RESOLUTION NO. 87-19

RESOLUTION OF THE CITY COUNCIL OF THE CITY OF RICHMOND, CALIFORNIA, APPROVING THE GREEN INFRASTRUCTURE PLAN AS REQUIRED BY THE REGIONAL WATER QUALITY CONTROL BOARD NPDES PERMIT CAS612008 AT SECTION C.3.J.I.

WHEREAS, on November 19, 2015, the San Francisco Bay Regional Water Quality Control Board (Water Board) adopted the reissuance of the Municipal Regional Stormwater NPDES Permit No CAS612008 (MRP 2.0); and

WHEREAS, MRP 2.0 requires the City of Richmond to develop and approve a Green Infrastructure Plan by September 2019; and

WHEREAS, the development and approval of a Green Infrastructure Plan ensures compliance with Section C.3.j.i requirements of the National Pollutant Discharge Elimination System permit; and

WHEREAS, the City of Richmond's Green Infrastructure Plan will guide a shift from conventional "collect and convey" storm drain infrastructure to more resilient, sustainable stormwater management systems; and

WHEREAS, the Green Infrastructure Plan outlines a comprehensive process for the planning, design, construction and maintenance of green infrastructure facilities within the City of Richmond to create resilient stormwater management systems; and

WHEREAS, the Green Infrastructure Plan addresses addresses pollutants of concern (including PCBs, Mercury, oils, and metals) in urban stormwater run-off from privately and publicly owned lands prior to reaching local watersheds and the Bay; and

NOW, THEREFORE, BE IT RESOLVED that the Council of the City of Richmond hereby approves the Green Infrastructure Plan in compliance with MRP 2.0 Section C.3.j.i .

BE IT FURTHER RESOLVED that the form of the Green Infrastructure Plan is presented to the Council at this meeting (a copy of which is on file with the City Clerk).

BE IT FURTHER RESOLVED that the City Council finds that the Green Infrastructure Plan is exempt from the California Environmental Quality Act (CEQA), pursuant to CEQA Guidelines Section 15307, because its development is a requirement by the San Francisco Bay Water Quality Control Board (Order number R2-2015-0049) for the protection of natural resources.

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I certify that the foregoing resolution was passed and adopted by the Council of the City of Richmond at a regular meeting thereof held September 17, 2019, by the following vote:

AYES:	Councilmembers Bates, Johnson, Martinez, Myrick, Willis, Vice Mayor Choi, and Mayor Butt.
NOES:	None.
ABSTENTIONS:	None.
ABSENT:	None.

PAMELA CHRISTIAN
CLERK OF THE CITY OF RICHMOND
(SEAL)

Approved:

TOM BUTT
Mayor

Approved as to form:

BRUCE GOODMILLER
City Attorney

State of California }
County of Contra Costa : ss.
City of Richmond }

I certify that the foregoing is a true copy of **Resolution No. 87-19**, finally passed and adopted by the City Council of the City of Richmond at a regular meeting held on September 17, 2019.

Pamela Christian

Pamela Christian, Clerk of the City of Richmond

City of Richmond

Green Infrastructure Plan

DRAFT September 17, 2019

Prepared by:

City of Richmond
Water Resource Recovery Department
450 Civic Center Plaza
Richmond, CA 94804

With the support from:

NCE
501 Canal Blvd I
Richmond, CA 94804

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Acronyms

ABAG	Association of Bay Area Governments
BASMAA	Bay Area Stormwater Management Agencies Association
CAP	Climate Action Plan
CCCWP	Contra Costa Clean Water Program
CCW SWRP	Contra Costa Watersheds Stormwater Resource Plan
ESAs	Environmentally Sensitive Areas
GI	Green Infrastructure (Stormwater)
GIS	Geographic Information System
IRWMP	Integrated Regional Water Management Plan
MRP	Municipal Regional Stormwater Permit
MTC	Metropolitan Transportation Commission
NPDES	National Pollutant Discharge Elimination System
PCBs	Polychlorinated Biphenyls
RAA	Reasonable Assurance Analysis
ROW	City Right of Way
RWQCB	San Francisco Regional Quality Control Board
TMDL	Total Maximum Daily Load

1 Introduction and Overview

1.1 Regulatory Mandate

The City of Richmond (the City) is one of 76 local government entities subject to the requirements of the California Regional Water Quality Control Board for the San Francisco Bay Region's (RWQCB's) Municipal Regional Stormwater Permit (MRP). The MRP was last reissued in November 2015[1]. The MRP mandates implementation of a comprehensive program of stormwater control measures and actions designed to limit contributions of urban runoff pollutants to San Francisco Bay.

MRP Provision C.3.j.i. requires the City to prepare a Green Infrastructure Plan (the Plan), to be submitted with its Annual Report to the RWQCB due September 30, 2019.

Green Infrastructure (GI) refers to the construction and retrofit of storm drainage to reduce runoff volumes, disperse runoff to vegetated areas, harvest and use runoff where feasible, promote infiltration and evapotranspiration, and use bioretention and other natural systems to detain and treat runoff before it reaches our creeks and Bay. GI facilities include, but are not limited to, pervious pavement, infiltration basins, bioretention facilities or "raingardens", green roofs, and rainwater harvesting systems. GI can be incorporated into construction on new and previously developed parcels, as well as new and rebuilt streets, roads, and other infrastructure within the public right-of-way.

Water quality in San Francisco Bay is impaired by mercury and by polychlorinated biphenyls (PCBs). Sources of these pollutants include urban stormwater. By reducing and treating stormwater flows, green infrastructure reduces the quantity of these pollutants entering the Bay and will hasten the Bay's recovery.

Provisions C.11 and C.12 in the MRP require Contra Costa Permittees (Contra Costa County and its 19 cities and towns) to reduce estimated PCBs loading by 23 grams/year and estimated mercury loading by 9 grams/year using GI by June 30, 2020. Regionally, Permittees must also project the load reductions achieved via GI by 2020, 2030, and 2040, showing that collectively, reductions will amount to 3 kg/year PCBs and 10 kg/year mercury by 2040.

1.1.1 Further Background on Mercury and PCBs in San Francisco Bay

The MRP pollutant-load reduction requirements are driven by Total Maximum Daily Load (TMDL) requirements adopted by the RWQCB for mercury (Resolution No. R2-2004-0082 and R2-2005-0060) and PCBs (Resolution No. R2-2008-0012). Each TMDL allocates allowable annual loads to San Francisco Bay (a Waste Load Allocation, or WLA) from identified sources, including from urban stormwater.

The mercury TMDL addresses two water quality objectives. The first, established to protect people who consume Bay fish, applies to fish large enough to be consumed by humans. The objective is 0.2

[1] Order R2-2015-0049

milligrams (mg) of mercury per kilogram (kg) of fish tissue (average wet weight concentration measured in the muscle tissue of fish large enough to be consumed by humans). The second objective, established to protect aquatic organisms and wildlife, applies to small fish (3-5 centimeters in length) commonly consumed by the California least tern, an endangered species. This objective is 0.03 mg mercury per kg fish (average wet weight concentration). To achieve the human health and wildlife fish tissue and bird egg monitoring targets and to attain water quality standards, the Bay-wide suspended sediment mercury concentration target is 0.2 mg mercury per kg dry sediment.

A roughly 50% decrease in sediment, fish tissue, and bird egg mercury concentrations is necessary for the Bay to meet water quality standards. Reductions in sediment mercury concentrations are assumed to result in a proportional reduction in the total amount of mercury in the system, which will result in the achievement of target fish tissue and bird egg concentrations.

The PCBs TMDL was developed based on a fish tissue target of 10 nanograms (ng) of PCBs per gram (g) of fish tissue. This target is based on a cancer risk of one case per an exposed population of 100,000 for the 95th percentile San Francisco Bay Area sport and subsistence fisher consumer (32 g fish per day). A food web model was developed by San Francisco Estuary Institute (SFEI) to identify the sediment target concentration that would yield the fish tissue target; this sediment target was found to be 1 microgram (µg) of PCBs per kg of sediment.

Twenty percent of the estimated allowable PCB external load was allocated to urban stormwater runoff. The Bay Area-wide WLA for PCBs for urban stormwater is 2 kg/yr by 2030. This value was developed based on applying the required sediment concentration (1 µg/kg) to the estimated annual sediment load discharged from local tributaries.

1.2 Objectives and Vision

This Plan will guide a shift from conventional "collect and convey" storm drain infrastructure to more resilient, sustainable stormwater management systems that reduce runoff volumes, disperse runoff to vegetated areas, harvest and use runoff where feasible, promote infiltration and evapotranspiration, and use natural processes to detain and treat runoff. GI features and facilities include, but are not limited to, pervious pavement, infiltration basins, and bioretention facilities ("rain gardens"), green roofs, and rainwater harvesting systems.

As required by Provisions C.3.a. through C.3.i. in the MRP, these "Low Impact Development" practices are currently implemented on land development projects in the City. Specific methods and design criteria are spelled out in the Contra Costa Clean Water Program's (CCCWP's) *Stormwater C.3 Guidebook* (The Guidebook, Appendix A), which the City has referenced in Richmond Municipal Code (RMC) Chapter 12.22.

This Plan details how similar methods will be incorporated to retrofit existing storm drainage infrastructure using green infrastructure facilities constructed on public and private parcels and within the public right-of-way.

1.3 Plan Context and Elements

1.3.1 Planning Context

Municipal geography and demographics

The City is located 16 miles northeast of San Francisco, directly across San Francisco Bay. The City is on a peninsula separating San Francisco Bay (on the south) and San Pablo Bay (to the north), and it has 32 total miles of shoreline. The city's total area is 56.0 square miles, of which 33.7 are land area and 22.3 are water area. Wildcat Creek, San Pablo Creek, Castro Creek (Castro Cove), Cerrito Creek, Baxter Creek, Rheem Creek and Garrity Creek cross the City boundaries and eventually drain into the San Francisco Bay and San Pablo Bay. The City borders the cities of San Pablo, Albany, El Cerrito and Pinole.

According to the US Bureau Census 2011-2015 ACS 5-year estimate, the City has a population of 107, 597. The racial makeup of the City is 31.4% White, 26.6% Black or African American, 0.6% American Indian and Alaska Native, 13.5% Asian, 0.5% Native Hawaiian and other Pacific Islander, 21.8% other race, and 5.6% two or more races. The majority of residents are of ages 25-34. Within this age group, approximately 21.8% has some college education back ground but without a degree. The median household income is $55,102. Many neighborhoods of the City are considered disadvantaged communities. The City has observed a slight population growth of eight percent during the last 20 years as documented in its General Plan 2030.

Economic and Social Trends

The City has many assets and opportunities that can be leveraged to support local economic development. The City encompasses an excellent location and access to transportation. In addition to being located near the center of the Bay Area, Richmond benefits from a transportation network that includes Amtrak, BART, AC Transit, Interstate 80 and 580, Highway 101, municipal and privately-owned port facilities and a proposed ferry service in Marina Bay. The University of California, Berkeley operates a 300-employee, 150-acre field station in Richmond that is connected to the main campus by shuttle. Other amenities include unobstructed bay views, beautiful parks, an extended waterfront, relatively affordable housing, a rich history and a thriving arts community.

Inadequate or deteriorated infrastructure is an obstacle to economic development in key parts of the City. For example, the City needs to upgrade its sewage and stormwater management capacity. Improvements that will support local economic development include 1) addressing public safety and supporting neighborhood revitalization 2) cleaning up brownfield sites 3) maximizing opportunities to add affordable and market-rate housing 4) developing the City’s waterfront as an economic asset and community amenity and 5) addressing infrastructure needs.

