SAN FRANCISCO

stormwatermanagementrequirements

and design guidelines

May 2016 Version - Updates and errata will be published as necessary

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ACKNOWLEDGEMENTS

The *San Francisco Stormwater Management Requirements and Design Guidelines* team would like to thank the members of our green infrastructure community who have graciously shared their wisdom, support, and the many valuable lessons they have learned. We are particularly grateful to staff from the counties of Contra Costa and Santa Clara, California and the cities of Emeryville, California; Portland, Oregon; Philadelphia, Pennsylvania; and Seattle, Washington.

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Acronyms / Abbreviations

ASTM	ASTM International, formerly "American Society for Testing and Materials"
BMP	Best Management Practice
CEQA	California Environmental Quality Act
CSD	Combined Sewer Discharge
CWA	Clean Water Act
DMA	Drainage Management Area
GI	Green Infrastructure
Guidelines	San Francisco Stormwater Design Guidelines (2010)
LEED®	Leadership in Energy & Environmental Design
LID	Low Impact Design
MEP	Maximum Extent Practicable
MS4	Municipal Separate Storm Sewer System
MS4 Permit	NPDES Phase II Municipal Separate Storm Sewer System Permit
NPDES	National Pollutant Discharge Elimination System
PCBs	Polychlorinated biphenyls
Port	Port of San Francisco
ROW	Right-of-Way
SCP	Stormwater Control Plan
SFDPW	San Francisco Department of Public Works
SFPUC	San Francisco Public Utilities Commission
SMARTS	Stormwater Multiple Application & Report Tracking System
SMO	San Francisco Stormwater Management Ordinance
SMR	San Francisco Stormwater Management Requirements and Design Guidelines (2016)
SSIP	Sewer System Improvement Program
State Water Board	California State Water Resources Control Board
USEPA	United States Environmental Protection Agency

Glossary

Best Management Practices (BMPs) Constructed facilities or measures to help protect receiving water quality and control stormwater quantity, also referred to as stormwater controls.

Bioretention A BMP designed to retain stormwater runoff using vegetated depressions and soils to collect, store, treat, and infiltrate runoff.

Capacity The flow volume or rate that a stormwater facility is designed to safely receive, manage, or convey to meet a specific performance standard.

Catch Basin Underground concrete box structure with openings in curbs and gutters designed to collect runoff from streets and pavement.

Check Dam A low structure or weir placed across an open channel to control water depth or velocity along steeper slopes, or to control channel erosion. Check dams can also be placed underground within BMPs to regulate subterraneous stormwater flows.

Clean Water Act (CWA) The Federal Water Pollution Control Act, commonly referred to as the CWA, was designed to restore and maintain the chemical, physical, and biological integrity of the nation's waters by preventing point and nonpoint pollution sources, providing assistance to publicly owned treatment works for the improvement of wastewater treatment, and maintaining the integrity of wetlands. Requirements of the National Pollutant Discharge Elimination System program are defined under Sections 307, 402, 318 and 405 of the CWA.

Combined Sewer System A sewer system designed to convey and treat both sanitary sewage and stormwater. Approximately ninety percent of San Francisco is served by a combined sewer system.

Design Storm A hypothetical storm defined by a given return period (which refers to the frequency of a storm) and the storm duration. Together, these characteristics yield the storm's rainfall depth. The rainfall depth is applied to a prescribed hyetograph shape to create a rainfall distribution that is used in the analysis of existing drainage, design of new stormwater controls, or assessment of impacts of a proposed project on runoff flows and volumes.

Detention The capture, temporary storage, and slow release of stormwater runoff from a BMP or stormwater facility.

Development Any human-induced change to improved or unimproved real estate including but not limited to construction, installation, or expansion of a building or other structure; land division; street construction; drilling; and site alteration such as dredging, grading, paving, parking or storage facilities, excavation, filling, or clearing. Development encompasses both new development and redevelopment.

Discharge A release or flow of stormwater or other substance from a conveyance system or storage container.

Drainage Management Area (DMA) A discrete area that drains to a single stormwater BMP, to a series of hydraulically-connected BMP, or directly to the sewer system. A BMP is sized to accommodate runoff from its associated DMA for selected design storm.

Erosion The wearing away of land surface by wind or water. Erosion occurs naturally from weatherization or runoff but can be intensified by land-clearing practices related to farming, an increase of impervious surfaces, redevelopment, road building, or timber cutting.

Evapotranspiration The loss of water to the atmosphere by the combined processes of evaporation (from soil and plant surfaces) and transpiration (from plant tissues).

Grading The cutting or filling of the land surface to achieve a desired slope or elevation.

Green Infrastructure (GI) GI uses the natural processes of vegetation and soils to manage stormwater while providing a multitude of ancillary benefits such as carbon dioxide sequestration and neighborhood beautification . GI refers to stormwater management systems that mimic nature by soaking up and storing water.

Filter Fabric A water-permeable material, generally made of synthetic products such as polypropylene, used in stormwater management and erosion control applications to trap sediment or to prevent fine soil particles from clogging the aggregates.

Freeboard The vertical distance between the design water surface elevation (overflow elevation) and the elevation at which overtopping of the structure or facility that contains the water would occur.

Impervious Surface A surface that prevents the land's natural ability to absorb and infiltrate rainfall or stormwater. Impervious surfaces include, but are not limited to; building or structures, roof tops, impervious concrete and asphalt, and any other continuous watertight pavement or covering. Landscaped soil and pervious pavement, including pavers with pervious openings and seams, underlain with pervious soil or pervious storage material, are not impervious surfaces.

Infiltration The process by which surface water enters the soil. Infiltration is often expressed as a rate (inches per hour), which is determined through an infiltration test.

Jurisdiction The territory over which the legal authority of an institution extends. There are two stormwater management jurisdictions in San Francisco: Port of San Francisco land is subject to Port requirements while other areas are subject to San Francisco Public Utilities Commission requirements.

Leadership in Energy & Environmental Design (LEED) A green building certification program created by the U.S. Green Building Council (USGBC) that recognizes best-in-class building strategies and practices. To receive LEED certification, building projects satisfy prerequisites and earn points to achieve different levels of certification.

Low Impact Development (LID) A stormwater and land use management strategy that strives to mimic pre-disturbance hydrologic processes of infiltration, filtration, storage, evaporation, and transpiration by emphasizing conservation, use of on-site natural features, site planning, and distributed stormwater management facilities (such as green infrastructure) that are integrated into a project design.

Maximum Extent Practicable (MEP) A standard which involves applying BMPs that reduce the discharge of pollutants in stormwater runoff. MEP is the result of the cumulative effect of implementing, continuously evaluating, and making corresponding changes to a variety of technically and economically feasible BMPs that ensure the most appropriate controls are implemented in the most effective manner.

Municipal Separate Sewer System (MS4) A conveyance or system of conveyances (including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, man-made channels, or storm drains): (i) designed or used for collecting or conveying stormwater; (ii) which is not a combined sewer; and (iii) which is not part of a Publicly Owned Treatment Works (POTW) as defined at Title 40 of the Code of Federal Regulations (CFR) 122.2. A "Small MS4" is defined as an MS4 that is not a permitted MS4 under the Phase I regulations. This definition of a Small MS4 applies to MS4s operated within cities and counties as well as governmental facilities that have a system of storm sewers. Most of San Francisco is served by combined sewers; only about ten percent of the city uses a municipal separate sewer system.

National Pollutant Discharge Elimination System (NPDES) The national program for administering and regulating Sections 307, 318, 402, and 405 of the Clean Water Act (CWA).

Overflow Excess volume of stormwater or wastewater that exceeds the storage or conveyance capacity of a facility or system component and causes a release of flow to another facility or system component or to the environment.

Pervious (Permeable) Surface A surface that allows stormwater to infiltrate into the ground. Examples include pasture, native vegetation areas, landscape areas, and permeable pavement.

Post-Construction Stormwater Management Implementation of permanent GI facilities that will capture and treat stormwater throughout the life of a project after construction is complete.

Potable Water Water that is safe for drinking and cooking.

Pretreatment Treatment of stormwater before it is discharged to a BMP or to the collection system.

Retention The removal of stormwater runoff from the sewer system via infiltration, evapotranspiration, or rainwater harvesting, which prevent it from leaving the development site.

Right of Way (ROW) A path on a property owner's land which other people have a legal right to use.

Runoff Water originating from rainfall, melted snow, and other sources (e.g., sprinkler irrigation) that flows over the land surface to drainage facilities, rivers, streams, springs, seeps, ponds, lakes, and wetlands.

Run-on Stormwater surface flow from a contributing area that enters a specific area such as a BMP (e.g. run-on to permeable pavement).

Safety Factor A sizing multiplier that evaluates the risks and values of specific conditions, including the failure mode of the construction material, unexpected construction deficiencies, and potential cost of system failure. The safety factor is applied to the maximum performance limit to calculate a risk-based design value used for sizing facilities. A safety factor must be used to provide reasonable assurance of acceptable long-term system performance.

San Francisco Stormwater Management Ordinance (SMO) In 2010, the San Francisco Board of Supervisors passed San Francisco's first SMO, which requires the installation and maintenance of stormwater management controls for development and redevelopment projects meeting specific area and project type criteria. The SMO provides the SFPUC and Port with the legal authority to implement the post-construction program outlined in the SMR.

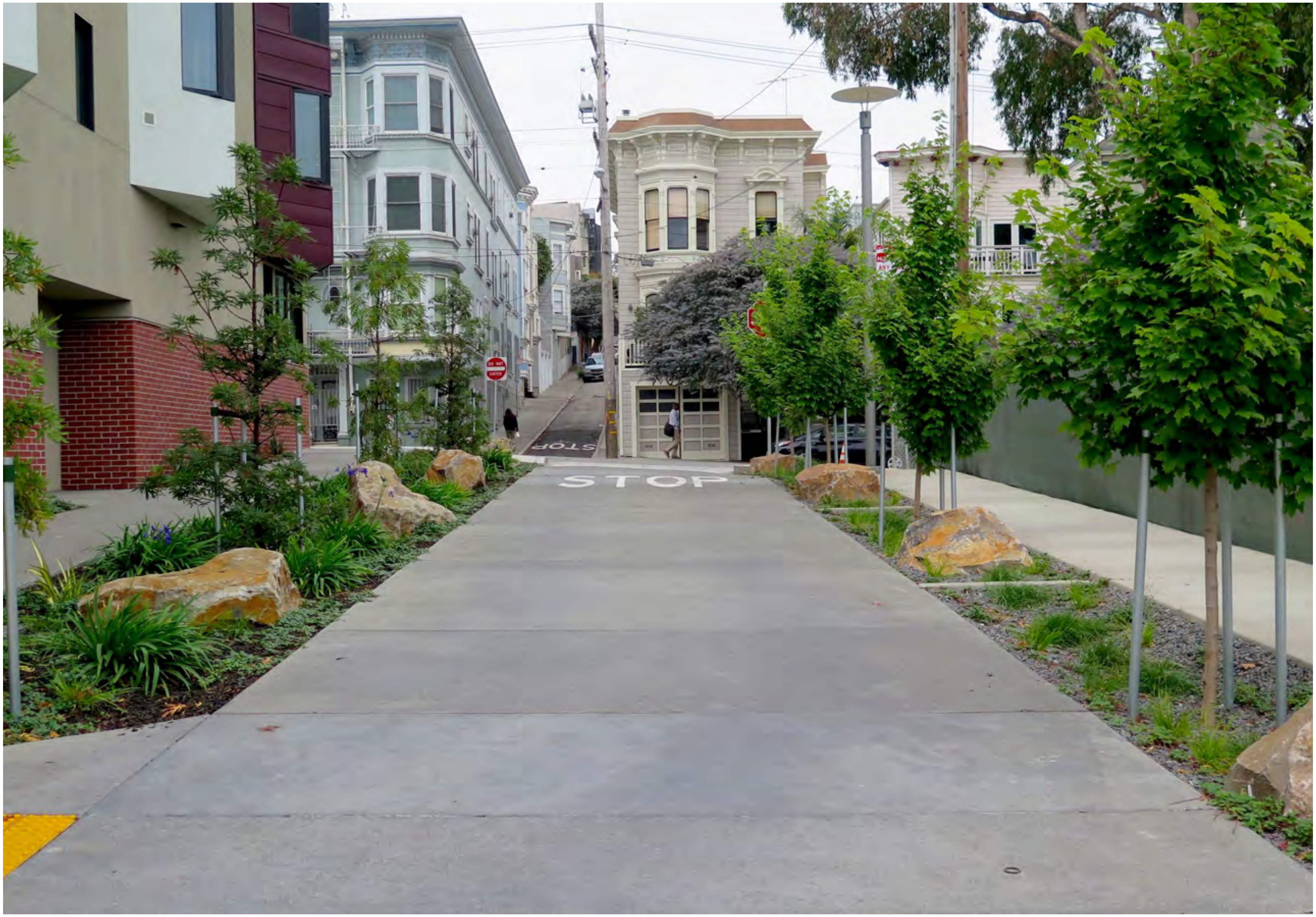
Source Control The technique of stopping and/ or reducing pollutants at their point of generation so that they do not come into contact with stormwater. "Source Controls" or "Source Control BMPs" refer to the operational practices and structural BMPs that capture potential pollutants at the source.

Stormwater Runoff during and following precipitation and snowmelt events, including surface runoff, drainage, and interflow.

Stormwater Multiple Application and Report Tracking System (SMARTS) SMARTS has been developed to provide an online tool to assist dischargers in submitting required reports and documentation, viewing/printing Receipt Letters, monitoring the status of submitted documents, and viewing their application/renewal fee statements. The system will also allow the Regional Board and State Board staff to process and track the discharger submitted documents.

Stormwater Control Plan (SCP) A required submittal for projects creating and/or replacing 5,000 square feet or more of impervious surface that demonstrates they have met all applicable stormwater performance requirements. The SCP allows the SFPUC and the Port to review projects that are subject to the SMR and evaluate compliance. A Preliminary SCP is submitted at the design development phase of the project and must be approved by the SFPUC or the Port before a Site or Building Permit will be issued. A Final SCP is typically submitted at the 100 percent construction document phase of the project. The components of an SCP are described in *Chapter 9: Stormwater Control Plan Requirements*.

Time of Concentration The amount of time it takes stormwater runoff to travel from the most distant point (measured by travel time) on a particular site or DMA to a particular point of interest.



Hickory Street in San Francisco, CA is lined with bioretention on each side. *Photo: Krystal Zamora*

Summary of Changes in the 2016 SMR

This document is an update of the 2010 *San Francisco Stormwater Design Guidelines (Guidelines).* In addition to updating performance requirements and compliance processes, the 2016 SMR better delineates requirements versus guidelines and allows for easier access to information with modular chapters that can be downloaded from the internet and read separately. To facilitate the transition from the 2010 *Guidelines* to the 2016 SMR, a short description of each chapter of the SMR and the significant changes from the 2010 *Guidelines* is provided below.

1 ***Introduction*** Provides a broad overview of the SMR, significance, and purpose.

2 ***Regulatory Context*** Describes how the SMR fits in with federal, state, and local stormwater requirements.

Chapter 2 Changes:

- *A number of local codes, regulations, and guidance documents that influence the implementation of GI have been added to Chapter 2. These regulations and guidance documents were developed over the past five years; most notable is the Stormwater Management Ordinance, which provides the SFPUC and Port with the legal authority to implement the post-construction program outlined in the SMR.*

3 ***Low Impact Design in San Francisco*** Contextualizes the use of LID and stormwater management in San Francisco.

Chapter 3 Changes:

- *Two chapters in the 2010* Guidelines *(San Francisco Context and Multi-Purpose Design) were integrated in Chapter 3 to provide a succinct description of the opportunities for and benefits of LID in San Francisco.*

4 ***Green Infrastructure Design Approach*** Guides design teams through a six-step process for incorporating GI into a project's site design.

Chapter 4 Changes:

- *Previously titled The Stormwater Control Plan, this chapter was a combination of design guidelines and requirements focused on the creation of a SCP. The intent of this updated chapter is to provide general design guidance for any project interested in incorporating green infrastructure and other stormwater management strategies. Information required for completion of a SCP can be found in the new* Chapter 7: Stormwater Control Plan Requirements.

5 ***Combined Sewer Area Performance Requirements*** Describes performance requirements specific to projects in the combined sewer areas.

Chapter 5 Changes:

- *The threshold at which projects must comply with the SMR has been redefined. In the 2010* Guidelines*, projects* ***disturbing 5,000 square feet or more of the ground surface*** *were subject to the requirements. In the revision, the threshold has been revised to projects* ***creating and/or replacing 5,000 square feet or more of impervious surface****.*

- *The 2016 version includes an option for eligible projects to comply with Modified Compliance requirements. This option was not available in the 2010 SMR.*

6 ***Separate Sewer Area Performance Requirements*** Describes performance requirements specific to projects in the separate sewer areas.

Chapter 6 Changes:

- *Small Projects are regulated under the 2016 SMR. Small Projects (those creating and/or replacing 2,500-5,000 square feet of impervious surface) must implement one or more Site Design Measure(s). Projects of this size were not regulated in the 2010* Guidelines.

- *The threshold at which Large Projects must comply with the SMR has been redefined. In the 2010* Guidelines*, projects* ***disturbing 5,000 square feet or more of the ground surface*** *were subject to the requirements. In the revision, the threshold for Large Projects has been revised to projects* ***creating and/or replacing 5,000 square feet or more of impervious surface****.*

- *The 2016 SMR require use of preferred BMPs to the maximum extent practicable before consideration of remaining BMPs. The 2010* Guidelines *did not include a required BMP Hierarchy. The required BMP Hierarchy prioritizes infiltration-based BMPs, rainwater harvesting, and vegetated roofs followed by lined bioretention (commonly known as a "flow-through planter"). Detention-based controls that do not include biofiltration (e.g., detention tanks) do not meet Large Project performance requirements under the 2016 SMR. Large Projects in the separate sewer areas may be able to incorporate high-rate filtration BMPs (i.e. tree-box filters and media filters) into their site design pending approval by the SFPUC or Port. (See Figure 8: Separate Sewer Area BMP Hierarchy for more information).*

7 ***Stormwater Management in the Streets*** Outlines when right-of-way projects are required to comply with the SMR.

Chapter 7 Changes:

- *This chapter was added to the 2016 SMR.*

8 ***Green Building Certification Credits*** Describes how the SMR requirements can apply to Leadership in Energy and Environmental Design (LEED) and GreenPoint Rated systems.

Chapter 8 Changes:

- *This chapter was added to the 2016 SMR.*

9 ***Stormwater Control Plan Requirements*** Describes the components required for a complete SCP submittal, applicable to all projects that create and/or replace 5,000 square feet or more of impervious surface.

Chapter 9 Changes:

- *This chapter was added to the 2016 SMR.*

10 ***Inspection and Enforcement Requirements*** Describes the SFPUC and Port inspection and enforcement protocols applicable to all projects that submit an SCP.

Chapter 10 Changes:

- *No significant changes were made in this chapter.*

11 ***References and Resources*** Contains all content, photo, and figure references for the SMR.

Chapter 11 Changes:

- *This chapter was added to the 2016 SMR.*

The SMR also contains the following appendices with supplemental information:

Appendix A. BMP Fact Sheets Detailed information about each stormwater control BMP, including siting requirements, design considerations, and sizing procedures.

Appendix A Changes:

- *BMPs have been grouped by scale (small-scale BMPs for small, single-parcel sites vs. large-scale BMPs for large, multi-parcel sites), and listed approximately in order of the preferred BMP Hierarchy from* Chapter 6: Separate Sewer Area Performance Requirements.
- *Conveyance swales, vegetated buffer strips, swirl separators, drain inserts and water quality inlets are classified as pre-treatment devices that may only be used as part of a larger "treatment train" of two or more BMPs in series.*
- *Limitations of infiltration-based BMPs, including set-back distances and depth to groundwater, were updated, and references to the new* Appendix C: Criteria for Infiltration-Based BMPs *were added.*
- *BMPs shown in* Appendix B: Green Infrastructure Typical Details and Specifications *were updated for consistency with the details.*
- *New case studies and example installations were added to several BMPs.*
- *Dry wells were renamed as "subsurface infiltration systems" and detention vaults as "subsurface detention systems."*
- *One BMP, the vegetated rock filter, was removed from the BMP Fact Sheets as it is rarely used in San Francisco nor is its use encouraged by the SFPUC or the Port.*

Appendix B. Green Infrastructure Typical Details and Specifications Show *typical* configurations, rather than required *standard* configurations, of GI. Licensed professionals can and should modify facility configurations, materials, or notes based on specific project conditions.

Appendix B Changes:

- *This appendix was added to the 2016 SMR.*

Appendix C. Criteria for Infiltration-Based BMPs Siting requirements for infiltration-based BMPs as well as guidance on soil classification and infiltration rate testing.

Appendix C Changes:

- *This appendix was added to the 2016 SMR.*

Appendix D. Vegetation Palette for Bioretention BMPs A list of plants appropriate for bioretention-based GI based on plant needs such as shade or sun, irrigation, maintenance, and other factors.

Appendix D Changes:

- *This appendix was revised to describe important considerations regarding plant selection for bioretention-based GI and includes a palette of locally available climate-appropriate plants that can tolerate periodic inundation and soil saturation.*

Appendix E. Illustrative Green Infrastructure Examples These illustrations demonstrate how LID and GI can be integrated into San Francisco's diverse landscape.

Appendix E Changes:

- *This appendix was added to the 2016 SMR.*

An impervious gutter directs roof runoff to a rain garden. Photo: Ken Kortkamp

Executive Summary

Stormwater management is a critical municipal responsibility that has a direct impact on public health and safety, surface water quality, urban design, and wildlife habitat.

Like many California municipal agencies, the San Francisco Public Utilities Commission (SFPUC) and the Port of San Francisco (Port) administer stormwater management programs developed in accordance with the federal Clean Water Act (CWA) and a State of California National Pollutant Discharge Elimination System (NPDES) permit.

NPDES permits for stormwater specify a suite of activities that municipalities must undertake to reduce pollution in stormwater runoff. One of these activities is the development, implementation, and enforcement of a program to reduce pollutants in stormwater runoff from new development and redevelopment projects. This effort is commonly referred to as a *post-construction stormwater control program*.

In 2007, SFPUC and Port staff initiated a community planning effort to develop a regulatory guidance document that fulfilled state and federal requirements for post-construction stormwater runoff control. The 2010 *San Francisco Stormwater Design Guidelines* (*Guidelines*) and the San Francisco *Stormwater Management Ordinance* were the culmination of that effort.

The San Francisco Stormwater Management Requirements and Design Guidelines

The 2010 *Stormwater Design Guidelines* has evolved to become the 2016 *Stormwater Management Requirements and Design Guidelines*. The new title better reflects its dual function as a document detailing mandatory requirements and design tool providing suggestions to inspire creative Low Impact Design.

Low Impact Design and Green Infrastructure

Low Impact Design is a planning and design approach that seeks to manage stormwater as close to its source as possible. LID employs principles such as minimizing and disconnecting impervious area, and uses landscape-based technologies to create site drainage that treats stormwater as a resource rather than a waste product.

The term "**green infrastructure**" refers collectively to the actual technologies that are used to infiltrate, evapotranspire, treat, and/or reuse stormwater. Individual GI facilities, such as cisterns, rain gardens, permeable pavement, and vegetated roofs, are also referred to as "**best management practices" (BMPs)** or "**stormwater controls**" throughout this document.

After five years of implementing the 2010 *Guidelines*, this 2016 update incorporates new guidance for the Stormwater Control Plan (SCP) submittal and review process as well as new requirements based on the 2013 modification of the *NPDES Phase II Municipal Separate Storm Sewer System Permit* (MS4 Permit) that the SFPUC and Port must comply with. A complete outline of changes from the 2010 *Guidelines* to the 2016 *Stormwater Management Requirements and Design Guidelines* (SMR) is included with the *Table of Contents* and other introductory materials.

The SMR describes the regulatory context for a post-construction stormwater control program and leads developers, engineers, and architects through the process of incorporating performance-based GI into site design. The SMR also presents the stormwater performance requirements and documentation that must be submitted for project approval. It describes the required components of a SCP, a document that allows City staff to assess compliance with the requirements, and explains how SCP approval is incorporated into San Francisco's building permit review process. It also includes Best Management Practice (BMP) selection hierarchies applicable to the combined and separate sewer areas, BMP fact sheets that provide siting and design information, as well as typical GI details and specifications to aid design.

Applicability

The performance requirements outlined in this document vary depending on the type of sewer system servicing a project (combined or separate), the agency with jurisdiction over the project (SFPUC or Port), and the size of the project.

Effective May 27, 2016, the revised SMR applies to all new and redevelopment projects in the separate and combined sewer areas that create and/or replace 5,000 square feet or more of impervious surface. As required by the 2013 MS4 Permit, the SMR will also apply to projects in the separate sewer areas that create and/or replace between 2,500 and 5,000 square feet of impervious surface, with less stringent performance requirements. More information on the new performance requirements can be found in *Chapter 5: Combined Sewer Area Performance Requirements* and *Chapter 6: Separate Sewer Area Performance Requirements*.

The 2010 *Guidelines* applies to projects for which a Preliminary SCP was submitted before May 27, 2016. The 2016 SMR applies to projects with Preliminary SCPs submitted on or after May 27, 2016.

