

Guidance for Sizing Green Infrastructure Facilities in Street Projects



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Introduction and Regulatory Background

Provision C.3.j. in the reissued Municipal Regional Stormwater Permit¹ (MRP) requires each Permittee to “complete and implement a Green Infrastructure (GI) Plan for the inclusion of low impact development drainage design into storm drain infrastructure on public and private lands, including streets, roads, storm drains, parking lots, building roofs, and other storm drain infrastructure elements.”

Provision C.3.j.i.(g) further mandates that these plans include:

Requirements that projects be designed to meet the treatment and hydromodification sizing requirements in Provisions C.3.c. and C.3.d. For street projects not subject to Provision C.3.b.ii. (i.e., non-Regulated Projects) Permittees may collectively propose a single approach with their Green Infrastructure Plans for how to proceed should project constraints preclude fully meeting the C.3.d. sizing requirements. The single approach can include different options to address specific issues or scenarios. That is, the approach shall identify the specific constraints that would preclude meeting the sizing requirements and the design approach(es) to take in that situation. The approach should also consider whether a broad effort to incorporate hydromodification controls into green infrastructure, even where not otherwise required, could significantly improve creek health and whether such implementation may be appropriate, plus all other information as appropriate (e.g., how to account for load reduction for the PCBs or mercury TMDLs).

This document represents the “single approach” collectively proposed by the Permittees for how to proceed when constraints on GI projects affect facility sizing in street projects. For other types of projects, information on hydraulic sizing is provided in the technical guidance manuals for Provision C.3 developed by each countywide stormwater program.

Hydraulic Sizing Requirements

MRP Provision C.3.d contains criteria for sizing stormwater treatment facilities. Facilities may be sized on the basis of flow, volume, or a combination of flow and volume. With adoption of the 2009 MRP, a third option for sizing stormwater treatment facilities was added to Provision C.3.d. This option states that “treatment systems that use a combination of flow and volume capacity shall be sized to treat at least 80 percent of the total runoff over the life of the project, using local rainfall data.”

This option can also be used to develop sizing factors for facilities with a standard cross-section (i.e., where the volume available to detain runoff is proportional to facility surface area). To calculate sizing factors, inflows, storage, infiltration to groundwater, underdrain discharge, and overflows are tracked for each time-step during a long-term simulation. The continuous simulation is repeated, with variations in the treatment surface area, to determine the minimum area required for the facility to capture and treat 80% of the inflow during the simulation.

¹ Order R2-2015-0049

Such an analysis was conducted for BASMAA by Dubin Environmental Consulting and is described in the attached Technical Report. The analysis shows that bioretention facilities with the current-standard cross-section can capture and treat the Provision C.3.d amount of runoff when sized to 1.5% - 3% of tributary equivalent impervious area, depending on location.

Hydromodification Management

A principal objective of LID is to mimic natural hydrology in the post-development condition. This is accomplished by retaining and infiltrating runoff flows during small to medium events. Flows from larger events are detained and slowed.

MRP Provision C.3.g. includes requirements and criteria for implementing hydromodification management (HM). These HM requirements apply to Regulated Projects that create or replace an acre or more of impervious area, increase the amount of impervious area over the pre-project condition, and flow to creeks that are at risk of erosion. As such, the HM requirements do not apply to street projects that retrofit drainage systems that receive runoff from existing roofs and paving.

However, Provision C.3.j.i.(g) states that the Permittees' approach to sizing GI facilities "...should also consider whether a broad effort to incorporate hydromodification controls into green infrastructure, even where not otherwise required, could significantly improve creek health and whether such implementation may be appropriate..."

Various criteria for HM design have been used in California and throughout the U.S. These criteria have been based on one or more of the following principles:

- Maintaining watershed processes
- Maintaining a site-specific water balance
- Maintaining the value of the curve number used in the NRCS method of computing peak runoff
- Controlling increases in peak flows from a specified storm size
- Controlling increases in the duration of flows at each intensity within a specified range (flow duration control)
- Controlling the likelihood of downstream erosion in streams (erosion potential, or Ep)

Generally, for any HM criterion used, facilities with more storage and a larger infiltrative area will be more effective in meeting the criterion than facilities with less storage and a smaller infiltrative area.

In the statewide municipal stormwater NPDES permit for small MS4s, Provision E.12.f. includes the following HM standard applicable to Bay Area small MS4s: "Post-project runoff shall not exceed estimated pre-project flow rate for the 2-year, 24-hour storm..."

Dubin (2014) conducted modeling to evaluate whether this standard would be met in the San Francisco Phase II counties (Marin, Sonoma, Napa, and Solano) by a bioretention facility meeting the minimum requirements in that permit's Provision

E.12.f. Dubin's analysis found that a facility sized to 4% of tributary equivalent impervious area, and having a 6-inch deep reservoir with 2 inches of freeboard, 18 inches of treatment soil, and a 12-inch-deep "dead storage" gravel layer below the underdrain, would meet this standard, even in the wettest portions of the Bay Area.

