waters requirements
  - Environmentally sensitive areas
  - Receiving Waters
  - CEQA conditions
- Site-specific Characteristics
  - Drainage characteristics
  - Soil characteristics, geologic conditions
  - Elevated groundwater conditions
  - Groundwater protection areas
  - Natural sediment loads
- Infrastructure & Project-specific Characteristics
  - Programmatic or funding restrictions
  - Right of way constraints
  - Existing features (drainage, curb and gutter, grades, etc.)
  - Utility constraints (e.g., pipelines, cables)
  - Availability of irrigation water
  - Availability of power
  - Types of traffic loads
  - Maintenance resources and expertise

D. Feasibility/MEP Analysis of LID Design Principles

The feasibility criteria in Table 3-2 may be considered for Category 3 and 4 Projects. The criteria may be used to demonstrate the maximum extent a BMP can be implemented for a specific project, as well as to determine certain BMP techniques as infeasible.

The following sections identify common Transportation Project elements that should be evaluated as part of the analysis to determine the feasibility of implementing BMPs to the MEP.

Table 3-2. Feasibility Criteria

1. Funding Restrictions / Other Programmatic Restrictions	Programmatic restrictions / constraints (partial infeasibility) Programmatic infeasibility (total infeasibility)
a. The BMPs techniques described within this Guidance may be implementable and approvable for a wide variety of Transportation Projects, capital improvement programs, and funding sources; however, some programs or funding sources may place constraints on the nature or type of project features that can be implemented. For example, funding sources for certain safety improvement projects may have strict project / program requirements that only allow funding for select project features. Such constraints may restrict the feasibility of some BMP techniques. b. Other programs may require project features that affect BMP implementation, such as compliance with Americans with Disabilities Act (ADA) requirements. c. Some BMP techniques may be too costly for the scope of the project.	

Table 3-2. Feasibility Criteria

2. Drainage Connectivity and Utilities	Drainage connectivity opportunities / constraints with adjoining sites / jurisdictions
	Utility conflicts
	Proximity to environmentally sensitive areas, drinking water wells, etc.

a. The project may alter previously established drainage patterns. New Transportation Projects and improvements to existing transportation facilities must tie into adjoining drainage features creating opportunities for and potential constraints on implementation of BMP techniques. The drainage characteristics of each project site must be evaluated to determine which BMP techniques will be feasible, and the extent to which such BMPs may be implemented.

b. Run-on conditions from adjoining properties or existing roadway surfaces will affect how certain BMP techniques can be implemented within a project. Run-on conditions should be determined and analyzed to determine the extent to which they influence BMP selection and implementation. Opportunities for re-directing run-on prior to entering the project site to reduce the hydraulic impact on water quality BMPs should be considered.

c. Location of existing utilities may reduce the feasibility of certain BMP techniques.

d. Design and placement of new utilities can provide opportunities for implementation of BMP techniques. New utilities should be considered along with BMP design and placement to maximize implementation opportunities and minimize feasibility constraints.

3. Street Widths and Parking Requirements	General Plan roadway classification
	Code restrictions on street widths
	Parking requirements / restrictions

a. General Plan roadway classifications and local code requirements may place minimum width restrictions on roads, limiting the amount of impervious surface that can be reduced and the remaining space available for BMP technique implementation.

b. Parking area requirements and restrictions may limit the amount of pervious surface that can be reduced and the remaining space available for BMP implementation.

4. Drainage Swales	Sufficient right-of- way for swale installation
	Sufficient grade / drainage connectivity
	Drainage area size / ability to divert run-on
	Soil characteristics
	Aesthetics
	Vector issues
	ADA compliance

a. Sufficient ROW must be present for proper swale installation. Proper grade and drainage connectivity must be available to provide for broader, shallower flows while tying into existing local drainage.

b. The size of the project's drainage area, amount of site run-on, and ability to redirect the run-on will affect the size and feasibility of drainage swales.

c. Vegetated drainage swales require healthy vegetation for proper functionality. Irrigation water and power must be available for maintaining proper vegetative growth during dry periods. Using non-native vegetation may increase maintenance costs and resource requirements, which may affect feasibility of implementation.

d. Soil characteristics should allow for infiltration.

e. Aesthetic goals and vector control requirements may necessitate specific swale features or affect the feasibility of their implementation.

Table 3-2. Feasibility Criteria

<table>
<tr><td rowspan="4">5. Bioretention Curb Extensions and Sidewalk Planters</td><td>Sufficient right of way for installation</td></tr>
<tr><td>Drainage connectivity</td></tr>
<tr><td>Safety protection</td></tr>
<tr><td>Plant maintenance suitability / feasibility, including irrigation availability</td></tr>
<tr><td colspan="2">a. Sufficient ROW must be present for using the median for bioretention or including bioretention curb extension or sidewalk planters within a Transportation Project, including ADA requirements.
b. Bioretention features must tie into existing drainage conditions.
c. Traffic and pedestrian safety and site aesthetics may affect the feasibility of the use of medians for bioretention or the feasibility of identifying locations for installation of curb extensions or sidewalk planters.
d. Irrigation water and power must be available for proper plant maintenance. Using native vegetation vs. non-native may reduce the need for maintenance, improving feasibility.</td></tr>
<tr><td rowspan="3">6. Permeable Pavement</td><td>Traffic suitability, including projected traffic index/structural section to accommodate traffic loading requirements</td></tr>
<tr><td>Parking surfaces present</td></tr>
<tr><td>Soils characteristics</td></tr>
<tr><td colspan="2">e. Permeable pavement can be an effective BMP technique in selected low speed areas, e.g., entrance/exits to parking lots, or parking areas (e.g., dedicated areas or along existing streets) applications, but is not considered suitable for most city and county Transportation Projects.
f. Permeable pavement is not suitable for transportation surfaces with high traffic or that may bear a heavy load.
g. Using permeable pavement for parking surfaces may be feasible unless soil characteristics will not support infiltration or drainage conditions affect functionality.
h. Specialized maintenance is necessary for permeable pavements to maintain the intended infiltration capacity. The ability for a public agency to provide resources (funding, labor, and equipment) for proper maintenance of permeable surfaces will affect feasibility.</td></tr>
<tr><td rowspan="3">7. Sidewalk Trees and Tree Boxes</td><td>Sufficient ROW for installation</td></tr>
<tr><td>Sufficient space to prevent sidewalk buckling or for root barriers</td></tr>
<tr><td>Safety protection</td></tr>
<tr><td colspan="2">a. Sufficient ROW within the Transportation Project site must be present for implementation of this BMP technique.
b. Irrigation water and power must be available for proper tree maintenance. Using native vs. non-native trees may reduce the need for maintenance, improving feasibility.
c. Traffic and pedestrian safety and site aesthetics may affect locating sidewalk trees or tree boxes and their feasibility.</td></tr>
<tr><td rowspan="2">8. Maintenance Requirements</td><td>Maintenance funding availability</td></tr>
<tr><td>Maintenance expertise / equipment availability</td></tr>
<tr><td colspan="2">a. Every BMP technique described in this Guidance requires maintenance to help ensure long term effectiveness. The feasibility of any BMP technique will depend upon the level of maintenance resources available in the long term.
b. The feasibility of BMP techniques will depend on the level of expertise necessary to maintain the BMPs. Project owners and operators must have the expertise and equipment necessary to maintain all aspects of the BMP techniques selected for a project, or have the resources to contract for the maintenance.
c. Several BMP techniques may require another public agency or department for proper maintenance. For example, maintenance of vegetated BMPs may fall within a local landscape maintenance program. As such, the resources, equipment, expertise available from other agencies may affect BMP feasibility.
d. Several BMP techniques may require consideration of existing source control programs, e.g., catch-basin cleaning or street sweeping. The local LIP should be consulted for applicable source control requirements.</td></tr>
</table>

Section 4
Source Control BMPs

Each Category 3 or 4 Project must evaluate and incorporate applicable Source Control BMPs into project planning to control pollutants after project construction is complete and the project is put into its intended service.

Table 4-1 identifies the recommended Source Control BMPs applicable to Category 3 or 4 Projects. Structural and Non-Structural Source Control BMPs may be applicable.

The agency responsible for implementing and maintaining the applicable Source Control BMPs should be identified and documented. In addition, it is recommended that the project proponent review the Source Control BMPs identified within the LIP of the jurisdiction within which the project is planned to determine if any additional Source Control BMPs may apply to the project.

Table 4-1. Potential Source Control BMPs for Transportation Projects

Recommended Source Control BMPs
Category 3 or 4 Projects
Non-Structural Source Control BMPs
▪ Landscape Management ▪ BMP Maintenance ▪ Litter Control ▪ Sweeping of Road Surfaces Adjoining Curb and Gutter ▪ Other Non-structural Measures for Public Agency Projects ▪ Drainage Facility Inspection and Maintenance
Structural Source Control BMPs
▪ Provide Storm Drain System Stenciling and Signage ▪ Use Efficient Irrigation Systems & Landscape Design, Water Conservation, Smart Controllers, and Source Control ▪ Finished Grade of Landscaped Areas ▪ Protect Slopes and Channels ▪ Site Design and Landscape Planning (Hillside Landscaping)

Section 5
Other Programmatic Elements

A. Project Documentation

For Category 1 and 2 projects (Emergency and Maintenance Projects, respectively), the project development file should contain documentation showing that this Guidance and the implementation of LID-based BMP practices did not apply.

All Category 3 and 4 projects require supplemental documentation in the project development file that includes the following:

- Project category and type;
- Site constraints;
- Project feasibility analysis findings; and
- LID-based BMPs incorporated into the project.

Where a Category 3 or 4 Project meets the Criteria for Project Coverage, and an evaluation of the feasibility of incorporating the LID BMP techniques described within this Guidance has been performed, the type and extent of the BMP techniques determined feasible will be incorporated into project plans and documented within the development files associated with the project. Permittee MS4 staff responsible for assuring compliance with MS4 Permit requirements will evaluate the applicability and feasibility determination made by project proponents for each project. Where appropriate, these staff may require additional information to demonstrate compliance with this guidance in order for acceptance and permitting. Appendix B includes a template for documenting the project specific analysis for Category 3 and 4 projects.

If the funding source of a Category 3 or 4 Project has requirements that affect what project features and/or BMPs may be incorporated or implemented, such as block grant funding, the funding requirements may be used in determining the feasibility of BMPs. Funding requirements affecting BMP implementation must be documented to demonstrate how the requirements affect the feasibility determinations within the Transportation Project BMP Template, or similar documentation, and must be included within the project file.

A project proponent may document the proposed BMP techniques via the Transportation Project BMP Template (See attached) to the proposed project plans, such as contract documents or specifications, or directly within the project plans as plan notes. Project plans and file documentation will show or describe the types, sizes, and locations of BMP techniques proposed for each proposed project. The Permittee will maintain the documentation along with all other information required for approval and permitting the proposed project within the project files.

B. Compliance with Other Permit Requirements

Other regulations and requirements are applicable to public street, road, highway, and freeway projects, for example, 404 Permit/401 Certification requirements, and NPDES General Construction Permit requirements. Other permit conditions may require additional or more (or less) stringent BMP implementation. Compliance with this Guidance does not supplant all conditions associated with other permits and programs. In cases where other requirements are similar but not prescriptive nor specific, they do not automatically overrule a feasibility evaluation performed using this Guidance. In such cases, the feasibility evaluation performed using this Guidance shall be considered the most thorough evaluation also meeting the intent of the other similar requirements.

Projects that have completed design phases but have not been constructed (shelved projects) do not have to be redesigned to incorporate the requirements of this guidance as long as they have satisfied CEQA approval at the time of design.

C. Project BMP Credits

Concepts for earning and applying BMP credits from one Transportation project to another may be developed by each Permittee. Reference local program implementation plan documentation for program availability and the process for applying project BMP credits.

D. Other Considerations

This Guidance has been developed to assist project proponents and Permittee staff with implementing the public street, road, highway, and freeway BMP requirements within the MS4 Permit. Project proponents or Permittees wishing to go beyond MEP requirements to develop "demonstration projects" for stormwater quality design may do so, as long as the MEP requirements for each BMP technique are met. Such demonstration projects would be developed under a different, more expansive determination of feasibility not considered to be the standard applicable to conventional Transportation projects.

A. Glossary

B. Transportation Project BMP Template

A. Glossary

Adjacent – Proposed project sites (or land parcels) or jurisdictions that share a common border. For example, a parcel slated for new development or significant redevelopment that has a common border with an existing road ROW that will be modified as a result of the development project.

Best Management Practice (BMP) – Defined in 40 CFR 122.2 as schedules of activities, prohibitions of practices, maintenance procedures, and other management practices to prevent or reduce the pollution of Waters of the U.S. BMPs also include treatment requirements, operating procedures and practices to control plant site runoff, spillage or leaks, sludge or waste disposal, or drainage from raw material storage. In the case of MS4 permits, BMPs are typically used in place of numeric effluent limits.

Bioretention - BMP that functions as a soil and plant-based filtration device that removes pollutants through a variety of physical, biological, and chemical treatment processes. These facilities normally consist of a grass buffer strip, sand bed, ponding area, organic layer or mulch layer, planting soil, and plants. The runoff's velocity is reduced by passing over or through buffer strip and subsequently distributed evenly along a ponding area. Exfiltration of the stored water in the bioretention area planting soil into the underlying soils occurs over a period of days.

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.]).

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

Curb Extension - Landscaped areas within the parking zone of a street that capture urban runoff. Curb extensions are enclosed by a curb on the street side, which has openings, called "curb cuts," that allow street runoff to enter and exit the facility. Extending into the street from the curb narrows the road width which also increases pedestrian safety and helps calm traffic. A curb extension allows water to flow into a landscaped area that may include vegetated swales, planters, or rain gardens.

Drainage Swale - Open channels designed to accept sheet flow runoff and convey it in broad shallow flow. The intent of swales is to reduce stormwater volume through infiltration, improve water quality through vegetative or soil filtration, and reduce flow velocity by increasing channel roughness.

Emergency - Any sudden, unexpected occurrence, involving a clear and imminent danger, demanding immediate action to prevent or mitigate loss of, or damage to, life, health, property, or essential public services. "Emergency" includes such occurrences as fire, flood, earthquake, or other soil or geologic movements, as well as such occurrences as riot, accident, or sabotage.

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.

Freeway – A divided arterial highway with full control of access and with grade separations at intersections.

General Plan - Blueprints for jurisdictions in the San Bernardino County MS4 Permit area that describe the future growth and development planned within the area over the long term. The General Plan acts as a constitution for both public and private development, the foundation upon which local leaders make growth and use related decisions. The General Plan is meant to express goals with respect to both human-made and natural environments and sets forth the policies and implementation measures to achieve them for the welfare of those who live, work, and do business in the area.

Grade Separation - A crossing of two highways or a highway and a railroad at different levels.

Highway, Street, or Road – A general term denoting a public way for the transportation of people, materials, goods, and services but primarily for vehicular travel.

Horizontal Alignment Correction – A road project designed to increase the sight distance for drivers that does not change existing road capacity.

Hydrologic Conditions of Concern (HCOC) - Condition when a proposed hydrologic change is deemed to have the potential to cause significant impacts on downstream channels and aquatic habitats, alone or in conjunction with impacts of other projects.

Impervious - Any surface in the landscape that cannot effectively absorb or infiltrate rainfall; for example, sidewalks, rooftops, roads, and parking lots.

Local Implementation Plan (LIP) - Document describing an individual Permittee's implementation procedures for compliance with the MS4 Permit, including ordinances, databases, plans, and reporting materials.

Low Impact Development (LID) – A stormwater management and land development strategy that combines a hydrologically functional site design with pollution prevention measures to compensate for land development impacts on hydrology and water quality. LID techniques mimic the site predevelopment site hydrology by using site design techniques that store, infiltrate, evapotranspire, bio-filter or detain runoff close to its source.

Maximum Extent Practicable (MEP) – Is not defined in the CWA; it refers to management practices, control techniques, and system design and engineering methods for the control of pollutants taking into account considerations of synergistic, additive, and competing factors, including, but not limited to pollutant removal effectiveness, regulatory compliance, gravity of the problem, public acceptance, social benefits, cost and technological feasibility. MEP is the technology-based standard established by Congress in CWA section 402(p)(3)(B)(iii) that operators of MS4s must meet. Technology-based standards establish the level of pollutant reductions that dischargers must achieve, typically by treatment or by a combination of source control and treatment control BMPs. MEP generally emphasizes pollution prevention and source control BMPs primarily (as the first line of defense) in combination with treatment methods serving as a backup (additional line of defense). MEP considers economics and is generally, but not necessarily, less stringent than BAT. A definition for MEP is not provided either in the statute or in the regulations. Instead, the definition of MEP is dynamic and will be defined by the following process over time: municipalities propose their definition of MEP by way of their urban runoff management programs. Their total collective and individual activities conducted pursuant to the urban runoff management programs becomes their proposal for MEP as it applies both to their overall effort, as well as to specific activities (e.g., MEP for street sweeping, or MEP for MS4 maintenance). In the absence of a proposal acceptable to the Regional Board, the Regional Board defines MEP.

MS4 Permit – National Pollutant Discharge Elimination System (NPDES) Permit and Waste Discharge Requirements for the San Bernardino County Flood Control District, San Bernardino County, and the incorporated Cities of San Bernardino County within the Santa Ana Region (Order No. R8-2010-0036, NPDES Permit No. CAS618036).

New Development – Categories of development identified in Section XI.D of the MS4 Permit. "New Development" does not include routine maintenance to maintain original line and grade, hydraulic capacity, or original purpose of a facility, nor does it include emergency required to protect public health and safety.

New Street/Road Project – Proposed street/road project that will establish a new highway, street, or road, rather than modify an existing road.

Non-Adjacent – Proposed project sites (or land parcels) that do not share a common border. For example, a parcel slated for new development or significant redevelopment that does not share a common border with an existing road that will be improved as a result of the development project.

Overlay – An overlay is a layer, usually hot mix asphalt, placed on existing flexible or rigid pavement to restore ride quality, to increase structural strength (load carrying capacity), and to extend the service life.

Pervious – Surface or area that is not impervious (see definition for "impervious").

Pollutant – Any agent that may cause or contribute to the degradation of water quality such that a condition of pollution or contamination is created or aggravated. It includes any type of industrial, municipal, and agricultural waste discharged into water. The term "pollutant" is defined in section 502(6) of the Clean Water Act as follows: "The term 'pollutant' means dredged spoil, solid waste, incinerator residue, sewage, garbage, sewage sludge, munitions, chemical wastes, biological materials, radioactive materials, heat, wrecked or discarded equipment, rock, sand, cellar dirt and industrial, municipal, and agricultural waste discharged into water." It has also been interpreted to include water characteristics such as toxicity or acidity.

Pollutants of Concern - A list of potential pollutants to be analyzed for in the Monitoring and Reporting Program. This list shall include: TSS, total inorganic nitrogen, total phosphorus, soluble reactive phosphorus, acute toxicity, fecal coliform, total coliform, pH, and chemicals/potential pollutants expected to be present on the project site. In developing this list, consideration should be given to the chemicals and potential pollutants available for stormwater to pick-up or transport to receiving waters, all Pollutants for which a waterbody within the permit area that has been listed as impaired under CWA Section 303(d), the category of development and the type of pollutants associated with that development category. It also refers to pollutants for which water bodies are listed as impaired under CWA section 303(d), pollutants associated with the land use type of a development, and/or pollutants commonly associated with urban runoff. pollutants commonly associated with urban runoff include total suspended solids; sediment; pathogens (e.g., bacteria, viruses, protozoa); heavy metals (e.g., copper, lead, zinc, and cadmium); petroleum products and polynuclear aromatic hydrocarbons; synthetic organics (e.g., pesticides, herbicides, and PCBs); nutrients (e.g., nitrogen and phosphorus fertilizers); oxygen-demanding substances (decaying vegetation, animal waste, and anthropogenic litter).

Preventive Maintenance - A planned treatment on a road in good condition that is intended to preserve the system retard future deterioration, prolong service life, and delay the need for rehabilitation.

Project Proponent – The agency or jurisdiction responsible for the management and maintenance of the Transportation project following its completion.

Receiving Water – Waters of the U.S. (as defined by the MS4 Permit) within the area under the jurisdiction of the MS4 Permit.

Reverse Parkway Drain – A design feature that allows for street runoff to enter a parkway, rather than conventionally draining a parkway area into the street. For example, curb cuts that allow street drainage into the parkway where vegetated BMPs may be implemented.

Right-of-Way (ROW) - A general term denoting land, property, or interest therein (usually in a strip) acquired for or devoted to transportation purposes.

Road – see "Highway, Street, or Road"

Routine Street/Road Maintenance – Maintenance work that is planned and performed on a regular basis to maintain and preserve the condition of the highway system or to respond to specific conditions and events that restore the highway system to an adequate level of service.

Shoulder - The paved or unpaved portion of the roadway contiguous with the traveled way for accommodating stopped vehicles, for emergency use, and for lateral support of base and surface courses.

Significant Redevelopment – The addition or creation of 5,000, or more, square feet of impervious surface on an existing developed site. This includes, but is not limited to, construction of additional buildings and/or structures, extension of the existing footprint of a building, construction of impervious or compacted soil parking lots. Significant Redevelopment does not include routine maintenance activities that are conducted to maintain original line and grade, hydraulic capacity, the original purpose of the constructed facility or emergency actions required to protect public health and safety

Street – see "Highway, Street, or Road"

Surface Footprint – The area of an existing road that is part of the active transportation surface.

Transportation Projects – Public streets, roads, highways or freeway improvements within the area under the jurisdiction of the MS4 Permit used for transportation of automobiles, trucks, motorcycles, and other vehicles; excludes routine road maintenance activities where the surface footprint is not increased.

Turn Pocket – Addition of impervious surface at an existing roadway intersection for the purpose of facilitating right or left turns.

Water Quality Management Plan (WQMP) – A plan developed to mitigate the impacts of urban runoff from new development and significant redevelopment projects - requirements contained within Section XI.D of the MS4 Permit.

B. Transportation Project BMP Template

Transportation Project BMP Template
San Bernardino County Municipal Stormwater Management Program

The federal Clean Water Act establishes requirements for the discharge of urban runoff from Municipal Separate Storm Sewer Systems (MS4) under the National Pollutant Discharge Elimination System (NPDES) program. On January 29, 2010, the Santa Ana Regional Water Quality Control Board (RWQCB) issued Permit Order No. R8-2010-0036 ("MS4 Permit") to authorize the discharge of urban runoff from MS4 facilities in San Bernardino County within the Santa Ana River watershed.

The MS4 Permit requires development of a standard design and post-development Best Management Practices (BMP) guidance to guide application of Low Impact Development (LID) BMPs to the maximum extent practicable (MEP) on public street, road, highway, and freeway improvement projects to reduce the discharge of pollutants to receiving waters. The San Bernardino County MS4 Permittees have prepared the Transportation Projects Guidance (Guidance) to provide guidance to city engineers, planners, MS4 program staff, and Transportation project proponents on how to address the permit requirements within their jurisdictions. The guidance is largely based upon public street, road, highway, and freeway BMP techniques contained within USEPA's Municipal Handbook *Managing Wet Weather with Green Infrastructure: Green Streets*.

This template was prepared to provide a tool for project proponents to (1) determine the applicability of the Guidance to a proposed Transportation Project; (2) provide a process for evaluating the feasibility of using LID-based techniques in the proposed project; and (3) establish a template for documenting the project evaluation process and the decisions made regarding the feasibility to incorporate LID-based BMPs into the design of the project.

This Transportation Project BMP Template has been prepared to assist the Permittees with documenting the incorporation of LID BMPs into public street, road, highway, and freeway projects consistent with the following criteria:

- Residential Street Projects
  Residential street projects comprising an entire block length, intersection to intersection, with a minimum length of ¼ mile.

- City Street / Road Projects
  City street / road arterial projects (single or multi-lane) extending from arterial intersection to arterial intersection, with a minimum length of ½ mile.

- Highways / Freeways
  Highway / freeway projects with a minimum length of 1 mile. Local grade separation projects that are part of a highway / freeway project with a minimum length of 1 mile.

If the Guidance applies to the proposed project, this template should be used to evaluate the feasibility of incorporating LID-based BMPs into the project design. Figure 1-1 illustrates the process for completing the template.

San Bernardino County

Santa Ana Region MS4 Permit Program

Template for
Low Impact Development:
Guidance and Standards for Transportation Projects

Insert Project Name

Prepared for/by:

Insert Owner/Developer Name

Insert Address

Insert City, State, ZIP

Insert Telephone

Prepared by (if prepared by Consultant):

Insert Consulting/Engineering Firm Name

Insert Address

Insert City, State, ZIP

Insert Telephone

Insert Address

Project Certification

This report has been completed in compliance with the *Low Impact Development: Guidance and Standards for Transportation Projects*, prepared to comply with the Santa Ana Region MS4 Permit requirements applicable to Transportation Projects. The signatory of this document attests to the technical information contained herein and the date upon which recommendations, conclusions, and decisions have been based. I find this report to be complete, current, and accurate:

Name: ___________________________________

Title: ___________________________________

Agency: ___________________________________

Date: ___________________________________

Section 1: Introduction

Overview

The federal Clean Water Act (CWA) establishes requirements for the discharge of urban runoff from Municipal Separate Storm Sewer Systems (MS4) under the National Pollutant Discharge Elimination System (NPDES) program. On January 29, 2010, the Santa Ana Regional Water Quality Control Board (RWQCB) issued Permit Order No. R8-2010-0036 ("MS4 Permit") to authorize the discharge of urban runoff from MS4 facilities in San Bernardino County within the Santa Ana Region MS4 Permit area.

The MS4 Permit requires development of a standard design and post-development Best Management Practices (BMP) guidance to guide application of Low Impact Development (LID) BMPs to the maximum extent practicable (MEP) on streets, roads, highways or freeways under the jurisdiction of the Permittees used for transportation of automobiles, trucks, motorcycles, and other vehicles. To provide consistency within the Santa Ana River Watershed, this Guidance attempts to mirror much of the *Low Impact Development: Guidance and Standards for Transportation Projects* documents previously prepared by Riverside County's stormwater program and approved by the RWQCB. This Transportation Guidance provides direction to Transportation Project owners and operators regarding how to address MS4 Permit requirements for public works Transportation Projects within the MS4 Permit jurisdiction.

The LID-based BMP techniques contained within this document are based on information provided by a variety of sources, including the *Design Handbook for Low Impact Development Best Management Practices* prepared by the Riverside County Flood Control and Water Conservation District, USEPA's Municipal Handbook, *Managing Wet Weather with Green Infrastructure: Green Streets*, and the *Low Impact Development Manual for Southern California* prepared for the Southern California Stormwater Monitoring Coalition, in cooperation with the State Water Resources Control Board, by the Low Impact Development Center. This Guidance also provides links and references to other sources of information regarding the application of LID-based BMPs to Transportation Projects (Section 6). This referenced material should be used by the project owner/operator as appropriate to support the use of this template during the project design phase.

This template was prepared to provide a tool for project proponents to (1) determine the applicability of the Guidance to a proposed Transportation Project; (2) provide a process for evaluating the feasibility of using LID-based techniques in the proposed project; and (3) establish a template for documenting the project evaluation process and the decisions made regarding the feasibility to incorporate LID-based BMPs into the design of the project. Users should review the Guidance before applying this template to a proposed project.

Guidance Applicability

The Transportation Project BMP Template provides a framework for the documentation of the feasibility and scope of both LID and treatment BMP implementation. Table 1.1 summarizes the applicability of the Guidance to Transportation Projects. If the Guidance applies to the proposed project, this Template should be used to evaluate the feasibility of incorporating LID-based BMPs into the project design. Figure 1-1 illustrates the process for completing the template. Data gathered during completion of the feasibility analysis (Sections 5 and 6) are entered into Table 7.1. Appendix A-1 is used only for those BMPs designated as feasible in Table 7.1. Full documentation of infeasibility and BMP sizing is required for submittal and approval by the approving jurisdiction.

Table 1.1. Transportation Project Guidance Applicability

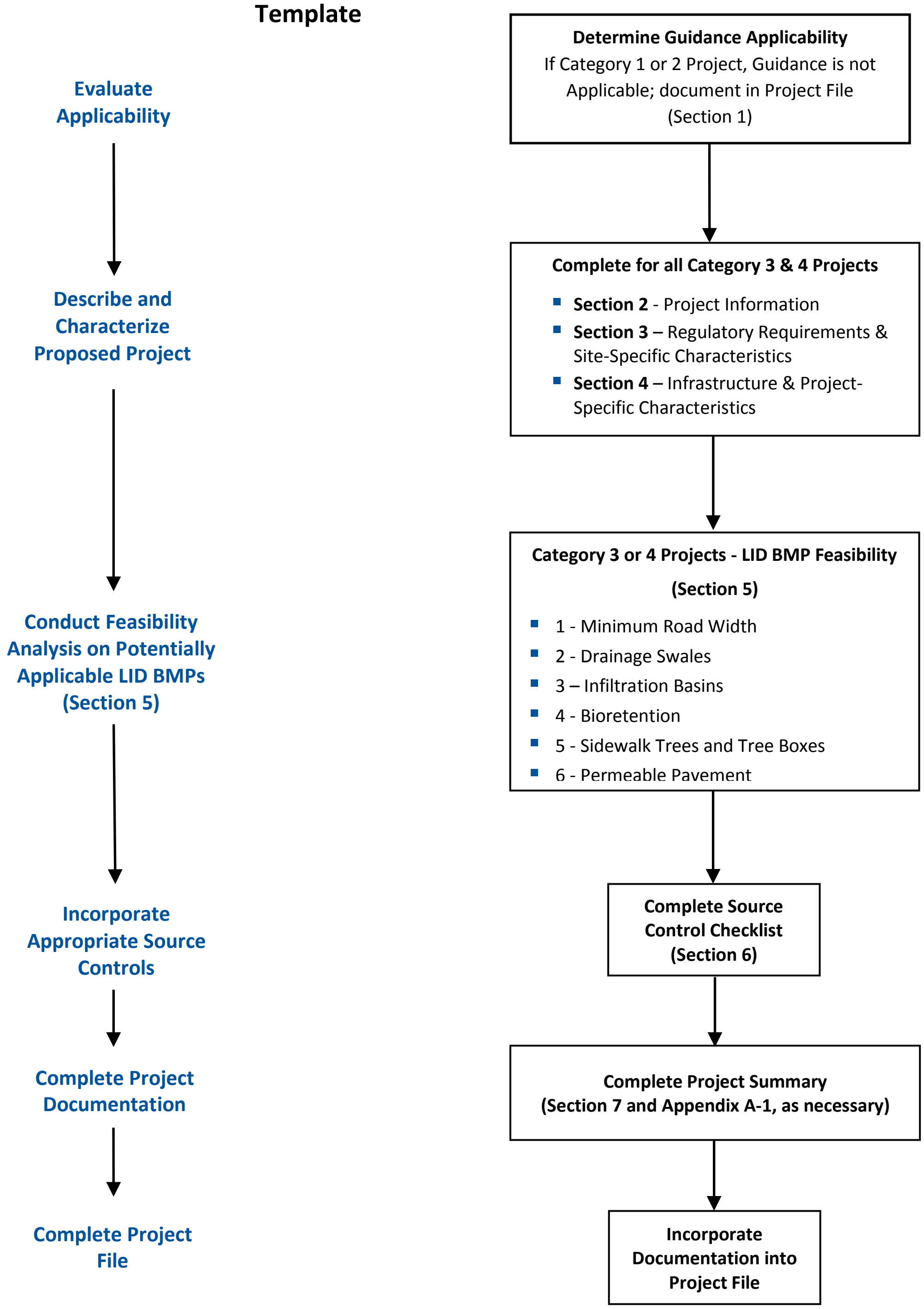
The Transportation Project Guidance applies to the following projects:

- Public Transportation Projects in the area covered by the Santa Ana Region MS4 Permit, which involve the construction of new transportation surfaces or the improvement of existing transportation surfaces.