Low Impact Design & Green Infrastructure

The 2013 MS4 Permit requires the use of Low Impact Design (LID) and Green Infrastructure (GI) to comply with stormwater management requirements. This requirement is in keeping with San Francisco's policy goals for promoting sustainable development. A LID approach applies decentralized, on-site strategies, such as GI, to manage the quantity and quality of stormwater runoff. The approach integrates stormwater into the urban environment to achieve multiple goals. It reduces stormwater pollution and restores natural hydrologic function to San Francisco's watersheds. It can also provide wildlife habitat and contribute to the gradual creation of a greener city. GI can be integrated into all development types, from public open spaces and recreational areas to high-density housing and industrial areas.

Stormwater Benefits of Implementing the SMR

The SMR was originally adopted by the City and County of San Francisco on January 12, 2010. In the first five years since its adoption, SCPs have been submitted for approximately 193 acres of single parcel projects in the combined sewer area. By the time all proposed projects are constructed, they are anticipated to manage approximately 60 million gallons of stormwater per year (MG/year), of which 19 MG/year will be completely removed from the sewer system. In SFPUC separate sewer areas, SCPs have been submitted for approximately 101 acres of single parcel projects since 2010. Once these projects are constructed, they are anticipated to manage approximately 27 MG/year, treating it before discharging to receiving waters. These single project parcels are anticipated to be complete within the next five years.

SFPUC and Port staff are also working with developers and planners for the City's redevelopment areas to ensure that large multi-parcel areas will meet stormwater management requirements as they are built out over the next 20 to 30 years. Projections suggest that approximately 129 acres in combined sewer areas and 1,544 acres in separate sewer areas will be managed once proposed redevelopment projects are fully constructed.

Bioretention planters are featured in private patios of a condominium development in San Francisco, CA.
Photo: Krystal Zamora

1 Introduction

San Francisco's location adjacent to the Pacific Coast and San Francisco Bay, the largest estuary on the west coast of the United States, gives the City significant environmental, social, and economic advantages; it also confers unique responsibilities for water quality protection upon the City and its citizens.

The San Francisco Public Utilities Commission (SFPUC) and the Port of San Francisco (Port) have partnered to create the *San Francisco Stormwater Management Requirements and Design Guidelines* (SMR) for San Francisco's developers, designers, engineers, and general public. The SMR presents the regulatory requirements for post-construction stormwater management controls for new and redevelopment projects and helps design teams implement these stormwater controls. The San Francisco *Stormwater Management Ordinance* (SMO) requires such controls for new and redevelopment projects in both the City's separate and combined sewer areas.

While water quality protection and reduced stormwater volume in the City's sewer system are the fundamental drivers behind stormwater management, well-designed stormwater controls offer many ancillary benefits. The SMR encourages innovative and multi-purpose design solutions for meeting stormwater requirements in San Francisco's urban setting. In addition to protecting water quality and reducing stormwater volume, well-designed multi-purpose solutions can contribute to attractive civic spaces, open spaces, and streetscapes. They can also protect and enhance wildlife habitat and reframe stormwater as a resource, not a waste product.

A disconnected roof downspout spills into a bioretention planter. Photo: Krystal Zamora

By implementing the stormwater management strategies articulated in this document, each project will contribute to the incremental restoration of the health of the City's watersheds, protect the Bay and Ocean, and build a greener San Francisco. Patrick Condon, Chair in Landscape and Livable Environments at the University of British Columbia, underscores the contribution that each site can make to a region: "What the cell is to the body, the site is to the region. And just as the health of the body is dependent on the health of the individual cells that make it up, so too is the ecological and economic health of the region dependent on the sites that comprise it."

The SMR functions as both policy document and design tool. It explains the environmental and regulatory drivers behind stormwater management, demonstrates the concepts that inform the design of stormwater controls, provides an overview of the benefits of Low Impact Design (LID) and green infrastructure (GI), describes the City's post-construction stormwater management requirements and lays out the process of creating a Stormwater Control Plan (SCP) to comply with stormwater regulations. The SMR is specific to San Francisco's environment and reflect the City's density, climate, diversity of land uses, and varying topography.

Bioretention planters are a central feature in a courtyard area. Photo: Krystal Zamora

2 Regulatory Context

The federal Clean Water Act establishes the foundation for stormwater regulation across the Country. State, regional, and municipal laws and policies under the Clean Water Act help to ensure that San Francisco's stormwater requirements are appropriate for the City's geography, climate, and development patterns.

The Clean Water Act

In 1972, Congress passed the Clean Water Act (CWA) to regulate the discharge of pollutants to receiving waters such as oceans, bays, rivers, and lakes. Under the CWA, waste discharges from industrial and municipal sources are regulated through the State of California National Pollutant Discharge Elimination System (NPDES) permit program.

Stormwater runoff, now recognized by the United States Environmental Protection Agency (USEPA) as a leading contributor to water quality degradation in the United States, was unregulated until 1987, when section 402(p) was added to the CWA. Section 402(p) established requirements to regulate polluted stormwater runoff under the NPDES program.

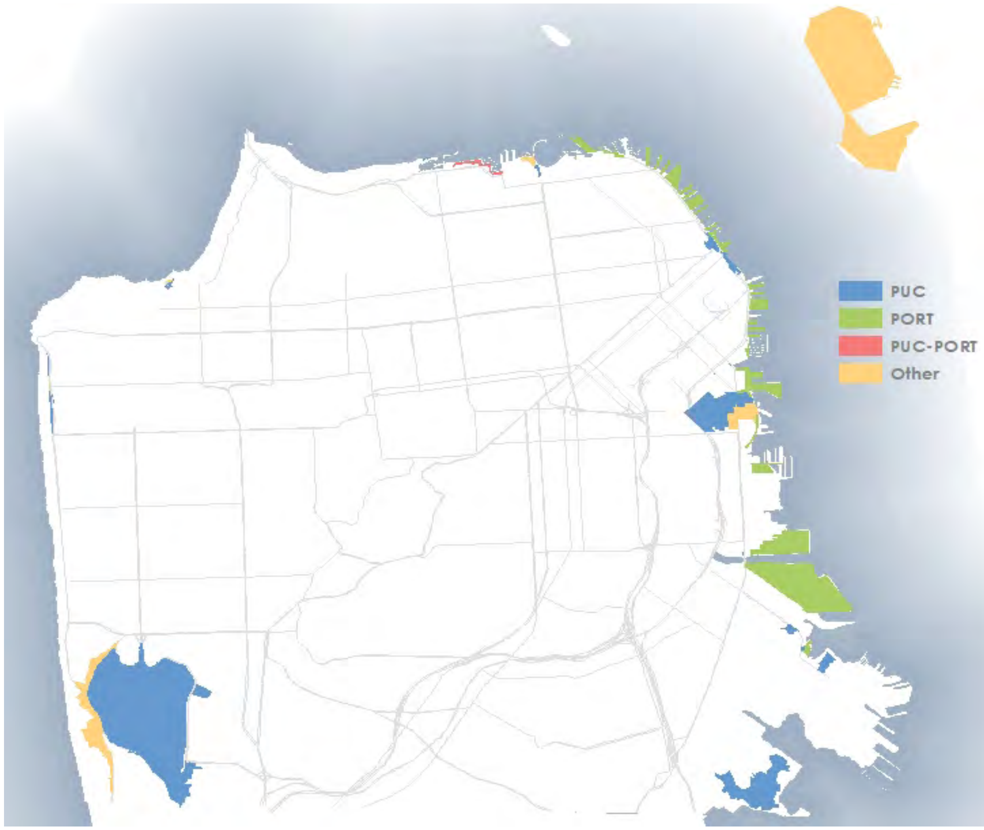


Figure 1. *Separate sewer areas and jurisdictions. (Note: map is updated as-needed, for the most recent map go to www.sfwater.org/smr)*

Stormwater discharges from **municipal separate storm sewer systems (MS4s)** serving populations of 100,000 or less are currently regulated by the State-issued *NPDES Phase II Municipal Separate Storm Sewer System Permit* (MS4 Permit). This permit requires, among other things, that municipalities implement a program to control post-construction stormwater runoff from certain new and redevelopment projects. San Francisco's separate sewer areas cover approximately 10 percent of the city, serve fewer than 100,000 people, and are subject to the MS4 Permit requirements (Figure 1). San Francisco's *Stormwater Management Ordinance* (SMO) gives the City and County of San Francisco the authority to implement the post-construction requirements of the MS4 Permit.

Approximately 90 percent of San Francisco is served by a **combined sewer system** that conveys both sewage and stormwater to one of three sewage treatment plants before the treated effluent is discharged to receiving water bodies. Although the combined sewer area is not subject to the MS4 Permit, controlling stormwater entering the combined sewer system has multiple benefits: it reduces the burden on the treatment plants, buffers the collection system, and reduces the water pollution associated with wet weather discharges. For these reasons, the SMO also requires stormwater management projects within the combined sewer system.

The NPDES Phase II Municipal Separate Storm Sewer System Permit

The MS4 Permit protects receiving water quality in California through regulations contained in the permit's eleven programmatic elements (see http://www.waterboards.ca.gov/water_issues/programs/stormwater/phase_ii_municipal.shtml for more information). The Stormwater Management Requirements (SMR) complies with the MS4 Permit's Post-Construction Storm Water Management Program requirement. This section of the permit requires Permittees, such as the SFPUC and Port, to oversee implementation of a post-construction stormwater management program for new and redevelopment projects. The Permittee requirements can generally be grouped into three actions:

1. Develop, implement, and enforce a program to address stormwater runoff from new and redevelopment projects to ensure that controls are in place to prevent or minimize water quality impacts;
2. Use an ordinance or other regulatory mechanism to control post-construction runoff from new and redevelopment projects to the extent allowable under the law; and
3. Ensure the adequate long-term operation and maintenance of BMPs.

The Maximum Extent Practicable (MEP) Treatment Standard

Agencies with Phase II Permits must implement regulations requiring new and redevelopment projects to "reduce the discharge of pollutants to the maximum extent practicable, including management practices, control techniques and systems, design and engineering methods."

Treatment to the MEP can be achieved by applying the best management practices (BMPs) that are most effective at treating pollutants in stormwater runoff. The State Water Resources Control Board (State Water Board) has said of the MEP standard that there "must be a serious attempt to comply, and practical solutions may not be lightly rejected." The State Water Board also states that if project proponents implement only a few of the least expensive stormwater BMPs, it is likely that the MEP standard has not been met. If, on the other hand, a project proponent implements all applicable and effective BMPs except those shown to be technically infeasible, or those whose cost would exceed any benefit to be derived, then the project proponent would have achieved treatment to the MEP. As technology and design innovation improve, stormwater BMPs become more effective.

The definition of MEP continually evolves with the field to encourage innovation and improved water quality protection. Because of this, some end-of-pipe strategies, such as vortex separators, which were considered to meet the MEP standard ten years ago, are no longer accepted as such. Similarly, in cases where just one BMP may have gained project approval in the past, today there are many cases where multiple BMPs will be required to achieve treatment to the MEP.

Phytoremediation

Vegetated BMPs, such as bioretention systems, provide contaminant reduction via phytoremediation. The United States Environmental Protection Agency (US EPA) defines phytoremediation as "the direct use of green plants and their associated microorganisms to stabilize or reduce contamination in soils, sludges, sediments, surface water, or ground water". Soils that are planted have an increased ability to degrade, remove, and mineralize total petroleum hydrocarbons (TPHs), polycyclic aromatic hydrocarbons (PAHs), pesticides, chlorinated solvents, and surfactants compared to bare soils.

Some plant species have demonstrated the ability to absorb or immobilize heavy metal contaminants, while some may metabolize or accumulate organic and nutrient pollutants. For more information about phytoremediation and plants that have been studied for phytoremediative properties, see the *LID Technical Guidance Manual for Puget Sound* (2005), the US EPA's *Introduction to Phytoremediation* (2000), and *Phyto* (2015) by Kirkwood and Kennen.

In addition, the MS4 Permit lays out specific performance measures and a BMP selection process, which Permittees must enforce in areas under their jurisdiction.

The Regional Water Quality Control Board monitors San Francisco's implementation of MS4 Permit requirements. The SFPUC and Port must submit reports on their respective development review efforts, the number and type of projects reviewed, and the stormwater controls included in each project.

Pollutants of Concern

Stormwater runoff from developed surfaces causes pollutants to enter water bodies within and around San Francisco in a variety of ways. In combined sewer areas, wet weather flows that surpass the capacity of the collection system result in combined sewer discharges to the Bay and Ocean. In separate sewer areas, stormwater runoff that has mobilized various pollutants discharges directly into receiving waters.

Gross pollutants mobilized by stormwater include litter, plant debris and floatable materials. Gross pollutants often harbor other pollutants such as heavy metals, pesticides, and bacteria. They also pose their own environmental impacts, such as degradation of wildlife habitat, water quality, and the aesthetic quality of waterways, and they can pose a strangling and choking hazard to wildlife.

Sediment is a common component of stormwater runoff. Sediment, both coarse and fine (also known as "suspended"), degrades aquatic habitat and can be detrimental to aquatic life by interfering with photosynthesis, respiration, growth, reproduction, and oxygen exchange. Construction sites, roadways, rooftops, and areas with loose topsoil are major sources of sediment. Sediment is a vehicle for many other pollutants, such as trace metals and hydrocarbons. Over half the trace metal load carried in stormwater is associated with sediment. Because of this, effective sediment removal also reduces a broader range of pollutants in runoff.

Oil and grease include a wide range of organic compounds, some of which are derived from animal and vegetable products and others from petroleum products. Sources of oil and grease include leaks and breaks in mechanical systems, spills, restaurant waste, improperly disposed of waste oil, and the cleaning and maintenance of vehicles and mechanical equipment.

Nutrients like nitrogen and phosphorous are typically used as fertilizers for parks and golf courses and are often found in stormwater runoff. They can promote excessive and accelerated growth of aquatic vegetation, such as algae, resulting in low dissolved oxygen. Un-ionized ammonia, a form of nitrogen, can be toxic to fish. In San Francisco, nutrients carried in runoff are a significant concern for enclosed freshwater bodies such as Lake Merced, more so than they are for the San Francisco Bay and Pacific Ocean.

Pesticides (herbicides, fungicides, rodenticides, and insecticides) are often detected in stormwater at toxic levels, even when they have been applied in accordance with label instructions. As pesticide use has increased, so have concerns about their adverse effects on the environment and human health. Accumulation of these compounds in simple aquatic organisms, such as plankton, provides an avenue for biomagnification through the food web, potentially resulting in elevated levels of toxins in organisms that feed on them, such as fish and birds.

Organics can be found in stormwater in low concentrations. They include synthetic compounds associated with adhesives, cleaners, sealants, and solvents that are widely used and are often stored and disposed of improperly.

Bacteria can enter stormwater via sources such as animal excrement, decay of organic materials, and combined sewer discharges. High levels of bacteria in stormwater runoff can lead to beach closures due to the threat to human health.

Dissolved metals, including lead, zinc, cadmium, copper, chromium, and nickel, are mobilized by stormwater when it runs off of surfaces such as galvanized metal, paint, automobiles, and preserved wood, whose surfaces corrode, flake, dissolve, decay, or leach. Metals are toxic to aquatic organisms, can bioaccumulate in fish and other animals, and have the potential to contaminate drinking water supplies.

Polychlorinated biphenyls (PCBs) and mercury are legacy contaminants that are found in low concentrations in soils associated with historically industrialized areas. San Francisco Bay is listed by the USEPA as an "impaired water body" for these contaminants. Control of PCBs and mercury will be implemented through design measures that limit the mobilization of these pollutants in contaminated soils.

Algal blooms, which create toxic conditions for aquatic organisms in lakes and ponds, are caused by fertilizers and other nutrients in stormwater runoff. Photo: NOAA Great Lakes Environmental Natural Resources Laboratory

Stormwater runoff transports trash to local water bodies, where it creates an aesthetic nuisance, harms wildlife, and pollutes receiving waters. Photo: The Chronicle

Bioretention in Stuttgart, Germany beautifies a pedestrian path. Photo: Ken Kortkamp

The Stormwater Management Ordinance

In 2010, the San Francisco Board of Supervisors passed San Francisco's first SMO, which requires the installation and maintenance of stormwater management controls for development and redevelopment projects meeting specific area and project type criteria. The SMO provides the SFPUC and Port with the legal authority to implement the post-construction program outlined in the SMR. The SMO was updated in 2016 to comply with the 2013 MS4 Permit and to reflect improvements made in the City's stormwater management review processes since enactment of the SMO in 2010.The SMO is available on the SFPUC website at www.sfwater.org/smr.

Codes, Regulations, and Guidance Documents Relevant to Green Infrastructure

The State of California and City of San Francisco have developed a number of codes, requirements, and guidance documents that influence the implementation of stormwater management controls. Particularly relevant to green infrastructure (GI) are the San Francisco Building, Green Building, Plumbing, Public Works, Health codes, and the Port of San Francisco Building Code. The full text of these codes can be found at http://www.amlegal.com/library/ca/index.shtml and http://sfport.com, respectively. The California Green Building Standards Code and Plumbing Code, both of which are incorporated into respective City of San Francisco and Port of San Francisco codes, can be found at http://www.bsc.ca.gov/Home/Current2013Codes.aspx.

Additionally, various City documents provide design guidance for on-site stormwater management, downspout disconnection, rainwater harvesting, permeable pavement, GI technologies, and utility conflicts.

On-site Stormwater Management

The **2013 San Francisco Green Building Code** is based on the 2013 California Green Building Standards Code. These codes require stormwater management as an integral part of green building requirements. San Francisco Green Building Code **Sections 4.103.1.2** (residential) **and 5.103.1.6** (nonresidential) require projects to meet the requirements outlined in the SMR. **Section 106A.3.2.4** of the **2013 Port of San**

Francisco Building Code requires projects in Port jurisdiction to meet performance requirements articulated in the SMR and in Article 4.2 of the San Francisco Public Works Code (i.e. the SMO).

Downspout Disconnection

The San Francisco Plumbing Code was amended in 2005 to allow roofs and other building areas to drain to locations other than the combined sewer system. The relevant section of the San Francisco Plumbing Code reads:

> **Plumbing Code, Section 1101.1.1:** *All storm or casual water from roof areas, balconies, lightwells, courtyards or similar areas which total more than 200 square feet (18.4 square meters) aggregate shall drain or be conveyed directly to the building drain, or building sewer, or to an approved alternate location based on approved geotechnical and engineering designs. Such drainage shall not be directed to flow onto adjacent property or over public way, including sidewalks.*

An "approved alternate location" is the key phrase that allows for downspout disconnection and includes properly designed stormwater management controls such as cisterns and rain gardens.

The Port Plumbing Code also allows roof areas to drain to an "approved alternate location." The relevant section of the Port Plumbing Code reads:

> **Plumbing Code, Section 1503.4:** *All storm water or casual water from roof areas which total more than 200 square feet (18.58 m^2) shall drain or be conveyed directly to the building drain or storm drain or to an approved alternative location based on geotechnical and engineering design approved by Port of San Francisco's Engineering Divisions Environmental Specialist. Such drainage shall not be directed to flow onto adjacent property or over public sidewalks. Building projections not exceeding 12 inches (305 mm) in width are exempt from drainage requirements without area limitations.*

An interior roof drain discharges to a courtyard bioretention planter in San Francisco, CA. This properly designed and permitted stormwater facility is an example of an "approved alternate location" for stormwater discharge. Photo: Polly Perkins

A cistern at Mills College in Oakland, CA is a stormwater BMP and a design element. Photo: Ingrid Severson

Rainwater Harvesting

The "NONPOTABLE RAINWATER CATCHMENT SYSTEMS" Chapter of the **California Plumbing Code** details regulations governing the installation, construction, alteration, and repair of non-potable rainwater catchment systems. In addition, provisions in the "ALTERNATE WATER SOURCES FOR NONPOTABLE APPLICATIONS" Chapter, for may also apply to rainwater catchment systems.

San Francisco's 2012 *Non-Potable Water Use Ordinance* establishes approved uses, permits, water quality standards, and system design requirements for large rainwater harvesting systems. The ordinance includes specifications for rainwater harvesting (rainwater collected from roofs), as well as the reuse of stormwater (rainwater collected from at-grade surfaces), graywater, blackwater, and foundation drainage. In 2016, the ordinance was updated to require all new buildings of 250,000 square feet or more of gross floor area, located within the boundaries of San Francisco's designated recycled water use area, to install non-potable water reuse systems to treat and reuse available alternate water sources for toilet and urinal flushing as well as irrigation. This requirement will expand to the entire city on November 1, 2016. Regulated projects will need approvals from the SFPUC and permits from both the Department of Public Health and Department of Building Inspection to verify compliance with the requirements and local health and safety codes.

These requirements are codified in **San Francisco Health Code Article 12C**. A more detailed discussion of specifications and permitting requirements for rainwater harvesting is provided in the Rainwater Harvesting fact sheet in *Appendix A: BMP Fact Sheets*. A link to Health Code Article 12C along with other information about San Francisco's non-potable water program can be found at http://sfwater.org/NP.

Permeable Pavement

Permeable Paving Systems SFDPW Director's Order (pending release 2016): This order specifies San Francisco's requirements for where to install permeable pavers within the public right-of- way (ROW).

Green Infrastructure Typical Details and Specifications

The SFPUC's **Green Infrastructure Typical Details and Specifications** incorporate current best practices in GI design nationwide and, at the same time, reflect the unique challenges and specific needs for designing and building GI in San Francisco. These details show *typical* configurations, rather than required *standard* configurations. Licensed professionals can and should modify facility configurations, materials, or notes based on specific project conditions. Successful GI projects depend on site-specific design, both in the context of private parcels and in the public ROW. They are available on the SFPUC website at www.sfwater.org/smr.

Rain gardens along Portland's waterfront provide functional greening elements. Photo: Ken Kortkamp

Subsurface Utility Conflicts

The SFPUC is in the process of developing **Standards for the Protection of Wastewater & Water Assets** (Protection Standards) to ensure that the installation of surface improvements in existing San Francisco public ROW that may impact wastewater assets or stormwater conveyance. The goal of these standards is to balance the public benefits of surface improvements with SFPUC's need to maintain subsurface assets and to protect public health. The Protection Standards will include requirements for installing GI which preserve SFPUC access to subsurface infrastructure for future maintenance, repair, or replacement activities. They will be made publicly available when finalized in 2016.

California Environmental Quality Act

The California Environmental Quality Act (CEQA) environmental review process imposes both procedural and substantive requirements for environmental protection. CEQA requires local jurisdictions to identify and evaluate the environmental impacts of their actions, including project impacts on local hydrology and water quality. CEQA review is a parallel and separate process that is not connected to compliance with the SMR. However, many projects subject to the SMR will also require some level of CEQA review, and meeting the performance requirements described in the SMR will typically assist projects in demonstrating that they will not significantly impact hydrology and water quality.

Local San Francisco manufacturer, Heath Ceramics, was awarded an Urban Watershed Stewardship Grant from the SFPUC to install permeable paving in the sidewalk along their storefront. Photo: Heath Ceramic

If subject to the SMO, the initial CEQA evaluation of a project should broadly discuss how required stormwater management controls will be implemented and how the implementation of controls would mitigate potential negative effects of stormwater runoff.

Synergy with other Programs and Planning Processes

The SMR is designed to work with San Francisco's existing and emerging programs and planning processes. There are multiple City-led initiatives currently underway which incorporate on-site stormwater management into project development. Each initiative contains mutually supportive policies, goals, and requirements focused on GI implementation. These initiatives target different land use types and project sizes with the ultimate goal of reducing stormwater runoff from a wide variety of urban surfaces (Figure 2).

The first initiative includes regulations governing new and redevelopment on large parcels. The SMR and SMO require GI in new and redevelopment projects on public and private parcels over certain size thresholds. The second initiative includes City-led programs, such as the SFPUC's Sewer System Improvement Program (SSIP) and the multi-agency *Better Streets Plan*, which result in large City-funded capital projects on streets and public parcels that can include GI. The third initiative is City-funded incentive programs designed to encourage implementation of GI in small community-led projects.

The SSIP is the SFPUC's 20-year capital improvement plan to address system-wide needs, update the aging sewer system, and protect public health and the environment. The Urban Watershed Assessment, a component of the SSIP, is a citywide planning effort that will define and develop surface drainage and collection system projects to reach SFPUC Wastewater Enterprise goals and will include proposals for GI projects.

The *Better Streets Plan* and related implementation efforts are a collaborative project of the SFPUC, the San Francisco Planning Department, SFDPW, the City's transit agencies, and other agencies to create a unified set of standards, guidelines, and implementation strategies to govern how the City designs the public ROW. The goal of *Better Streets*-related programs is to implement projects that jointly improve pedestrian safety, enhance landscaping, and include innovative methods for reducing stormwater runoff in the streets and sidewalks to create a more attractive and sustainable public realm.

The SFPUC also sponsors various GI incentive programs for members of the public. These programs are constantly evolving to meet new needs and serve new constituencies. Incentive programs include a subsidy program for small-scale rainwater harvesting installations and the Urban Watershed Stewardship Grant Program, which supports schools, neighborhood groups, and non-profits in planning, design, and construction of GI facilities. These types of incentive programs result in GI installations on both private and public property.

