City of Capitola

Stormwater Technical Guide for Tier 2 and Tier 3 Projects

Guidance Document for Meeting Stormwater Post-Construction Requirements for Tier 2 and Tier 3 Projects

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SECTION 1
POST-CONSTRUCTION REQUIREMENTS

The General Phase II permit for discharges to small Municipal Separate Storm Sewer Systems (MS4s) was adopted by the State Water Resources Control Board in February 2013. The California Regional Water Quality Control Board for the Central Coast Region (Water Board) adopted the Post-Construction Requirements (PCRs) in July 2013. Permittees within the boundaries defined by the Water Board; including cities, certain institutions, and unincorporated urban areas; are subject to the PCRs.

This "Stormwater Technical Guide for Tier 2 and Tier 3 Projects" (Tier 2 and Tier 3 Guide) details requirements for Tier 2 (treatment) and Tier 3 (retention) projects within the City of Capitola. This Guide is designed as a tool to ensure compliance with the PCRs, facilitate review of applications, and promote integrated Low Impact Development (LID) design. This Guide interprets, clarifies, and adds to the PCR requirements.

What Projects Must Comply?

Development and redevelopment projects within the City are required to implement PCRs. The level and type of PCR implementation is determined by the scale of on-site development. Table 1-1 summarizes the criteria for determining the project type (i.e. applicable tier).

Table 1-1: Project Type

<table>
<tr><th>Tier</th><th>Detached Single Family Homes</th><th>All Others (Commercial, Industrial, Two-& Multi-Family Homes)</th></tr>
<tr><td>Exempt</td><td colspan="2">New/Replaced impervious area < 2,500 sf</td></tr>
<tr><td>Tier 1</td><td>New/Replaced impervious area ≥ 2,500 sf</td><td>New/Replaced impervious area ≥ 2,500 sf</td></tr>
<tr><td>Tier 2</td><td rowspan="2">Net impervious area ≥ 15,000 sf</td><td>Net impervious area ≥ 5,000 sf</td></tr>
<tr><td>Tier 3</td><td>New/Replaced impervious area ≥ 15,000 sf</td></tr>
<tr><td>Tier 4</td><td colspan="2">New/Replaced impervious area ≥ 22,500 sf</td></tr>
</table>

Notes:
Impervious area = includes structures, pavement, hardscaping – essentially any surface that will not allow water to infiltrate into the ground.
Net impervious area = the difference between post-project and pre-project impervious areas.
sf = square feet

This Guide addresses the requirements for Tier 2 and Tier 3 projects. Note that development projects in Tier 2 must incorporate the requirements for Tiers 1 and 2; projects in Tier 3 must incorporate the requirements of Tiers 1, 2, and 3. For Tier 1 projects, refer to the *Stormwater Technical Guide for Tier 1 Projects*. The requirements for all tiers are summarized in Table 1-2.

All projects must also conserve natural areas, protect slopes and channels against erosion, and comply with local stream setback and tree-preservation policies as determined by the Community Development Department.

Table 1-2: Tiered Implementation Requirements

Type of Project	Performance Requirements
Exempt from PCRs	**Runoff Reduction** • Minimize runoff by redirecting downspouts to landscape • Install a rain barrel
Tier 1 • Projects, including single-family homes, that create or replace 2,500 square feet or more of impervious area	**Site Design and Runoff Reduction** • Limit disturbance of natural drainage features. • Limit clearing, grading, and soil compaction. • Minimize impervious surfaces. • Minimize runoff by dispersing runoff to landscape or using permeable pavements
Tier 2 • Detached single-family homes that create or replace 15,000 SF or more of net impervious surface. • All other projects that create or replace 5,000 SF or more of net impervious surface.	**Water Quality Treatment** • Meet all Tier 1 requirements • Treat runoff with an approved and appropriately sized LID treatment system prior to discharge from the site.
Tier 3 • Projects including single-family homes that create or replace 15,000 SF or more of impervious surface.	**Runoff Retention** • Meet all Tier 1 and Tier 2 requirements • Prevent offsite discharge from events up to the 95th percentile rainfall event using Stormwater Control Measures.

The PCRs include a Tier 4 requirement: Projects that create or replace 22,500 square feet of impervious surface. In addition to meeting all Tier 3 performance requirements, for these larger projects, post-development peak flows discharged from the site must not exceed pre-project peak flows for the 2-year through 10-year storm events.

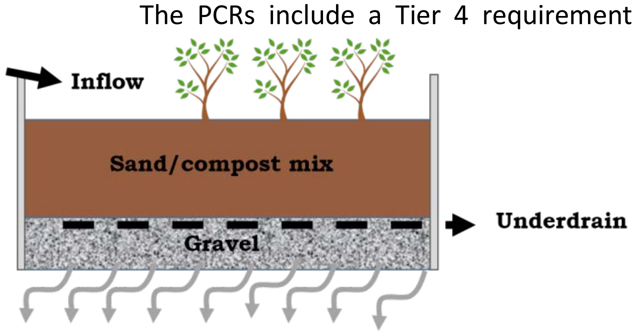

Figure 1-1. Example Bioretention Facilities

What is Low Impact Development?

LID design aims to mimic pre-development site hydrology as well as protect water quality by managing stormwater as close to its source as possible via infiltration into soils, evapotranspiration via plants, and/or harvesting for use. Runoff from roofs and paved areas is dispersed to landscaped areas or routed to LID facilities distributed throughout the site to minimize the impact of runoff from impervious areas (i.e. roofs, patios, pavement, etc.) to the storm drain, which ultimately flow to local streams, rivers, and the ocean. These LID facilities—typically bioretention, see Figure 1-1—infiltrate most runoff. During long and intense storms, underdrains convey treated stormwater to storm drains. During exceptionally large events, overflows are safely conveyed off-site.

Some of the advantages of LID are:

- Provides effective stormwater treatment by filtering pollutants and sequestering them within soils.
- Processes pollutants through biological action in the soil, rendering some pollutants less toxic. Quick-draining bioretention facilities do not harbor mosquitoes or other vectors.
- Maintains the natural hydrologic condition, including recharge to groundwater and contribution to stream flows.
- Requires maintenance similar to landscaped areas of similar size; no special equipment is needed.
- Above-ground, visible facilities are easy to monitor and inspect.
- Facilities can be an attractive landscape amenity.

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SECTION 2
THE PATH TO STORMWATER COMPLIANCE

Start Early

LID features and facilities must be integrated into the planning, design, construction, operation, and maintenance of your development or redevelopment project.

Your LID strategy should be an integral part of the earliest decisions about how the site will be developed. Once subdivision lot lines have been sketched, or buildings and parking have been arranged on a commercial site, the LID design may already be constrained—often unnecessarily.

The PCRs require the local municipality to maintain a database of LID facilities and ensure the facilities are operating as designed. The site layout, drainage and LID facilities are all conditions of project approval; as such, they may not be removed or rendered ineffective without the permitting agency's approval.

At this earliest stage, also consider who will be responsible for maintaining bioretention or other LID facilities in perpetuity. In most cases, the municipality will require the property owner, by agreement, to regularly inspect the facilities, allow access for municipal inspections, and give the municipality the right to conduct remedial maintenance and recover costs if facilities are not properly maintained.

In residential subdivisions, the need to provide for maintenance of stormwater treatment facilities can affect the layout of streets and lots, decisions whether to incorporate a homeowner's association (HOA), liability, insurance, and capital considerations, and the value of the individual built lots. In addition, municipalities may require the builder provide an extended maintenance and warranty period for the facilities before turning them over to an HOA or other entity for maintenance in perpetuity. Again, it's best to start early!