The Transportation Project Guidance does not apply to the following projects that are either exempt or covered by other MS4 Permit requirements:

- Transportation Projects that have received CEQA approval by the effective date of this Guidance
- Emergency Projects, as defined by this Guidance (see Section 2 of the Guidance)
- Maintenance Projects, as defined by this Guidance (see Section 2 of the Guidance)
- Dirt or gravel roads
- Transportation Projects that are part of a private new development or significant redevelopment project and required to prepare a Water Quality Management Plan (WQMP)
- Transportation Projects subject to other MS4 Permit requirements, e.g., California Transportation Department (Caltrans) oversight projects, cooperative projects with an adjoining County or an agency outside the jurisdiction covered by the Santa Ana Region MS4 Permit

Figure 1-1. Process to Complete Transportation Project BMP Template



Section 2: Project Information

The purpose of this section is to provide general project information and a description of the proposed project. The description should have sufficient detail to identify the project location, project boundaries and size, and, if classified as a Category 3 Project, the basis for the subcategorization (Capacity vs. Non-Capacity Roadway Improvement Project).

<table>
<tr><th colspan="8">Table 2.1 - Project Characteristics</th></tr>
<tr><td colspan="2">Project Name</td><td colspan="6"></td></tr>
<tr><td colspan="2">Project Owner/Operator (Agency)</td><td colspan="6"></td></tr>
<tr><td colspan="2">Project Contact Name:</td><td colspan="6"></td></tr>
<tr><td>Mailing Address:</td><td colspan="2"></td><td>E-mail Address:</td><td></td><td>Telephone:</td><td colspan="2"></td></tr>
<tr><td colspan="2">Project Category</td><td colspan="6">Check the box for the applicable Project Category (See Table 2-1 in Guidance

☐ Category 3 – Existing Transportation Project
☐ Category 4 – New Transportation Project</td></tr>
<tr><td colspan="8">Check the appropriate boxes below, based on the Project Category checked above</td></tr>
<tr><td colspan="2" rowspan="2">Category 3</td><td colspan="2">☐ Roadway Capacity Improvement Project</td><td colspan="4">☐ Lane additions
☐ Bridge project
☐ Grade separation project
☐ Other project type</td></tr>
<tr><td colspan="2">☐ Non-Capacity Roadway Improvement Project</td><td colspan="4">☐ Shoulder improvements
☐ Parking lane improvements
☐ Turn pocket addition
☐ Signal project that adds a turn lane
☐ Horizontal alignment correction (improve sight distance)
☐ Grade separation project
☐ Passing lane addition
☐ Turn out addition
☐ Other project type</td></tr>
<tr><td colspan="2">Category 4</td><td colspan="6">☐ New road project
☐ New bridge project</td></tr>
<tr><td colspan="8">Project Schedule:

</td></tr>
</table>

Table 2.2 - Project Description

General Project Description:					
Project Area (ft^2):		Project Length (ft):		Coordinates of the approximate center of the project:	Latitude: Longitude:
For Category 3 & 4 projects, complete the information below.					
Describe how the existing surface footprint will be modified, if applicable					
Describe how the capacity of the existing transportation surface (if any) will be improved					

Section 3: Regulatory Requirements & Site-Specific Chararacteristics

Describe the regulatory requirements and site-specific characteristics associated with the project site that can influence the selection of LID-based BMPs. Attach supporting information, as needed.

Table 3.1 – Regulatory Requirements & Site-Specific Characteristics	
Regulatory Requirements	
Consult Local Implementation Plan(s) to document pollutants of concern based on impaired waters listings or TMDL implementation requirements.	
Document any known CEQA conditions, Multi-Species Habitat Conservation Plan, California Fish & Game Code Section 1600, CWA Section 401, or CWA Section 404 requirements	
Site-Specific Characteristics	
Drainage Area (ft^2)	
Existing Site Impervious Area (ft^2)	
Expected Post-Project Impervious Area (ft^2)	
Hydrologic Soil Group* *Describe hydrologic soil group and associated infiltration characteristics, if known*	
Expected Infiltration Characteristics *Describe known infiltration characteristics based on soil group or soil test data (attach if such data are available)*	
Natural Sediment Load Characteristics *Describe local sediment characteristics that could impact selection or functionality of BMPs*	
Depth to Groundwater *Determine depth to groundwater, if known (provide source of information*)	

* See soils section of the Flood Control District's Hydrology Manual
http://www.sbcounty.gov/dpw/floodcontrol/pdf/HydrologyManual.pdf

Section 4: Infrastructure & Project-Specific Characteristics

Describe the existing infrastructure and project-specific characteristics associated with the project site that can influence the selection of LID-based BMPs. Attach supporting information, as needed; insert N/A for any element that is not applicable to the proposed project.

Table 4.1 - Infrastructure & Project-Specific Characteristics	
Programmatic & Funding Restrictions	
Project Funding *Provide information regarding project funding*	Project Budget:
	Funding Source:
	Are there any limitations or restrictions on the use of dedicated funds: ☐ Yes; if this box checked, explain limitations ☐ No
Programmatic Constraints *Identify any programmatic or regulatory constraints, e.g., Americans with Disabilities Act; need for emergency access, etc.*	Does the project require compliance with other programmatic, regulatory, or code requirements that may affect application of BMPs? ☐ Yes; if this box checked, explain limitations ☐ No
Impaired Waters & TMDL Requirements	
Regulatory Constraints *Describe applicable BMP specific requirements to address impaired water related concerns*	Identify the MS4 Local Implementation Plan(s) consulted: Does the applicable LIP(s) identify any BMP requirements that need to be implemented in the project area: ☐ Yes; describe the BMP requirements and how they have been addressed in the project design: ☐ No
Right-of-Way (ROW)	
ROW Constraints *Describe potential ROW constraints to BMP implementation*	
Drainage Connectivity	
Connectivity Constraints *Based on drainage features of the project site, describe potential constraints to BMP implementation*	

Table 4.1 - Infrastructure & Project-Specific Characteristics	
Utilities	
Utility Constraints *Identify any utility-related constraints*	Does the project have any utility constraints that that may affect application of BMPs? ☐ Yes; if this box checked, explain constraints ☐ No
Resource Availability	
Irrigation Water *Describe availability of irrigation water to support BMPs that require establishment of landscaping*	
Power *Describe availability of power to support use of an irrigation system*	
Estimated Road Use	
Vehicle Load *Describe the expected vehicle loads, e.g., H-20 truck loads, that will use the transportation surface after project completion*	
Maximum Allowable Speed (MAS) *Describe expected speed of vehicles on completed transportation surface; if variable, provide the MAS for different project elements*	
Roadside Parking Requirements *Describe any minimum requirements associated with design of roadside parking areas*	
Capacity Design (Average Daily Traffic, ADT). Is the ADT ≥ 25,000?	☐ Yes ☐ No

Section 5: BMP Feasibility Analysis

Section 5.1 - Overview

Projects categorized as a Category 3 or Category 4 shall incorporate the following site design BMP principles to the maximum extent feasible:

Conservation of natural areas to the extent feasible

Minimization of the impervious footprint

Minimization of disturbances to natural drainage

Design and construction of pervious areas to receive runoff from impervious areas

Use of landscaping that minimizes irrigation and runoff, promotes surface infiltration, and minimizes the use of pesticides and fertilizers

The extent to which these design principles may be incorporated into a project through the use of BMP techniques depends on the project type and the project-specific feasibility analysis. This section provides a stepwise approach for evaluating the feasibility to incorporate LID-based BMPs into a proposed project. Table 5.1 identifies the BMPs required for evaluation in relation to the project category or type. Based on the box checked the project reviewer is directed to the appropriate table for subsequent analyses. Table 5.2 provides sources for BMP planning and design information that may be considered for use in Transportation Projects. Table 5.3 provides a checklist for LID BMP feasibility analysis for Category 3 or 4 projects.

Section 5.2 – BMP References

To support completion of the feasibility analyses for each LID-based BMP in Table 5.3, Table 5.2 provides sources for BMP design information that may be considered for use in Transportation Projects. These information sources are intended to guide decision-making with regards to making feasibility determinations about the efficacy of incorporating LID-based BMPs in the project design. Additional general information regarding the use of LID-based BMPs in Transportation Projects may be found in Section 6.C of the Guidance.

The resource information provided in Table 5.2 does not represent an exhaustive list of source material regarding LIP-based BMPs; in fact, new information regarding how to design LID-based BMPs is regularly published. In addition, this information is not to be used as a substitute for development of engineering designs appropriate to the project site.

Table 5.1 - LID BMP Evaluation Requirements
These LID BMPs must be included in the feasibility analysis
▪ 1 - Minimum Road Width ▪ 2 - Drainage Swales ▪ 3 – Infiltration Basins ▪ 4 - Bioretention ▪ 5 - Sidewalk Trees and Tree Boxes ▪ 6 - Permeable Pavement

Table 5.2 – BMP Design Information						
LID-based BMP Information Source	**Minimum Street Width[3]**	**Drainage Swales**	**Infiltration Basins**	**Bioretention**	**Sidewalk Trees & Tree Boxes**	**Permeable Pavement**
Riverside County Flood Control and Water Conservation District Design Handbook for Low Impact Development Management Practices http://rcflood.org/NPDES/LIDBMP.aspx	--	--	Section 3.1	Section 3.5	Section 3.5, p. 5[1]	Section 3.3
Low Impact Development Manual for Southern California: Technical Guidance and Site Planning Strategies http://www.casqa.org/LID/SoCalLID/tabid/218/Default.aspx	--	pp. 137-138	--	pp. 68-84	p. 71[1]	pp. 83-113
U. S. EPA Municipal Handbook: Green Streets, Managing Wet Weather with Green Infrastructure[2] http://water.epa.gov/infrastructure/greeninfrastructure/upload/gi_munichandbook_green_streets.pdf	pp. 2-4[3]	--	--	--	--	--
County of San Diego, Low Impact Development Handbook: Stormwater Management Strategies http://www.sdcounty.ca.gov/dplu/docs/LID-Handbook.pdf (General Information) http://www.sdcounty.ca.gov/dplu/docs/LID-Appendices.pdf (Fact Sheets)	Fact Sheet 14, 15[3]	--	--	Fact Sheets 15, 19	--	pp. 46-51, Fact Sheets 8, 9, 10
County of Los Angeles Low Impact Development Standards Manual. January 2009. http://dpw.lacounty.gov/wmd/LA_County_LID_Manual.pdf	--	--	--	--	pp. 49-52[1]	pp. 53-57
City of Santa Barbara Storm Water BMP Guidance Manual http://www.santabarbaraca.gov/Resident/Community/Creeks/Storm_Water_Management_Program.htm	--	Section 6.6.2	--	Section 6.6.1	Section 6.9.2[1]	Section 6.8
Caltrans Treatment Control BMP Technology Report http://www.dot.ca.gov/hq/env/stormwater/annual_report/2008/annual_report_06-07/attachments/Treatment_BMP_Technology_Rprt.pdf	--	p. D-5	--	pp. B-11 – B-12	pp. B-7 – B-10	--
Evaluation of Best Management Practices for Highway Runoff Control: Low Impact Development Design Manual for Highway Runoff Control http://www.coralreef.gov/transportation/evalbmp.pdf	--	Section 14	--	Section 5	--	Section 10

[1] Information focuses on design of planter boxes

[2] Handbook provides information on all LID types except Infiltration Basins, but information is general in nature

[3] Shall follow approving agency's street width standards.

Table 5.3 – LID BMP Feasibility Analysis Category 1 – Minimum Road Widths	
1.a - Does the project need to meet jurisdictional code or General Plan requirements for minimum road widths?	☐ Yes; if checked, describe requirements ☐ No
1.b – Based on the findings of 1.a., determine if this BMP can be applied to the project. If applicable, describe how it was incorporated into the project design.	☐ Applicable, describe design features incorporating this BMP; include in Table 7.1 ☐ Not Applicable, describe basis for decision (e.g., project requirements, traffic or pedestrian safety concerns)

Table 5.3 – LID BMP Feasibility Analysis Category 2 – Drainage Swales	
2.a – Are there any programmatic constraints that prevent the use of this BMP, *e.g., Americans with Disabilities Act; need for emergency access, funding restrictions, etc.? See Section 3.b of the Guidance.*	☐ Yes; if checked, provide basis for finding and STOP; this BMP is infeasible ☐ No; BMP is potentially feasible, continue to 2.b
2.b - Considering grade and need for drainage connectivity, is there sufficient ROW for proper swale installation?	☐ No; if checked, provide basis for finding ☐ Yes
2.c - Can drainage swales be sized large enough to capture site run-on and redirect it into the drainage system?	☐ No; if checked, provide basis for finding ☐ Yes
2.d - Are existing soil characteristics sufficient to support infiltration such that nuisance or vector conditions are not created by any ponded water that may occur?	☐ No; if checked, provide basis for finding ☐ Yes
• If "No" is checked for 2.b, 2.c, <u>or</u> 2.d, then STOP - this BMP is infeasible; attach appropriate documentation support as needed • If "Yes" is checked for 2.b, 2.c, <u>and</u> 2.d, then this BMP is potentially feasible, continue on to 2.e and 2.f	
2.e - Are irrigation water and power available to support vegetation in swale during dry periods?	☐ No; if checked, provide basis for finding ☐ Yes
2.f - If irrigation water and power are not available, can the site support native vegetation that does not require irrigation?	☐ No; if checked, provide basis for finding ☐ Yes
• If "No" is checked for 2.e <u>and</u> 2.f, this BMP is infeasible • If "Yes" is checked for 2.e <u>or</u> 2.f, then this BMP is potentially feasible; continue to 2.g	
2.g – Are there any special maintenance, equipment, or experience requirements associated with the implementation of this BMP?	☐ Yes; if checked, provide basis for finding and determine whether the findings prevent implementation of this BMP ☐ No
2.h – If this BMP is implemented, will there be any one-time capital costs incurred, e.g., for new equipment required to maintain the BMP, that impacts project funding?	☐ Yes; if checked, provide basis for finding and determine whether the findings prevent implementation of this BMP ☐ No
2.i – Is there long-term funding available to maintain this BMP?	☐ Yes ☐ No
• If any of the findings from 2.g, 2.h <u>or</u> 2.i prevent the use of this BMP, then this BMP is infeasible; attach appropriate documentation as needed • If the findings from 2.g., 2.h, <u>and</u> 2.i do not prevent implementation of this BMP, then the BMP is feasible; incorporate into Table 7.1	

Table 5.3 – LID BMP Feasibility Analysis Category 3 – Infiltration Basins	
3.a – Are there any programmatic constraints that prevent the use of this BMP, *e.g., Americans with Disabilities Act; need for emergency access, funding restrictions, etc.? See Section 3.b of the Guidance.*	☐ Yes; if checked, provide basis for finding and STOP; this BMP is infeasible ☐ No; BMP is potentially feasible, continue to 3.b
3.b - Do appropriate soil conditions exist at the project site to allow effective infiltration consistent with a drawdown period, not to exceed 72 hours?	☐ No; if checked, provide basis for finding ☐ Yes
3.c - Is there at least 10 feet separation between the planned basin invert and the measured groundwater elevation?	☐ No; if checked, provide basis for finding ☐ Yes
3.d- Is there at least 100 feet separation from the proposed basin(s) and any known water supply wells?	☐ No; if checked, provide basis for finding ☐ Yes
3.e - Is the underlying soil and/or groundwater free from any known contamination?	☐ No; if checked, provide basis for finding ☐ Yes
3.f - Is there sufficient space to size or place an infiltration basin that: • Has slopes that are no steeper than 4:1, <u>and</u> • Is located at least 100 feet from bridge structures?	☐ No; if checked, provide basis for finding ☐ Yes
3.g - For a project area that has high vehicular traffic (25,000 or more average daily traffic), can the planned infiltration basin meet the MS4 Permit's pretreatment of runoff requirements?	☐ No; if checked, provide basis for finding ☐ Yes
3.h - Can an infiltration basin be incorporated into the site plan in a manner that does not create traffic or pedestrian safety concerns?	☐ No; if checked, provide basis for finding ☐ Yes
3.i - Does inclusion of an infiltration basin detract from the aesthetics of the roadway or project area that cannot be mitigated?	☐ No; if checked, provide basis for finding ☐ Yes
• If "No" is checked for any of the above questions (3.b – 3.i), this BMP is infeasible • If "Yes" is checked for all of the above (3.b - 3.i), then this BMP is potentially feasible; continue to 3.j	
3.j – Are there any special maintenance, equipment, or experience requirements associated with the implementation of this BMP?	☐ Yes; if checked, provide basis for finding and determine whether the findings prevent implementation of this BMP ☐ No
3.k – If this BMP is implemented, will there be any one-time capital costs incurred, e.g., for new equipment required to maintain the BMP, that impacts project funding?	☐ Yes; if checked, provide basis for finding and determine whether the findings prevent implementation of this BMP ☐ No
3.l – Is there long-term funding available to maintain this BMP?	☐ Yes ☐ No
• If any of the findings from 3.j, 3.k <u>or</u> 3.l prevent the use of this BMP, then this BMP is infeasible; attach appropriate documentation as needed • If the findings from 3.j., 3.k, <u>and</u> 3.l do not prevent implementation of this BMP, then the BMP is feasible; incorporate into Table 7.1	

Table 5.3 – LID BMP Feasibility Analysis
Catergory 4 – Bioretention

4.a – Are there any programmatic constraints that prevent the use of this BMP, *e.g., Americans with Disabilities Act; need for emergency access, funding restrictions, etc.? See Section 3.b of the Guidance.*	☐ Yes; if checked, provide basis for finding and STOP; this BMP is infeasible ☐ No; BMP is potentially feasible, continue to 4.b
4.b - Is there sufficient ROW to consider curb extensions?	☐ No; if checked, provide basis for finding ☐ Yes
4.c - Is there sufficient ROW to consider sidewalk planters?	☐ No; if checked, provide basis for finding ☐ Yes
4.d – Is there sufficient space to consider using the road median for bioretention?	☐ No; if checked, provide basis for finding ☐ Yes
• If "No" is checked for 4.b, 4.c <u>and</u> 4.d, then STOP - this BMP is infeasible; attach appropriate documentation support as needed • If "Yes" is checked for 4.b, 4.c <u>or</u> 4.d, then this BMP is potentially feasible, continue on to 4.e	
4.e – Can the site be designed so that median, curb extensions or sidewalk planters tie into the existing drainage at the project site?	☐ No; if checked, provide basis for finding ☐ Yes
• If "No" is checked for 4.e, then STOP - this BMP is infeasible; attach appropriate documentation support as needed • If "Yes" is checked for 4.e, then this BMP is potentially feasible, continue on to 4.f and 4.g	
4.f - Are irrigation water and power available to support bioretention area or sidewalk planters?	☐ No; if checked, provide basis for finding ☐ Yes
4.g - If irrigation water and power are not available, can the site support native vegetation that does not require irrigation?	☐ No; if checked, provide basis for finding ☐ Yes
• If "No" is checked for 4.f <u>and</u> 4.g, then STOP - this BMP is infeasible • If "Yes" is checked for 4.f <u>or</u> 4.g, then this BMP is potentially feasible; continue on to 4.h	
4.h – Based on anticipated traffic capacity and MAS applicable to the project site, are there any traffic or pedestrian safety concerns that prevent application of this BMP?	☐ Yes; if checked, provide basis for finding ☐ No
• If "Yes" is checked for 4.h this BMP is infeasible • If "No" is checked for 4.h, then this BMP is potentially feasible; continue to 4.i.	
4.i – Are there any special maintenance, equipment, or experience requirements associated with the implementation of this BMP?	☐ Yes; if checked, provide basis for finding and determine whether the findings prevent implementation of this BMP ☐ No
4.j – If this BMP is implemented, will there be any one-time capital costs incurred, e.g., for new equipment required to maintain the BMP, that impacts project funding?	☐ Yes; if checked, provide basis for finding and determine whether the findings prevent implementation of this BMP ☐ No
4.j – Is there long-term funding available to maintain this BMP?	☐ Yes ☐ No
• If any of the findings from 4.i, 4.j <u>or</u> 4.k prevent the use of this BMP, then this BMP is infeasible; attach appropriate documentation as needed • If the findings from 4.i, 4.j, <u>and</u> 4.k do not prevent implementation of this BMP, then the BMP is feasible; incorporate into Table 7.1	

Table 5.3 – LID BMP Feasibility Analysis Category 5 – Sidewalk Trees and Tree Boxes	
5.a – Are there any or programmatic constraints that prevent the use of this BMP, *e.g., Americans with Disabilities Act; need for emergency access, funding restrictions, etc.? See Section 3.b of the Guidance.*	☐ Yes; if checked, provide basis for finding and STOP; this BMP is infeasible ☐ No; BMP is potentially feasible, continue to 5.b
5.b - Is there sufficient ROW to incorporate sidewalk trees or tree boxes into the project site?	☐ No; if checked, provide basis for finding ☐ Yes
• If "No" is checked for 5.b, then STOP - this BMP is infeasible; attach appropriate documentation support as needed • If "Yes" is checked for 5.b, then this BMP is potentially feasible, continue on to 5.c and 5.d	
5.c - Are irrigation water and power available to support vegetation in the bioretention area or sidewalk planters?	☐ No; if checked, provide basis for finding ☐ Yes
5.d - If irrigation water and power are not available, can the site support native vegetation that does not require irrigation?	☐ No; if checked, provide basis for finding ☐ Yes
• If "No" is checked for 5.c <u>and</u> 5.d, then STOP - this BMP is infeasible • If "Yes" is checked for 5.c <u>or</u> 5.d, then this BMP is potentially feasible; continue on to 5.e	
5.e – Based on anticipated traffic capacity and MAS applicable to the project site, are there any traffic or pedestrian safety concerns that prevent application of this BMP?	☐ Yes; if checked, provide basis for finding ☐ No
• If "Yes" is checked for 5.e this BMP is infeasible • If "No" is checked for 5.e, then this BMP is potentially feasible; continue to 5.f	
5.f – Are there any special maintenance, equipment, or experience requirements associated with the implementation of this BMP?	☐ Yes; if checked, provide basis for finding and determine whether the findings prevent implementation of this BMP ☐ No
5.g – If this BMP is implemented, will there be any one-time capital costs incurred, e.g., for new equipment required to maintain the BMP, that impacts project funding?	☐ Yes; if checked, provide basis for finding and determine whether the findings prevent implementation of this BMP ☐ No
5.h – Is there long-term funding available to maintain this BMP?	☐ Yes ☐ No
• If any of the findings from 5.f, 5.g <u>or</u> 5.h prevent the use of this BMP, then this BMP is infeasible; attach appropriate documentation as needed • If the findings from 5.f, 5.g <u>and</u> 5.h do not prevent implementation of this BMP, then the BMP is feasible; incorporate into Table 7.1	

Table 5.3 – LID BMP Feasibility Analysis Category 6 – Permeable Pavement	
6.a – Are there any or programmatic constraints that prevent the use of this BMP, *e.g., Americans with Disabilities Act; need for emergency access, funding restrictions, etc.? See Section 3.b of the Guidance.*	☐ Yes; if checked, provide basis for finding; STOP, this BMP is infeasible ☐ No; BMP is potentially feasible, continue to 6.b
6.b - Does the planned road project include any of the listed types of impervious surfaces (check all that apply)?	☐ Roadside parking/parking lane ☐ Driveways ☐ Sidewalks, walkways ☐ None of the above
• If "none of the above" is checked in 6.b, then STOP – BMP is infeasible • If any box other than "none of the above" is checked, BMP is potentially feasible; continue to 6.c	
6.c – Will any of the transportation surfaces checked in 6.b be subject to high traffic volume or heavy traffic loads that prevent the use of permeable pavement?	☐ Yes; if checked, provide basis for finding ☐ No
6.d – Do the underlying soils at the project site provide adequate infiltration capacity for use of this BMP while not causing structural concerns?	☐ No; if checked, provide basis for finding ☐ Yes
• If "Yes" is checked for 6.c <u>or</u> "No" is checked for 6.d, then STOP - this BMP is infeasible; attach appropriate documentation support as needed • If "No" is checked for 6.c <u>and</u> "Yes" is checked for 6.d, then this BMP is potentially feasible for all impervious surface types checked in 6.b; continue to 6.e • If "Yes" is checked for 6.c <u>and</u> 6.d <u>and</u> "sidewalks, walkways" was checked in 6.b, then this BMP is potentially feasible for sidewalk or walkway elements of the project; continue to 6.e	
6.e – Are there any special maintenance, equipment, or experience requirements associated with the implementation of this BMP?	☐ No; if checked, provide basis for finding and determine whether the findings prevent implementation of this BMP ☐ Yes
6.f – Will the BMP maintain an adequate service life (at least 5 years) such that the BMP is economically feasible?	☐ No; if checked, provide basis for finding and determine whether the findings prevent implementation of this BMP ☐ Yes
6.g – If this BMP is implemented, will there be any one-time capital costs incurred, e.g., for new equipment required to maintain the BMP, that impacts project funding?	☐ Yes; if checked, provide basis for finding and determine whether the findings prevent implementation of this BMP ☐ No
6.h – Is there long-term funding available to maintain this BMP?	☐ Yes ☐ No
• If any of the findings from 6.e, 6.f, 6.g <u>or</u> 6.h prevent the use of this BMP, then this BMP is infeasible; attach appropriate documentation as needed • If the findings from 6.e, 6.f, 6.g <u>and</u> 6.h do not prevent implementation of this BMP, then the BMP is feasible; incorporate into Table 7.1	

Section 6: Source Control BMPs

Section 6 identifies source control BMPs potentially applicable to the proposed project. The project reviewer should evaluate the applicability of each source control BMP and identify the agency responsible for implementing the BMPs once the project is constructed.

Table 6.1 - Source Control BMPs

Source Control BMP	Check One		If not Included, Provide Basis	If Included, Agency Responsible for Implementation
	Included	Not Included		
Category 3 or 4 Projects				
Irrigation System and Landscape Maintenance	☐	☐		
Sweeping of Transportation Surfaces adjoining curb and gutter	☐	☐		
Drainage Facility Inspection and Maintenance	☐	☐		
MS4 Stenciling and Signage	☐	☐		
Landscape and Irrigation System Design	☐	☐		
Protect Slopes and Channels	☐	☐		

Section 7: Conformance and Project Summary

Table7.1 summarizes and documents (a) applicability and use of LID-based BMPs in the project design (from Section 5); (b) applicable source control BMPs (from Section 6); and (c) known regulatory requirements that impacted the project design (from Section 3). Fill out the information relevant to the project type and provide supporting information where needed. Continue to Section 8 on the following page for the steps to follow for applicable projects to appropriately size proposed BMP(s). If the project has more than one outlet, then complete additional versions of this form for each outlet.

Table 7.1 Conformance Summary

1 – Minimum Road Width

☐ Infeasible ☐ Feasible

2 – Drainage Swales

☐ Infeasible ☐ Feasible If required, LID BMP Volume equivalency (%): __________
Copy Item 13 in Form A-6

3 – Infiltration Basins

☐ Infeasible ☐ Feasible If feasible, Retention Volume (ft^3): __________
Copy Item 12a or 12b (for applicable BMP) from Table A-7

4 – Bioretention (w/o Underdrains)

☐ Infeasible ☐ Feasible If feasible, Retention Volume (ft^3): __________
Copy Item 15 from Table A-8

5 – Sidewalk Trees and Tree Boxes

☐ Infeasible ☐ Feasible If feasible, Retention Volume (ft^3): __________
Copy Item 3 from Table A-9

6 – Permeable Pavement

☐ Infeasible ☐ Feasible If feasible, Retention Volume (ft^3): __________
Copy Item 8 from Table A-10

7 – Bioretention (with Underdrains)

☐ Infeasible ☐ Feasible If feasible, Retention Volume (ft^3): __________
Copy Item 15 in Form A-11

8 - Total LID DCV for the Transportation Project (ft^3): __________ *Copy Item 7 in Form A-2*

LID BMP performance criteria are achieved if answer to any of the following is "Yes":

- Full retention of LID DCV with infiltration basins, bioretention without underdrains, permeable pavement, and street trees: Yes ☐ No ☐ *If yes, sum of Items 3, 4, 5 , and 6 is greater than Item 8*
- Combination of on-site retention and infiltration BMPs for a portion of the LID DCV, and flow-based biotreatment BMPs that address all pollutants of concern for the remaining LID DCV: Yes ☐ No ☐ *If yes, sum of Items 3, 4, 5, 6 and 7 is greater than Item 8; and Item 2 is greater than the percent remaining DCV based on Figure 5-2 from TGD for WQMP.*
- On-site retention is determined to be infeasible and biotreatment BMPs provide flow-based biotreatment for all pollutants of concern for full LID DCV:

  Yes ☐ No ☐ *If yes, Item 2 is greater than Item 8, based on Figure 5-2 from the TGD for WQMP*

Table 7.1 Conformance Summary (cont.)	
Regulatory Requirements Document design elements that address any known regulatory requirements (see Table 3.1); if none, check the N/A box.	☐ Design elements affected by regulatory requirements Describe: ☐ N/A
Source Control BMPs Summarize the applicable source controls and the agency responsible for implementation	

Section 8: BMP Sizing for Applicable Green Streets Projects

*NOTE: **All** documentation and analyses used in this section shall be provided using the forms in Appendix A-1, Project BMP Sizing Documentation or by using the Riverside County LID Manual Worksheets. Submitted Transportation Project documents will include completed copies of these worksheets or forms.*

The following steps are used to size previously selected BMPs (e.g. LID and Treatment Control) for **Category 3 and 4** projects:

1. Delineate drainage areas tributary to proposed BMP locations and compute imperviousness.

2. Using the information provided in Table 5.2 above, look up the recommended sizing method for the BMP selected in each drainage area and calculate target sizing criteria (e.g., Design Capture Volume).