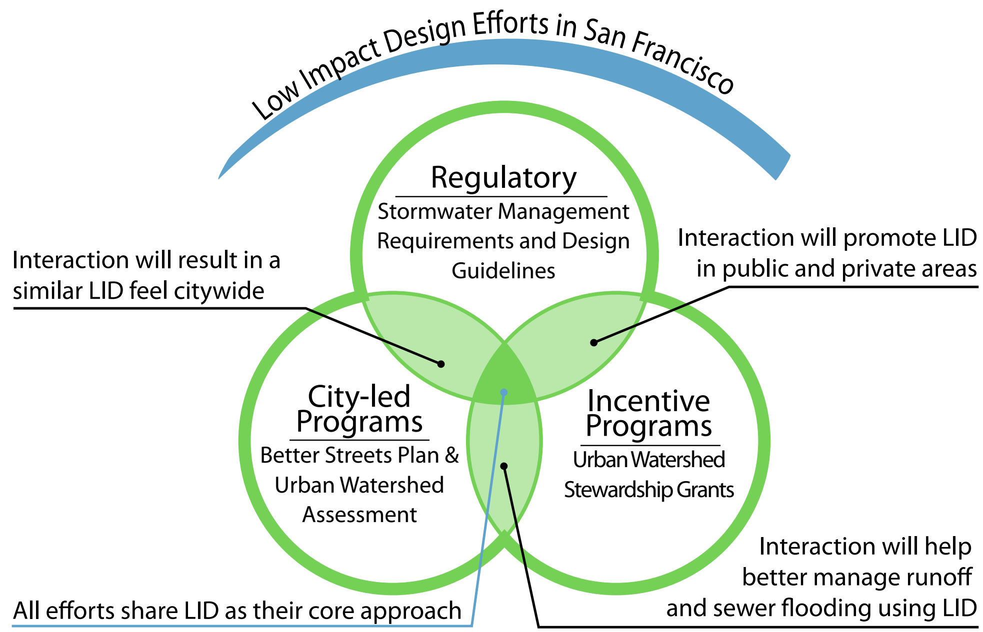


Figure 2. *The City of San Francisco facilitates the implementation of LID at different scales through multiple initiatives.*

3 Low Impact Design in San Francisco

Before San Francisco developed into the thriving city it is today, it consisted of a diverse range of habitats including oak woodlands, native grasslands, riparian areas, wetlands, and sand dunes. Streams and lakes captured and conveyed rainwater. Tidal wetlands lined the Bay and functioned as natural filtering systems and as buffers from major storms. Rainwater infiltrated into the soil, replenishing groundwater and contributing to stream base flow. Low Impact Design provides the opportunity to manage stormwater runoff while restoring elements of natural hydrologic function to the City's urban watersheds.

The San Francisco Context

Today, impervious surfaces such as buildings, streets, and parking lots cover most of the City, preventing rainfall from infiltrating into the ground. Over time, creeks have been connected to the sewers and buried, and tidal wetlands have been filled. Instead of percolating into soils, runoff now travels over impervious surfaces, mobilizes pollutants like oil and debris, and washes them into the sewer system or receiving water bodies. During heavy rain events, stormwater runoff can contribute to localized flooding, combined sewer discharges, and the degradation of surface water quality. Moreover, the decrease in infiltration resulting from paved surfaces contributes to groundwater depletion. Low Impact Design (LID) and green infrastructure (GI) can help mitigate these adverse effects. With every project contributing incremental improvements, San Francisco can work toward restoring natural hydrologic function in its urban watersheds.

Figure 3. *San Francisco is topographically divided into eight individual watersheds.*

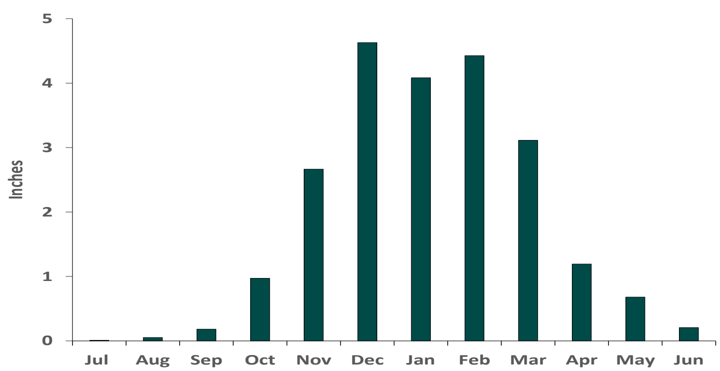


Figure 4. *Average monthly rainfall for San Francisco. Source: National Weather Service Gage, Federal Office Building, 1985 to 2014*

San Francisco's Urban Watersheds

San Francisco can be roughly divided into two major drainages: the eastern and western basins. These basins are comprised of eight major sub-basins, or watersheds, containing diverse urban neighborhoods with a range of residential, commercial, and industrial land uses, open spaces, and natural areas. Each watershed has unique topography, hydrology, soils, vegetation and water resources that create opportunities and challenges for drainage and stormwater management (Figure 3).

San Francisco has a temperate Mediterranean climate, with dry summers and rainy winters (Figure 4). In a typical year, San Francisco receives less than an inch total of rain from May through September and about 22 inches of rain between October and April. Consequently, the City can experience extended dry periods in the summer, with little to no rain, punctuated by flooding in the winters.

The potential to restore watershed function and capacity for stormwater infiltration varies dramatically by location. In many areas of the City, particularly in the western basins, soils are generally sandy and can provide excellent infiltration rates and pollution removal. However, the ability to infiltrate stormwater may be limited in areas that have steep slopes, shallow depth to bedrock or to the water table, clay soils, contaminated soils, or that are built on bay mud or fill over former creeks and wetlands. Where infiltration is limited, a wide array of stormwater management strategies that do not depend upon infiltration can be implemented.

San Francisco's Stormwater Infrastructure

Approximately 90 percent of San Francisco is served by a combined sewer system, with the remaining 10 percent served by separate storm sewer systems or lacking stormwater infrastructure (see Figure 5).

San Francisco's **combined sewer system** conveys wastewater and stormwater in the same set of pipes. The combined flows receive treatment at one of three wastewater treatment plants before being discharged to the Bay and Ocean. San Francisco's combined sewer system treats most stormwater runoff to secondary standards. However, when the capacity of the system is exceeded by large storm events, localized flooding and combined sewer discharges (CSDs) can occur. In the event of a CSD, the system discharges a mixture of stormwater and sanitary effluent that has received the equivalent of wet-weather primary treatment to receiving water bodies. These discharges are almost entirely stormwater (typically consisting of roughly 94 percent stormwater and 6 percent sewage), but pollutants in both the stormwater and sanitary components can cause elevated bacteria concentrations in receiving waters.

The primary reason for implementing LID measures in areas served by the combined sewer system is to reduce and delay the volumes and peak flows of stormwater reaching the sewer system, helping to reduce CSD volumes and protect water quality. Post-construction controls in combined sewer areas can also improve the capacity and efficiency of the City's collection and treatment facilities.

In San Francisco's **separate sewer system** areas, stormwater flows directly to receiving waters without passing through a wastewater treatment plant. In these areas, the primary reason for implementing GI is to improve the water quality of the stormwater, thus reducing the amount of pollutants reaching receiving waters.

Although the stormwater management goals for combined sewer areas are different from those for separate sewer areas, GI can enhance and diversify the functions of both systems, and many fundamental stormwater management technologies apply to both.

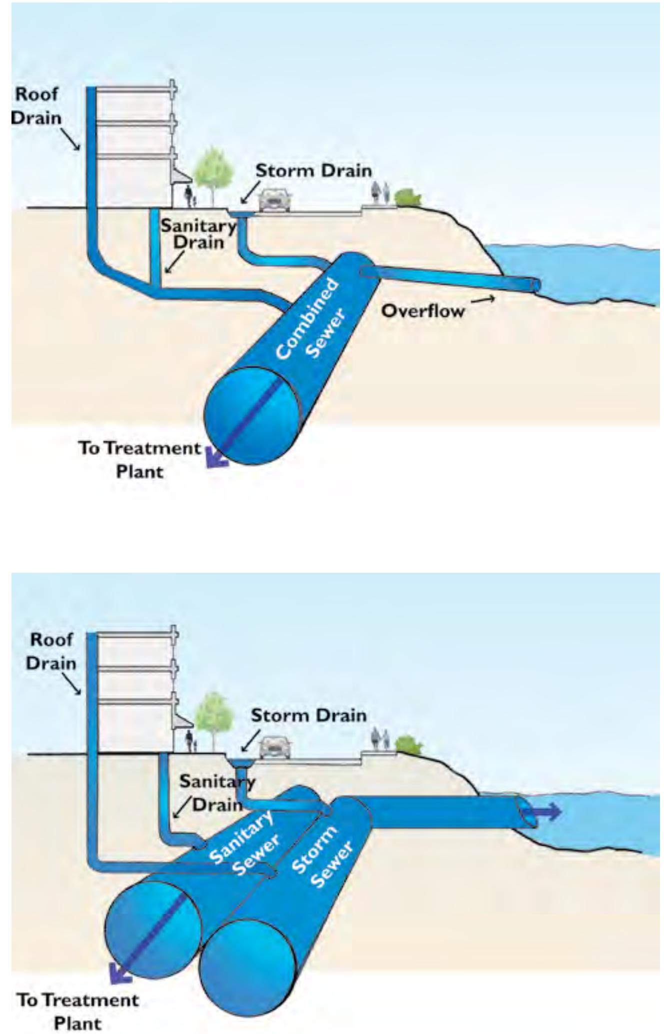


***Figure 5.** Combined sewer systems (top) serve 90 percent of San Francisco. Separate sewer systems (bottom) serve 10 percent. Image: modified from King County Wastewater Management Division*

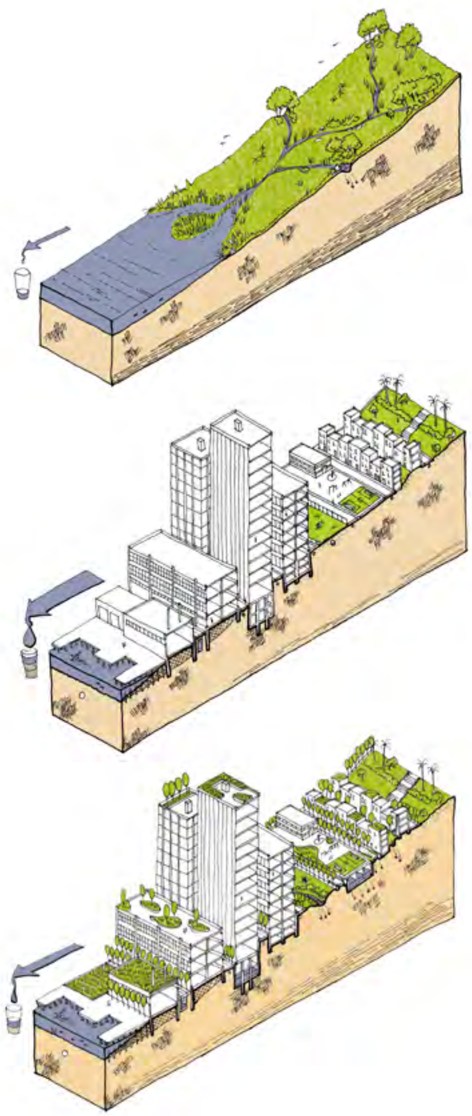


Figure 6. *LID seeks to reduce runoff and restore hydrologic function through effective site planning, increased permeability, and landscape-based BMPs.*

Low Impact Design & Green Infrastructure

To lessen the impacts of urbanization on stormwater quality and peak flows, cities around the world are taking advantage of LID, which promotes the use of ecological and landscaped-based systems to manage stormwater. LID is a design approach that aims to mimic pre-development drainage patterns and hydrologic processes by increasing retention, detention, infiltration, and treatment of stormwater runoff at its source. This decentralized approach can facilitate more sustainable uses of stormwater and allow for different adaptation strategies to changing environmental conditions that are not available for centralized conveyance systems.

A LID approach uses GI such as flow-through planters, swales, rain gardens and permeable pavement to manage stormwater on site. These technologies capture, filter, and slow stormwater runoff, thereby improving stormwater quality and reducing the quantity of runoff. GI is aimed at removing pollutants and treating what is known as the “first flush”. The first flush is the dirtiest runoff, usually generated during the beginning of a rain event; it mobilizes the majority of the pollutants and debris that have accumulated on impervious surfaces since the last rain.

Multiple Benefits of LID

LID integrates water quality protection with the creation and enhancement of urban wildlife habitat, responsible use of water, environmental education, and watershed stewardship. Implementation of GI can also achieve urban design goals such as improving the aesthetics of the built environment, increasing pedestrian safety, calming traffic, making streets and public spaces greener, and providing structure, texture, and identity to the City’s streets and other public spaces. Widespread implementation of GI may also decrease downstream stormwater infrastructure costs by reducing stormwater flows and volumes. Figure 6 shows how LID can be incorporated into an urban setting like San Francisco’s without compromising its character and livability.

Open space is a valuable amenity in the dense, highly urbanized city of San Francisco. GI can double as **civic spaces**, **open spaces, and recreational areas**: a constructed wetland filters stormwater and can be the center of a neighborhood nature area; a vegetated roof that reduces stormwater discharge might also be a gathering area. Mint Plaza, located at the corner of Mint and Fifth Streets in San Francisco, serves as an inclusive public space that is closed to automobile traffic and is programmed for events and temporary art installations. The site's planted rain gardens provide aesthetic value along with on-site retention and biofiltration of stormwater runoff. The 20,000 square foot (sf) space is paved with aggregate stone pavers sloped toward slot drains that collect the remaining runoff and send it to a subsurface infiltration system for groundwater recharge.

GI can also contribute to San Francisco's **urban ecosystem** by enhancing existing wildlife habitats and creating new ones. Habitat can be created by implementing stormwater BMPs on the roofs of buildings and along planned city habitat corridors. In London, England, and Basel, Switzerland, vegetated roofs are being used to provide patches of foraging, breeding, and nesting habitat for endangered wildlife, including several beetle, spider, and bird species.

Integrating GI into the **streetscape** yields a safer and more attractive pedestrian realm through the inclusion of vegetated curb extensions, sidewalk planters, street trees, and pervious surfaces that add attractive, pedestrian-scale details. These elements can simultaneously achieve stormwater management goals and improve streets for pedestrians and local residents by encouraging walking, reducing noise, and calming traffic. They can improve neighborhood aesthetics, safety, quality of life, and property values. Completed in 2014, the Cesar Chavez Streetscape Improvement Project in San Francisco's Mission District includes a one-mile corridor of GI featuring bioretention bulb outs and planters as well as permeable concrete to naturally capture stormwater before it enters the combined sewer system. The GI was integrated with street trees and other traditional plantings to provide aesthetic benefits, shade, and a reduction of the urban heat island effect, while curb bulb outs help slow automobile traffic and increase pedestrian safety.

The vegetated roof at the Ortega Branch Library in San Francisco includes an Ortega Living Roof Cam that streams on their website. *Photo: Robin Scheswhol*

This joint project between the San Francisco Public Utilities Commission and Department of Public Works added bioretention planters as well as pedestrian, traffic, and bicycle improvements to Cesar Chavez St. *Photo: Robin Scheswhol*

Mint Plaza in San Francisco is an example of how LID can be integrated into an ultra-urban setting. The design includes rain gardens, permeable paving, and a subsurface infiltration gallery. *Photo: Krystal Zamora*

Stormwater is also a valuable **water resource**. Using stormwater on-site rather than releasing it downstream decreases demand for potable water and can protect receiving waters by reducing runoff rates, volumes, and pollutant loads. Cisterns collect stormwater and store it for non-potable uses such as irrigation and toilet flushing, uses that unnecessarily burden potable water supplies. Stormwater can even contribute to future potable water supplies, by recharging underground aquifers. The Port of San Francisco's James R. Herman Cruise Terminal at Pier 27 features a siphonic roof drain system. Rainwater travels through a vortex filtration system and is collected in five aboveground storage tanks with a combined 41,000 gallon capacity. Collected rainwater is treated using an ozone recirculation system, then used for toilet flushing and landscape irrigation. Any surplus rainwater collected from the roof is treated using downspout filters before flowing into the bay.

LID can also be a useful tool for **environmental education** when it is integrated into school curricula, public outreach, or interpretive signs. LID concepts can be presented at many different levels of complexity, from an introduction to watersheds to an explanation of the hydrologic cycle and environmental stewardship. LID concepts touch upon numerous disciplines, including biology, ecology, watershed planning, engineering, design, and resource management. Lafayette Elementary School in the Outer Richmond district of San Francisco was a recipient of the SFPUC's Urban Watershed Stewardship Grant, which aims to reduce stormwater via impervious surface removal and GI. The grant funded a rainwater harvesting system, pavement removal and gardens, as well as an outdoor classroom.

The James R. Herman Cruise terminal at Pier 27 in San Francisco features a rainwater harvesting system for irrigation. Photo: Port of San Francisco

An integrated rainwater harvesting system and garden help illustrate rainwater reuse to students at Lafayette Elementary in San Francisco, CA. Photo: Polly Perkins

SFPUC headquarters at 525 Golden Gate Avenue in San Francisco's Civic Center District. *Photo: Robyn Scheswohl*

Lastly, GI can help the design and development community achieve various **green building certification credits**, which aim to minimize the environmental impacts of development and provide high quality, healthy environments. In San Francisco, both Leadership in Energy and Environmental Design (LEED®), a green building rating system developed by the U.S. Green Building Council, and the GreenPoint Rated system, a rating system developed by the non-profit Build It Green, are being used to assess the environmental quality of site and building design. In both systems, stormwater management facilities can earn points toward certification. Achieving green building certification credits is required by the San Francisco Green Building Ordinance (http://sfdbi.org/green-building-ordinance). Information on how compliance with the SMR relates to LEED and GreenPoint Rated credits is provided in *Chapter 8: Green Building Certification Credits*. In 2012, the SFPUC completed construction of its new 277,500-square-foot headquarters at 525 Golden Gate Avenue in San Francisco's Civic Center District. Two non-potable water systems, a Living Machine® and a rainwater harvesting system, helped the building obtain LEED Platinum certification. The Living Machine® treats all of the building's wastewater, up to 5,000 gallons per day, and then distributes the treated water for toilet flushing. The 25,000 gallon cistern captures rainwater from the building's roof and daycare center's play area. The water is then treated and distributed to subsurface irrigation for plantings and street trees that surround the building.

The Academy of Sciences in Golden Gate Park is a LEED Platinum building and includes a 2.5-acre vegetated roof. Photo: Rana Creek – Living Architecture

4 Green Infrastructure Design Approach

Designing green infrastructure is an iterative process that requires an inter-disciplinary team to ensure the design of beautiful, practical, and functional green infrastructure.

This chapter describes an approach to integrating green infrastructure (GI) into site design. Although the elements of this approach are presented as a linear series of tasks, in practice, the process should be iterative. For example, although delineating Drainage Management Areas (DMAs) comes before sizing best management practices (BMPs), the performance results obtained in the BMP sizing calculations may lead to new thinking about drainage management area location and size.

Conveyance features, such as this trench drain and runnel, can be used to move stormwater between treatment controls.
Photo: Rosey Jencks

Green Infrastructure Design Process

Task 1. Characterize Existing Site Conditions

1A. Determine performance requirements and goals

1B. Identify physical site constraints and opportunities

1C. Establish programmatic needs

Task 2. Create Conceptual Stormwater Management Plan

2A. Assemble an inter-disciplinary team and use Low Impact Design Principles and Strategies

2B. Evaluate and select potential BMPs

2C. Delineate DMAs

2D. Conceptually site BMPs

Task 3. Develop the Stormwater Management Plan

3A. Locate BMPs

3B. Size BMPs using the BMP sizing calculator or modeling

3C. Re-evaluate BMP selection and ensure sizing meets performance requirements and goals

Task 4. Finalize Stormwater Management Plan

Task 5. Select and Locate Source Controls

Task 6. Develop Inspection and Maintenance Plans

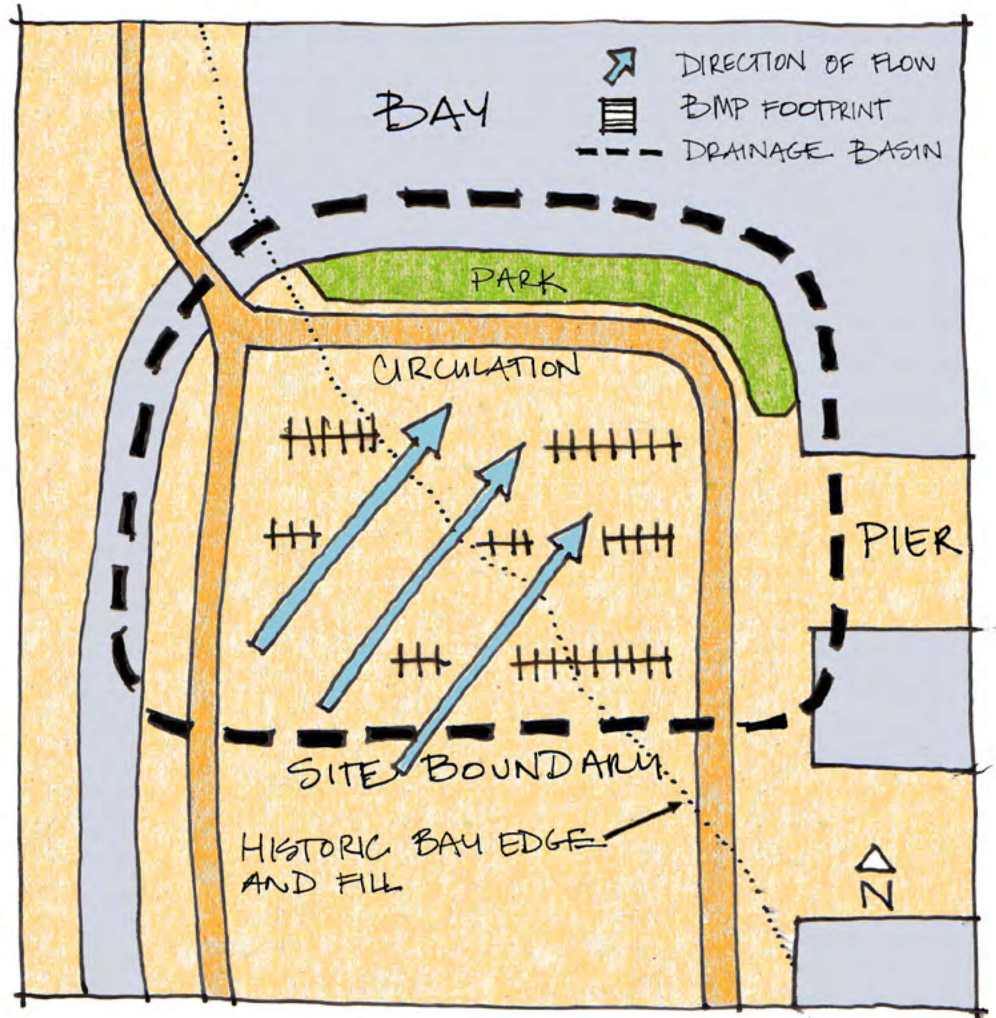
Task 1

Characterize Existing Site Conditions

The stormwater management approach appropriate for a given site is largely dictated by existing site conditions. Soil types, topography, drainage patterns, existing vegetation, wildlife habitat, proximity to receiving waters, existing and adjacent structures, adjacent land uses, historical and cultural features, proposed land use/programming of the project, sewer service area type, and jurisdiction are all factors that design teams should consider before locating and designing GI.

1A. Determine stormwater management performance requirements

Design teams should determine whether their project will be built in the City's combined or separate sewer areas, as stormwater management performance requirements differ depending on the sewer system. An interactive map of San Francisco's separate sewer areas is available on the San Francisco Public Utilities Commission (SFPUC) website at www.sfwater.org/smr. If a project is located in a separate sewer area, design teams should also determine whether the project is in the SFPUC or Port jurisdiction, as performance requirements vary by jurisdiction (see map of jurisdictional boundaries in *Chapter 2: Regulatory Context*, Figure 1).



1B. Identify physical site constraints and opportunities

Designers should begin by identifying site opportunities and constraints that will drive the site's stormwater management design. Understanding the performance requirements as well as the proposed development program, density, and intensity of land use will allow design opportunities and constraints to become clear.

Existing site conditions present opportunities and constraints that will shape the design. Opportunities include existing drainage patterns and vegetation, oddly configured or otherwise unbuildable parcels, easements, and landscape amenities, including open spaces that can serve as locations for BMPs. For example, differences in elevation across the site and existing low-lying areas present opportunities to implement BMPs that reduce or eliminate the need for pumping or other mechanical conveyance, a savings in both installation and long-term operation costs.

Constraints might include impermeable soils, a high water table, contaminated soils, geotechnical instability, existing utilities, and historical and cultural resources. Site-specific infiltration tests and other geotechnical investigations by a licensed engineer will be needed to select appropriate BMPs. For more information about approved infiltration testing protocols, see *Appendix C: Criteria for Infiltration-Based BMPs.*

1C. Establish programmatic needs

The programmatic needs of a project will shape the types of spaces available to manage stormwater. Programmatic needs may include commercial seating areas, pedestrian corridors, or recreational community facilities. Programming differs depending on the type of development; for example, a zero lot line residential building's needs would contrast greatly with the needs of a high school.