The City is home to a variety of employers in key industries including green businesses, high-technology, manufacturing, distribution, petroleum refining, retail/entertainment and shipping. Richmond’s skilled workforce enjoys a variety of jobs that offer opportunities for building equity — contributing to overall community health and individual achievement. Transformed waterfront areas including the Southern Shoreline and San Pablo Peninsula provide recreational opportunities for residents and visitors and attract new residential and commercial development. A range of housing options are available to meet the needs of all segments of the population, and well-maintained streets and properties contribute to a sense of neighborhood pride.

Development and Redevelopment Trends

The City's General Plan 2030 identified change areas to incorporate mixed-use corridors that offer a range of local-serving commercial establishments, attractive streetscapes, higher-density housing and convenient and efficient circulation. Figure 1 portrays land use change areas such as Macdonald Avenue, Hilltop, Downtown, Ford Peninsula in Marina Bay, Ferry Terminal in Marina Bay, Northshore, Northern Parkway, San Pablo Peninsula, Port Authority Use Area, Regatta/Marina Bay, Southern Gateway are major activity centers, offering attractive retail and office space, and transformation of industrial areas. In those areas where there is transformation of existing industrial facilities or new establishments of industrial facilities, it is a requirement that such uses are required to incorporate measures to minimize impacts to residential uses such as enclosure of industrial activities in buildings, use of screening for visually unattractive uses, site design, soundproofing and landscaping, and to minimize impacts to residents from noise, exposure to toxic substance emissions whether via airborne or waterborne mechanisms, vibration, odors and truck traffic. The redevelopment of these major corridors will provide opportunities for implementation of GI whether they are on private parcels or in the City ROW to address legacy pollutants such as PCBs from historic land uses.

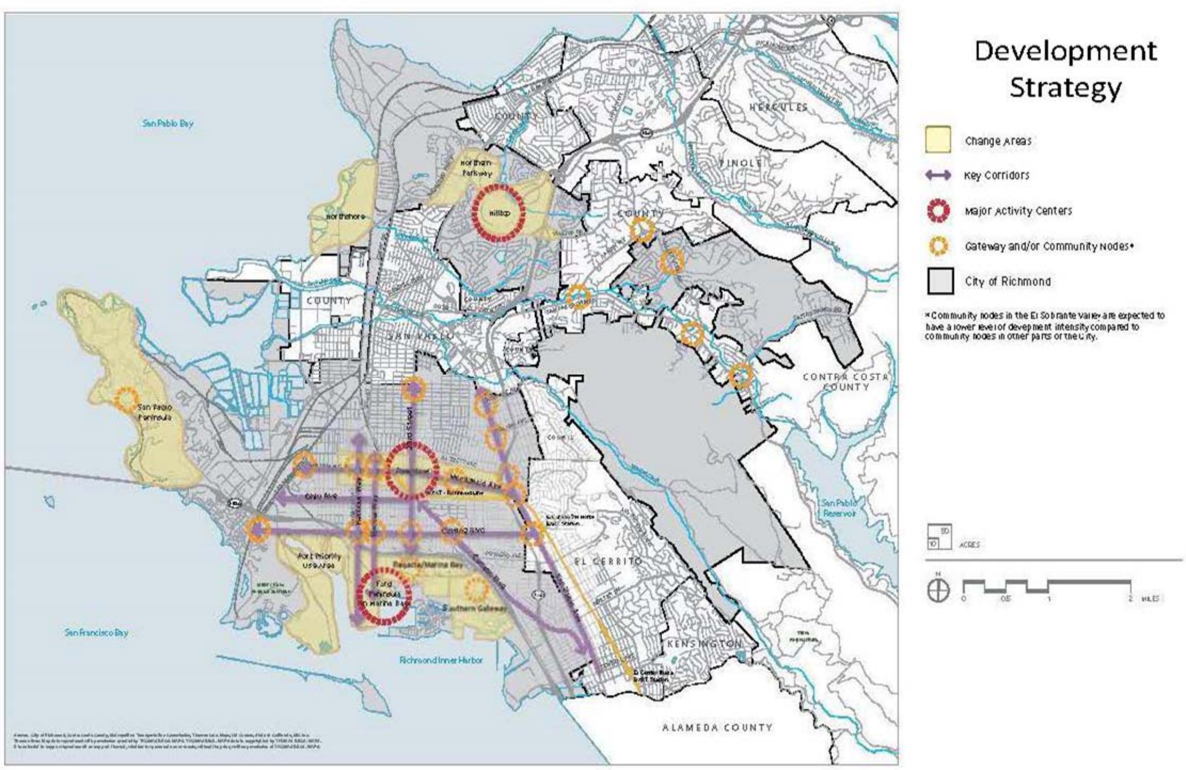


Figure 1. Richmond Development Strategy. Map is from Richmond General Plan 2030.

Commitment and Actions for Sustainability

The City is committed to transform its community to one that is sustainable through the protection of the environment, conservation of natural resources and reduction of greenhouse gas emissions associated with climate change. To help spearhead this effort, the City Council adopted its Climate Action Plan (CAP) in October 2016, which serves as a guideline for the City's future sustainability efforts.

The City has joined California's renewable energy movement by opting up its buildings and facilities to the local Community Choice Aggregation energy program, MCE's Deep Green 100% renewable electricity service. This energy is derived from California solar and wind; thereby eliminating all greenhouse gas emissions associated with its facilities' electricity in 2017.

Shortly after the adoption of the MRP in 2009, the City adopted its Food Ware Ordinance to ban the use of Polystyrene foam food ware. In 2018, the City amended and adopted the ordinance to ban the distribution of plastic straws and stirrers at all food servicing establishments. In 2013, the City banned the distribution of single-use plastic carryout bags at retail businesses.

Staffing and Scope of Sustainability Programs

Table 1 lists the City's divisions that are responsible for the implementation of the City's sustainability programs.

Scope of Sustainability Program	**Department/Division/Program**
Climate Action Plan	City Manager's Office, Environmental Initiative
Recycling and Solid Waste Management	City Manager's Office, Environmental Initiative
Foodware (polystyrene-based food ware and straws) and Plastic Bag bans	City Manager's Office, Environmental Initiative
Green Renewable Energy	City Manager's Office, Environmental Initiative
Stormwater Management and Discharge Control	Water Resource Recovery Department, Environmental Compliance Program
Wastewater Pollution Prevention and FOG Program	Water Resource Recovery Department, Environmental Compliance Program

CEQA

A notice of Exemption for the Green Infrastructure Plan was filed with the Contra Costa County Clerk on July 30, 2019. Any future projects that are to be constructed as recommended by the Plan will initiate a study to determine potential environmental impacts. The Plan has been determined to have no potential to generate significant adverse impacts to the environment.

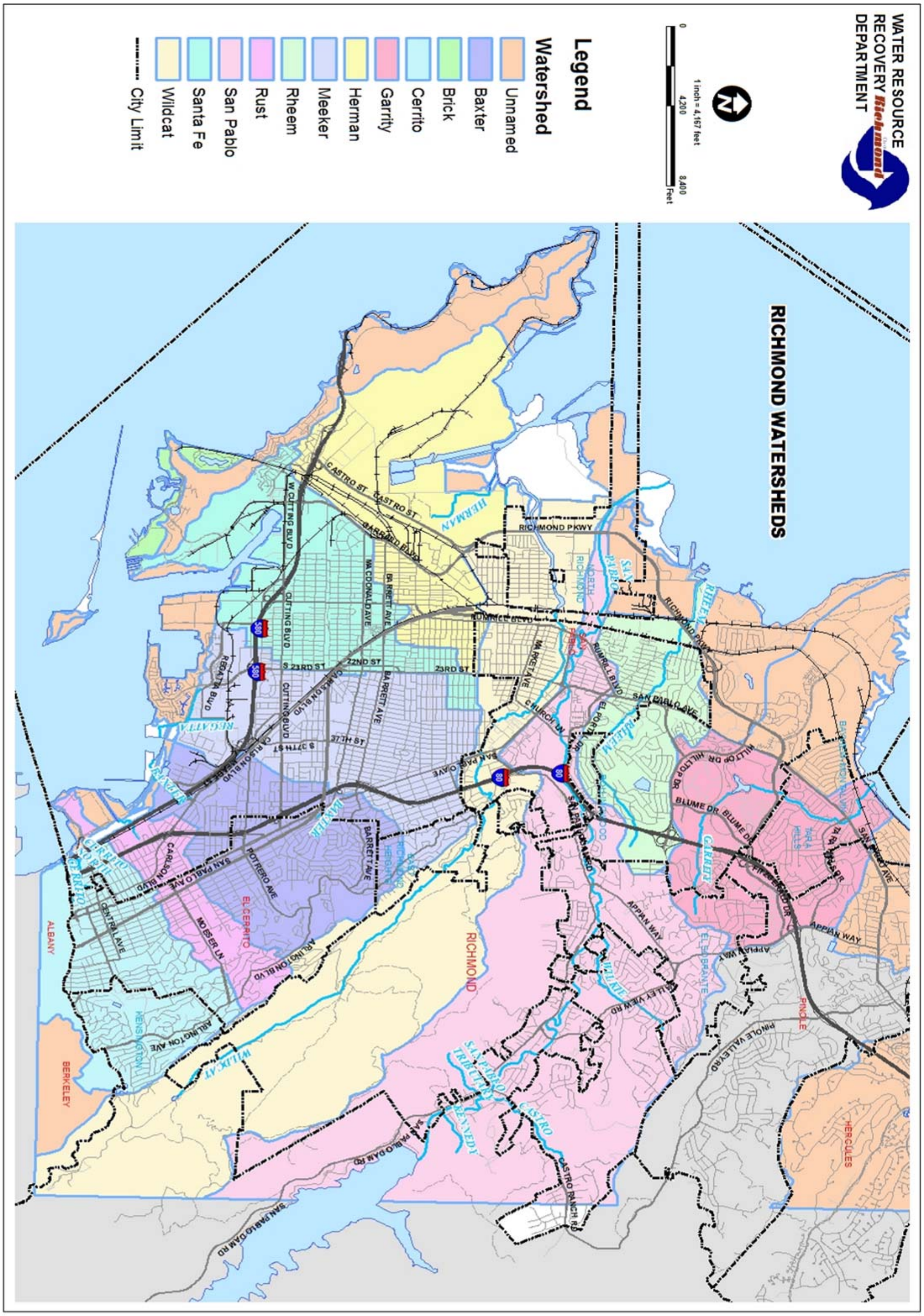
1.3.2 Watersheds and Storm Drainage Infrastructure

Watersheds and Watershed Characteristics and Challenges

The City has identified eleven (11) watersheds in its jurisdiction that drain to either the San Francisco Bay or the San Pablo Bay (see Appendix B). Portions of the watershed area are outside the city limits because the peripheral areas along the hills east of the City slope toward Richmond. The watershed area is generally bounded on the west by Richmond Parkway, Manor Drive and Road 20 on the north, Arlington Boulevard on the east, and San Francisco Bay on the south. There are also three separate watershed areas north of the primary City area that have independent storm drain systems and are not connected to the City's main system. Four independent watershed areas near the Hilltop Regional Shopping Center (Hilltop Mall) area discharge into local storm drain basin or creeks. The total watershed area tributary to the Richmond storm drainage system is approximately 7,200 acres.

The Richmond watershed area exhibits an undulating terrain with topographic surface elevations ranging from 700+ feet down to 0 feet (sea level). The City of Richmond is situated immediately adjacent to San Francisco and San Pablo Bays, and the prevailing surface terrain slopes generally from east to west. The upper watersheds are located near the East Richmond Heights area, and the lower watersheds fan westward toward the bay. The general slopes within the high watershed areas (from the high ridgeline along the east of the City down to the beginning of the lower watersheds where slopes are milder) range from 10 to 20 percent grades. The majority of the City is situated within the lower watershed areas, and the general slope is approximately 1 percent from east to west.