Steps to Compliance

Here are some of the key stormwater compliance milestones as you manage your development project:

1. Pre-Application Meeting
2. Follow this Guidance
3. Stormwater Control Plan
4. Draft Stormwater Facilities Operation and Maintenance Plan
5. Detailed Project Design
6. Construction
7. Transfer Maintenance Responsibility

1: Pre-Application Meeting

Discuss stormwater requirements for your project with planning and public works staff prior to submitting an application. Their experience with similar projects and with local procedures, requirements, and community plans can provide invaluable insights. Current contacts are listed at the City's website.

You should also discuss with staff the right timing for completing your Stormwater Control Plan. Often, site designs take a few iterative reviews by staff before a satisfactory site layout is achieved. It is important to consider site drainage and locations for bioretention facilities throughout this iterative process. However, it may make sense to delay compilation and formal submittal of your Stormwater Control Plan until the site layout is fairly well set.

2: Follow the Guide

Read this Guide all the way through and understand the principles and design procedures before beginning to design your project. Then, follow the steps in Section 3 as you lay out the site.

3: Stormwater Control Plan

Prepare and submit a complete Stormwater Control Plan with your application for a land use permit, or for other permits (grading or building) if planning approval is not required. Stormwater Control Plan format and instructions are provided as Appendix A, and available in on the City's website.

The Stormwater Control Plan will demonstrate that adequate LID features and facilities can be accommodated within your site and landscape design.

Be sure the LID facilities shown on your Stormwater Control Plan Exhibit are also shown, as appropriate, on your preliminary site design, architectural design, and landscape designs.

Your Stormwater Control Plan may also be used in supporting a Negative Declaration or may be referenced in an Environmental Impact Report. In general, for most projects, implementing the techniques and criteria in this Guide will be considered to mitigate the project's potential impacts on stormwater runoff.

If your project receives Planning discretionary approval, a Condition of Approval will specify the project be constructed consistent with the Stormwater Control Plan.

As described in Section 3, your Stormwater Control Plan will include a Construction Checklist of items to be followed up during the final design phase of your project.

Your Stormwater Control Plan must also include a statement accepting responsibility to maintain the stormwater treatment facilities until that responsibility is transferred to the project operator or owner or another responsible party, and a commitment to execute a maintenance agreement.

4: LID Facilities Operation and Maintenance Plan

The LID Facilities Operation and Maintenance Plan (O&M Plan) is a living document used to plan, direct, and record maintenance of stormwater treatment facilities. It identifies the individuals responsible for maintenance, who must keep an up-to-date copy and file periodic updates with the City.

The O&M plan should be updated with as-built documentation of how the facilities are constructed.

5: Detailed Project Design

During this stage, the landscape design must integrate the functionality of LID features and facilities into the aesthetic and functional values of the project.

Typical design issues include edges and transitions to allow runoff to flow from sidewalks and paved areas into bioretention areas, dissipation of energy gained by runoff flowing down slopes, planting and irrigation of bioretention facilities, and integration of berms, fences, and walls in or near bioretention facilities. Section 4 includes design suggestions and tips.

Your submitted construction documents will include a Construction Checklist cross-referencing the Stormwater Control Plan features with the plan sheets. This checklist helps the plan checker to review the architectural, landscape, and grading and drainage plans and ensures the LID design features and facilities are integrated into the project design.

6: Construct the Project

Careful construction of LID facilities, coordinated with the building of the development, will help ensure the facilities function as intended and will also minimize future maintenance issues. Items to check during construction include:

- Avoid compaction of native soils in and around where bioretention facilities will be constructed.
- Divert any runoff flows during their construction.
- Closely follow design elevations.
- Grade parking lots, driveways, and streets to promote evenly distributed sheet flow into self-retaining landscaped areas or bioretention facilities.
- Set overflow inlets at the proper height so the surface of the bioretention facility ponds as intended.

Appendix B contains an inspection schedule and checklist for construction of bioretention facilities.

7: Transfer Maintenance Responsibility

Following construction—or perhaps following a maintenance and warranty period—formally transfer maintenance responsibility to the owner or operator of the project, who will maintain the facilities in perpetuity. In the case of a residential subdivision, this may be a homeowners association, if that arrangement has been approved by the City.

SECTION 3
PREPARING A STORMWATER CONTROL PLAN

Objectives

Your Stormwater Control Plan for a Tier 2 or Tier 3 project must demonstrate your project incorporates site design characteristics, landscape features, and engineered facilities that will:

- Minimize imperviousness.
- Detain and treat, and/or retain, the specified amounts of runoff.
- Slow runoff rates.
- Reduce pollutants in post-development runoff.

You will need to show all runoff from impervious areas is either dispersed to pervious areas or is routed to a properly designed LID facility.

A complete and thorough Stormwater Control Plan will enable City development review staff to verify your project complies with these requirements.

It is strongly recommended you retain a design professional familiar with the requirements.

Contents

Your Stormwater Control Plan will consist of a report and an exhibit. City staff will use the Stormwater Control Plan Checklist, detailed in the Tier 2 and Tier 3 Stormwater Control Plan (Appendix A), to evaluate the completeness of your Plan.

Step-by-Step Instructions

Plan and design your stormwater controls integrally with the site plan and landscaping for your project. This strategy requires you invest in early and ongoing coordination among project architects, landscape architects, geotechnical engineers, and civil engineers. However, it can pay big dividends in a cost-effective, aesthetically pleasing design—and by avoiding design conflicts later.

Your initial, conceptual design for the project should include site drainage. This should include identifying areas where runoff can be dispersed and/or the location and approximate size of stormwater treatment and flow-control facilities.

Follow these eight steps to complete your preliminary design and your Stormwater Control Plan.

- Step 1: Project Information
- Step 2: Opportunities and Constraints
- Step 3: Conceptual Site Design
- Step 4: Calculations and Documentation
- Step 5: Design Details
- Step 6: Source Controls
- Step 7: Maintenance
- Step 8: Construction Checklist

1: Project Information

Enter the following into the Project Data Form, which can be found in the Stormwater Control Plan (Appendix A):

- Project Name/Number
- Application Submittal Date
- Project Location
- Applicant Contact Information
- Project Phase
- Project Type and Description
- Project Site Area (square feet)
- Total Pre-Project Impervious Area (square feet)
- Total Post-Project Impervious Area (square feet)
- Total New Impervious Area (square feet)
- Total Replaced Impervious Area within an Urban Sustainability Area (USA)*
- Total Replaced Impervious Area not within a USA*
- Watershed Management Zone (1, 4, or 4a)
- Design Storm Frequency and Depth

*Urban Sustainability Areas are areas, approved by Water Board staff, where municipalities seek to preserve or enhance an existing pedestrian and/or public-transit-oriented urban design through high-density infill and redevelopment. *The City of Capitola does not currently have any Urban Sustainability Areas (USAs), rendering attention to this aspect non-applicable.*

To determine replaced impervious surface area, it is necessary to overlay a drawing of the existing, pre-project impervious areas with the proposed site plan and evaluate which portions of the existing impervious areas will be covered with new impervious surfaces.

Figure 3-1 is an example sketch depicting an existing parking lot and lawn area (i.e. impervious and pervious areas, respectively), and new and replaced impervious areas.

