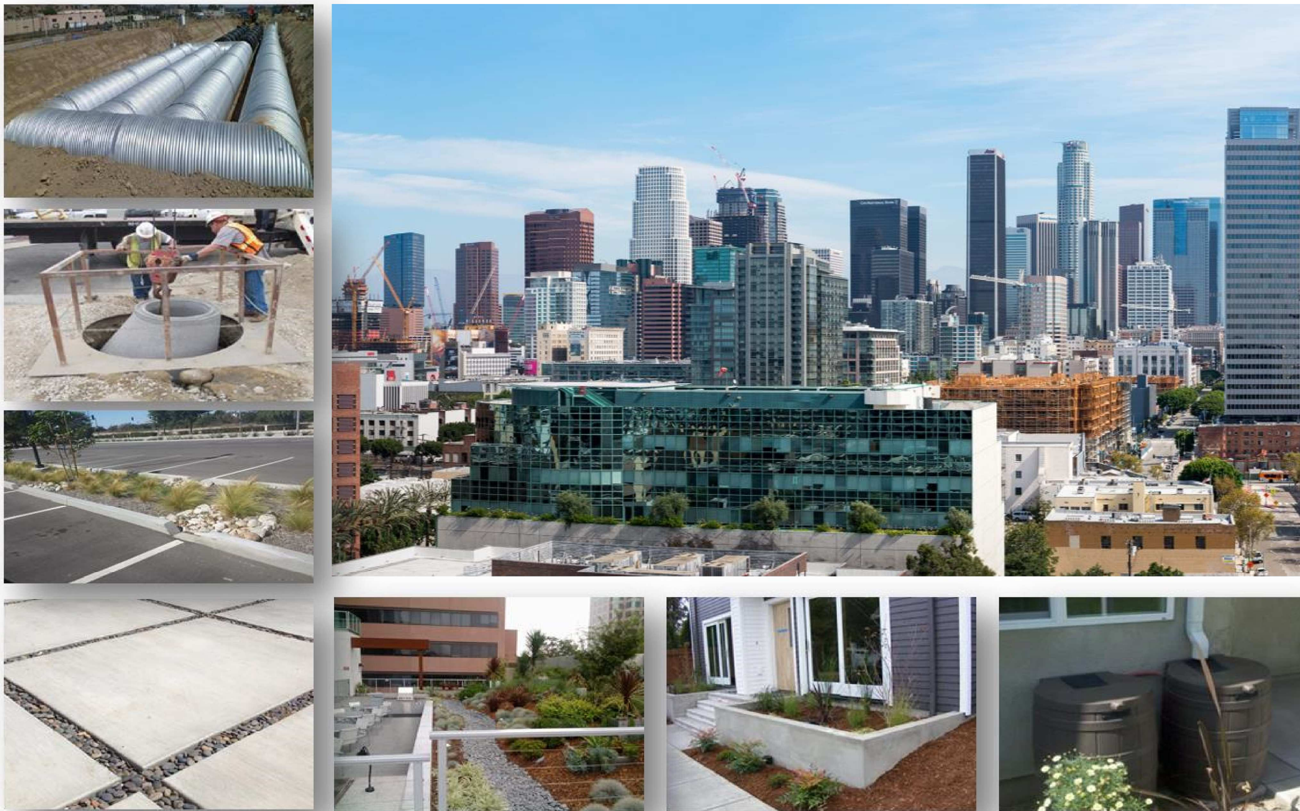

PLANNING AND LAND DEVELOPMENT HANDBOOK FOR LOW IMPACT DEVELOPMENT (LID)

PART B
PLANNING ACTIVITES
5TH EDITION

May 9, 2016

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This 5th edition is a revision to the 4th edition to reflect the latest LID requirements as defined by the National Pollution Discharge Elimination System Permit (NPDES No. CASOO4001) and the City of Los Angeles Municipal Code. The handbook was originally created under the direction of the City of Los Angeles, who is fully responsible for the content within and a technical committee comprised of the Departments of Planning, Building and Safety, and Water and Power, the Bureaus of Street Services and Engineering, and individuals from the development, environmental, and consultant community.

This Development Best Management Practices Handbook, Part B Planning Activities, 5th edition was adopted by the City of Los Angeles, Board of Public Works on May 9, 2016, as authorized by Section 64.72 of the Los Angeles Municipal Code approved by Ordinance No. 183833.

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ACRONYMS AND ABBREVIATION

BMP	Best Management Practices
BOE	Bureau of Engineering
BOS	Bureau of Sanitation
CGPL	California General Plan Law
CEQA	California Environmental Quality Act
CZARA	Coastal Zone Act Reauthorization Amendments of 1990
C&A	Covenant and Agreement
DCP	Los Angeles Department of City Planning
EAF	Environmental Assessment Form
EIR	Environmental Impact Report
USEPA	United States Environmental Protection Agency
ESA	Environmentally Sensitive Area
ETWU	Estimated Total Water Use
CGPL	California General Plan Law
LADBS	Los Angeles Department of Building and Safety
LID	Low Impact Development
MAWA	Maximum Applied Water Allowance
MND	Mitigated Negative Declaration
MS4	Municipal Separate Storm Sewer Systems
NPDES	National Pollutant Discharge Elimination System
O&M	Operation and Maintenance
PCIS	Plan Check and Inspection System
RWQCB	Los Angeles Regional Water Quality Control Board
SOR	Stormwater Observation Report
SWRCB	State Water Resources Control Board (California)
SUSMP	Standard Urban Stormwater Mitigation Plan
ULARA	Upper Los Angeles River Area
ULARWM	Upper Los Angeles River Area Watermaster
WPD	Watershed Protection Division

SECTION 1: INTRODUCTION

1.1 BACKGROUND

Urban runoff discharged from municipal storm drain systems has been identified by local, regional, and national research programs as one of the principal causes of water quality impacts in most urban areas. Urban runoff potentially contains a host of pollutants such as trash and debris, bacteria and viruses, oil and grease, sediments, nutrients, metals, and toxic chemicals.

These contaminants can adversely affect receiving and coastal waters, associated biota, and public health. An epidemiological study by the Santa Monica Bay Restoration Project was conducted to investigate possible health effects of swimming in Santa Monica Bay. Study results indicated that individuals swimming near flowing storm drain outlets have a greater risk of developing various symptoms of illnesses compared to those swimming 400 yards away from the same drains. In addition, oil and grease from parking lots, leaking petroleum or other hydrocarbon products, leachate from storage tanks, pesticides, cleaning solvents, and other toxic chemicals can contaminate stormwater and be transported downstream into water bodies and receiving waters. Fertilizer constituents from lawns and golf courses or leaking septic tanks can cause algal blooms. Disturbances of the soil from construction can allow silt to wash into storm channels and receiving waters, making them muddy, cloudy, and inhospitable to natural aquatic organisms. Heavy metals are toxic to aquatic organisms and many artificial surfaces of the urban environment such as galvanized metal, paint, or preserved wood containing metals contribute to stormwater pollution as the surfaces corrode, flake, dissolve, or decay.

Land development and construction activities significantly alter drainage patterns and contribute pollutants to urban runoff primarily through erosion and removal or change of existing natural vegetation. When homes, shops, work places, recreational areas, roads, parking lots, and structures are built, increased flows are discharged into local waterways. As the amount of impervious surface increases, water that once percolated into the soil now flows over the land surface. Accordingly, increases in impervious surfaces can increase the frequency and intensity of stormwater flows through a watershed. Flow from rainstorms and other water uses wash rapidly across the impervious landscape, scouring the surface of various kinds of urban pollutants such as automotive fluids, cleaning solvents, toxic or hazardous chemicals, detergents, sediment, metals, bacteria, pesticides, oil and grease, and food wastes. These pollutants, unfiltered and unfettered, flow through stormwater infrastructure and ultimately contaminate receiving waters.

1.2 HANDBOOK PURPOSE AND SCOPE

The purpose of this handbook is to assist developers in complying with the requirements of the Development Planning Program regulations of the City's Stormwater Program. This handbook summarizes the City's project review and permitting process, identifies stormwater mitigation measures, and references source and treatment control BMP information. It provides guidance for individuals involved in new development and redevelopment projects. The target audience for this handbook includes developers, designers, contractors, homeowners, and City staffs that are engaged in plan-checking, permitting, and inspections related to land development activities. This handbook also contains the necessary forms and worksheets required to be completed by the developer for approval.

1.3 LEGAL FRAMEWORK

With public concern growing over urban runoff and stormwater pollution, local, state, and federal agencies have devised plans to control and/or treat stormwater-related pollution before it reaches receiving waters.

The Federal Clean Water Act is the principal vehicle for control of stormwater pollution. Under the Federal Clean Water Act, each municipality throughout the nation is issued a stormwater permit through the National Pollutant Discharge Elimination System (NPDES) program. The primary goal of each permit is to stop polluted discharges from entering the storm drain system and local receiving and coastal waters. In California, the NPDES stormwater permitting program is administered by the State Water Resources Control Board (SWRCB) through its nine Regional Boards.

On Nov 8, 2012, the Los Angeles Regional Water Quality Control Board (Regional Board or RWQCB) adopted Order No. RA-2012-0175 the NPDES Stormwater Permit (Permit) for the County of Los Angeles and cities within (NPDES No. CAS004001). The Permit was issued to Los Angeles County Flood Control District, the county of Los Angeles, and 84 incorporated cities within the coastal watersheds of Los Angeles County to reduce pollutants discharged from their Municipal Separate Storm Sewer Systems (MS4) to the Maximum Extent Practicable (MEP) statutory standard. On December 28, 2012 the Order became effective.

The requirement to implement the Permit is based on federal and state statutes, including Section 402(p) of the Federal Clean Water Act, Section 6217 of the Coastal Zone Act Reauthorization Amendments (CZARA) of 1990, and the California Water Code. The Federal Clean Water Act amendments of 1987 established a framework for regulating stormwater discharges from municipal, industrial, and construction activities under the NPDES program. The primary objectives of the stormwater program requirements are to:

- Effectively prohibit non-stormwater discharges, and
- Reduce the discharge of pollutants from stormwater conveyance systems to the MEP statutory standard.

Based on the Permit issued by the Regional Board, each permittee is required to develop and implement a number of stormwater management programs designed to reduce pollutants in stormwater and urban runoff. These programs are the Public Information and Participation Program, Industrial/Commercial Facilities Program, Illicit Connections and Illicit Discharges Elimination Program, Planning and Land Development Program, Development Construction Program, Public Agency Activities Program, and the Monitoring and Reporting Program.

One of these programs, the Planning and Land Development Program, focuses on preventing pollutants that could be generated from new development and redevelopment projects from reaching stormwater conveyance systems and receiving waters. Under this program, the RWQCB developed requirements for the Standard Urban Stormwater Mitigation Plan (SUSMP) which requires specific development and redevelopment categories to manage stormwater runoff. In 2002, the City of Los Angeles implemented the SUSMP program requiring all the affected land development projects to capture or treat stormwater runoff.

A relatively recent stormwater management approach aimed at achieving this goal is the use of Low Impact Development (LID). Over the past 10 years, LID practices have received increased attention and implementation, becoming a leading practice for stormwater management. In recognition of this, recent actions by the RWQCB, SWRCB, and US EPA have prioritized the use of LID as the preferred approach to stormwater management, including for the purpose of water quality compliance.

LID is a stormwater management strategy that seeks to mitigate the impacts of increases in runoff and stormwater pollution as close to its source as possible. LID comprises a set of site design approaches and Best Management Practices (BMPs) that promote the use of natural systems for infiltration, evapotranspiration, and use of stormwater. These LID practices can effectively remove nutrients, bacteria, and metals from stormwater while reducing the volume and intensity of stormwater flows. With respect to urban development and redevelopment projects, it can be applied onsite to mimic the site's predevelopment drainage characteristics. Through the use of various infiltration techniques, LID is geared towards minimizing surface area that produces large amounts of runoff and does not allow water to infiltrate into the ground. Where infiltration is infeasible, the use of bioretention, rain gardens, vegetated rooftops, and rain barrels that will store, evaporate, detain, and/or treat runoff can be used.

In November 2011, the City adopted the Stormwater LID Ordinance (Ordinance #181899) with the stated purpose of:

- Requiring the use of LID standards and practices in future developments and redevelopments to encourage the beneficial use of rainwater and urban runoff;
- Reducing stormwater/urban runoff while improving water quality;
- Promoting rainwater harvesting;
- Reducing offsite runoff and providing increased groundwater recharge;
- Reducing erosion and hydrologic impacts downstream; and
- Enhancing the recreational and aesthetic values in our communities.

The recently adopted NPDES Permit also adopts Low Impact Development principals and requires development and redevelopment projects to incorporate similar requirements as those outlined in the City's LID Ordinance. Under the City's LID Ordinance, stormwater mitigation is required for a much larger number of development and redevelopment projects.

In addition to the LID provisions, other programs dealing with stormwater pollution include the State of California General Plan Law (CGPL) for Municipalities and the California Environmental Quality Act (CEQA). The California CGPL and CEQA provide a basis for municipalities to review and comment on all projects within their jurisdiction. Under the CGPL, municipalities are required to develop policies and regulations that guide development within the municipality. Each development project is reviewed for conformance with these policies. Under CEQA, projects are also subject to review and comment for potential adverse environmental impacts, including impacts from stormwater discharges.

1.4 PLANNING AND LAND DEVELOPMENT PROGRAM

The Planning and Land Development Program is, in order of priority, comprised of a LID Plan and/or Source Control Measures. This handbook provides guidance for compliance with the LID and requirements. Project applicants will be required to incorporate stormwater mitigation measures into their design plans and submit the plans to the City for review and approval as described in Section 2.