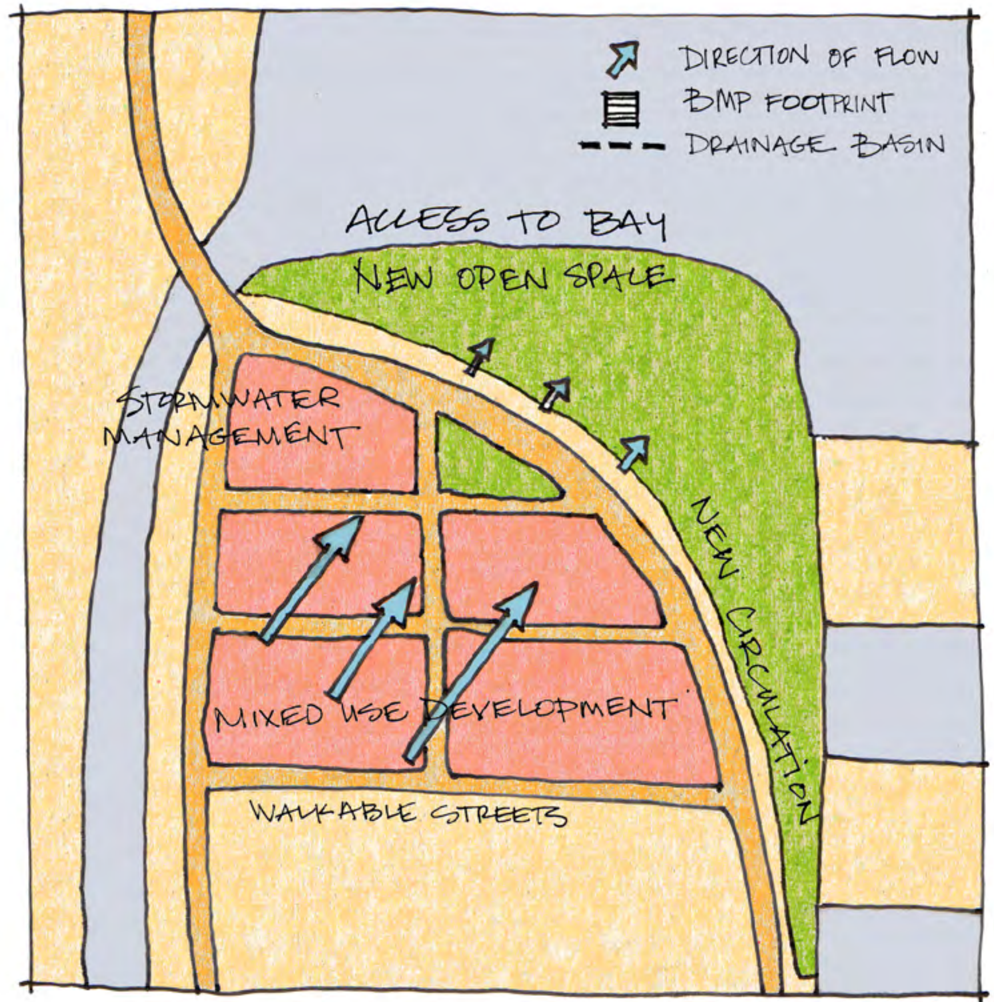
Task 2

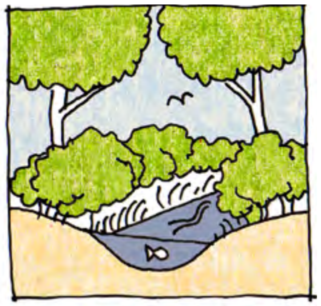
Create Conceptual Stormwater Management Plan

Using the evaluation of existing conditions and stormwater management performance requirements, design teams can begin to develop a stormwater management plan. A draft stormwater management plan should show, at the conceptual level, how water will move across the site and which BMPs will be used to manage that water. This is an appropriate level of design to bring to the SFPUC's suggested Pre-Application Meeting, outlined in *Chapter 9: Stormwater Control Plan Requirements*.

2A. Assemble an interdisciplinary team and use Low Impact Design Principles and Strategies

The property owner should assemble an interdisciplinary team early in the design process to ensure well-designed and feasible GI. These teams typically consist of the property owner, civil engineer, architect, landscape architect, and plumbing designer. When developing the stormwater management approach, project teams should review the Low Impact Design-based (LID) principles and implement the associated strategies listed on the next page as appropriate. While some of the LID Principles and Strategies are more applicable to suburban development and may be less suited to San Francisco's dense urban environment, they represent the industry standard for LID.

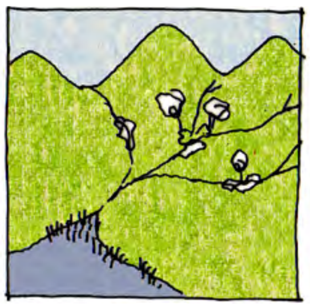




LID Principles and Strategies

Principle 1: Preserve and protect creeks, wetlands, existing vegetation, and other wildlife habitat.

- Incorporate creeks, wetlands, and existing vegetation into the site design. Develop setbacks to protect these areas.
- Encourage planting of new trees and preservation of healthy established trees.
- Look at each site as an opportunity to protect, enhance, or create wildlife habitat.



Principle 2: Incorporate existing drainage patterns, soil conditions, and geology into site design.

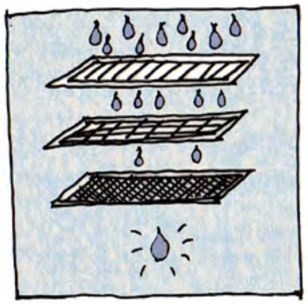
- Design stormwater BMPs to take advantage of existing drainage paths and minimize re-grading.
- Minimize soil disturbance and improve soil quality through soil amendments and creation of a microbial community.
- Concentrate development on parts of the site with less permeable soils and preserve areas that can promote infiltration.
- Prioritize the use of infiltration-based BMPs where soils, groundwater, and geology allow.

Principle 3: Minimize and disconnect impervious surfaces.

- Use landscaping and permeable paving materials rather than traditional hardscape in plazas, sidewalks, driveways, streets, parking areas, and patios.
- Install vegetated roofs to reduce runoff from buildings.

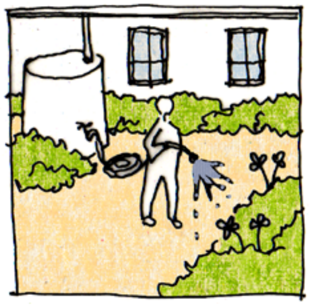
Principle 4: Treat stormwater at its source.

- Identify pollutants of concern and their sources early in the design process and install source control measures where appropriate.
- Detain and retain runoff throughout the site to manage runoff as close to its source as possible.



Principle 5: Treat stormwater as a resource, not a waste product.

- Capture stormwater for irrigation, toilet flushing, cooling towers, and other non-potable applications.
- Design multi-purpose BMPs that not only manage stormwater but also improve streetscape and public space design.
- Incorporate environmental education and interpretation into GI where appropriate.
- Use GI to amplify urban design and place using site-specific strategies.



Bioretention reduces stormwater runoff in a parking lot at an industrial site in San Francisco. Photo: Krystal Zamora

2B. Evaluate and select potential BMP types

Considering site constraints and opportunities as well as the performance requirements established in Task 1, the design team can now identify the types of BMPs that are best suited for the project site. At this stage, design teams should use the Combined or Separate Sewer Area BMP Hierarchy to guide the BMP selection process. Use of the Separate Sewer Area BMP Hierarchy is required and aligns with BMP selection requirements in the *NPDES Phase II Municipal Separate Storm Sewer System Permit.* The Combined Sewer Area BMP Hierarchy is a guidance tool that leads design teams through the City's preferred BMP selection process.

Both BMP hierarchies prioritize rainwater harvesting, infiltration-based BMPs, and vegetated roofs followed by lined bioretention (commonly known as a "flow-through planter"). If none of these BMPs are feasible on site, projects proponents in combined sewer areas can use detention-based BMPs that do not incorporate biotreatment (i.e. detention tanks and ponds) in their site design. Projects in separate sewer areas may be able to incorporate high-rate filtration BMPS (e.g., tree-box filters and media filters) pending approval by the SFPUC or Port. The Combined Sewer Area BMP Hierarchy can be found in *Chapter 5: Combined Sewer Area Performance Requirements* and the Separate Sewer Area BMP Hierarchy in *Chapter 6: Separate Sewer Area Performance Requirements*.

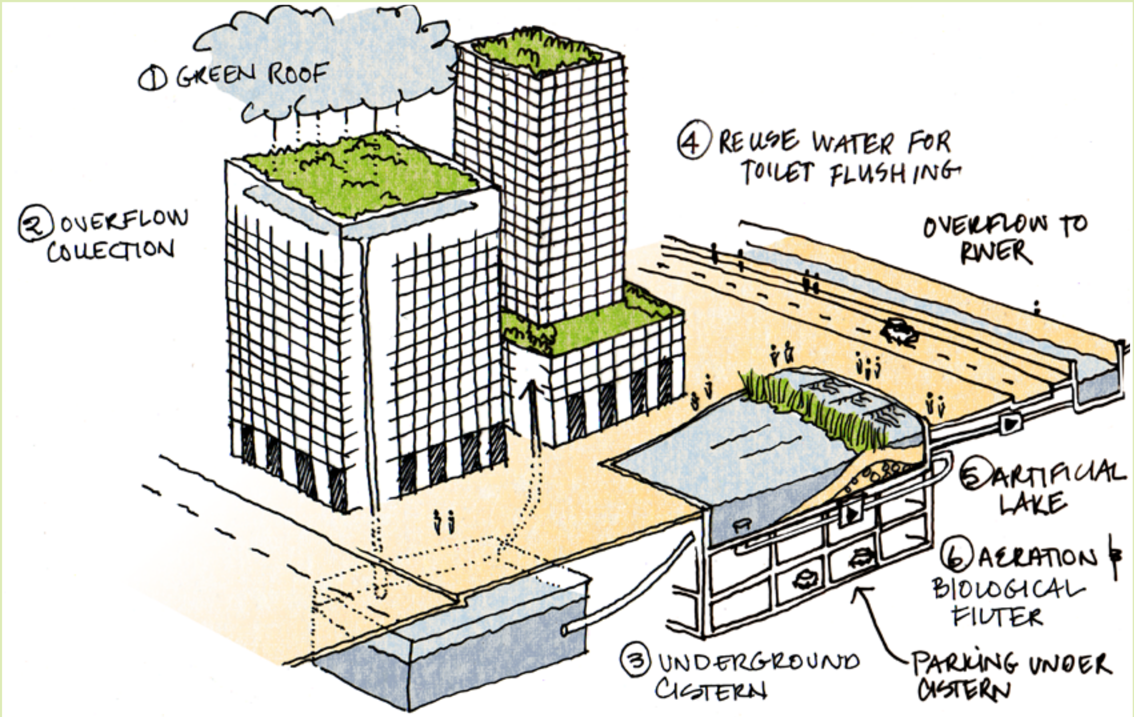


Photo: Rosey Jencks

Case Study: Berlin Treatment Train

The design for Potsdamer Platz, one of Berlin's most important public squares, includes a stormwater treatment train that uses multiple stormwater management strategies (indoor use, storage, biofiltration, and outdoor use) to control both the quality and the volume of stormwater on-site. The roofs of the development, some of which are vegetated roofs and some of which are traditional, harvest rainwater to be used in the buildings for toilet flushing and irrigation. During large storm events, five underground cisterns store rainwater and then release it slowly into a series of pools and planted 'biotopes' for filtration. In the summer months, additional filters can be added to remove algae. Treated rainwater then flows through a very popular outdoor waterscape where employees and visitors gather.

BMPs in Series (i.e. Treatment Trains)

A single BMP may not retain or treat enough runoff from its contributing DMA to meet applicable performance requirements. In these cases, a combination of several BMPs in succession, known as a "treatment train," may be used to enhance stormwater management effectiveness. BMPs in series increase volume and peak flow reduction capacity as well as improve water quality by treating a wider range of pollutants than a single BMP. BMPs in series can also improve the long-term efficiency of BMPs and reduce the maintenance requirements for each BMP in the train.

Some example treatment train configurations include:

Cistern overflow → Rain garden or flow-through planter

Vegetated roof → Flow-through planter

Vegetated swale → Rain garden

Detention tank → Flow-through planter

A few principles to keep in mind in the design of treatment trains include:

- Think of each element in a treatment train as a separate functional unit.
- Before adding additional elements to a treatment train, analyze their performance relative to preceding BMPs in the train. If the expected stormwater benefits of the additional element are limited, the increase in cost may outweigh the benefits.
- Do not alter or remove any single BMP without a corresponding resizing of remaining BMPs in the treatment train, otherwise the capacity of the remaining BMPs may be exceeded.

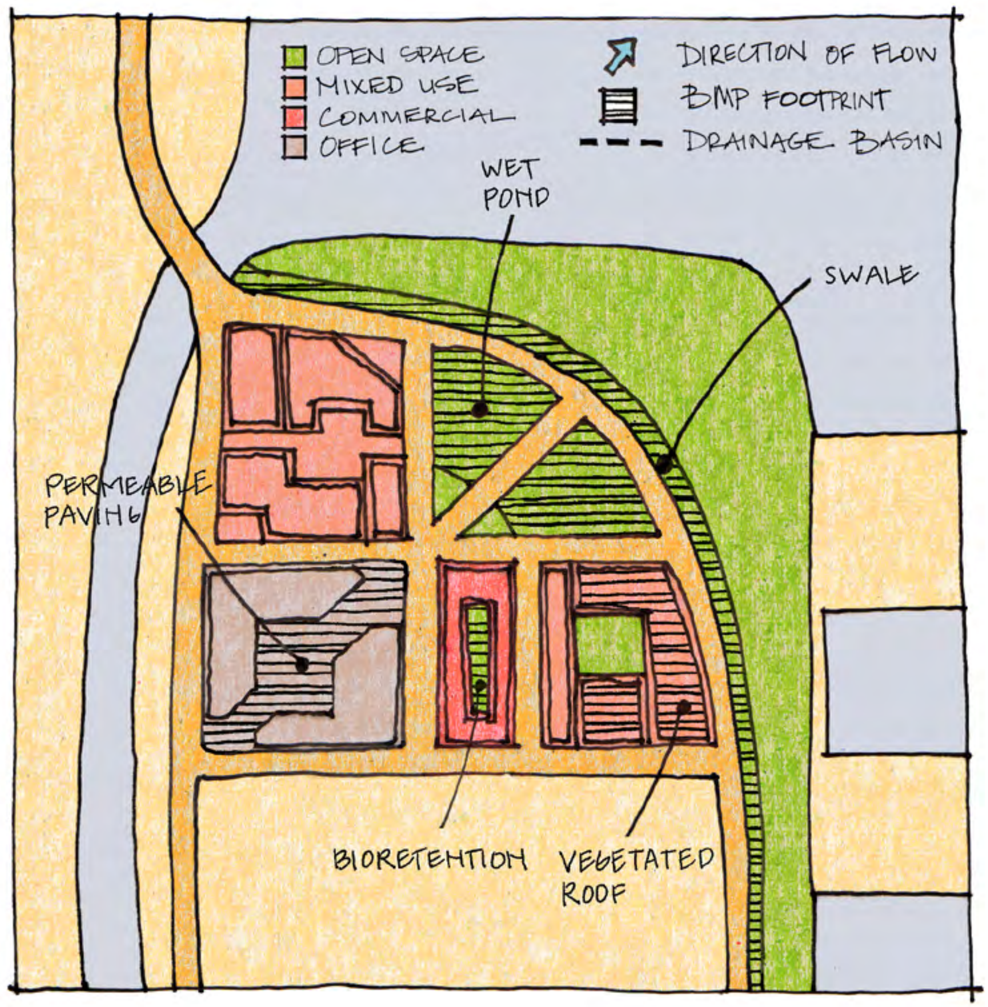
Table 1 provides a list of BMPs approved for use in meeting San Francisco's stormwater performance requirements (described in *Chapter 5: Combined Sewer Area Performance Requirements and Chapter 6: Separate Sewer Area Performance Requirements*). Photos, siting and design information about these BMPs is provided in *Appendix A: BMP Fact Sheets*, and detailed design guidance is provided in *Appendix B: Green Infrastructure Typical Details and Specifications*.

2C. Delineate DMAs

To better understand the flow of stormwater across the site, design teams need to delineate the major post-development drainage patterns, including sub-watersheds and DMAs. A sub-watershed area is defined as the contributing surface that drains to a single (separate or combined) sewer system connection. Sub-watersheds can be broken down into one or more DMAs. A DMA is a discrete area that drains to a single stormwater control, to a series of hydraulically-connected controls (known as a "treatment train"), or directly to the sewer system. Instructions for delineating sub-watershed areas and DMAs are provided in the *Stormwater Control Plan (SCP) Instructions* (available at www.sfwater.org/smr). While BMP selection is typically not yet finalized at this point, the design team can develop DMAs that work with the stormwater design approach and iteratively refine the BMP selection later in the process (see Task 4).

Table 1. Stormwater Controls (i.e. BMPs)

BMP	Description
Rainwater Harvesting	A system that collects and stores runoff from roofs or other impervious surfaces for non-potable reuse.
Vegetated Roof	A vegetative layer grown on a roof.
Permeable Pavement	Pavement that allows runoff to pass through it to the soil below, thereby reducing the runoff from a site.
Unlined Bioretention	A vegetated stormwater facility (e.g., rain garden) that captures, infiltrates, transpires, and treats polluted runoff, thereby reducing stormwater volume, attenuating peak flow, and improving stormwater quality.
Lined Bioretention	A vegetated stormwater facility (e.g., flow-through planter) that captures, transpires, and treats polluted runoff. It is designed with a liner and an underdrain to direct treated runoff to the sewer system.
Subsurface Infiltration System	An underground stormwater storage facility (e.g., infiltration gallery) that receives runoff through subsurface piping and stores water until it infiltrates into the soil.
Infiltration Trench	A rock-filled trench that receives stormwater runoff from the ground surface (not through subsurface pipes) and allows it to infiltrate.
Infiltration Basin	A shallow impoundment underlain by permeable soil that captures stormwater, stores it, and allows it to infiltrate.
Bioretention Swale	A treatment-based facility such as a tree-box filter that uses biological processes to filter pollutants out of stormwater. Use of these BMPs is only allowed under special circumstances and is at the discretion of the SFPUC or Port.
High-Rate Biofiltration	A treatment-based facility such as a tree-box filter that uses biological processes to filter pollutants out of stormwater. Use of these BMPs is only allowed under special circumstances and is at the discretion of the SFPUC or Port.
Media Filter	A filter that treats stormwater via filtration and adsorption of pollutants to the filter media. Use of these BMPs is only allowed under special circumstances and is at the discretion of the SFPUC or Port.
Subsurface Detention System	An underground storage tank (e.g., detention tank or vault) that temporarily stores stormwater and slowly releases it back to the sewer system to reduce peak flows.
Detention Pond	A shallow impoundment that temporarily stores stormwater and slowly releases it back to the sewer system to reduce peak flows.
Wet Pond	A basin constructed to detain stormwater and maintain a permanent pool of water throughout the wet season and potentially throughout the year.
Constructed Wetland	A man-made wetland designed to collect and purify stormwater through microbial transformation, plant uptake, settling of particulates, and adsorption. This BMP is typically implemented as a centralized treatment facility.



2D. Conceptually site BMPs

After delineating DMAs, design teams can select and site BMPs that suit the site, align with the team's design goals, and respond to the site constraints and programmatic needs.

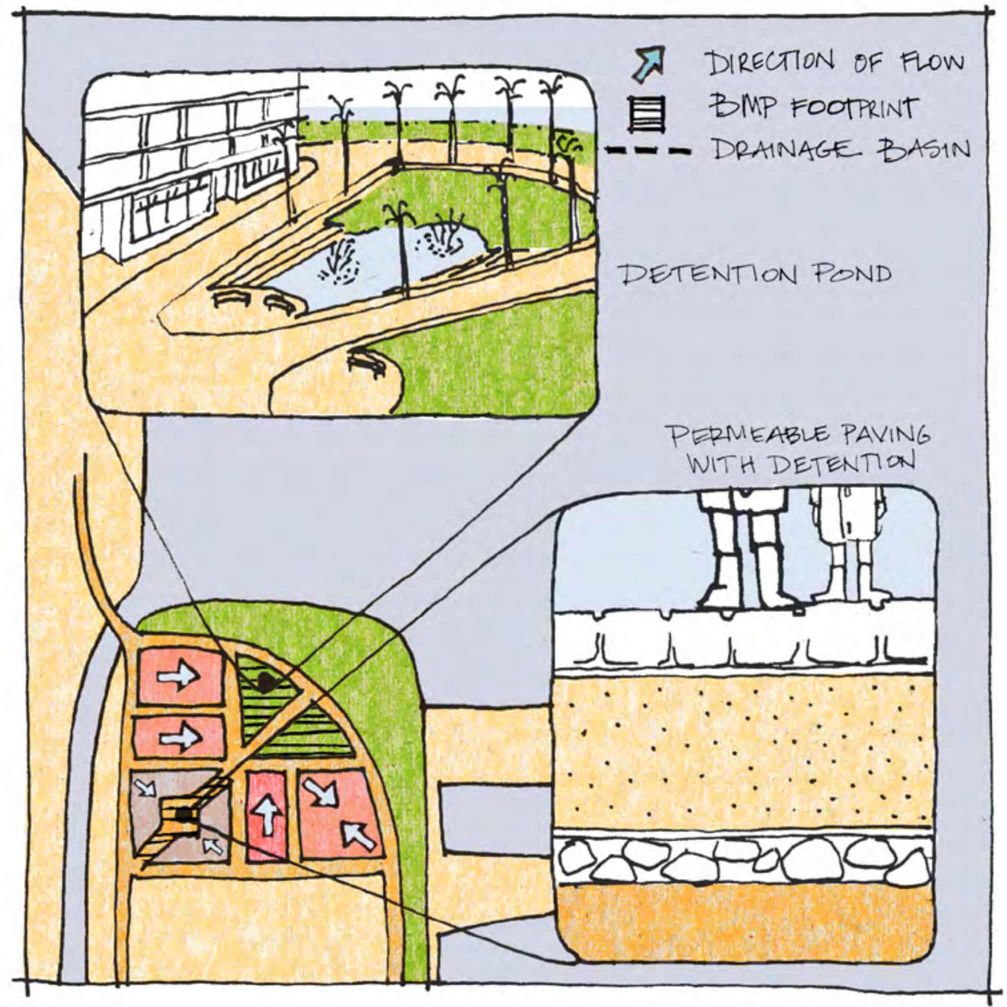
Task 3

Develop the Stormwater Management Plan

At this point in the design process, design teams should have a general idea of the types and locations of BMPs that account for site conditions and meet project goals. Proponents are now ready to further develop the stormwater management plan and size BMPs to demonstrate compliance with the performance requirements. The outcome of this process is an appropriate level of design for a Preliminary SCP, outlined in *Chapter 9: Stormwater Control Plan Requirements*.

3A. Locate BMPs

Finalizing the locations of the selected BMPs requires collaboration among the interdisciplinary team to ensure that programmatic needs are met, physical constraints and opportunities are considered, and stormwater is managed safely. For example, the team must confirm that site grading and piping networks capture runoff from the entire intended DMA and direct it to the BMP. For BMPs located on structures, the team must confirm that the structure can safely bear the load of the BMP. They must also confirm that the BMP placement will not create utility, regulatory or programming conflicts. Lastly, using simplified sizing ratios to approximate BMP size, they should confirm that there will be sufficient space for the proposed BMPs.