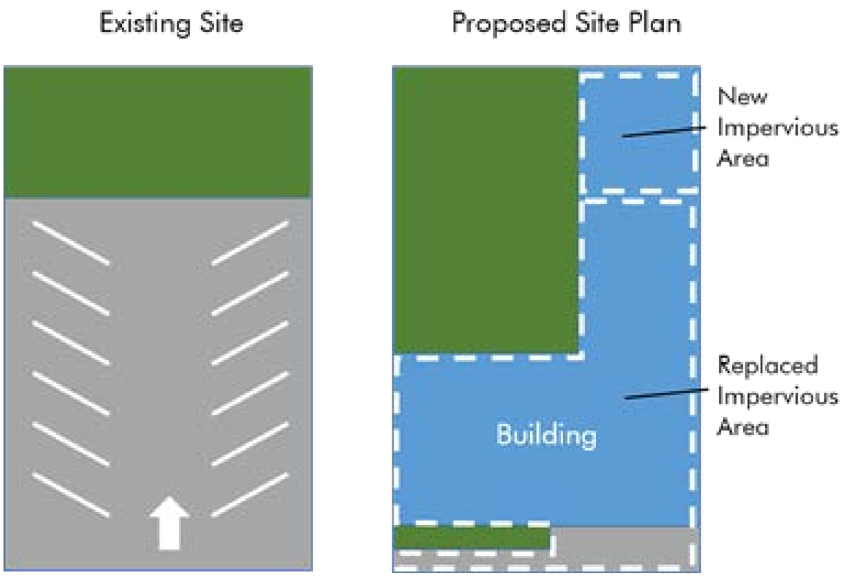

Figure 3-1. Replaced Impervious Area

2: Opportunities and Constraints

Review the following information before developing your Stormwater Control Plan and design:

- Existing natural hydrologic features, including natural areas, wetlands, watercourses, seeps, springs, and areas with significant trees.
- Site constraints such as endangered species habitat, protected vegetation, and archaeological resources.
- Site topography and drainage, including the contours of slopes, the general direction of surface drainage, local high or low points or depressions, and any outcrops or other significant geologic features.
- Zoning, including setbacks and minimum landscaping requirements and open space.
- Soil types—including NRCS Hydrologic Soil Groups—and depth to groundwater.

Prepare a brief narrative describing site opportunities and constraints.

Opportunities might include low areas, oddly configured or otherwise unbuildable areas, setbacks, easements, or buffers (which can double as locations for bioretention facilities), differences in elevation (which can provide hydraulic head needed to move runoff to LID facilities), and soils favorable to infiltration.

Constraints might include impermeable soils, near-surface bedrock, high groundwater, groundwater pollution or contaminated soils, steep slopes, geotechnical instability (for example, coastal bluffs), high-intensity land use, heavy pedestrian or vehicle traffic, endangered species habitat, protected vegetation, archaeological resources, or safety concerns.

3: Conceptual Site Design

Optimize the site layout. Apply the following design principles:

- Define the development envelope and protected areas, identifying areas that are most suitable for development and areas that should be left undisturbed.
- Limit grading; preserve natural landforms and drainage patterns.
- Set back development from creeks, wetlands, and riparian habitats to the maximum degree practical and at minimum, as required by local policies.
- Preserve significant trees.

Limit paving and roofs. Where possible and consistent with zoning, design compact, taller structures, narrower and shorter streets and sidewalks, smaller parking lots (fewer stalls, smaller stalls, and more efficient lanes), and indoor or underground parking. Examine the site layout and circulation patterns and identify areas where landscaping or planter boxes can be substituted for pavement.

Use pervious pavements where possible. Inventory paved areas and identify locations where permeable pavements, such as crushed aggregate, turf block, unit pavers with permeable joints, pervious concrete, or pervious asphalt can be substituted for impervious concrete or asphalt paving. Pervious pavements are most applicable where native soils are permeable. On sites with clay soils, it may still be possible to use unit pavers or pervious pavement with a sufficiently deep and well-drained base course. Pervious pavements such as turf block can sometimes be used for overflow parking or for emergency access lanes (check with the local fire department).

Direct drainage to landscaped areas. There are two options for handling runoff from impervious areas:

- **Disperse runoff to lawns or landscaping.** Limit the ratio of impervious to pervious area to 2:1 maximum. Pervious areas must be relatively flat, and the surface should be graded to a slightly concave surface to create a "self-retaining" area. Sites in densely urbanized areas are often too constrained to implement this option.
- **Route runoff to LID facilities.** LID facilities detain and infiltrate runoff. For rough site layout, consider that bioretention facilities require between 4% and 10% of tributary impervious area.

See Section 4 for design criteria for self-retaining areas and bioretention facilities.

Tips for conceptual drainage design.

Most LID facilities are bioretention facilities and include underdrains. A bioretention facility requires three to four feet of head from inlet to underdrain outlet, which can be connected to an underground storm drain or daylighted.

On flat sites, it usually works best to intersperse self-retaining areas and bioretention facilities throughout the site. Grade parking lots and driveways to sheet flow runoff directly into the landscaped areas. Use valley gutters or trench drains, rather than underground pipes, to convey runoff for longer distances.

On sloped sites, it may work better to collect upslope runoff in conventional catch basins and pipe it to downslope bioretention facilities.

Use the head from roof downspouts by connecting leaders all the way to landscaping or bioretention facilities. Where necessary, bubble-ups can be used to disperse piped runoff.

Siting LID facilities. Facilities should be easily accessible for inspection and maintenance.

In commercial, mixed-use, and multi-family developments, facilities can be located in parking medians, parking islands, street setbacks, side and rear setbacks, and other landscaped areas.

In residential subdivisions, the most practical strategy may be to drain the lots to the street in the conventional manner, and then drain the street to a bioretention area. It is most advantageous to create a separate parcel or parcels owned in common, which can double as a landscape amenity or a park (this is one reason why it is important to plan stormwater treatment and flow-control before drawing subdivision lot lines). Facilities in back or side yards should be avoided. If facilities are located on individual lots, prospective buyers may find undesirable the necessary legal restrictions on what they can do with those facilities.

Other types of treatment facilities. Bioretention facilities can typically be fit into parking medians, street setbacks, foundation plantings, and other landscaping features without significantly affecting the uses or layout of the site.

Further, bioretention facilities are relatively easy to maintain, provide aesthetic appeal, attenuate peak flows, and are quite effective at removing pollutants, including pollutants associated with very fine particulates in rain and atmospheric dust.

Alternative designs should provide equal or greater protection against shock loadings and spills, and equal or greater accessibility and ease of inspection and maintenance.

In some cases, it is very difficult to accommodate bioretention facilities on smaller, densely developed sites. Tree-box-type biofilters or in-vault media filters may be used to meet Tier 2 (treatment) requirements in the following circumstances:

- Projects that create or replace an acre or less of impervious area and are located in a locally designated pedestrian-oriented district, and have at least 85% of the entire project site covered by permanent structures
- Facilities receiving runoff solely from existing (pre-project) impervious areas.
- Historic sites, structures, or landscapes that cannot alter their original configuration without compromising their historic integrity.

The proposed tree-box-type biofilters or in-vault media filters must meet the criteria in Appendix C.

4. Calculations and Documentation

Your Stormwater Control Plan must include an exhibit showing the entire site divided into Drainage Management Areas (DMAs) and the locations and approximate sizes of LID facilities. Each should be clearly labeled so the exhibit can be cross-referenced to the text and tables in the report.

The report will include a brief description of each DMA and each LID facility—and tabulated calculations.

Section 4 includes a detailed procedure for documenting your site design and showing your LID facilities meet the minimum sizing requirements.

5. Design of LID Facilities

Design criteria in Section 4 will assist you to plan for construction of LID facilities as part of your project. The criteria that apply to your planned facilities should be summarized in your Stormwater Control Plan. Anticipated exceptions to the design criteria should be noted.

6. Source Controls

Your Stormwater Control Plan must identify and describe any potential pollutant sources that will be created or expanded as part of the development project.

Review the Pollutant Sources/Source Control Checklist included as Appendix D. Begin by identifying which of the listed potential sources are associated with your project.

Then, create a table in the format provided in the Tier 2 and Tier 3 Stormwater Control Plan. Enter each identified source in the left-hand column; then add the corresponding permanent, structural source controls from the Pollutant Sources/Source Control Checklist into the center column of your table.

In a narrative, explain any special features, materials, or methods of construction that will be used to implement these permanent, structural source controls.

To complete your table, refer once again to the Pollutant Sources/Source Controls Checklist (Appendix D, Column 4). List the operational source controls corresponding to the sources you've identified into the right-hand column of your table. These controls should be implemented as long as the identified activities (sources) continue at the site. These controls may be required as a condition of a use permit or other revocable discretionary approval for specific uses of the site.