3. Using the information provided in Table 5.2 above, appropriately design your BMP(s) per the provided guidance links.

4. Attempt to provide the calculated sizing criteria for the selected BMPs.

5. If sizing criteria cannot be achieved, document the constraints that override the application of BMPs, and provide the largest portion of the sizing criteria that can be reasonably provided given constraints.

If BMPs cannot be sized to provide the calculated volume for the tributary area, it is still essential to design the BMP inlet, energy dissipation, and overflow capacity for the full tributary area to ensure that flooding and scour is avoided. It is strongly recommended that BMPs which are designed to less than their target design volume be designed to bypass peak flows.

For those **Category 4** projects that cannot meet the sizing criteria, notification to the Santa Ana Regional Water Quality Control Board – Inland Stormwater Unit is required. Notification must include a cover letter justifying why your **Category 4** project cannot meet the sizing criteria and needs to include the feasibility analysis used to reach that conclusion. A copy of this notification must also be included in Appendix A-1, below.

Appendix A-1: Project BMP Sizing Documentation

Table A-1 LID BMP Performance Criteria for Design Capture Volume		
1 Drainage area (ft^2): ________	**2** Imperviousness after applying preventative site design practices (Imp%): _____	**3** Runoff Coefficient (Rc): _______ *$R_c = 0.858(Imp\%)^{3} - 0.78(Imp\%)^{2} + 0.774(Imp\%) + 0.04$*
4 Determine 1-hour rainfall depth for a 2-year return period $P_{2yr\text{-}1hr}$ (in): ____ *http://hdsc.nws.noaa.gov/hdsc/pfds/sa/sca_pfds.html*		
5 Compute P_6, Mean 6-hr Precipitation (inches): ________ *P_6 = Item 4 *C_1, where C_1 is a function of site climatic region specified in Table 3-2 of the TGD for WQMP (Valley = 1.4807; Mountain = 1.909; Desert = 1.2371)*		
6 Drawdown Rate *Use 48 hours unless site has soils with average field-measured permeability greater than 2 inches/hr. The necessary BMP footprint is a function of drawdown time. While shorter drawdown times reduce the performance criteria for LID BMP design capture volume, the depth of water that can be stored is also reduced, therefore larger BMP footprints may be needed to capture smaller design capture volume in sites with soil permeability less than 2 in/hr.*		24-hrs ☐ 48-hrs ☐
7 Compute design capture volume V_{DCV} (ft^3): ________ *V_{SDCV} = 1/12 * [Item 1* Item 3 *Item 5 * C_2], where C_2 is a function of drawdown rate (24-hr = 1.582; 48-hr = 1.963)* *Compute separate V_{DCV} for each DA to a roadway inlet*		

Table A-2 Summary of HCOC Assessment			
Does project have the potential to cause or contribute to an HCOC in a downstream channel: Yes ☐ No ☐ *Go to: http://sbcounty.permitrack.com/WAP/* If "Yes", then complete HCOC assessment of site hydrology for 2 yr storm event using Tables A-3 through A-5 and insert results below. Tables A-3 through A-5 may be replaced by computer software analysis that is based on the San Bernardino County Hydrology Manual. *Complete separate HCOC assessment for each DA to a roadway inlet* If "No," then proceed to Form A-6			
Condition	Runoff Volume (ft^3)	Time of Concentration (min)	Peak Runoff (cfs)
Pre-developed	**1** ________ *Table A-3, Item 8*	**2** ________ *Table A-4, Item 13*	**3** ________ *Table A-5, Item $6_{pre\text{-}developed}$*
Post-developed	**4** ________ *Table A-3, Item 9*	**5** ________ *Table A-4, Item 14*	**6** ________ *Table A-5, Item $6_{post\text{-}developed}$*
Difference	**7** __________ *Item 4 – Item 1*	**8** __________ *Item 5 – Item 2*	**9** __________ *Item 6 – Item 3*
Difference (as % of pre-developed)	**10** __________% *Item 7 / Item 1*	**11** __________% *Item 8 / Item 2*	**12** __________% *Item 9 / Item 3*

Table A-3 HCOC Assessment for Runoff Volume

Variables *Complete separate HCOC assessment for each DA to a roadway inlet*	**Pre-developed DA**	**Post-developed DA**
1 Land cover		
2 Hydrologic Soil Group		
3 Drainage Area (ft^2) *Sum of DAs should equal total site area (Form 2-2)*		
4 Curve Number (CN) *Use Items 1 and 2 to select curve number from TGD for WQMP Appendix C-2*		
5 Pre-developed soil storage capacity, S (in): *S = 1000 / Item 4 - 10*		
6 Pre-developed initial abstraction, I_a (in): *I_a = 0.2 * Item 5*		
7 Precipitation for 2 yr, 24 hr storm (in): ____________ *Go to: http://hdsc.nws.noaa.gov/hdsc/pfds/sa/sca_pfds.html*		
8 Pre-developed volume (ft^3): _______ *V_{pre} =(1 / 12) * (Item 3) * [(Item 7 – Item 6)^2 / (Item 7 – Item 6 + Item 5)]*		
9 Post-developed volume (ft^3): _______ *V_{post} = (1 / 12) * (Item 3) * [(Item 7 – Item 6)^2 / (Item 7 – Item 6 + Item 5)]*		
10 Volume Reduction Needed to meet HCOC Requirement (ft^3): _______ *V_{HCOC} = (Item 9 * 0.95) – Item 8*		

Table A-4 HCOC Assessment for Time of Concentration

Compute time of concentration for pre and post developed conditions *(For projects using the Hydrology Manual complete the form below)*

Variables	Pre-developed DA	Post-developed DA
1 Length of flowpath (ft) *Use Form 3-2 Item 5 for pre-developed condition*		
2 Change in elevation (ft)		
3 Slope (ft/ft) *S_o = Item 2 / Item 1*		
4 Land cover		
5 Initial DA Time of Concentration (min) *TGD for WQMP Appendix C-1*		
6 Length of conveyance from DA outlet to project site outlet (ft) *For post-developed condition, use length of linear BMP receiving runoff from the DA*		
7 Cross-sectional area of channel / gutter / swale (ft^2)		
8 Wetted perimeter of channel / gutter / swale (ft)		
9 Manning's roughness of channel / gutter / swale (n)		
10 Flow velocity (ft/sec): *V_{fps} = (1.49 / Item 9) * (Item 7/Item 8)^0.67 * (Item 3)^0.5*		
11 Travel time to outlet (min): *T_t = Item 6 / (Item 10 * 60) or if BMP is not a swale or linear bioretention, then provide the hydraulic retention time*		
12 Total time of concentration (min): *T_c = Item 5 + Item 11*		

13 Pre-developed time of concentration (min): __________

14 Post-developed time of concentration (min): __________

15 Additional time of concentration needed to meet HCOC requirement (min): ________ *$T_{C\text{-}HCOC}$ = (Item 14 * 0.95) – Item 13*

Table A-5 HCOC Assessment for Peak Runoff

Compute peak runoff for pre and post developed conditions. *(For projects using the Hydrology Manual complete the form below)*

Variables *Complete separate HCOC assessment for each DA to a roadway inlet*	Pre-developed DA	Post-developed DA
1 Rainfall Intensity for storm duration equal to time of concentration: *I_{peak} = 10^(LOG Form A-2 Item 4 - 0.7 LOG Form A-5 Item 5 + 1.067)*		
2 Drainage Area (ft^2)		
3 Ratio of pervious area to total area		
4 Pervious area infiltration rate (in/hr) *Use pervious area CN and antecedent moisture condition with TGD for WQMP Appendix C-3*		
5 Maximum loss rate (in/hr): *F_m = Item 2 * Item 3*		
6 Peak Flow from DA (cfs): *Q_p =Item 2 * 0.9 * (Item 1 - Item 5)*		
7 Peak runoff reduction needed to meet HCOC Requirement (cfs): ________ $Q_{p\text{-}HCOC}$ = (Item $6_{post\text{-}developed}$ * 0.95) – Item $6_{pre\text{-}developed}$		

Table A-6 Drainage Swale			
Variable *Use columns to the right to compute runoff volume treatment from proposed Drainage Swales*	DA	DA	DA
1 Pollutants addressed with BMP *List all pollutant of concern that will be effectively reduced through specific Unit Operations and Processes described in Table 5-5 of the WQMP Guidance*			
2 Flow depth for water quality treatment (ft) *BMP specific, see Table 5-6 in TGD for WQMP for reference to BMP design details*			
3 Bed slope (ft/ft) *BMP specific, see Table 5-6 in TGD for WQMP for reference to BMP design details*			
4 Manning's roughness coefficient			
5 Bottom width (ft): *b_w = (Form 4.3-5 Item 6 * Item 4) / (1.49 * Item $2^{\wedge 1.67}$ * Item $3^{\wedge 0.5}$)*			
6 Side Slope (ft/ft) *BMP specific, see Table 5-6 in TGD for WQMP for reference to BMP design details*			
7 Cross sectional area (ft^2): *A = (Item 5 * Item 2) + (Item 6 * Item $2^{\wedge 2}$)*			
8 Water quality flow velocity (ft/sec): *V = Form 4.3-5 Item 6 / Item 7*			
9 Flow capacity (cfs): *Q = Item 7 * Item 8*			
10 Hydraulic residence time (min) *Pollutant specific, see Table 5-6 in TGD for WQMP for reference to BMP design details*			
11 Length of flow based BMP (ft): *L = Item 8 * Item 10 * 60*			
12 Water surface area at water quality flow depth (ft^2): *SA_{top} = (Item 5 + (2 * Item 2 * Item 6)) * Item 11*			
13 LID BMP Volume equivalency (%): *Use Item 9 (flow capacity) and Figure 5-2 in the TGD for WQMP*			

Table A-7 Infiltration Basins			
Variable *Use columns to the right to compute runoff volume retention from Infiltration Basin and Infiltration Trench BMPs*	DA	DA	DA
1 Infiltration rate of underlying soils (in/hr), *See Section 5.4.2 and Appendix D of the TGD for WQMP for minimum requirements for assessment methods.*			
2 Infiltration safety factor, *See Section 5.4.2 and Appendix D of the TGD for WQMP*			
3 Design percolation rate (in/hr): *P_{design} = Item 1 / Item 2*			
4 Infiltrating surface area, SA_{BMP} (ft^2), *surface area of basin or trench bottom*			
5 Ponded water drawdown time (hr), *default is 48 hrs*			
6 Duration of storm as basin is filling (hrs) *Typical ~ 3hrs*			
7 Ponding surface area, SA_{ponded} (ft^2), *Only included in certain BMP types, see Table 5-4 in the TGD for WQMP for reference to BMP design details*			
8 Ponding Depth (ft): *d_{pond} = Minimum of (1/12 * Item 3 * Item 5) or maximum ponding depth – see Section 5.4.2 and Appendix D of the TGD for WQMP for minimum requirements for assessment methods*			
9 Gravel layer surface area, SA_{gravel} (ft^2), *Only included in certain BMP types, see Table 5-4 in the TGD for WQMP for reference to BMP design details*			
10 Gravel depth, d_{gravel} (ft) *Only included in certain BMP types, see Table 5-4 in the TGD for WQMP for reference to BMP design details*			
11 Gravel porosity, *Only included in certain BMP types, see Table 5-4 in the TGD for WQMP for reference to BMP design details*			
12a Basin Retention Volume (ft^3): *$V_{retention}$ = Item 3 *Item 4 * (Item 5 + Item 6)*			
12b Trench Retention Volume (ft^3): *$V_{retention}$ = (Item 3 * Item 4 * Item 6) + (Item 7 * Item 8) + (Item9 * Item 10 * Item 11)*			

Table A-8 Bioretention (w/o Underdrains)			
Variable *Use columns to the right to compute runoff volume retention from Infiltration Bioretention BMPs without Underdrains*	DA	DA	DA
1 Infiltration rate of underlying soils (in/hr), *See Section 5.4.2 and Appendix D of the TGD for WQMP for minimum requirements for assessment methods.*			
2 Infiltration safety factor, *See Section 5.4.2 and Appendix D of the TGD for WQMP*			
3 Design percolation rate (in/hr): *P_{design} = Item 1 / Item 2*			
4 Infiltrating surface area, SA_{inf} (ft^2), *surface area of basin or trench bottom*			
5 Ponded water drawdown time (hr), *default is 48 hrs*			
6 Duration of storm as basin is filling (hrs) *Typical ~ 3hrs*			
7 Ponding surface area, SA_{ponded} (ft^2), *area of surface ponding*			
8 Ponding Depth (ft): *d_{pond} = Minimum of (1/12 * Item 3 * Item 5) or maximum ponding depth – see Section 5.4.2 and Appendix D of the TGD for WQMP for minimum requirements for assessment methods*			
9 Gravel layer surface area, SA_{gravel} (ft^2), *area of gravel layer surface*			
10 Gravel depth, d_{gravel} (ft), *depth of gravel layer*			
11 Gravel porosity, n_{gravel}, *effective porosity of gravel layer*			
12 Soil layer surface area, SA_{soil} (ft^2), *area of soil layer surface*			
13 Soil layer depth, d_{soil} (ft), *depth of gravel layer*			
14 Soil porosity, n_{soil}, *effective porosity of gravel layer*			
15 Retention Volume (ft^3): *$V_{retention}$ = (Item 3 * Item 4 * Item 6) + (Item 7 * Item 8) + (Item9 * Item 10 * Item 11) + (Item 12 * Item 13 * Item 14)*			

Table A-9 Sidewalk Trees and Tree Boxes			
Variable *Use columns to the right to compute runoff volume retention from proposed street tree BMPs. If street tree is in a planterbox that receives runoff from the street via curbcut, then use Form A-11 to compute additional retention volume*	DA	DA	DA
1 Number of Street Trees			
2 Average canopy cover over impervious area (ft^2)			
3 Runoff volume retention from street trees (ft^3): *$V_{retention}$ = Item 1 * Item 2 * (0.05/12) assuming retention of 0.05 inches of runoff*			

Table A-10 Permeable Pavement BMPs			
Variable *Use columns to the right to compute runoff volume retention from proposed permeable pavement BMPs*	DA	DA	DA
1 Infiltration rate of underlying soils (in/hr) *See Section 5.4.2 and Appendix D of the TGD for WQMP for minimum requirements for assessment methods*			
2 Infiltration safety factor *See Section 5.4.2 and Appendix D of the TGD for WQMP*			
3 Design percolation rate (in/hr): *P_{design} = Item 1 / Item 2*			
4 Infiltrating surface area, SA_{BMP} (ft^2)			
5 Gravel depth, d_{media} (ft)			
6 Gravel porosity			
7 Duration of storm as basin is filling (hrs) *Typical ~ 3hrs*			
8 Retention Volume (ft^3): *$V_{retention}$ = Item 4 * [(Item 5 * Item 6) + (Item 7 * (Item 3 / 12)]*			

Table A-11 Bioretention (with Underdrain)			
Variable *Use columns to the right to compute runoff volume retention from Bioretention (w/o Underdrain) BMPs*	DA	DA	DA
1 Infiltration rate of underlying soils (in/hr) *See Guidance Section 5.4.2 and Appendix D for minimum requirements for assessment methods.*			
2 Infiltration safety factor *See Guidance Section 5.4.2 and Appendix D*			
3 Design percolation rate (in/hr) *P_{design} = Item 1 / Item 2*			
4 Ponded water drawdown time (hr), *default is 48 hrs*			
5 Maximum ponding depth (ft) *BMP specific, see Table 5-4 in Guidance for reference to BMP design details*			
6 Ponding Depth (ft) *d_{BMP} = Minimum of (1/12 * Item 2 * Item 3) or Item 5*			
7 Infiltrating surface area, SA_{BMP} (ft^2) *area beneath gravel layer for BMPs without underdrains*			
8 Amended soil depth, d_{media} (ft) *Only included in certain BMP types, see Table 5-4 in Guidance for reference to BMP design details*			
9 Amended soil porosity			
10 Gravel depth, d_{media} (ft) *Only included in certain BMP types, see Table 5-4 in Guidance for reference to BMP design details*			
11 Gravel porosity			
12 Duration of storm as basin is filling (hrs) *Typical ~ 3hrs*			
13 Retention Volume (ft^3) *$V_{retention}$ = Item 7 * [Item 6 + (Item 8 * Item 9) + (Item 10 * Item 11) + (Item 12 * (Item 3 / 12))]*			

BMP Inspection / Maintenance			
BMP	Responsible Party(ies)	Inspection / Maintenance Activities Required	Minimum Frequency of Activities

Appendix B – WQMP Template

Water Quality Management Plan (WQMP)

For:

Insert Project Name

WHERE APPLICABLE, INSERT GRADING PERMIT NO., BUILDING PERMIT NO., TRACT NUMBER, LAND DEVELOPMENT FILE NO., CUP, SUP AND/OR APN (SPECIFY LOT NUMBERS IF SITE IS A PORTION OF A TRACT)

Prepared for:

Insert Owner/Developer Name

Insert Address

Insert City, State, ZIP

Insert Telephone

Prepared by:

Insert Consulting/Engineering Firm Name

Insert Address

Insert City, State, ZIP

Insert Telephone

Approval Date:_____________________

Implementation Date:_____________________

Project Owner's Certification

Permit/Application Number(s):		Grading Permit Number(s):	
Tract/Parcel Map Number(s):		Building Permit Number(s):	
CUP, SUP, and/or APN (Specify Lot Numbers if Portions of Tract):			

This Water Quality Management Plan (WQMP) has been prepared for Owner/Developer Name by Consulting/Engineering Firm Name. The WQMP is intended to comply with the requirements of the Jurisdiction name NPDES Stormwater Program requiring the preparation of the plan.

The undersigned, while it owns the subject property, is responsible for the implementation of the provisions of this plan and will ensure that this plan is amended as appropriate to reflect up-to-date conditions on the site consistent with the San Bernardino County Municipal Stormwater Management Program and the intent of the NPDES Permit for Waste Discharge Requirements for the County of San Bernardino and the incorporated Cities of San Bernardino County within the Santa Ana Region (CAS618036, Order R8-2010-0036). Once the undersigned transfers its interest in the property, its successors-in-interest shall bear the aforementioned responsibility to implement and amend the WQMP. An appropriate number of approved and notarized signed copies of this document shall be available on the subject site in perpetuity.

Owner Name:			
Title			
Company			
Address			
Email			
Telephone #			
Signature		Date	
Engineer:		PE Stamp Below	
Title			
Company			
Address			
Email			
Telephone #			
Signature			

Contents

Forms

Section 1 Discretionary Permit(s)

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<tr><td colspan="2">Project Owner Contact Name:</td><td colspan="4"></td></tr>
<tr><td>Mailing Address:</td><td></td><td>E-mail Address:</td><td></td><td>Telephone:</td><td></td></tr>
<tr><td colspan="2">Permit/Application Number(s):</td><td></td><td>Tract/Parcel Map Number(s):</td><td colspan="2"></td></tr>
<tr><td colspan="2">Additional Information/
Comments:</td><td colspan="4"></td></tr>
<tr><td colspan="2">Description of Project:</td><td colspan="4"></td></tr>
<tr><td colspan="2">Provide summary of Conceptual WQMP conditions (if previously submitted and approved). Attach complete copy.</td><td colspan="4"></td></tr>
</table>

Section 2 Project Description

2.1 Project Information

This section of the WQMP should provide the information listed below. The information provided for Conceptual/ Preliminary WQMP should give sufficient detail to identify the major proposed site design and LID BMPs and other anticipated water quality features that impact site planning. Final Project WQMP must specifically identify all BMP incorporated into the final site design and provide other detailed information as described herein.

The purpose of this information is to help determine the applicable development category, pollutants of concern, watershed description, and long term maintenance responsibilities for the project, and any applicable water quality credits. This information will be used in conjunction with the information in Section 3, Site Description, to establish the performance criteria and to select the LID BMP or other BMP for the project or other alternative programs that the project will participate in, which are described in Section 4.

Form 2.1-1 Description of Proposed Project			
1 Development Category (Select all that apply):			
☐ Significant re-development involving the addition or replacement of 5,000 ft^2 or more of impervious surface on an already developed site	☐ New development involving the creation of 10,000 ft^2 or more of impervious surface collectively over entire site	☐ Automotive repair shops with standard industrial classification (SIC) codes 5013, 5014, 5541, 7532-7534, 7536-7539	☐ Restaurants (with SIC code 5812) where the land area of development is 5,000 ft^2 or more
☐ Hillside developments of 5,000 ft^2 or more which are located on areas with known erosive soil conditions or where the natural slope is 25 percent or more	☐ Developments of 2,500 ft^2 of impervious surface or more adjacent to (within 200 ft) or discharging directly into environmentally sensitive areas or waterbodies listed on the CWA Section 303(d) list of impaired waters.	☐ Parking lots of 5,000 ft^2 or more exposed to storm water	☐ Retail gasoline outlets that are either 5,000 ft^2 or more, or have a projected average daily traffic of 100 or more vehicles per day
☐ Non-Priority / Non-Category Project *May require source control LID BMPs and other LIP requirements. Please consult with local jurisdiction on specific requirements*.			

2 Project Area (ft2):		**3** Number of Dwelling Units:		**4** SIC Code:	

5 Is Project going to be phased? Yes ☐ No ☐ *If yes, ensure that the WQMP evaluates each phase as a distinct DA, requiring LID BMPs to address runoff at time of completion.*
6 Does Project include roads? Yes ☐ No ☐ *If yes, ensure that applicable requirements for road projects are addressed (see Appendix A of TGD for WQMP)*

2.2 Property Ownership/Management

Describe the ownership/management of all portions of the project and site. State whether any infrastructure will transfer to public agencies (City, County, Caltrans, etc.) after project completion. State if a homeowners or property owners association will be formed and be responsible for the long-term maintenance of project stormwater facilities. Describe any lot-level stormwater features that will be the responsibility of individual property owners.

Form 2.2-1 Property Ownership/Management
Describe property ownership/management responsible for long-term maintenance of WQMP stormwater facilities:

2.3 Potential Stormwater Pollutants

Determine and describe expected stormwater pollutants of concern based on land uses and site activities (refer to Table 3-3 in the TGD for WQMP).

Form 2.3-1 Pollutants of Concern

Pollutant	Circle One: E=Expected, N=Not Expected		Additional Information and Comments
Pathogens (Bacterial / Virus)	E	N	
Phosphorous	E	N	
Nitrogen	E	N	
Sediment	E	N	
Metals	E	N	
Oil and Grease	E	N	
Trash/Debris	E	N	
Pesticides / Herbicides	E	N	
Organic Compounds	E	N	
Other:			

2.4 Water Quality Credits

A water quality credit program is applicable for certain types of development projects if it is not feasible to meet the requirements for on-site LID. Proponents for eligible projects, as described below, can apply for water quality credits that would reduce project obligations for selecting and sizing other treatment BMP or participating in other alternative compliance programs. Refer to Section 6.2 in the TGD for WQMP to determine if water quality credits are applicable for the project.

Form 2.4-1 Water Quality Credits			
1 Project Types that Qualify for Water Quality Credits: *Select all that apply*			
☐ Redevelopment projects that reduce the overall impervious footprint of the project site. [Credit = % impervious reduced]	Higher density development projects ☐ Vertical density [20%] ☐ 7 units/ acre [5%]	☐ Mixed use development, (combination of residential, commercial, industrial, office, institutional, or other land uses which incorporate design principles that demonstrate environmental benefits not realized through single use projects) [20%]	☐Brownfield redevelopment (redevelop real property complicated by presence or potential of hazardous contaminants) [25%]
☐ Redevelopment projects in established historic district, historic preservation area, or similar significant core city center areas [10%]	☐ Transit-oriented developments (mixed use residential or commercial area designed to maximize access to public transportation) [20%]	☐ In-fill projects (conversion of empty lots & other underused spaces < 5 acres, substantially surrounded by urban land uses, into more beneficially used spaces, such as residential or commercial areas) [10%]	☐ Live-Work developments (variety of developments designed to support residential and vocational needs) [20%]
2 Total Credit % _____ *(Total all credit percentages up to a maximum allowable credit of 50 percent)*			
Description of Water Quality Credit Eligibility (if applicable)			

Section 3 Site and Watershed Description

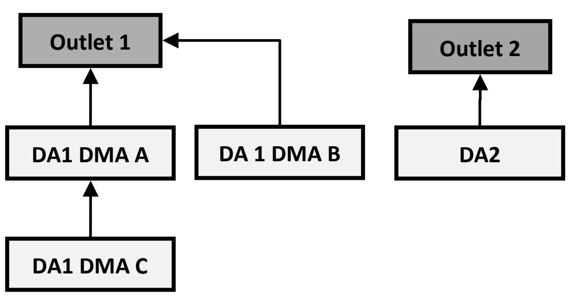
Describe the project site conditions that will facilitate the selection of BMP through an analysis of the physical conditions and limitations of the site and its receiving waters. Identify distinct drainage areas (DA) that collect flow from a portion of the site and describe how runoff from each DA (and sub-watershed DMAs) is conveyed to the site outlet(s). Refer to Section 3.2 in the TGD for WQMP. Complete form 3.2 for each DA on the project site.

Form 3-1 Site Location and Hydrologic Features

Site coordinates *take GPS measurement at approximate center of site*	Latitude ________	Longitude ________	Thomas Bros Map page ______

1 San Bernardino County climatic region: ☐ Valley ☐ Mountain

2 Does the site have more than one drainage area (DA): Yes ☐ No ☐ *If no, proceed to Form 3-2. If yes, then use this form to show a conceptual schematic describing DMAs and hydrologic feature connecting DMAs to the site outlet(s). An example is provided below that can be modified for proposed project or a drawing clearly showing DMA and flow routing may be attached*



Example only – modify for project specific WQMP

Conveyance	Briefly describe on-site drainage features to convey runoff that is not retained within a DMA
DA1 DMA C flows to DA1 DMA A	*Ex. Bioretention overflow to vegetated bioswale with 4' bottom width, 5:1 side slopes and bed slope of 0.01. Conveys runoff for 1000' through DMA 1 to existing catch basin on SE corner of property*
DA1 DMA A to Outlet 1	
DA1 DMA B to Outlet 1	
DA2 to Outlet 2	

Form 3-2 Existing Hydrologic Characteristics for Drainage Area (DA)				
For each drainage area's sub-watershed DMA, provide the following characteristics	DMA A	DMA B	DMA C	DMA D
1 DMA drainage area (ft^2)				
2 Existing site impervious area (ft^2)				
3 Antecedent moisture condition *For desert areas, use http://www.sbcounty.gov/dpw/floodcontrol/pdf/20100412_map.pdf*				
4 Hydrologic soil group *Refer to Watershed Mapping Tool – http://sbcounty.permitrack.com/WAP*				
5 Longest flowpath length (ft)				
6 Longest flowpath slope (ft/ft)				
7 Current land cover type(s) *Select from Fig C-3 of Hydrology Manual*				
8 Pre-developed pervious area condition: *Based on the extent of wet season vegetated cover good >75%; Fair 50-75%; Poor <50% Attach photos of site to support rating*				

Form 3-3 Watershed Description	
Receiving waters *Refer to Watershed Mapping Tool -* *http://sbcounty.permitrack.com/WAP* *See 'Drainage Facilities" link at this website*	
Applicable TMDLs *Refer to Local Implementation Plan*	
303(d) listed impairments *Refer to Local Implementation Plan and Watershed Mapping Tool –* *http://sbcounty.permitrack.com/WAP and State Water Resources Control Board website – http://www.waterboards.ca.gov/santaana/water_issues/programs/tmdl/index.shtml*	
Environmentally Sensitive Areas (ESA) *Refer to Watershed Mapping Tool –* *http://sbcounty.permitrack.com/WAP*	
Unlined Downstream Water Bodies *Refer to Watershed Mapping Tool –* *http://sbcounty.permitrack.com/WAP*	
Hydrologic Conditions of Concern	☐ Yes *Complete Hydrologic Conditions of Concern (HCOC) Assessment. Include Forms 4.2-2 through Form 4.2-5 and Hydromodification BMP Form 4.3-10 in submittal* ☐ No
Watershed–based BMP included in a RWQCB approved WAP	☐ Yes *Attach verification of regional BMP evaluation criteria in WAP* • *More Effective than On-site LID* • *Remaining Capacity for Project DCV* • *Upstream of any Water of the US* • *Operational at Project Completion* • *Long-Term Maintenance Plan* ☐ No

Section 4 Best Management Practices (BMP)

4.1 Source Control BMP

4.1.1 Pollution Prevention

Non-structural and structural source control BMP are required to be incorporated into all new development and significant redevelopment projects. Form 4.1-1 and 4.1-2 are used to describe specific source control BMPs used in the WQMP or to explain why a certain BMP is not applicable. Table 7-3 of the TGD for WQMP provides a list of applicable source control BMP for projects with specific types of potential pollutant sources or activities. The source control BMP in this table must be implemented for projects with these specific types of potential pollutant sources or activities.

The preparers of this WQMP have reviewed the source control BMP requirements for new development and significant redevelopment projects. The preparers have also reviewed the specific BMP required for project as specified in Forms 4.1-1 and 4.1-2. All applicable non-structural and structural source control BMP shall be implemented in the project.