1.4.1 Low Impact Development Plan

Adopted by the City of Los Angeles (November 14, 2011; updated September 2015) the Stormwater LID Ordinance requires stormwater mitigation for all development and redevelopment projects that create, add, or replace 500 square feet or more of impervious area.

The Stormwater LID Ordinance applies to all development and redevelopment in the City of Los Angeles that requires building permits within the City after the ordinance effective date except for the following:

- A development or redevelopment that only creates, adds, or replaces less than 500 square feet of impervious area;
- A development or redevelopment involving only emergency construction activity required to immediately protect public health and safety;
- Infrastructure projects within the public right-of-way;
- A development or redevelopment involving only activity related to gas, water, cable, or electricity services on private property;
- A development or redevelopment involving only re-striping of permitted parking lots;
- A project involving only exterior movie and television production sets, or facades on existing developed site.

SECTION 2: PROJECT REVIEW AND PERMITTING PROCESS

2.1 PLAN APPROVAL PROCESS

The requirement to incorporate stormwater pollution control measures into the design plans of new development and redevelopment projects in order to mitigate stormwater quality impacts is implemented through the City's plan review and approval process. During the review process, the plans will be reviewed for compliance with the City's General Plans, zoning ordinances, and other applicable local ordinances and codes, including stormwater requirements. Plans and specifications will be reviewed to ensure that the appropriate BMPs are incorporated to address stormwater pollution prevention goals. The reviewer will also determine if project designs need to be modified to address stormwater pollution prevention objectives.

New development and redevelopment projects are mainly processed through Department of City Planning (DCP) and LADBS. Entitlement approvals are processed by DCP and these projects require discretionary action. Building/Grading Permit approvals are processed by LADBS.

2.1.1 Department of City Planning Process

The Permit requirements are taken into account during the CEQA process for discretionary projects. The CGPL and CEQA provide a basis for municipalities to review and comment on all projects within their jurisdiction. Under CEQA, projects are also subject to review for any adverse impacts the projects may have on the environment, including those impacts from stormwater discharges. These project types (e.g., zone variances, conditional use permits, plan amendments, site plan reviews, etc.) are considered discretionary review projects requiring review by an elected or appointed decision-making body. All applications for DCP's discretionary decisions are required to be accompanied by an environmental clearance (e.g., Categorical Exemption, Negative Declaration, Mitigated Negative Declaration, or Environmental Impact Report). When an applicant files an application for a discretionary project, DCP staff at the public counter will determine whether the project qualifies for an exemption from CEQA. If the project is not exempt and could possibly have a significant impact, the applicant files an Environmental Assessment Form (EAF).

The DCP Plan Implementation Division prepares the Initial Study and Checklist. DCP takes mandatory compliance with the LID Ordinance into account when analyzing projects' potential impacts in regards to water absorption rates, drainage patterns, urban runoff or other water quality issues. In most cases, compliance with the LID Ordinance ensures that the project will have a less than significant effect upon the environment Stormwater mitigation measures. If no significant effect upon the environment is found in this and other CEQA categories, a Negative

Declaration will be issued for the project. If mitigation measures are needed, a Mitigated Negative Declaration (MND) is issued for the project, or an Environmental Impact Report (EIR) is required. Following approval by DCP, building/grading permits are obtained from LADBS.

2.1.2 Department of Building and Safety Process

Applicants must submit design plans to LADBS personnel for review and approval prior to issuance of building/grading permits. LADBS personnel determine if the project requires stormwater mitigation measures and refer applicable projects to WPD for review and approval. LADBS issues the applicant a "Clearance Worksheet" that identifies all of the outstanding approvals from City agencies. A building/grading permit will be issued once all corrections have been completed and clearances are obtained, including for stormwater requirements.

Outlined below are some guidelines for project applicants to follow in submitting design plans for review and approval.

Step One - Submit design plans

The project applicant submits the design plans to LADBS. During the plan review process, LADBS will refer projects needing discretionary action to DCP for additional processing.

Step Two - Define the project category

The plan check engineer will review the design plans and determine if the project is subject to the LID provisions. If the project is subject to LID provisions the plan check engineer will refer the applicant to WPD.

Step Three – Issue Building and/or Grading Permit

Once all items on the "Clearances Worksheet" have been completed, including stormwater requirements imposed by WPD, the plan check engineer issues the Building and/or Grading Permit.

2.1.3 Department of Public Works / Bureau of Sanitation Process

To ensure compliance with all City Codes, it is recommended that the architect, civil engineer, plumbing engineer, and/or landscape architect coordinate at the early stage of the project design. Also WPD plan-checking staff is available for consultation regarding the applicable requirements based on the project concept.

Step One - Identify appropriate BMPs

Identify, evaluate, and incorporate into the plan documents the appropriate BMPs for the project categories listed in Section 3 of this handbook.

To assist the residents in small scale residential development/redevelopment projects (4 units or less) Appendix E contains prescriptive methods detailing BMPs to be incorporated into the design plans. The advantage of the prescriptive methods is they were developed as pre-approved designs. Use of prescriptive methods for these types of project categories will dramatically reduce plan preparation and review time.

Approval for development projects and building/grading permits will not be granted/issued until appropriate and applicable stormwater BMPs are incorporated into the project design plans. Also, a plumbing permit from LADBS will be required for certain treatment control BMPs such as grease traps, sump pumps, and clarifiers. For all projects other than small scale residential developments (4 units or less), if an infiltration BMP is chosen for treatment control, a soils report to address the feasibility of infiltration will be required to be submitted with the plan for review and approval.

Step Two– Submit LID plans to WPD for review

For first review, the following is a list of the minimum submittal requirements for Small Scale Residential Developments (4 units or less):

- One (1) set of full plans (plot/site, elevation, utility, mechanical, plumbing, architectural, and landscape plans Projects greater than 2,500 SF will need to be wet stamped by a Civil Engineer/ Architect (of Record).
- Plans must include, but not limited to, at least the following:
    - Site / Plot Plan: Location and size of BMP(s) and identify landscaping area
    - BMP sizing by tributary area.
    - Detail of BMP(s) (including invert outlet elevations).
    - Architectural Building Elevations: Identify all downspouts and location of BMP(s).
- Stormwater Summary Form (Appendix C)
- Stormwater Observation Report Form (Appendix C)
- Draft Covenant & Agreement (C&A) Form (Appendix C) with an Operation & Maintenance Plan as discussed in Section 2.3 and 8.5”x11” Plot Plan clearly showing BMP size and location(s).

For first review, the following is a list of the minimum submittal requirement for All Other Development projects:

- One (1) set of plans (plot/site, architectural building elevations, utility, mechanical, plumbing, grading and landscape plans).
- LID Report which at a minimum include, but not limited to, at least the following:
    - Existing site conditions
    - Scope of work (Proposed site conditions)
    - Discussion on feasibility screening (infiltration, capture & use, and high efficiency biofiltration)
    - Volume calculation (by tributary area)
        - If certain areas will not be treated, quantify and explain how it will be compensated in a different tributary area.
- Plans must include, but not limited to, at least the following:
    - Location of all BMPs on plans, including elevations and drainage patterns.
    - Detailed drawings of all BMPs, including model, size, and capacity
    - Stenciling note and/or detail
    - Trash enclosure location and details
    - Landscaping areas
    - Stormwater Summary Form (Appendix D)
    - Stormwater Observation Report Form (Appendix D)
  - Manufacturer's product specifications to verify that the selected BMP model can adequately handle the design volume.
    - Stormwater Summary Form (Appendix C)
    - Stormwater Observation Report Form (Appendix D)
- Draft Covenant & Agreement (C&A) Form (Appendix D) with an Operation & Maintenance Plan as discussed in Section 2.3 and 8.5"x11" Plot Plan clearly showing BMP size and location(s).
- Final plans must be wet-stamped and signed by an engineer and/or architect.

Step Three – WPD Approval

WPD plan-checking staff will review the submitted documents and identify corrections. Once all LID requirements have been met, WPD staff will stamp **three (3) sets** of the approved plans, sign the applicant's clearance worksheet, and clear the project in the LADBS plan check tracking system, known as the Plan Check and Inspection System (PCIS).

2.2 INSPECTION PROCESS

To ensure that all stormwater related BMPs are constructed and/or installed in accordance with the approved LID Plan the City requires a Stormwater Observation Report (SOR) to be submitted to the City prior to the issuance of the Certificate of Occupancy (C of O).

All projects reviewed and approved will require a SOR which shall be prepared, signed, and stamped by the engineer of record (for example, a California-licensed civil engineer, architect, or qualified professional) responsible for the approved LID Plan, certifying that:

1. They are the engineer or architect responsible for the approved LID Plan and;
2. They, or the designated staff under their responsible charge, have performed the required site visits at each significant construction stage and at completion to verify that the BMPs shown on the approved plan have been constructed and installed in accordance with the approved LID Plan.

Project applicant (or engineer/architect/contractor) is required to bring the SOR form, approved plans and photos of the BMPs taken during various construction phases to the Bureau of Sanitation's public counter. An original SOR needs to be submitted (not a photocopy). The Certificate of Occupancy will be issued by LADBS after all required clearances are obtained, including the one by WPD plan-checking staff. At that stage the project has been determined, through the normal inspection process, to be built in accordance with the approved plan, including the construction and/or installation of appropriate stormwater-related BMPs and the project has been determined to comply with all applicable codes, ordinances, and other laws.

2.3 BMP MAINTENANCE

A Covenant and Agreement (C&A) document shall be submitted, along with the design plans showing the project's stormwater measures, during the plan review and approval process, and must be signed by the legal owner or authorized agent of the property. The C&A shall also be recorded with the County Recorder. The City will withhold the grading and/or building permit for the development application until this requirement is satisfied. A sample form of the C&A is provided in Appendix D.

Maintenance is crucial for proper and continuous operation, effectiveness, and efficiency of a structural or treatment control BMP. The cost of long-term maintenance should be evaluated during the BMP selection process. By signing a maintenance form, the legal property owner affirms he/she will perform regular and long-term maintenance of all BMPs installed onsite. For residential properties where the structural or treatment control BMPs are located within a common area and will be maintained by a homeowner's association, language regarding the responsibility for maintenance must be included in the project's conditions, covenants and restrictions (CC&Rs). The C&A is bound to the property and transfers to the new owner with any subsequent sale of the property. It should be noted that an original copy of the letter of authority should be submitted for individuals signing the C&A form that are not the property owners. Attached to the C&A will be an Operation and Maintenance (O&M) Plan (see Appendix D for a sample) describing the BMP operation and maintenance procedures, employee training program and duties, operating schedule, maintenance frequency, routine service schedule, and other activities. A maintenance log shall be maintained at the facility to document all of the activities mentioned above. These documents may be inspected by the City of Los Angeles at any time and shall be made available to the City upon request.

2.4 MUNICIPAL PROJECTS

Stormwater mitigation measures are required for all projects subject to the LID Plan. City projects that will be processed through DCP and/or LADBS will be subject to the review and approval process described in Section 2.1. For other City projects that do not undergo the plan review and approval process with DCP and/or LADBS, the public agency must use this handbook to incorporate the required stormwater mitigation measures into their projects.

Public agency projects other than from the City of Los Angeles, such as State of California, County of Los Angeles, the Metropolitan Transit Authority that require a permit from LADBS are required to prepare a LID Plan and implement stormwater mitigation measures. In addition, non-roadway transportation projects that meet the thresholds for LID categories are also required to implement stormwater mitigation measures. Examples of such projects include the rail lines and stations, airport runways, and busways. Such projects must incorporate stormwater BMPs into their design plans and specifications, which must be submitted to WPD for review and approval.

SECTION 3: STORMWATER MANAGEMENT MEASURES

3.1 GENERAL REQUIREMNTS

Project applicants for all developments and redevelopments will be required to incorporate stormwater mitigation measures into their design plans and submit the plans to the City for review and approval as indicated in Section 2. Projects must incorporate the following performance measures and practices into their design plans.

(1) Lessen the water quality impacts of development by using smart growth practices such as compact development, directing development towards existing communities via infill or redevelopment, and safeguarding of environmentally sensitive areas.

(2) Minimize the adverse impacts from storm water runoff on the biological integrity of Natural Drainage Systems and the beneficial uses of water bodies in accordance with requirements under CEQA (Cal. Pub. Resources Code § 21000 et seq.).

(3) Minimize the percentage of impervious surfaces on land developments by minimizing soil compaction during construction, designing projects to minimize the impervious area footprint, and employing Low Impact Development (LID) design principles to mimic predevelopment hydrology through infiltration, evapotranspiration and rainfall harvest and use.

(4) Maintain existing riparian buffers and enhance riparian buffers when possible.

(5) Minimize pollutant loadings from impervious surfaces such as roof tops, parking lots, and roadways through the use of properly designed, technically appropriate BMPs (including Source Control BMPs such as good housekeeping practices), LID Strategies, and Treatment Control BMPs.

(6) Properly select, design and maintain LID and Hydromodification Control BMPs to address pollutants that are likely to be generated, reduce changes to pre-development hydrology, assure long-term function, and avoid the breeding of vectors.

(7) Prioritize the selection of BMPs to remove storm water pollutants, reduce storm water runoff volume, and beneficially use storm water to support an integrated approach to protecting water quality and managing water resources in the following order of preference:

(a) On-site infiltration, bioretention and/or rainfall harvest and use.

(b) On-site biofiltration, off-site ground water replenishment, and/or off-site retrofit.

3.2 LOW IMPACT DEVELOPMENT (LID) PLAN

3.2.1 SMALL SCALE RESIDENTIAL DEVELOPMENT PROJECTS (4 UNITS AND LESS)

Small scale residential projects include all projects (4 units or less) that have a land disturbance activity and add, create or replace more than 500 square feet of impervious area. The majority of these projects are not required to complete a formal hydrologic analysis or obtain approval from the Upper Los Angeles River Area (ULARA) Watermaster. The basic objectives for these projects include reducing a site's impervious surfaces, improving a site's ability to infiltrate stormwater, conserving stormwater runoff for other on-site water demand uses, and reducing negative impacts downstream.