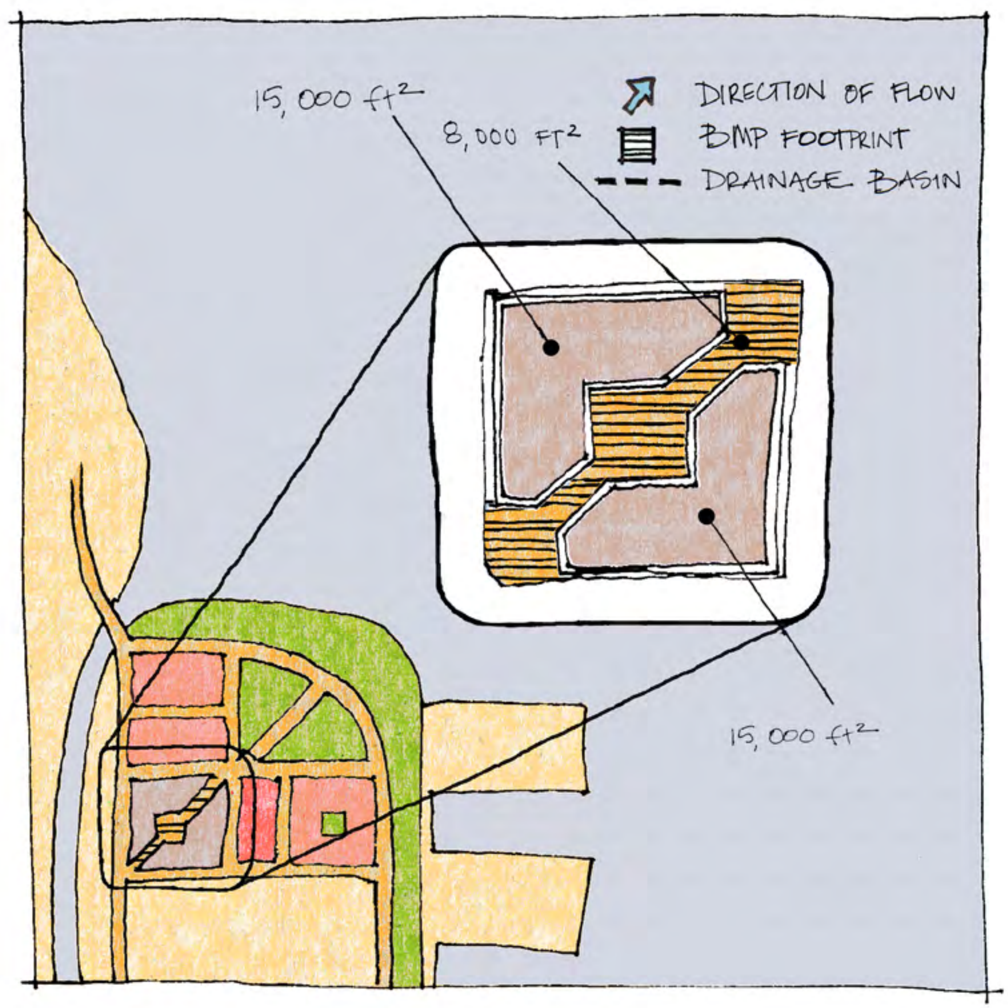
A rain garden at Glencoe Elementary in Portland, Oregon reduces stormwater flows to Portland's wastewater collection system. *Photo: Rosey Jencks*

3B. Size BMPs using the BMP sizing calculator or modeling

After selecting and locating stormwater controls that are appropriate for site conditions, design teams must size the BMPs to achieve the desired stormwater performance results. Projects that are five acres or less, or with sub-watershed areas that are two acres or less, can use the SFPUC's electronic BMP Sizing Calculators to size BMPs. Larger, more complex development projects can use the BMP Sizing Calculators as planning tools, but must use modelling to prove compliance with the SMR.

If using the calculators, all performance requirements are built into the spreadsheets, which, upon entry of site information, automatically provide runoff reduction estimates and indicate whether the site design passes (meets requirements) or fails (does not meet requirements). The BMP Sizing Calculator results allow design teams to iteratively complete a stormwater management plan for the site, showing proposed land uses, sub-watershed areas and DMAs, and specific BMP designs.

The two calculator spreadsheets, one for combined sewer area projects and one for separate sewer area projects, are available on the SFPUC website at www.sfwater.org/smr. For additional guidance on BMP sizing, see the memorandum *Combined Sewer Area BMP Sizing Calculator Approach Using the Santa Barbara Urban Hydrograph Method* , which provides guidance on the calculator approach and design parameters for each BMP (available at www.sfwater.org/smr).



Designing to Minimize Maintenance

Streamlined maintenance and maximized performance can be achieved by incorporating the following design strategies:

- Use pretreatment systems to remove coarse sediment and litter, particularly for infiltration systems. Pretreatment systems can reduce the velocity of flows entering the BMP, reducing wear on the BMP and extending its useful life.
- Use simple and passive systems that minimize piping, complex routing, and pumping.
- Whenever possible, select BMPs that do not require slow-release control structures. Such structures can clog and require periodic inspection and maintenance.
- Whenever possible, select stormwater facilities that are above-ground, as they are more likely to be visible and therefore receive maintenance.
- Use deep-rooted vegetation in conjunction with infiltration BMPs. Good root structure helps to maintain soil porosity and reduces the maintenance needs of the BMP. For a list of recommended vegetation species for bioretention, see Appendix D: Vegetation Palette for Bioretention BMPs.
- Avoid using woody plants, shrubs or trees in conjunction with underdrained BMPs to reduce the potential for underdrain clogging and damage due to root intrusion.

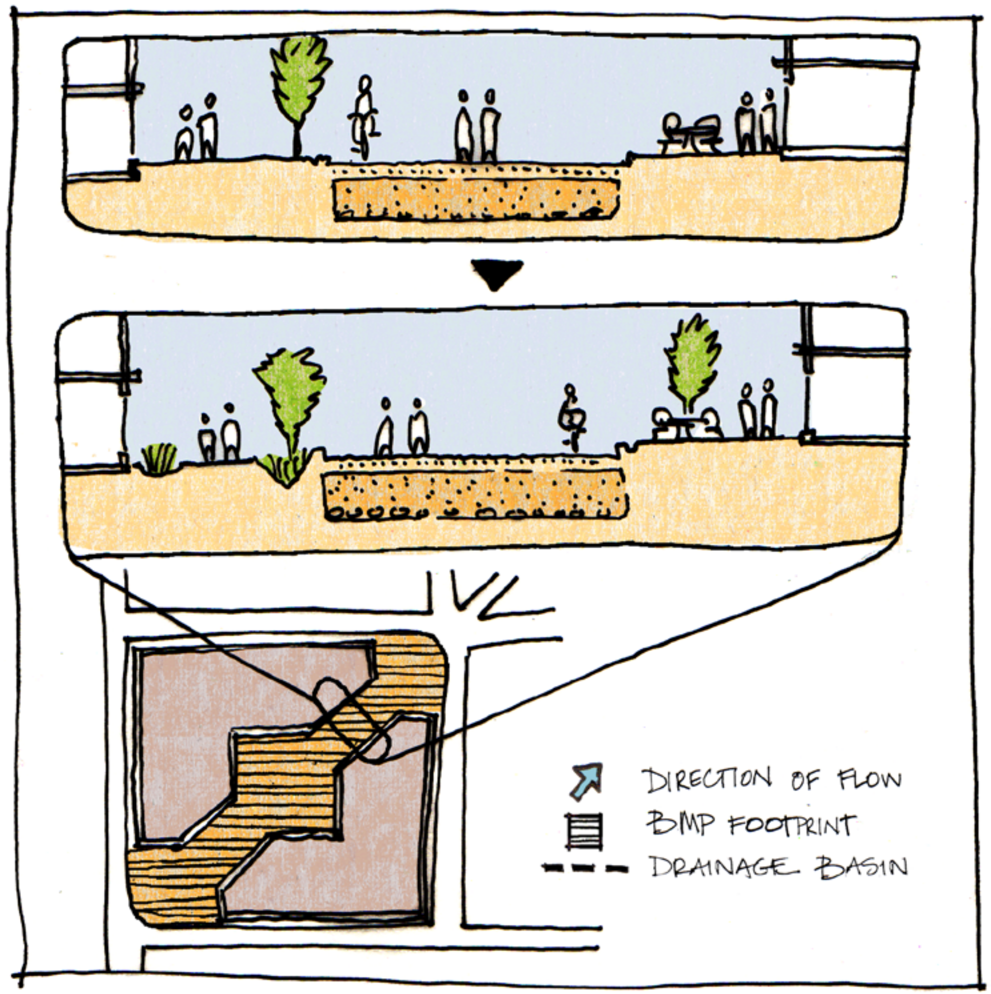
3C. Design BMPs

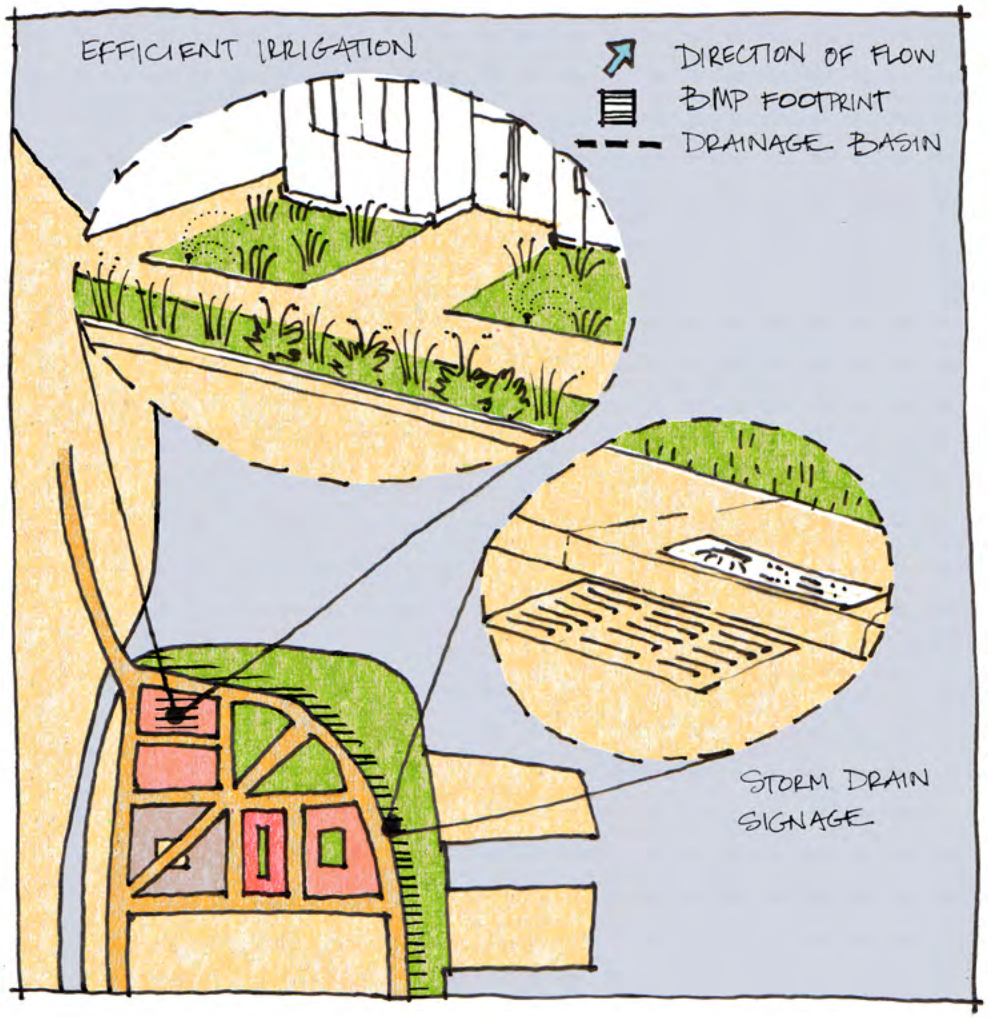
This is where the design and detailing of all BMPs takes place, separately from locating and sizing. The interdisciplinary design team should coordinate to determine BMP materials, plantings, plumbing connections, etc. The SFPUC has developed the *Green Infrastructure Typical Details and Specifications* (Appendix B) to help inform BMP design. These details incorporate the latest best practices in green infrastructure design national-wide and, at the same time, reflect the unique challenges and specific needs for designing and building green infrastructure in the City and County of San Francisco. They show **typical** configurations, rather than required **standard** configurations. Licensed professionals can and should modify facility configurations, materials, or notes based on specific project conditions. *Appendix A: BMP Fact Sheets* is another valuable design tool that provides guidance on BMP design parameters, such as the ponding depth, media depth, and maximum drawdown times.

Task 4

Finalize Stormwater Management Plan

At this point BMP type, location, and size should be finalized. Design teams should review the LID Principles and Strategies prioritized from Task 2A and confirm that they have been achieved. If not, an iterative design process that includes revising BMP selection or size may be necessary to ensure that the project achieves its design goals and meets all applicable performance requirements. An example of a completed stormwater management plan is available online at www.sfwater.org/smr.





Task 5

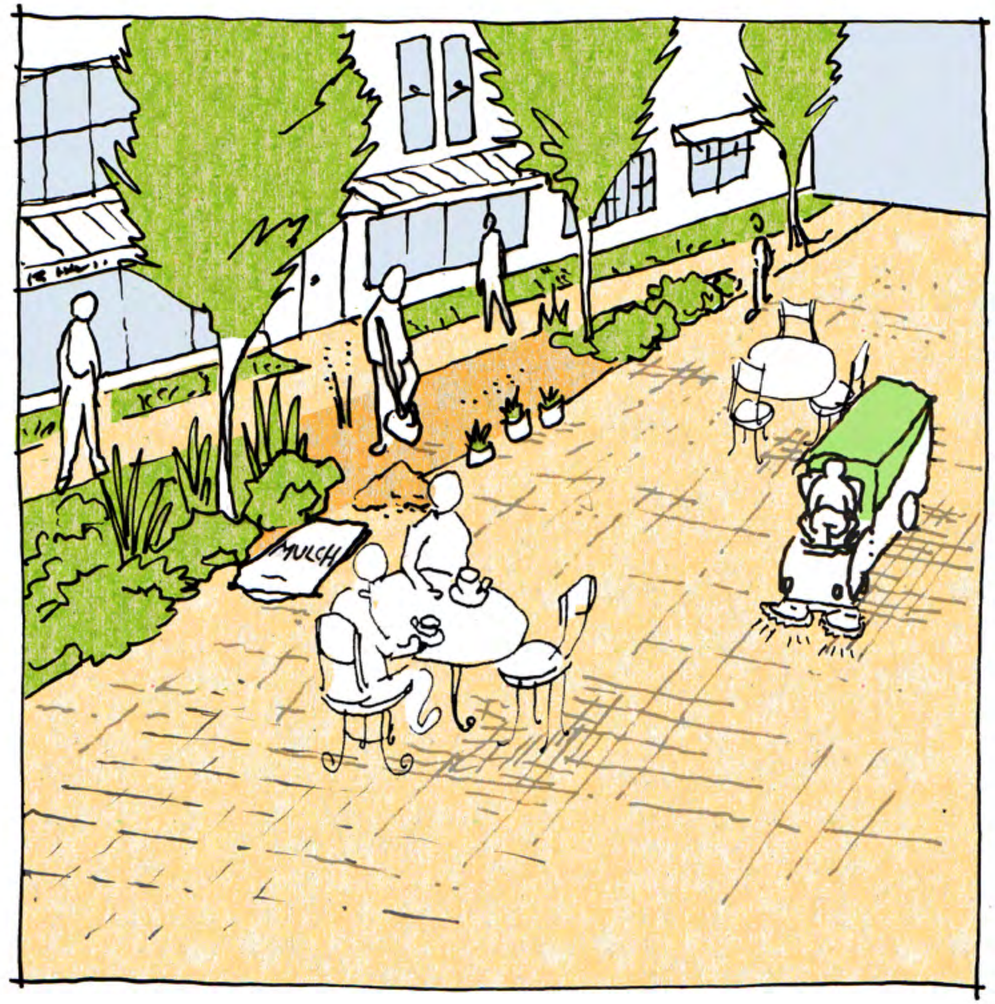
Select and Locate Source Controls

Everyday activities such as recycling, trash disposal, and vehicle and equipment washing generate pollutants such as trash, sediments, oil and grease, nutrients, pesticides, and metals, all of which can be mobilized by stormwater runoff. The Pollutants of Concern section in *Chapter 2: Regulatory Context* describes the main categories of pollutants, their sources, and their environmental consequences. These pollutants can be minimized by applying source controls. Source controls prevent pollutant generation and discharge by controlling pollution at its source, or, at a minimum, limiting stormwater exposure to pollutants. The BMPs discussed in Tasks 1-4 focus on managing stormwater flow and volumes, whereas source controls focus on preventing pollutants from entering stormwater runoff during storms.

Source controls include both structural features and operational practices. Typical structural source controls involve covering, berming, or hydraulically isolating a potential pollutant source area. Operational source control measures include routine pavement sweeping and substituting traditional materials with those that are less toxic; for example, replacing traditional anodized chain link fencing with vinyl coated fencing.

The Source Control section of *Appendix A: BMP Fact Sheets* provides example source controls for specific pollutant-generating activities and sources. It also includes a list of source control resources.

Task 6



Develop Inspection and Maintenance Plans

Stormwater controls must be routinely inspected and maintained to ensure that they are functioning effectively. Typical inspection and maintenance activities are described in *Appendix A: BMP Fact Sheets* and in the *Annual Self-Certification Checklists and Instructions*, which are available online at www.sfwater.org/smr.

Project proponents for sites that create or replace 5,000 sf or more impervious surface must develop inspection and maintenance plans that include the following:

1. **Identify who will own or have operational responsibility** for the facility. In the case of privately owned facilities regulated by the SFPUC, the property owner will be responsible for routine inspections and maintenance. In the case of facilities within the Port's jurisdiction, operational responsibility will be assigned through lease and development agreements.

2. **Identify inspection and maintenance activities and schedules** for all BMP types at the site.

3. **Formalize inspection and maintenance responsibilities.** Projects under SFPUC jurisdiction will use a Maintenance Agreement recorded with the property. Projects under Port jurisdiction will use lease agreements, management agreements, licenses, or comparable documents.

The property owner or delegate must **maintain the stormwater control facilities in perpetuity** from the completion of construction. If the ownership or lease is transferred, inspection and maintenance responsibilities must also be formally transferred to the new owner, occupant, or lessee.

Stormwater controls installed to meet SFPUC or Port performance requirements will be inspected through the SFPUC or Port maintenance inspection programs, described in *Chapter 10: Inspection and Enforcement*.

A vegetated roof and other LID features at the Eco-Center at Heron's Head Park help illustrate sustainable design practices to students in San Francisco's Bayview-Hunters Point neighborhood. Photo: Rosey Jencks

5 Combined Sewer Area Performance Requirements

To improve stormwater management across San Francisco's combined sewer areas, the City of San Francisco requires all projects creating and/or replacing 5,000 square feet or more of impervious surface to comply with stormwater management requirements and to submit a Stormwater Control Plan.

The primary reason for implementing post-construction stormwater controls in combined sewer areas is to reduce and delay the volumes and peak flows of stormwater reaching the sewer system. Reducing these volumes and flows can help to reduce combined sewer discharge volume, decrease flooding, and protect water quality. This chapter describes the stormwater performance requirements for projects constructed in combined sewer areas.

Pre-Development Conditions

The SFPUC and Port interpret the term "pre-development" to be the existing conditions on the site before construction of the proposed development project. "Pre-development" is not the natural condition of the site prior to human development. For project sites where demolition has occurred before initiation of the current development project, the pre-development condition is defined as the most recent **active** land use.

Changes in Performance Requirements for Combined Sewer Areas | 2010 to 2016

The 2016 performance requirements for projects within the combined sewer area contain two key differences from the 2010 performance requirements:

1. The threshold at which projects must comply with the SMR has been redefined. In the 2010 *Guidelines*, projects **disturbing 5,000 square feet or more of the ground surface** were subject to the requirements. In the 2016 SMR, the threshold has been revised to projects **creating and/or replacing 5,000 square feet or more of impervious surface**.
2. The 2016 SMR includes Modified Compliance for eligible projects. This option was not available in the 2010 *Guidelines*.

Applicability Dates

The 2010 *Guidelines* performance requirements apply to projects for which a Preliminary SCP was submitted before May 27, 2016. The 2016 SMR performance requirements apply to projects with Preliminary SCPs submitted on or after May 27, 2016.

Combined Sewer Area Performance Requirements

In areas served by the combined sewer system, new or redevelopment projects that create and/or replace 5,000 square feet or more of impervious surface must manage the flow rate and volume of stormwater discharging to the combined sewer system. The combined sewer system performance requirements are divided into two cases based on existing site imperviousness:

- **Case 1:** Projects with existing imperviousness of less than or equal to 50 percent must maintain a stormwater runoff rate and volume at or below pre-development conditions for the 1- and 2-year, 24-hour design storms.
- **Case 2:** Projects with existing imperviousness of greater than 50 percent must reduce the stormwater runoff rate and volume by 25 percent relative to pre-development conditions for the 2-year, 24-hour design storm.

Under certain conditions right-of-way (ROW) projects must comply with the Stormwater Management Requirements (SMR), as described in *Chapter 7: Stormwater Management Requirements in the Streets*.

Activities that create or replace impervious surface include, but are not limited to, the construction, modification, conversion, or alteration of any building or structure and the creation or replacement of outdoor impervious surfaces such as parking areas, driveways, or private street areas.

The SMR does *<u>not</u>* apply to the following activities:

- pavement maintenance activities such as top-layer asphalt grinding and repaving within the existing footprint;
- replacement of existing sidewalks and streets dedicated to and accepted by the City;
- interior remodeling projects;
- re-roofing;
- exterior wall surface replacement; or
- utility repair work requiring trenching or excavation with in-kind surface replacement.

Impervious Surface

The San Francisco Public Utilities Commission (SFPUC) and Port of San Francisco (Port) define an "impervious surface" as a surface that prevents the land's natural ability to absorb and infiltrate rainfall or stormwater. Impervious surfaces include, but are not limited to; building or structures, roof tops, impervious concrete and asphalt, and any other continuous watertight pavement or covering. Landscaped soil and pervious pavement, including pavers with pervious openings and seams, underlain with pervious soil or pervious storage material, are not impervious surfaces.

For the purpose of determining whether a project is subject to the SMR, surfaces that are traditionally impervious, including the entire building footprint and paved or hardscape areas, are included in the summation of created and/or replaced impervious surface. This is to ensure that all stormwater management BMPs (including green roofs and permeable pavement) undergo design review and are included in long-term maintenance agreements.

Basis of Combined Sewer Area Performance Requirements

The performance requirements for combined sewer areas are based upon the stormwater requirements from Sustainable Sites Credit 6.1 "Stormwater Design: Quantity Control" in *LEED version 2.2 for New Construction and Major Renovation*. Coordinating the SMR performance requirements with LEED credits allows the development community to achieve two goals by meeting one performance requirement (i.e. meet the SMR and receive LEED points). The SMR performance requirements remain valid for *LEED version 2009* points, but do not directly correlate with *LEED version 4*. Further information regarding LEED credit requirements is presented in *Chapter 8: Green Building Certification Requirements*.

LID Principles and Strategies

The San Francisco Public Utilities Commission (SFPUC) recommends that design teams consider the Low Impact Design (LID) Principles and Strategies, presented in *Chapter 4: Green Infrastructure Design Approach*, when developing the stormwater management approach for their sites. The five LID Principles and Strategies include preserving and protecting creeks, wetlands, existing vegetation, and other wildlife habitat; incorporating existing drainage patterns, soil conditions, and geology into the site design; minimizing and disconnecting impervious surfaces; treating stormwater at its source; and treating stormwater as a resource, not a waste product.

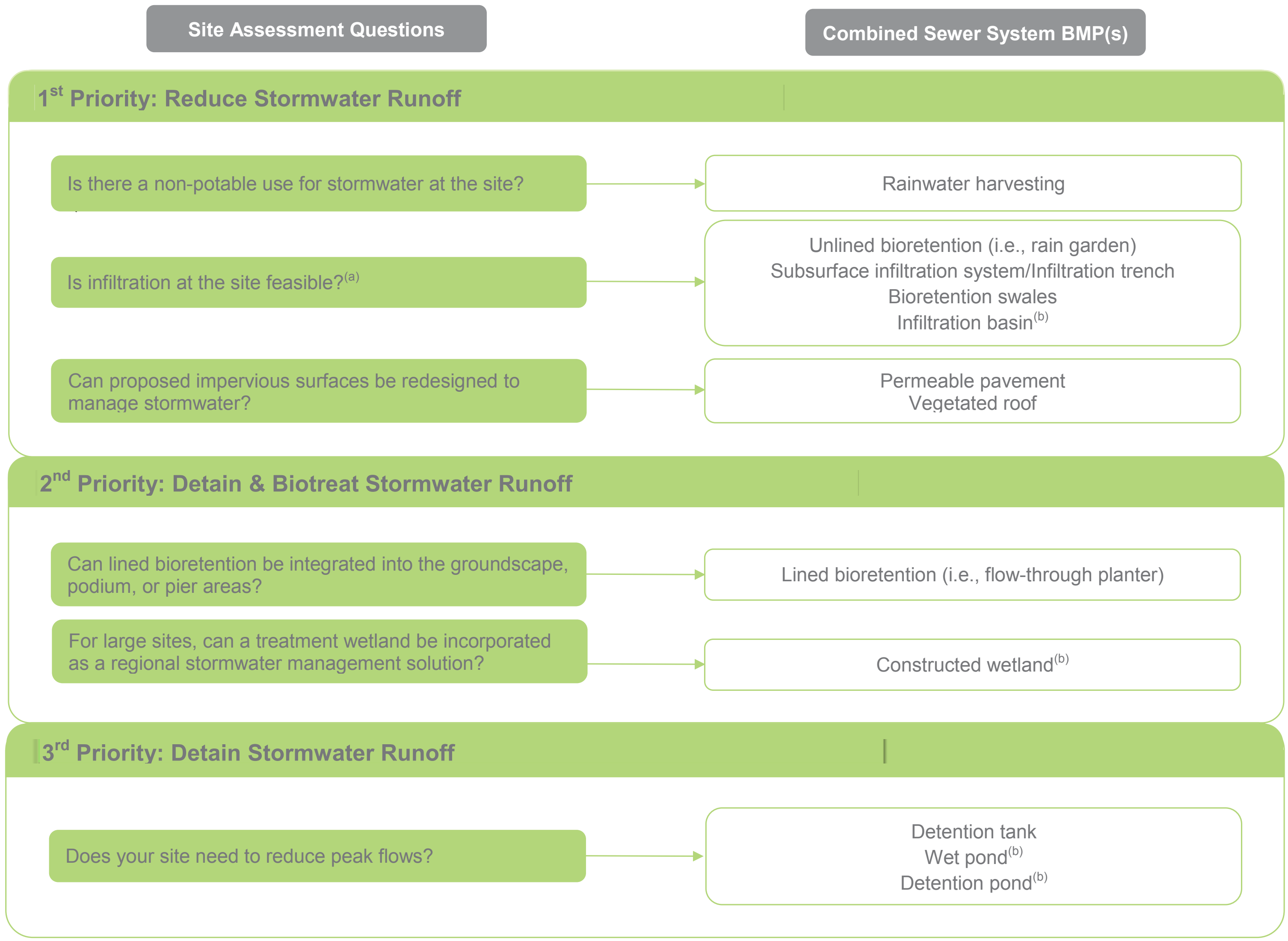
Bioretention in an industrial area of San Francisco. Photo: Krystal Zamora

Preferred BMP Selection

When selecting BMPs to meet the performance requirements, the SFPUC and Port encourage design teams in combined sewer areas to use the Combined Sewer Area BMP Hierarchy (Figure 7). The Combined Sewer Area BMP Hierarchy presents a process for selecting BMPs that prioritizes reuse (rainwater harvesting), infiltration, and vegetated roofs. However, for some sites in San Francisco's combined sewer areas, reuse, infiltration, or vegetated roofs may not be feasible when the following conditions are present:

- Little to no demand for non-potable water (rainwater harvesting); and
- Documented high concentrations of pollutants in underlying soil or groundwater, preventing infiltration; or
- Potential geotechnical hazard that could be exacerbated by infiltration; or
- Being located on elevated structures, such as piers over water, causing infiltration to be infeasible.