Form 4.1-1 Non-Structural Source Control BMPs

Identifier	Name	Check One		Describe BMP Implementation OR, if not applicable, state reason
		Included	Not Applicable	
N1	Education of Property Owners, Tenants and Occupants on Stormwater BMPs	☐	☐	
N2	Activity Restrictions	☐	☐	
N3	Landscape Management BMPs	☐	☐	
N4	BMP Maintenance	☐	☐	
N5	Title 22 CCR Compliance (How development will comply)	☐	☐	
N6	Local Water Quality Ordinances	☐	☐	
N7	Spill Contingency Plan	☐	☐	
N8	Underground Storage Tank Compliance	☐	☐	
N9	Hazardous Materials Disclosure Compliance	☐	☐	

Form 4.1-1 Non-Structural Source Control BMPs

Identifier	Name	Check One		Describe BMP Implementation OR, if not applicable, state reason
		Included	Not Applicable	
N10	Uniform Fire Code Implementation	☐	☐	
N11	Litter/Debris Control Program	☐	☐	
N12	Employee Training	☐	☐	
N13	Housekeeping of Loading Docks	☐	☐	
N14	Catch Basin Inspection Program	☐	☐	
N15	Vacuum Sweeping of Private Streets and Parking Lots	☐	☐	
N16	Other Non-structural Measures for Public Agency Projects	☐	☐	
N17	Comply with all other applicable NPDES permits	☐	☐	

Form 4.1-2 Structural Source Control BMPs

Identifier	Name	Check One		Describe BMP Implementation OR, If not applicable, state reason
		Included	Not Applicable	
S1	Provide storm drain system stencilling and signage (CASQA New Development BMP Handbook SD-13)	☐	☐	
S2	Design and construct outdoor material storage areas to reduce pollution introduction (CASQA New Development BMP Handbook SD-34)	☐	☐	
S3	Design and construct trash and waste storage areas to reduce pollution introduction (CASQA New Development BMP Handbook SD-32)	☐	☐	
S4	Use efficient irrigation systems & landscape design, water conservation, smart controllers, and source control (Statewide Model Landscape Ordinance; CASQA New Development BMP Handbook SD-12)	☐	☐	
S5	Finish grade of landscaped areas at a minimum of 1-2 inches below top of curb, sidewalk, or pavement	☐	☐	
S6	Protect slopes and channels and provide energy dissipation (CASQA New Development BMP Handbook SD-10)	☐	☐	
S7	Covered dock areas (CASQA New Development BMP Handbook SD-31)	☐	☐	
S8	Covered maintenance bays with spill containment plans (CASQA New Development BMP Handbook SD-31)	☐	☐	
S9	Vehicle wash areas with spill containment plans (CASQA New Development BMP Handbook SD-33)	☐	☐	
S10	Covered outdoor processing areas (CASQA New Development BMP Handbook SD-36)	☐	☐	

Form 4.1-2 Structural Source Control BMPs

Identifier	Name	Check One		Describe BMP Implementation OR, If not applicable, state reason
		Included	Not Applicable	
S11	Equipment wash areas with spill containment plans (CASQA New Development BMP Handbook SD-33)	☐	☐	
S12	Fueling areas (CASQA New Development BMP Handbook SD-30)	☐	☐	
S13	Hillside landscaping (CASQA New Development BMP Handbook SD-10)	☐	☐	
S14	Wash water control for food preparation areas	☐	☐	
S15	Community car wash racks (CASQA New Development BMP Handbook SD-33)	☐	☐	

4.1.2 Preventative LID Site Design Practices

Site design practices associated with new LID requirements in the MS4 Permit should be considered in the earliest phases of a project. Preventative site design practices can result in smaller DCV for LID BMP and hydromodification control BMP by reducing runoff generation. Describe site design and drainage plan including:

- A narrative of site design practices utilized or rationale for not using practices
- A narrative of how site plan incorporates preventive site design practices
- Include an attached Site Plan layout which shows how preventative site design practices are included in WQMP

Refer to Section 5.2 of the TGD for WQMP for more details.

Form 4.1-3 Preventative LID Site Design Practices Checklist
Site Design Practices *If yes, explain how preventative site design practice is addressed in project site plan. If no, other LID BMPs must be selected to meet targets*
Minimize impervious areas: Yes ☐ No ☐
Maximize natural infiltration capacity: Yes ☐ No ☐
Preserve existing drainage patterns and time of concentration: Yes ☐ No ☐
Disconnect impervious areas: Yes ☐ No ☐
Protect existing vegetation and sensitive areas: Yes ☐ No ☐
Re-vegetate disturbed areas: Yes ☐ No ☐
Minimize unnecessary compaction in stormwater retention/infiltration basin/trench areas: Yes ☐ No ☐
Utilize vegetated drainage swales in place of underground piping or imperviously lined swales: Yes ☐ No ☐
Stake off areas that will be used for landscaping to minimize compaction during construction : Yes ☐ No ☐

4.2 Project Performance Criteria

The purpose of this section of the Project WQMP is to establish targets for post development hydrology based on performance criteria specified in the MS4 Permit. These targets include runoff volume for water quality control (referred to as LID design capture volume), and runoff volume, time of concentration, and peak runoff for protection of any downstream waterbody segments with a HCOC. ***If the project has more than one outlet for stormwater runoff, then complete additional versions of these forms for each DA / outlet.***

Methods applied in the following forms include:

- For LID BMP Design Capture Volume (DCV), the San Bernardino County Stormwater Program requires use of the P_6 method (MS4 Permit Section XI.D.6a.ii) – Form 4.2-1
- For HCOC pre- and post-development hydrologic calculation, the San Bernardino County Stormwater Program requires the use of the Rational Method (San Bernardino County Hydrology Manual Section D). Forms 4.2-2 through Form 4.2-5 calculate hydrologic variables including runoff volume, time of concentration, and peak runoff from the project site pre- and post-development using the Hydrology Manual Rational Method approach. For projects greater than 640 acres (1.0 mi^2), the Rational Method and these forms should not be used. For such projects, the Unit Hydrograph Method (San Bernardino County Hydrology Manual Section E) shall be applied for hydrologic calculations for HCOC performance criteria.

Refer to Section 4 in the TGD for WQMP for detailed guidance and instructions.

Form 4.2-1 LID BMP Performance Criteria for Design Capture Volume		
1 Project area (ft^2): ________	**2** Imperviousness after applying preventative site design practices (Imp%): _____	**3** Runoff Coefficient (Rc): _______ *R_c = 0.858(Imp%)^3-0.78(Imp%)^2+0.774(Imp%)+0.04*
4 Determine 1-hour rainfall depth for a 2-year return period $P_{2yr-1hr}$ (in): ____ *http://hdsc.nws.noaa.gov/hdsc/pfds/sa/sca_pfds.html*		
5 Compute P_6, Mean 6-hr Precipitation (inches): ________ *P_6 = Item 4 *C_1, where C_1 is a function of site climatic region specified in Form 3-1 Item 1 (Valley = 1.4807; Mountain = 1.909; Desert = 1.2371)*		
6 Drawdown Rate *Use 48 hours as the default condition. Selection and use of the 24 hour drawdown time condition is subject to approval by the local jurisdiction. The necessary BMP footprint is a function of drawdown time. While shorter drawdown times reduce the performance criteria for LID BMP design capture volume, the depth of water that can be stored is also reduced.*		24-hrs ☐ 48-hrs ☐
7 Compute design capture volume, DCV (ft^3): ________ *DCV = 1/12 * [Item 1* Item 3 *Item 5 * C_2], where C_2 is a function of drawdown rate (24-hr = 1.582; 48-hr = 1.963)* *Compute separate DCV for each outlet from the project site per schematic drawn in Form 3-1 Item 2*		

Form 4.2-2 Summary of HCOC Assessment

Does project have the potential to cause or contribute to an HCOC in a downstream channel: Yes ☐ No ☐

Go to: http://sbcounty.permitrack.com/WAP/

If "Yes", then complete HCOC assessment of site hydrology for 2yr storm event using Forms 4.2-3 through 4.2-5 and insert results below

(Forms 4.2-3 through 4.2-5 may be replaced by computer software analysis based on the San Bernardino County Hydrology Manual)

If "No," then proceed to Section 4.3 Project Conformance Analysis

Condition	Runoff Volume (ft^3)	Time of Concentration (min)	Peak Runoff (cfs)
Pre-developed	**1** ________ *Form 4.2-3 Item 12*	**2** ________ *Form 4.2-4 Item 13*	**3** ________ *Form 4.2-5 Item 10*
Post-developed	**4** ________ *Form 4.2-3 Item 13*	**5** ________ *Form 4.2-4 Item 14*	**6** ________ *Form 4.2-5 Item 14*
Difference	**7** ________ *Item 4 – Item 1*	**8** ________ *Item 5 – Item 2*	**9** ________ *Item 6 – Item 3*
Difference (as % of pre-developed)	**10** ________% *Item 7 / Item 1*	**11** ________% *Item 8 / Item 2*	**12** ________% *Item 9 / Item 3*

Form 4.2-3 HCOC Assessment for Runoff Volume

Compute weighted curve number for pre and post developed conditions	Pre-developed DA *Add more columns if more than 4 DMA*				Post-developed DA *Add more columns if more than 4 DMA*			
	DMA A	DMA B	DMA C	DMA D	DMA A	DMA B	DMA C	DMA D
1 Land Cover type								
2 Hydrologic Soil Group (HSG)								
3 DMA Area, ft^2 *sum of areas of DMA should equal area of DA*								
4 Curve Number (CN) *use Items 1 and 2 to select the appropriate CN from Appendix C-2 of the TGD for WQMP*								

	5 Pre-Developed area-weighted CN: ______	**6** Post-Developed area-weighted CN: ______
	7 Pre-developed soil storage capacity, S (in): _____ *S = (1000 / Item 5) - 10*	**8** Post-developed soil storage capacity, S (in): _____ *S = (1000 / Item 6) - 10*
	9 Initial abstraction, I_a (in): _______ I_a *= 0.2 * Item 7*	**10** Initial abstraction, I_a (in): _______ I_a *= 0.2 * Item 8*

11 Precipitation for 2 yr, 24 hr storm (in): ___________
Go to: http://hdsc.nws.noaa.gov/hdsc/pfds/sa/sca_pfds.html

12 Pre-developed Volume (ft^3): ________
*V_{pre} =(1 / 12) * (Item sum of Item 3) * [(Item 11 – Item 9)^2 / ((Item 11 – Item 9 + Item 7)*

13 Post-developed Volume (ft^3): ________
*V_{pre} =(1 / 12) * (Item sum of Item 3) * [(Item 11 – Item 10)^2 / ((Item 11 – Item 10 + Item 8)*

14 Volume Reduction needed to meet HCOC Requirement, (ft^3): ________
*V_{HCOC} = (Item 13 * 0.95) – Item 12*

Form 4.2-4 HCOC Assessment for Time of Concentration

Compute time of concentration for pre and post developed conditions for each DA *(For projects using the Hydrology Manual complete the form below)*

Variables	Pre-developed DA *Add more columns if more than 4 DMA*				Post-developed DA *Add more columns if more than 4 DMA*			
	DMA A	DMA B	DMA C	DMA D	DMA A	DMA B	DMA C	DMA D
1 Length of flowpath (ft) *Use Form 3-2 Item 5 for pre-developed condition*								
2 Change in elevation (ft)								
3 Slope (ft/ft), *S_o = Item 2 / Item 1*								
4 Land cover								
5 Initial DMA Time of Concentration (min) *Appendix C-1 of the TGD for WQMP*								
6 Length of conveyance from DMA outlet to project site outlet (ft) *May be zero if DMA outlet is at project site outlet*								
7 Cross-sectional area of channel (ft^2)								
8 Wetted perimeter of channel (ft)								
9 Manning's roughness of channel (n)								
10 Channel flow velocity (ft/sec) *V_{fps} = (1.49 / Item 9) * (Item 7/Item 8)^0.67 * (Item 3)^0.5*								
11 Travel time to outlet (min) *T_t = Item 6 / (Item 10 * 60)*								
12 Total time of concentration (min) *T_c = Item 5 + Item 11*								

13 Pre-developed time of concentration (min): __________ *Minimum of Item 12 pre-developed DMA*

14 Post-developed time of concentration (min): __________ *Minimum of Item 12 post-developed DMA*

15 Additional time of concentration needed to meet HCOC requirement (min): _______ *T_{C-HCOC} = (Item 14 * 0.95) – Item 13*

Form 4.2-5 HCOC Assessment for Peak Runoff

Compute peak runoff for pre and post developed conditions

Variables		Pre-developed DA to Project Outlet *Add more columns if more than 3 DMA*			Post-developed DA to Project Outlet *Add more columns if more than 3 DMA*		
		DMA A	DMA B	DMA C	DMA A	DMA B	DMA C
1 Rainfall Intensity for storm duration equal to time of concentration *I_{peak} = 10^(LOG Form 4.2-1 Item 4 - 0.6 LOG Form 4.2-4 Item 5 /60)*							
2 Drainage Area of each DMA (ft^2) *For DMA with outlet at project site outlet, include upstream DMA (Using example schematic in Form 3-1, DMA A will include drainage from DMA C)*							
3 Ratio of pervious area to total area *For DMA with outlet at project site outlet, include upstream DMA (Using example schematic in Form 3-1, DMA A will include drainage from DMA C)*							
4 Pervious area infiltration rate (in/hr) *Use pervious area CN and antecedent moisture condition with Appendix C-3 of the TGD for WQMP*							
5 Maximum loss rate (in/hr) *F_m = Item 3 * Item 4* *Use area-weighted F_m from DMA with outlet at project site outlet, include upstream DMA (Using example schematic in Form 3-1, DMA A will include drainage from DMA C)*							
6 Peak Flow from DMA (cfs) *Q_p =Item 2 * 0.9 * (Item 1 - Item 5)*							
7 Time of concentration adjustment factor for other DMA to site discharge point *Form 4.2-4 Item 12 DMA / Other DMA upstream of site discharge point (If ratio is greater than 1.0, then use maximum value of 1.0)*	DMA A	*n/a*			*n/a*		
	DMA B		*n/a*			*n/a*	
	DMA C			*n/a*			*n/a*

8 Pre-developed Q_p at T_c for DMA A: ______ *Q_p = Item 6_{DMAA} + [Item 6_{DMAB} * (Item 1_{DMAA} - Item 5_{DMAB})/(Item 1_{DMAB} - Item 5_{DMAB})* Item $7_{DMAA/2}$] + [Item 6_{DMAC} * (Item 1_{DMAA} - Item 5_{DMAC})/(Item 1_{DMAC} - Item 5_{DMAC})* Item $7_{DMAA/3}$]*	**9** Pre-developed Q_p at T_c for DMA B: ______ *Q_p = Item 6_{DMAB} + [Item 6_{DMAA} * (Item 1_{DMAB} - Item 5_{DMAA})/(Item 1_{DMAA} - Item 5_{DMAA})* Item $7_{DMAB/1}$] + [Item 6_{DMAC} * (Item 1_{DMAB} - Item 5_{DMAC})/(Item 1_{DMAC} - Item 5_{DMAC})* Item $7_{DMAB/3}$]*	**10** Pre-developed Q_p at T_c for DMA C: _____ *Q_p = Item 6_{DMAC} + [Item 6_{DMAA} * (Item 1_{DMAC} - Item 5_{DMAA})/(Item 1_{DMAA} - Item 5_{DMAA})* Item $7_{DMAC/1}$] + [Item 6_{DMAB} * (Item 1_{DMAC} - Item 5_{DMAB})/(Item 1_{DMAB} - Item 5_{DMAB})* Item $7_{DMAC/2}$]*
10 Peak runoff from pre-developed condition confluence analysis (cfs): ______ *Maximum of Item 8, 9, and 10*		
11 Post-developed Q_p at T_c for DMA A: ____ *Same as Item 8 for post-developed values*	**12** Post-developed Q_p at T_c for DMA B: _____ *Same as Item 9 for post-developed values*	**13** Post-developed Q_p at T_c for DMA C: ____ *Same as Item 10 for post-developed values*
14 Peak runoff from post-developed condition confluence analysis (cfs): ______ *Maximum of Item 11, 12, and 13*		
15 Peak runoff reduction needed to meet HCOC Requirement (cfs): _______ *Q_{p-HCOC} = (Item 14 * 0.95) – Item 10*		

4.3 Project Conformance Analysis

Complete the following forms for each project site DA to document that the proposed LID BMPs conform to the project DCV developed to meet performance criteria specified in the MS4 Permit (WQMP Template Section 4.2). For the LID DCV, the forms are ordered according to hierarchy of BMP selection as required by the MS4 Permit (see Section 5.3.1 in the TGD for WQMP). The forms compute the following for on-site LID BMP:

- Site Design and Hydrologic Source Controls (Form 4.3-2)
- Retention and Infiltration (Form 4.3-3)
- Harvested and Use (Form 4.3-4) or
- Biotreatment (Form 4.3-5).

At the end of each form, additional fields facilitate the determination of the extent of mitigation provided by the specific BMP category, allowing for use of the next category of BMP in the hierarchy, if necessary.

The first step in the analysis, using Section 5.3.2.1 of the TGD for WQMP, is to complete Forms 4.3-1 and 4.3-3) to determine if retention and infiltration BMPs are infeasible for the project. For each feasibility criterion in Form 4.3-1, if the answer is "Yes," provide all study findings that includes relevant calculations, maps, data sources, etc. used to make the determination of infeasibility.

Next, complete Forms 4.3-2 and 4.3-4 to determine the feasibility of applicable HSC and harvest and use BMPs, and, if their implementation is feasible, the extent of mitigation of the DCV.

If no site constraints exist that would limit the type of BMP to be implemented in a DA, evaluate the use of combinations of LID BMPs, including all applicable HSC BMPs to maximize on-site retention of the DCV. If no combination of BMP can mitigate the entire DCV, implement the single BMP type, or combination of BMP types, that maximizes on-site retention of the DCV within the minimum effective area.

If the combination of LID HSC, retention and infiltration, and harvest and use BMPs are unable to mitigate the entire DCV, then biotreatment BMPs may be implemented by the project proponent. If biotreatment BMPs are used, then they must be sized to provide sufficient capacity for effective treatment of the remainder of the volume-based performance criteria that cannot be achieved with LID BMPs (TGD for WQMP Section 5.4.4.2). Under no circumstances shall any portion of the DCV be released from the site without effective mitigation and/or treatment.

Form 4.3-1 Infiltration BMP Feasibility

Feasibility Criterion – Complete evaluation for each DA on the Project Site

1 Would infiltration BMP pose significant risk for groundwater related concerns? Yes ☐ No ☐

Refer to Section 5.3.2.1 of the TGD for WQMP

If Yes, Provide basis: (attach)

2 Would installation of infiltration BMP significantly increase the risk of geotechnical hazards? Yes ☐ No ☐

(Yes, if the answer to any of the following questions is yes, as established by a geotechnical expert):

- The location is less than 50 feet away from slopes steeper than 15 percent
- The location is less than eight feet from building foundations or an alternative setback.
- A study certified by a geotechnical professional or an available watershed study determines that stormwater infiltration would result in significantly increased risks of geotechnical hazards.

If Yes, Provide basis: (attach)

3 Would infiltration of runoff on a Project site violate downstream water rights? Yes ☐ No ☐

If Yes, Provide basis: (attach)

4 Is proposed infiltration facility located on hydrologic soil group (HSG) D soils or does the site geotechnical investigation indicate presence of soil characteristics, which support categorization as D soils? Yes ☐ No ☐

If Yes, Provide basis: (attach)

5 Is the design infiltration rate, after accounting for safety factor of 2.0, below proposed facility less than 0.3 in/hr (accounting for soil amendments)? Yes ☐ No ☐

If Yes, Provide basis: (attach)

6 Would on-site infiltration or reduction of runoff over pre-developed conditions be partially or fully inconsistent with watershed management strategies as defined in the WAP, or impair beneficial uses? Yes ☐ No ☐

See Section 3.5 of the TGD for WQMP and WAP

If Yes, Provide basis: (attach)

7 Any answer from Item 1 through Item 3 is "Yes": Yes ☐ No ☐

If yes, infiltration of any volume is not feasible onsite. Proceed to Form 4.3-4, Harvest and Use BMP. If no, then proceed to Item 9 below.

8 Any answer from Item 4 through Item 6 is "Yes": Yes ☐ No ☐

If yes, infiltration is permissible but is not required to be considered. Proceed to Form 4.3-2, Hydrologic Source Control BMP.
If no, then proceed to Item 9, below.

9 All answers to Item 1 through Item 6 are "No":

Infiltration of the full DCV is potentially feasible, LID infiltration BMP must be designed to infiltrate the full DCV to the MEP.
Proceed to Form 4.3-2, Hydrologic Source Control BMP.

4.3.1 Site Design Hydrologic Source Control BMP

Section XI.E. of the Permit emphasizes the use of LID preventative measures; and the use of LID HSC BMPs reduces the portion of the DCV that must be addressed in downstream BMPs. Therefore, all applicable HSC shall be provided except where they are mutually exclusive with each other, or with other BMPs. Mutual exclusivity may result from overlapping BMP footprints such that either would be potentially feasible by itself, but both could not be implemented. Please note that while there are no numeric standards regarding the use of HSC, if a project cannot feasibly meet BMP sizing requirements or cannot fully address HCOCs, feasibility of all applicable HSC must be part of demonstrating that the BMP system has been designed to retain the maximum feasible portion of the DCV. Complete Form 4.3-2 to identify and calculate estimated retention volume from implementing site design HSC BMP. Refer to Section 5.4.1 in the TGD for more detailed guidance.

Form 4.3-2 Site Design Hydrologic Source Control BMPs

1 Implementation of Impervious Area Dispersion BMP (i.e. routing runoff from impervious to pervious areas), excluding impervious areas planned for routing to on-lot infiltration BMP): Yes ☐ No ☐ *If yes, complete Items 2-5; If no, proceed to Item 6*			
Variables *Aggregate impervious area dispersion with equal ratios of pervious to impervious;*	BMP Type and DA	BMP Type and DA	BMP Type and DMA *Use additional forms for more BMP*
2 Total impervious area draining to pervious area			
3 Ratio of pervious area receiving runoff to impervious area			
4 Retention volume achieved from impervious area dispersion (ft^3) *V = Item2 * Item 3 * (0.5/12), assuming retention of 0.5 inches of runoff*			
5 Sum of retention volume achieved from impervious area dispersion (ft^3): _______ $V_{retention}$ *=Sum of Item 4 for all BMPs*			
6 Implementation of Localized On-lot Infiltration BMPs (e.g. on-lot rain gardens): Yes ☐ No ☐ *If yes, complete Items 7-13 for aggregate of all on-lot infiltration BMP in each DA; If no, proceed to Item 14*	BMP type and DA	BMP type and DA	BMP Type and DA *Use additional forms for more BMPs*
7 Ponding surface area (ft^2)			
8 Ponding depth (ft)			
9 Surface area of amended soil/gravel (ft^2)			
10 Average depth of amended soil/gravel (ft)			
11 Average porosity of amended soil/gravel			
12 Retention volume achieved from on-lot infiltration (ft^3) $V_{retention}$ *= (Item 7 *Item 8) + (Item 9 * Item 10 * Item 11)*			
13 Runoff volume retention from on-lot infiltration (ft^3): _______ $V_{retention}$ *=Sum of Item 12 for all BMPs*			

Form 4.3-2 cont. Site Design Hydrologic Source Control BMPs

14 Implementation of evapotranspiration BMP (green, brown, or blue roofs): Yes ☐ No ☐ *If yes, complete Items 15-20. If no, proceed to Item 21*	BMP type and DA	BMP type and DA	BMP Type and DA *Use additional forms for more BMP*
15 Rooftop area planned for ET BMP (ft^2)			
16 Average wet season ET demand (in/day) *Use local values, typical ~ 0.1*			
17 Daily ET demand (ft^3/day) *Item 15 * (Item 16 / 12)*			
18 Drawdown time (hrs) *Copy Item 6 in Form 4.2-1*			
19 Retention Volume (ft^3) $V_{retention}$ *= Item 17 * (Item 18 / 24)*			
20 Runoff volume retention from evapotranspiration BMPs (ft^3): _______ $V_{retention}$ *=Sum of Item 19 for all BMPs*			
21 Implementation of Street Trees: Yes ☐ No ☐ *If yes, complete Items 20-2. If no, proceed to Item 24*	BMP type and DA	BMP type and DA	BMP Type and DA *Use additional forms for more BMPs*
22 Number of Street Trees			
23 Average canopy cover over impervious area (ft^2)			
24 Runoff volume retention from street trees (ft^3) $V_{retention}$ *= Item 22 * Item 23 * (0.05/12) assume runoff retention of 0.05 inches*			
25 Runoff volume retention from street tree BMPs (ft^3): _______ $V_{retention}$ *= Sum of Item 24 for all BMPs*			
26 Implementation of residential rain barrels/cisterns: Yes☐ No ☐ *If yes, complete Items 27-28; If no, proceed to Item 29*	BMP type and DA	BMP type and DA	BMP Type and DA *Use additional forms for more BMPs*
27 Number of rain barrels/cisterns			
28 Runoff volume retention from rain barrels/cisterns (ft^3) $V_{retention}$ *= Item 27 * 3*			
29 Runoff volume retention from residential rain barrels/Cisterns (ft3): ________ $V_{retention}$ *=Sum of Item 28 for all BMPs*			
30 Total Retention Volume from Site Design Hydrologic Source Control BMPs: _______ *Sum of Items 5, 13, 20, 25 and 29*			

4.3.2 Infiltration BMPs

Use Form 4.3-3 to compute on-site retention of runoff from proposed retention and infiltration BMPs. Volume retention estimates are sensitive to the percolation rate used, which determines the amount of runoff that can be infiltrated within the specified drawdown time. The infiltration safety factor reduces field measured percolation to account for potential inaccuracy associated with field measurements, declining BMP performance over time, and compaction during construction. Appendix D of the TGD for WQMP provides guidance on estimating an appropriate safety factor to use in Form 4.3-3.

If site constraints limit the use of BMPs to a single type and implementation of retention and infiltration BMPs mitigate no more than 40% of the DCV, then they are considered infeasible and the Project Proponent may evaluate the effectiveness of BMPs lower in the LID hierarchy of use (Section 5.5.1 of the TGD for WQMP)

If implementation of infiltrations BMPs is feasible as determined using Form 4.3-1, then LID infiltration BMPs shall be implemented to the MEP (section 4.1 of the TGD for WQMP).

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Form 4.3-3 Infiltration LID BMP (including underground BMPs)

1 Remaining LID DCV not met by site design HSC BMP (ft^3): _______ *V_{unmet} = Form 4.2-1 Item 7 - Form 4.3-2 Item 30*

BMP Type *Use columns to the right to compute runoff volume retention from proposed infiltration BMP (select BMP from Table 5-4 in TGD for WQMP)*	BMP Type and DA	BMP Type and DA	BMP Type and DA *Use additional forms for more BMPs*
2 Infiltration rate of underlying soils (in/hr) *See Section 5.4.2 and Appendix D of the TGD for WQMP for minimum requirements for assessment methods*			
3 Infiltration safety factor *See TGD Section 5.4.2 and Appendix D*			
4 Design percolation rate (in/hr) *P_{design} = Item 2 / Item 3*			
5 Ponded water drawdown time (hr) *Copy Item 6 in Form 4.2-1*			
6 Maximum ponding depth (ft) *BMP specific, see Table 5-4 of the TGD for WQMP for BMP design details*			
7 Ponding Depth (ft) *d_{BMP} = Minimum of (1/12 * Item 4 * Item 5) or Item 6*			
8 Infiltrating surface area, SA_{BMP} (ft^2) *the lesser of the area needed for infiltration of full DCV or minimum space requirements from Table 5.7 of the TGD for WQMP*			
9 Amended soil depth, d_{media} (ft) *Only included in certain BMP types, see Table 5-4 in the TGD for WQMP for reference to BMP design details*			
10 Amended soil porosity			
11 Gravel depth, d_{media} (ft) *Only included in certain BMP types, see Table 5-4 of the TGD for WQMP for BMP design details*			
12 Gravel porosity			
13 Duration of storm as basin is filling (hrs) *Typical ~ 3hrs*			
14 Above Ground Retention Volume (ft^3) *$V_{retention}$ = Item 8 * [Item7 + (Item 9 * Item 10) + (Item 11 * Item 12) + (Item 13 * (Item 4 / 12))]*			
15 Underground Retention Volume (ft^3) *Volume determined using manufacturer's specifications and calculations*			

16 Total Retention Volume from LID Infiltration BMPs: ___________ *(Sum of Items 14 and 15 for all infiltration BMP included in plan)*

17 Fraction of DCV achieved with infiltration BMP: ______% *Retention% = Item 16 / Form 4.2-1 Item 7*

18 Is full LID DCV retained on-site with combination of hydrologic source control and LID retention and infiltration BMPs? Yes ☐ No ☐

If yes, demonstrate conformance using Form 4.3-10; If no, then reduce Item 3, Factor of Safety to 2.0 and increase Item 8, Infiltrating Surface Area, such that the portion of the site area used for retention and infiltration BMPs equals or exceeds the minimum effective area thresholds (Table 5-7 of the TGD for WQMP) for the applicable category of development and repeat all above calculations.

4.3.3 Harvest and Use BMP

Harvest and use BMP may be considered if the full LID DCV cannot be met by maximizing infiltration BMPs. Use Form 4.3-4 to compute on-site retention of runoff from proposed harvest and use BMPs.

Volume retention estimates for harvest and use BMPs are sensitive to the on-site demand for captured stormwater. Since irrigation water demand is low in the wet season, when most rainfall events occur in San Bernardino County, the volume of water that can be used within a specified drawdown period is relatively low. The bottom portion of Form 4.3-4 facilitates the necessary computations to show infeasibility if a minimum incremental benefit of 40 percent of the LID DCV would not be achievable with MEP implementation of on-site harvest and use of stormwater (Section 5.5.4 of the TGD for WQMP).

Form 4.3-4 Harvest and Use BMPs			
1 Remaining LID DCV not met by site design HSC or infiltration BMP (ft^3): _______ *V_{unmet} = Form 4.2-1 Item 7 - Form 4.3-2 Item 30 – Form 4.3-3 Item 16*			
BMP Type(s) *Compute runoff volume retention from proposed harvest and use BMP (Select BMPs from Table 5-4 of the TGD for WQMP)*	BMP Type and DA	BMP Type and DA	BMP Type and DA *Use additional forms for more BMPs*
2 Describe cistern or runoff detention facility			
3 Storage volume for proposed detention type (ft^3) *Volume of cistern*			
4 Landscaped area planned for use of harvested stormwater (ft^2)			
5 Average wet season daily irrigation demand (in/day) Use local values, typical ~ 0.1 in/day			
6 Daily water demand (ft^3/day) *Item 4 * (Item 5 / 12)*			
7 Drawdown time (hrs) *Copy Item 6 from Form 4.2-1*			
8 Retention Volume (ft^3) *$V_{retention}$ = Minimum of (Item 3) or (Item 6 * (Item 7 / 24))*			
9 Total Retention Volume (ft^3) from Harvest and Use BMP: _________ *Sum of Item 8 for all harvest and use BMP included in plan*			
10 Is the full DCV retained with a combination of LID HSC, retention and infiltration, and harvest and use BMPs? Yes ☐ No ☐ *If yes, demonstrate conformance using Form 4.3-10. If no, then re-evaluate combinations of all LID BMP and optimize their implementation such that the maximum portion of the DCV is retained on-site (using a single BMP type or combination of BMP types). If the full DCV cannot be mitigated after this optimization process, proceed to Section 4.3.4.*			

4.3.4 Biotreatment BMP

Biotreatment BMPs may be considered if the full LID DCV cannot be met by maximizing retention and infiltration, and harvest and use BMPs. A key consideration when using biotreatment BMP is the effectiveness of the proposed BMP in addressing the pollutants of concern for the project (see Table 5-5 of the TGD for WQMP).