REQUIREMENTS:

i. Development or redevelopment less than one acre and adding less than 10,000 square feet of impervious surface area shall implement adequately sized LID BMP alternatives as defined and listed in Appendix E; or

ii. Development or redevelopment that are one acre or greater of disturbed area and adding more than 10,000 square feet of impervious surface area, the development shall comply with the standards and requirements of Section 3.2.3 - All Other Developments.

iii. Development and redevelopment projects that are greater than or equal to 2,500 square feet <u>and</u> within an ESA, shall comply with the standards and requirements of Section 3.2.3 - All Other Developments.

BEST MANAGEMENT PRACTICES (BMPS):

The following LID BMPs have been established as prescriptive LID BMPs to be employed on a qualifying small scale project. These BMPs are presented in the form of Fact Sheets in Appendix E with the intent of providing background context and sizing requirements to facilitate a permit applicant to follow and comply with the City of Los Angeles' Stormwater LID Ordinance. Applicants may choose from one or more of the prescriptive BMPs to comply with the ordinance.

The prescriptive specific small scales BMPs include the following:

1. Rain Tanks (with optional tree planting)
2. Permeable Pavements (or Porous Pavement Systems)
3. Planter Boxes
4. Rain Gardens
5. Dry Wells

Figure 3.1 demonstrates the use of all five of these small scale residential BMPs at a residence.

Figure 3.1- Small Scale Residential BMP Schematic

3.2.2 ALL OTHER DEVELOPMENTS

Any new development or redevelopment project that does not meet the requirements of Section 3.1.2 – Small Scale Residential Development Projects, shall comply with this section.

A LID Plan shall be prepared to comply with the following:

1. Stormwater runoff will be infiltrated, evapotranspired, captured and used, and/or treated through high removal efficiency Best Management Practices onsite, through stormwater management techniques as identified in Section 4.1. The onsite stormwater management techniques must be properly sized, at a minimum, to infiltrate, evapotranspire, store for use, and/or treat through a high removal efficiency biofiltration/biotreatment system, without any stormwater runoff leaving the site to the maximum extent feasible, for at least the volume of water produced by the stormwater quality design storm event that results from:

   i. The 0.75-inch, 24-hour rain event, or

   ii. The 85th percentile 24-hour runoff event determined from the Los Angeles County 85th percentile precipitation isohyetal map, ***whichever is greater****.*

   Refer to Los Angeles County website to determine the depth of the 85^{th} percentile, 24-hour runoff event. http://dpw.lacounty.gov/wrd/hydrologygis/. See also Appendix F.

REQUIREMENTS:

All other developments (residential developments of 5 units or more and nonresidential developments) shall adhere to the following requirements:

1. For new development or where redevelopment results in an alteration of at least fifty percent or more of the impervious surfaces of an existing developed site, the entire site shall comply with the standards and requirements of Section 3.2.2; or

2. Where the redevelopment results in an alteration of less than fifty percent of the impervious surfaces of an existing developed site, only such incremental development shall comply with the standards and requirements of Section 3.2.2.

If partial or complete onsite compliance of any type is technically infeasible, the project Site and LID Plan shall at a minimum treat runoff using a structural BMP as well as mitigated the equivalent volume under the Offsite Mitigation Option. Figure 3.3 depicts the design requirements for all other developments.

3.3 HYDROMODIFICATION

New development and/or redevelopment projects that drain to natural drainage systems in a small part of the Upper Los Angeles River watershed shall control post-development peak storm water runoff discharge rates, velocities, and duration (peak flow control) to mimic pre-development hydrology and to prevent accelerated stream erosion and to protect stream habitat. These controls should be consistent with the Hydromodification Control Plan developed by the County of Los Angeles, Department of Public Works.

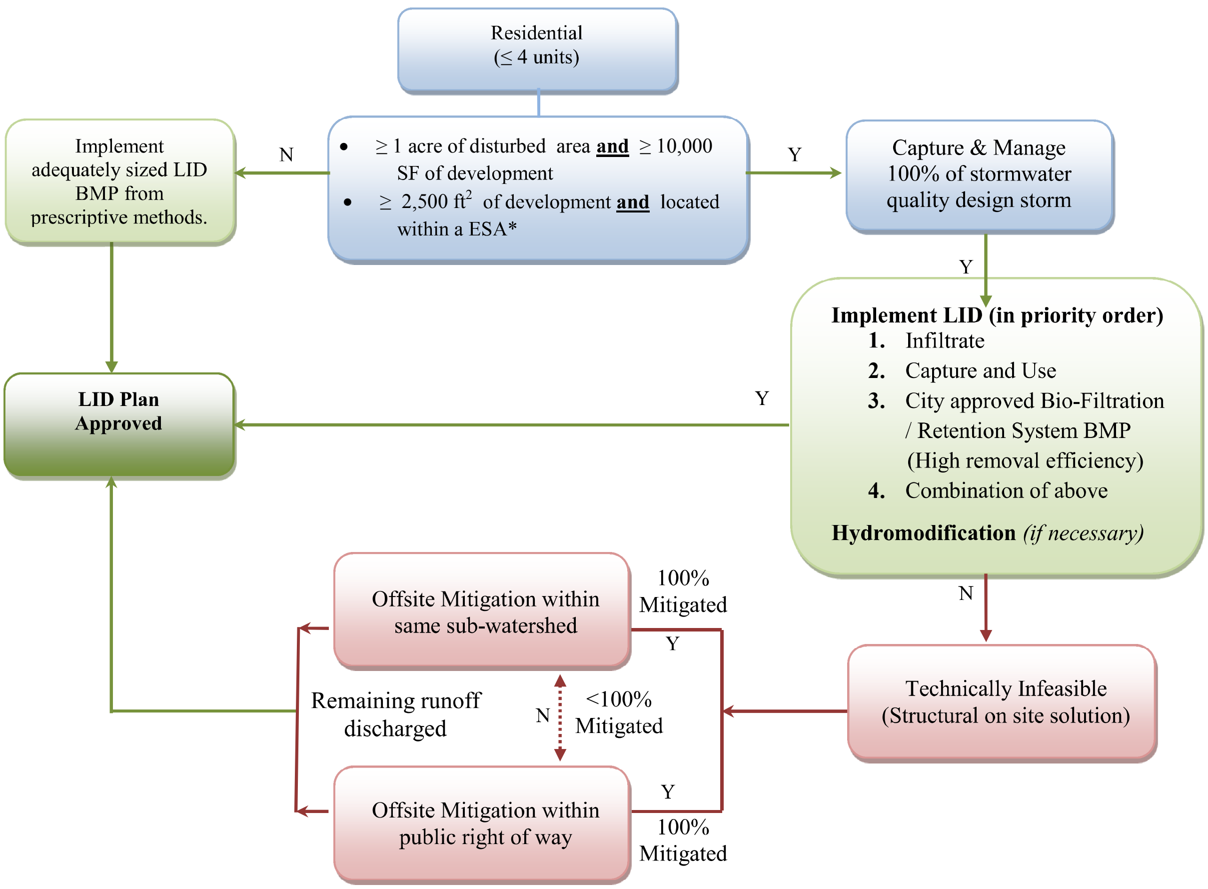
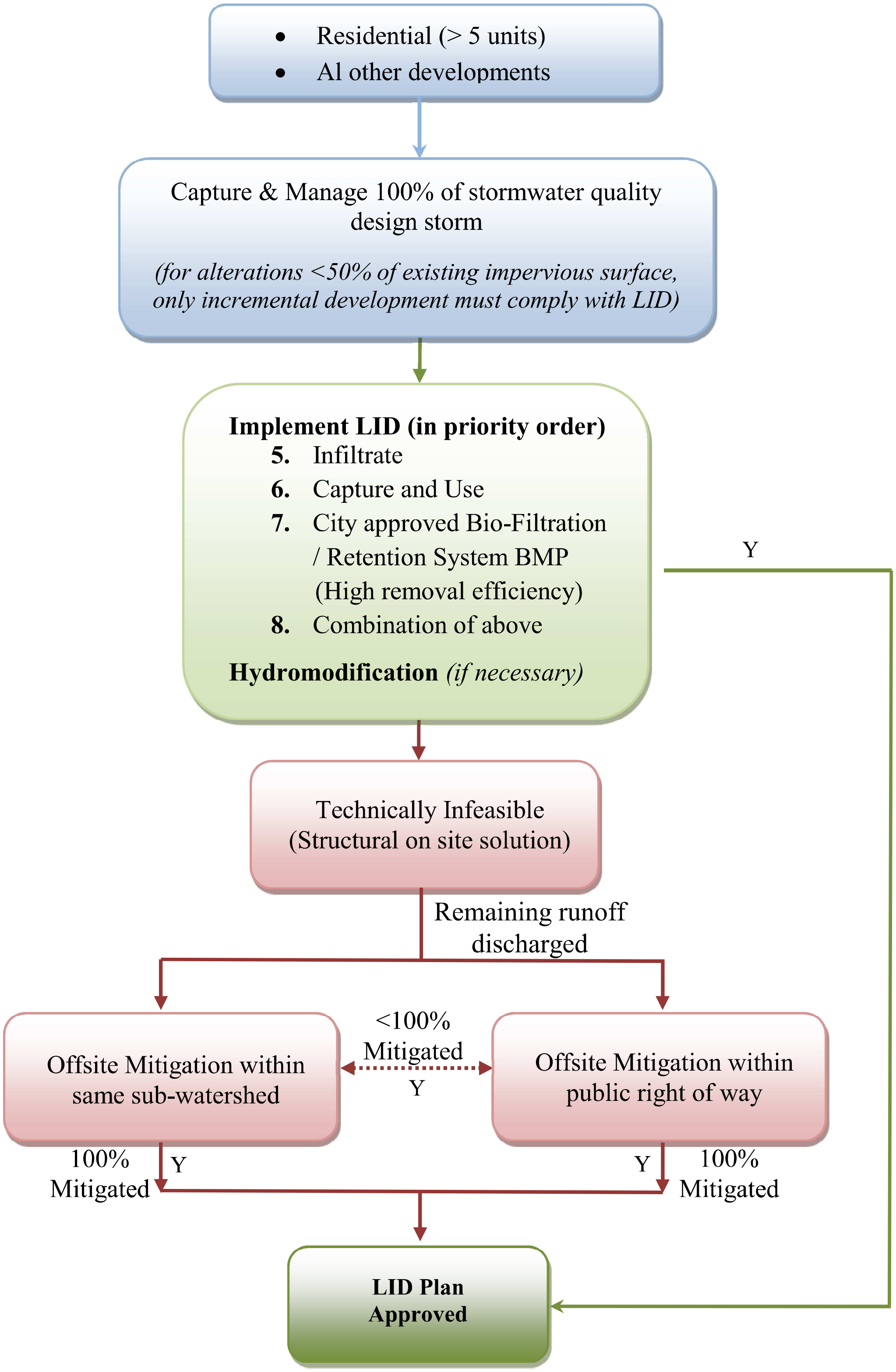


Figure3.2- Requirements for Residential Development of 4 Units or Less

Figure 3.3 – Requirements for All Other Development



3.4 SOURCE CONTROL MEASURES

Source control measures are low-technology practices designed to prevent pollutants from contacting stormwater runoff or to prevent discharge of contaminated runoff to the storm drainage system. This section addresses source control measures consisting of specific design features or elements. These control measures have been developed for specific types of sites or activities that have been identified as potential significant sources of pollutants in stormwater. When appropriate, the source control measure requirements discussed in this section shall be incorporated in the design plans in conjunction with any other operational source control measure such as good housekeeping, and employee training to optimize pollution prevention.

Some of the measures presented in this section require connection to the sanitary sewer system. Connection and discharge to the sanitary sewer system without prior approval or obtaining the required permits is prohibited. Contact the WPD staff to obtain information regarding obtaining sanitary sewer permits from the appropriate City office. Discharges of certain types of flows to the sanitary sewer system may be cost prohibitive and may not be allowed. The designer is urged to contact the appropriate City offices prior to completing site and equipment design of the facility.

Source control measures and associated design features specified for various sites and activities are summarized in Table 3.1. Fact Sheets are presented in Appendix G for each source control measure. These sheets include design criteria established by the City to ensure effective implementation of the required measures.

Table 3.1: Summary of Source Control Measure Design Features

Source Control Measure [(a)]	**DESIGN FEATURE OR ELEMENT**						
	Signs, placards, stencils	Surfacing (compatible, impervious)	Covers, screens	Grading/berming to prevent run-on	Grading/berming to provide secondary containment	Sanitary sewer connection	Emergency Storm Drain Seal
Storm Drain Message and Signage (S-1)	X						
Outdoor Material Storage Area Design (S-2)		X	X	X	X		X
Outdoor Trash Storage and Waste Handling Area Design (S-3)		X	X	X		X	
Outdoor Loading/Unloading Dock Area Design (S-4)		X	X	X	X		
Outdoor Repair/Maintenance Bay Design (S-5)		X	X	X	X		X
Outdoor Vehicle/Equipment/ Accessory Washing Area Design (S-6)		X	X	X	X	X	X
Fueling Area Design (S-7)		X	X	X	X		X

(a) Refer to Fact Sheets in Appendix G for detailed information and design criteria.

SECTION 4: BMP PRIORITIZATION AND SELECTION

4.1 PRIORITIZATION OF BMP SELECTION

BMPs shall be designed to manage and capture stormwater runoff. Infiltration systems are the first priority type of BMP improvements as they provide for percolation and infiltration of the stormwater into the ground, which not only reduces the volume of stormwater runoff entering the MS4, but in some cases, can contribute to groundwater recharge. If stormwater infiltration is not possible based on one or more of the project site conditions listed below, the developer shall utilize the next priority BMP.