In such cases, bioretention facilities that include an impermeable liner and an underdrain at the bottom of the storage layer (a configuration commonly known as a "flow-through planter") may be used. If none of these BMPs are feasible on site, projects in combined sewer areas should then consider detention-based BMPs that do not incorporate biotreatment (i.e. detention tanks and ponds). All stormwater controls used for compliance with the SMR must be located on a parcel, unless a project applies for Modified Compliance or triggers the combined sewer area ROW requirements outlined on in *Chapter 7: Stormwater Management Requirements in the Streets*.



Notes:
(a) For information on infiltration constraints and feasibility refer to Appendix C: Infiltration Guidance.
(b) Typically appropriate for large or multi-parcel sites.

Figure 7. *Combined Sewer Area BMP Hierarchy*

Modified Compliance

In 2014, the SFPUC initiated a Modified Compliance Program for the combined sewer area to allow projects with proven site challenges to comply with the SMR via modified stormwater control performance requirements or the use of BMPs in adjacent public sidewalks to meet standard performance requirements. The Modified Compliance Program was developed based on feedback from the development and design community, research and modeling by the SFPUC, and coordination with the San Francisco Planning and Urban Research Association (SPUR). Table 2 provides more information on the eligibility and compliance options of the Modified Compliance Program. Modified Compliance Program materials are available on the SFPUC website at www.sfwater.org/smr.

Table 2. The Modified Compliance Program

Eligibility

- Applies only to Case 2 projects (sites with existing imperviousness of greater than 50 percent) served by the combined sewer system
- Requires evaluation of site constraints, including high groundwater, shallow depth to bedrock, poorly infiltrating soils, contamination, and presence of zero lot line conditions (buildings that extend to the property lines)
- Requires evaluation of project potential for rainwater harvesting
- Requires the submittal of a Modified Compliance Application (available at www.sfwater.org/smr) documenting these evaluations **prior** to submittal of Preliminary SCP.

Outcomes

Eligible projects may meet SMR requirements via:

- **Modification of performance requirements**: Allowed decrease in volume reduction requirements (to a minimum of 10%) and required increase in peak rate reduction requirements at a 1:1 ratio (to a maximum of 40%). For example, if the volume reduction requirement is decreased from 25% to 20%, the required peak flow reduction increases from 25% to 30%.

  OR

- **BMPs in adjacent public sidewalk**: The use of stormwater BMPs in the adjacent public right-of-way (i.e. sidewalks) to comply with standard Combined Sewer Area performance requirements.

Modified Compliance was allowed for this multi-use building in the Mission District of San Francisco, which was constrained by Type D soils. Lined bioretention planters and rainwater harvesting were implemented to achieve the modified performance requirements *Photo: Krystal Zamora*

6 Separate Sewer Area Performance Requirements

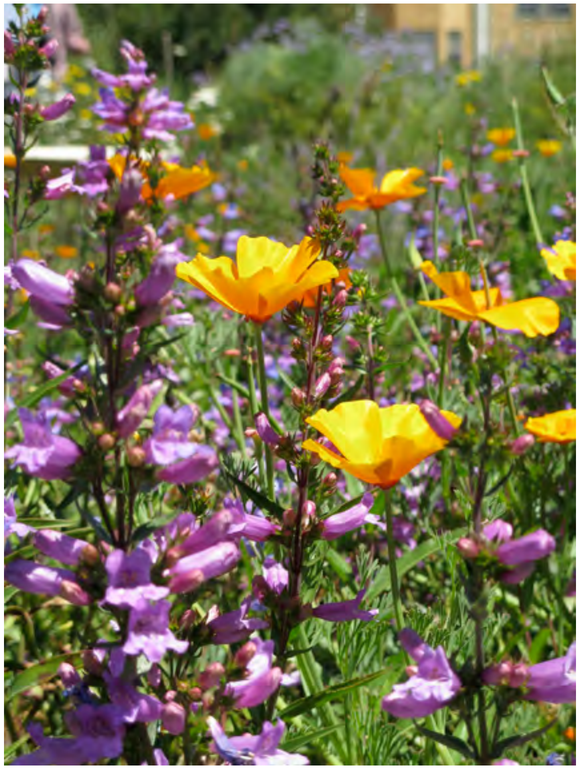
To improve stormwater management across San Francisco's separate sewer areas, the City of San Francisco has adopted stormwater management performance requirements for two project sizes based on the area of impervious surface created and/or replaced.

The primary reason for implementing post-construction stormwater controls in separate sewer areas is to protect the water quality of receiving waters by reducing runoff and improving stormwater quality. This chapter describes the stormwater performance requirements for separate sewer areas.

Separate Sewer Area Requirements Overview

In areas served by separate sewer systems, performance requirements vary according to the following project size thresholds:

- **Small Project**: 2,500 to 5,000 square feet of impervious surface created and/or replaced
- **Large Project**: 5,000 square feet or more of impervious surface created and/or replaced



California native plants require less water once established. Photo: Rosey Jencks

Activities that create or replace impervious surface include, but are not limited to, the construction, modification, conversion, or alteration of any building or structure and the creation or replacement of outdoor impervious surfaces such as parking areas, driveways, or private street areas.

The SMR does *not* apply to the following activities:

- pavement maintenance activities such as top-layer asphalt grinding and repaving within the existing footprint;
- replacement of existing sidewalks and streets dedicated to and accepted by the City;
- interior remodeling projects;
- re-roofing;
- exterior wall surface replacement; or
- utility repair work requiring trenching or excavation with in-kind surface replacement.

Table 3 summarizes performance requirements by project size. A more detailed description of the requirements follows the table.

Table 3. Separate Sewer Area Performance and Documentation Requirements by Project Size

Size	Impervious Surface Created or Replaced	Performance Requirements	Documentation Requirements
Small Project	2,500 – 5,000 square feet	Implement at least one Site Design Measure (see Table 4)	Submit estimated runoff reduction volume using the State Water Board SMARTS calculator
Large Project	≥ 5,000 square feet	Implement source controls and BMPs to meet performance requirements: • Projects within SFPUC jurisdiction must manage the 90th percentile, 24-hour storm • Projects within the Port's jurisdiction must manage the 85th percentile, 24-hour storm	• Stormwater Control Plan to SFPUC or Port (See Chapter 9) • A signed and recorded Maintenance Agreement (SFPUC jurisdiction) or Operations & Maintenance Verification Documents (Port jurisdiction) • A signed Certificate of Acceptable Construction

Impervious Surface

The San Francisco Public Utilities Commission (SFPUC) and Port of San Francisco (Port) define an "impervious surface" as a surface that prevents the land's natural ability to absorb and infiltrate rainfall or stormwater. Impervious surfaces include, but are not limited to; building or structures, roof tops, impervious concrete and asphalt, and any other continuous watertight pavement or covering. Landscaped soil and pervious pavement, including pavers with pervious openings and seams, underlain with pervious soil or pervious storage material, are not impervious surfaces.

For the purpose of determining whether a project is subject to the SMR, surfaces that are traditionally impervious, including the entire building footprint and paved or hardscape areas, are included in the summation of created and/or replaced impervious surface. This is to ensure that all stormwater management BMPs (including green roofs and permeable pavement) undergo design review and are included in long-term maintenance agreements.

Basis of Separate Sewer Area Performance Requirements

SFPUC Requirements The SFPUC performance requirements for Large Projects are based upon the stormwater requirements from Sustainable Sites Credit 6.2 "Stormwater Design: Quality Control" in *LEED version 2.2 for New Construction and Major Renovation*. Coordinating the SMR performance requirements with LEED credits allows the development community to achieve two goals by meeting one performance requirement (i.e. meet the SMR performance requirements and receive LEED points). The requirements remain valid for *LEED version 2009* points, but do not directly correspond with *LEED version 4*. Further information regarding LEED credit requirements is presented in *Chapter 8: Green Building Certification Requirements*.

Port Requirements The Port performance requirements for Large Projects are based upon the stormwater requirements from the 2013 *NPDES Phase II Municipal Separate Storm Sewer System Permit*.

Small Project Separate Sewer Area Requirements

Projects in separate sewer areas that create and/or replace 2,500-5,000 square feet of impervious surface must implement one or more of the Site Design Measures listed in Table 4 to reduce runoff from the project site.

Table 4. Site Design Measures

Site Design Measure	Description
Soil Quality Improvement	Improvement of soil through soil amendments and the creation of microbial community.
Tree Planting and Preservation	Planting new trees and/or preserving healthy, established trees.
Disconnection of Rooftop and Impervious Area	Rerouting rooftop drainage pipes to cisterns or permeable areas instead of to the storm sewer.
Permeable Pavement	Pavement that allows runoff to pass through it to the soil below, thereby reducing the runoff from a site.
Green Roof	A vegetative layer grown on a roof (rooftop garden).
Vegetated Swale	A vegetated open channel designed to treat and attenuate runoff.
Rainwater Harvesting	System that collects and stores runoff from roofs or other impervious surfaces for non-potable reuse.
Stream Setback or Buffer	A vegetated area with trees, shrubs, and herbaceous vegetation that exists or is established to protect a stream system, lake, reservoir, or coastal estuarine area.

Small Projects must submit the estimated runoff reduction that will be achieved by implementing the proposed Site Design Measures. The runoff reduction should be estimated using the State Water Board's *Stormwater Multiple Application & Report Tracking System (SMARTS) Post-Construction Calculator* (available at http://www.waterboards.ca.gov/water_issues/programs/stormwater/phase_ii_municipal.shtml) and submitted to the SFPUC or Port.

Large Project Separate Sewer Area Performance Requirements

Large Projects create and/or replace 5,000 square feet or more of impervious surface and are required to comply with the following requirements:

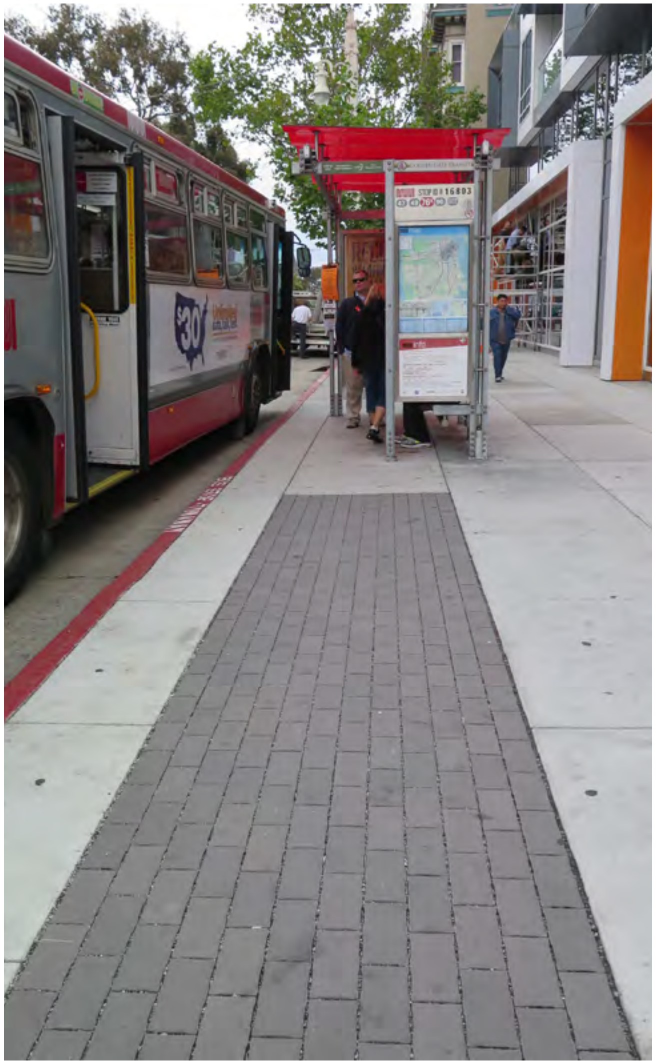
1 - Site Design Requirements

In both SFPUC and Port jurisdiction areas, separate sewer area projects must consider optimizing the site layout using the Low Impact Design (LID) Principles and Strategies presented in *Chapter 4: Green Infrastructure Design Approach*, Task 4. Design teams must review the list of Principles and Strategies, assess potential for using these design principles in project design, implement them to the extent feasible, and document implementation in their SCP Narrative.

2 - Stormwater Management Performance Requirements

SFPUC Requirements

Stormwater controls for **Large Projects under SFPUC jurisdiction** must be designed to infiltrate, evapotranspire, bioretain, and/or biotreat the stormwater volume generated by the 90th percentile, 24-hour storm. This storm translates to a rainfall depth of approximately 0.75 inches and a rainfall intensity of approximately 0.24 inches per hour.



Permeable pavers along Van Ness Ave in San Francisco, CA.
Photo: Krystal Zamora

Bioretention planters in a residential courtyard in San Francisco, CA. Photo: Krystal Zamora

Port Requirements

Stormwater controls for **Large Projects under Port jurisdiction** must be designed to infiltrate, evapotranspire, bioretain, and/or biotreat the stormwater volume for the 85th percentile, 24-hour storm. This storm translates to a rainfall depth of approximately 0.63 inches and a rainfall intensity of approximately 0.2 inches per hour.

Portion of the Site Subject to SMR Performance Requirements

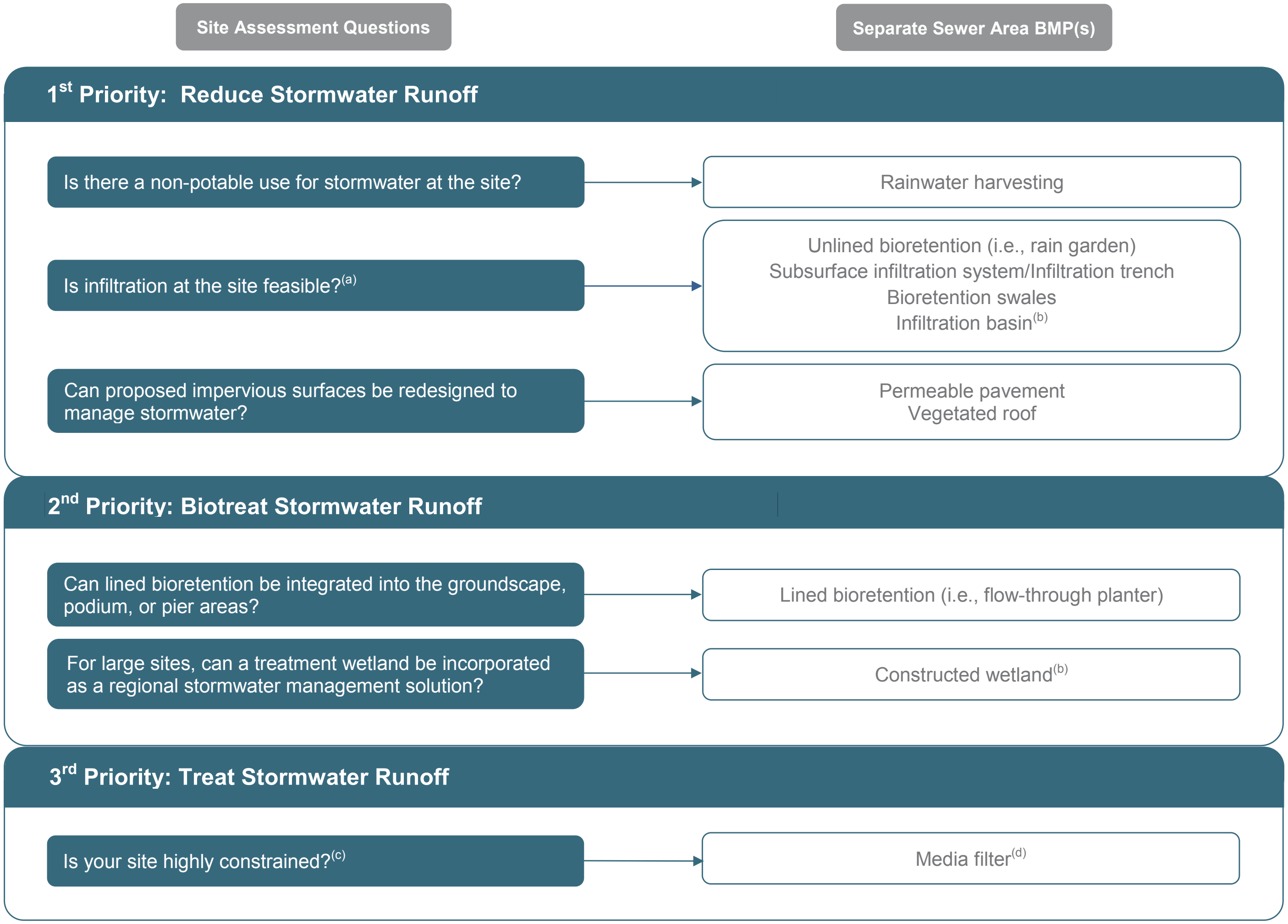
For **Large Project sites in both SFPUC and Port jurisdictions**, the portion of the site subject to performance requirements varies according to the increase in post-project site imperviousness, as follows:

- Projects that increase the imperviousness of the site by **more than 50 percent** compared to pre-development conditions must manage the stormwater from the entire site, including existing **and** created and/or replaced impervious surface (i.e. **all** of the impervious area on the site) to the maximum extent practicable.
- Projects that increase the imperviousness of the site by **less than 50 percent** compared to pre-development conditions must manage the stormwater from created and/or replaced impervious surface **only**.

Under certain conditions right-of-way projects must comply with the SMR, as described in *Chapter 7: Stormwater Management Requirements in the Streets*.

3 - BMP Selection Requirements

When selecting BMPs to meet the stormwater management performance requirements, Large Projects in separate sewer areas must use the Separate Sewer Area BMP Hierarchy (Figure 8) and complete the corresponding *Separate Sewer Area BMP Selection Form* (available on the SFPUC website at www.sfwater.org/smr) to demonstrate that they are proposing to use preferred BMPs to the maximum extent practicable before selecting lower priority BMPs for stormwater management.



Notes:
(a) For information on infiltration constraints and feasibility refer to Appendix C: Infiltration Guidance.
(b) Typically appropriate for large or multi-parcel sites.
(c) Refer to the Separate Sewer Area BMP Selection Form within the SCP Application for guidance on which sites are considered highly constrained.
(d) Use of these BMPs is only allowed under special circumstances and is at the discretion of the SFPUC or Port.

Figure 8. *Separate Sewer Area BMP Hierarchy*

The Mission Bay traffic circle in San Francisco, CA manages stormwater from adjacent streets. Photo: Urban Watershed Management Program

The Separate Sewer Area BMP Hierarchy presents a process for selecting BMPs that requires the prioritization of reuse (i.e. rainwater harvesting), infiltration, and vegetated roofs. However, for some sites in San Francisco's separate sewer areas, reuse and infiltration may not feasible when the following conditions are present:

- Little to no demand for non-potable water (rainwater harvesting); and
- Documented high concentrations of pollutants in underlying soil or groundwater, preventing infiltration; or
- Potential geotechnical hazard that could be exacerbated by infiltration; or
- Being located on elevated structures, such as piers over water, causing infiltration to be infeasible.

In such cases, bioretention facilities that include an impermeable liner and an underdrain at the bottom of the storage layer (a configuration commonly known as a "flow-through planter") may be used for projects. In cases with extreme constraints, the SFPUC and Port may grant permission for the use of high rate filtration devices such as media filters. All stormwater controls used for compliance with the SMR must be located on a parcel, unless a project a triggers the separate sewer area right-of-way (ROW) requirements outlined in *Chapter 7: Stormwater Management Requirements in the Streets*.

Changes in Performance Requirements for Separate Sewer Areas | 2010 to 2016

The performance requirements in the 2016 SMR are similar to those of the 2010 *Guidelines* for most separate sewer area projects, but there are several important differences:

1. **Small Projects (those creating and/or replacing 2,500-5,000 square feet of impervious surface) are regulated under the 2016 Stormwater Management Requirements (SMR).** Small Projects must implement one or more Site Design Measure(s). Projects of this size were not regulated in the 2010 *Guidelines*.

2. **The threshold at which Large Projects must comply with the SMR has been redefined.** In the 2010 *Guidelines*, projects **disturbing 5,000 square feet or more of the ground surface** were subject to the requirements. In the 2016 SMR, the threshold for Large Projects has been revised to projects **creating and/or replacing 5,000 square feet or more of impervious surface**.

3. **The 2016 SMR requires the use of preferred Best Management Practices (BMPs) to the maximum extent practicable before consideration of remaining BMPs.** The 2010 *Guidelines* did not include a BMP Hierarchy.

   The BMP Hierarchy prioritizes rainwater harvesting, infiltration-based BMPs, and vegetated roofs followed by lined bioretention (e.g. lined bioretention with an underdrain, commonly known as a "flow-through planter"). If none of these BMPs are feasible on site, projects may be able to incorporate high-rate filtration BMPs (e.g. tree-box filters and media filters) into their site design pending approval by the SFPUC or Port.

   Detention-based controls that do not include biotreatment (e.g. detention tanks) do not meet Large Project performance requirements under the 2016 SMR. (See Figure 8:Separate Sewer Area BMP Hierarchy for more information).

Applicability Dates

The 2010 *Guidelines* performance requirements apply to projects for which an Preliminary Stormwater Control Plan (SCP) was submitted before May 27, 2016. The 2016 SMR performance requirements apply to projects with Preliminary SCPs submitted on or after May 27, 2016.

The Leland Ave Streetscape Improvement Project created one of the first streets to include green infrastructure in San Francisco, featuring bioretention and permeable pavement. Photo: Robin Scheswohl

7 Performance Requirements in the Streets

This chapter explains when right-of-way projects are required to comply with the SMR.

Application of Combined Sewer Area Performance Requirements to Right-of-Way Improvements

In addition to parcel-only projects, the combined sewer area stormwater performance requirements apply to a subset of right-of-way (ROW) projects developed in conjunction with large, multi-parcel development projects subject to the Subdivision Code (available at http://www.amlegal.com/library/ca/sfrancisco.shtml) and those that create private ROW. Impervious surface that is created and/or replaced by this subset of ROW projects must be included in calculations determining whether projects meet the 5,000 square foot impervious surface threshold and are therefore subject to the combined sewer area stormwater performance requirements.

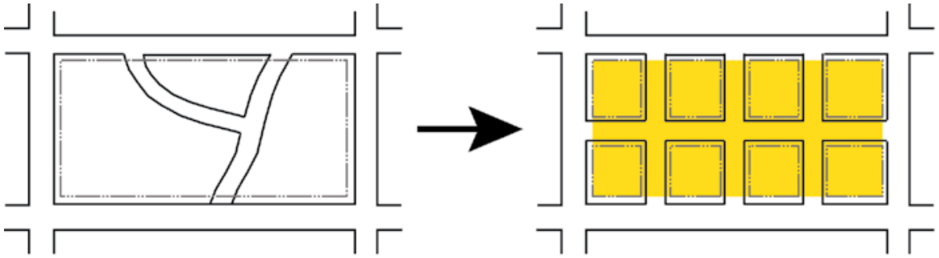
The following diagrams illustrate scenarios where the combined sewer area performance requirements do and do not apply to the ROW:

Graphics Legend:

Area subject to combined sewer area performance requirements.