Figure 2. Richmond Watersheds



Storm Sewer System and Challenges (Pertinent to GI)

Currently, the City's storm drain system consists of several independent networks of storm drain catch basins and pipes that discharge into basins, creeks, or the bay. Throughout the system, portions of the storm drain system drain very small areas and have not been a historical problem. The portions of the system deemed insignificant include pipes that are very small in diameter used to convey stormwater across streets lacking valley gutters (not used as a collection system pipe) and select non-main pipes. Recent failures of corrugated metal storm pipes due to the age of the infrastructure have forced the City strategically analyze and formulate a plan to address these pipes. The locations of these pipes are potentially identified as opportunities to convert grey to green infrastructure where practical. Storm drain networks discharging into ponds include the system discharging into the Booker T Anderson Jr. Park and the Hilltop Mall area system, which discharges into Hilltop Lake. Other storm drain networks also discharge into some type of open channel (either canal or swales) and are collected by a downstream storm drain system. The remaining networks discharge into the bay. Hilly areas of the City such as East Richmond Height or Point Richmond are challenging to plan GI projects.

Flood Zones

The recent update of the City's storm drain master plan has identified four flooding high priority areas according to data gathered in relation to flooding hot spots from complaints received as well as documentation from operation and maintenance activities. The four areas are depicted in Appendix 2. The storm drain networks in the four high priority areas were analyzed. The results showed these areas will experience pronounced flooding when experience 10-year and 100 year storm events due to insufficient or the lack of storm drain inlets to capture flow, and/or undersized storm pipes. Proposed capital improvement projects in these areas include the replacement or upsize of pipes and storm drain inlets in these high priority areas. However, the City will evaluate whether the implementation of GI is feasible to address flooding issues.

Funding for Maintenance and for Capital Improvements

Effective operation and maintenance is essential to the success of GI and improvement of water quality. GI facilities constructed on private properties are maintained at the property owners' expense as required through operation and maintenance agreements set forth by the City. Currently, the City maintains GI facilities on public parcel-based properties and in the public right-of-way (ROW). However, as this inventory grows, the City will have a significant annual resource demand beyond what is currently available. The City will need additional funding sources and will continue to evaluate options.

1.3.3 Related Regional and Countywide Plans and Planning Documents

This Plan has been coordinated with the following regional stormwater documents:

- The Contra Costa Watersheds Stormwater Resource Plan (CCW SWRP). The CCW SWRP was funded by State Water Resources Control Board under a Proposition 1 Grant, with matching contributions provided by Contra Costa municipalities individually and collectively through the Contra Costa Clean Water Program (CCCWP). The CCW SWRP identified and prioritized potential multi-benefit stormwater management projects, including GI projects in watersheds and jurisdictions throughout Contra Costa County. Projects identified within the CCW SWRP are eligible to apply for future state funding. Many of the projects included in this Plan were drawn from the CCW SWRP project opportunity lists.

- The Contra Costa Countywide Reasonable Assurance Analysis (RAA). The RAA for Green Infrastructure is being prepared by Contra Costa municipalities collectively through the CCCWP and is consistent with guidance prepared by the Bay Area Stormwater Management Agencies Association (BASMAA). The RAA for Green Infrastructure uses a water quality model coupled with continuous simulation hydrologic output to estimate baseline loadings of pollutants and the reductions that might be achieved through green infrastructure implementation in 2020, 2030, and 2040 under various scenarios, which include implementation of projects identified in this Plan. Results pertinent to green infrastructure planning and implementation are discussed in Section 2 of this Plan.

1.3.4 Related Local Planning Documents

GI can be integrated into a wide diversity of public and private projects. Public projects can incorporate green infrastructure in streets, parks, schools, and other civic properties. In order to ensure that GI is considered and supported in the range of planning and design processes for these projects, the City has reviewed and/or updated the following planning documents to appropriately incorporate GI requirements:

Table 2. Documents Updated to Align with this Green Infrastructure Plan

Document	Summary of Updates	Completion or Updated Date	Responsible Department
Richmond General Plan 2030	The Plan includes GI as a requirement for all development and redevelopment projects	April, 2012	Planning
City Center Specific Plan	Although the Plan has not been updated since the adoption of MRP 1.0, it is to implement GI requirement as stated in Richmond General Plan 2030 and any subsequent updates	January, 2001	Planning
Bicycle Master Plan	The Plan includes GI as a requirement for all improvements of bicycle ways.	November, 2011	Planning
Pedestrian Master Plan	The Plan includes GI as a requirement for all improvements of bicycle ways.	February, 2017	Planning
Urban Greening Master Plan	The Plan includes implementation of GI when feasible.	April, 2017	Planning
Parks Master Plan	Any future updates of this	December, 2010	Planning

	plan will include implementation of GI requirement stated in Richmond General Plan 2030 and any subsequent updates of this Plan.		
Richmond Bay Specific Plan	The Plan includes GI as a requirement for all developments.	December, 2016	Planning
Storm Drain Master Plan	The Plan includes implementation of GI when practical to reduce flooding.	December, 2018	Water Resource Recovery

The City's Stormwater Management and Discharge Control Ordinance, RMC 12.22, enforces the implementation of GI since the adoption of the MRP in 2009. Thereafter, the Richmond General Plan and its subsequent updates GI as an element to be implemented citywide, both on privately and publicly owned lands. Plans that were adopted prior to 2009 will be updated to include the implementation of GI, thus in alignment with GI requirement stated in the Richmond General Plan 2030 and subsequent updates.

1.3.5 Outreach and Education

The Plan development process engaged a wide variety of stakeholders, including both government staff and local non-profit organizations who are actively involved with the planning of projects that include GI (i.e. Pogo Park, the Watershed Project and the Trust of Public Land). The City also anticipates engaging its official body and local communities as projects move forward towards design and implementation. Outreach efforts conducted by the City as part of the development of the Plan include:

- Presentation to City Council on GI Framework and the development of GI Plan on June 6th, 2017.
- The City hosted a total of nine "Climate Smart Cities" workshops which included the planning and development of GIS tools for GI in fiscal year 2016-2017.
- GI is incorporated into discussions at monthly project coordination meeting since 2016. This meeting is held on the 4th Tuesday of every month.
- Water Resource Recovery Department Staff meet with the Planning and Engineering Department annually to discuss potential/planned projects and the incorporation of GI in these projects.
- Water Resource Recovery Department Staff meet with Parks and Landscaping Department annually to discuss the maintenance of GI on public owned parcels and ROW.
- The City participated in "Green Infrastructure Planning and Implementation" workshop on September 26, 2018 at the Shadelands Arts Center with the Contra Costa Clean Water Program. Three City staff members attended this workshop.
- Parks and Landscaping Staff participated in the "Maintenance Green Infrastructure Including Bioretention Facilities" workshop held on March 21, 2019.

1.3.6 Policies, Ordinances, and Legal Mechanisms

The following policies, ordinances, and legal mechanisms are in place relating to the implementation of goals put forth in this Plan:

- Richmond Municipal Code 12.22, Storm Water Management and Discharge Control Ordinance (Appendix C)
- The City's GI Framework, approved by City Manager with City's Council's authorization in June, 2017 (Appendix D)

2 Green Infrastructure Targets

Provisions C.11 and C.12 in the MRP require Contra Costa Permittees (Contra Costa County and its 19 cities and towns) to reduce estimated PCBs loading by 23 grams/year and estimated mercury loading by 9 grams/year using GI by June 30, 2020. Regionally, Permittees must also project the load reductions achieved via green infrastructure by 2020, 2030, and 2040, showing that collectively, reductions will amount to 3 kg/year PCBs and 10 kg/year mercury by 2040.

This planning process developed and assessed projections for the square footage of impervious surface to be retrofitted and treated with GI from private projects within the City's jurisdiction by 2020, 2030, and 2040. It also incorporates targets for the square footage of impervious surface to be retrofitted and treated with green infrastructure through potential public projects within the City's jurisdiction by 2020, 2030, and 2040.

2.1 Private Development Projections

- *Provision C.3.j.i.(2)(c); TRT Item 12*

To forecast private development, the City participated in a regional process coordinated through the CCCWP and shared with BASMAA member agencies. This process utilized the outputs of UrbanSim, a model developed by the Urban Analytics Lab at the University of California under contract to the Bay Area Metropolitan Transportation Commission (MTC). UrbanSim is a modeling system developed to support the need for analyzing the potential effects of land use policies and infrastructure investments on the development and character of cities and regions. The Bay Area's application of UrbanSim was developed specifically to support the development of Plan Bay Area, the Bay Area's Sustainable Communities planning effort.

MTC forecasts growth in households and jobs and uses the UrbanSim model to identify development and redevelopment sites to satisfy future demand. Model inputs include parcel-specific zoning and real estate data; model outputs show increases in households or jobs attributable to specific parcels. The methods and results of the Bay Area UrbanSim model have been approved by both MTC and Association of Bay Area Government (ABAG) Committees for use in transportation projections and the regional Plan Bay Area development process.

The CCCWP process used outputs from the Bay Area UrbanSim model to map parcels predicted to undergo development or redevelopment in each Contra Costa jurisdiction at each time increment specificed in the MRP (2020, 2030, and 2040). The resulting maps were reviewed by local staff for consistency with the City's local knowledge and local planning and economic development initiatives. The maps were revised, and each revision documented.

It is assumed that multifamily residential and commercial/industrial developments will incorporate stormwater treatment facilities (typically bioretention) in accordance with MRP Provisions C.3.b., C.3.c., and C.3.d. Because of high land values, it is expected that more than 50% of the existing impervious area in each parcel will be replaced if a parcel is developed, and therefore the entire parcel will be subject to Provision C.3 requirements (that is, will be retrofit with GI), consistent with the "50% rule" requirements of MRP Provision C.3.b.

Existing impervious surface for each affected parcel was estimated using the 2011 National Land Cover Database. Estimates were spot-checked and revised based on local knowledge and available satellite imagery.

Based on these assumptions and the revised maps, the amounts of existing impervious surface forecast to be retrofit with GI via private development are as shown in Table 3 and Figure 3.

Table 3. Estimate of impervious surface retrofitted or to be retrofitted through private projects.