7. LID Facility Maintenance

For Tier 2 and 3 Projects, your Stormwater Control Plan will describe maintenance needs of your bioretention facilities, source control measures, and stormwater conveyance systems. The maintenance plan will identify the location of the facilities to be inspected, the frequency of periodic inspections, and maintenance responsibilities. Annual reporting will be provided to the City at the facility owner's expense.

For residential subdivisions, consult with City staff, then detail the planned arrangements in your Stormwater Control Plan. Include, as available and applicable, information about joint ownership of parcels where bioretention facilities are to be located, about incorporating a homeowners association, about provisions to be incorporated in Codes, Covenants, and Restrictions, and other relevant information.

Include in your Stormwater Control Plan the following statement:

> *"The applicant accepts responsibility for the operation and maintenance of stormwater treatment and flow-control facilities for the life of the project. Any future change or alteration, or the failure to maintain any feature described herein can result in penalties including but not limited to fines, property liens, and other actions for enforcement of a civil judgment."*

A complete and detailed list of maintenance and inspection requirements, including inspection frequencies, will be required in your Stormwater Facilities Operation and Maintenance Plan (O&M Plan). Your O&M plan must also include detailed documentation of how your facilities are constructed. The O&M plan will be linked to a legally binding agreement executed between the owner and the City. That agreement identifies the legally responsible person charged with implementing the O&M Plan over the life of the project. This agreement is a covenant running with the land, so that transfer to a new owner will transfer the responsibility for O&M.

For this stage, include in your Stormwater Control Plan a summary of the general maintenance requirements for your bioretention facilities. You will find a discussion of maintenance requirements in Section 5.

8. Construction Checklist

Include in your Stormwater Control Plan a Construction Checklist following the format provided in the Stormwater Control Plan Format for Tier 2 and Tier 3 Projects (Appendix A).

Complete the first two columns in the checklist, listing each stormwater source control and treatment measure identified in the plan and identifying the page number where it appears. Later, you will copy-and-paste the same table into your construction documents. Complete the rightmost column, listing the sheet number(s) where the same measure is shown on the construction plans.

Certification

Include the following statement by a licensed civil engineer, architect, or landscape architect:

> *"The preliminary design of stormwater treatment facilities and other stormwater pollution control measures in this plan are in accordance with the current edition of the City of Capitola's Stormwater Technical Guide."*

Alternative Compliance Options

The PCRs allow two options for alternative compliance with on-site retention requirements (Tier 3). Both require a demonstration that on-site compliance, as described above, is technically infeasible. Tier 2 (treatment) requirements must still be met on-site.

To propose alternative compliance, first prepare a complete Stormwater Control Plan as described in this Section. Prepare your LID design as described in Section 4. The Stormwater Control Plan should show a complete and thorough implementation of opportunities for implementing LID, including delineation of DMAs and sizing of LID facilities. Show clearly in the plan the extent to which LID can and will be implemented on-site and explain why further implementation of LID is infeasible.

Potential causes of infeasibility include:

- High seasonal groundwater limits infiltration and/or prevents construction of subgrade stormwater control measures
- Near-surface bedrock or other impermeable conditions limit infiltration
- Soil types significantly limit infiltration
- Pollutant mobilization in soil or groundwater is a documented concern
- Space constraints imposed by infill projects, some redevelopment, and high density development, etc.
- Geotechnical hazards

- Proximity to drinking water wells (within 100’)
- Incompatibility with connections to the City’s storm drain system (for example, a project drains to an existing stormwater collection system, the elevation of which precludes connections to a properly functioning treatment or flow control facility).

Ten Percent Adjustment

Compliance with the criterion to prevent offsite discharge from events up to the 95th percentile rainfall event can be waived if stormwater control measures occupy an area equivalent to no less than 10% of the project’s Equivalent Impervious Surface Area (EISA)

Tabulate the EISA and the area of stormwater control measures and show totals for each; then divide the area of stormwater control measures by the EISA to show the 10% criterion is met or exceeded.

Formats and instructions for this tabulation are in Section 4.

Off-Site Compliance

Nearly all development projects should be able to achieve on-site compliance using the instructions and criteria in the Guide.

If you believe on-site compliance is infeasible for your site, and you wish to propose an off-site mitigation project, begin by contacting City staff for further guidance.

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SECTION 4
DOCUMENTING YOUR LID DESIGN

LID and Compliance with the PCRs

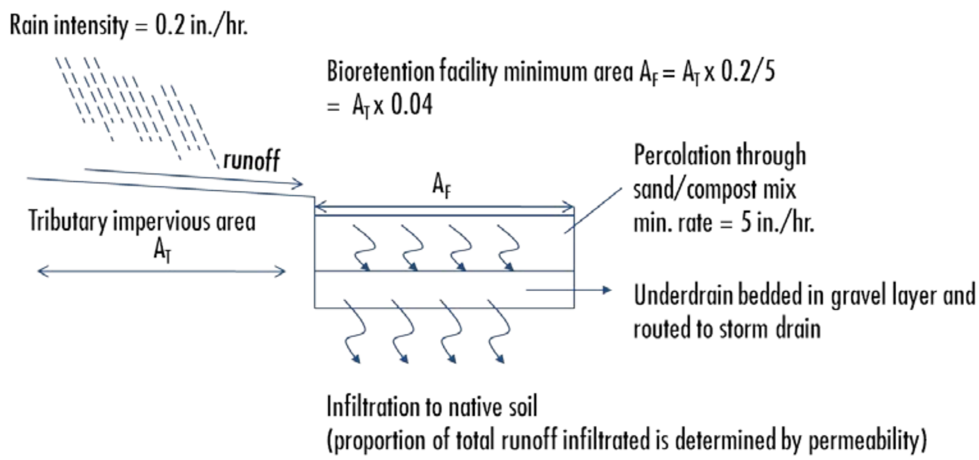
The following design and documentation procedure facilitates rapid and thorough evaluation of a LID design for compliance with the Post-Construction Requirements.

The procedure involves dividing the site into Drainage Management Areas (DMAs) and tracking the drainage from each DMA. The procedure accounts for pervious areas and dispersal of runoff from impervious area to landscape. The procedure is iterated until LID facilities are adequately sized to treat runoff (for projects in Tier 2) or retain runoff (Tier 3).

For Tier 2 projects, LID facilities are designed to detain and treat runoff produced by a rainfall intensity of 0.2 inches per hour. A sizing factor of 0.04 is used, which greatly simplifies calculations. See Figure 4-1.

For Tier 3 projects, LID facilities are sized according to the 95th Percentile Storm Depth. A 95th Percentile Storm Depth map, prepared by the Water Board is provided as a reference in Appendix E. You should use the most recent map available, which can be found on the Water Board's website. The LID facilities may be sized with a volume equal to the runoff volume produced by the design storm (simple method) or by iterative calculations routing the design storm hydrograph through the facility. These calculations account for infiltration that occurs simultaneously with inflow (routing method). The routing method results in a smaller facility volume and footprint.

Figure 4-1: Derivation of Sizing Factor for sizing Tier 2 Bioretention Facilities



As specified in the PCRs, bioretention facilities for Tier 2 are designed to retain and treat runoff produced by a rainfall intensity equal to 0.2 inches per hour. Measured over years, these low-intensity storms produce most of the total volume of runoff (80% or more). The planting medium (sand/compost mix) specified in this Guide is designed to filter runoff at a rate of at least 5 inches per hour. If 100% of rainfall ends up as inflow to the bioretention facility (a conservative assumption), then the ratio of tributary impervious area to bioretention surface area needs to be: 0.2 inches/hour ÷ 5 inches/hour = 0.04.

The Santa Barbara County Microsoft Excel-based calculator, which can be found at the Santa Barbara County website: www.sbprojectcleanwater.org, facilitates tracking of DMAs and sizing calculations for Tier 2 and Tier 3 projects. It can be used to prepare your design and your Tier 2 and/or Tier 3 Stormwater Control Plan submittal.