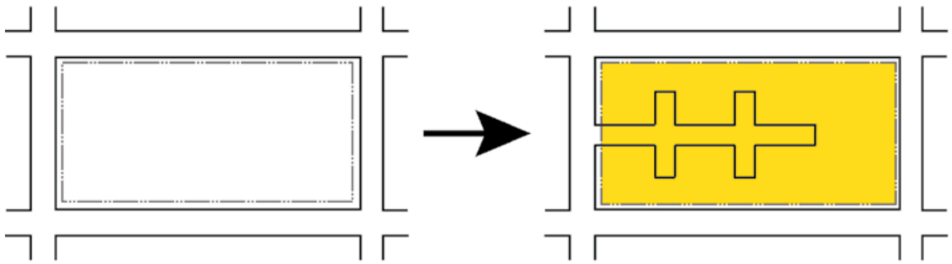
Area **not** subject to combined sewer areas performance requirements.

1. Created and/or replaced impervious surfaces within a development project that will be new public ROW dedicated to the City.



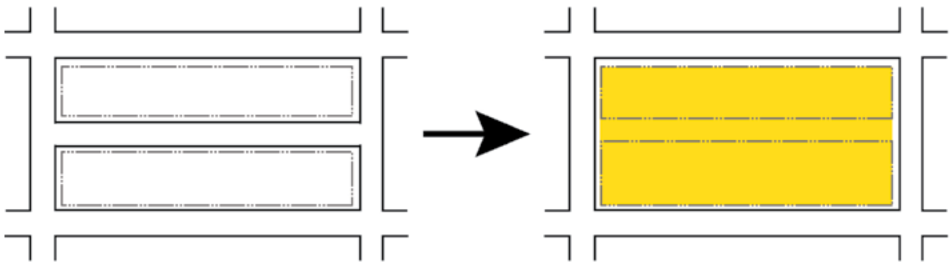
This scenario occurs when large parcels are redeveloped and subdivided, creating new public ROWs that are eventually dedicated to and accepted by the City. Paper streets, or streets that have been dedicated but not accepted by the City, are also covered by this scenario.

2. Created and/or replaced impervious surfaces within a development project that are or will be private streets, roads, or pedestrian walks.



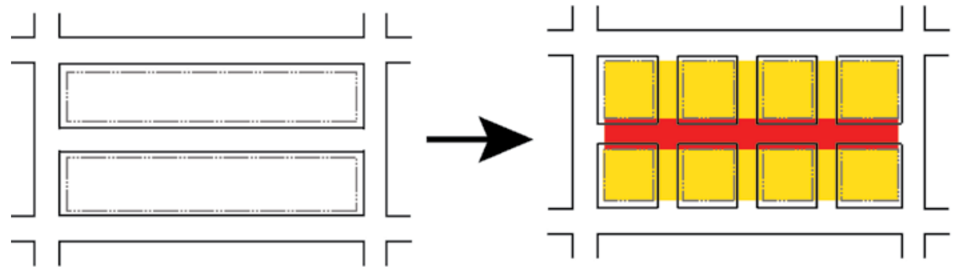
This scenario occurs when private parcels are redeveloped and create private ROWs that are not dedicated to or accepted by the City.

3. Created and/or replaced impervious surfaces within a development project that are located in existing public ROWs and that will be permanently closed to vehicular traffic or vacated.



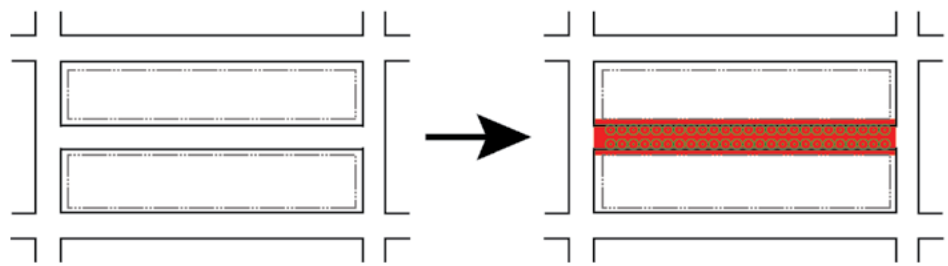
This scenario occurs when a development project includes a permanent street closure or vacation. Street vacations occur when what was formerly a public ROW becomes a private parcel (this is the opposite of creating a new street). A permanent street closure occurs when a street is permanently closed to vehicular traffic.

4. Existing public ROWs (either adjacent to or bisecting the Development Project) that are being disturbed in conjunction with a Development Project.



This scenario occurs when an existing public ROW is adjacent to or bisects Development Project(s) subject to the SMO. Even if improvements to the existing public ROWs are required, those ROWs in the combined sewer area are not subject to the Stormwater Management Ordinance (SMO) as long as the public ROW was previously dedicated to and accepted by the City. Note: Different rules apply to existing public ROW projects in the City's separate sewer areas, which are described in the following section.

5. Improvements to existing public ROWs NOT associated with a Development Project.



This scenario occurs when there is an improvement project for an existing dedicated and accepted public ROW but there is no associated Development Project(s). Note: Different rules apply to existing public ROW improvement projects in the City's separate sewer areas, which are described in the following section.

Application of Separate Sewer Area Large Project Performance Requirements to Right-of-Way Improvements

Large Project stormwater performance requirements apply to public ROW projects that fall into two categories: 1) public ROW areas developed in conjunction with large, multi-parcel development projects which meet a set of specific criteria and 2) new or retrofitted public ROW areas not associated with development projects which meet another set of specific criteria. Note that in the first case, the impervious surface that is created and/or replaced by these ROW projects should be included in calculations determining whether development projects meet the 5,000 square foot impervious surface threshold and are therefore subject to the Large Project stormwater performance requirements. Large project performance requirements also apply to private ROW projects.

The Large Project performance requirements do not apply to the following types of ROW projects:

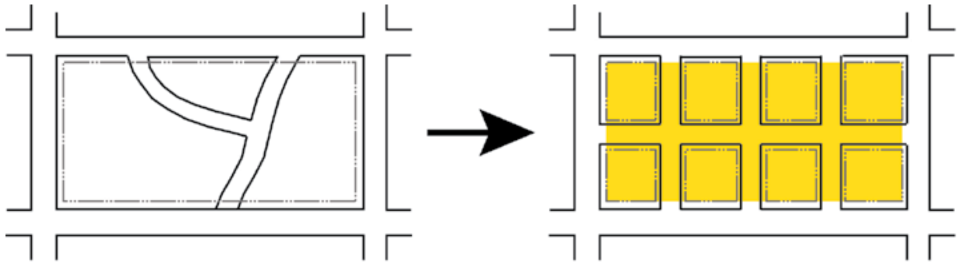
- New ROW projects that create less than 5,000 square feet of new impervious ROW and are not associated with a development project **do not** need to comply with the separate sewer area performance requirements.
- Projects on existing public ROW that add more than 5,000 square feet of impervious surface in the form of new bike lanes or sidewalk **do not** need to comply with the separate sewer area performance requirements.

The Large Project performance requirements apply to the following types of ROW projects:

Graphics Legend:

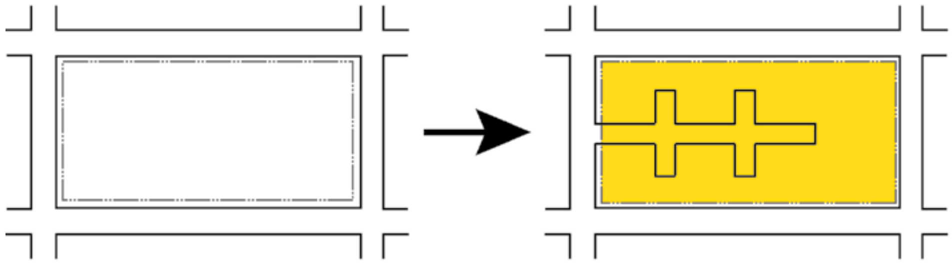
Area subject to separate sewer area performance requirements.

1. Created and/or replaced impervious surfaces within a development project that will be newly dedicated or newly accepted public ROWs.



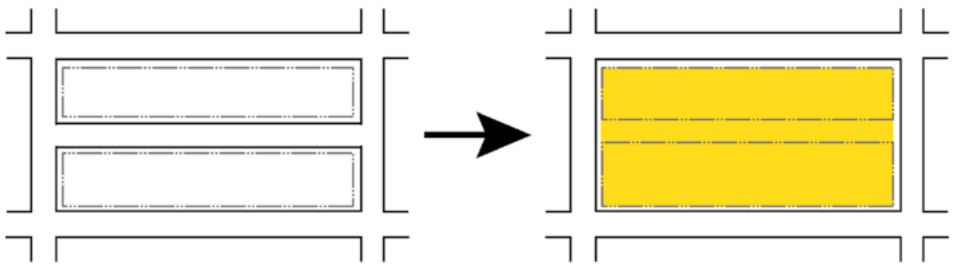
This scenario occurs when large parcels are redeveloped and subdivided, creating new public ROWs that are eventually dedicated to and accepted by the City. Paper streets, or streets that have been dedicated but not accepted by the City, are also covered by this scenario.

2. Created and/or replaced impervious surfaces within a development project that are or will be private streets, roads, or pedestrian walks.



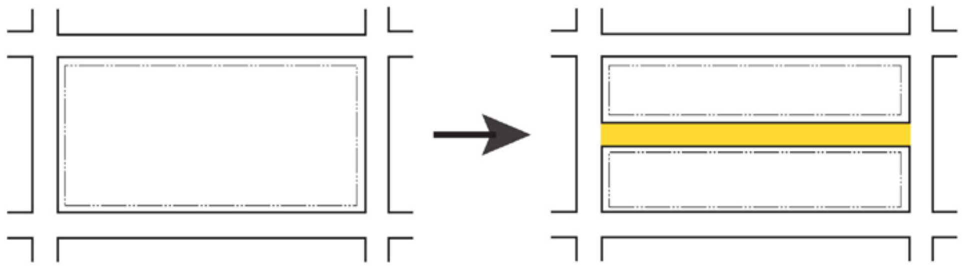
This scenario occurs when private parcels are redeveloped and create private ROWs that are not dedicated to or accepted by the City.

3. Created and/or replaced impervious surfaces within a development project that are located in existing public ROWs and that will be permanently closed to vehicular traffic or vacated.

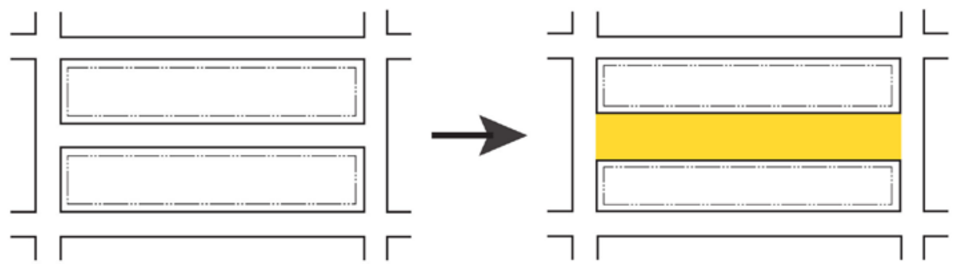


This scenario occurs when a development project includes a permanent street closure or vacation. Street vacations occur when what was formerly a public ROW becomes a private parcel (this is the opposite of creating a new street). A permanent street closure occurs when a street is permanently closed to vehicular traffic.

4. New ROW projects that create 5,000 square feet or more of new impervious surface, *whether developed in conjunction with a parcel project or not.* These projects must meet performance requirements to the extent feasible.



5. Widening of existing ROW with additional traffic lanes that create 5,000 square feet or more of new impervious surface, *whether developed in conjunction with a parcel project or not* (does not include widening of existing streets to include new bike lanes or sidewalks). These projects must meet performance requirements to the extent feasible.



Permeable pavers contribute to this projects compliance with the SMR in San Francisco. *Photo: Krystal Zamora*

8 Green Building Certification Credits

Stormwater management can help project proponents achieve green building certification credits. In San Francisco, both Leadership in Energy and Environmental Design and the GreenPoint Rated system are being used to assess the environmental quality of site and building design.

LEED

The implementation of green infrastructure (GI) can help project proponents earn Leadership in Energy and Environmental Design (LEED) stormwater credits. Recognizing the multiple benefits of GI, project proponents may also earn LEED credits in other areas, such as Sustainable Sites and Water Efficiency (Tables 5 & 6).

Projects seeking LEED credits for stormwater management may choose to meet different performance requirements, depending on time of project registration. Until October 31, 2016, projects can choose to pursue certification in either *LEED version 2009 for New Construction and Major Renovation* or *LEED version 4 for Building Design and Construction*. After this date, only *LEED version 4* certification will be available. More information about *LEED version 4* credits can be found at http://www.usgbc.org/leed#credits.

LEED version 2009

Combined sewer area projects seeking *LEED version 2009* certification should achieve the Sustainable Sites Credit 6.1 "Stormwater Design: Quantity Control" for 1 point provided that the project meets the combined sewer area Case 1 or Case 2 requirements. **Separate sewer area projects** seeking *LEED version 2009* certification should achieve the Sustainable Sites Credit 6.2 "Stormwater Design: Quality Control" for 1 point.

Table 5. *LEED version 2009* credits related to stormwater management

LEED Category	Credits		Points
Sustainable Sites	SS6.1	Stormwater Design–Quantity Control	1
	SS6.2	Stormwater Design–Quality Control	1
	SS5.1	Site Development–Protect or Restore Habitat	1
	SS5.2	Site Development–Maximize Open Space	1
	SS7.1	Heat Island Effect–Nonroof	1
	SS7.2	Heat Island Effect–Roof	1
Water Efficiency	WE1	Water Efficient Landscaping (Option 1)	2
	WE1	Water Efficient Landscaping (Option 2)	4
	WE2	Innovative Wastewater Technologies	2
	WE3	Water Use Reduction (30%, 35%, 40% Reduction)	2, 3, 4

LEED version 4

Projects seeking *LEED version 4* certification must comply with more stringent stormwater management performance requirements. In *LEED version 4*, stormwater management credits have been combined under a single "Rainwater Management" credit in the Sustainable Sites category. This credit requires that the project use GI to manage the 98th percentile rainfall event on-site for 3 points or the 95th percentile event for 2 points; zero lot line projects (projects with buildings that extend to the property lines) receive 3 points for managing the 85th percentile event.

Both **combined sewer area projects** (Case 1 and Case 2) and **separate sewer area projects** that comply with the SMR may have to implement additional stormwater management to receive *LEED version 4* stormwater management credits.

Table 6. *LEED version 4* credits related to stormwater management

LEED Category	Credit	Points
Sustainable Sites	SS Rainwater Management (Option 1: Path 1, Path 2, Path 3)	2, 3, 4 [a]
	SS Rainwater Management (Option 2)	3 [a]
	SS Site Development–Protect or Restore Habitat (Option 1)	2 [a]
	SS Open Space	1
	SS Heat Island Reduction (Option 1)	2 [a]
	SS Heat Island Reduction (Option 2)	1 [a]
	SS Site Assessment	1
Water Efficiency	WE Outdoor Water Use Reduction (Option 1)	2 [a]
	WE Outdoor Water Use Reduction (Option 2: 50%, 100% Reduction)	1, 2
	WE Outdoor Water Use Reduction (25%, 30%, 35%, 40%, 45%, 50% Reduction)	1, 2, 3, 4, 5, 6 [b]
	WE Cooling Tower Water Use	2 [c]
	WE Water Metering	1

Notes:
a. Except Healthcare facilities.
b. School, Retail, Hospitality, and Healthcare facilities can earn an additional point by meeting additional requirements.
c. Must meet minimum number of cycles to earn 1 point and use a minimum of 20% recycled non-potable water.

GreenPoint Rated

The GreenPoint Rated system is a California-based third-party residential certification system. In addition to stormwater credits, points can be earned in the areas of site design, landscaping, and exterior finishing (Table 7). More information about this system is available at http://greenpointrated.com.

Table 7. *GreemPoint Rated* credits related to stormwater management

GreenPoint Checklist(a) Section	Measure		Points (Category)
Site	A4	Heat Island Effect Reduction	1 (Energy)
	A6.1	Permeable Paving Material	1 (Water)
	A6.2	Filtration and/or Bio-Retention Features	1 (Water)
	A6.4	Smart Stormwater Street Design [b]	1 (Community)
	A7	Stormwater Control: Performance Path	3 (Water)
Landscape	C1	Plants Grouped by Water Needs (Hydrozoning)	1 (Water)
	C2	Three Inches of Mulch in Planting Beds	1 (Water)
	C3.3	Drought Tolerant, California Native, Mediterranean Species, or Other Appropriate Species	3 (Water)
	C6	High-Efficiency Irrigation System	2 (Water)
	C7	One Inch of Compost in the Top Six to Twelve Inches of Soil	2 (Water)
	C8	Rainwater Harvesting System	3 (Water)
	C9	Recycled Wastewater Irrigation System	1 (Water)
	C11	Landscape Meets Water Budget	2 (Water)
	C16	Maintenance Control with Certified Professional	1 (Water)
Exterior	E6	Vegetated Roof	2 (Community), 2 (Energy)

Notes:
a. Both Multifamily and Single Family Checklists
b. Multifamily Checklist only

Boardwalks provide access across waterfront bioretention facilities in Seattle, WA. Photo: Rosey Jencks

9 Stormwater Control Plan Requirements

Submittal of a Stormwater Control Plan is required for all projects that create and/or replace 5,000 square feet or more of impervious surface. The SCP is reviewed by the SFPUC or Port to determine whether a proposed project meets performance requirements.

The San Francisco Public Utilities Commission (SFPUC) and the Port of San Francisco (Port) require the submittal of a Stormwater Control Plan (SCP) for all projects creating and/or replacing 5,000 square feet or more of impervious surface. Project proponents must complete a SCP to demonstrate that they have met all applicable stormwater performance requirements. The SCP allows the SFPUC and the Port to review projects that are subject to the SMR and evaluate compliance.

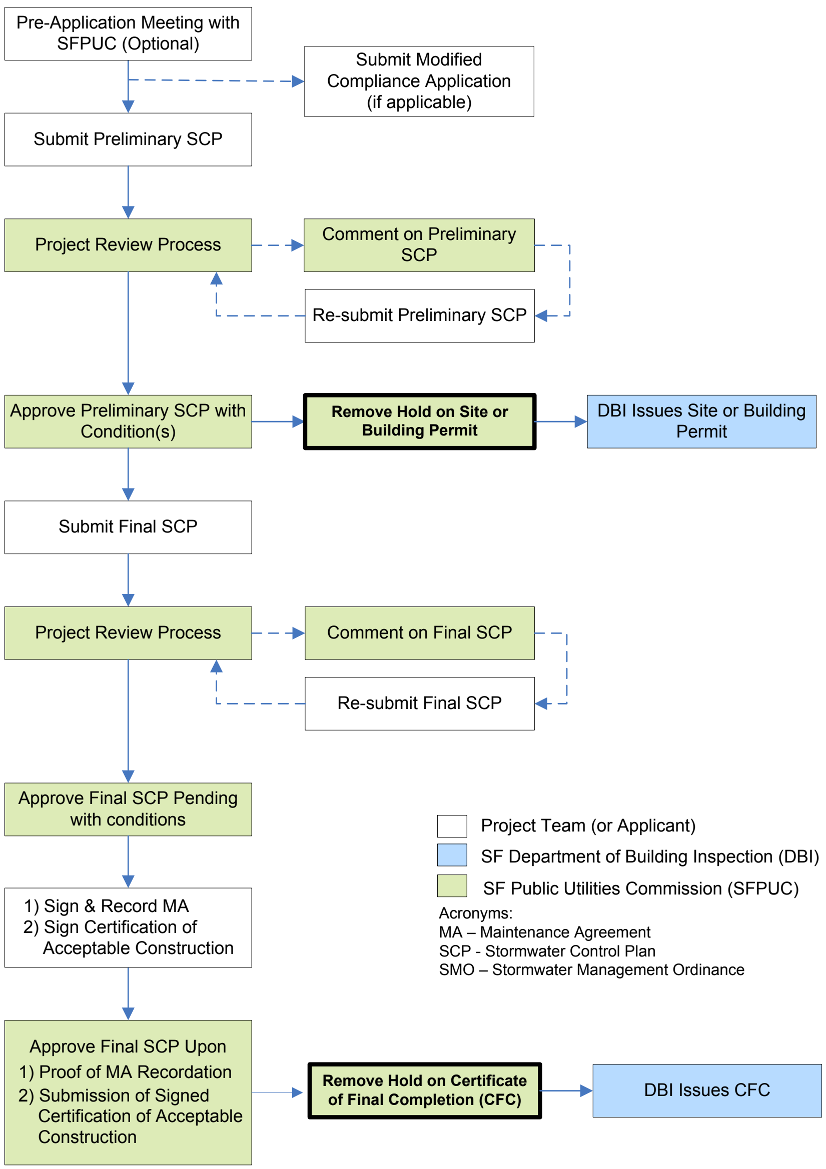


Figure 9. *The SFPUC Stormwater Control Plan submittal and approval process*

Typical SCP Submittal Process Timeline

The SCP review process consists of two review stages: **Preliminary SCP** and **Final SCP**. Figures 9 and 10 illustrate the SFPUC's and Port's typical SCP review processes, respectively. They are largely similar, except that the SFPUC has partnered with the San Francisco Department of Building Inspection (DBI) for enforcement and the Port houses its own enforcement mechanisms.

Before submitting a Preliminary SCP, design teams are encouraged to discuss the proposed stormwater management approach with SFPUC or Port staff at a **pre-application meeting**. Design teams should schedule a meeting early in the project planning phases. Early coordination minimizes design issues throughout the review process. SFPUC or Port review staff will provide technical assistance to the design team during the entire development of the site design and SCP (Preliminary and Final) to the extent feasible. Review staff will provide design guidance via email or phone calls to facilitate compliance with the Stormwater Management Requirements (SMR).

If project proponents with constrained sites in the combined sewer area wish to apply for the **Modified Compliance** option, they must submit a Modified Compliance Application before submitting a Preliminary SCP. The Modified Compliance Application, complete with submittal instructions, is available online at www.sfwater.org/smr.

Project proponents typically submit a **Preliminary SCP** at the design development phase of the project; the Preliminary SCP must be approved by the SFPUC or the Port before a Site or Building Permit will be issued. The Preliminary SCP acts as a proof-of-concept of the overall stormwater management approach; plans should reflect the design level typical of a Site Permit (e.g. 100% design development). Formal review entails validation of stormwater calculations, confirmation of proper and safe design of Best Management Practices (BMPs), and assurance that there are no fatal flaws in the stormwater management concept. Some Preliminary SCPs may need to be revised several times to develop a sound stormwater management approach before they can be approved.

A **Final SCP** is typically submitted at the 100 percent construction document phase of the project. Whereas a Preliminary SCP must demonstrate that the proposed stormwater management approach is sound, a Final SCP must prove that the overall proposed design as well as BMP selection, sizing, and configuration account for site constraints and meets stormwater requirements. Final SCPs must be stamped by a California licensed engineer or landscape architect. If a Final SCP is reviewed and found to be acceptable it is Approved with Conditions. These conditions always contain the submittal of a **Certification of Acceptable Construction** and **maintenance documentation**.

In order to obtain SCP Final Approval, a Certification of Acceptable Construction and maintenance documentation must be submitted to the SFPUC or Port. The DBI and Port will not release the Certificate of Final Construction for the project until the SFPUC or Port approves the Final SCP.

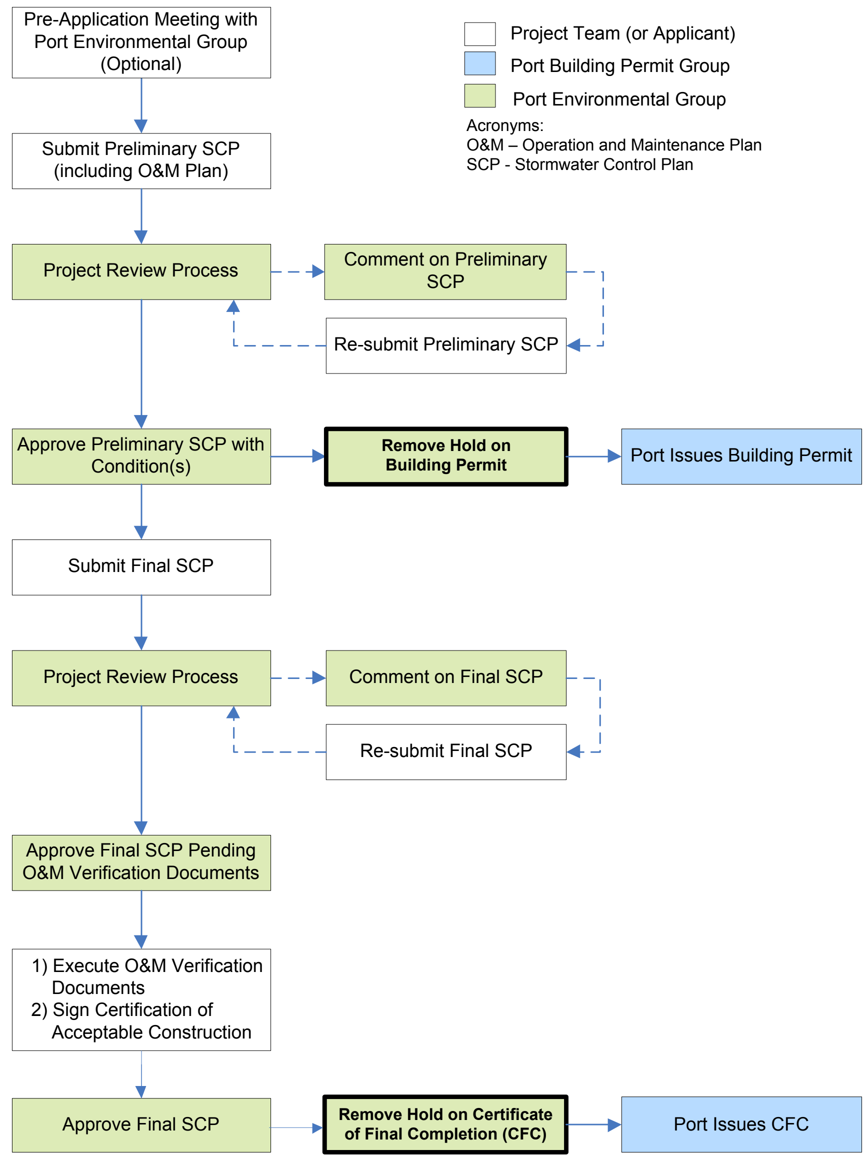


Figure 10. *The Port Stormwater Control Plan submittal and approval process*

Certification of Acceptable Construction

The project's Civil Engineer or Landscape Architect must observe all stormwater BMPs at major stages of construction and upon completion to ensure that the BMPs have been built in general accordance with the Final SCP Approved with Conditions. This observation is documented by the submission of the Certification of Acceptable Construction form, which must be provided to the SFPUC or the Port upon completion of construction. If there are construction-related issues which indicate that the installation does not meet the intent of the Final SCP Approved with Conditions, the property owner is responsible for ensuring corrective action is taken. If the issues are not rectified, a Certification of Final Completion will not be issued by the DBI or Port, depending on jurisdiction.