Year	Treated Area (Acres)	Comments
2020	330	Includes private regulated projects (completed, in-progress, and planned)
2030	178	Accounted by UrbanSim projections
2040	414	Accounted by UrbanSim projections

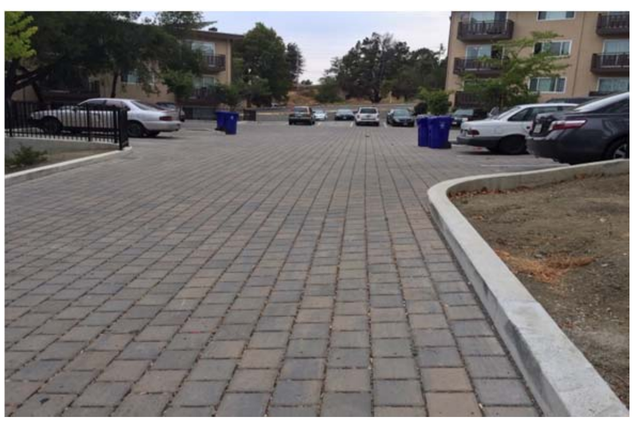
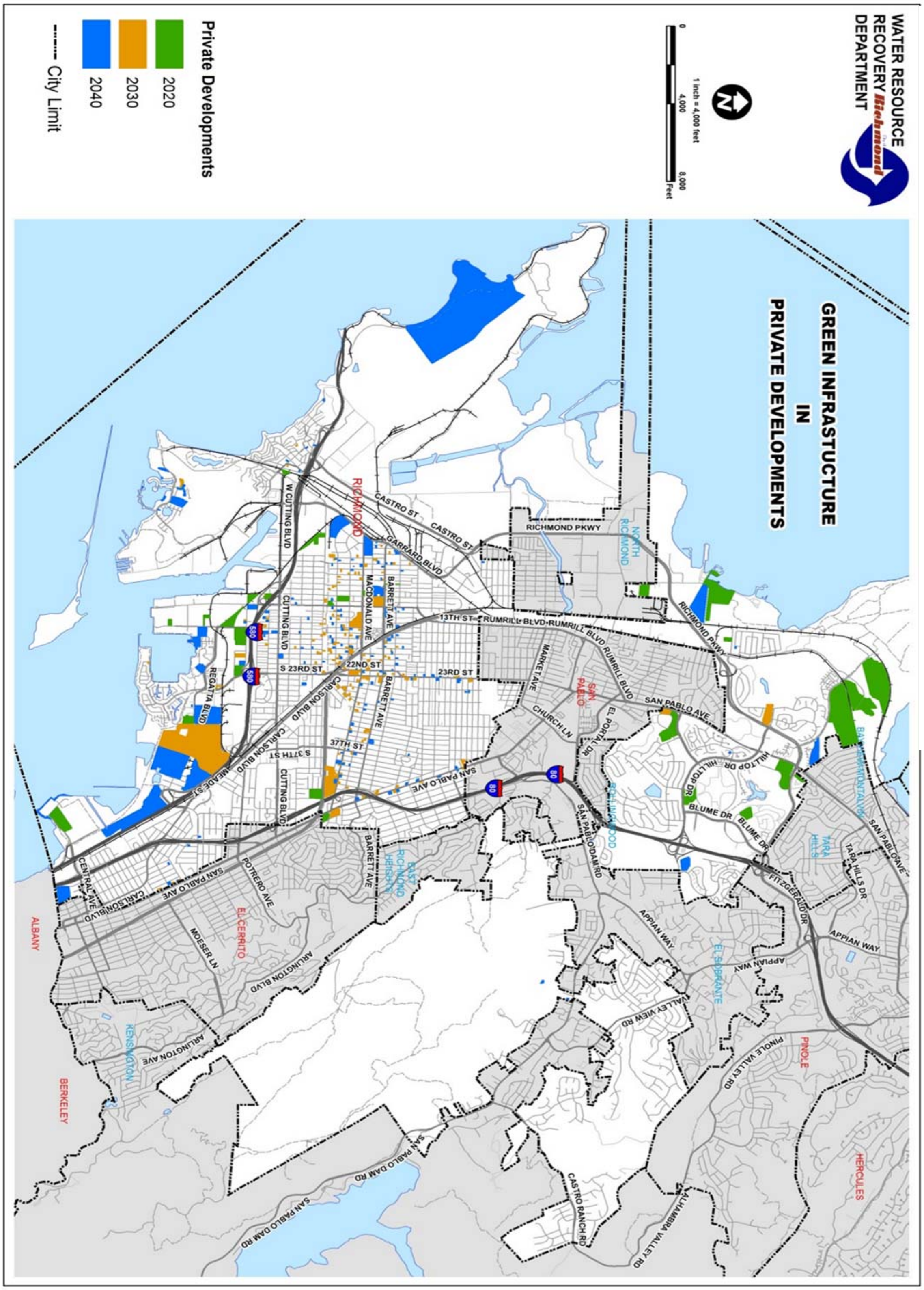


Figure 3. Private Projects Planned or Completed 2020, 2030, and 2040.



2.2 Targets for Public Projects

Forecasted impervious surface to be retrofit via public projects is in two categories:

1. Estimated tributary impervious surface for Green Infrastructure Projects identified in this Plan.
2. Additional tributary impervious surface associated with projects yet to be identified. These projects are associated with general geographic areas (neighborhoods or blocks) but specific facility locations have not yet been identified.

These forecasts are summarized in Table 4 and portrayed in Figure 4.

Table 4. Estimate of impervious surface retrofitted or to be retrofitted through public projects.

Year	Total Area Treated (Acres)
2020	283
2030	183
2040	106

2.3 Projected Load Reductions

The Contra Costa County permittees have collectively agreed to investigate alternative measures (in-lieu fees, pay for performance) to address pollutant load reduction on a countywide scale that is most cost effective. In this way, those permittees without pollutant present in their communities are able to meet MRP requirements. However, the legal and administrative requirements are complex, which would require consideration effort to determine, and may or may be fruitfully. This Plan includes a draft memorandum describing the Reasonable Assurance Analysis Countywide Attainment Strategy as, which provides a preliminary projection for load reductions achieved via GI by 2020, 2030, and 2040 at the Countywide level using the preliminary RAA model. The GI projects and project opportunities included in this Plan are accounted for in the Reasonable Assurance Analysis Countywide Attainment Strategy (Appendix E).

3 Public Project Identification, Prioritization, and Mapping

Element Addresses MRP Provision C.3.j.i.(2)

3.1 Tools for Public Project Identification and Prioritization

Publicly owned parcels and ROWs that could potentially be retrofit to include multi-benefit stormwater capture facilities were identified as part of the Contra Costa Watersheds Stormwater Resource Plan (SWRP) (CCCWP, 2018). These potential project locations were used as the basis for identifying future public retrofit locations within the City. A summary of the project identification and prioritization process conducted for the SWRP is described herein; additional details may be found in the SWRP (CCCWP, 2018).

3.1.1 SWRP Project Opportunity Identification

The SWRP identified public retrofit opportunities through a request for planned projects, sent to the Contra Costa County Permittees, along with a geographic information system (GIS)-based project opportunity analysis, conducted using data received from the Permittees through a data request. Information related to the identification of potential projects was received from 25 jurisdictions, government agencies, non-governmental organizations, and watershed groups that were contacted with potential project requests.

The desktop GIS analysis entailed screening for publicly-owned parcels and ROWs without physical feasibility constraints that would preclude implementation of a stormwater capture project. The project opportunity analysis consisted of the following steps:

1. Identify publicly-owned parcels through parcel ownership and/or tax-exempt status.
2. Screen identified publicly-owned parcels to identify those at least 0.1 acres in size; and with average slopes less than 10%.
3. Identify ROW using the county-wide roadway data layer. Roadways considered were state and county highways and connecting roads, as well as local, neighborhood, and rural roads.
4. Identify land uses associated with identified parcels and surrounding identified ROWs with a combination of ABAG land use categories and use codes provided by the Contra Costa County Assessor.
5. Screen all identified locations (i.e., parcels and ROWs) for physical feasibility. The following screening relating to physical constraints was applied to identified sites (to the extent that the necessary data had been provided or obtained):
    a. Regional facilities were not considered for parcels that were greater than 500 feet from a storm drain, due to limited feasibility in treating runoff from a larger drainage area;
    b. Parcel-based facilities were not considered for sites that were more than 50% undeveloped land uses, due to the limited potential for pollutant of concern load reduction;
    c. Parcels with significant drainage area outside of urbanized areas were removed, as these sites would not provide opportunity for significant pollutant of concern load

reduction;

d. Sites more than 50% within environmentally sensitive areas (ESAs) (designated wetlands, biologically sensitive areas) were removed so as not to disturb these habitats;

e. Sites with more than 50% overlying landslide hazard zones were removed to avoid the potential for increasing landslide risk.

The remaining identified public parcels and ROWs were considered preliminarily feasible for installation of stormwater capture facilities and were analyzed using a metrics-based multi benefit analysis. The results of the metrics-based multi-benefit analysis provided some information helpful for consideration of GI priorities within the City. A summary of the project opportunity classification and scoring conducted for the SWRP is provided in the following section.

3.1.2 SWRP Project Opportunity Metrics-Based Multi-Benefit Analysis

To conduct the SWRP project opportunity metrics-based multi-benefit analysis required as part of the SWRP, additional data was analyzed and classifications were made regarding the project opportunities. First, all project opportunities (i.e., including those identified through the GIS opportunity analysis and the stakeholder potential projects process) were classified using the following information:

1. Stormwater capture project type;
2. Infiltration feasibility;
3. Facility type; and
4. Drainage area information.

Details regarding each of these classifications are provided in the following sections.

Stormwater Capture Project Type

All physically feasible project opportunities that did not include a previously defined non-GI stormwater capture facility (e.g., stream restoration projects provided by Stakeholders as part of the SWRP project request) were assumed to be feasible for GI implementation as part of the SWRP project opportunity classification. The projects identified through the GIS opportunity analysis and stakeholder stormwater capture projects process were categorized as parcel-based, regional, or ROW/green street projects, as summarized in Table 5.

Table 5. GI Project Types and Categorization Criteria

GI Project Type	Definition	Description
ROW/green street projects	Treating the road and portions of adjacent parcels	• All street-based projects.

GI Project Type	Definition	Description
Regional Projects	Treating a large area draining to the parcel	• The parcel contains at least 0.5 acre of undeveloped or pervious area (as identified through the land use class); and • The drainage area is larger than the parcel itself and the location is sufficiently close to a storm drain (i.e., within 500 feet, where storm drain pipe data is available).
Parcel-based projects	Treating the drainage area only on the identified parcel	• All +6947other parcel locations.

Infiltration Feasibility

All SWRP project opportunity locations were categorized as feasible, infeasible, or partially feasible for infiltration, based on underlying hydrologic soil group, depth to groundwater (as data was available), nearby soil or groundwater contamination, and presence of underlying geotechnical hazards, as described in Table 6.

Table 6. SWRP Project Opportunity Infiltration Feasibility Categorization Criteria

Infiltration Feasibility Category	Description
Hazardous/infeasible for infiltration	Projects that are located: • More than 50% overlying liquefaction hazards; or • Within 100 feet of a site with soil or groundwater contamination (e.g., based on proximity to active GeoTracker[2] or EnviroStor[3] sites).
Infiltration safe but only partially feasible	None of the above constraints exist, but the soil underlying the facility is relatively poorly draining (identified as hydrologic soil group [HSG] C or D).
Infiltration feasible	The site has none of the infiltration hazards present and the soil underlying the facility is relatively well draining (identified as HSG A or B).

For the purpose of SWRP project opportunity multi-benefit scoring (i.e., the metrics-based analysis

[2] GeoTracker is a California State Water Resources Control Board website which tracks sites with the potential to impact water quality in California, including contaminated sites (https://geotracker.water7boards.ca.gov/).

[3] EnviroStor is the Department of Toxic Substances Control's data management system for tracking cleanup, permitting, enforcement and investigation efforts at hazardous waste facilities and sites with known contamination or sites where there may be reasons to investigate further (https://www.envirostor.dtsc.ca.gov/public/).

conducted), locations feasible for infiltration were assumed to retain the full water quality capture volume. At locations that are partially feasible for infiltration, it was assumed that infiltration would be promoted in the facility, but the full water quality capture volume would not be infiltrated due to poor drainage. These areas were assumed to infiltrate to the extent possible using a raised underdrain. Locations that are hazardous for infiltration were assumed to implement non- infiltrating GI projects (i.e., lined bioretention) and were assumed to retain no volume.