Step-by-Step

The procedure requires the following steps:

1. Delineate DMAs.
2. Identify DMA types. Minimize the amount of impervious area draining to bioretention facilities.
3. Identify bioretention facility locations.
4. Calculate the required minimum area (footprint) of each bioretention facility.
5. Compare the required footprint to the area available. Iterate until all bioretention facilities meet or exceed the minimum required area.

1: Delineate DMAs

Drainage Management Areas (DMAs) are portions of a project site that drain to a common point. Each DMA must contain only one type of surface (e.g., landscaped, impervious, or pervious pavement).

In your Stormwater Control Plan Exhibit, lines delineating DMAs will generally follow roof ridges and grade breaks. It is advantageous to first prepare a base map using the project grading plan and roof plan, and then delineate the DMAs. This helps ensure your Stormwater Control Plan is consistent with the site plan, landscaping plan, and architectural plans.

There are four types of DMAs:

- Self-treating areas
- Self-retaining areas
- Areas draining to self-retaining areas
- Areas draining to a bioretention facility

Self-Treating Areas. Self-treating areas are natural or landscaped areas that do not drain to bioretention facilities, but rather drain directly off site or to the storm drain system. Examples include upslope undeveloped areas which are ditched and drained around a development and grassed slopes which drain directly to a street or storm drain. In general, self-treating areas include no impervious areas, unless the impervious area is very small (5% or less) relative to the receiving pervious area, and slopes are gentle enough to ensure runoff will be absorbed into the vegetation and soil.

Self-Retaining Areas. Self-retaining areas are used where, because of site layout or topography, it is not possible to drain entirely pervious areas off-site separately. The technique works best on flat, heavily landscaped sites. To create self-retaining turf and landscape areas in flat areas or on terraced slopes, berm the area or depress the grade into a concave cross-section so that these areas will retain the first inch of rainfall. Specify slopes, if any, toward the center of the pervious areas. Inlets of area drains, if any, should be set three inches or more above the low point to allow ponding. Green roofs and pervious pavements—when constructed according to the design criteria in this Guide—are considered self-retaining areas.

Areas Draining to Self-Retaining Areas. Runoff from impervious areas, such as roofs, can be managed by routing it to self-retaining pervious areas. The maximum ratio is two parts impervious area for every one part pervious area (2:1 ratio). The drainage from the impervious area must be directed to and dispersed within the pervious area, and the entire area must be designed to retain an inch of rainfall without flowing off-site. For example, if the maximum ratio of two parts impervious area into one part pervious area is used, then the pervious area must be graded concave or bermed so that three inches of water over its surface are absorbed before overflowing to an off-site drain. Prolonged ponding is a potential problem at higher impervious/ pervious ratios. In your design, ensure that the pervious area soils infiltrate well enough to handle the additional run-on.

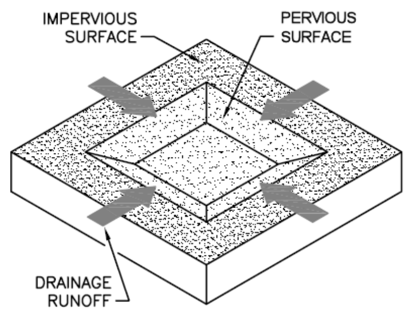


Figure 4-2: Self-Retaining Areas

Self-retaining areas are designed to retain the first one inch of rainfall without producing any runoff. During intense storms, runoff may drain off-site, to the storm drain system, or to LID facilities.

Areas Draining to a LID Facility. The square footage of these areas is used to calculate the required footprint and volume of the LID facility. More than one drainage area (DMA) can drain to the same LID facility. However, a particular DMA can only drain to one LID facility.

Where possible, design site drainage so only impervious roofs and pavement (not landscaped areas) drain to LID facilities. This yields a simpler, more efficient design and also helps protect LID facilities from becoming clogged by sediment.

2. Categorize and Tabulate DMAs

For each DMA, determine whether it will be self-treating, self-retaining, drains to a self-retaining area, or drains to a LID facility. Group the DMAs by type. For each DMA, tabulate the square footage and the post-project surface, and corresponding runoff factor.

Use the surface types and runoff factors in Table 4-1.

Table 4-1: Runoff Factors for Small Storms (for LID Design)

Type of surface	Runoff Factor
Roofs and paving	1.0
Landscaped areas	0.1
Bricks or solid pavers on sand base	0.5
Pervious concrete or asphalt	0.0
Turfblock or gravel—total section at least 6" deep	0.0

3. Select and Lay Out LID Facilities

From your conceptual drainage design (see Section 3) identify the locations and footprint of LID facilities. Once you have laid out the LID facilities, calculate the square footage you have set aside for each LID facility. Then, recalculate the square footage of your DMAs to omit the square footage now dedicated to LID facilities.

Design criteria for LID facilities are at the end of this Section.

4. Calculate minimum facility footprints

The following discussion is based on the Microsoft Excel based calculator developed by Santa Barbara County and can be found at the Santa Barbara County website: www.sbprojectcleanwater.org. Specific tools and methods utilized for designing Stormwater Control Measures (SCMs) are at the discretion of the Engineer; validation of results obtained through the use of available online calculators shall be the sole responsibility of the Engineer. Note that sizing calculations/methods must be submitted with the Stormwater Control Plan.

For Tier 2 projects, the minimum area for bioretention facilities can be found by summing up the contributions of each tributary DMA and multiplying by the sizing factor of 0.04. The Tier 2 and Tier 3 Stormwater Control Plan shows a format for tabulating DMAs draining to a LID facility and for calculating the required minimum area of a bioretention facility that meets the Tier 2 criteria. The table must be completed for each bioretention facility—or use a sizing calculator.

For Tier 3 projects, first find the applicable storm depth based on location. A map is provided for your reference in Appendix E; however, you should use the most recent maps and instructions available from the Central Coast Water Board website (search for "Central Coast 95th percentile rainfall maps"). **The 95th percentile storm applies throughout the City of Capitola, to which the PCRs apply. Storm depths vary from 1.8 to 2.1 inches.**

Next, determine any adjustments allowed for previously existing development. Typically this refers to Urban Sustainability Areas (USAs), although the City of Capitola currently has none.

The calculator allows you to enter, for each DMA, new impervious area, replaced impervious area in a USA, and replaced impervious area not in a USA.

Given the storm depth (convert to feet) and applicable amount of impervious area (in square feet), calculate the required facility size using the simple method or the routing method described below:

Simple method: Determine the required minimum volume V (in cubic feet) by multiplying as follows:

$V = \Sigma$ [DMA (sf) × runoff factor] × storm depth (ft)

Routing method: Enter the following information into the calculator:

- New tributary impervious area
- Replaced tributary impervious area within a USA
- Replaced tributary impervious area not within a USA
- Design storm depth (from 95^{th} percentile map)
- Hydrologic Soil Group or design infiltration rate for subsurface soils (see discussion below)
- Facility infiltration area (area in contact with subsurface soils—minimum is 4% of tributary impervious area)

The calculator performs the following based on the Unit Hydrograph method:

- Distributes the design storm depth over time increments according to a Type 1 unit hydrograph
- Calculates facility inflow rate and volume for each time increment
- Calculates facility infiltration rate and infiltration volume for each time increment
- Calculates incremental increase or decrease in storage and cumulative storage for each time increment
- Tracks and outputs time for facility to drain fully

The calculator outputs the maximum cumulative storage volume required to retain the design storm. As required by the PCRs, the calculator multiplies this volume by 1.2 when the drawdown time exceeds 48 hours (the likely condition when facilities are located in lower-permeability soils).

This is the minimum storage volume to be used for your design.

Infiltration rate for routing method: You may use the default option or, alternatively, submit data from on-site testing.