The order of priority specified below shall apply to all projects categorized as "all other developments" in accordance with Section 3.2.2. Each type of BMP shall be implemented to the maximum extent feasible when determining the appropriate BMPs for a project.

1. Infiltration Systems
2. Stormwater Capture and Use
3. High Efficiency Biofiltration/Bioretention Systems
4. Combination of Any of the Above

For purposes of compliance with the LID requirements, and without changing the priority order of design preferences as mentioned in this section, all runoff from the water quality design storm event, as determined in Section 3.2.2 above, that has been treated through an onsite high removal efficiency biofiltration system shall be credited as equivalent to 100% infiltration regardless of the runoff leaving the site from the onsite high removal efficiency biofiltration system and that runoff volume shall not be subject to the offsite mitigation requirements.

If partial or complete onsite compliance of any type is technically infeasible, the project Site and LID Plan shall be required to maximize onsite compliance. Under this option a mechanical / hydrodynamic unit may be used. Any remaining runoff that cannot feasibly be managed onsite must be mitigated under the offsite mitigation option.

4.2 INFILTRATION FEASIBILITY SCREENING

The implementation of infiltration BMPs may be deemed infeasible at a project site due to existing site conditions. To assist in the determination of compliance feasibility, a categorical screening of specific site information shall be carried out to assess site conditions.

The first category of screening shall consist of specific site conditions which, if present at the site, would deem the specified BMP-type “feasible”. The second category of screening shall consist of specific site conditions which, if present at the site, would deem the BMP-type “potentially feasible”. Project locations passing this screening category may still be able to utilize the screened compliance measure, though the implementation of such a measure may require supplementary actions. The third category of screening shall consist of site conditions which, if present at the site, would deem a specified BMP-type “infeasible”. This type of screening can generally be carried out in the pre-planning stage of a project. These categorical screenings must be verified by a site-specific geotechnical investigation report and/or hydrologic analysis conducted and certified by a State of California registered professional geotechnical engineer or geologist and approved by LADBS. Refer to the County of Los Angeles Department of Public Works Geotechnical and Materials Engineering Division for testing methods that can be used to determine the insitu infiltration rates[1].

To assist in the determination of site feasibility for infiltration BMPs, Table 4.1 has been created.

1 http://ladpw.org/gmed/permits/docs/policies/GS200.1.pdf

	Category 1 Screening (Feasible)	**Category 2 Screening (Potentially Feasible)**	**Category 3 Screening (Infeasible)**
Description	1. Underlying Groundwater ☐ Depth of bottom of infiltration facility to observed groundwater is > 10 ft 2. Site Soils ☐ Infiltration rate (K_{sat}) is > 0.5 in/hr ☐ Geotechnical hazards are not a potential near the site 3. Site Surroundings ☐ Buildings or structures are at least 25 ft away from the potential infiltration BMP ☐ Site is not located within the designated hillside grading area. ☐ No continuous presence of dry weather flows	1. Underlying Groundwater ☐ Depth from bottom of infiltration facility to observed groundwater is ≤ 10 ft ☐ Unconfined aquifer is present with beneficial uses that may be impaired by infiltration. Full treatment required if this is the case ☐ Groundwater is known to be polluted. Infiltration must be determined to be beneficial 2. Site Soils ☐ Infiltration rate is ≤ 0.5 in/hr but potential connectivity to higher K_{sat} soils is feasible ☐ Geotechnical hazards such as liquefaction are a potential near the site 3. Site Surroundings ☐ Buildings or structures are within 10 to 25 ft of the potential infiltration BMP ☐ High-risk areas such as service/gas stations, truck stops, and heavy industrial sites. Full treatment is required if this is the case, or high-risk areas must be separate from stormwater runoff mingling	1. Underlying Groundwater ☐ Depth from bottom of infiltration facility to observed groundwater is ≤ 5 ft ☐ Sites with soil and/or groundwater contamination** 2. Site Soils ☐ Infiltration rate is ≤ 0.3 in/hr and connectivity to higher K_{sat} soils is infeasible ☐ Building sites designated "Landslide" or "Hillside Grading" areas as specified by the Department of City Planning's Zone Information and Map Access System (ZIMAS) ☐ Geotechnical hazards such as liquefaction, collapsible soils, or expansive soils exist 3. Site Surroundings ☐ Site is located on a fill site ☐ Site is located on or within 50 feet upgradient of a steep slope (20% or greater) and has not been approved by a professional geotechnical engineer or geologist
Instructions	If all of the above boxes are checked, they shall be confirmed by a site-specific geotechnical investigation report and/or hydrologic analysis conducted and certified by a State of California registered professional geotechnical engineer or geologist, verifying that infiltration BMPs are feasible at the site*. Otherwise, proceed to Category 2 screening.	If all of the above boxes are checked, or if corresponding boxes in Category 1 are checked in combination with the above boxes, a site-specific geotechnical investigation report and/or hydrologic analysis conducted and certified by a State of California registered professional geotechnical engineer or geologist shall be carried out to approve infiltration measures*. Otherwise, proceed to Category 3 screening.	If any of the above boxes are checked, a site-specific geotechnical investigation report and/or hydrologic analysis conducted and certified by a State of California registered professional geotechnical engineer or geologist shall be submitted to prove infiltration practices are not feasible. *

Table 4.1: Infiltration Feasibility Screening

* Geotechnical Reports shall be approved by LADBS Grading Division. See Geotechnical Report Requirements herein.

** The presence of soil and/or groundwater contamination and/or the presence of existing or removed underground storage tanks shall be documented by CEQA or NEPA environmental reports, approved geotechnical reports, permits on file with the City, or a review of the State of California's Geotracker website.

Assessing Site Infiltration Feasibility

Assessing a site's potential for implementation of Low Impact Development Best Management Practices (LID BMPs) and infiltration BMPs requires both the review of existing information and the collection of site-specific measurements. Available information regarding site layout and slope, soil type, geotechnical conditions, and local groundwater conditions should be reviewed as discussed below. In addition, soil and infiltration testing is required to be conducted to determine if stormwater infiltration is feasible and to determine the appropriate design parameters for the infiltration BMP.

<u>Geotechnical Considerations and Report Requirements:</u>

As determined by the City of Los Angeles, Department of Building and Safety, Grading Division, a geotechnical report will be required for projects that will incorporate infiltration as part of the drainage system. Geotechnical reports shall be signed by a professional Geotechnical or Civil Engineer licensed in the State of California and/or a Certified Engineering Geologist.

Refer to the current Building & Safety information bulletin, "Guidelines for Stormwater Infiltration" for additional information, Appendix H.

<u>Site Conditions</u>

Slope:

The site's topography should be assessed to evaluate surface drainage, topographic high and low points, and to identify the presence of steep slopes that qualify as "Hillside Grading Areas" or "Landslide" locations, all of which have an impact on what type of infiltration BMPs will be most beneficial for a given project site. Stormwater infiltration is more effective on level or gently sloping sites. On hillsides, infiltrated runoff may seep a short distance down slope, which could cause slope instability depending on the soil or geologic conditions, or result in nuisance seepage. Figure E-1 in Appendix E provides general guidance of the City with slopes greater than 15%. Refer to LADBS Parcel Profile Report to see if project is located within one of these areas.

Soil Type and Geology:

The site's soil types and geologic conditions should be determined to evaluate the site's ability to infiltrate stormwater and to identify suitable, as well as unsuitable locations for locating infiltration-based BMPs. Areas designated as "liquefaction" should not be considered for infiltration. Refer to LADBS Parcel Profile Report to see if project is located within one of these areas.

In addition, available geologic or geotechnical reports on local geology should be reviewed to identify relevant features such as depth to bedrock, rock type, lithology, faults, and hydrostratigraphic or confining units. These geologic investigations may also identify shallow water tables and past groundwater issues that are important for BMP design (see below). Figure E-5 in Appendix E provides general guidance identifying parts of the City that have well-draining soil conditions.

Groundwater Considerations:

The depth to groundwater beneath the project during the wet season may preclude infiltration. A minimum of five feet of separation to the seasonal (December through April) high ground water level and mounded groundwater level is required. For projects located in the Upper Los Angeles River Area, ten feet of separation is required.

Infiltration on sites with contaminated soils or groundwater that could be mobilized or exacerbated by infiltration is not allowed, unless a site-specific analysis determines the infiltration would be beneficial. A site-specific analysis may be conducted where groundwater pollutant mobilization is a concern to allow for infiltration-based BMPs. Areas with known groundwater impacts include sites listed by the RWQCB's Leaking Underground Storage Tanks (LUST) program and Site Cleanup Program (SCP). The California State Water Resources Control Board maintains a database of registered contaminated sites through their 'Geotracker' Program. Registered contaminated sites can be identified in the project vicinity when the site address is typed into the "map cleanup sites" field. Mobilization of groundwater contaminants may also be of concern where contamination from natural sources is prevalent (e.g., marine sediments, selenium rich groundwater, to the extent that data is available). Figure E-3 in Appendix E provides general guidance identifying parts of the City that may be in areas of concern.

Upper Los Angeles River Watermaster Requirements:

Infiltration projects located in the Upper Los Angeles River Area (ULARA) must comply with the requirements of the ULARA Watermaster[2]. Boundaries, requirements and approval process of the ULARWM are shown in Appendix I.

Managing Offsite Drainage:

Locations and sources of offsite run-on to the site must be identified early in the design process. Offsite drainage must be considered when determining appropriate BMPs for the site so that the drainage can be managed. By identifying the locations and sources of offsite drainage, the volume of water running onto the site may be estimated and factored into the siting and sizing of onsite BMPs. Vegetated swales or storm drains may be used to intercept,

2 http://www.ularawatermaster.com/

divert, and convey offsite drainage through or around a site to prevent flooding or erosion that might otherwise occur.

4.3 CAPTURE AND USE FEASIBILITY SCREENING

Capture and use, commonly referred to as rainwater harvesting, collects and stores stormwater for later use, thereby offsetting potable water demand and reducing pollutant loading to the storm drain system, therefore sufficient landscaped area with appropriate water demand is needed for the captured runoff to be directed to. Partial capture and use can also be achieved as part of a treatment train by directing the overflow to a bioretention system to provide additional volume reduction and water quality treatment in instances where the quantity of runoff from a storm event exceeds the volume of the collection tank.

In the City of Los Angeles, the use of collected stormwater will primarily be limited to irrigation of landscaped surfaces. However, as new guidelines and guidance becomes available the potential for other uses of collected stormwater will be considered. Capture and use BMPs that are designed with the intent to use captured stormwater for indoor or consumptive purposes will be reviewed on a case-by-case basis to ensure that all treatment, plumbing, and Building and Safety codes are met.

Assessing Site Capture and Use Feasibility

As with infiltration BMPs, assessing a site's potential for implementation of capture and use BMPs requires both the review of existing information and the collection of site-specific measurements. Available information regarding the site's landscaped area should be reviewed as discussed below. In addition, human health concerns should be prioritized, particularly with regards to vector control issues arising from the addition of standing water on site.

Landscaped Area Assessment

To determine a site's feasibility for capture and use BMPs, the Estimated Total Water Usage (ETWU) for irrigation from October 1 – April 30 must be greater than or equal to the volume of water produced by the stormwater quality design storm event (i.e. $ETWU_{7\text{ - month}} \geq Vm$).

Los Angeles County Department of Public Health Requirements

Projects that are implementing rainfall or urban runoff capture and distribution systems must obtain approval from the County of Los Angeles, Department of Public Health. See Appendix J for the Policy and Operation Manual.

Vector Control Considerations

A vector is any insect, arthropod, rodent, or other animal that is capable of harboring or transmitting a causative agent of human disease. In the City of Los Angeles, the most significant vector population related to stormwater is mosquitoes.

Vector sources occur where conditions provide habitat suitable for breeding, particularly any source of standing water. This means that stormwater BMPs, especially those of the capture and use type, can be breeding grounds for mosquitoes and other vectors resulting in adverse public health effects related to vectors and disease transmission. Because of this, efforts shall be made to design capture and use BMPs that do not facilitate the breeding of vectors. Vectors should be considered during the preparation of stormwater management and maintenance plans and during preconstruction planning to avoid creating possible public health hazards.

Oversized capture and use BMPs designed to hold captured stormwater for longer than 72 hour periods will require additional treatment such as filtration or disinfection to protect the collection tanks from fouling, to prevent the breeding of vectors, and/or to improve the quality of water for reuse applications. These BMPs must have appropriate vector control measures incorporated into the design of the system to exclude vector access and breeding (i.e., observation access for vector inspection and treatment). They should be approved by the County of Los Angeles Department of Public Health. These scenarios will be reviewed on a case-by-case basis.

If vector breeding is taking place at a site as a result of contained stormwater or inadequately maintained BMPs, the Greater Los Angeles County Vector Control District has the ability to fine site owners for violating the California Health and Safety Code (Section 2060 – 2067).

4.4 INFILTRATION BMPS

Infiltration refers to the physcial process of percolation, or downward seepage, of water through a soil's pore space. As water infiltrates, the natural filtration, adsorption, and biological decomposition properties of soils, plant roots, and micro-organisms work to remove pollutants prior to the water recharging the underlying groundwater. Infiltration BMPs include infiltration basins, infiltration trenches, infiltration galleries, bioretention without an underdrain, dry wells, and permeable pavement. Infiltration can provide multiple benefits, including pollutant removal, peak flow control, groundwater recharge, and flood control. However, conditions that can limit the use of infiltration include soil properties, proximity to building foundations and other infrastructure, geotechnical hazards (e.g., liquefaction, landslides), and potential adverse impacts on groundwater quality (e.g industrial pollutant source areas, contaminated soils, groundwater plumes)[3]. To ensure that infiltration would be physcially feasible and desireable (i.e., not have adverse impacts), a categorical screening of site feasibility criteria must be completed prior to the use of infiltration BMPs following the guidelines presented in Section 4.2.