Use Form 4.3-5 to summarize the potential for volume based and/or flow based biotreatment options to biotreat the remaining unmet LID DCV. Biotreatment computations are included as follows:

- Use Form 4.3-6 to compute biotreatment in small volume based biotreatment BMP (e.g. bioretention w/underdrains);
- Use Form 4.3-7 to compute biotreatment in large volume based biotreatment BMP (e.g. constructed wetlands);
- Use Form 4.3-8 to compute sizing criteria for flow-based biotreatment BMP (e.g. bioswales)

Form 4.3-5 Selection and Evaluation of Biotreatment BMP		
1 Remaining LID DCV not met by site design HSC, infiltration, or harvest and use BMP for potential biotreatment (ft^3): __________ *Form 4.2-1 Item 7 - Form 4.3-2 Item 30 – Form 4.3-3 Item 16- Form 4.3-4 Item 9*	List pollutants of concern *Copy from Form 2.3-1*	
2 Biotreatment BMP Selected *(Select biotreatment BMP(s) necessary to ensure all pollutants of concern are addressed through Unit Operations and Processes, described in Table 5-5 of the TGD for WQMP)*	Volume-based biotreatment *Use Forms 4.3-6 and 4.3-7 to compute treated volume* ☐ Bioretention with underdrain ☐ Planter box with underdrain ☐ Constructed wetlands ☐ Wet extended detention ☐ Dry extended detention	Flow-based biotreatment *Use Form 4.3-8 to compute treated volume* ☐ Vegetated swale ☐ Vegetated filter strip ☐ Proprietary biotreatment
3 Volume biotreated in volume based biotreatment BMP (ft^3): ________ *Form 4.3-6 Item 15 + Form 4.3-7 Item 13*	4 Compute remaining LID DCV with implementation of volume based biotreatment BMP (ft^3): _____ *Item 1 – Item 3*	5 Remaining fraction of LID DCV for sizing flow based biotreatment BMP: ______% *Item 4 / Item 1*
6 Flow-based biotreatment BMP capacity provided (cfs): ________ *Use Figure 5-2 of the TGD for WQMP to determine flow capacity required to provide biotreatment of remaining percentage of unmet LID DCV (Item 5), for the project's precipitation zone (Form 3-1 Item 1)*		
7 Metrics for MEP determination: • Provided a WQMP with the portion of site area used for suite of LID BMP equal to minimum thresholds in Table 5-7 of the TGD for WQMP for the proposed category of development: ☐ *If maximized on-site retention BMPs is feasible for partial capture, then LID BMP implementation must be optimized to retain and infiltrate the maximum portion of the DCV possible within the prescribed minimum effective area. The remaining portion of the DCV shall then be mitigated using biotreatment BMP.*		

Form 4.3-6 Volume Based Biotreatment – Bioretention and Planter Boxes with Underdrains

Biotreatment BMP Type *(Bioretention w/underdrain, planter box w/underdrain, other comparable BMP)*	BMP Type and DA	BMP Type and DA	BMP Type and DA *Use additional forms for more BMP*
1 Pollutants addressed with BMP *List all pollutant of concern that will be effectively reduced through specific Unit Operations and Processes described in Table 5-5 of the TGD for WQMP*			
2 Amended soil infiltration rate *Typical ~ 5.0*			
3 Amended soil infiltration safety factor *Typical ~ 2.0*			
4 Amended soil design percolation rate (in/hr) P_{design} *= Item 2 / Item 3*			
5 Ponded water drawdown time (hr) *Copy Item 6 from Form 4.2-1*			
6 Maximum ponding depth (ft) *see Table 5-6 of the TGD for WQMP for reference to BMP design details*			
7 Ponding Depth (ft) d_{BMP} *= Minimum of (1/12 * Item 4 * Item 5) or Item 6*			
8 Amended soil surface area (ft^2)			
9 Amended soil depth (ft) *see Table 5-6 of the TGD for WQMP for reference to BMP design details*			
10 Amended soil porosity, *n*			
11 Gravel depth (ft) *see Table 5-6 of the TGD for WQMP for reference to BMP design details*			
12 Gravel porosity, *n*			
13 Duration of storm as basin is filling (hrs) *Typical ~ 3hrs*			
14 Biotreated Volume (ft^3) $V_{biotreated}$ *= Item 8 * [(Item 7/2) + (Item 9 * Item 10) +(Item 11 * Item 12) + (Item 13 * (Item 4 / 12))]*			

15 Total biotreated volume from bioretention and/or planter box with underdrains BMP: ___________
Sum of Item 14 for all volume-based BMPs included in this form

Form 4.3-7 Volume Based Biotreatment – Constructed Wetlands and Extended Detention

Biotreatment BMP Type *Constructed wetlands, extended wet detention, extended dry detention, or other comparable proprietary BMP. If BMP includes multiple modules (e.g. forebay and main basin), provide separate estimates for storage and pollutants treated in each module.*	BMP Type and DA		BMP Type and DA		BMP Type and DA *Use additional forms for more BMP*	
	Forebay	Basin	Forebay	Basin	Forebay	Basin
1 Pollutants addressed with BMP forebay and basin *List all pollutant of concern that will be effectively reduced through specific Unit Operations and Processes described in Table 5-5 of the TGD for WQMP*						
2 Bottom width (ft)						
3 Bottom length (ft)						
4 Bottom area (ft^2) *A_{bottom} = Item 2 * Item 3*						
5 Side slope (ft/ft)						
6 Depth of storage (ft)						
7 Water surface area (ft^2) $A_{surface}$ *=(Item 2 + (2 * Item 5 * Item 6)) * (Item 3 + (2 * Item 5 * Item 6))*						
8 Storage volume (ft^3) *For BMP with a forebay, ensure fraction of total storage is within ranges specified in BMP specific fact sheets, see Table 5-6 of the TGD for WQMP for reference to BMP design details* V *=Item 6 / 3 * [Item 4 + Item 7 + (Item 4 * Item 7)^0.5]*						
9 Drawdown Time (hrs) *Copy Item 6 from Form 2.1*						
10 Outflow rate (cfs) *Q_{BMP} = (Item $8_{forebay}$ + Item 8_{basin}) / (Item 9 * 3600)*						
11 Duration of design storm event (hrs)						
12 Biotreated Volume (ft^3) *$V_{biotreated}$ = (Item $8_{forebay}$ + Item 8_{basin}) +(Item 10 * Item 11 * 3600)*						

13 Total biotreated volume from constructed wetlands, extended dry detention, or extended wet detention : ___________
(Sum of Item 12 for all BMP included in plan)

Form 4.3-8 Flow Based Biotreatment

Biotreatment BMP Type *Vegetated swale, vegetated filter strip, or other comparable proprietary BMP*	BMP Type and DA	BMP Type and DA	BMP Type and DA *Use additional forms for more BMP*
1 Pollutants addressed with BMP *List all pollutant of concern that will be effectively reduced through specific Unit Operations and Processes described in TGD Table 5-5*			
2 Flow depth for water quality treatment (ft) *BMP specific, see Table 5-6 of the TGD for WQMP for reference to BMP design details*			
3 Bed slope (ft/ft) *BMP specific, see Table 5-6 of the TGD for WQMP for reference to BMP design details*			
4 Manning's roughness coefficient			
5 Bottom width (ft) *b_w = (Form 4.3-5 Item 6 * Item 4) / (1.49 * Item 2^1.67 * Item 3^0.5)*			
6 Side Slope (ft/ft) *BMP specific, see Table 5-6 of the TGD for WQMP for reference to BMP design details*			
7 Cross sectional area (ft^2) *A = (Item 5 * Item 2) + (Item 6 * Item 2^2)*			
8 Water quality flow velocity (ft/sec) *V = Form 4.3-5 Item 6 / Item 7*			
9 Hydraulic residence time (min) *Pollutant specific, see Table 5-6 of the TGD for WQMP for reference to BMP design details*			
10 Length of flow based BMP (ft) *L = Item 8 * Item 9 * 60*			
11 Water surface area at water quality flow depth (ft^2) *SA_{top} = (Item 5 + (2 * Item 2 * Item 6)) * Item 10*			

4.3.5 Conformance Summary

Complete Form 4.3-9 to demonstrate how on-site LID DCV is met with proposed site design hydrologic source control, infiltration, harvest and use, and/or biotreatment BMP. The bottom line of the form is used to describe the basis for infeasibility determination for on-site LID BMP to achieve full LID DCV, and provides methods for computing remaining volume to be addressed in an alternative compliance plan. If the project has more than one outlet, then complete additional versions of this form for each outlet.

Form 4.3-9 Conformance Summary and Alternative Compliance Volume Estimate
1 Total LID DCV for the Project (ft^3): __________ *Copy Item 7 in Form 4.2-1*
2 On-site retention with site design hydrologic source control LID BMP (ft^3): __________ *Copy Item 30 in Form 4.3-2*
3 On-site retention with LID infiltration BMP (ft^3): __________ *Copy Item 16 in Form 4.3-3*
4 On-site retention with LID harvest and use BMP (ft^3): __________ *Copy Item 9 in Form 4.3-4*
5 On-site biotreatment with volume based biotreatment BMP (ft^3): __________ *Copy Item 3 in Form 4.3-5*
6 Flow capacity provided by flow based biotreatment BMP (cfs): __________ *Copy Item 6 in Form 4.3-5*
7 LID BMP performance criteria are achieved if answer to any of the following is “Yes”: • Full retention of LID DCV with site design HSC, infiltration, or harvest and use BMP: Yes ☐ No ☐ *If yes, sum of Items 2, 3, and 4 is greater than Item 1* • Combination of on-site retention BMPs for a portion of the LID DCV and volume-based biotreatment BMP that address all pollutants of concern for the remaining LID DCV: Yes ☐ No ☐ *If yes, a) sum of Items 2, 3, 4, and 5 is greater than Item 1, and Items 2, 3 and 4 are maximized; or b) Item 6 is greater than Form 4.3--5 Item 6 and Items 2, 3 and 4 are maximized* ▪ On-site retention and infiltration is determined to be infeasible and biotreatment BMP provide biotreatment for all pollutants of concern for full LID DCV: Yes ☐ No ☐ *If yes, Form 4.3-1 Items 7 and 8 were both checked yes*
8 If the LID DCV is not achieved by any of these means, then the project may be allowed to develop an alternative compliance plan. Check box that describes the scenario which caused the need for alternative compliance: • Combination of HSC, retention and infiltration, harvest and use, and biotreatment BMPs provide less than full LID DCV capture: ☐ *Checked yes for Form 4.3-5 Item 7, Item 6 is zero, and sum of Items 2, 3, 4, and 5 is less than Item 1. If so, apply water quality credits and calculate volume for alternative compliance, V_{alt} = (Item 1 – Item 2 – Item 3 – Item 4 – Item 5) * (100 - Form 2.4-1 Item 2)%* • An approved Watershed Action Plan (WAP) demonstrates that water quality and hydrologic impacts of urbanization are more effective when managed in at an off-site facility: ☐ *Attach appropriate WAP section, including technical documentation, showing effectiveness comparisons for the project site and regional watershed*

4.3.6 Hydromodification Control BMP

Use Form 4.3-10 to compute the remaining runoff volume retention, after LID BMP are implemented, needed to address HCOC, and the increase in time of concentration and decrease in peak runoff necessary to meet targets for protection of waterbodies with a potential HCOC. Describe hydromodification control BMP that address HCOC, which may include off-site BMP and/or in-stream controls. Section 5.6 of the TGD for WQMP provides additional details on selection and evaluation of hydromodification control BMP.

Form 4.3-10 Hydromodification Control BMPs

1 Volume reduction needed for HCOC performance criteria (ft^3): _______ *(Form 4.2-2 Item 4 * 0.95) – Form 4.2-2 Item 1*	**2** On-site retention with site design hydrologic source control, infiltration, and harvest and use LID BMP (ft^3): __________ *Sum of Form 4.3-9 Items 2, 3, and 4 Evaluate option to increase implementation of on-site retention in Forms 4.3-2, 4.3-3, and 4.3-4 in excess of LID DCV toward achieving HCOC volume reduction*
3 Remaining volume for HCOC volume capture (ft^3): __________ *Item 1 – Item 2*	**4** Volume capture provided by incorporating additional on-site or off-site retention BMPs (ft^3): __________ *Existing downstream BMP may be used to demonstrate additional volume capture (if so, attach to this WQMP a hydrologic analysis showing how the additional volume would be retained during a 2-yr storm event for the regional watershed)*

5 If Item 4 is less than Item 3, incorporate in-stream controls on downstream waterbody segment to prevent impacts due to hydromodification ☐ *Attach in-stream control BMP selection and evaluation to this WQMP*

6 Is Form 4.2-2 Item 11 less than or equal to 5%: Yes ☐ No ☐

If yes, HCOC performance criteria is achieved. If no, select one or more mitigation options below:

- Demonstrate increase in time of concentration achieved by proposed LID site design, LID BMP, and additional on-site or off-site retention BMP ☐
  BMP upstream of a waterbody segment with a potential HCOC may be used to demonstrate increased time of concentration through hydrograph attenuation (if so, show that the hydraulic residence time provided in BMP for a 2-year storm event is equal or greater than the addition time of concentration requirement in Form 4.2-4 Item 15)
- Increase time of concentration by preserving pre-developed flow path and/or increase travel time by reducing slope and increasing cross-sectional area and roughness for proposed on-site conveyance facilities ☐
- Incorporate appropriate in-stream controls for downstream waterbody segment to prevent impacts due to hydromodification, in a plan approved and signed by a licensed engineer in the State of California ☐

7 Form 4.2-2 Item 12 less than or equal to 5%: Yes ☐ No ☐

If yes, HCOC performance criteria is achieved. If no, select one or more mitigation options below:

- Demonstrate reduction in peak runoff achieved by proposed LID site design, LID BMPs, and additional on-site or off-site retention BMPs ☐
  BMPs upstream of a waterbody segment with a potential HCOC may be used to demonstrate additional peak runoff reduction through hydrograph attenuation (if so, attach to this WQMP, a hydrograph analysis showing how the peak runoff would be reduced during a 2-yr storm event)
- Incorporate appropriate in-stream controls for downstream waterbody segment to prevent impacts due to hydromodification, in a plan approved and signed by a licensed engineer in the State of California ☐

4.4 Alternative Compliance Plan (if applicable)

Describe an alternative compliance plan (if applicable) for projects not fully able to infiltrate, harvest and use, or biotreat the DCV via on-site LID practices. A project proponent must develop an alternative compliance plan to address the remainder of the LID DCV. Depending on project type some projects may qualify for water quality credits that can be applied to reduce the DCV that must be treated prior to development of an alternative compliance plan (see Form 2.4-1, Water Quality Credits). Form 4.3-9 Item 8 includes instructions on how to apply water quality credits when computing the DCV that must be met through alternative compliance. Alternative compliance plans may include one or more of the following elements:

- On-site structural treatment control BMP - All treatment control BMP should be located as close to possible to the pollutant sources and should not be located within receiving waters;
- Off-site structural treatment control BMP - Pollutant removal should occur prior to discharge of runoff to receiving waters;
- Urban runoff fund or In-lieu program, if available

Depending upon the proposed alternative compliance plan, approval by the executive officer may or may not be required (see Section 6 of the TGD for WQMP).

Section 5 Inspection and Maintenance Responsibility for Post Construction BMP

All BMP included as part of the project WQMP are required to be maintained through regular scheduled inspection and maintenance (refer to Section 8, Post Construction BMP Requirements, in the TGD for WQMP). Fully complete Form 5-1 summarizing all BMP included in the WQMP. Attach additional forms as needed. The WQMP shall also include a detailed Operation and Maintenance Plan for all BMP and may require a Maintenance Agreement (consult the jurisdiction's LIP). If a Maintenance Agreement is required, it must also be attached to the WQMP.

Form 5-1 BMP Inspection and Maintenance			
BMP	Reponsible Party(s)	Inspection/ Maintenance Activities Required	Minimum Frequency of Activities

Section 6 WQMP Attachments

6.1. Site Plan and Drainage Plan

Include a site plan and drainage plan sheet set containing the following minimum information:

- Project location
- Site boundary
- Land uses and land covers, as applicable
- Suitability/feasibility constraints
- Structural Source Control BMP locations
- Site Design Hydrologic Source Control BMP locations
- LID BMP details
- Drainage delineations and flow information
- Drainage connections

6.2 Electronic Data Submittal

Minimum requirements include submittal of PDF exhibits in addition to hard copies. Format must not require specialized software to open. If the local jurisdiction requires specialized electronic document formats (consult the LIP), this section will describe the contents (e.g., layering, nomenclature, geo-referencing, etc.) of these documents so that they may be interpreted efficiently and accurately.

6.3 Post Construction

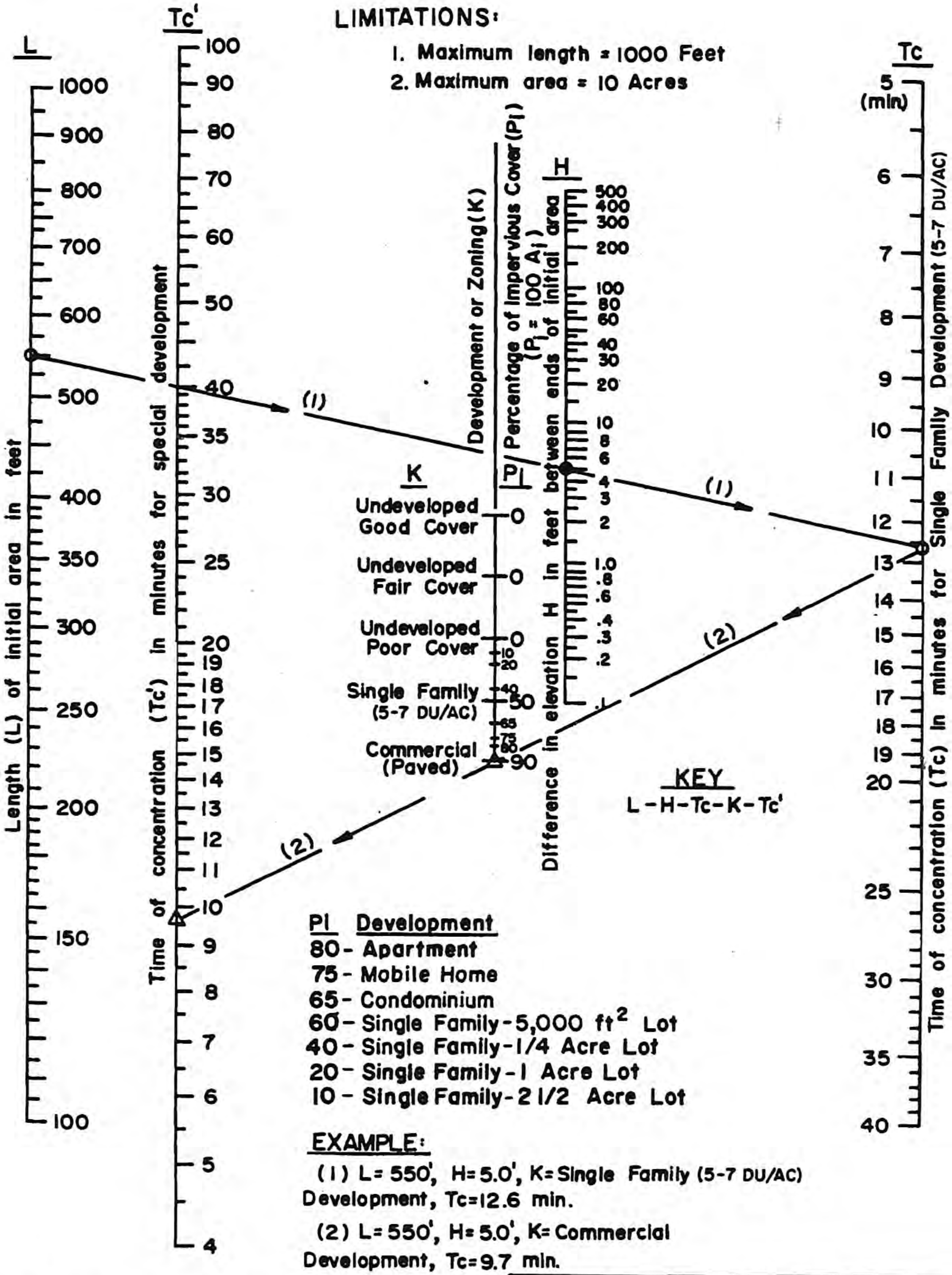
Attach all O&M Plans and Maintenance Agreements for BMP to the WQMP.

6.4 Other Supporting Documentation

- BMP Educational Materials
- Activity Restriction – C, C&R's & Lease Agreements

Appendix C – San Bernardino County Hydrology Manual (Selected Figures)

Appendix C-1 – SB County Hydrology Manual Figure D-1, Time of Concentration Nomograph



PI	Development
80	Apartment
75	Mobile Home
65	Condominium
60	Single Family - 5,000 ft^2 Lot
40	Single Family - 1/4 Acre Lot
20	Single Family - 1 Acre Lot
10	Single Family - 2 1/2 Acre Lot

EXAMPLE:

(1) L = 550', H = 5.0', K = Single Family (5-7 DU/AC) Development, Tc = 12.6 min.

(2) L = 550', H = 5.0', K = Commercial Development, Tc = 9.7 min.

SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

TIME OF CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA

Figure D-1

Appendix C - 2 – SB County Hydrology Manual Figure C-3, Curve Numbers of Hydrologic Soil

Curve (1) Numbers of Hydrologic Soil-Cover Complexes For Pervious Areas-AMC II

Cover Type (3)	Quality of Cover (2)	Soil Group A	B	C	D
NATURAL COVERS -					
Barren (Rockland, eroded and graded land)		78	86	91	93
Chaparral, Broadleaf (Manzonita, ceanothus and scrub oak)	Poor	53	70	80	85
	Fair	40	63	75	81
	Good	31	57	71	78
Chaparral, Narrowleaf (Chamise and redshank)	Poor	71	82	88	91
	Fair	55	72	81	86
Grass, Annual or Perennial	Poor	67	78	86	89
	Fair	50	69	79	84
	Good	38	61	74	80
Meadows or Cienegas (Areas with seasonally high water table, principal vegetation is sod forming grass)	Poor	63	77	85	88
	Fair	51	70	80	84
	Good	30	58	71	78
Open Brush (Soft wood shrubs - buckwheat, sage, etc.)	Poor	62	76	84	88
	Fair	46	66	77	83
	Good	41	63	75	81
Woodland (Coniferous or broadleaf trees predominate. Canopy density is at least 50 percent.)	Poor	45	66	77	83
	Fair	36	60	73	79
	Good	25	55	70	77
Woodland, Grass (Coniferous or broadleaf trees with canopy density from 20 to 50 percent)	Poor	57	73	82	86
	Fair	44	65	77	82
	Good	33	58	72	79
URBAN COVERS -					
Residential or Commercial Landscaping (Lawn, shrubs, etc.)	Good	32	56	69	75
Turf (Irrigated and mowed grass)	Poor	58	74	83	87
	Fair	44	65	77	82
	Good	33	58	72	79
AGRICULTURAL COVERS -					
Fallow (Land plowed but not tilled or seeded)		77	86	91	94

SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

CURVE NUMBERS FOR PERVIOUS AREAS

Curve (1) Numbers of Hydrologic Soil-Cover Complexes For Pervious Areas-AMC II

Cover Type (3)	Quality of Cover (2)	Soil Group A	B	C	D
AGRICULTURAL COVERS (Continued)					
Legumes, Close Seeded (Alfalfa, sweetclover, timothy, etc.)	Poor	66	77	85	89
	Good	58	72	81	85
Orchards, Evergreen (Citrus, avocados, etc.)	Poor	57	73	82	86
	Fair	44	65	77	82
	Good	33	58	72	79
Pasture, Dryland (Annual grasses)	Poor	68	79	86	89
	Fair	49	69	79	84
	Good	39	61	74	80
Pasture, Irrigated (Legumes and perennial grass)	Poor	58	74	83	87
	Fair	44	65	77	82
	Good	33	58	72	79
Row Crops (Field crops - tomatoes, sugar beets, etc.)	Poor	72	81	88	91
	Good	67	78	85	89
Small grain (Wheat, oats, barley, etc.)	Poor	65	76	84	88
	Good	63	75	83	87

Notes:

1. All curve numbers are for Antecedent Moisture Condition (AMC) II.
2. Quality of cover definitions:

   Poor-Heavily grazed, regularly burned areas, or areas of high burn potential. Less than 50 percent of the ground surface is protected by plant cover or brush and tree canopy.

   Fair-Moderate cover with 50 percent to 75 percent of the ground surface protected.

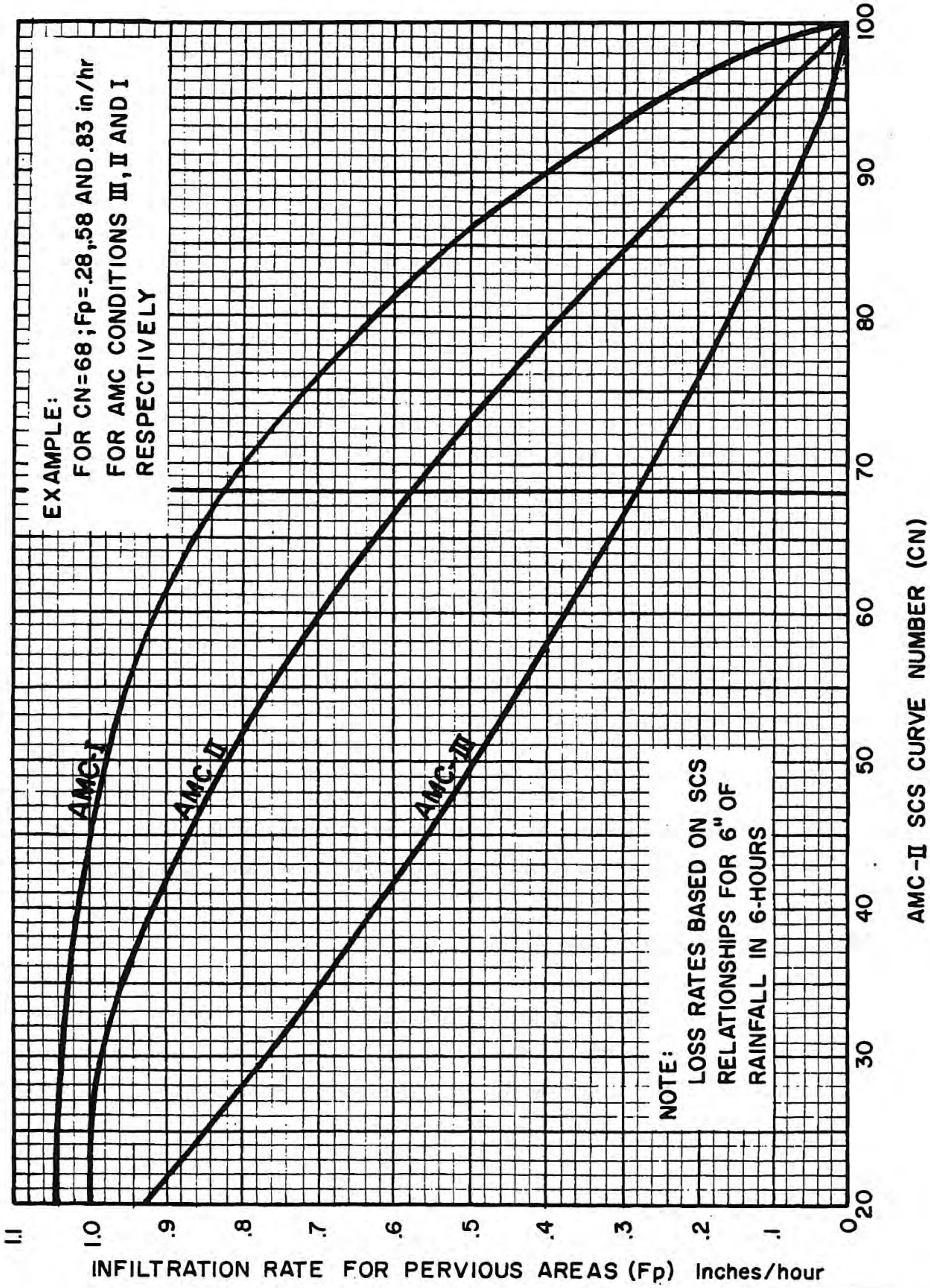
   Good-Heavy or dense cover with more than 75 percent of the ground surface protected.
3. See Figure C-2 for definition of cover types.

SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

CURVE NUMBERS FOR PERVIOUS AREAS

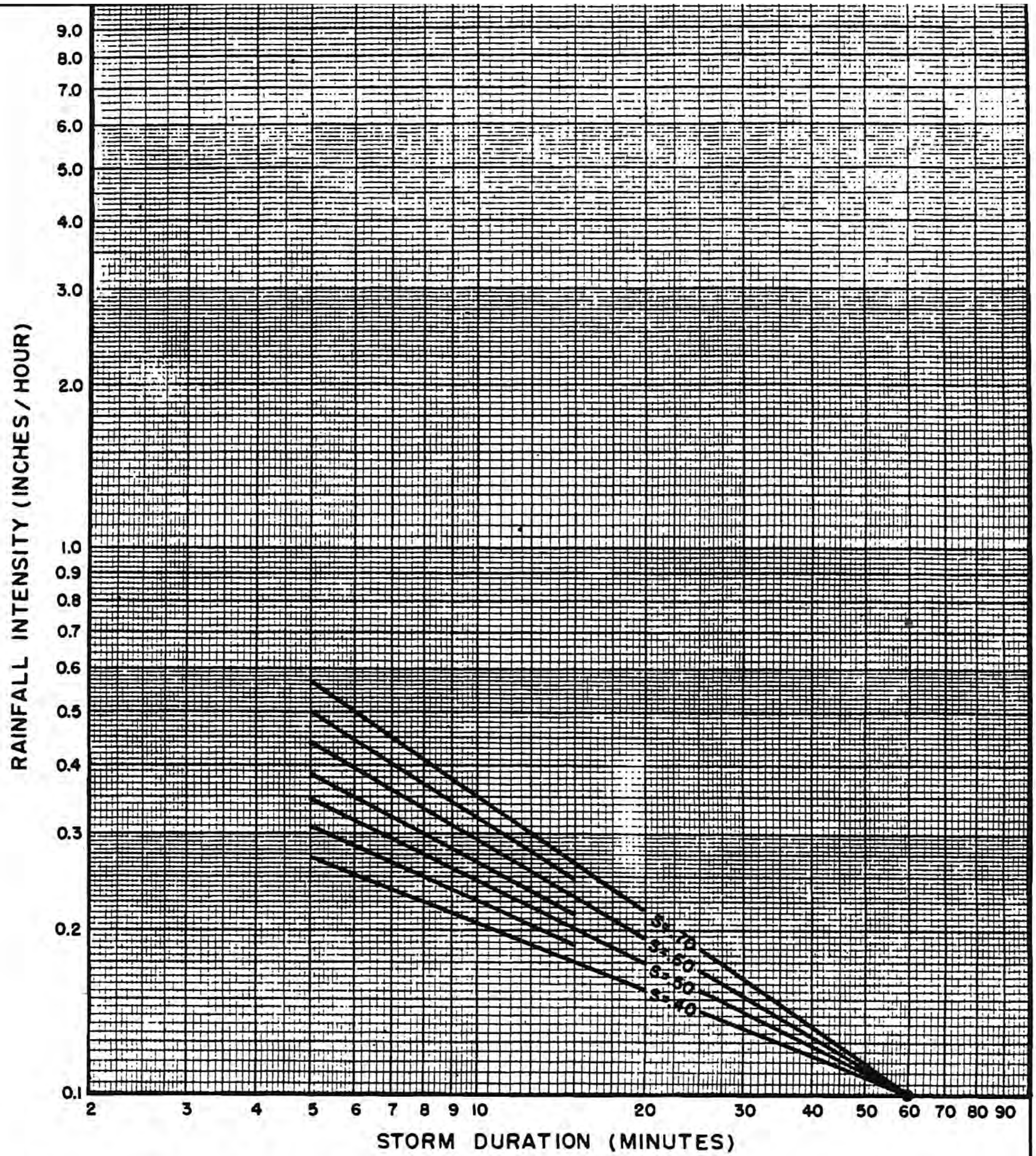
Appendix C - 3 – SB County Hydrology Manual Figure C-6, Infiltration Rate for Pervious Areas versus SCS Curve Numbers



SAN BERNARDINO COUNTY
HYDROLOGY MANUAL

INFILTRATION RATE FOR PERVIOUS AREAS VERSUS SCS CURVE NUMBERS

Appendix C - 4 – SB County Hydrology Manual Figure D-3, Intensity – Duration Curves Calculation Sheet



DESIGN STORM FREQUENCY =_____ YEARS

ONE HOUR POINT RAINFALL =_____ INCHES

LOG-LOG SLOPE =_____

PROJECT LOCATION =________________

SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

INTENSITY - DURATION CURVES CALCULATION SHEET

FIGURE D-3

Appendix D – Section VII – Infiltration Rate Evaluation Protocol and Factor of Safety Recommendations, Orange County TGD Appendices, May 19, 2011

APPENDIX VII. INFILTRATION RATE EVALUATION PROTOCOL AND FACTOR OF SAFETY RECOMMENDATIONS

VII.1. Introduction

Soil characterization and infiltration testing is required in order to properly size and locate stormwater management facilities. The purpose of this appendix is to provide guidance for investigating infiltration at both the project planning and design phases, as well as provide requirements for applying a factor of safety to testing results.

VII.1.1. Two phases of assessment

The role of soil characterization and infiltration testing differs with the phase of project development as described below.

Site Assessment / Project Planning Phase: Soil characterization or infiltration testing may be conducted to determine if infiltration is a potentially feasible BMP and/or where on the site infiltration is potentially infeasible. The intent of this investigation is to identify if the project site, or a portion of the site, has soils that are clearly unsuitable for infiltration. For those sites or portions of the site where soils are unsuitable, infiltration BMPs can be eliminated from consideration. The intent of this testing is not to prove definitively that infiltration is feasible. Simpler methods may be used to determine infiltration potential at this phase. The observed infiltration rate is adjusted to account for the type of test and the uncertainty of the testing method and reported as the *measured infiltration rate* for the purpose of evaluating feasibility. These methods are not appropriate to determine the *design infiltration rate*.

Site Planning / Design Phase: Where infiltration BMPs are selected, infiltration testing must be conducted to determine the *design infiltration rate* of proposed facilities, except in limited cases where infiltration rate is presumed to be sufficient as identified in Section **VII.1.2**. The required size of the proposed facilities strongly depends on the design infiltration rate; therefore, testing may be required at the preliminary site design phase to facilitate site planning. However, infiltration testing must be conducted as close to the proposed facility as possible, therefore, conducting testing after preliminary site design also has merits. Use of more sophisticated methods at this phase allows better confidence in testing and therefore a lower factor of safety on observed infiltration rates (and therefore smaller facility designs). Factors of safety are discussed in **VII.4**.

Soil characterization and infiltration testing can be considered to fulfill two functions:

1. Determine where infiltration is potentially feasible and must be considered (if other limitations, such as depth to groundwater or contamination, do not restrict infiltration). This role is satisfied through simple infiltration tests, or use of maps and available data.
2. Determine the design infiltration rate for proposed facilities. This function is satisfied through more sophisticated investigation methods, conducted by a qualified professional.

Table VII.1 provides required methods of assessing infiltration rate for each purpose.

Table VII.1: Recommended Infiltration Investigation Methods

Methods for Identifying Areas Potentially Feasible for Infiltration	• **Use of Regional Maps and "Available Data"**[1] **OR** • **Simple Open Pit Infiltration Test** **OR** • Any of the testing methods used to establish design infiltration rate (below)
Methods for Establishing Design Infiltration Rate	• **Open Pit Falling Head Procedure** • **Single Ring Infiltrometer Test** • **Double Ring Infiltrometer Test** • **Well Permeameter Method (USBR Procedure 7300-89)** • **Percolation Test Procedure** (Riverside County Department of Environmental Health) • Other analysis methods at the discretion of the project engineer and approval of the reviewing agency

[1]Available data is defined in Section **VII.2** below and does not require additional investigation.

VII.1.2. Waiver of Infiltration Testing Requirements

The infiltration testing requirements described in this appendix are not applicable for certain combinations of BMP type and general soil condition. In cases where available soils information indicates that the soils are clearly sufficient to support the level of infiltration required for proper function of the BMP and uncertainty in infiltration rate would not significantly influence the performance of the practice, it is not mandatory to conduct infiltration testing. Conditions under which infiltration testing requirements are waived include:

- **Impervious area dispersion** (See **HSC-2: Impervious Area Dispersion**): Testing requirements are waived for this BMP for all soil types. Soil amendments are required to use this practice where site soils are hydrologic soil group C or D.
- **Localized on-lot infiltration** (See **HSC-1: Localized On-Lot Infiltration**): Testing requirements are waived for this BMP for A, B, and C soil types if soil type and general drainage conditions are confirmed with site-specific information. This BMP is not suitable for D soils unless infiltration testing demonstrates that the ponded depth would drain within 24 hours.
- **Porous pavement designed to be self-retaining** (See **INF-6: Permeable Pavement (concrete, asphalt, and pavers)**): Testing requirements for this BMP are waived for A, B, and C soil types if soil type and general drainage conditions are confirmed with site-specific information. This waiver does not apply to porous pavement that accepts run-on from a tributary area larger than 50 percent of its area.
- **Bioinfiltration** (See **INF-4: Bioinfiltration Fact Sheet**). Based on the LID BMP hierarchy, this type of BMP may only be used if infiltration of the full DCV is not feasible; therefore exploratory infiltration rate assessment (Section **VII.2**) is required. However, testing to determine design infiltration rate (Section **VII.3**) is not required. See **Appendix XI** for instructions for sizing the infiltration component of a bioinfiltration BMP to achieve maximum feasible infiltration.

VII.1.3. A Note on "Infiltration Rate" vs. "Percolation Rate"

A common misunderstanding is that the "percolation rate" obtained from a percolation test is equivalent to the "infiltration rate" obtained from a single or double ring infiltrometer test. While the percolation rate is related to the infiltration rate, percolation rates tend to overestimate infiltration rates and can be off by a factor of ten or more because they incorporate both downward and horizontal fluxes of water, whereas infiltration only refers to a downward flux of water. When using borehole-type methods, the percolation rate obtained shall be converted to a reasonable estimate of the infiltration rate using the Porchet Method (aka Inverse Borehole Method) (See Example VII.1).

VII.1.4. Grading Plans

Many projects require a significant amount of grading prior to their construction. It is important to determine if the BMP will be placed in cut or fill since this may affect the performance of the BMP or even the soil. As such, preliminary site grading plans showing the proposed BMP locations are required along with section views through each BMP clearly identifying the extents of cut or fill. In addition, since it is imperative that any testing be performed at the proper elevations and locations, it is highly recommended that the preliminary site grading plans be provided to the engineer/geologist prior to any tests being performed.

VII.1.5. Cut Condition

Where the proposed infiltration BMP is to be located in a cut condition, the infiltration surface level at the bottom of the BMP might be far below the existing grade. For example, if the infiltration surface of a proposed BMP is to be located at an elevation that is currently beneath 15 feet of cut, how can the proposed infiltration surface be tested?

In order to determine an infiltration rate where the proposed infiltration surface is in a cut condition, the following procedures may be used:

1) USBR 7300-89, "Procedure for Performing field Permeability Testing by the Well Permeameter Method" (Section **VII.3.7** below). Note that this result must be converted to an infiltration rate.
2) The percolation test (Section **VII.3.8** below). Note that this result must be converted to an infiltration rate.

VII.1.6. Fill Condition

If the bottom of a BMP (infiltration surface) is in a fill location, the infiltration surface may not exist prior to grading. How then can the infiltration rate be determined? For example, if a proposed infiltration BMP is to be located in 12 feet of fill, how could one reasonably establish an infiltration rate prior to the fill being placed?

Unfortunately, no reliable assumptions can be made about the in-situ properties of fill soil. As such, the bottom, or rather the infiltration surface of the BMP, must extend into natural soil. The natural soil shall be tested at the design elevation prior to the fill being placed.

For shallow fill depths, fill material can be selectively graded to provide reliable infiltration properties. However, in some cases, due to considerable fill depth, the extension of the BMP down to natural soil and selective grading of fill material may prove infeasible. In that case, because of the uncertainty of fill parameters as described above, an infiltration BMP may not be feasible.

VII.2. Methods for Identifying Areas Potentially Feasible for Infiltration

This section describes methods that shall be used, as applicable, to determine whether soils are potentially feasible for infiltration, and where potentially feasible soils exist. Soils would be considered potentially feasible for infiltration if the *measured infiltration rate* obtained from field-testing or obtained by applying professional judgment to available data taken within the Project vicinity is greater than 0.3 inches per hour. *Measured* rates shall account for uncertainty and bias in measurement methods by applying a factor of safety of 2.0 to testing results.

The *measured infiltration rate* calculated for the purpose of infiltration infeasibility screening (**TGD Section 2.4.2.4**) shall be based on a factor of safety of 2.0 applied to the rates obtained from the infiltration test results. No adjustments from this value are permitted. The factor of safety used to compute the *design infiltration rate* shall not be less than 2.0, but may be higher at the discretion of the design engineer and acceptance of the plan reviewer, per the considerations described in Section **VII.4**.

VII.2.1. Use of Regional Maps and "Available Data"

This section describes a method that satisfies the requirements for infiltration screening of small projects as defined by the TGD Infeasibility Screening Criteria (**TGD Section 2.4.2.4**). This method uses regionally mapped data coupled with all applicable data available through other site investigations to identify locations not potentially feasible for infiltration as a result of low infiltration rate or high groundwater table.

Via this method, areas of a project identified as having D soils or identified as having depth to first groundwater less than 5 feet are considered infeasible for infiltration if available data confirm these determinations.

Infiltration constraint maps are available in **Appendix XVI** and will be refined as part of the development of Watershed Hydromodification and Infiltration Management Plans. These maps identify constraints, including hydrologic soil group (A,B,C,D), and depth to first groundwater, which should be confirmed through review of available data.

"Available data" is defined as data collected by the project or otherwise available that provides information about infiltration rates and/or groundwater depths. Applicable data is expected to be available as part of nearly all projects subject to New Development and Significant Redevelopment stormwater management requirements in Orange County. Data sources may include:

- Geotechnical investigations
- Due diligence site investigations
- Other CEQA investigations
- Investigations performed on adjacent sites with applicability to the project site

For projects permitted to utilize this method, additional infiltration testing data is not required to be obtained, however, infiltration testing data which is already available from previous studies must be used.

For the purpose of this method, large projects and small projects are defined in Table VII.2. The distinction between large and small projects based the lower spatial variability expected on smaller projects and the lower project value. In these cases, the expense associated with infiltration testing of HSG D soils to attempt to identify localized exceptions to this mapped and supported determination is considered to be an unreasonable economic burden.

Table VII.2: Definition of Project Size Categories

	Residential	Commercial, Institutional	Industrial
Small Projects	Less than 10 acres and less than 30 DU	Less than 5 acres and less than 50,000 SF	Less than 2 acre and less than 20,000 SF
Large Projects	Greater than 10 acres or greater than 30 DU	Greater than 5 acres or greater than 50,000 SF	Greater than 2 acre or greater than 20,000 SF

VII.2.2. Simple Open Pit Infiltration Test

The Simple Open Pit Infiltration Test is a site-specific method which can be used to provide a preliminary screening value. This approach cannot be used to find a design infiltration rate. The intent of the Simple Open Pit Infiltration Test is to determine whether or not the local infiltration rate is potentially adequate for LID infiltration BMPs. This approach does not need to be conducted by a licensed professional.

1. The test should be at the proposed facility location or within the immediate vicinity.
2. Excavate a test hole to an elevation 2 feet deeper than the bottom of the infiltration system to account for soil amendment. If the depth of the proposed facility is not known at the time of testing, the excavation should be 6 feet deep. The test hole can be excavated with small excavation equipment or by hand using a shovel, auger, or post hole digger. The hole should be a minimum of 2 feet in diameter and should be sufficient to allow for observation of the water surface level in the bottom of the hole. Remove loose material, as much as possible from the bottom of the hole but avoid compaction of the bottom surface. If a layer hard enough to prevent further excavation is encountered during excavation, or if noticeable moisture/water is encountered in the soil, stop and measure this depth. Proceed with the test at this depth.
3. Fill the hole with water to a height of about 6 inches from the bottom of the hole, and record the exact time. Check the water level at regular intervals (every minute for fast-draining soils to every 10 minutes for slower-draining soils) for a minimum of 1 hour or until all of the water has infiltrated. Record the distance the water has dropped from a fixed reference point such as the top edge of the hole.
4. The infiltration rate is calculated by dividing the change in water elevation time (inches) by the duration of the test (hours).
5. Repeat this process two more times, for a total of three rounds of testing. These tests should be performed as close together as possible to accurately portray the soil's ability to infiltrate at different levels of saturation. The third test provides the best measure of the saturated infiltration rate.

6. For each test pit required, record all three testing results with the date, duration, drop in water height, and conversion into inches per hour.

VII.3. Methods for Establishing Design Infiltration Rate

Allowable methods of establishing design infiltration rate include:

- Open Pit Falling Head Procedure (Section **VII.3.4**)
- Single Ring Infiltrometer Test (Section **VII.3.5**)
- Double Ring Infiltrometer Test (Section **VII.3.6**)
- Well Permeameter Method (USBR Procedure 7300-89) (Section **VII.3.7**)
- Percolation Test Procedure (Riverside County Department of Environmental Health) (Section **VII.3.8**)
- Other analysis methods at the discretion of the project engineer and approval of the reviewing agency

A qualified professional must exercise judgment in the selection of the infiltration test method. Where satisfactory data from adjacent areas is available that demonstrates infiltration testing is not necessary, the infiltration testing requirement may be waived. Waiver of site specific testing is subject to approval by the local approval authority. Recommendation for foregoing infiltration testing must be submitted in a report which includes supporting data and is stamped and signed by the project geotechnical engineer or project geologist.

VII.3.1. Testing Criteria

1. Testing must be conducted or overseen by a qualified professional, either a Professional Engineer (PE) or Registered Geologist (RG) licensed in the State of California.
2. The elevation of the test must correspond to the facility elevation, plus 2 feet to account for soil amendments under the infiltration system. If a confining layer, or soil with a greater percentage of fines, is observed during the subsurface investigation to be within 4 feet of the bottom of the planned infiltration system, the testing should be conducted within that confining layer. The boring log must be continued to a depth adequate to show separation between the bottom of the infiltration facility and the seasonal high groundwater level.
3. Tests must be performed in the immediate vicinity of the proposed facility. Exceptions can be made to the test location provided the qualified professional can support that the strata are consistent from the proposed facility to the test location.
4. Infiltration testing should not be conducted in engineered or undocumented fill.

VII.3.2. Minimum Number of Required Tests

- A total of two infiltration tests for every 10,000 square feet of lot area available for new or redevelopment (minimum 2 tests per priority project).

- An additional test for every 10,000 square feet of lot area available for new or redevelopment.
- At least one test for any potential street facility.
- One test for every 100 lineal feet of infiltration facility.
- In general no more than five valid tests are required per development, unless more tests would be valuable or necessary (at the discretion of the qualified professional assessing the site, as well as the reviewing agency).

Where multiple types of facilities are used, it is likely that multiple tests will be necessary, since different facility types may infiltrate at different depths and an infiltration test can test only a single soil stratum. It is highly recommended to conduct an infiltration test at each stratum used. Additional testing may be required at the discretion of the local approval authority.

VII.3.3. Factors of Safety

Long term monitoring has shown that the performance of working full-scale infiltration facilities may be far lower than the rate measured by small-scale testing. There are several reasons for this:

1. Over time, the surface of infiltration facilities can become plugged as sedimentary particles accumulate at the infiltration surface.
2. Post-grading compaction of the site can destroy soil structure and seriously impact the facility's performance.
3. Testing procedures in general are subject to errors which can skew the results.

The method for determination of the factor of safety described in Section **VII.4** includes, among other factors, a consideration of the testing methods used to measure infiltration rate. The open pit falling head test (see Section **VII.3.4**) is considered the most reliable infiltration testing method if constructed to the recommended dimensions.

VII.3.4. Open Pit Falling Head Procedure

The open pit falling head procedure is performed in an open excavation and therefore is a test of the combination of vertical and lateral infiltration. The tester and excavator should conduct all testing in accordance with OSHA regulations regarding open pit excavations.

1. Excavate a hole with bottom dimensions of at least 2 feet by 4 feet into the native soil to the elevation 2 feet below the proposed facility bottom to account for amendment of soils under infiltration areas. If a smooth excavation bucket is used, scratch the sides and bottom of the hole with a sharp pointed instrument, and remove the loose material from the bottom of the test hole. The bottom of the hole should not be compacted and should be as level as possible.
2. Fill the hole with clean water a minimum of 1 foot above the soil to be tested, and maintain this depth of water for at least 4 hours (or overnight if clay soils are present) to

presoak the native material. In sandy soils with little or no clay or silt, soaking is not necessary. If after filling the hole twice with 12 inches of water, the water seeps completely away in less than 10 minutes, the test can proceed immediately.

3. Determine how the water level will be accurately measured. The measurements should be made with reference to a fixed point. A lath placed in the test pit prior to filling or a sturdy beam across the top of the pit are convenient reference points.
4. After the pre-saturation period, refill the hole with water to 12 inches above the soil and record the time. For deep holes, it may be necessary to use remote sensing equipment to accurately measure changes in water level. Alternative water head heights may be used for testing provided the presaturation height is adjusted accordingly and the water head height used in infiltration testing is 50 percent or less than the water head height in the proposed stormwater system during the design storm event. Measure the water level to the nearest 0.01 foot (⅛ inch) at 10-minute intervals for a total period of 1 hour (or 20-minute intervals for 2 hours in slower soils) or until all of the water has drained. In faster draining soils (sands and gravels), it may be necessary to shorten the measurement interval in order to obtain a well-defined infiltration rate curve. Constant head tests may be substituted for falling head tests at the discretion of the professional overseeing the infiltration testing.
5. Repeat the test. Successive trials should be run until the percent change in measured infiltration rate between two successive trials is minimal (<10 percent). The trial should be discounted if the infiltration rate between successive trials increases. At least three trials must be conducted. After each trial, the water level is readjusted to the 12 inch level. Record results.
6. The average infiltration rate over the last trial should be used to calculate the unadjusted (pre-factor of safety) infiltration rate. The final rate must be reported in inches per hour.
7. Upon completion of the testing, the excavation must be backfilled.
8. For very rapidly draining soils, it may not be possible to maintain a water head above the bottom of the test pit. If the infiltration rate meets or exceeds the flow of water into the test pit, conduct the test in the following manner:
    a) Approximate the area over which the water is infiltrating.
    b) Using a water meter, bucket, or other device, measure the rate of water discharging into the test pit.
    c) Calculate the infiltration rate by dividing the rate of discharge (cubic inches per hour) by the area over which it is infiltrating (square inches) and correcting to units of inches per hour.

VII.3.5. Single Ring Infiltrometer Test

Single ring infiltrometer tests using a large ring in diameter (40 inches or larger is optimal) have been shown to closely match full-scale facility performance (**Figure VII.1** to **Figure VII.3**). The cylindrical ring is driven approximately 12 inches into the soil. Water is ponded within the ring above the soil surface. The upper surface of the ring is often covered to prevent evaporation. Using the constant head method, the volumetric rate of water added to the ring sufficient to maintain a constant head within the ring is measured. The test is complete and the tested infiltration rate, I_t, is determined after the flow rate has stabilized (ASTM D5126).

To help maintain a constant head, a variety of devices may be used. A hook gage, steel tape or rule, length of steel, or plastic rod pointed on one end can be used for measuring and controlling the depth of liquid (head) in the infiltrometer ring. If available, a graduated Mariotte tube or automatic flow control system may also be used. Care should be taken when driving the ring into the ground as there can be a poor connection between the ring wall and the soil. This poor connection can cause a leakage of water along the ring wall and an overestimation of the infiltration rate.

The volume of liquid used during each measured time interval may be converted into an incremental infiltration velocity (infiltration rate) using the following equation:

$$I_t = V/(A*t)$$

where:

I_t = tested infiltration rate, in/hr
V = volume of liquid used during time interval to maintain constant head in the ring, in^3
A = internal area of ring, in^2
t = time interval, hr.

Figure VII.1. Photo of Single Ring Infiltrometer

Figure VII.2. Single Ring Infiltrometer Construction

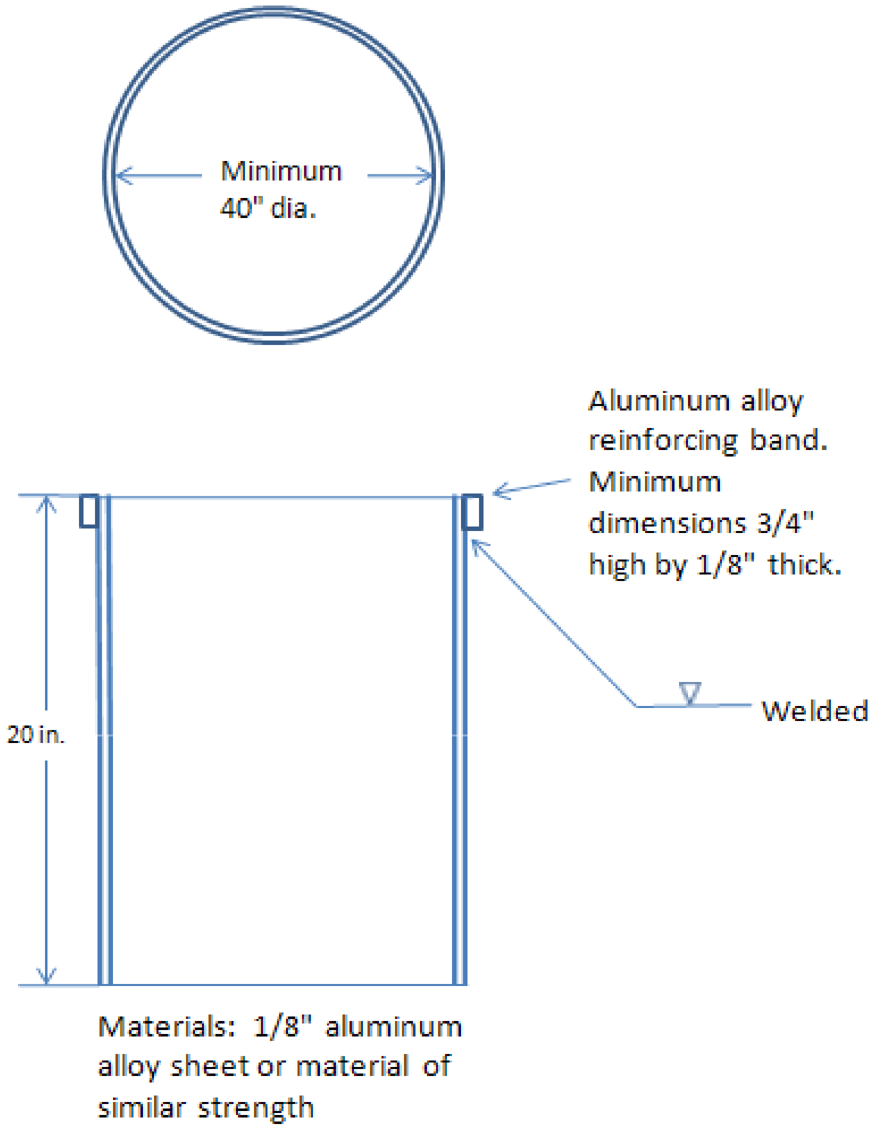


Figure VII.3. Single Ring Infiltrometer Setup with Mariotte Tube

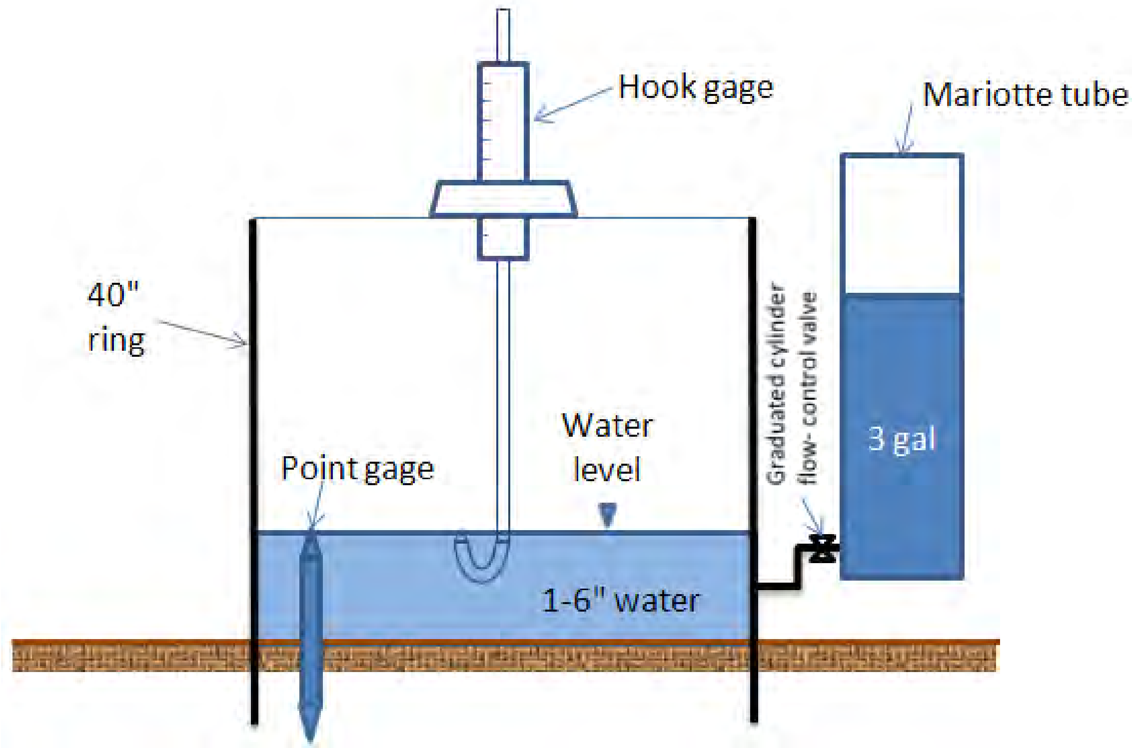


Figure VII.4. Sample Test Data Form for Single Ring Infiltrometer Test

SINGLE RING INFILTROMETER TEST DATA							
Project Name and Test Location:			Constants-	Ring Data		Liquid Containers	
				Ring Area, A_r (in^2)	Depth of Liquid (in)	Reservoir Container Volume, V_r (in^3/in)	
Test By:		USCS Class:		Penetration of Ring into Soil (in.):			
Liquid Used:		pH:		Ground Temp (°F):		at Depth:	
Date of Test:		Depth to Water Table:					
Liquid Level Maintained by using:	( ) Flow Valve ( ) Float Valve ( ) Marriotte Tube ( ) Other:						
Additional Comments:							

Time interval	Time (hr:min)	Dt (min) & Total	Flow Readings: Elev., H (In)	Flow Readings: ΔH (in) & Q_f* (in^3)	Liquid Temp (°F)	Infiltratn Rate, I**(in/hr)	Remarks
1 - Start							
End							
2 - Start							
End							
3 - Start							
End							
4 - Start							
End							
5 - Start							
End							
6 - Start							
End							
7 - Start							
End							
8 - Start							
End							
9 - Start							
End							
10 - Start							
End							
11 - Start							
End							
12 - Start							
End							
13 - Start							
End							
14 - Start							
End							
15 - Start							
End							

*Flow, $Q_f = \Delta H \times V_r$ **Infiltration Rate, $I = (Q_f/A_r)/$

VII.3.6. Double Ring Infiltrometer Test

The double ring infiltrometer test (ASTM D3385) is a well-recognized and documented technique for directly measuring the soil infiltration rate of a site (see **Figure VII.5** to **Figure VII.12**). Double ring infiltrometers were developed in response to the fact that smaller (less than 40 inch diameter) single ring infiltrometers tend to overestimate vertical infiltration rates. This has been attributed to the fact that the flow of water beneath the cylinder is not purely vertical and diverges laterally. Double ring infiltrometers minimize the error associated with the single-ring method because the water level in the outer ring forces vertical infiltration of water in the inner ring. Care should be taken when driving the rings into the ground as there can be a poor connection between the ring wall and the soil. This poor connection can cause a leakage of water along the ring wall and an overestimation of the infiltration rate. The double-ring infiltrometer test should be performed at an elevation 2 feet below the proposed elevation of the infiltration surface to account for the use of soil amendments below the infiltration system.

A typical double ring infiltrometer would consist of a 12 inch inner ring and a 24 inch outer ring. While there are two operational techniques used with the double-ring infiltrometer, the constant head method and the falling head method, ASTM D3385 mandates the use of the constant head method. With the constant head method, water is consistently added to both the outer and inner rings to maintain a constant level throughout the testing. The volume of water needed to maintain the fixed level of the inner ring is measured. To help maintain a constant head, a variety of devices may be used. A hook gage, steel tape or rule, or length of steel or plastic rod pointed on one end, can be used for measuring and controlling the depth of liquid (head) in the infiltrometer ring. If available, a graduated Mariotte tube or automatic flow control system may also be used.