SWRP Project Opportunity Facility Type

Each SWRP project opportunity location was assigned a facility type. For potential projects identified by the Permittees and/or stakeholders, a facility type was assigned based on the facility description or classification provided by the agency or project proponent. For project opportunities identified through the GIS analysis, the facility type was assumed to be GI, with infiltration capability defined based on the infiltration feasibility screening. The resulting SWRP multi-benefit stormwater capture project types that were considered for the Plan included:

- Capture and Reuse
- Constructed Wetland
- Lined Bioretention
- Unlined Bioretention
- Unlined Swale
- Water Quality Basin

SWRP Project Opportunity Drainage Area

For each identified project opportunity, the drainage area was identified and characterized as follows:

1. All project opportunities with identified drainage areas were characterized as provided by project proponents.
2. For ROW project opportunities for which the drainage area had not been characterized, the roadway and an assumed tributary width (e.g., 50 feet per side) that extends into the adjacent parcels was considered the drainage area.
3. For parcel-based project opportunities for which the drainage area had not been characterized, the entire parcel was assumed to make up the drainage area.
4. For regional project opportunities for which the drainage area had not been characterized, the drainage area characterization (i.e., slope and land use) was approximated.

SWRP Project Opportunity Metrics-Based Multi-Benefit Analysis Scoring

Using the information compiled in the identified project opportunity database, each SWRP identified project received a score using a metrics-based multi benefit analysis. A description of each scored project component is provided below:

- Parcel area (for regional and parcel-based GI projects only) - This scoring component awarded more points for larger parcels.
- Slope – This scoring component awarded more points to flatter slopes and is related to ease of construction and implementation.
- Infiltration feasibility – More points were awarded to projects that overlie infiltrating soils.

- PCBs/mercury yield classification in project drainage area – This scoring component is related to the influent TMDL pollutant loads; higher potential load reduction achieved higher points.
- Removes pollutant loads from stormwater – Points were awarded to facilities designed as GI or treatment control facilities for this scoring component.
- Augments water supply – Increasing points were awarded based on potential water supply provided for this scoring component.
- Provides flood control benefits – Flood control facilities received points specific to providing flood control benefits for this scoring component.
- Re-establishes natural water drainage systems or develops, restores, or enhances habitat and open space – Hydromodification control, stream restoration, and habitat restoration projects received points specific to providing these environmental benefits, for this scoring component.
- Provides community enhancement and engagement – Projects that specifically provide public use areas or public education components with potential opportunities for community engagement and involvement were given points specific to providing community benefits, for this scoring component.

All classified and scored SWRP projects were compiled into a master database as part of the SWRP and organized by Permittee. The SWRP identified projects located within the City's jurisdictional boundary were provided to the City for review. The project classification information and SWRP score were provided to the City for informational purposes.

3.2 Maps and Project Lists

Public Project Priorities for 2020

Table 7 shows public projects that are either completed, in-progress, or planned by 2020. See a map of the project location in Figure 4.

Project Name	Project Type	Description	Project Site Area (Acres)	Project Status
Meade Street By-Pass	ROW	Construction of street by-pass to better traffic flow. GI required.	2	Completed
Moody Underpass	ROW	Construction of underpass to avoid railroad traffic especially for emergency vehicles. GI required.	2	Completed
Port of Honda	Parcel-Based	Improvement at the Port	238	Completed
Cutting Blvd and S 1st Street	ROW	GI pilot project to capture and treat street runoff in industrial area	5	Completed

		known to have elevated PCBs concentration.		
Nevin Ave between 19th St and 27th St	ROW	Street improvement project.	28	Completed
Unity Park	Parcel-Based	Park improvement	4	Completed
Booker T Anderson Parking Lot Improvement	Parcel-Based	Parking lot improvement and flood mitigation.	2	Completed
Greening the Last Mile	ROW	GI project to capture and treat street runoff	2	Completed

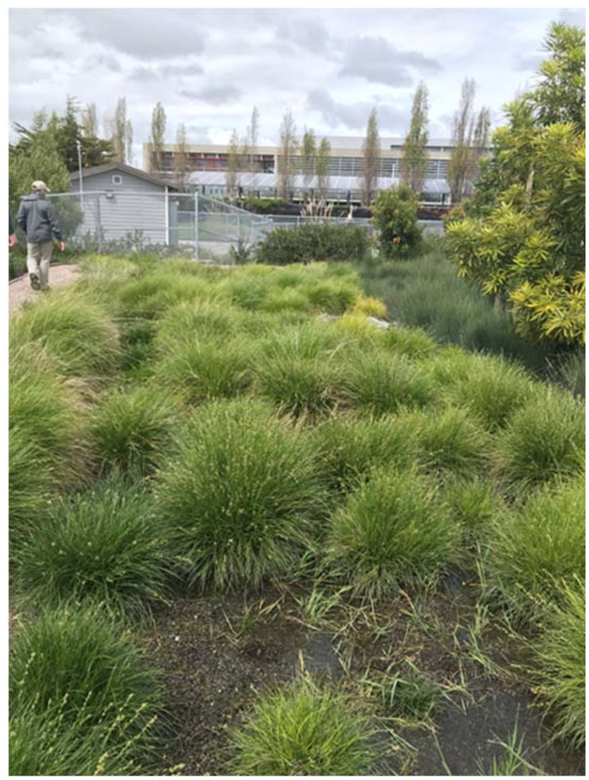
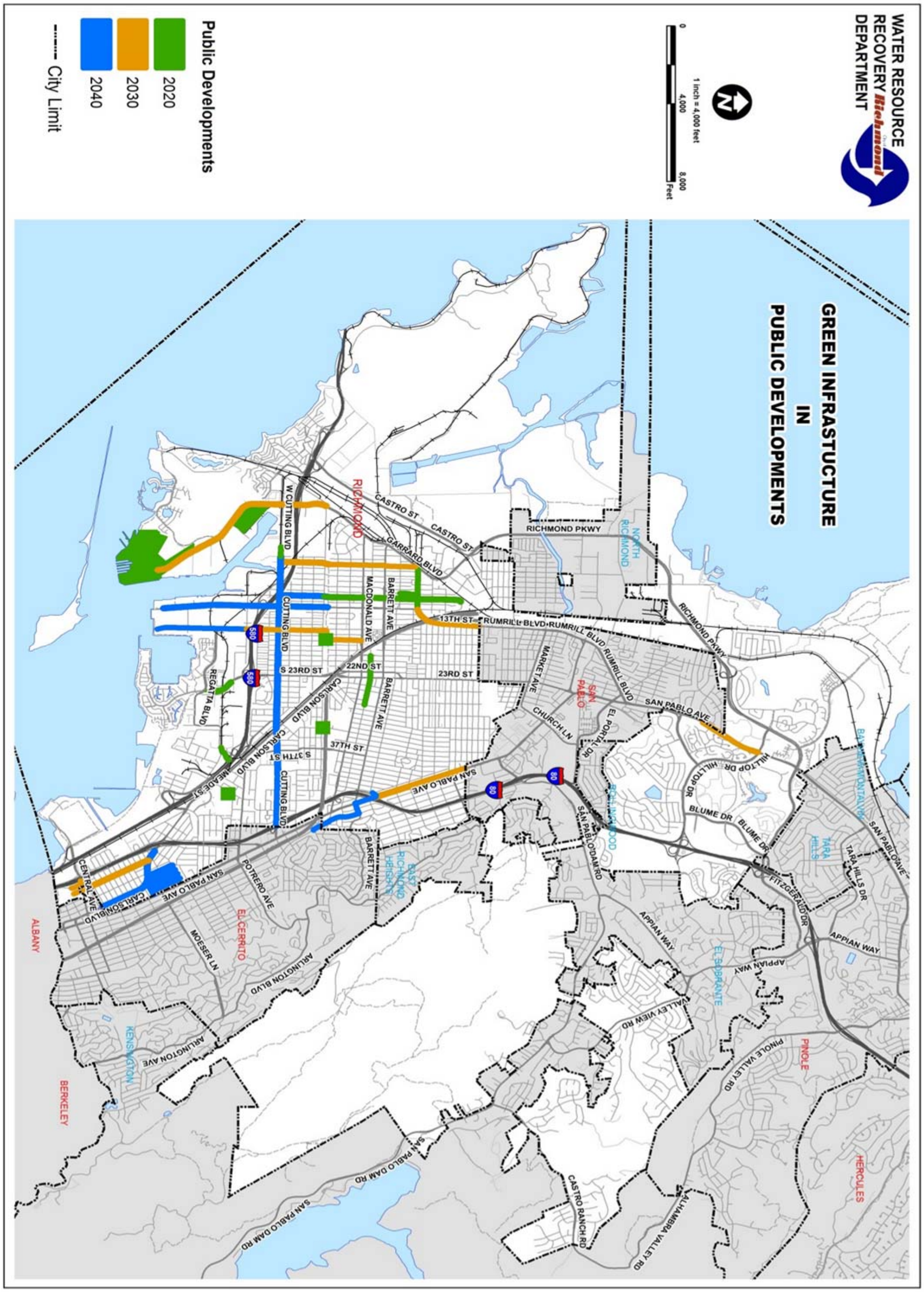


Figure 4. Public Projects Planned or Completed 2020, 2030, and 2040.



4 Early Implementation Projects

4.1 Review of Capital Improvement Projects

MRP Provision C.3.j.ii. requires that the City must prepare and maintain a list of public and private GI projects planned for implementation during the 2015-2020 permit term, and public projects that have potential for green infrastructure measures. The City submitted an initial list with the FY 15-16 Annual Report to the RWQCB and updated the list in the FY 16-17 and FY 17-18 Annual Reports.

The creation and maintenance of this list is supported by guidance developed by BASMAA: "Guidance for Identifying Green Infrastructure Potential in Municipal Capital Improvement Projects" (May 6, 2016). The BASMAA Guidance is attached to this document as Appendix F.

Below is the CIP's process in reviewing planned public projects.

1. Initial Screening – The Planning, Engineer and Water Resource Recovery departments screen out certain types of projects from further consideration. Within the City's Capital Budget, routine maintenance projects such as storm drain repairs, building/facility maintenance, parking lots maintenance, ADA transition plan implementation and signal maintenance are deemed to not have GI potential.
2. The following categories were utilized when screening projects:
   a. Projects with no green infrastructure potential due to limited right-of-way, safety issues, lack of storm drain infrastructure and difficulty in maintaining.
   b. Projects too early to assess due to limited information. A subsequent assessment can be performed at a later term to determine its applicability.
   c. Projects too late to change due for those already receive allocated funding, in construction, or have moved to a final design stage.
   d. Projects consisting of maintenance or minor alterations.
   e. Projects with funding limitations.

4.2 List of Projects Identified

CIP Projects with Green Infrastructure potential that were identified during 2015-2019 are listed in Table 8, along with their status.

Table 8 – CIP Projects with Green Infrastructure potential identified during 2015-2019.

Project Name	Project Type	Description	Project Site Area (acres)	Project Status
Yellow Brick Road	ROW	Safe routes to school.	44	Design Phase
Richmond Wellness Trail	ROW	Bicycle and pedestrian safety improvement with interactive health themed trail.	44	Design Phase
2nd Street Bikeway	ROW	Bicycle trail connects Richmond Greenway to San Francisco Bay	74	Concept Plan.

		Trail.		
San Pablo Ave Green Spine	ROW	Continued Green Infrastructure Spine on San Pablo Ave.	8	Designed. Lack funding.
13th Street	ROW	Bicycle and pedestrian safety improvement trail.	104	Planning Phase
Cutting between S 2nd and S 4th Street	ROW	Green infrastructure installation to target runoff from streets in industrial area.	9	Concept Plan.
Barrett Blvd and Key Blvd Bikeway	ROW	Safe Bicycle Route	19	Planning Phase

4.3 Workplan for Completion

The City's Stormwater Budget is approximately $1,850,000 per year which funds the operation and maintenance of its stormwater infrastructure and some MRP permit compliance activities. However, this budget is not sufficient to support all costs related to the implementation of the MRP. The City's General Fund will not be able to cover the additional expected expense for GI as part of public (re)development of public priority parcels and ROW in Richmond. As such, the City will rely solely on funding from outside sources (i.e. alternative compliance, grant fund) for implementation of GI beyond the requirements outlined in Provision C.3.b of the MRP as has been the practice.