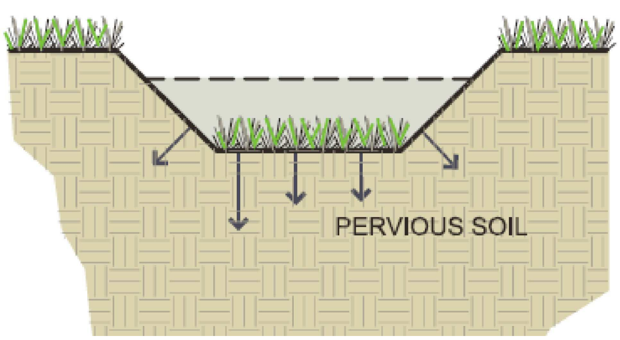
4.4.1 Infiltration BMP Types

Surface Infiltration BMPs

These BMPs rely on infiltration in a predominantly vertical (downward) direction and depend primarily on soil characteristics in the upper soil layers. These infiltration BMPs include:

Infiltration Basins

An infiltration basin consists of an earthen basin constructed in naturally pervious soils with a flat bottom typically vegetated with dry-land grasses or irrigated turf grass. An infiltration basin functions by retaining the design runoff volume in the basin and allowing the retained runoff to percolate into the underlying native soils over a specified period of time.



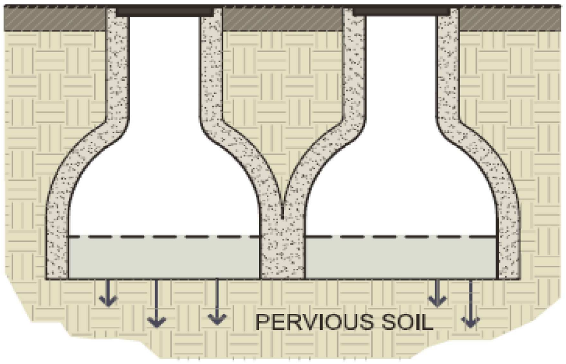
Infiltration Trenches

Infiltration trenches, which are similar to basins, are long, narrow, gravel-filled trenches, often vegetated, that infiltrate stormwater runoff from small drainage areas. Infiltration trenches may include a shallow depression at the surface, but the majority of runoff is stored in the void space within the gravel and infiltrates through the sides and bottom of the trench.

3 Depending on the design of the infiltration practice, Federal Underground Injection Control (UIC) Rules (40 CFR 144) may apply, which may further restrict the use of infiltration facilities in some locations.

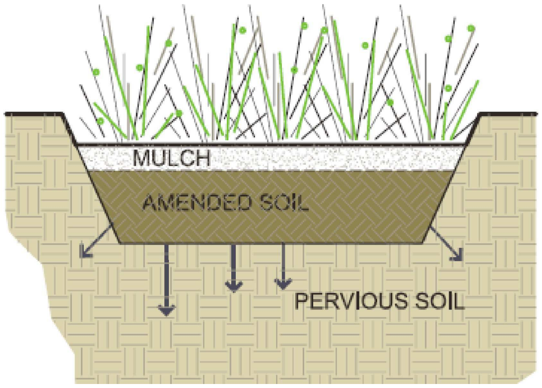
Infiltration Galleries

Infiltration galleries are open-bottom, subsurface vaults that store and infiltrate stormwater. A number of vendors offer prefabricated, modular infiltration galleries that provide subsurface storage and allow for infiltration. Infiltration galleries come in a variety of material types, shapes and sizes.



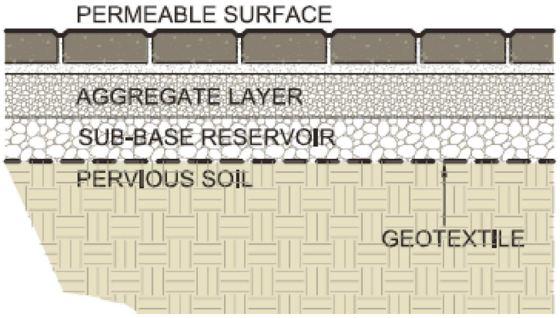
Bioretention

Bioretention stormwater treatment facilities are landscaped shallow 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, plantings, and, optionally, a subsurface gravel reservoir layer.



Permeable Pavements

Permeable (or pervious) pavements contain small voids that allow water to pass through to a stone base. They come in a variety of forms; they may be a modular paving system (concrete pavers, modular grass or gravel grids) or poured-in-place pavement (porous concrete, permeable asphalt). All permeable pavements with a stone reservoir base treat stormwater and remove sediments and metals to some degree by allowing stormwater to percolate through the pavement and enter the soil below.

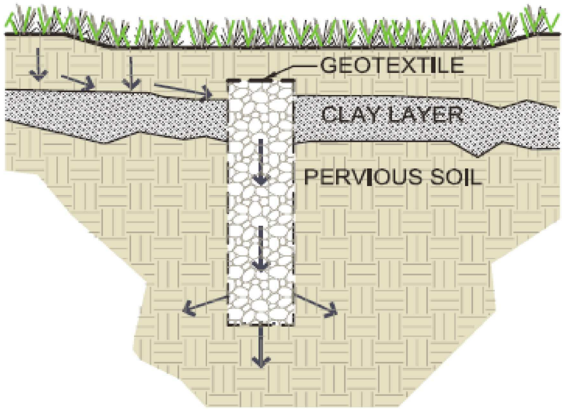


Multi-Directional Infiltration BMPs

These BMPs take advantage of the hydraulic conductivities (K_{sat}) of multiple soil strata and infiltration in multiple directions. They may be especially useful at locations where low K_{sat} values are present near the surface and soils with higher permeabilities exist beneath. A Multi-Directional Infiltration BMP may be implemented to infiltrate water at these lower soil layers, thus allowing infiltration to occur at sites that otherwise would be infeasible. These infiltration BMPs typically have smaller footprints and include, but are not limited to:

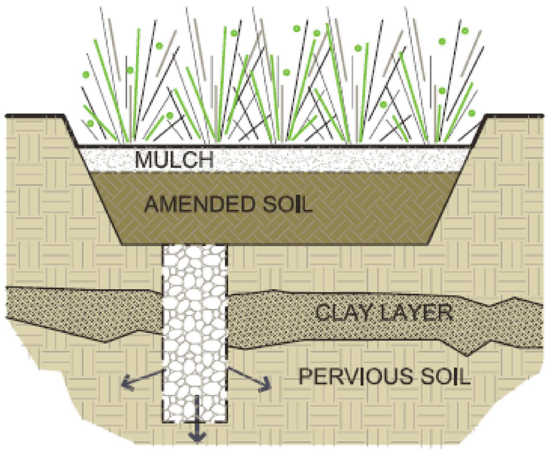
Dry Wells

A dry well is defined as an excavated, bored, drilled, or driven shaft or hole whose depth is greater than its width. Drywells are similar to infiltration trenches in their design and function, as they are designed to temporarily store and infiltrate runoff, primarily from rooftops or other impervious areas with low pollutant loading. A dry well may be either a drilled borehole filled with aggregate or a prefabricated storage chamber or pipe segment.



Hybrid Bioretention/Dry Wells

A bioretention facility with dry wells is useful in areas with low surface-level hydraulic conductivities that would normally deem a bioretention BMP infeasible but have higher levels of permeability in deeper strata. By incorporating drywells underneath the bioretention facility, water is able to be infiltrated at deeper soil layers that are suitable for infiltration, if present. This hybrid BMP combines the aesthetic and filtration qualities of a bioretention facility with the enhanced infiltration capabilities of a dry well.



4.4.2 Siting Requirements and Opportunity Criteria

Drainage areas implementing infiltration BMPs must pass the Category 1 or Category 2 Screening in accordance with the siting requirements set forth in Table 4.1. This screening process must be approved by a site-specific geotechnical investigation report and/or hydrologic analysis conducted and certified by a State of California registered professional geotechnical engineer or geologist.

Additionally, drainage areas that will result in high sediment loading rates to the infiltration facility shall require pretreatment to reduce sediment loads and avoid system clogging. Examples of appropriate pretreatment may include: sedimentation/settling basins, baffle boxes, hydrodynamic separators, media filters, vegetated swales, or filter strips.

4.4.3 Calculating Size Requirements for Infiltration BMPs

The main challenge associated with infiltration BMPs is preventing system clogging and subsequent infiltration inhibition. In addition, infiltration BMPs must be designed to drain in a reasonable period of time so that storage capacity is available for subsequent storms and so that standing water does not result in vector risks or plant mortality. Infiltration BMPs should be designed according to the requirements listed in Table 4.2 and outlined in the text following.

Infiltration facilities must be sized to completely infiltrate the design capture volume within 48 hours. Steps for the simple sizing method are provided below.

Step 1: Calculate the Design Volume

Infiltration facilities shall be sized to capture and infiltrate the design capture volume (V_{design}) of water produced by the stormwater quality design storm event as determined in section 3.2.2

$$V_{design}\text{ (cu ft)} = 0.0625\ (ft)\ \times \text{Catchment Area (sq ft)}$$

or

$$V_{design}\text{ (cu ft)} = \text{depth of from } 85^{th} \text{ percentile (ft)}^{4}\ \times \text{Catchment Area (sq ft)}$$

Where:

Catchment Area = (Impervious Area x 0.9) + [(Pervious Area + Undeveloped Area) x 0.1]

For catchment areas given in acres, multiply the above equation by 43,560 sq. ft./acre.

4 Refer to Los Angeles County website to determine the depth of the 85th percentile, 24-hour runoff event. http://dpw.lacounty.gov/wrd/hydrologygis/. See also Appendix F.

Table 4.2: Infiltration BMP Design Criteria

Design Parameter	Unit	Basins and Trenches	Galleries	Bioinfiltration	Permeable Pavement	Dry Well[d]	Hybrid Bioretention/ Dry Well
Design Capture Volume, $V_{capture}$	cubic feet	Volume of water produced by the stormwater quality design storm event as determined in section 3.2.2 0.0625 (ft) x Catchment Area (sq. ft.)[a] *or* *= depth of from 85th percentile (ft) x Catchment Area (sq ft)*					
Design Drawdown Time	hrs	At surface = 48 Below grade = up to 96					
Setbacks and Elevations	-	In accordance with the Infiltration Feasibility Criteria, Section 4.2 and current Stormwater Informational Bulletien.					
Pretreatment	-	Appropriate Treatment Control Measure shall be provided as pretreatment for all tributary surfaces.					
Hydraulic Conductivity, $K_{sat,measured}$	in/hr	Measured hydraulic conductivity at the location of the proposed BMP at the depth of the proposed infiltrating surface (or effective infiltration rate where multi directional infiltration is occurring).					
Factor of Safety, FS[b]	-	3					
Facility geometry	-	Basin: Bottom slope ≤ 3%; side slope ≤ 3:1 (H:V)	Flat bottom slope	Bottom slope ≤ 3%; side slope ≤ 3:1 (H:V)	Pavement slope ≤ 5%; If ≥ 2%, area shall be terraced	Typical 18 – 36 inch diameter; flat bottom slope	Bioretention: Bottom slope ≤ 3%; side slope ≤ 3:1 (H:V) Drywell: flat bottom
Ponding Depth	inch	18 (max)[c]	-	18 (max)[c]	-	-	18 (max)[c]
Media Depth	feet	2 (min) 8 (max)	-	2 (min) 8 (max)	2 (min) 8 (max)	-	2 (min) 8 (max)
Washed gravel media diameter	inch	1 – 3	-	-	1 - 2	3/8 – 1	3/8 - 1
Inlet erosion control	-	Energy dissipater to reduce velocity					
Overflow device	-	Required if system is on-line and does not have an upstream bypass structure. Shall be designed to handle the peak storm flow in accordance with the Building and Safety code and requirements					

a: Catchment area = (impervious area x 0.9) + [(pervious area + undeveloped area) x 0.1]

b: Listed FS values to be used only if soil infiltration / percolation test was performed and a detailed geotechnical report from a professional geotechnical engineer or engineering geologist is provided. A FS of 6 will be assigned if only a boring was done.

c: Ponding depth may vary for galleries (which have a storage depth) and may be different from one vendor to another.

d. City of Los Angeles does not require the reduction factor to be applied to measured percolation rate.

Step 2: Determine the Design Infiltration Rate

The infiltration rate will decline between maintenance cycles as the surface becomes clogged with particulates and debris. 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 sizing of facilities depending on a site's infiltration rate and expected surface loading. Where applicable, the measured infiltration rate discussed here is the infiltration rate of the underlying soils and not the infiltration rate of the filter media bed or engineered surface soils.Facility maintenance is required to maintain the infiltration rate for the life of the project. Infiltration rates used for design must be divided by the appropriate factors of safety.

$$K_{sat,design} = K_{sat,measured}/FS$$

Where:

FS = Infiltration factor of safety, in accordance with Table 4.2

Measured infiltration rates shall be determined by in-ground, site specific infiltration tests or can be based on laboratory tests conducted on soil samples collected during the exploratory work for a site-specific geotechnical report.

Step 3: Calculate the BMP Surface Area

Determine the size of the required infiltrating surface by assuming the design capture volume will fill the available ponding depth plus the void spaces of the gravel fill (normally about 30 - 40% [5]) or amended soil (normally about 20 – 30%).