The volume of liquid used during each measured time interval may be converted into an incremental infiltration velocity (infiltration rate) using the following equation:

$$I_t = V/(A*t)$$

where:

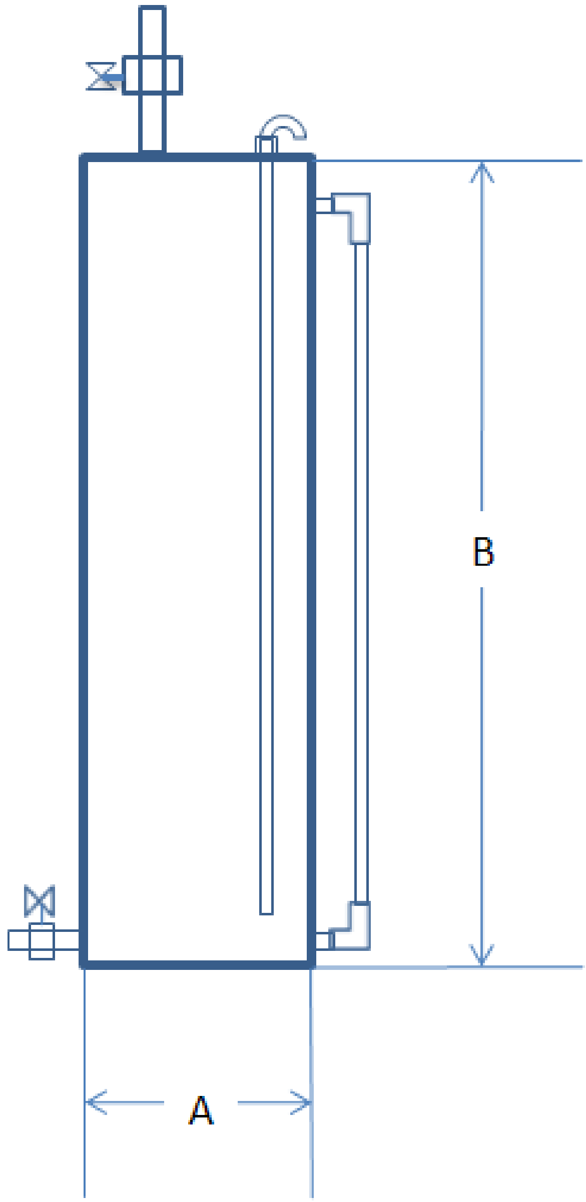
I_t = tested infiltration rate, in/hr
V = volume of liquid used during time interval to maintain constant head in the inner ring, in^3
A = area of inner ring, in^2
t = time interval, hr.

Figure VII.5. Photo of Simple Double Ring Infiltrometer

Figure VII.6. Photo of Pre-fabricated Double Ring Infiltrometer

(Photo courtesy of Turf-Tec International)

Figure VII.7. Mariotte Tube



Mariotte Tube
Useful Capacity

	1 gal	3 gal
A =	3 in.	6 in.
B =	18 in.	24 in.

Figure VII.8. Double Ring Infiltrometer Construction

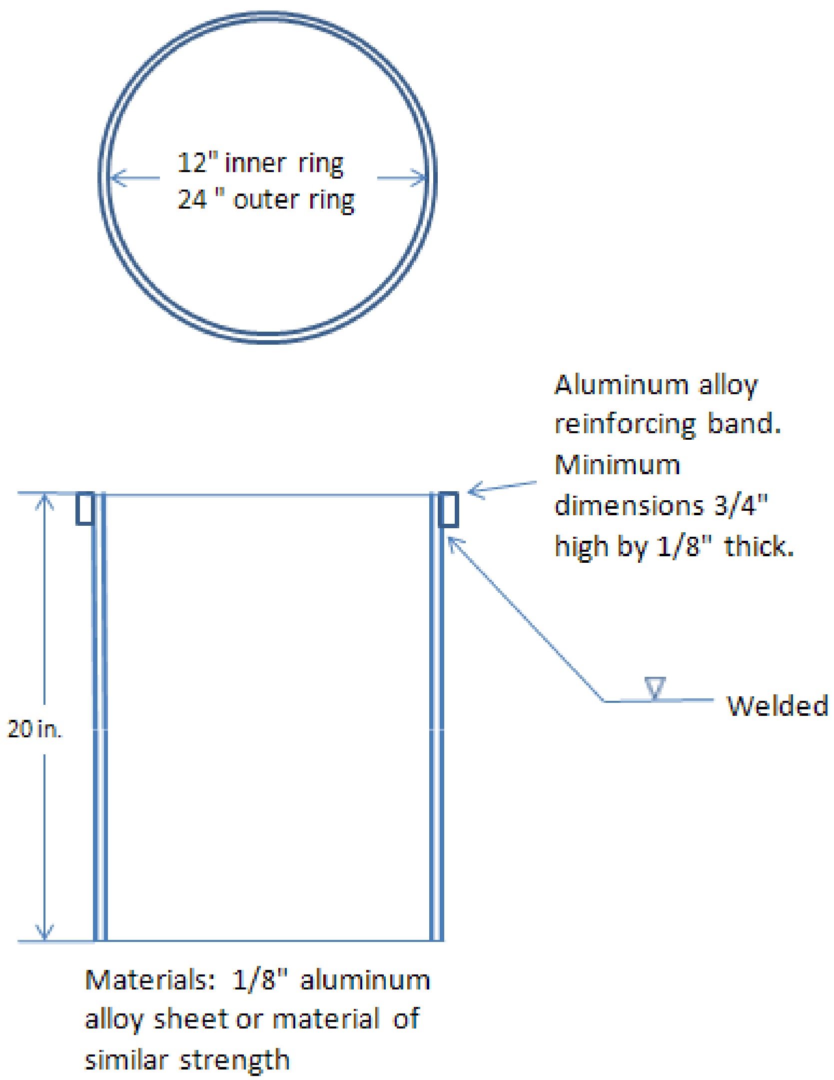


Figure VII.9. Double Ring Setup with Mariotte Tubes

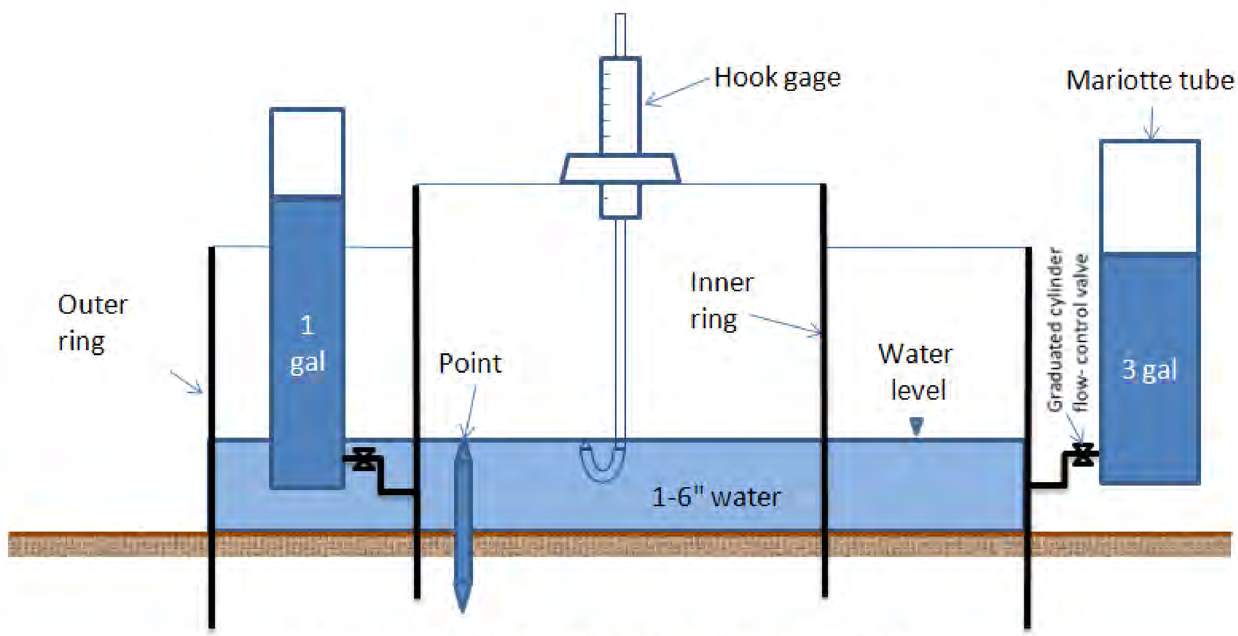


Figure VII.10. Double Ring Infiltrometer Set-up with Mariotte Tubes

(Photo courtesy of Turf-Tec International)

Figure VII.11. Double Ring Infiltrometer Set-up for Test at Basin Surface Elevation

(Photo courtesy of Turf-Tec International)

Figure VII.12. Sample Test Data Form for Double Ring Infiltrometer Test

DOUBLE RING INFILTROMETER TEST DATA

Project Name and Test Location:

Test By: USCS Class:

Water Table Depth: Penetration of Rings into Soil (in.): Inner: Outer:

Date of Test: Liquid Used: pH: Ground Temp (°F): at Depth:

Liquid Level Maintained by using: ( ) Flow Valve ( ) Float Valve ( ) Marriotte Tube ( ) Other:

Additional Comments:

Constants-	Ring Data		Liquid Containers	
	Area, A_r (in^2)	Depth of Liquid (in)	No.	Vol., V_r (in3/in)
Inner Ring:				
Annular Space:				

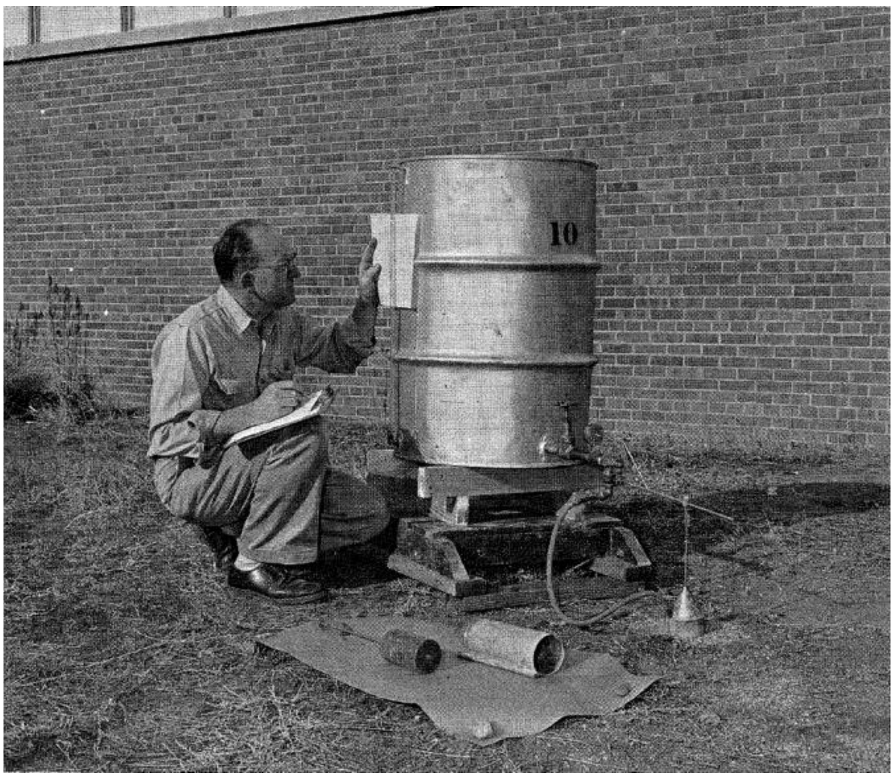
Time interval	Time (hr:min)	Dt (min) & Total	Inner Ring		Annular Ring		Liquid Temp °F	Infiltration Rate, I**		Remarks
			Elev., H (In)	ΔH (in) &	Elev., H (In)	ΔH (in) &		Inner in/hr	Outer in/hr	
1 - Start										
End										
2 - Start										
End										
3 - Start										
End										
4 - Start										
End										
5 - Start										
End										
6 - Start										
End										
7 - Start										
End										
8 - Start										
End										
9 - Start										
End										
10 - Start										
End										
11 - Start										
End										
12 - Start										
End										
13 - Start										
End										
14 - Start										
End										
15 - Start										
End										

*Flow, $Qf = \Delta H \times Vr$ **Infiltration Rate, $I = (Qf/Ar)/\Delta t$

VII.3.7. Well Permeameter Method (USBR Procedure 7300-89)

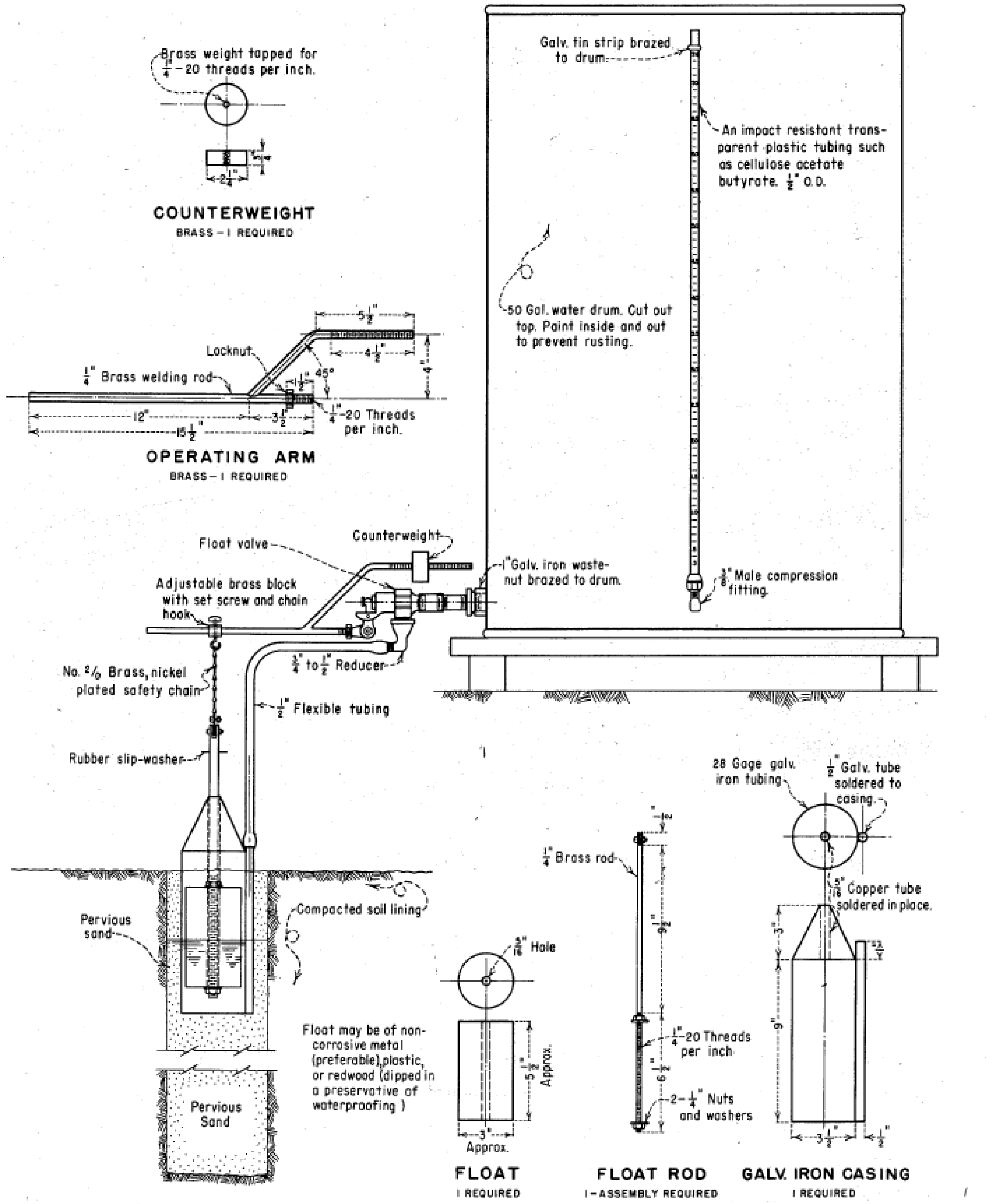
Similar to a constant-head version of the percolation test used for seepage pit design is the Well Permeameter Method of the United States Bureau of Reclamation (see **Figure VII.13** and **Figure VII.14**). [12]USBR 7300-89 is an in-hole hydraulic conductivity test performed by drilling test wells with a 6-8 inch diameter auger to the desired depth. This test measures the rate at which water flows into the soil under constant-head flow conditions and is used to determine field-saturated hydraulic conductivity. As with the percolation test, the rate determined with this test is a "percolation rate" and not an infiltration rate, but this procedure uses special equation(s) to establish an infiltration rate from the data produced. See USBR procedure 7300-89 for more details.

Figure VII.13. Typical Well Permeameter Test Installation



[12] A detailed description of this procedure along with a complete example using the associated equations can be found in the United States Bureau of Mines and Reclamation (USBR) document 7300-89.

Figure VII.14. Well Permeameter Test Equipment



VII.3.8. Percolation Test Procedure

The percolation test procedure below (per Riverside County Department of Environmental Health) should only be performed by those individuals trained and educated to perform, understand and evaluate the field conditions and tests. This would include those who hold one of the following State of California credentials and registrations: Professional Civil and Geotechnical Engineers, Certified Engineering Geologist and Certified Hydrogeologist.

The procedure for this test varies, depending on the depth of the hole to be used. Procedures for both scenarios (less than 10 feet or 10 - 40 feet deep) and diagrams (**Figure VII.15** to **Figure VII.17**) are included below. When the percolation testing has been completed, a 3 foot long surveyor's stake (lath) shall be flagged with highly visible banner tape and placed in the location of the test indicating date, test hole number as shown on the field data sheet, and firm performing the test.

VII.3.8.1. Shallow Percolation Test (less than 10 feet)

Test Preparation

1) The test hole opening shall be between 8 and 12 inches in diameter or between 7 and 11 inches on each side if square.

2) The bottom elevation of the test hole shall correspond to the bottom elevation of the proposed basin (infiltration surface). Keep in mind that this procedure will require the test hole to be filled with water to a depth of at least 5 times the hole's radius.

3) The bottom of the test hole shall be covered with 2 inches of gravel.

4) The sides of the hole shall remain undisturbed (not smeared) after drilling and any cobbles encountered left in place.

5) **Pre-soaking** shall be used with this procedure. Invert a full 5 gallon bottle (more if necessary) of clear water supported over the hole so that the water flow into the hole holds constant at a level at least 5 times the hole's radius above the gravel at the bottom of the hole. Testing may commence after all of the water has percolated through the test hole or after 15 hours has elapsed since initiating the pre-soak. However, to assure saturated conditions, testing must commence no later than 26 hours after all pre-soak water has percolated through the test hole. The use of the "continuous pre-soak procedure" is no longer accepted. When sandy soils (as described below) are present, the test shall be run immediately.

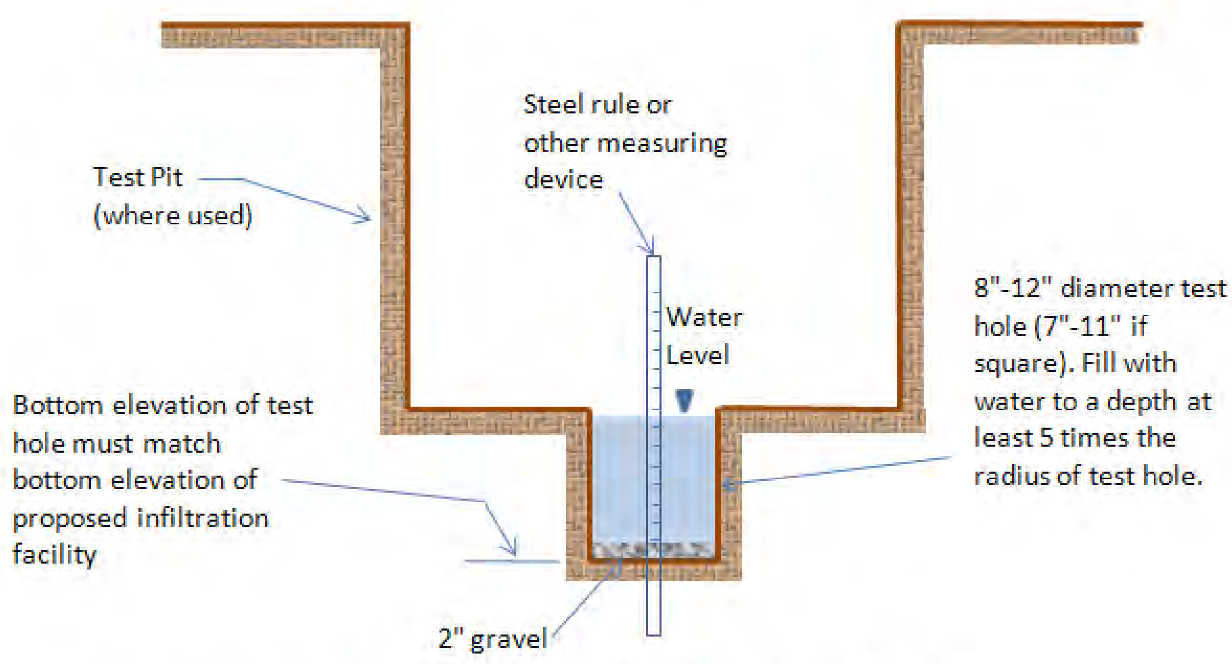
Test Procedure

Test hole shall be carefully filled with water to a depth equal to at least 5 times the hole's radius (H/r>5) above the gravel at the bottom of the test hole prior to each test interval.

- In **sandy soils**, when 2 consecutive measurements show that 6 inches of water seeps away in less than 25 minutes, the test shall be run for an additional hour with measurements taken every 10 minutes. Measurements shall be taken with a precision of 0.25 inches or better. The drop that occurs during the final 10 minutes is used to calculate the percolation rate. Field data must show the two 25 minute readings and the six 10 minute readings.

- In **non-sandy soils**, obtain at least twelve measurements per hole over at least six hours with a precision of 0.25 inches or better. From a fixed reference point, measure the drop in water level over a 30 minute period for at least 6 hours, refilling after every 30 minute reading. The total depth of the hole must be measured at every reading to verify that collapse of the borehole has not occurred. The drop that occurs during the final reading is used to calculate the percolation rate.

Figure VII.15. Test Pit for Shallow Percolation Test



VII.3.8.2. Deep Percolation Test (10 - 40 feet)

Test Preparation

1) Borehole diameter shall be either 6 inch or 8 inch only. No other diameter test holes will be accepted.

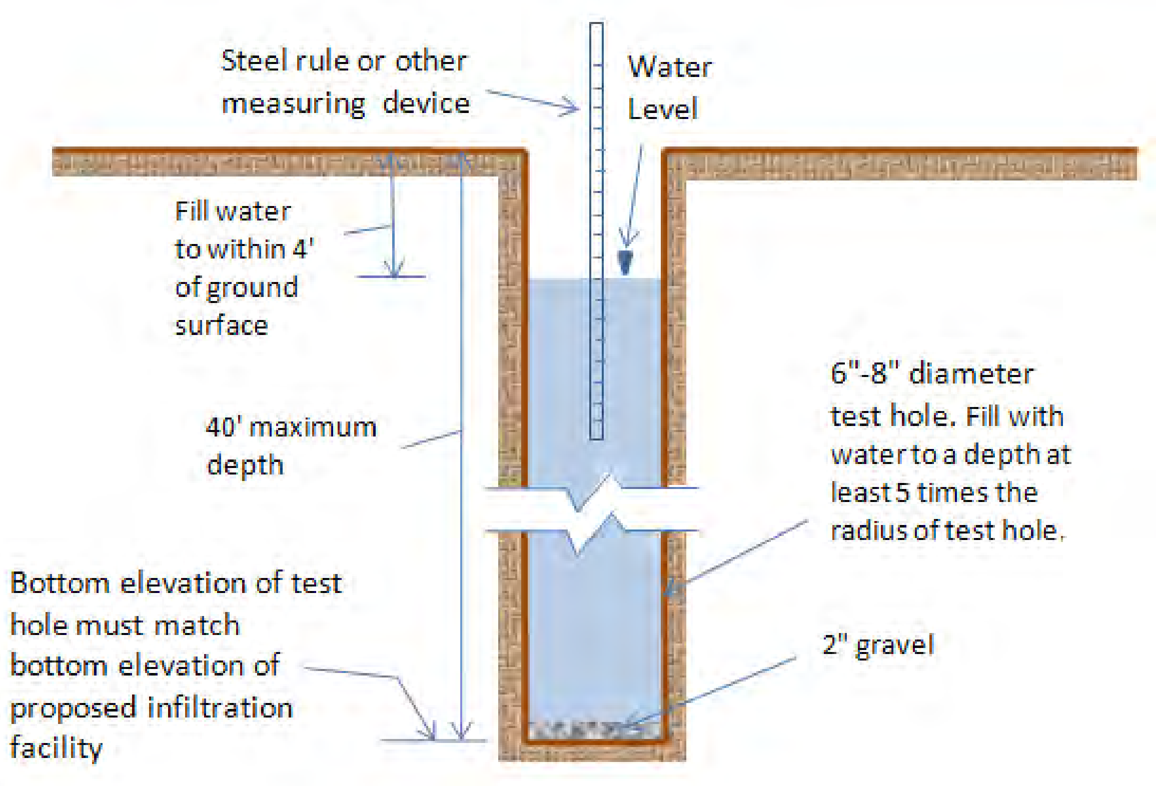
2) The bottom elevation of the test hole shall correspond to the bottom elevation of the proposed basin (infiltration surface). Keep in mind that this procedure will require the test hole to be filled with water to a depth of at least 5 times the hole's radius.

3) The bottom of the test hole shall be covered with 2 inches of gravel.

4) The sides of the hole shall remain undisturbed (not smeared) after drilling and any cobbles encountered left in place. Special care should be taken to avoid cave-in.

5) **Pre-soaking** shall be used with this procedure. Invert a full 5 gallon bottle of clear water supported over the hole so that the water flow into the hole holds constant at a maximum depth of 4 feet below the surface of the ground or if grading cuts are anticipated, to the approximate elevation of the **top** of the basin but at least 5 times the hole's radius ($H/r > 5$). Pre-soaking shall be performed for 24 hours unless the site consists of sandy soils containing little or no clay. If sandy soils exist as described below, the tests may then be run after a 2 hour pre-soak. However, to assure saturated conditions, testing must commence no later than 26 hours after all pre-soak water has percolated through the test hole. The "continuous pre-soak procedure" is not accepted. When sandy soils (as described below) are present, the test shall be run immediately.

Figure VII.16. Test Pit for Deep Percolation Test



Test Procedure

Carefully fill the hole with clear water to a maximum depth of 4 feet below the surface of the ground or, if grading cuts are anticipated, to the approximate elevation of the **top** of the basin. However, at a minimum, the bore hole shall be filled with water to a depth equal to 5 times the hole's radius (H/r>5).

In **sandy soils**, when 2 consecutive measurements show that 6 inches of water seeps away in less than 25 minutes, the test shall be run for an additional hour with measurements taken every 10 minutes. Measurements shall be taken with a precision of 0.25 inches or better. The drop that occurs during the final 10 minutes is used to calculate the percolation rate. Field data must show the two 25 minute readings and the six 10 minute readings.

In **non-sandy soils**, the percolation rate measurement shall be made on the day following initiation of the pre-soak as described in Item #5 above. From a fixed reference point, measure the drop in water level over a 30 minute period for at least 6 hours, refilling after every 30 minute reading. Measurements shall be taken with a precision of 0.25 inches or better. The total depth of hole must be measured at every reading to verify that collapse of the borehole has not occurred. The drop that occurs during the final reading is used to calculate the percolation rate.

Figure VII.17. Photo of Percolation Test Pit.

(Use of perforated PVC pipe is a variation.)

Figure VII.18. Sample Test Data Form for Percolation Test

Percolation Test Data Sheet

Project:			Project No:			Date:	
Test Hole No:			Tested By:				
Depth of Test Hole, D_T:			USCS Soil Classification:				
Test Hole Dimensions (inches)					Length	Width	
Diameter (if round)=			Sides (if rectangular)=				

Sandy Soil Criteria Test*

Trial No.	Start Time	Stop Time	Time Interval, (min.)	Initial Depth to Water (in.)	Final Depth to Water (in.)	Change in Water Level (in.)	Greater than or Equal to 6"? (y/n)
1							
2							

*If two consecutive measurements show that six inches of water seeps away in less than 25 minutes, the test shall be run for an additional hour with measurements taken every 10 minutes. Other wise, pre-soak (fill) overnight. Obtain at least twelve measurements per hole over at least six hours (approximately 30 minute intervals) with a precision of at least 0.25".

Trial No.	Start Time	Stop Time	Δt Time Interval (min.)	D_o Initial Depth to Water (in.)	D_f Final Depth to Water (in.)	ΔD Change in Water Level (in.)	Percolation Rate (min./in.)
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							

COMMENTS:

Example VII.1: Percolation Rate Conversion Example

(Porchet Method, aka Inverse Borehole Method):

The bottom of a proposed infiltration basin would be at 5.0 feet below natural grade. Percolation tests are performed within the boundaries of the proposed basin location with the depth of the test hole set at the infiltration surface level (bottom of the basin). The Percolation Test Data Sheet (Table 5) is prepared as the test is being performed. After the minimum required number of testing intervals, the test is complete. The data collected at the final interval is as follows:

Time interval, Δt = 10 minutes
Initial Depth to Water, D_0 = 12.25 inches
Final Depth to Water, D_f = 13.75 inches
Total Depth of Test Hole, D_T = 60 inches
[13]Test Hole Radius, r = 4 inches

The conversion equation is used:

$$I_t = \frac{\Delta H(60r)}{\Delta t(r + 2H_{avg})}$$

"H_o" is the initial height of water at the selected time interval.

$H_o = D_T - D_0 = 60 – 12.25 = 47.75$ inches

"H_f" is the final height of water at the selected time interval.

$H_f = D_T - D_0 = 60 - 13.75 = 46.25$ inches

"ΔH" is the change in height over the time interval.

$\Delta H = \Delta D = H_o - H_f = 47.75 – 46.25 = 1.5$ inches

"H_{avg}" is the average head height over the time interval.

$H_{avg} = (H_o - H_f)/2 = (47.75 – 46.25)/2 = 47.0$ inches

"I_t" is the tested infiltration rate.

$$I_t = \frac{\Delta H(60r)}{\Delta t(r + 2H_{avg})} = \frac{(1.5\ in)(\frac{60\ min}{hr})(4\ in)}{(10\ \text{min})((4\ in) + 2(47\ in))} = 0.37\ in/hr$$

[13] Where a rectangular test hole is used, an equivalent radius should be determined based on the actual area of the rectangular test hole (i.e., $r = (A/\pi)^{0.5}$).