The default option is to use the Hydrologic Soil Group (HSG) that best characterizes site soils. To support your selection of an HSG, attach to your Stormwater Control Plan on-site boring logs or other information such as a geotechnical report for the site. In the calculator, HSG A/B soils (soils with no significant clay component) are assigned an infiltration rate of 0.75 in/hr. and HSG C/D soils are assigned an infiltration rate of 0.25 in/hr.

Should you wish to submit data from on-site testing, consult with City staff regarding acceptable test methods. Acceptance of results is at the discretion of City staff. Because of limitations in the precision of infiltration rate testing at low rates, this option may be used only to support an infiltration of 0.5 in/hr or greater; otherwise the default 0.25 in/hr will apply.

For LID facilities other than bioretention—such as dry wells, infiltration trenches, or infiltration basins—divide the infiltration rate by a safety factor of 2.0 to account for potential reductions in infiltration rates over time (this factor may be waived by local staff if an adequately designed and maintained treatment system is installed upstream of the infiltration facility).

To design a bioretention facility that contains the minimum volume, assume the porosity Φ of the gravel layer is equal to 0.4. The underdrain is placed at the top of this layer. Storage in the planting soil and surface reservoir is not credited.

If the simple method is used for sizing, then divide the calculated minimum storage volume by 0.4 to determine the volume of gravel required. Dividing the volume of gravel by the facility infiltration area (horizontal plane in contact with native soils, in square feet) yields the required average gravel layer depth.

If the routing method is used, then the minimum storage volume required changes as the facility infiltration area (typically this is the same as the footprint) is adjusted. Try entering different facility infiltration areas into the calculator, finding the resulting minimum storage volume, and determining the resulting gravel layer depth.

5. Repeat until facility area is adequate

The calculator is set up to track DMAs and the routing of drainage from DMAs to LID facilities. The calculator facilitates exploration of options to delineate DMAs differently and associate DMAs with different LID facilities and calculates the minimum storage volume that results. Iterate (repeat) this process to develop your design.

Review the site plan to determine if, for each LID facility, the square footage reserved is sufficient to accommodate the minimum footprint. Also consider (for Tier 3 projects) if the resulting gravel depth is constructible.

If necessary, revise your site plan, facility designs, or both. Revisions may include:

- Reducing the overall imperviousness of the project site.
- Changing the grading and drainage to redirect some runoff toward other LID facilities which may have more capacity.
- Making tributary landscaped DMAs self-treating or self-retaining.

- Expanding the LID facility footprint/infiltration area.
- Using large-diameter pipes, arches, vaults, or other structures to more efficiently create subsurface storage and thereby reduce the facility depth and volume of gravel required.

Bioretention Facility Design Criteria

Layout. Bioretention facilities may be of any shape. However, the following layers must be designed and built flat and level throughout the facility (See Page 4-11, Bioretention Facility - Cross-Section):

- Bottom of the excavation
- Top of gravel storage layer
- Top of soil layer
- Rim of facility reservoir

The facility must be designed to "fill up like a bathtub." This rule ensures all the storage is used during intense rainfall, prevents short-circuiting, and avoids erosion of the soil mix.

The surface reservoir should be level and circumscribed by a rigid boundary such as a concrete curb, masonry, or landscape timbers. To address concerns about a trip hazard, or to achieve a softer visual affect, soil mix and/or mulch may be gently mounded against the rigid edge. Plantings can be selected and arranged to discourage entry.

Gravel layer. "Class 2 permeable," Caltrans specification 68-1.025, is recommended. Drain rock or other granular material may be used; however, a layer of pea gravel or other intermediate-sized material should cover the top of the drain rock to reduce movement of fines from the soil layer into the interstices of the drain rock. Do not use filter fabric for this purpose.

Soil mix. A mixture of sand (60%-70%) and compost (30%-40%) should be used. The specification developed by the Bay Area Stormwater Management Agencies Association (BASMAA, 2010) is recommended.

Underdrain. Use minimum 4-inch diameter PVC SDR 35 or equivalent, perforated pipe, installed with the holes facing down. The underdrain itself must be in the bedded in the gravel layer; the discharge elevation (typically, where the underdrain is connected to the overflow structure) is critical and must be no lower than the top of the gravel layer. Provide a threaded, capped cleanout connected by a sweep bend.

Landscape Design and Landscaping. Many bioretention facilities incorporate native plants in an attractive garden setting, achieving low maintenance costs, low water demand, and maximum habitat value. However, combined uses, including active uses on turf or mulch, may be appropriate for part or all of a bioretention facility.

Select a plant palette to tolerate fast-draining soils and the microclimate specific to the facility location. The soil surface will be inundated briefly and rarely (for a few hours, possibly up to five occasions during a wet winter, and typically less frequently) but otherwise dry unless irrigated. Consider the facility's relationship to existing and proposed buildings and the resulting exposure to sun, heat, shade, and wind. Here are some problem conditions that should be avoided when developing a planting plan:

- Overly dense plantings that, after growing in, prevent flow into and through the surface reservoir
- Aggressive roots that block inflow or percolation
- Invasive weeds
- Plants that need irrigation or fertilization

Trees and large shrubs installed in bioretention facilities are susceptible to blowing over before roots are established. They should be staked securely. Three stakes per tree are recommended at windy sites.

Aged mulch, also called compost mulch, reduces the ability of weeds to establish, keeps the soil mix moist, and replenishes soil nutrients. Compared to bark mulch, aged mulch has somewhat less tendency to float into overflow inlets during intense storms.

Irrigation. Irrigation controls should allow separate control of times and durations of irrigation for bioretention facilities vs. other landscape areas. Smart irrigation controllers are strongly encouraged. Available controllers can access weather stations, use sensors to measure soil temperature and moisture, and allow input of soil types, plant types, root depth, light conditions, slope, and usable rainfall. Bioretention facilities may need to be irrigated more than once a day.

Drip emitters are strongly recommended over spray irrigation. Use multiple, lower-flow (0.5 to 2.0 gallons per hour) emitters—two to four emitters for perennials, ground covers, and bunchgrasses; four to six emitters for larger shrubs and trees.

If spray heads are used, they must be positioned to avoid direct spray into outlet structures.

Signage. Each bioretention facility must include a sign meeting current City standards. Signs must be visible to site users and to maintenance personnel.

Tips for Avoiding Design Conflicts

Review your bioretention design for the following:

- Elevations all around each facility are consistent with grading, drainage, and paving plans; and with architectural plans.
- Facilities do not interfere with circulation or with pedestrian access between parking areas and building entrances.
- Facilities are represented in architectural and landscape renderings.
- Bioretention facilities are shown in landscape plans, and a suitable plant palette has been chosen.
- Cable vaults, phone vaults, electrical boxes, and other utility boxes are accommodated in designated locations outside the bioretention facilities.
- Foundations and pavement subgrades adjacent to the facilities are shored and protected against moisture intrusion, as needed.

Ten Percent Adjustment

As noted in Section 3, following determination that it is infeasible to incorporate facilities that will detain the specified amount of runoff on-site, compliance may be achieved by dedicating a minimum 10% of the site's "Equivalent Impervious Surface Area" (EISA) to Stormwater Control Measures (SCMs).

Calculation of EISA. First divide the site into DMAs. Delineate separate DMAs for each surface type.

Tabulate and total the square footage of DMAs with concrete or asphalt paving, conventional or metal roofs, or other wholly impervious surfaces.

Then tabulate the square footage of DMAs with the surfaces shown in Table 4-2. Multiply the square footage of each DMA by the "correction factor" shown and total the products.

Table 4-2: Correction Factors for Use in Calculating EISA (from the PCRs)

Pervious Surface	Correction Factor
Pervious concrete	0.60
Cobbles	0.60
Pervious Asphalt	0.55
Natural Stone (without grout)	0.25
Turf Block	0.15
Brick (without grout)	0.13
Unit Pavers on Sand	0.10
Crushed Aggregate	0.10
Grass	0.10

Total the contributions of the pervious and partially pervious DMAs. This is the EISA for the site.