Determine the minimum infiltrating surface area necessary to infiltrate the design volume:

$$A_{min} = (V_{design} \text{ x } 12 \text{ in/ft}) / (T \text{ x } K_{sat,\ design})$$

Where:

A_{min} = Minimum infiltrating surface area (ft^2)

T = Drawdown time (hours), 48 hours

The calculated minimum BMP surface area only considers the surface area of the BMP where infiltration can occur. For dry wells, the calculated surface area is the total surface area of the well lying in soils with $K_{sat,measured}$ values > 0.3 in/hr. In other words, the portion of the dry well that extends through impermeable layers should not be considered part of the infiltrating area. For the hybrid bioretention/dry well BMP design, the calculated BMP surface area applies to the combined surface area of the bioretention facility and the infiltrating portion of the underlying dry well(s).

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5 Terzaghi and Peck stated that in the densest possible arrangement of cohesionless spheres, the porosity is equivalent to 26%; in the loosest possible arrangement, the porosity is equal to 47% (Terzaghi K. and Peck R. Soil Mechanics in Engineering Practice. 2nd ed. New York: John Wiley and Sons; 1967).

For infiltration basins, the surface area should be calculated as the surface area at mid-ponding depth. For infiltration trenches, the surface area should be calculated at the bottom of the trench.

Note that A_{min} represents the minimum calculated surface area. It is up to the discretion of the developer if A_{min} will be exceeded to allow for less media storage.

*Step 4: Calculate the Total Storage Volume**

Determine the storage volume of the infiltration unit to be filled with media for capturing the design capture volume.

$$V_{storage} = V_{design} / n$$

Where:

$V_{storage}$ = Minimum media storage of the infiltration facility (ft^3)
n = void ratio (use 0.40 for gap graded gravel)

* Note: Dry wells with gravel fill may not store the entire design volume; additional storage unit(s) to capture the remaining design volume may be required upstream of the dry well.

Step 5: Calculate the Media Storage Depth

Determine the depth of the infiltration unit to be filled with media for capturing the design capture volume. The depth shall not exceed 8 feet – except for dry well(s).

$$D_{media} = V_{storage} / A_{min}$$

Where:

D_{media} = Minimum media storage depth of the infiltration facility (ft)

If D_{media} is calculated as greater than 8 feet, the design infiltration area (A_{design}) shall be increased and the depth of media shall be recalculated until it is less than 8 feet.

Many project developers may elect to increase the design infiltration area such that $A_{design}>A_{min}$. This is especially feasible where infiltration rates are relatively high (leading to a low A_{min} value). The depth of media (D_{media}) should be calculated using the actual design area in Step 5 above. For projects with designed infiltration areas significantly higher than A_{min}, it may be feasible to have no media storage (i.e. D_{media} = 0 ft). For this to apply, the following condition must be met:

$$A_{design} \geq (V_{design} \times 12in/ft) / (K_{sat,design} \times T)$$

Infiltration Sizing Example

Given: 30,000 ft^2 apartment complex (including parking) with 10,000 ft^2 of landscaped area. An infiltration test has resulted in a $K_{sat,measured}$ value of 1.0 in/hr; Factor of Safety = 3. Design an infiltration trench meeting the sizing requirements. Assume the trench is full of gap-graded gravel with a void ratio of 0.4.

1) Determine V_{design}

   85th Percentile storm event = 1.1-inch (0.0916 ft) > 0.75-inch (0.0625 ft)

   Therefore, use 1.1-inch (0.0916 ft)

   Catchment Area = (30,000ft^2 x 0.9) + [(10,000 ft^2) x 0.1] = 28,000 ft^2

   V_{design} = 0.0916 ft * 28,000 ft^2 = **2,565 ft^3**

2) Determine $K_{sat,design}$

   $K_{sat,design}$ = $k_{sat,\ measured}$ / FS = (1 in/hr) / 3 = **0.333 in/hr**

3) Determine A_{min}

   $A_{min} = (V_{design} \times 12 /(T \times k_{sat,\ design})$

   = (2,565ft^3 x 12 in/ft)/(48hrs x 0.333 in/hr) = **1,925 ft^2**

4) Determine $V_{storage}$

   $V_{storage} = V_{design} / n$ = 1,750 / 0.4 = **6,412ft^3**

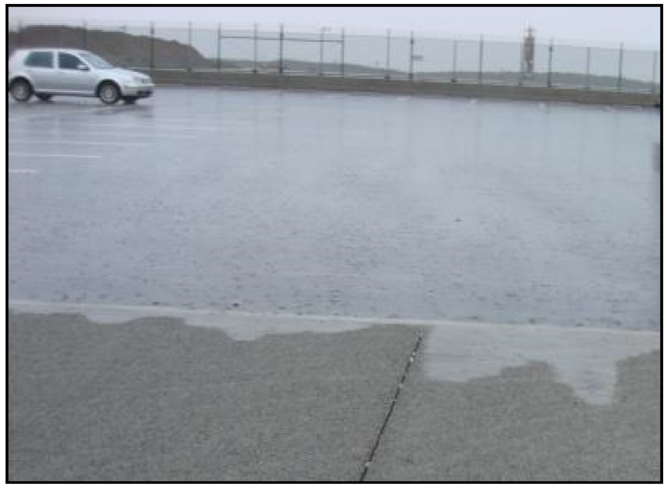
5) Determine D_{media}

   $D_{media} = V_{storage} / A_{min}$ = 6,412 ft^3 / 1,925 ft^2 = **3.33 ft**

The trench should therefore be designed with a minimum of 1,925ft^2 of infiltrating surface area. At this minimum surface area, the gravel media depth should be at least 3.33 ft.

4.4.4 Design Criteria and Requirements

Unless specifically stated, the following criteria and requirements listed below are required for the implementation of all infiltration BMPs. Provisions not met must be approved by the City of Los Angeles.



Permeable Pavement Application
Los Angeles World Airports Parking

- Infiltration BMPs have been designed and constructed to promote uniform ponding and infiltration.
- Where necessary, a sediment forebay or separate pretreatment unit (e.g. vegetated swale, filter strip, hydrodynamic device, etc.) is located between the inlet and infiltration BMP. The sediment forebay has a volume greater than or equal to 25% of the total design volume.
- Sediment forebay has a minimum length to width ratio of 2:1 and is designed to conduct flow to the infiltration BMP.
- Any embankment slopes (interior and exterior) are not steeper than 3:1 (H:V) unless approved by the City of Los Angeles.
- The bottom of the infiltration bed is native soil and has been over-excavated to at least one foot in depth. It is recommended that the excavated soil be amended with 2 – 4 inches of coarse sand before being replaced uniformly without compaction.
- The hydraulic conductivity (Ksat) of the subsurface layers is sufficient to ensure the maximum drawdown time of 48 hours.
- Where Ksat values are greater than 2.4 in/hr, pretreatment is provided to address pollutants of concern prior to infiltration to protect groundwater quality; pretreatment may be considered to be addressed in the amended media or sand layers within the BMP if provided.
- Provided overflow safely conveys flows to the downstream stormwater conveyance system, an additional BMP, or an alternatively acceptable discharge point.
- Where the infiltration system is placed underground, an observation well is provided for inspection/mainteance purposes.
- Porous pavement facilities consist of various layers of material. The top layer consists of either asphalt or concrete with a percentage of voids of at least 15%. This layer is followed by a washed stone reservoir layer or a thick layer of washed aggregate with 25-

35% voids. Two transition layers are also present. The depth of each layer and the specific materials used shall be determined by a licensed civil engineer.

- Dry wells shall be filled with 3/4 – 1 inch washed crushed rock, recycled concrete aggregate, or open-graded gravel (i.e. gravel with a small percentage of small particles). If a perforated pipe has been installed in the well, perforations are 3/8" and are smaller than the fill gravel. A woven geotextile shall be placed over the top of the drywell to prevent sediment clogging.

4.4.5 Soil and Vegetation Requirements

Soil and vegetation to be incorporated in infiltration facilities shall be selected by a licensed landscape architect. In general, drought and flood resistant plant species native to California should be selected when possible. Soil media should be selected to not restrict performance requirements. Selected soils shall therefore have a higher hydraulic conductivity than the underlying soil, shall be able to support the selected plant palette, and shall be graded to provide adequate filtration as to not clog underlying soils.

4.4.6 Construction Requirements

To preserve and avoid the loss of infiltration capacity, the following construction guidelines shall be adhered to:

Underground Infiltration Units
Lowe's, Pacoima

- The entire area draining to the infiltration facility is stabilized before construction of the infiltration facility begins, or a diversion berm is placed around the perimeter of the infiltration site to prevent sediment entrance during construction.
- Infiltration BMPs shall not be used as sediment control facilities during construction.
- Compaction of the subgrade with vehicles and/or equipment is minimized. If the use of heavy equipment on the base of the facility cannot be avoided, the infiltrative capacity shall be restored by tilling or aerating prior to placing the infiltrative bed.
- Where pervious pavement is to be installed, installation of the pavement shall be scheduled as the the last installation at a development site. Vehicular traffic is prohibited for at least 2 days following installation. Site materials shall not stored on pervious pavement.

4.4.7 Operations and Maintenance

- Frequent inspections of the infiltration facilities shall occur to ensure that surface ponding infiltrates into the subsurface completely within the design drawdown time following storms. If vector breeding is taking place at a site as a result of contained stormwater or inadequately maintained BMPs, the Greater Los Angeles County Vector Control District has the ability to fine site owners for violating the California Health and Safety Code (Section 2060 – 2067).
- Regular inspections shall take place to ensure that the pretreatment sediment removal BMP/forebay is working efficiently. Sediment buildup exceeding 50% of the forebay sediment storage capacity shall be removed.
- The infiltration facility shall be maintained to prevent clogging. Maintenance activities include checking for debris/sediment accumulation and removal of such debris.
- Facility soil (if applicable) shall be maintained. Flow entrances, ponding areas, and surface overflow areas will be inspected for erosion periodically. Soil and/or mulch will be replaced as necessary to maintain the long-term design infiltration rate for the life of the project.
- Site vegetation shall be maintained as frequently as necessary to maintain the aesthetic apperance of the site as well as the filtration capabilities (where applicable). This includes the removal of fallen, dead, and/or invasive plants, watering as necessary, and the replanting and/or reseeding of vegetation for reestablishment as necessary.
- Pervious pavement areas that are damaged or clogged shall be replaced/repaired per manufacture's recommendation as needed.
- Follow all propritery operation and maintenance requirements

4.5 CAPTURE AND USE BMPS

Capture and Use refers to a specific type of BMP that operates by capturing stormwater runoff and holding it for efficient use at a later time. On a commercial or industrial scale, capture and use BMPs are typically synonomous with cisterns, which can be implemented both above and below ground. Cisterns are sized to store a specified volume of water with no surface discharge until this volume is exceeded. The primary use of captured runoff is for subsurface drip irrigation purposes. 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 stormwater runoff that flows overland into a stormwater conveyance system, less pollutants are transported through the conveyance system into local streams and the ocean. The onsite use of the harvested water for non-potable domestic purposes conserves City-supplied potable water and, where directed to unpaved surfaces, can recharge groundwater in local aquifers.

Underground Cistern
Taylor Yard

4.5.1 Siting Requirements and Opportunity Criteria

Drainage areas implementing capture and use BMPs must pass the feasibility screening in accordance with the siting requirements set forth in Section 4.3. This screening process must be approved by a site-specific geotechnical investigation report and/or hydrologic analysis conducted and certified by a State of California registered professional civil engineer, geotechnical engineer, geologist, or other qualified professional.

Capture and use BMPs designed for these extended holding times will require additional treatment such as filtration or disinfection to protect the collection tanks from fouling, to prevent the breeding of vectors, and/or to improve the quality of water for reuse applications. These scenarios will be reviewed on a case-by-case basis.

4.5.2 Irrigation / Dispersial of Captured Stormwater

A developer is required to hold harvested stormwater for the purpose of irrigation during dry periods. Calculations in line with the California Department of Water Resources Model Water Efficent Landscape Ordiance AB 1881 (also refer to City of Los Angles Irrigation Guidelines[6]) shall be provided. Captured stormwater should be used to offset the potable irrigation demand that would occur during the rain season (Oct 1 – Apr 31, 7 months). If the volume of captured

6 City of Los Angles Irrigation Guidelines: http://cityplanning.lacity.org/Forms_Procedures/2405.pdf

stormwater exceeds the Estimated Total Water Use for the rain season ($ETWU_7$),excess stormwater shall, at a minimum establish a schedule to release captured stormwater over landscaping.

4.5.3 Design Criteria and Requirements

- Unless specifically stated, the following criteria and requirements listed below are required for the implementation of all capture and use BMPs. Provisions not met must be approved by the City of Los Angeles.
- Fertilizers, pesticides, or herbicides on landscaped areas shall be minmized.
- Above-ground cisterns are secured in place and designed to meet seismic requiremnts for tanks.
- Overflow outlet is provided upstream of the tank inlet and is designed to disperse overflow onsite. Dispersial and overflow must be through an approved landscape areas where erosion or suspension of sediment is minimized, or through a high flow biotreatment BMP. Overflow from the tank into the storm drain system is not allowed.

Capture & Use

- For landscape applications, a subsurface drip irrigation system, a pop up, or other approved irrigation system, has been aproved and installed to adequately discharge the captured water[7].
- If a pumping system is used, a reliable pump capable of delivering 100% of the design capacity is provided. Pump is accessible for maintenance. Pump has been selected to operate within 20% of its best operating efficiency. A high/low-pressure pump shut off system is installed in the pump discharge piping in case of line clogging or breaking.
- If an automated harvesting control system is used, it is complete with a rainfall or soil moisture sensor. The automated system has been programmed to not allow for continuous application on any area for more than 2-hours.
- Dispersion is directed so as not to knowingly cause geotechnical hazards related to slope stability or triggering expansive (clayey) soil movement.
- Cisterns do not allow UV light penetration to prevent algae growth.
- Cistern placement allows easy access for regular maintenance. If cistern is undergrond, manhole shall be accessible, operational, and secure.

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7 If alternative distribution systems (such as spray irrigation) are approved, the City will establish guidelines to implement these new systems.