5 Tracking and Mapping Public and Private Projects Over Time

5.1 Tools and Process

The CCCWP has developed a county-wide GIS platform for maintaining, analyzing, displaying, and reporting relevant municipal stormwater program data and information related to MRP Provisions C.10 (trash load reduction activities) and C.11/C.12 (mercury and PCBs source property identification and abatement screening activities). This tool is also used to track and report on GI project implementation.

The CCCWP's stormwater GIS platform features web maps and applications created using ESRI's ArcGIS Online (AGOL) for Organizations environment, which accesses GIS data, custom web services and reports that are hosted within an Amazon cloud service running ESRI's ArcGIS Server technology.

The *C.3 Project Tracking and Load Reduction Accounting Tool* within the CCCWP AGOL system is used to track and report on GI project implementation. It is currently used to track and map existing private and public projects incorporating GI; in the future it may also be used to map planned projects and will allow for ongoing review of opportunities for incorporating GI into existing and planned CIPs. The AGOL system can be used to develop maps that can be displayed on public-facing websites or distributed to the public. These maps can be developed to contain information regarding the GI project data input into the AGOL system.

The *C.3 Project Tracking and Load Reduction Accounting Tool* is intended to be used to allow for estimates of potential project load reduction for PCBs and mercury and presently supports the BASMAA Interim Accounting Methodology for certain load reduction activities. In the future, the tool is planned to be updated with the RAA methodology developed for the County. That functionality is planned to be active by the end of the current permit term.

The City actively engages with the AGOL tool and maintains up-to-date City project data. The City currently conducts updates of the AGOL tool annually or more frequently as necessary.

6 Design Guidelines and Specifications

6.1 Guidelines for Streetscape and Project Design

The City's Street Standards were last updated in 1991. However, these standards do not include details relating to treatment of stormwater through GI. The City is currently updating its Street Standards to incorporate Sustainable Street guidelines. In the meantime, design elements to be included in streetscape improvements and complete streets projects will follow guidelines as included in the San Mateo County *Sustainable Green Streets and Parking Lots Design Guidebook*, specifically Chapter 5: Key Design and Construction Details (San Mateo County Wide Water Pollution Prevention Program, 2009), and other streetscape resources available on the CCCWP website. The City also references the BASMAA *Guidance for Identifying Green Infrastructure Potential in Municipal Capital Improvement Projects* (BASMAA, 2016) during CIP project review for GI potential.

6.2 Specifications and Typical Design Details

The City will follow guidelines and designs GI features (infiltration planter, flow through planter, and bioretention) and facilities in accordance with the applicable specifications and criteria in the Guidebook. Inspection requirements for these facilities are also included in the Guidebook.

Details and specifications that are needed for design of street retrofit projects may be adapted from the San Francisco Public Utilities Commission Stormwater Requirements and Design Guidelines (Green Infrastructure Details) (SFPUC, 2016), the Central Coast Low Impact Development Institute Bioretention Standard Details and Specifications (CASQA and LIDI, 2017), the BASMAA Urban Greening details (BASMAA, 2017, provided in Appendix G of this Plan), or other resources compiled by the CCCWP and available through its website.

6.3 Sizing Requirements

New development or redevelopment projects are subjected to MRP provision C.3.d, whether they are on private or public owned parcels, will be sized to comply with the Volume Hydraulic Design Basis included in MRP provision C.3.d.i.(1). Sizing guidance to meet MRP provision C.3.d.i.(1) requirements is available in the Guidebook. For public GI retrofit projects located in the ROW, the City will follow the BASMAA released *Guidance for Sizing Green Infrastructure Facilities in Street Projects* (Appendix H) for voluntary street retrofit projects, pending any subsequent guidance approved by the SF RWQCB. For regional projects, sizing will be conducted on a project-specific basis and may include consideration of treatment facilities, other pollutant priorities (i.e., trash), or other factors present in the watershed.

7 Funding Options

7.1 Funding Strategies

As mentioned in Section 4.3, the City's Stormwater Budget is not sufficient to support all costs related to the implementation of the MRP. The City relies solely on funding from outside sources (i.e. alternative compliance, grant fund) for implementation of GI beyond the requirements outlined in Provision C.3.b of the MRP as has been the practice.

The City plans to seek grant funding for public parcel-based and ROW projects through various dynamic sources. Grant funding opportunities are summarized in Table 9. These opportunities were drawn from the *Roadmap of Funding Solutions for Sustainable Streets* Report produced by the Regional Roundtable on Sustainable Streets, convened by BASMAA in 2017, as well as summary reports produced by the California Natural Resources Agency (CNRA).

Table 9. Grant Funding Opportunities

Grant Program	Funding Source	Administering Agency	Match Requirement
Stormwater Grant Program – Implementation Grants	Prop 1 (State)	State Water Resources Control Board	50% of project cost, less for disadvantaged communities.
Proposition 1	Prop 1 (State)	State Coastal Conservancy	Not required but improves project score.
Integrated Regional Water Management Implementation Grants	Prop 1 (State)	Department of Water Resources	50% of project cost.
Caltrans Implementation Agreement	State Highway Operation and Protection Program (SHOPP) (State)	Caltrans	Not required.
Urban Greening Grant Program	Cap and Trade Funding (State)	CNRA	Not required but improves project score.
Cultural Community & Natural Resources	Prop 68 (State)	CNRA	Not required but improves project score.
Green Infrastructure Program	Prop 68 (State)	CNRA	Not required but improves project score.
Urban Stormwater and Waterways Improvement Program	Prop 68 (State)	CNRA	Not required but improves project score.
California River and Parkways	Prop 68 (State)	CNRA	Not required but improves project score.
California Trails and Greenway Investments	Prop 68 (State)	CNRA	Not required but improves project score.
Enviromental Enhancement and Mitigation	Prop 68 (State)	CNRA	Not required but improves project score.

Pedestrian, Bicycle and Trail Facilities	Measure J (Local)	Contra Costa County	Not required but improves project score.
Transportation for Clean Air (TFCA)	TFCA Regional Fund (State)	Bay Area Air Quality Management District	10% of project cost.
San Francisco Bay Water Quality Improvement Grants	Federal	US Environmental Protection Agency	50% of project cost.

Other funding options that the City may consider in the future include:

Regional Project Grant Fund Opportunities: As has been the practice in the past, the City may consider partnership with other municipalities and/or agencies in regional project opportunities.

Alternative Compliance: Providing regulated projects with alternative mechanisms for C.3 stormwater compliance (e.g., when compliance cannot be achieved on-site) can leverage development activities to build and maintain public GI facilities. Credit trading programs can incentivize nonregulated properties to retrofit impervious surfaces. Some alternative compliance mechanisms are currently allowed under the MRP, but more complex approaches like in-lieu fees and credit trading will require development of new programs and ordinances.

Public-Private Partnerships (P3S): This is an option in which GI facilities are jointly funded by the City and a private organization or land owner for the benefit of both parties.

8 Adaptive Management

8.1 Process for Plan Updates

The City will amend or update this Plan as required by the RWQCB. Plan revisions may include updates of public and private GI projects implemented and public GI projects identified for future implementation. Components of this Plan will also be included in other future City planning documents, as described in section 1.3.4 of this Plan.

8.2 Pursuing Future Funding Sources

Currently, the City does not have the ability to independently raise taxes to implement the projects identified in the *GI Plan* due to conditions included under California Propositions 13, Prop 218, and Prop 26. In 2012, Contra Costa County Permittees set forth a ballot measure to establish a tax in Contra Costa to help with the compliance costs of the NPDES permit; however, this measure failed. The City will continue to evaluate the feasibility to raise funds for the implementation of this plan through grant sources, as described under section 7.2, fees, or other means.

8.3 Alternative Compliance and Credit Trading Investigations

The cities of Richmond, San Pablo, and Walnut Creek (in conjunction with municipal partners across the Bay Area) are proposing to establish a water quality trading and/or banking system for Contra Costa County to address the countywide load reduction requirements of the PCBs and mercury TMDLs. This water quality trading system would have the ability to more efficiently and affordably improve water quality, reduce compliance pressures on Permittees, and decrease the overall costs of water quality improvements. In pursuit of such a system, these three cities submitted a grant application to EPA under the SF Bay Water Quality Improvement Fund Request for Proposals. The project proposed in the submitted grant application is intended to promote GI implementation across Contra Costa County and the Bay Area with the potential for substantial costs savings while meeting the same water quality goals. Additional information regarding how such a program could be used to achieve the requirements in MRP Provisions C.11/C.12 for PCBs and mercury load reductions through GI is provided in Appendix 5 of this Plan.

9 References

BASMAA, 2016. Guidance for Identifying Green Infrastructure Potential in Municipal Capital Improvement Program Projects. Prepared by BASMAA Development Committee. May 6.

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APPENDIX A

CONTRA COSTA
CLEAN WATER
PROGRAM

STORMWATER C.3 GUIDEBOOK

Stormwater Quality Requirements for Development Applications

7th Edition
May 17, 2017
Visit www.cccleanwater.org for updates.

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Stormwater C.3 Guidebook

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925-313-2360

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7TH EDITION — MAY 17, 2017

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Stormwater Glossary

Bay Area Stormwater Management Agencies Association (BASMAA)
Association of Bay Area municipal stormwater programs, including the Contra Costa Clean Water Program. BASMAA implements various regional activities mandated by the **Municipal Regional Permit**, provides a forum for promoting regional consistency among stormwater programs, and coordinates negotiations with the **Regional Water Board** on behalf of the permittees.

Best Management Practice (BMP)
Any procedure or device designed to minimize the quantity of pollutants that enter the storm drain system or to control stormwater flow.

Bioretention
The practice of capturing runoff within a matrix of soil and plant roots. Following capture, the runoff is evapotranspirated or infiltrated to surrounding and underlying soils. During frequent or intense runoff events, the soil-and-plant-root matrix may become saturated, in which case excess runoff may be discharged to an underdrain (**biotreatment**).

Biotreatment
The practice of filtering runoff through a matrix of soil and plant roots prior to discharge to a receiving water or municipal storm drain.

C.3
Provision in the **Municipal Regional Permit.** Requires the Permittees to use their planning authorities to include appropriate source control, site design, and stormwater treatment measures in new development and redevelopment projects to address pollutant discharges and prevent increases in runoff flows.

C.3 Web Page
http://www.cccleanwater.org/new-development-c-3/

California Stormwater Quality Association (CASQA)
Publisher of the California Stormwater Best Management Practices Handbooks.
https://www.casqa.org/sites/default/files/BMPHandbooks/BMP_NewDevRedev_Complete.pdf

California BMP Method
A method for determining the required volume of stormwater treatment facilities. Described in Section 5.5.1 of the California Stormwater Best Management Practice Manual (New Development) (CASQA, 2003).

Condition of Approval (COA) Requirements a municipality may adopt for a project in connection with a discretionary action (e.g., adoption of an EIR or negative declaration or issuance of a use permit). COAs may specify features required to be incorporated into the final plans for the project and may also specify uses, activities, and operational measures that must be observed over the life of the project.

Contra Costa Clean Water Program (CCCWP) CCCWP is established by an agreement among 19 Contra Costa cities and towns, Contra Costa County, and the Contra Costa County Flood and Water Conservation District. CCCWP implements common tasks and assists the member agencies to implement their local stormwater pollution prevention programs.

Design Storm A hypothetical rainstorm defined by rainfall intensities and durations.