VII.4. Considerations for Infiltration Rate Factor of Safety

Given the known potential for infiltration BMPs to fail over time, an appropriate factor of safety applied to infiltration testing results must be mandatory. The infiltration rate will decline between maintenance cycles as the BMP surface becomes occluded and particulates accumulate in the infiltrative layer. Monitoring of actual facility performance has shown that the full-scale infiltration rate is far lower than the rate measured by small-scale testing. It is important that adequate conservatism is incorporated in the selection of design infiltration rates. The design infiltration rate discussed here is the infiltration rate of the underlying soil, below the elevation to which soil amendments would not be provided.

The factor of safety that should be applied to measured infiltration rates is a function of:

- Suitability of underlying soils for infiltration
- The infiltration system design.

These factors are discussed in the following sections.

The *measured infiltration rate* calculated for the purpose of infiltration infeasibility screening (**TGD Section 2.4.2.4**) shall be based on a factor of safety of 2.0 applied to the rates obtained from the infiltration test results. No adjustments from this value are permitted. The factor of safety used to compute the *design infiltration rate* shall not be less than 2.0, but may be higher at the discretion of the design engineer and acceptance of the plan reviewer, per the considerations described in the following sections.

It is recognized that there are competing objectives in the selection of a factor of safety. There is an initial economic incentive to select a lower factor of safety to yield smaller BMP designs. A low factor of safety also allows a broader range of systems to be considered "feasible" in marginal conditions. However, there are both economic and environmental incentives for the use of an appropriate factor of safety to prevent premature failure and substandard performance. The use of an artificially low factor of safety to demonstrate feasibility in the design process is shortsighted in that it does not consider the long term feasibility of the system.

The best way to balance these competing factors is through a commitment to thorough site investigation, use of effective pretreatment controls, good construction practices, the commitment to restore the infiltration rates of soils that are damaged by prior uses or construction practices, and the commitment to effective maintenance practices. However, these commitments do not mitigate the need to apply a factor of safety to account for uncertainty and long term deterioration that cannot be technically mitigated. Therefore, a factor of safety of no less than 2.0 shall be used to compute the design infiltration rate.

VII.4.1. Site Suitability Considerations

Suitability assessment related considerations include (**Table VII.3**):

- Soil assessment methods – the site assessment extent (e.g., number of borings, test pits, etc.) and the measurement method used to estimate the short-term infiltration rate.
- Predominant soil texture/percent fines – soil texture and the percent of fines can greatly influence the potential for clogging.
- Site soil variability – site with spatially heterogeneous soils (vertically or horizontally) as determined from site investigations are more difficult to estimate average properties for resulting in a higher level of uncertainty associated with initial estimates.
- Depth to seasonal high groundwater/impervious layer – groundwater mounding may become an issue during excessively wet conditions where shallow aquifers or shallow clay lenses are present.

Table VII.3: Suitability Assessment Related Considerations for Infiltration Facility Safety Factors

Consideration	High Concern	Medium Concern	Low Concern
Assessment methods (see explanation below)	Use of soil survey maps or simple texture analysis to estimate short-term infiltration rates	Direct measurement of ≥ 20 percent of infiltration area with localized infiltration measurement methods (e.g., infiltrometer)	Direct measurement of ≥ 50 percent of infiltration area with localized infiltration measurement methods or Use of extensive test pit infiltration measurement methods
Texture Class	Silty and clayey soils with significant fines	Loamy soils	Granular to slightly loamy soils
Site soil variability	Highly variable soils indicated from site assessment or limited soil borings collected during site assessment	Soil borings/test pits indicate moderately homogeneous soils	Multiple soil borings/test pits indicate relatively homogeneous soils
Depth to groundwater/ impervious layer	<5 ft below facility bottom	5-10 ft below facility bottom	>10 below facility bottom

Localized infiltration testing refers to methods such as the double ring infiltrometer test (ASTM D3385-88) which measure infiltration rates over an area less than 10 sq-ft, may include lateral flow, and do not attempt to account for heterogeneity of soil. The amount of area each test represents should be estimated depending on the observed heterogeneity of the soil.

Extensive infiltration testing refers to methods that include excavating a significant portion of the proposed infiltration area, filling the excavation with water, and monitoring drawdown. The excavation should be to the depth of the proposed infiltration surface and ideally be at least 50 to 100 square feet.

In all cases, testing should be conducted in the area of the proposed BMP where, based on review of available geotechnical data, soils appear least likely to support infiltration.

VII.4.2. Design Related Considerations

Design related considerations include (**Table VII.4**):

- Size of area tributary to facility – all things being equal, risk factors related to infiltration facilities increase with an increase in the tributary area served. Therefore facilities serving larger tributary areas should use more restrictive adjustment factors.
- Level of pretreatment/expected influent sediment loads – credit should be given for good pretreatment by allowing less restrictive factors to account for the reduced probability of clogging from high sediment loading. Also, facilities designed to capture runoff from relatively clean surfaces such as rooftops are likely to see low sediment loads and therefore should be allowed to apply less restrictive safety factors.
- Redundancy – facilities that consist of multiple subsystems operating in parallel such that parts of the system remains functional when other parts fail and/or bypass should be rewarded for the built-in redundancy with less restrictive correction and safety factors. For example, if bypass flows would be at least partially treated in another BMP, the risk of discharging untreated runoff in the event of clogging the primary facility is reduced. A bioretention facility that overflows to a landscaped area is another example.
- Compaction during construction – proper construction oversight is needed during construction to ensure that the bottoms of infiltration facility are not overly compacted. Facilities that do not commit to proper construction practices and oversight should have to use more restrictive correction and safety factors.

Table VII.4: Design Related Considerations for Infiltration Facility Safety Factors

Consideration	High Concern	Medium Concern	Low Concern
Tributary area size	Greater than 10 acres.	Greater than 2 acres but less than 10 acres.	2 acres or less.
Level of pretreatment/ expected influent sediment loads	Pretreatment from gross solids removal devices only, such as hydrodynamic separators, racks and screens AND tributary area includes landscaped areas, steep slopes, high traffic areas, or any other areas expected to produce high sediment, trash, or debris loads.	Good pretreatment with BMPs that mitigate coarse sediments such as vegetated swales AND influent sediment loads from the tributary area are expected to be relatively low (e.g., low traffic, mild slopes, disconnected impervious areas, etc.).	Excellent pretreatment with BMPs that mitigate fine sediments such as bioretention or media filtration OR sedimentation or facility only treats runoff from relatively clean surfaces, such as rooftops.
Redundancy of treatment	No redundancy in BMP treatment train.	Medium redundancy, other BMPs available in treatment train to maintain at least 50% of function of facility in event of failure.	High redundancy, multiple components capable of operating independently and in parallel, maintaining at least 90% of facility functionality in event of failure.
Compaction during construction	Construction of facility on a compacted site or elevated probability of unintended/ indirect compaction.	Medium probability of unintended/ indirect compaction.	Heavy equipment actively prohibited from infiltration areas during construction and low probability of unintended/ indirect compaction.

VII.4.3. Determining Factor of Safety

A factor of safety shall be used. To assist in selecting the appropriate design infiltration rate, the measured short term infiltration rate should be adjusted using a weighted average of several safety factors using the worksheet shown in **Worksheet H** below. The design infiltration rate would be determined as follows:

1. For each consideration shown in **Table VII.3** and **Table VII.4** above, determine whether the consideration is a high, medium, or low concern.
2. For all high concerns, assign a factor value of 3, for medium concerns, assign a factor value of 2, and for low concerns assign a factor value of 1.
3. Multiply each of the factors by the corresponding weight to get a product.
4. Sum the products within each factor category to obtain a safety factor for each.
5. Multiply the two safety factors together to get the final combined safety factor. If the combined safety factor is less than 2, then 2 shall be used as the safety factor.
6. Divide the measured short term infiltration rate by the combined safety factor to obtain the adjusted design infiltration rate for use in sizing the infiltration facility.

The design infiltration rate shall be used to size BMPs and to evaluate their expected long term performance. This rate shall not be less than 2, but may be higher at the discretion of the design engineer.

Worksheet H: Factor of Safety and Design Infiltration Rate and Worksheet

Factor Category		Factor Description	Assigned Weight (w)	Factor Value (v)	Product (p) $p = w \times v$
A	Suitability Assessment	Soil assessment methods	0.25		
		Predominant soil texture	0.25		
		Site soil variability	0.25		
		Depth to groundwater / impervious layer	0.25		
		Suitability Assessment Safety Factor, $S_A = \Sigma p$			
B	Design	Tributary area size	0.25		
		Level of pretreatment/ expected sediment loads	0.25		
		Redundancy	0.25		
		Compaction during construction	0.25		
		Design Safety Factor, $S_B = \Sigma p$			
Combined Safety Factor, $S_{TOT} = S_A \times S_B$					
Measured Infiltration Rate, inch/hr, K_M (corrected for test-specific bias)					
Design Infiltration Rate, in/hr, $K_{DESIGN} = S_{TOT} \times K_M$					
Supporting Data					
Briefly describe infiltration test and provide reference to test forms:					

Note: The minimum combined adjustment factor shall not be less than 2.0 and the maximum combined adjustment factor shall not exceed 9.0.

VII.5. References

ASTM D 3385-94, 2003. “Standard Test Method for Infiltration Rate of Soils Field Using Double-Ring Infiltrometer.” American Society for Testing Materials, Conshohocken, PA. 10 Jun, 2003.

Caltrans, 2003. “Infiltration Basin Site Selection”. Study Volume I. California Department of Transportation. Report No. CTSW-RT-03-025.

City of Portland, 2010. *Appendix F.2: Infiltration Testing.* Portland Stormwater Management Manual, Revised February 1, 2010.

United States Department of the Interior, Bureau of Reclamation (USBR), 1990a, "Procedure for Performing Field Permeability Testing by the Well Permeameter Method (USBR 7300-89)," in Earth Manual, Part 2, A Water Resources Technical Publication, 3rd ed., Bureau of Reclamation, Denver, Colo.

Appendix E – Section XII – Conceptual Biotreatment Selection, Design, and Maintenance Criteria Orange County TGD Appendices, May 19, 2011

APPENDIX XII. CONCEPTUAL BIOTREATMENT SELECTION, DESIGN, AND MAINTENANCE CRITERIA

The purpose of this Appendix is to provide conceptual-level guidance for selection, design, and maintenance of biotreatment BMPs. This Appendix is intended to be used as a concise reference for the biotreatment BMP design philosophy.

This Appendix is not intended to provide BMP-specific guidance or design-level specifications. BMP-specific guidance for the recognized suite of available biotreatment BMPs is provided in BMP Fact Sheets in **Appendix XIV**.

This Appendix is not intended to be use for specific criteria. Detailed and prescriptive guidance for sizing and designing biotreatment to achieve the maximum feasible infiltration and ET is provided in **Appendix XI**.

XII.1. Definition of Biotreatment BMPs

Biotreatment BMPs are a broad class of structural LID BMPs that treat stormwater using a suite of treatment mechanisms characteristic of biologically active systems. The design of biotreatment BMPs should strive to achieve the following goals, as applicable:

- Foremost, the BMP should be designed to provide the highest possible pollutant removal, with emphasis on removal of pollutants of concern.
- The BMP should be aesthetically pleasing.
- The BMP should provide multiple benefits such as aesthetic enjoyment, wildlife habitat, open space, and/or support recreational use (i.e. be an element of a trail system);
- The BMP should include educational signage for visitors if appropriate; that
- Ancillary elements (fencing, gates, and access roads) should serve to mitigate risks (i.e. drowning, vandalism) and minimize costs of maintenance.

Biotreatment BMPs provide a variety of treatment mechanisms to remove both suspended and dissolved pollutants in urban storm water runoff. All biotreatment BMPs include treatment mechanisms that employ soil microbes and plants. Biotreatment BMPs may be either flow-based (limited storage) or volume-based (storage a key design component) and are designed to treat and discharge urban stormwater runoff to a downstream conveyance system. Biotreatment BMPs can be designed to promote infiltration and ET even though they are treat-and-release BMPs. Systems not designed primarily to infiltrate or evapotranspire stormwater may still reduce the volume of stormwater via infiltration and ET. If necessary to mitigate risks to structures, human health, or other concerns, a biotreatment BMP may also be lined to prevent infiltration of urban storm water runoff into the underlying soils.

Operations and maintenance of biotreatment BMPs should emphasize preservation of hydraulic function and the promotion of robust biological processes. Biotreatment BMPs typically utilize "soft" infrastructure (e.g., vegetative slope stabilization as opposed to rip rap slope stabilization) and therefore require an adaptive approach to maintenance and performance enhancement, more typical of landscape maintenance than maintenance of hard infrastructure.

Note that while biotreatment BMPs may provide habitat value, plant growth may damage infrastructure elements in the facility such as fencing, curbs, etc. This hazard can be mitigated by incorporating root barriers or through regular maintenance.

The following sections provide principles that should govern the design, operation, and maintenance of biotreatment BMPs installed to meet permit requirements in Orange County.

XII.2. Biotreatment Selection to Address Pollutants of Concern

Biotreatment BMPs shall be selected that provide unit operations and processes (UOPs) that address the project pollutants of concern. The process of biotreatment BMP selection shall consist of the steps described in **TGD Section 2.4.2.5**.

XII.3. Conceptual Biotreatment Design Requirements

Biotreatment design requirements shall be consistent with the following principles:

- **Biotreatment BMPs shall be sized according to permit requirements described in the** Section 2.4 of the **Model WQMP.**
- **Biotreatment BMPs shall incorporate unit processes to address pollutants of concern. See TGD Section 2.4.2.5 for guidance.**
- **Biotreatment BMPs shall be designed to achieve the maximum feasible infiltration and ET by adhering to the criteria described in Appendix XI.**
- **Biotreatment BMPs shall be designed per the published design standards contained in the BMP Fact Sheets (Appendix XIV.5) and the design manuals referenced by these Fact Sheets.**
- **Biotreatment BMPs shall support a robust vegetative and microbial community appropriate to the local climate:**
  - For bioretention systems[18], select vegetation that is drought tolerant and can also survive extended periods of saturated soils.

[18] The use of the term "bioretention systems" in this appendix refers to bioretention with underdrains, rain gardens with underdrains, planter boxes with underdrains, curb-extension planter boxes with underdrains, proprietary bioretention systems, and other similar BMPs.

  - For constructed stormwater wetlands and wet detention basins (wet ponds), select native species that include significant rhizomes and provide habitat benefits.
  - For constructed stormwater wetlands and wet detention basins (wet ponds) provide appropriate mix of open water to vegetated area. The appropriate mix depends on the primary target constituents. For example, where nitrate is the dominant nutrient, the appropriate mix would include a higher proportion of vegetated area such as 80% vegetated, 20% open water.
  - For dry extended vegetated detention basins, vegetated swales, and filter strips, select a variety of plant species that are drought tolerant, but can also survive periodic inundation.
  - Provide an irrigation system, if necessary, for plant establishment and maintenance.
- **Biotreatment BMPs shall incorporate amended media and soils designed for the intended function of the BMP.**
  - Select amended media for use in bioretention systems that is effective at removing pollutants of concern, can absorb and evapotranspirate runoff, and where appropriate, can facilitate infiltration.
  - Select media and soils that will not potentially leach pollutants, specifically dissolved nutrients and metals in some cases.
  - Amend soils in dry extended detention basins, swales, and filter strips to provide suitable soils for supporting plants, which can absorb and evapotranspire runoff and where appropriate facilitate infiltration.
  - Design wet detention basins (wet ponds) and constructed stormwater wetlands using soils that support growth of attached plants.
- **BMPs hydraulics shall be designed to maximize pollutant removal functions.**
  - For all biotreatment BMPs, design inlets or overland flow entry to BMPs to prevent scour or re-entrainment of pollutants.
  - Provide maximum flow path distance between outlet and inlet and with sufficient length to width ratio to limit short circuiting.
  - For constructed stormwater wetlands and wet detention basins, provide the storage capacity for the DCV in the wet pool at a minimum.
  - Seasonal constructed stormwater wetlands and seasonal wet detention basins should not be used unless there is a reasonable expectation that tributary land uses will provide dry weather flows during seasonally wet period to maintain vegetation and prevent stagnant water.
  - For constructed stormwater wetlands and wet detention basins designed to be continually wet (opportunities may be limited in Orange County), ensure that a low-flow source of water is present to maintain vegetation and prevent stagnant conditions.
  - Design features shall allow for monitoring of drawdown such as depth markers and monitoring ports.

- For bioretention systems, provide media contact time sufficient for pollutant removal, with upper limitations on contact time to avoid leaching of retained pollutants. Traditional media should generally be designed in the range of 2 to 12 inches per hour, while specialized media can be effective for many pollutants of concern at much higher flowrates (residence times on the order of several minutes). For bioretention systems, design media mix and layer separation systems (i.e. between media and gravel layers) to reduce potential for clogging.
- For bioretention systems that include infiltration as a component, design a gravel pool below the underdrains (where used; ensure that the soils below this area can infiltrate (i.e., do not compact, or if compacted, restore soil infiltration capacity)). The minimum depth of gravel pool should be determined based on the underlying infiltration based on the amount of water that will infiltrate in 48 hours (see **Appendix XI.2**)
- For bioretention systems that will include infiltration as a component, the soil below the gravel pool must be able to allow infiltration. The soil may not be compacted. If the soil is compacted, the soil infiltration capacity must be restored.
- Consider using hydraulic control on the outlet of bioretention systems whenever practical rather than using media with lower infiltration rates for hydraulic control. This practice aids in avoiding clogging and can improve uniformity of performance over the life of the facility.
- For bioretention systems, do not use geotextile fabrics between layers of media due to clogging issues; use progressively-graded aggregate layers to prevent migration of fines if necessary.
- For bioretention systems limit ponding depths to 12 inches, unless system is isolated from public access via fencing or equivalent, then ponding depths should be limited to 18 inches.
- Bioretention systems and dry extended detention basins shall be designed to limit surface ponding to less than 96 hours for vector control per **California Department of Health Guidelines**. To provide a margin of safety, bioretention systems and extended detention basins should be designed to limit surface ponding to 72 hours. Subsurface ponding (in stone or gravel trenches) can create a vector hazard if the media has pore spaces that vectors can breed in.
- For biotreatment BMPs that employ extended detention, design outlet structures to ensure appropriate drawdown times and patterns and prevent floatables from leaving the facility; ensure that small storms receive appropriate extended detention times. A common rule of thumb is that the bottom half of the facility volume should draw down in two thirds of the total drawdown time.
- Outlet structures should be located and designed so that they are accessible for inspection and maintenance.
- For vegetated swales and filter strips, provide level spreaders and check dams where appropriate to promote even distribution of flow across the system.

  - Design systems such that flows above the BMP design intensity are provided a flow route that bypasses the BMP or can be passed through the BMP without entraining soils, media, or captured pollutants.
- **Biotreatment BMPs shall be subject to rigorous construction oversight, acceptance, and documentation process.**
  - Provide construction oversight by trained professionals to ensure that the BMP is installed as designed.
  - Consider conducting a flow test for bioretention systems to ensure they function at the design level.
  - Require the preparation of as-built drawings that clearly indicated design features of the BMP and inlet and outlet systems.
  - Inspect BMPs after initial commissioning to ensure that they are functioning as intended. More frequent inspection during initial operation periods (i.e., first rainy season) can help to mitigate early problems and ensure design level performance.

XII.4. Conceptual Biotreatment Operation Requirements

An operation and maintenance plan shall be developed for biotreatment BMPs that includes the following elements:

- **Frequency and type of inspections,**
- **Observations during wet weather to visually observe whether the BMP is functioning as intended,**
- **List of parameters/checklists for identifying maintenance needs and triggering maintenance activities,**
- **Vegetation management plan, including routine maintenance, and irrigation, if necessary,**
- **Sediment, trash and debris removal, and**
- **Routine and major (infrequent) maintenance activities.**

Reclaimed water considerations for operation of biotreatment BMPs:

If the project utilizes reclaimed water for irrigation, the project is required to comply with all waste discharge requirements and water provider use requirements applicable to the project. It is the responsibility of the project owner to ensure that operation of the project complies with these requirements. It is the responsibility of the water provider to ensure that requirements associated with the use of reclaimed water result in BMP operations that are protective of receiving water quality.

XII.5. Conceptual Biotreatment Maintenance Requirements

Biotreatment maintenance requirements contained in the Project O&M Plan shall be consistent with the following principles:

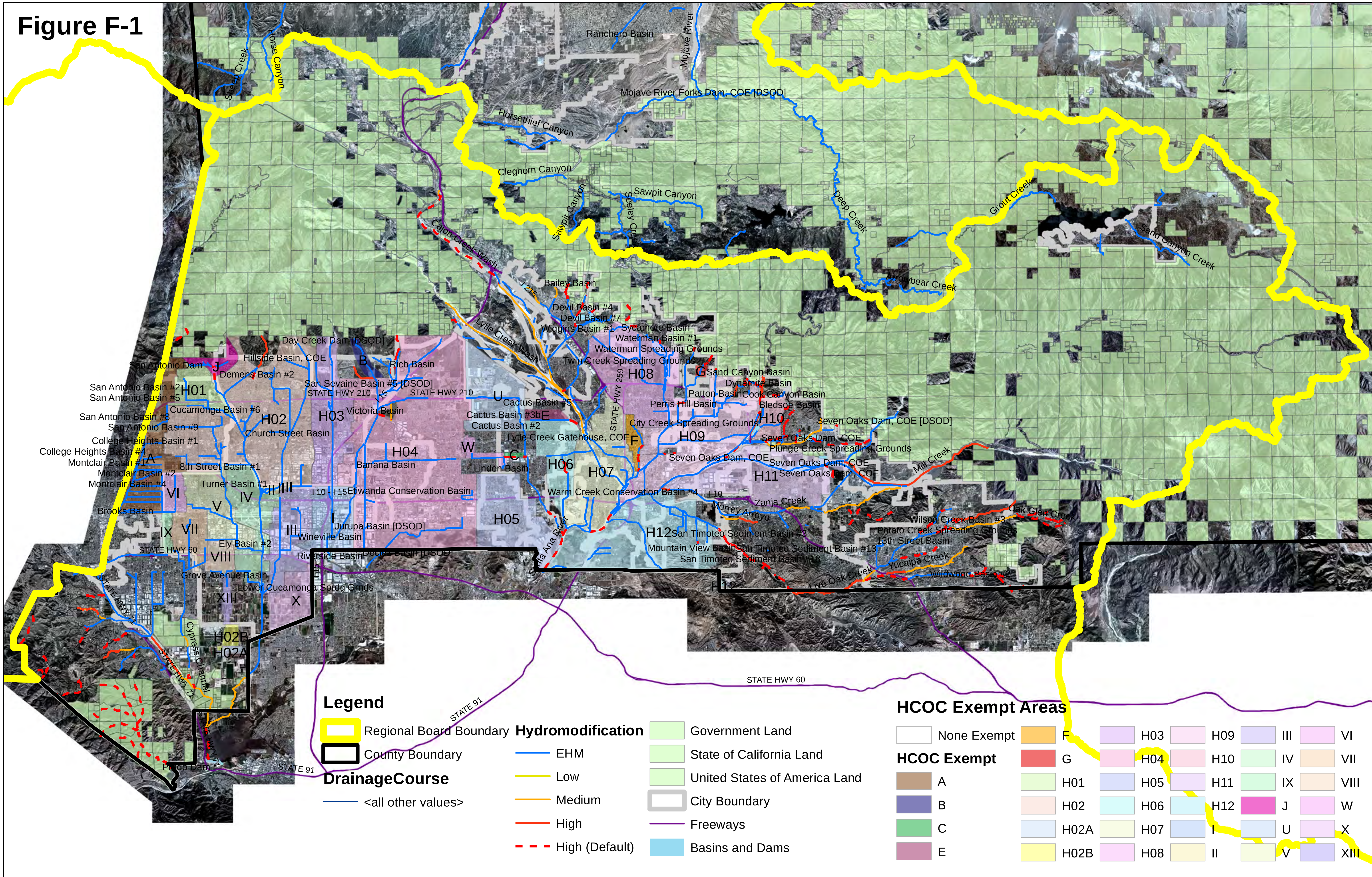
- **Routine maintenance shall be provided to ensure consistently high performance and extend facility life.**
    - Maintain vegetation and media to perpetuate a robust vegetative and microbial community (thin/trim vegetation, replace spent media and mulch).
    - Periodically remove dead vegetative biomass to prevent export of nutrients or clogging of the system.
    - Remove accumulated sediment before it significantly interferes with system function.
    - Where filtration/infiltration is employed, conduct maintenance to prevent surface clogging (surface scarring, raking, mulch replacement, etc.).
    - Add energy dissipation and scour-protection as required based on facility inspection.
    - Routinely remove accumulated sediment at the inlet and outlet and trash and debris from the entire BMP.
- **Major maintenance shall be provided when the performance of the facility declines significantly and cannot be restored through routine maintenance.**
    - Replace media / planting soils as triggered by reduction in filtration/infiltration rates or decline in health of biological processes.
    - Provide major sediment removal to restore volumetric capacity of basin-type BMPs.
    - Repair or modify inlets/outlets to restore original function or enhance function based on observations of performance.

Detailed descriptions of BMP maintenance activities are provided in:

- Los Angeles County Stormwater BMP Operations and Maintenance Manual, Chapter 5: http://dpw.lacounty.gov/DES/design_manuals/StormwaterBMPDesignandMaintenance.pdf

Appendix F – HCOC Exemption Criteria and Map

Figure F-1


Legend
Regional Board Boundary
County Boundary
DrainageCourse
<all other values>
Hydromodification
EHM
Low
Medium
High
High (Default)
Government Land
State of California Land
United States of America Land
City Boundary
Freeways
Basins and Dams
HCOC Exempt Areas
None Exempt
HCOC Exempt
A
B
C
E
F
G
H01
H02
H02A
H02B
H03
H04
H05
H06
H07
H08
H09
H10
H11
H12
I
II
III
IV
IX
J
U
V
VI
VII
VIII
W
X
XIII
Ranchero Basin
Mojave River
Horse Canyon
Sheep Creek
Mojave River Forks Dam, COE [DSOD]
Horsethief Canyon
Cleghorn Canyon
Sawpit Canyon
Seeley Creek
Deep Creek
Grout Creek
Sand Canyon Creek
Bear Creek
Cajon Creek Wash
Lytle Creek Wash
Bailey Basin
Devil Basin #4
Devil Basin #7
Wiggins Basin #1
Sycamore Basin
Waterman Basin #1
Waterman Spreading Grounds
Twin Creek Spreading Grounds
Day Creek Dam [DSOD]
Hillside Basin, COE
San Antonio Dam
Demens Basin #2
Rich Basin
San Sevaine Basin #5 [DSOD]
STATE HWY 210
Sand Canyon Basin
Dynamite Basin
Patton Basin
Cook Canyon Basin
Perris Hill Basin
Bledsoe Basin
City Creek Spreading Grounds
Seven Oaks Dam, COE [DSOD]
Seven Oaks Dam, COE
Plunge Creek Spreading Grounds
Mill Creek
San Antonio Basin #2
San Antonio Basin #5
San Antonio Basin #8
San Antonio Basin #9
Cucamonga Basin #6
Church Street Basin
Victoria Basin
Cactus Basin #5
Cactus Basin #3b
Cactus Basin #2
Lytle Creek Gatehouse, COE
STATE HWY 259
College Heights Basin #1
College Heights Basin #4
Montclair Basin #1
Montclair Basin #2
Montclair Basin #4
8th Street Basin #1
Banana Basin
Linden Basin
Turner Basin #1
Etiwanda Conservation Basin
Warm Creek Conservation Basin #4
Zanja Creek
Morrey Arroyo
Oak Glen Creek
Wilson Creek Basin #3
Potato Creek Spreading Grounds
13th Street Basin
Yucaipa Creek
Wildwood Basin
Live Oak Creek
Brooks Basin
Jurupa Basin [DSOD]
Wineville Basin
Ely Basin #2
Riverside Basin
STATE HWY 60
Santa Ana River
San Timoteo Sediment Basin #3
Mountain View Basin
San Timoteo Sediment Basin #18
San Timoteo Sediment Basin #19
Grove Avenue Basin
Lower Cucamonga Sprdg Grnds
Cypress Channel
STATE HWY 71
Prado Dam
STATE 91
I 10
I 15
I 215

Hydromodification

A.1 Hydrologic Conditions of Concern (HCOC) Analysis

HCOC Exemption:

1. **Sump Condition:** All downstream conveyance channel to an adequate sump (for example, Prado Dam, Santa Ana River, or other Lake, Reservoir or naturally erosion resistant feature) that will receive runoff from the project are engineered and regularly maintained to ensure design flow capacity; no sensitive stream habitat areas will be adversely affected; or are not identified on the Co-Permittees Hydromodification Sensitivity Maps.

2. **Pre = Post**: The runoff flow rate, volume and velocity for the post-development condition of the Priority Development Project do not exceed the pre-development (i.e, naturally occurring condition for the 2-year, 24-hour rainfall event utilizing latest San Bernardino County Hydrology Manual.

   a. Submit a substantiated hydrologic analysis to justify your request.

3. **Diversion to Storage Area**: The drainage areas that divert to water storage areas which are considered as control/release point and utilized for water conservation.

   a. See Appendix F for the HCOC Exemption Map and the on-line Watershed Geodatabase (http://sbcounty.permitrack.com/wap) for reference.

4. **Less than One Acre**: The Priority Development Project disturbs less than one acre. The Co-permittee has the discretion to require a Project Specific WQMP to address HCOCs on projects less than one acre on a case by case basis. The project disturbs less than one acre and is not part of a common plan of development.

5. **Built Out Area**: The contributing watershed area to which the project discharges has a developed area percentage greater than 90 percent.

   a. See Appendix F for the HCOC Exemption Map and the on-line Watershed Geodatabase (http://sbcounty.permitrack.com/wap) for reference.

Summary of HCOC Exempted Area

	HCOC Exemption reasoning				
	1	2	3	4	5
Area					
A			X		X
B			X		
C					X
E			X		
F					X
G			X		X
H01	X		X		
H02	X		X		
H02A	X		X		
H02B			X		
H03			X		
H04	X		X		
H05	X				
H06			X		
H07	X				
H08	X		X		
H09	X				
H10	X		X		
H11	X		X		
H12	X				
J			X		
U			X		
W			X		
I			X		
II			X		
III					X
IV			X		X
V			X*		
VI					X
VII					X
VIII			X		
IX					X
X			X		
XIII			X		

*Detention/Conservation Basin