- Refer to County of Los Angeles , Department of Health Services for additional guidelines and requiremnets (Appendix J).
- Provide observation access for vector inspection and treatment.

4.5.4 Operations and Maintenance

- Cistern components, including spigots, downspouts, and inlets will be inspected 4 times annually to ensure proper functionality. Parts will be repaired or replaced as needed.
- Cisterns and their components will be cleaned as necessary to prevent algae growth and the breeding of vectors.
- Dispersion areas will be maintained to remove trash and debris, loose vegetation, and rehabilitate any areas of bare soil.
- Effective energy dissipation and uniform flow spreading methods will be employed to prevent erosion and facilitate dispersion.
- Cisterns will be emptied as necessary to prevent vector breeding, unless exclusion devices are implemented to prevent vector access. If vector breeding is taking place at a site as a result of contained stormwater or inadequately maintained BMPs, the Greater Los Angeles County Vector Control District has the ability to fine site owners for violating the California Health and Safety Code (Section 2060 – 2067).

4.6 HIGH EFFICENCY BIOFILTRATION BMPS

Bioretention (Planter Boxes)
Watermarke Tower

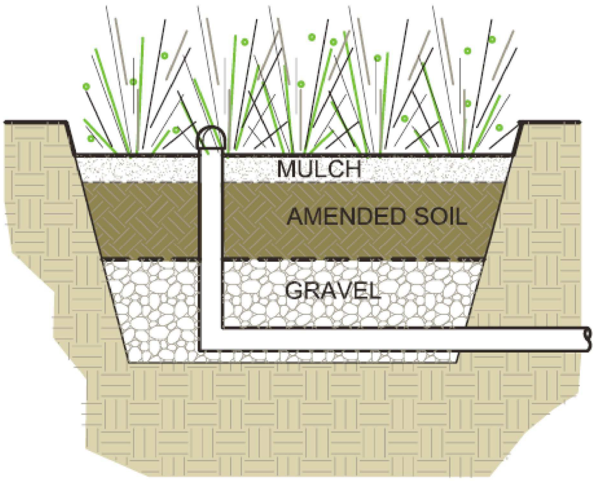
Projects that have demonstrated they cannot manage 100% of the water quality design volume onsite through infiltration and/or capture and use BMPs may manage the remaining volume through the use of a high removal efficiency biofiltration/biotreatment BMP. A high removal efficiency biofiltration/biotreatment BMP shall be sized to adequately capture 1.5 times the volume not managed through infiltration and/or capture and use.

Biofiltration BMPs are landscaped facilities that capture and treat stormwater runoff through a variety of physical and biological treatment processes. Facilities normally consist of a ponding area, mulch layer, planting soils, plants, and in some cases, an underdrain. Runoff that passes through a biofiltration system is treated by the natural adsorption and filtration characteristics of the plants, soils, and microbes with which the water contacts. Biofiltration BMPs include vegetated swales, filter strips, planter boxes, high flow biotreatment units, bioinfiltration facilities, and bioretention facilities with underdrains. Biofiltration can provide multiple benefits, including pollutant removal, peak flow control, and low amounts of volume reduction through infiltration and evapotranspiration.

4.6.1 Biofiltration BMP Types

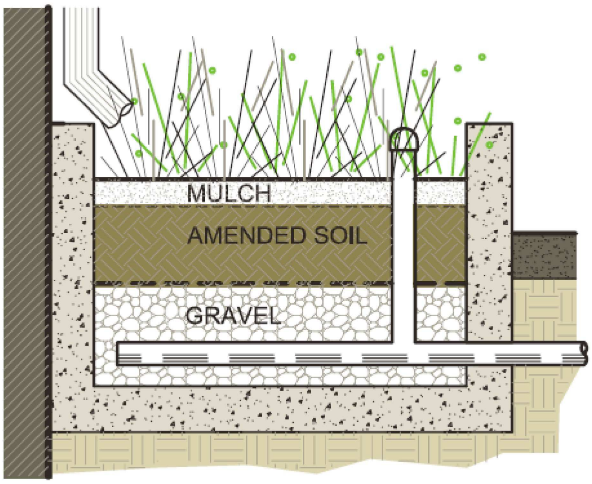
Biofiltration BMPs rely on various hydraulic residence times and flow-through rates for effective treatment. As a result, a variety of BMPs are available.

Bioretention with Underdrain



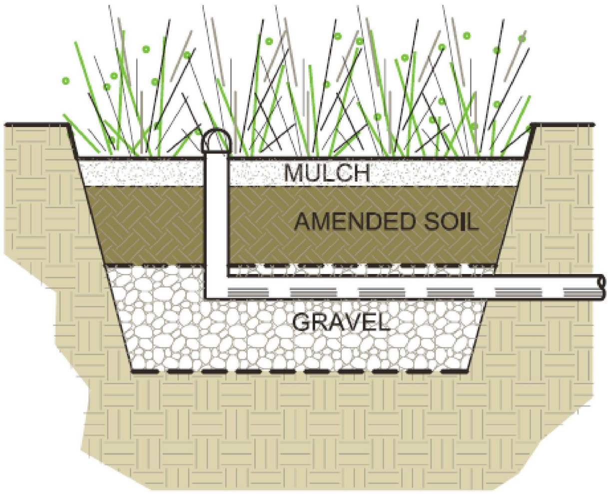
Bioretention facilities are landscaped shallow depressions that capture and filter stormwater runoff. As stormwater passes down through the planting soil, pollutants are filtered, adsorbed, and biodegraded by the soil and plants. Because they are not contained within an impermeable structure, they may allow for infiltration. For sites not passing the infiltration feasibility screening for reasons other than low infiltration rates (such as soil contamination, expansive soils, etc.), an impermeable liner may be needed to prevent incidental infiltration.

Planter Boxes



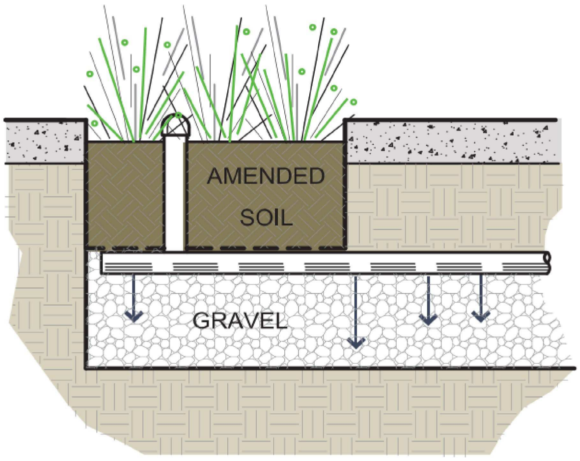
Planter boxes are bioretention treatment control measures that are completely contained within an impermeable structure with an underdrain (they do not infiltrate). They are similar to bioretention facilities with underdrains except they are situated at or above ground and are bound by impermeable walls. Planter boxes may be placed adjacent to or near buildings, other structures, or sidewalks.

Bioinfiltration



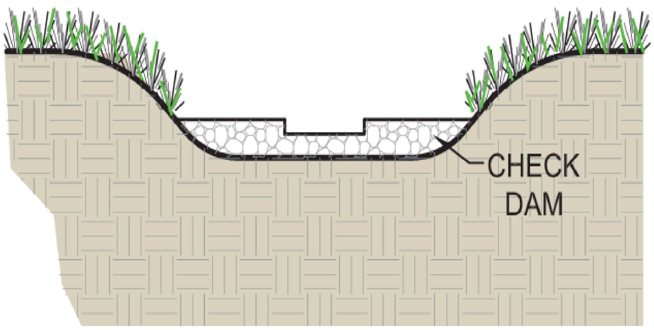
Bioinfiltration facilities are designed for partial infiltration of runoff and partial biotreatment. These facilities are similar to bioretention devices with underdrains but they include a raised underdrain above a gravel sump designed to facilitate infiltration and nitrification/denitrification. These facilities can be used in areas where there are little to no hazards associated with infiltration, but infiltration screening does not allow for infiltration BMPs due to low infiltration rates or high depths of fill.

High-Flow Biotreatment with Raised Underdrain



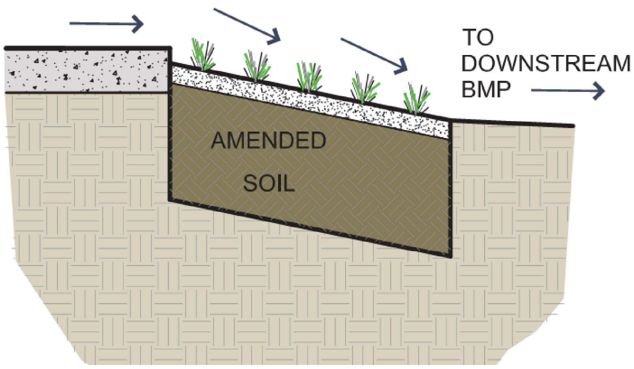
High-flow biotreatment devices are proprietary treatment BMPs that incorporate plants, soil, and microbes engineered to provide treatment at higher flow rates and with smaller footprints than their non-proprietary counterparts. Like bioinfiltration devices, they should incorporate a raised underdrain above a gravel sump to facilitate incidental infiltration where feasible. They must be shown to have pollutant removal efficiencies equal to or greater than the removal efficiencies of their non-proprietary counterparts. Proof of this performance must be provided by adequate third party field testing.

Vegetated Swales



Vegetated swales are open, shallow channels with dense, low-lying vegetation covering the side slopes and bottom that collect and slowly convey runoff to downstream discharge points. An effective vegetated swale achieves uniform sheet flow through the densely vegetated area for a period of several minutes. The vegetation in the swale can vary depending on its location and is the choice of the designer. Most swales are grass-lined.

Filter Strips (to be used as part of a treatment train)



Filter strips are vegetated areas designed to treat sheet flow runoff from adjacent impervious surfaces such as parking lots and roadways, or intensive landscaped areas such as golf courses. 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. Filter strips are primarily used to pretreat runoff before it flows to an infiltration BMP or another biofiltration BMP.

4.6.2 Siting Requirements and Opportunity Criteria

Sites with plans to implement high removal efficiency biofiltration/biotreatment systems for the management of stormwater must first be screened for infiltration and capture and use BMP feasibility. Biofiltration should be implemented to treat all runoff onsite to the maximum extent feasible at sites incapable of implementing infiltration and/or capture and use BMPs as a result of the feasibility screening process set forth in this handbook.

Sites implementing biofiltration BMPs must have sufficient area available to ensure that BMPs produce adequate contact time for filtration to occur. For biofiltration BMPs with underdrains, sufficient vertical relief must exist to permit vertical percolation through the soil media to the underdrain below. For biofiltration BMPs with incidental infiltration, it must be demonstrated that there are no hazards associated with infiltration (i.e. infiltration screening does not allow for infiltration BMPs due to low infiltration rates or high depths of fill).

4.6.3 Calculating Size Requirements for Biofiltration BMPs

Biofiltration BMPs should be designed according to the requirements listed in Table 4.3 and outlined in the section below.

Table 4.3: Biofiltration BMP Design Criteria

Design Parameter	Unit	Bioretention with Underdrain	Planter Box	Bioinfiltration	High Flow Biotreatment[a]	Vegetated Swale	Filter Strip
Design Capture Volume, $V_{capture}$	cubic feet	Volume of water produced by the stormwater quality design storm event as determined in section 3.1.2 = 1.5 x 0.0625 (ft) x Catchment Area (sq. ft.)[b] *or* *= 1.5 x depth of from 85^{th} percentile (ft) x Catchment Area (sq ft)*[b]					-
Drawdown Time	hr	Begins at surface = 48				-	-
Factor of Safety[c]	-	2				-	
Soil Media Infiltration Rate	in/hr	5 (max)			Per manufacturer's standards	-	
Max time to fill ponding depth (T_{Fill})	hrs	Min = 2; Max = 3[d]					
Contact Time	min	-				≥ 7	
Slope in Flow Direction	%	-				1% (min) 6% (max)	2% (min) 6% (max)
Flow Velocity	ft/sec	-				≤ 1	
Ponding Depth	inch	Min = 3 Max = 18	Min = 3 Max = 12	18	-	5	1
Minimim Inside Base Width	ft	2			-	Table 4.4	15
Soil Depth	ft	Min =1.5; Max = 2[d] ; Topped with 3" of mulch			-	2	-
Facility geometry	-	Bottom> 2% (max); Side slope ≤ 3:1(H:V)	-	Bottom> 2% (max) Side slope ≤3:1 (H:V)	-	See Table 4.5 Side slope ≤ 3:1 (H:V)	
Washed gravel diameter	inch	1-2			-	-	-
Underdrain	-	Slotted PVC pipe embeded in 12" gravel section(max), 6"(min); located 1" from bottom of facility		Slotted PVC pipe at least 2' above bottom of facility	Per manufacturer's standards	N/A	Not required
Erosion control	-	Energy dissipater to reduce velocity at inlet					
Overflow device	-	Shall be designed to handle peak storm flow in accordance with the Building and Safety code and requirements					Not Required

a: High flow biotreatment BMP design criteria displayed in Table 4.3 are general guidelines. Specific designs will vary depending on the vendor, design type, size, etc. High flow biotreatment BMPs must be sized to treat the design capture volume specified. They must be shown (by third party field testing) to have a pollutant removal efficiency equal to or greater than their non-proprietary counterparts.

b: Catchment area = (impervious area x 0.9) + [(pervious area + undeveloped area) x 0.1]

c: Listed FS values to be used only if soil infiltration / percolation test was performed and a detailed geotechnical report from a professional geotechnical engineer or engineering geologist is provided A FS of 6 will be assigned if only a boring was done.

d. For alternative designs see Appendix F

Biofiltration (Planter Boxes) treatment Sizing

With the exception of swales and filter strips, biofiltration facilities can be sized using one of two methods: a simple sizing method or a hydrologic routing modeling method. With either method the design capture volume must be completely infiltrated within the drawdown time shown in Table 4.3. Steps for the simple sizing method are provided below.