Detention The practice of holding stormwater runoff in ponds, vaults, within berms, or in depressed areas and letting it discharge slowly to the storm drain system. See definitions of **infiltration** and **retention**.

Directly Connected Impervious Area Any impervious surface which drains into a catch basin, area drain, or other conveyance structure without first allowing flow across pervious areas (e.g. lawns).

Direct Infiltration Infiltration via methods or devices, such as dry wells or infiltration trenches, designed to bypass unsaturated surface soils and transmit runoff directly to groundwater.

Drawdown time The time required for a stormwater detention or infiltration facility to drain and return to the dry-weather condition. For detention facilities, drawdown time is a function of basin volume and outlet orifice size. For infiltration facilities, drawdown time is a function of basin volume and infiltration rate.

Flow Control Control of runoff rates and durations as required by Provision C.3.g. of the **Municipal Regional Permit**.

Harvesting and Reuse The practice of capturing runoff and storing it for later use. Typical nonpotable uses include toilet flushing, landscape irrigation, and industrial uses such as concrete production or washing.

Head In hydraulics, energy represented as a difference in elevation. In slow-flowing open systems, the difference in water surface elevation, e.g., between an inlet and outlet.

Hydrograph Runoff flow rate plotted as a function of time.

Hydromodification Management
Control of runoff intensities and durations so as to reduce the potential for downstream erosion. Also see definition for **flow control.**

Hydrologic Soil Group
Classification of soils by the Natural Resources Conservation Service (NRCS) into A, B, C, and D groups according to infiltration capacity.

Impervious surface
Any material that prevents or substantially reduces infiltration of water into the soil. See discussion of imperviousness in Chapter Two.

Indirect Infiltration
Infiltration via facilities, such as bioretention areas, expressly designed to treat runoff and then allow infiltration to surface soils.

Infiltration
Seepage of runoff through soil to mix with groundwater. See definition of **retention.**

Infiltration Device
Any structure that is designed to infiltrate stormwater into the subsurface and, as designed, bypasses the natural groundwater protection afforded by surface or near-surface soil. See definition for **direct infiltration**.

Infiltration Rate
Rate at which water can be added to a soil without creating runoff.

Integrated Management Practice (IMP)
A facility **(BMP)** that provides small-scale treatment, retention, and/or detention and is integrated into site layout, landscaping and drainage design. See **Low Impact Development.**

Integrated Pest Management (IPM)
An approach to pest management that relies on information about the life cycles of pests and their interaction with the environment. Pest control methods are applied with the most economical means and with the least possible hazard to people, property, and the environment.

Lead Agency
The public agency that has the principal responsibility for carrying out or approving a project. (California Environmental Quality Act Guidelines §15367).

Low Impact Development (LID)
A stormwater management strategy aimed at maintaining or restoring the natural hydrologic functions of a site. LID design detains, treats, and infiltrates runoff by minimizing impervious area, using pervious pavements and green roofs, dispersing runoff to landscaped areas, and routing runoff to rain gardens, cisterns, swales, and other small-scale facilities distributed throughout a site.

Maximum Extent Practicable (MEP)	Standard, established by the 1987 amendments to the Clean Water Act, for the reduction of pollutant discharges from municipal storm drains.
Municipal Regional Permit	A stormwater NPDES permit and Waste Discharge Requirements issued by the San Francisco Bay Regional Water Quality Control Board to 76 cities, towns, and Flood Control Districts and reissued in November 2015.
Municipal Separate Storm Sewer System (MS4)	A conveyance or system of conveyances (including roads with drainage systems, municipal streets, catch basins, curbs, gutters, diteches, manmade channels, or storm drains) as defined in 40 CFR 122.26(b)(8).
National Pollutant Discharge Elimination System (NPDES)	As part of the 1972 Clean Water Act, Congress established the NPDES permitting system to regulate the discharge of pollutants from municipal sanitary sewers and industries. The NPDES was expanded in 1987 to incorporate permits for stormwater discharges as well.
Numeric Criteria	Sizing requirements for stormwater treatment facilities established in Provision C.3.d. of the **Municipal Regional Permit**.
Operation and Maintenance (O&M)	Refers to requirements in the **Municipal Regional Permit** to inspect treatment BMPs and implement preventative and corrective maintenance in perpetuity. See Chapter Five.
Percolation Rate	The rate at which water flows through a soil.
Permeable or Pervious or Porous Pavements	Pavements for roadways, sidewalks, or plazas that are designed to infiltrate runoff, including pervious concrete, pervious asphalt, porous pavers, and granular materials. See the Design Sheet for Pervious Pavements.
Permeability	The rate at which water flows through a saturated soil under steady state conditions.
Pre-Project	Conditions that exist on a development site immediately before the project to which municipal approvals apply.
Project	The whole of an action which has the potential for adding or replacing or resulting in the addition or replacement of roofs, pavement, or other impervious surfaces.
Proprietary Stormwater Treatment Facilities	Products designed and marketed by private businesses for treatment of stormwater. Many of these products do not meet requirements of the **Municipal Regional Permit.**

Rational Method A method of calculating runoff flows based on rainfall intensity, tributary area, and a factor representing the proportion of rainfall that runs off.

Regional Water Quality Control Board (Regional Water Board or RWQCB) California RWQCBs are responsible for implementing pollution control provisions of the Clean Water Act and California Water Code within their jurisdiction. There are nine California RWQCBs. Contra Costa County municipalities are under the jurisdiction of the RWQCB for the San Francisco Bay Region for stormwater discharges.

Regulated Project A land development project that exceeds the thresholds in Municipal Regional Permit Provision C.3.b. See Table 1-1 on p. 4.

Retention Practices such as infiltration, harvest and use, and evapotranspiration that reduce the amount of runoff discharged from a site.

Self-retaining area An area designed to retain runoff. Self-retaining areas may include graded depressions with landscaping or pervious pavements.

Self-treating area Natural, landscaped, or turf areas that drain overland off-site or to the storm drain system.

Source Control A facility or procedure to prevent pollutants from entering runoff.

Stormwater Control Plan A plan specifying and documenting permanent features and facilities to control pollutants and stormwater flows for the life of the project.

Stormwater Control Operation & Maintenance Plan A plan detailing operation and maintenance requirements for stormwater treatment and flow-control facilities incorporated into a project.

Storm Water Pollution Prevention Plan (SWPPP) A plan providing for temporary measures to control sediment and other pollutants during construction.

Treatment Removal of pollutants from runoff, typically by filtration or settling.

WEF Method A method for determining the minimum design volume of stormwater treatment facilities, described in *Urban Runoff Quality Management* (WEF/ASCE, 1998).

Water Board See **Regional Water Quality Control Board.**

Water Quality Volume (WQV) For stormwater treatment facilities that depend on detention to work, the volume of water that must be detained for a minimum specified **drawdown time** to achieve pollutant removal.

How to Use this Guidebook

Read the overview in Chapter One to get a general understanding of the requirements. Then follow the step-by-step instructions in Chapter Two to prepare your Stormwater Control Plan.

THIS *Guidebook* will help you ensure that your project complies with the C.3 requirements in the California Regional Water Quality Control Boards' Municipal Regional Permit. The requirements are complex and technical. Most applicants will require the assistance of a qualified civil engineer, architect, or landscape architect. Because every project is different, you should begin by scheduling a **pre-application meeting** with municipal planning staff.

To use the *Guidebook,* start by reviewing **Chapter One** to find out whether and how Provision C.3 applies to your project. Chapter One also provides an overview of the entire process of planning, design, construction, operation, and maintenance leading to compliance.

Then proceed to **Chapter Two** and follow the step-by-step guidance to prepare a Stormwater Control Plan for your site. The Stormwater Control Plan is submitted with your application for entitlements and development approvals.

Chapter Three, the Low Impact Development Design Guide, includes guidance for integrating Low Impact Development (LID) features and LID facilities (Integrated Management Practices, or IMPs) into your site design and landscape design, and instructions for preparing and presenting your design and calculations for treatment and flow controls. The calculations must be included in your Stormwater Control Plan to show compliance with permit requirements.

As you proceed with planning, design, and construction of your project, consult **Chapter Four** for design criteria and for tips for overseeing construction of LID features and facilities.

In **Chapter Five** you'll find a detailed description of the process for ensuring operation and maintenance of your treatment and flow control facilities over the life of the project. The chapter includes step-by-step instructions for preparing a Stormwater Facilities Operation and Maintenance Plan.

Local Requirements
Cities, towns, or the County may have requirements that differ from, or are in addition to, this county-wide Guidebook. See Appendix A for local requirements.

Throughout each Chapter, you'll find links to references and resources to help you understand the regulations, complete your Stormwater Control Plan, and design stormwater control measures for your project.

The most recent version of the *Guidebook,* including updates and errata, is on the Contra Costa Clean Water Program (CCCWP) website. The on-line *Guidebook* is in Adobe Acrobat format. If you are reading the *Guidebook* on an electronic device, you can use hyperlinks to navigate the document and—with an internet connection—also access various references. The hyperlinks are throughout the text, as well as in "References and Resources" sections and in the **Bibliography**. Some of these links (URLs) may be outdated. In that case, try entering portions of the title or other keywords into a web search.

Construction-Phase Controls
Your Stormwater Control Plan is a separate document from the Storm Water Pollution Prevention Plan (SWPPP). A SWPPP provides for temporary measures to control sediment and other pollutants during construction. See the CCCWP website for information on requirements for construction-phase controls.

► PLAN AHEAD TO AVOID THE THREE MOST COMMON MISTAKES

The most common (and costly) errors made by applicants for development approvals with respect to C.3 compliance are:

1. Not planning for C.3 compliance early enough. You should think about your strategy for C.3 compliance before completing a conceptual site design or sketching a layout of subdivision lots (Chapter 1).

2. Assuming underground or proprietary stormwater treatment facilities will be adequate for compliance. A complete Low Impact Development design, typically including bioretention facilities dispersed throughout the development, and integrated with the site plan and landscaping plan, is now required for nearly all projects (Chapter 2).

3. Not planning for periodic inspections and maintenance of treatment and flow-control facilities. Consider who will own and who will maintain the facilities in perpetuity and how they will obtain access, and identify which arrangements are acceptable to your municipality (Chapter 5).

Flood Controls
Implementation of the LID and Hydromodification (Flow Control) requirements in this *Guidebook* is separate from, and in addition to, flood control requirements that may apply to your project.

Chapter 1

Policies and Procedures

Determine if your development project must comply with the Municipal Regional Permit C.3 requirements, and review the steps to compliance.

Thresholds, Effective Dates, and Requirements

Table 1-1 (on the following page) summarizes requirements for development projects. Thresholds are based on the sum of **impervious area created or replaced** in connection with a project. The following may be excluded:

- Interior remodels and routine maintenance or repair such as replacement of a roof or exterior wall surface.
- Pavement resurfacing within the existing footprint. Generally, resurfacing is interpreted to mean work on existing pavement that does not involve changes to grading or drainage; however, municipal staff determines applicability on a case-by-case basis.
- Pervious pavements constructed to the criteria in this *Guidebook*.
- Swimming pools and other features that overflow and drain to the sanitary sewer.

► THE "50% RULE" FOR PROJECTS ON PREVIOUSLY DEVELOPED SITES

Projects on previously developed sites may also need to retrofit drainage to provide **treatment** of runoff from all impervious areas of the entire site. For sites creating or replacing a total amount of impervious area greater than the applicable threshold (Table 1-1):

- If the new project results in an alteration of **more than 50%** of the impervious surface of a previously existing development, and the existing development was not subject to stormwater treatment measures, then the entire project must be included in the treatment measure design.