Maintenance Agreement (SFPUC jurisdiction only)

Projects are required to install stormwater management controls and maintain those controls in perpetuity. Every Large Project subject to the SMR must sign and record a Maintenance Agreement to acknowledge and accept this maintenance responsibility. The Maintenance Agreement must be signed and recorded at the San Francisco Office of the Assessor prior to SFPUC approval of the Final SCP. For more information download the *Maintenance Agreement Recordation Instructions* available at www.sfwater.org/smr.

Operations & Maintenance Verification Documents (Port jurisdiction only)

Port project proponents (i.e., prospective lessees, licensees, or facility operators) may be required to install and maintain new stormwater management controls on Port property, and/or maintain existing stormwater management controls on Port Property in accordance with the terms of their lease agreement, management agreement, or license throughout the term of their agreement with the Port. The Port and Port project proponent will formalize and agree to operations and maintenance responsibilities for every Large Project subject to the SMR prior to Port approval of the Final SCP.

A swale in front of the San Francisco Public Utilities Commission's Channel Pump Station slows and treats stormwater before entering the Bay. Photo: SFPUC

Fire Station No.1 in San Francisco met the SMR with bioretention and permeable concrete. Photo: Ken Kortkamp

SCP Components for Single-Parcel Projects

Components of an SCP are listed below along with a short description of what is required in each section. Visit www.sfwater.org/smr to download the complete SCP instructions, forms, templates, memoranda, and worked examples. There are separate *SCP Instructions* and *Project Information Forms* for single parcel and multi-phase (i.e. redevelopment) projects.

Project Information Form

The Project Information Form includes property owner and applicant contact information, project location and description, a checklist to ensure completion of all SCP components, and a Statement of Certification with the preparer's name, license number and stamp.

Project Narrative

The Project Narrative is a concise description of the proposed project including existing conditions, opportunities and constraints for stormwater management, and overall stormwater management approach. A summary of the BMP selection process should be included to explain how the Combined or Separate Sewer Area BMP Hierarchy was used in selecting stormwater controls. Separate sewer area projects must also summarize how the LID Principles and Strategies outlined in *Chapter 4: Green Infrastructure Design Approach*, Task 4) have been incorporated into planning and design.

Separate Sewer Area BMP Selection Form (for separate sewer area projects ONLY)

The Separate Sewer Area BMP Selection Form aligns with the required Separate Sewer BMP Hierarchy outlined in *Chapter 6: Separate Sewer Area Performance Requirements*. It allows project applicants to demonstrate how they are proposing to use preferred BMPs to the maximum extent practicable. The Form presents thresholds, based on site conditions, which must be assessed before implementing a lower priority BMP.

Calculation Summary and Table

The Calculation Summary should clearly describe the stormwater control BMP performance calculation methods and assumptions. The table should clearly show that the proposed overall design meets the performance requirements and should summarize the stormwater runoff calculation results for each sub-watershed area, if applicable, and for the whole site.

Stormwater Management Plan

The Stormwater Management Plan is a site plan that tells the hydrologic story of the project site and demonstrates how the selected BMPs will manage runoff from their contributing areas. It is the only drawing required within the SCP that is not already created as part of the construction document plan set. The Stormwater Management Plan should define sub-watersheds and drainage management areas (DMAs), provide an Area Summary Table that summarizes surface area types and DMAs, and provide a typical detail for each type of BMP.

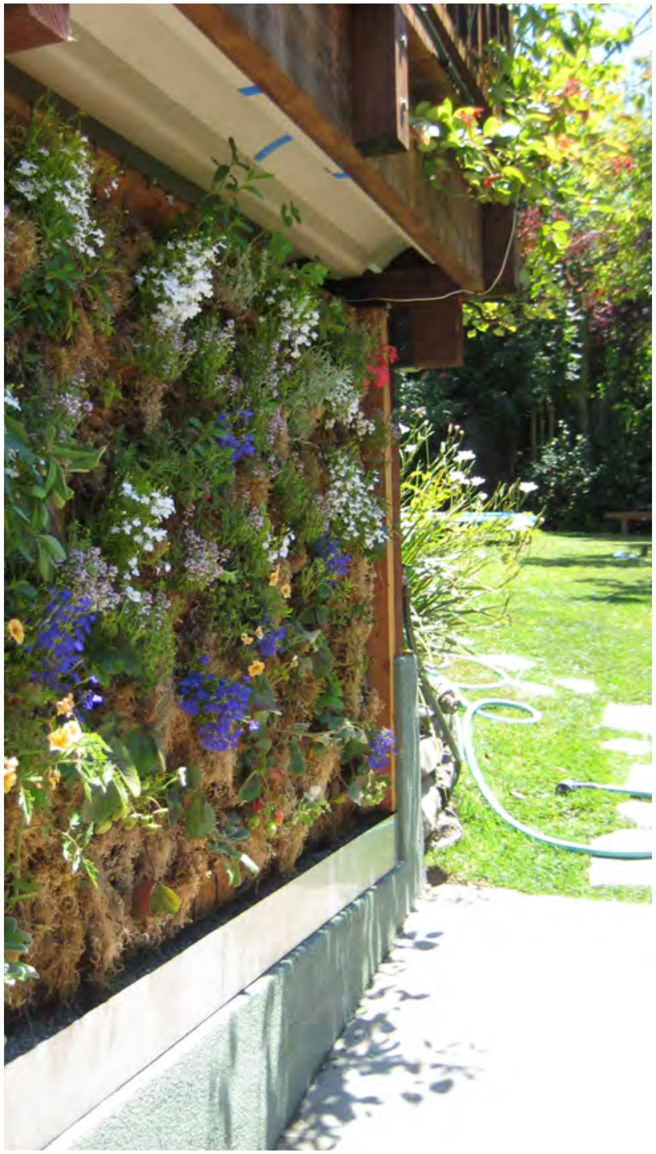
BMP Inspection Schedule

The BMP Inspection Schedule lists inspection activities and schedules. Projects can create an Inspection Schedule using the template in the *Technical Report Templates* or they can provide a custom BMP Inspection Schedule if necessary (e.g., for proprietary BMP systems such as vegetated roofs and rainwater harvesting systems). Refer to *Appendix A: BMP Fact Sheets* for recommended activities and frequency for standard BMPs. The *Technical Report Templates* are available online at www.sfwater.org/smr.

BMP Maintenance Schedule

The BMP Maintenance Schedule lists maintenance activities and schedules. Projects can create a Maintenance Schedule using the template in the *Technical Report Templates* or they can provide a custom BMP Maintenance Schedule if necessary (e.g., for proprietary BMP systems such as vegetated roofs and rainwater harvesting systems). Refer to *Appendix A: BMP Fact Sheets* for recommended activities and frequency for standard BMPs. The *Technical Report Templates* are available online at www.sfwater.org/smr.

Maintenance workers remove sediment from a sediment basin in a bioretention planter on Cesar Chavez St in San Francisco. Photo: Robin Scheswohl



This green wall in San Francisco, CA is irrigated using captured stormwater. Photo: Rachel Kraai

Source Control Checklist

Projects are also required to implement source controls for all pollutant-generating activities and pollutant sources associated with the project. Everyday activities such as recycling, trash disposal, and vehicle and equipment washing generate pollutants such as trash, sediments, oil and grease, nutrients, pesticides, and metals, all of which can be mobilized by stormwater runoff. The Source Control Checklist, available for download with the *Technical Report Templates* lists each potential source of polluted runoff, associated pollutants of concern, and proposed source controls. Refer to the SMR *Appendix A: BMP Fact Sheets* for resources on required source control measures. The *Technical Report Templates* are available online at www.sfwater.org/smr.

Calculation Spreadsheets or Modeling Output

The calculation spreadsheets or a modeling output should demonstrate that the SMR performance requirements have been met. Design teams should ensure that the information in the spreadsheets is consistent with corresponding sections of the SCP. For accepted modeling outputs, refer to the *SFPUC Accepted Hydrologic Calculation Methods*, available online at www.sfwater.org/smr.

Supporting Documentation

As appropriate, additional site-specific documentation can be submitted to support the stormwater management design and assumptions, such as proposed BMP proprietary product information (e.g. cut sheets and operations & maintenance documentation), relevant geotechnical report findings and/or infiltration testing results, and BMP specifications.

Construction Document Drawings (excerpts related to stormwater management)

Construction Documents must be included as reference material to ensure that BMPs are fully incorporated into the site design. Construction Document drawings should depict the existing and proposed conditions that are relevant to compliance with the SMR.

SCP Components for Multi-Phase Redevelopment Projects

Proponents of multi-phase redevelopment projects must provide additional information beyond the components described for single-parcel projects. For these projects, the ***Multi-Phase SCP Instructions*** and ***Project Information Form*** (available at www.sfwater.org/smr) are required. Multi-phase redevelopment projects offer the greatest opportunity for regional LID elements (i.e., stormwater facilities serving more than one parcel), such as constructed wetlands. The SFPUC and Port will work with project proponents who are proposing large projects to develop a comprehensive SCP that integrates stormwater management across multiple parcels.

10 Inspection and Enforcement

The San Francisco Public Utilities Commission and the Port of San Francisco require periodic inspections to ensure that BMPs are properly constructed and maintained and continue to provide effective stormwater management.

Once stormwater management facilities are incorporated into new development and redevelopment projects, the San Francisco Public Utilities Commission (SFPUC) and Port of San Francisco (Port) require periodic inspections to ensure that they are properly constructed and maintained and continue to provide effective stormwater management. Three types of inspections are required under this construction and maintenance verification program: SFPUC or Port construction inspection, annual self-certification inspections conducted by the property owner, Port tenant, or delegate thereof, and tri-annual inspections conducted by the SFPUC or the Port, depending on site jurisdiction. The SFPUC and the Port also inspect best management practices (BMPs) in response to complaints or emergencies. If maintenance requirements identified through inspections are not completed in accordance with the protocols described in this chapter, the SFPUC or the Port will take enforcement action.

Inspection and enforcement protocols described in this chapter apply to all projects required to submit a Stormwater Control Plan (SCP), that is, all projects creating and/or replacing 5,000 square feet or more of impervious surface (in both combined and separate sewer areas).

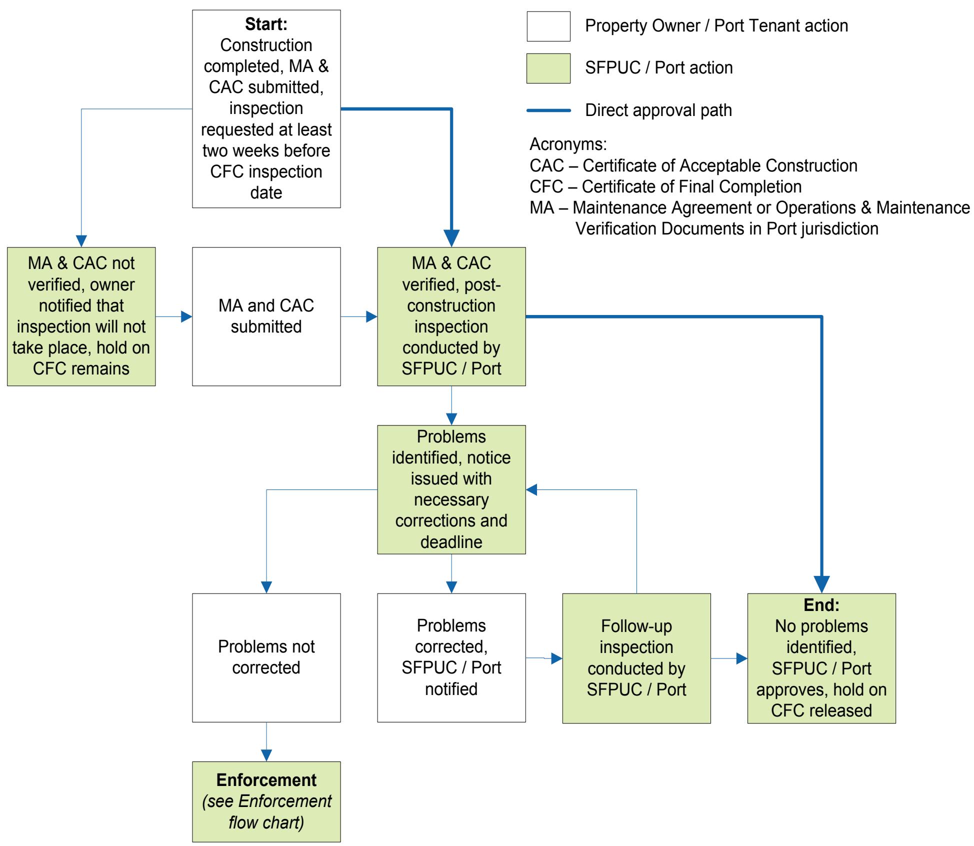


Figure 11. *Post-construction inspections.*

Inspections

Post-construction inspections

The Port or the SFPUC will inspect stormwater BMPs upon completion of construction. Inspection staff will confirm that stormwater facilities are built in conformance with the Final SCP approved plans. If there are issues that require follow-up, the Port or the SFPUC will send the property owner or Port tenant a notice stating what corrective action needs to be taken and the timeframe for corrective action. The deadline will be between 24 hours and 30 days from the date of the notice, depending on the severity of the problem. The property owner or Port tenant is responsible for correcting these issues and scheduling a follow-up inspection by the Port or the SFPUC. If the issues are rectified by the time of the follow-up inspection, the Certificate of Occupancy will be issued. A diagram showing the post-construction inspection process is shown in Figure 11.

Annual Self-Certification

After BMPs are successfully built, certified, and a Maintenance Agreement is recorded, the SFPUC will send annual self-certification inspection reminders to property owners at all sites with stormwater BMPs. The Port will send annual self-certification inspection reminders to Port tenants with stormwater BMP maintenance responsibilities as provided in lease agreements or comparable documents. These reminders include a submittal deadline and a blank *Self-Certification Checklist and Instructions* (available online at www.sfwater.org/smr). The property owner or Port tenant must perform the self-certification inspection and digitally submit the completed checklist for the prior year to the SFPUC or to the Port. With this submittal, the property owner or Port tenant must either propose approval or describe the maintenance to be performed if outstanding issues have not been resolved by the submittal date. The SFPUC or Port will either approve the submittal or prescribe the corrective actions necessary to address any problems identified. The property owner then submits documentation demonstrating the corrective actions were implemented. If corrective actions are not implemented, the Enforcement process begins.

If a property owner or Port tenant does not submit self-certification documents when due, the Enforcement process will take effect and the property owner or Port tenant may be required to pay a penalty. A diagram showing the annual self-certification process is shown in Figure 12.

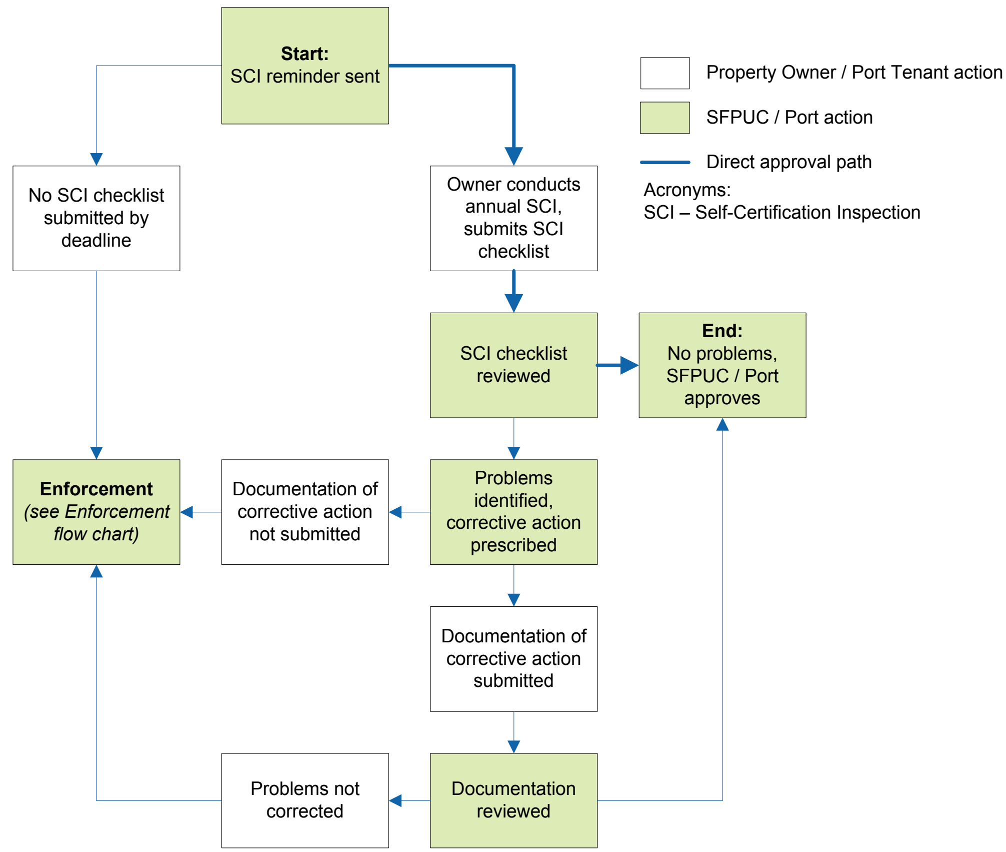


Figure 12. *Annual self-certification inspections.*

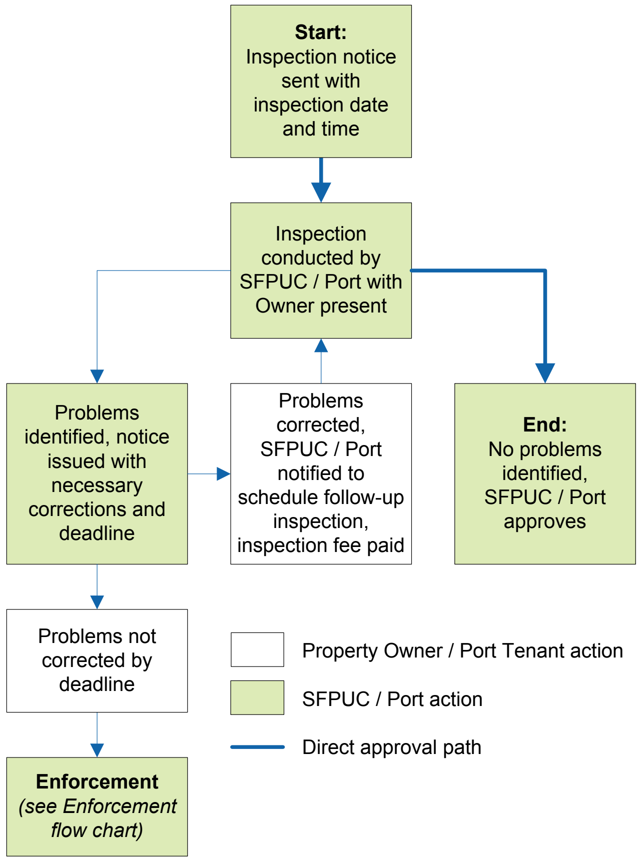


Figure 13. *Tri-annual Port/SFPUC inspections.*

Tri-annual SFPUC / Port Inspections

Every third year, the SFPUC or the Port will inspect stormwater BMPs. Property owners of sites or Port tenants due for inspection will be sent notices that include a proposed inspection date and time, as well as a phone number to call if property owner needs to reschedule or Port tenant needs to reschedule. If the inspection indicates that no maintenance issues require follow-up action, the annual certificate of compliance will be issued.

If there are issues that require follow-up, the SFPUC or Port will send the property owner or Port tenant a notice describing corrective action needed and when it must be completed. The deadline will be between 24 hours and 30 days from the date of the notice, depending on the severity of the problem. The property owner or Port tenant is responsible for correcting the issues and scheduling a follow-up inspection by the SFPUC or the Port within the time allotted. A diagram showing the tri-annual SFPUC or Port inspection process is shown in Figure 13.

Enforcement

For all three types of inspections, if the property owner or Port tenant is unresponsive or if maintenance issues are not corrected by prescribed deadlines, the SFPUC or the Port will take enforcement action. If enforcement is necessary, the SFPUC or the Port will issue a warning with a deadline for the property owner or Port tenant to take corrective action and schedule a follow-up inspection. The warning includes a penalty. If outstanding issues remain or if the owner or Port tenant is unresponsive, the SFPUC or the Port will issue a notice of violation and levy a fine in accordance with Article 4.1 of the San Francisco Public Works Code.

If the issues have not been corrected by the deadline, the SFPUC or the Port will perform the required work and bill the owner or Port tenant for cost of the work as well as the fine. If the owner or Port tenant does not pay the fine and the bill within 30 days, the SFPUC has the option initiate proceedings for a lien against the property and the Port has to option to pursue lease, license, or management agreement termination. A diagram showing the enforcement process is shown in Figure 14.

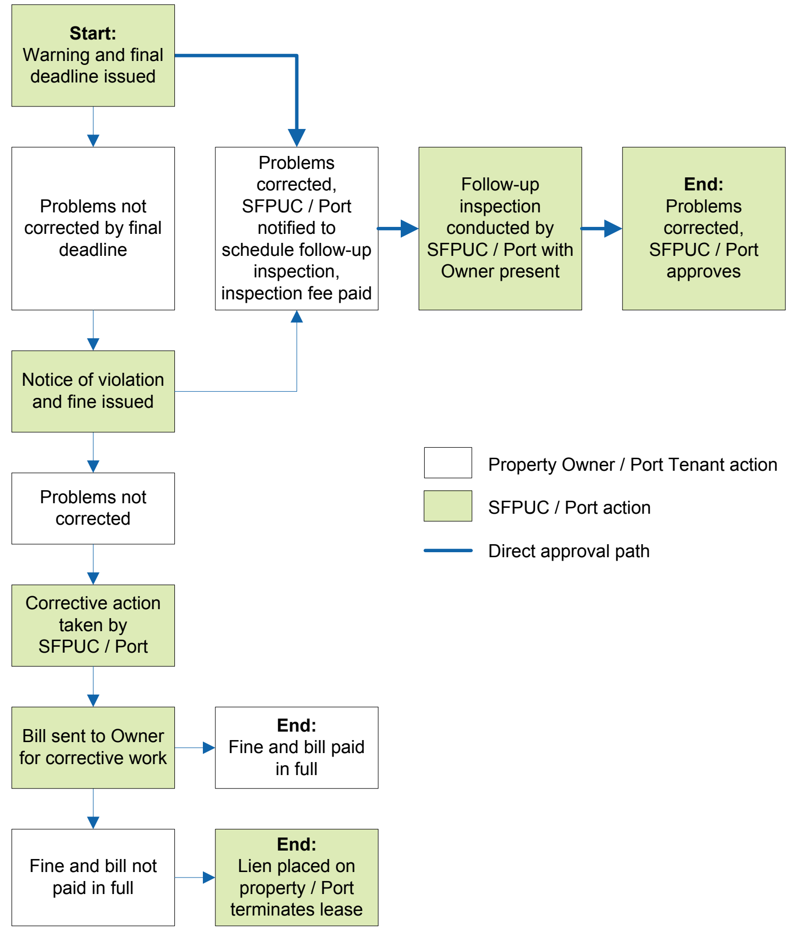


Figure 14. *Enforcement.*

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The Whole Foods building on Market St in San Francisco uses recycled water to water the planters on its rooftop patio. *Photo: Ken Kortkamp*

“Water is the most critical resource issue of our lifetime and our children’s lifetime. The health of our waters is the principal measure of how we live on the land.”

- Luna Leopold

SEAL OF THE CITY AND COUNTY OF SAN FRANCISCO

PORT OF SAN FRANCISCO

San Francisco Water Power Sewer

Services of the San Francisco Public Utilities Commission