Step 1: Calculate the Design Volume

Biofiltration facilities shall be sized to capture and treat 150% of the design capture volume (V_{design}) of water produced by the stormwater quality design storm event as determined in section 3.1.2

= 1.5 x 0.0625 (ft) x Catchment Area (sq. ft.)

or

= 1.5 x depth of from 85th percentile (ft) x Catchment Area (sq ft)

Where

Catchment area = (Impervious Area x 0.9) + [(Pervious Area + Undeveloped Area) x 0.1]

Step 2: Determine the Design Infiltration Rate

The infiltration rate will decline between maintenance cycles as the surface and underlying soil matrix becomes clogged with particulates and debris. 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 sizing of facilities depending on a site's infiltration rate and expected surface loading. Unlike infiltration BMPs, the measured infiltration rate discussed here is the infiltration rate of the filter media bed or engineered surface soils in the biofilter. A target long-term $K_{sat,media}$ of 5 in/hr is recommended for non-proprietary amended soil media. Facility maintenance is required to maintain the infiltration rate for the life of the project. Infiltration rates used for design must be divided by the appropriate factors of safety.

$$K_{sat,design} = K_{sat,media}/FS$$

Step 3: Calculate the BMP Ponding Depth

Select a ponding depth (d_p) that satisfies geometric criteria and is congruent with the constraints of the site. The ponding depth must satisfy the maximum ponding depth constraint shown in Table 4.3 as well as the following:

$$d_p \text{ (ft)} = (K_{sat,design} \times T) / 12$$

Where:

d_p = Ponding depth (ft)

$K_{sat,design}$= Design infiltration rate of filter media (in/hr)

T = Required surface drain time (hrs), from Table 4.3

Step 4: Calculate the BMP Surface Area

Calculate infiltrating surface area (filter bottom area) required:

$$A_{min} = \frac{V_{design}}{[(T_{fill} K_{sat,design}/12) + d_p]}$$

Where:

A_{min} = Design infiltrating area (ft^2)

T_{fill}= Time to fill to max ponding depth with water (hrs), assume a maximum of 3 hours. If the minimum area requirement cannot be achieved using the design criteria in Table 4.3, T_{fill} can be modified to a minimum of 1 hour.

The calculated BMP surface area only considers the surface area of the BMP where infiltration through amended media can occur. The total footprint of the BMP should include a buffer for side slopes and freeboard.

Bioinfiltration BMPs and high-flow biotreatment devices should incorporate a raised underdrain above the gravel sump to facilitate incidental infiltration where feasible. For these instances, infiltration screening in accordance with Section 4.2 must be carried out to show that infiltration BMPs are not allowed due to low infiltration rates or high depths of fill (i.e. there are not hazards associated with infiltration). These BMPs are not suitable for project sites that do not pass infiltration feasibility screening due to associated hazards of infiltration (e.g. high groundwater table, contaminated soil or groundwater, landslide zones, liquefaction, etc.)

Swale Sizing

Swales shall be designed with a trapezoidal channel shape with side slopes of 3:1 (H:V). They shall incorporate at least two feet of soil beneath the vegetated surface. The following steps shall be followed for swale sizing. As is the case with other biofiltration BMPs, the sizing criteria presented in Table 4.5 must be met.

Step 1: Determine the Swale Base Width and Corresponding Unit Length

The base width of a swale must be between 2 and 10 feet. The designer may select the base width that is most appropriate for the site, but the swale length (per unit catchment area) must meet the minimum requirements as shown in Table 4.6 below.

Table 4.4: Swale Base Length (Per Unit Catchment Area)

Base of Swale	ft	2	3	4	5	6	7	8	9	10
Minimum Swale Length per Acre of Catchment Area	ft/acre	770	635	535	470	415	370	335	305	285

Step 2: Determine the Distance Between Check Dams

For volume storage, swales must incorporate check dams at specified intervals depending on the longitudinal slope of the swale, which must be between one and six percent. The check dams must be 12 inches in height and include a 6 inch deep notch in the middle of the check dam that is between one and two feet wide. All check dam structures shall extend across the entire base of the swale. They may be designed using a number of different materials including concrete blocks, gabions, gravel bags, rip rap, or earthen berms. The distance between successive check dams shall be determined from the longitudinal slope of the swale in the flow direction. Table 4.5 summarizes the design distances between check dams based on slope.

*Table 4.5: Check Dam Spacing Requirements for Swales**

Slope	%	1	2	3	4	5	6
Distance Between Checkdams	ft	N/A	N/A	33	25	20	17

* Depending on location of swale, approval from LADBS Grading Division may be required.

For intermediary slopes not shown in Table 4.5, linear interpolation may be used to calculate the distance between check dam structures.

Step 3: Determine the Total Swale Length

The total length of the swale (L_{swale}) is a function of the catchment area and unit swale length from Table 4.6. Total swale length is calculated as follows:

$$L_{swale}\ (\text{ft}) = 1.5 \times \textit{Catchment Area}\ (\text{ft}^2) \times (1\ \text{acre}/43{,}560\ \text{ft}^2) \times \textit{Swale Length per Acre of Catchment Area}\ (\text{ft/acre})$$

Where

Catchment area = (Impervious Area x 0.9) + [(Pervious Area + Undeveloped Area) x 0.1]

If there is adequate space on the site to accommodate a larger swale, consider using a greater length to increase the hydraulic residence time and improve the swale's pollutant removal capability. If the calculated length is too long for the site, the layout may be modified by meandering the swale or increasing the base width of the swale up to 10 feet. The total swale length shall never be less than 100 feet.

Filter Strip Sizing

Because filter strips are most often used for pretreatment purposes, their design will depend on the desired flow-rate to be treated and the type of BMP downstream, among other factors. As a result, filter strip sizing is not covered in this handbook, but will be determined on a case-by-case basis by the City of Los Angeles.

Bioinfiltration Sizing Example

Given: 20,000 ft^2 commercial development, 100% impervious (negligible landscaping). Design a bioinfiltration BMP to treat runoff from the entire development ($K_{sat,media}$= 5 in/hr; Factor of Safety = 2, T_{Fill} = 3 hrs).

1) Determine V_{design}

   85th Percentile storm event = 1.1-inch (0.0916 ft) > 0.75-inch (0.0625 ft)

   Therefore, use 1.1-inch (0.0916 ft)

   Catchment Area = (20,000ft^2 x 0.9) = 18,000ft^2
   V_{design} = 1.5 x 0.0916ft x 18,000ft^2 = **2,473ft^3**

2) Determine $K_{sat,design}$
   $K_{sat,design}$ = (5 in/hr) /2 = **2.5 in/hr**

3) Determine d_p
   d_p = (2.5 in/hr * 48 hrs)/12 = 10.0 ft
   Adhering to the max ponding depth requirements of Table 4.5, ***d_p* = 1.50 ft**

4) Calculate the infiltrating surface area, A_{min}

   $$A_{min} = \frac{2{,}473 cuft}{[(3hr * 2.5\, in/hr / 12) + 1.5\ ft]} = \mathbf{1{,}136\ ft^2}$$

For a full capture system, each bioinfiltration unit must be sized by tributary area, for a total of 1,136 ft^2.

4.6.4 Design Criteria and Requirements

Unless specifically stated, all criteria and requirements listed below are required for the implementation of all biofiltration BMPs. Provisions not met must be approved by the City of Los Angeles.

Bioretention in a Parking Lot
Photo Credit: Geosyntec Consultants

- Where applicable, biofiltration BMPs shall be constructed with a minimum planting soil depth of 2 feet (3 feet preferred) and topped with 3 inches of mulch.
- Where applicable, biofiltration BMPs shall be designed to drain below the planting soil in less than 48 hours and completely drain from the underdrains in 96 hours.
- Underdrains shall be constructed of slotted PVC pipe, sloped at a minimum 0.5% and placed per Table 4.3 requirements. Underdrains drain freely to a downstream stormwater conveyance system, an additional BMP, or an alternatively acceptable discharge point.
- If system is online, an overflow is present. The overflow safely conveys flows to the downstream stormwater conveyance system, an additional BMP, or an alternatively acceptable discharge point.
- Inflow to swales shall be directed towards the upstream end of the swale.
- Bioinfiltration BMPs and high-flow biotreatment BMPs designed for secondary infiltration shall pass the infiltration feasibility screening for all hazardous criteria. If necessary, weep holes shall be used to increase infiltration.
- Swales shall be constructed with a bottom width between 2 and 10 feet. Check dams shall be incorporated at the appropriate distances as specified in Table 4.5. Check dams are 12 inches in height and include a 6 inch deep notch in the middle of the check dam that is 1-2 feet wide. Each check dam extends across the entire width of the swale's base.
- Filter strips shall be constructed to extend across the full width of the tributary area. They shall be designed with sufficient slope in the flow direction to prevent ponding. They shall have a minimum length of 4 ft in the flow direction when sized for pretreatment purposes.

4.6.5 Soil and Vegetation Requirements

Soil and vegetation to be incorporated in biofiltration facilities shall be selected by a licensed landscape architect. In general, drought and flood resistant plant species native to Southern California should be selected when possible. Soil media should be selected to facilitate vigorous plant growth and not restrict performance requirements. Where the project receiving waters are impaired for nutrients, media should be selected to minimize the potential for leaching of nutrients from biofiltration systems.

4.6.6 Operations and Maintenance

Biofiltration areas require annual plant, soil, and mulch layer maintenance to ensure optimum infiltration, storage, and pollutant removal capabilities. In general, biofiltration maintenance requirements are typical landscape care procedures. The following operations and maintenance practices will be adhered to:

- Facility soil will be maintained. Flow entrances, ponding areas, and surface overflow areas will be inspected for erosion periodically. Soil and/or mulch will be replaced as necessary to maintain an infiltration rate at or near the initial $K_{sat,design}$value for the duration of the project.
- Site vegetation will be maintained as frequently as necessary to maintain fire protection, public safety, and the aesthetic appearance of the site as well as the filtration capabilities. This includes the removal of fallen, dead, and/or invasive plants, watering as necessary, and the replanting and/or reseeding of vegetation for reestablishment as necessary. Swales and filters will be mowed as necessary.
- BMP inlets will be inspected and maintained to ensure even flow enters the facility. Sediment collecting at the inlet will be removed as necessary.
- Proprietary devices will be inspected and maintained in accordance with the requirements of the manufacturer.

SECTION 5: OFFSITE MITIGATION MEASURES

5.1 OFFSITE MITGATION MEASURES

The option for offsite mitigation shall only be exercised after the following conditions have been met:

1. All the stormwater management techniques allowed (i.e., in priority order of infiltration, capture and use, treated through high removal efficiency biofiltration system) have been exhausted (i.e. are deemed technically infeasible), and;

2. A flow based proprietary mechanical device is installed to meet the flow generated from the stormwater quality design storm in order to maximize onsite compliance.

Offsite project BMPs should be located as close as possible to the project site, on private and/or public land, and should address a mix of land uses similar to those included in the proposed project. The offsite project shall not be located within waters of the U.S. and it shall be demonstrated that equivalent pollutant removal is accomplished prior to discharge to waters of the U.S.

For the remaining runoff that cannot feasibly be managed onsite, the project shall implement offsite mitigation in either:

1. The public right of way immediately adjacent to the subject development and/or;

2. Within the same sub-watershed (as defined as draining to the same HUC-12 hydrologic area as defined by the MS4 Permit) as the proposed project

Construction of an offsite mitigation project(s) shall achieve at least the same level of water quality protection as if all of the runoff were retained onsite and also be sized to mitigate the volume from the onsite and the tributary area from the adjacent street (from the crown of the street to the curb face for the entire length of the development site). All City Departments will assist the developer, when and where feasible, permitting and implementation of LID BMP projects within the public right of way.

Construction work in the public right-of-way will be the responsibility of the developer, and requires a “Revocable Permit” from the Department of Public Works, Bureau of Engineering (BOE). The developer will also be required to file a covenant and agreement with the county recorder’s office to insure the owner assumes full responsibility for perpetual maintenance of the onsite and offsite BMP(s) executed by a covenant and agreement. The type of BOE permit required depends on the scope of construction work. Additional permit information and detailed flowcharts can be found at: http://eng.lacity.org/techdocs/permits/index.htm

Green Infrastructure Projects

In an effort to assist developers the City has recently approved and adopted a series of green street standard plans. These plans provide a series of standards that developers can implement utilizing the public right of way immediately adjacent to the development. These standard plans provide general requirements for green streets, parkway swales in major/secondary highways, parkway swales in local/collector streets, parkway swales with no street parking, vegetated stormwater curb extensions, and interlocking pavers for vehicular and pedestrian alleys. The green street standard plans can be obtained from the Bureau of Engineering's Website at:

- http://eng.lacity.org/techdocs/stdplans/s-400.htm
- http://eng.lacity.org/techdocs/stdplans/Pdfs/Green%20Street%20Standard%20Plans%20FAQ%20Sheet_091010.pdf

Additional information on the City's Green Streets and Green Alleys design Guidelines can be found at: www.lastormwater.org

Appendix A	Development Planning Ordinances
Appendix B	Contact List
Appendix C	Small Scale Residential Plan Check Forms
Appendix D	All Other Development Plan Check Review Forms
Appendix E	Small Scale Residential Prescriptive Measures
Appendix F	All Other Development Sample Design Calculations
Appendix G	Source Control Measures
Appendix H	LA Department of Building and Safety Stormwater Infiltration Guidelines
Appendix I	Upper Los Angeles River Watermaster Requirements
Appendix J	County of LA Department of Public Health Policy and Operations Manual