Additional Considerations for Bioretention Sizing

In summary, bioretention facilities for street projects sized to 1.5% - 3% of tributary equivalent impervious area (depending on their location in the Bay Area) can meet the criteria in Provision C.3.d., according to the modeling study documented in the attached Technical Memo.

There are many reasons to design and build facilities larger than the Provision C.3.d. minimum. Building larger facilities helps ensure the facilities perform to the minimum hydraulic capacity intended, despite minor flaws in design, construction, and maintenance, providing an engineering safety factor for the project. Further, larger-sized facilities may more effectively address objectives to maximize the removal of pollutants (particularly pollutants in dissolved form), to operate as full trash capture devices, and to manage hydromodification effects.

However, municipalities often face considerable challenges in retrofitting existing streetscapes with GI facilities. Constraints and design challenges typically encountered in the public right-of-way include:

- The presence of existing underground utilities (known and unknown during the design phase);
- The presence of existing above-ground fixtures such as street lights, fire hydrants, utility boxes, etc.;
- The presence of existing mature trees and root systems;
- The elevation of or lack of existing storm drains in the area to which to connect underdrains or overflow structures;
- Challenges of defining and controlling any catchment areas on adjacent private parcels that drain to the roadway surface;
- Low soil permeability and strength, and the need to protect the adjacent roadway structure;
- Competition with other assets & uses for limited right-of-way area; and
- Presence of archeologic/cultural deposits.

Use of the sizing factors in the attached Technical Memo will provide municipalities flexibility in design of bioretention facilities for street projects where constraints are present.

Recommendations for Sizing Approaches for Green Infrastructure Retrofit Facilities in Street Projects

1. Bioretention facilities in street projects should be sized as large as feasible and meet the C.3.d criteria where possible. Constraints in the public right-of-way may affect the size of these facilities and warrant the use of smaller sizing factors.

Bioretention facilities in street projects may use the sizing curves in the attached memorandum to meet the C.3.d criteria. Local municipal staff involved with other assets in the public right of way should be consulted to provide further guidance to design teams as early in the process as possible.

2. Bioretention facilities in street projects smaller than what would be required to meet the Provision C.3.d criteria may be appropriate in some circumstances. As an example, it might be appropriate to construct a bioretention facility where a small proportion of runoff is diverted from a larger runoff stream. Where feasible, such facilities can be designed as “off-line” facilities, where the bypassed runoff is not treated or is treated in a different facility further downstream. In these cases, the proportion of total runoff captured and treated should be estimated using the results of the attached memorandum. In cases where “in-line” bioretention systems cannot meet the C.3.d criteria, the facilities should incorporate erosion control as needed to protect the facility from high flows. See Figures 1 and 2 below for illustration of the in-line and off-line concepts.
3. Pollutant reduction achieved by GI facilities in street projects will be estimated in accordance with the Interim Accounting Methodologyⁱ or the applicable Reasonable Assurance Analysisⁱⁱ.



Figure 1: Off-line system in El Cerrito where low flow is diverted to the sidewalk planter and high flows continue down the gutter.



Figure 2: In-line system in Berkeley/Albany where low and high flows enter the system and overflows exit through a drain within the system.

ⁱ The Interim Accounting Methodology for TMDL Loads Reduced Report (BASMAA 2017) describes the methodology that is being used to demonstrate progress towards achieving the PCB and mercury load reductions required during the term of MRP 2.0. The methodology is based on the conversion of land use from a higher to a lower PCB or mercury loading rate during the redevelopment of a parcel. See:

[www.waterboards.ca.gov/sanfranciscobay/water_issues/programs/stormwater/Municipal/POC/Final%20Interim%20Accounting%20Methodology%20Report%20v.1.1%20\(Revised%20March%202017\).pdf](http://www.waterboards.ca.gov/sanfranciscobay/water_issues/programs/stormwater/Municipal/POC/Final%20Interim%20Accounting%20Methodology%20Report%20v.1.1%20(Revised%20March%202017).pdf)

ⁱⁱ A Reasonable Assurance Analysis (RAA) is a methodology used to demonstrate that implementation of pollutant control measures (such as GI facilities) over a specified time period will meet required pollutant load reductions associated with a TMDL. The Bay Area Reasonable Assurance Analysis Guidance Document (BASMAA 2017) establishes a regional framework and provides guidance for conducting PCBs and mercury RAAs in the San Francisco Bay Area. See: <http://basmaa.org/Announcements/bay-area-reasonable-assurance-analysis-guidance-document>