Calculation of SCM Area. Total the square footage of bioretention facilities and other facilities designed using the simple method or the calculator.

Ratio. Divide the SCM Area by the EISA to determine if the 10% criterion is met. Use of the 10% adjustment requires that the applicant first demonstrate the infeasibility of implementing bioretention facilities sized using the calculator to manage runoff from all impervious DMAs. The project must retain on-site the amount of runoff feasible.

Design Criteria for Porous Pavements

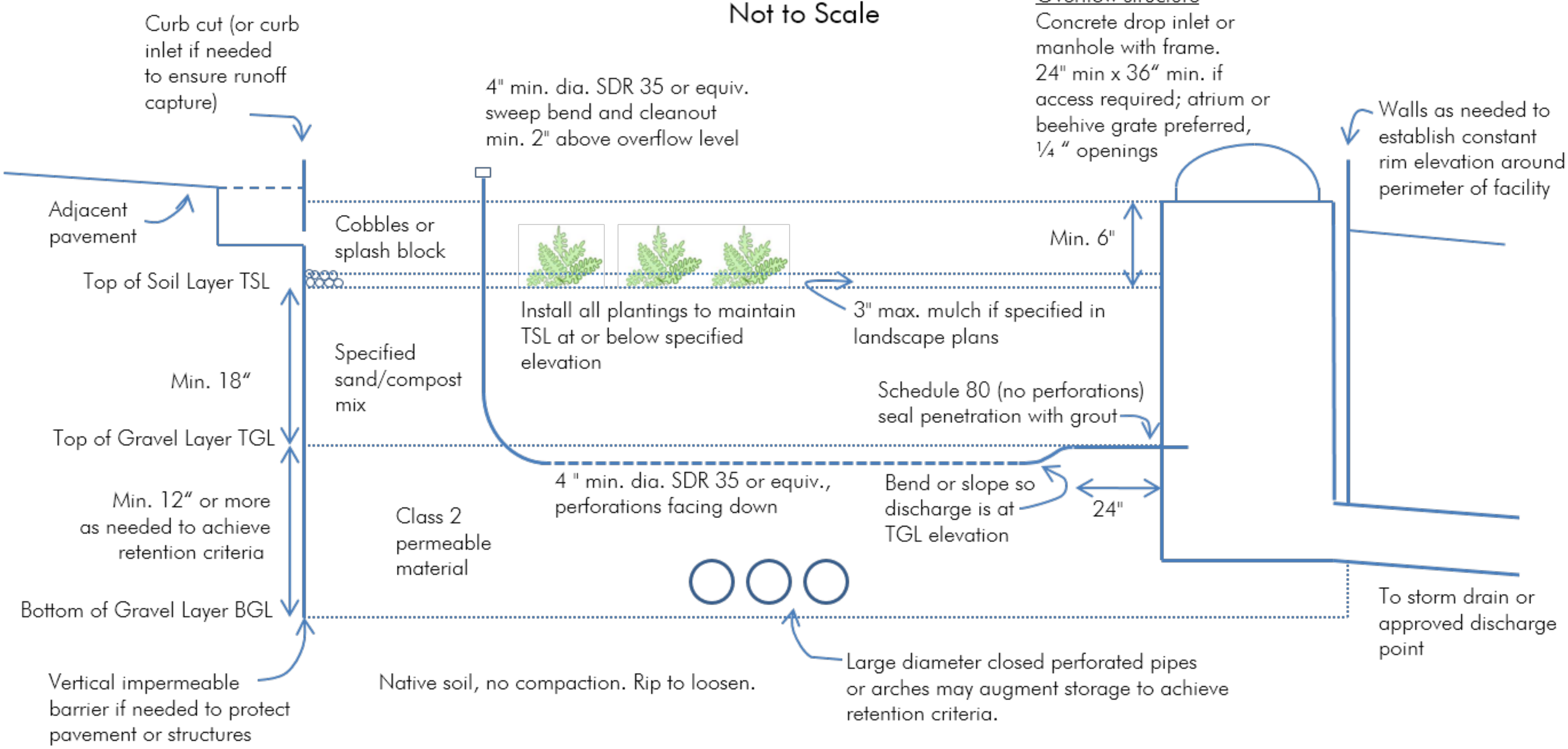
The following minimum design criteria must be followed where porous pavements are used as a site design measure for Tier 1 projects, or a self-retaining area for Tier 2 and 3 projects.

- No erodible areas drain on to permeable pavement.
- Subgrade compaction is minimal.
- Reservoir base course is of open-graded crushed stone. Base depth (three-inch or more) is adequate to retain rainfall and support design loads (more depth may be required).
- No subdrain is included or, if a subdrain is included, outlet elevation is a minimum of three inches above bottom of base course.
- Subgrade is level and slopes are not so steep that subgrade is prone to erosion.
- Rigid edge is provided to retain granular pavements and unit pavers.
- Solid unit pavers, if used, are set in sand or gravel with minimum 3/8 inch gaps between the pavers. Joints are filled with an open-graded aggregate free of fines.
- Permeable concrete or porous asphalt, if used, are installed by industry-certified professionals according to the vendor's recommendations.

Selection and location of pavements incorporates Americans with Disabilities Act requirements (if applicable), site aesthetics, and uses.

Bioretention Facility

Cross-section
Not to Scale

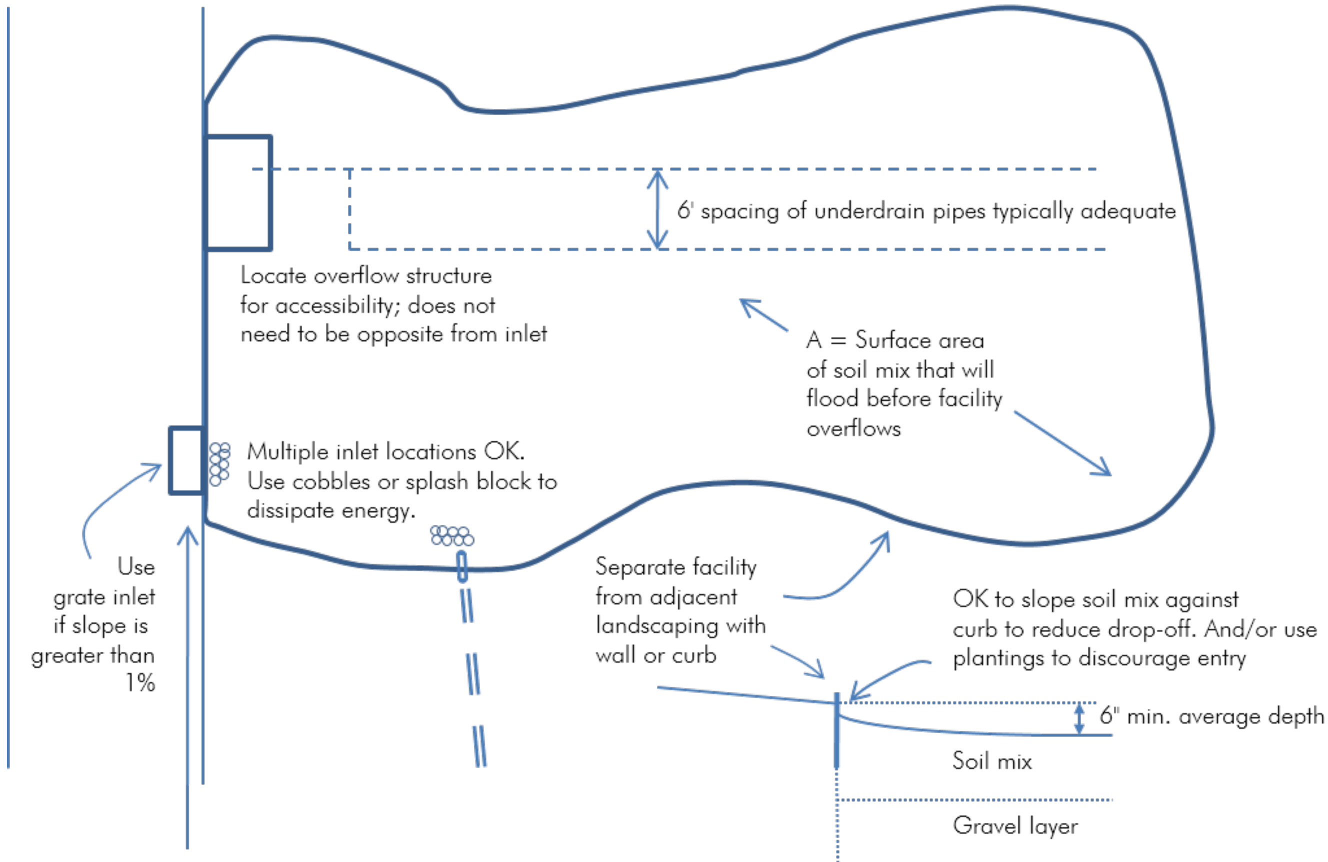


Notes:

- No liner, no filter fabric, no landscape cloth.
- Maintain BGL. TGL, TSL throughout facility area at elevations to be specified in plan.
- Class 2 permeable material layer may extend below and underneath drop inlet.
- Elevation of underdrain discharge is at top of gravel layer.
- See Chapter 4 for instructions on facility sizing and additional specifications.

Bioretention Facility

Plan (Not to Scale)



Note: Call out elevations of curb, pavement, inlet, top of soil layer (TSL), bottom of soil layer (BSL), and bottom of gravel layer (BGL) at all inlets and outlets and at key points along edge of facility.

SECTION 5
PREPARING YOUR BIORETENTION FACILITIES OPERATION & MAINTENANCE PLAN

Introduction

LID facilities—and in particular, bioretention facilities—require little care beyond normal maintenance and periodic rejuvenation of the landscaping. However, applicants must verify provisions have been made for maintenance of the LID facilities in perpetuity.

This verification is accomplished by executing and recording an agreement that "runs with the land." The agreement provides the municipality a right of access for inspections and requires the owner to certify annually that facilities have been recently inspected and are functioning as intended. If maintenance is not adequate, the municipality may conduct any maintenance or repairs needed and bill the owner to recover costs. The agreement is binding on future owners of the entire property or any subdivided portion of the property. A copy of the agreement is available at the City's website.

When facilities are located in a privately owned common area, such as street or landscaped area within a residential subdivision, the joint responsibilities of the property owners must be spelled out in codes, covenants, and restrictions (CC&Rs).

Your Operation and Maintenance Plan (O&M Plan) will address the specific drainage patterns and treatment facilities on the development site and is typically referenced in the agreement or attached as an exhibit. The O&M Plan is used to plan, direct, and record maintenance of the SCMs. The O&M Plan is kept on-site, and a copy maintained at City offices. Updated information, including contact information, must be provided to the City whenever a property is sold and whenever responsibility for maintenance is changed.

Step by Step

The City may require a draft O&M Plan be submitted when building permits are applied for — or even before. Follow these five steps to prepare your O&M Plan.

- Step 1: Designate Responsible Individuals
- Step 2: Describe the Facilities
- Step 3: Document the Facilities "As Built"
- Step 4: Schedule Maintenance Activities
- Step 5: Compile the Plan

1. Designate Responsible Individuals.

Identify the following individuals:

- Person who will have direct responsibility for the maintenance of stormwater controls, maintain self-inspection records, and sign any correspondence with the City regarding the inspections.
- Employees or contractors who will report to the designated contact and are responsible for carrying out maintenance.
- Contact for response to problems, such as clogged drains or broken irrigation mains, that would require immediate response should they occur during off-hours.

Describe the methods and schedule of initial training for staff or contractors regarding the purpose, mode of operation, and maintenance requirements for the facilities on the site.

2. Describe the Facilities to be Maintained

Incorporate the following into the O&M Plan:

- Figures from your Stormwater Control Plan delineating the Drainage Management Areas (DMAs) on the site and showing the locations of the bioretention facilities.
- The tabulation of the DMAs from the calculations in your Stormwater Control Plan.

3. Document Facilities "As Built"

Include from the final construction drawings:

- Plans, elevations, and details of the bioretention facilities. If necessary, annotate the drawings with the designations used in the Stormwater Control Plan so it is clear which drawing refers to which facility.
- Construction details and specifications, including depths of sand or soil, compaction, pipe materials, and bedding.
- Location and layouts of inflow piping and piping to off-site discharge.
- Native soils encountered (e.g., sand or clay lenses beneath or near facilities).

Changes made in the field during construction should be noted in the final Plan following construction.

4. Schedule Maintenance Activities

The following activities should be scheduled at least annually. The frequency should be adjusted in response to the needs of each particular facility.

Clean up. Remove any soil or debris blocking planter inlets or overflows. Remove trash that typically collects near inlets or gets caught in vegetation.

Prune or cut back plants for health and to ensure flow into inlets and across the surface of the facility. Remove and replant as necessary. When replanting, maintain the design surface elevation and minimize the introduction of soil.

Control weeds by manual methods and soil amendment. In response to problem areas or threatening invasions, corn gluten, white vinegar, vinegar-based products such as Burnout, or non-selective natural herbicides such as Safer's Sharpshooter may be used.

Add mulch. Aged mulch, also called compost mulch, reduces the ability of weeds to establish, keeps soil moist, and replenishes soil nutrients. Mulch may be added from time to time to maintain a mulch layer thickness of one- to two-inches, but only if the underlying soil surface beneath the mulch layer is a minimum six inches below the overflow elevation, consistently throughout the surface area of the facility.

Check signage. Remove graffiti and replace if necessary.

Check irrigation, if any, to confirm it is adequate but not excessive.

Landscape maintenance personnel should be aware of the following:

- **Do not add fertilizer to bioretention facilities.** Compost tea, available from various nurseries and garden supply retailers, may be applied at a recommended rate of five gallons mixed with 15 gallons of water per acre, up to two weeks prior to planting and once per year between March and June. Do not apply when temperatures are below 50°F or above 90°F or when rain is forecast in the next 48 hours.
- **Do not use synthetic pesticides on bioretention facilities.** Beneficial nematodes and non-toxic controls may be used. Acceptable natural pesticides include Safer® products and Neem oil.

5. Compiling the Plan

Format plans to 8½" x 11" where possible to facilitate duplication, filing, and handling. Include the revision date in the footer of each page. Consider scanning the graphics and incorporating with the text in electronic files that can be backed up.

Resources are available at the City's website to help you when preparing your O&M Plan

Updates to the O&M Plan

Updates can be made, and a copy transmitted to the City, at any time. In particular, contact information should be updated in a timely manner.

The O&M Plan should be reviewed annually and updated as needed.

SECTION 6
REFERENCES

The following references may be useful for design. Designs must meet the minimum standard specifications herein.

Central Coast Post-Construction Stormwater Requirements page containing the resolution, rainfall depths, and other technical resources for LID implementation: www.waterboards.ca.gov/centralcoast/water_issues/programs/stormwater/docs/lid/lid_hydromod_charette_index.shtml

City of Capitola Public Works Design Standards, available at: www.cityofcapitola.org/

California Stormwater Quality Association (CASQA) "Stormwater Best Management Practice Handbooks"

Santa Barbara Project Clean Water Stormwater Control Measures Sizing Calculator, available at: www.sbprojectcleanwater.org

Start At the Source: Design Guidance Manual for Stormwater Quality. Bay Area Stormwater Management Agencies Association, 1999.

Interlocking Concrete Pavement Institute www.icpi.org/

Porous Pavements, by Bruce K. Ferguson. 2005. ISBN 0-8493-2670-2

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