- If the new project results in an alteration of **less than 50%** of the impervious surface of a previously existing development, and the existing development was not subject to stormwater treatment measures, then only the new and replaced impervious surface must be included in the treatment system design.

Municipal staff will determine case-by-case when and how the "50% rule" applies. Staff may use the original entitlement (discretionary approval) or approved building plans as a guide when calculating the impervious area of the "previously existing development".

TABLE 1-1. THRESHOLDS, EFFECTIVE DATES, AND REQUIREMENTS (in order of increasing threshold).[1]

	Impervious Area Threshold	Effective Date	Requirement
Non-Regulated Projects	All projects requiring municipal approvals or permits (includes single-family residences)	5/1/2010	As encouraged or directed by local staff, preserve or restore open space, riparian areas, and wetlands as project amenities, minimize land disturbance and impervious surfaces (especially parking lots) cluster structures and pavements, include micro-detention in landscaped and other areas, and direct runoff to vegetated areas. Use Bay-friendly landscaping features and techniques. Include Source Controls specified in Appendix D.
	Projects between 2,500 and 10,000 square feet requiring approvals or permits (includes single-family residences)	12/1/2012	Using the template in Appendix C, prepare and submit a Stormwater Control Plan for a Small Land Development Project. Implement one of four options: (1) Disperse runoff from some amount of roof or paved area to a vegetated area; (2) incorporate some amount of permeable pavement into your project; (3) include a cistern or rain barrel if allowed by your municipality, or (4) incorporate a bioretention facility or planter box.
Regulated Projects	Auto service facilities, gas stations, restaurants, and uncovered parking lots over 5,000 square feet	12/1/2011	Prepare and submit a Stormwater Control Plan as described in Chapter 2, including features and facilities to ensure runoff is treated before leaving the site. Use the LID Design Guide in Chapter 3, including sizing factors and criteria for "treatment only."
	All projects between 10,000 square feet and one acre[2]	8/15/2006	
	Projects an acre and larger, unless exempted. See text.[2]	10/14/2006	Where required, design LID features and facilities for hydromodification management (HM, flow-control) as well as stormwater treatment. Prepare and submit a Stormwater Control Plan as described in Chapter 2 and use the LID Design Guide in Chapter 3, including the sizing factors and criteria for "treatment and flow control." See Appendix E for additional information.

[1] Summary only. Requirements for any particular project are determined by your municipality.
[2] Detached single-family homes that are not part of a larger plan of development are specifically excluded.
For road widening projects, count only the impervious area associated with new traffic lanes.

Compliance Process

Plan and design your stormwater controls integrally with the site planning and landscaping for your project, and coordinate your submittals at each stage so that your proposed **site plan, landscape plan, and stormwater compliance design are congruent.**

Applicants for development project approval follow these general steps to achieve C.3 compliance:

1. In a **pre-application meeting** with municipal staff, discuss C.3 compliance for your project—including how C.3 compliance review will be coordinated with review of site plans, architectural plans, landscaping plans, and tentative maps. Municipal staff may recommend you prepare and submit a preliminary site design prior to formally applying for planning and zoning approvals. Your preliminary site design should incorporate a conceptual plan for site drainage, including self-treating and self-retaining areas and the locations and footprints of any treatment and flow-control facilities. This additional up-front design effort will save time and avoid delays later in the review process.

2. **Review the instructions** in this *Guidebook* before you prepare your tentative map, preliminary site plan, drainage plan, architectural plan, and landscaping plan.

3. Prepare a **Stormwater Control Plan** and submit it with your application for development approvals (entitlements). Preparation of a complete and detailed Stormwater Control Plan is the key to cost-effective C.3 compliance and expeditious review of your project. Instructions for preparing a Stormwater Control Plan are in Chapters 2 and 3.

4. Following development approval, create your **detailed project design**, incorporating the features described in your Stormwater Control Plan. Follow the design criteria in Chapter 4.

5. In a **table on your construction plans**, list each stormwater control feature and facility and the plan sheet where it appears (see page 19).

6. Prepare a draft Stormwater Facility **Operation and Maintenance Plan** (Chapter 5) and submit it with your application for building permits. Execute legal documents assigning responsibility for operation and maintenance of stormwater facilities. Some municipalities require legal agreements and financial commitments for operation and maintenance be recorded prior to recordation of a final parcel map.

7. **Maintain stormwater facilities during construction** and following construction in accordance with required warranties.

8. During or following construction, submit a final Stormwater Facility Operation and Maintenance Plan and **formally transfer responsibility** for maintenance to the owner or permanent occupant.

9. The occupant or owner must **maintain the facilities in perpetuity**. Municipal staff will periodically verify the facilities are maintained.

C.3 Applicability and Entitlements

Provision C.3 compliance must be demonstrated at the time of application for a development project, including rezoning, tentative map, parcel map, conditional use permit, variance, site development review, design review, development agreement, or building permit.

All Regulated Projects require a Stormwater Control Plan showing the location and footprint of proposed impervious surfaces and of proposed stormwater facilities, and a description of how runoff will flow from impervious surfaces to the facilities. Instructions for preparing a Stormwater Control Plan are in Chapter Two.

► DEFINITION OF A "PROJECT"

When determining which Provision C.3 requirements apply, a "project" should be defined consistent with CEQA definitions of "project." That is, the "project" is the **whole of an action** that has the potential for adding or replacing, or resulting in the addition or replacement, of roofs, pavement, or other impervious surfaces and thereby resulting in increased flows and runoff pollutants. "Whole of an action" means the project may not be segmented or piecemealed into small parts if the effect is to reduce the quantity of impervious area for any part to below the C.3 threshold.

CEQA

See the Governor's Office of Planning and Research Technical Advisory, *CEQA and Low Impact Development Stormwater Design*, for guidance which will help coordinate C.3 and CEQA reviews.

The C.3 project scope includes any impervious surfaces added or replaced within the adjacent public right-of-way in connection with the project.

► GRANDFATHERING

Regulated Projects for which building or grading permits are issued after January 1, 2016 must include LID treatment measures. Criteria in the current edition of this *Guidebook* apply. Regulated Projects approved prior to that date, and which have approved Stormwater Control Plans, may be issued building permits and allowed to proceed. Regulated Projects with vesting tentative maps, regardless of the date of map approval, may be issued building permits to proceed with development in substantial compliance with the ordinance, policies, and standards in effect at the time the vesting tentative map was approved or conditionally approved, in accordance with California law.

This "grandfathering" applies only to the specific discretionary approval that was the subject of the original application. Subsequent applications for further approvals constitute a "project" for the purposes of C.3. If those subsequent approvals or entitlements cover specific locations, modes, or designs for addition or replacement of roofs, pavement, or other impervious surfaces, and if the impervious area created or replaced is in excess of the applicable thresholds, then the C.3 requirements will apply to those areas of the project covered by the subsequent approval or entitlement.

Consider for example an application for a subdivision tentative map which receives final discretionary approval prior to the C.3 start dates. The project may be exempt from Provision C.3; however, if the project proponent later applies for discretionary approval of specific locations, modes, or designs of paving and structures, then C.3 requirements would apply to those improvements.

► PROVISION C.3 COMPLIANCE REQUIREMENTS FOR SUBDIVISION MAPS

In general, it is recommended **stormwater treatment facilities not be located on individual single-family residential lots**, particularly when those facilities manage runoff from other lots, from streets, or from common areas. However, local requirements vary. A better alternative is to locate stormwater facilities on one or more separate, jointly owned parcels.

Applications for tentative maps may be required to include the following:

- Delineation of separate parcels upon which stormwater facilities will be located.
- Dedication of easements and inclusion of provisions related to provision C.3 compliance.
- Execution of, or commitment to execute later, a covenant running with the land and agreement for residents of the subdivision to operate and maintain stormwater facilities.
- Conditions, Covenants, and Restrictions (CC&Rs) recorded against the subdivision to establish reciprocal obligations of the lot owners to maintain stormwater facilities.

If a tentative map approval would potentially entitle future owners of individual parcels to construct new or replaced impervious area which, in aggregate, could exceed the thresholds in Table 1-1, then the applicant must take steps to ensure C.3 requirements can and will be implemented as the subdivision is built out.

If the tentative map application does not include plans for site improvements, the applicant should nevertheless identify the type, size, location, and final ownership of stormwater treatment and flow-control facilities adequate to serve new roadways and any common areas, and to also manage runoff from an expected reasonable estimate of the square footage of future roofs, driveways, and other impervious surfaces on each individual lot. The municipality may condition approval of the map on implementation of stormwater treatment measures in compliance with Provision C.3 when construction occurs on the individual lots. This condition may be enforced by a grant deed of development rights or by a development agreement.

If a municipality deems it necessary, the future impervious area of one or more lots may be limited by a deed restriction. This might be necessary when a project is exempted from one or all C.3 provisions because the total impervious area is below a threshold, or to ensure runoff from impervious areas added after the project is approved does not overload a stormwater treatment and flow-control facility.

Local Requirements

Cities, towns, or the County may have requirements that differ from, or are in addition to, this countywide Guidebook. See Appendix A for local requirements.

Subdivision maps should dedicate an **"open space easement, as defined by Government Code Section 51075,"** to suitably restrict the future building of structures at each stormwater facility location.

See the *Policy for C.3 Compliance for Subdivisions* on the Contra Costa Clean Water Program's C.3 web page. After consulting with local planning staff, applicants for subdivision approvals will propose one of the following four options, depending on project characteristics and local policies:

1. Show the sum of future impervious areas to be created or replaced on all parcels could not exceed the applicable C.3 thresholds shown in Table 1-1.

2. Show that, for each and every lot, the intended use can be achieved with a design which disperses runoff from roofs, driveways, streets, and other impervious areas to self-retaining pervious areas, using the criteria in Chapter 3 of this *Guidebook*.

3. Prepare improvement plans showing drainage to treatment and/or flow-control facilities designed in accordance with this *Guidebook,* and commit to constructing the facilities prior to transferring the lots.

4. Prepare improvement plans showing drainage to treatment and/or flow-control facilities designed in accordance with this *Guidebook*, and provide appropriate legal instruments to ensure the proposed facilities will be constructed and maintained by subsequent owners.

For the option selected, municipal staff will determine the appropriate conditions of approval, easements, deed restrictions, or other legal instruments necessary to assure future compliance. In general, when new streets and common areas are constructed, facilities to treat runoff from those new impervious areas must be constructed concurrently, and agreements for the operation and maintenance of those facilities must be executed timely.

► PHASED PROJECTS

Municipal staff may require, as part of an application for approval of a phased development project, a conceptual or master Stormwater Control Plan which describes and illustrates, in broad outline, how the drainage for the project will comply with the Provision C.3 requirements. The level of detail in the conceptual or master Stormwater Control Plan should be consistent with the scope and level of detail of the development approval being considered. The conceptual or master Stormwater Control Plan should specify that a more detailed Stormwater Control Plan for each later phase or portion of the project will be submitted with subsequent applications for discretionary approvals.

Hydromodification Management Requirements

As shown in Table 1-1, in addition to incorporating treatment controls, projects creating or replacing an acre or more of impervious area—unless exempted—must also provide flow control so post-project runoff does not exceed estimated pre-project rates and durations. Additional information on hydromodification management (HM) is in Appendix E.

► EXEMPTIONS

Projects may be exempted from HM requirements if any of the following apply:

- The post-project impervious area is less than, or the same as, the pre-project impervious area. (At the discretion of municipal staff, on HM projects applicants may provide treatment-only controls for an impervious square footage that is less than or equal to the pre-project impervious square footage. See Appendix E.)

- The project is located in a catchment that drains to pipes or hardened channels, or tidally influenced channels that extend continuously to the Bay, Delta, or a flow-controlled reservoir.

- The project is located in a catchment or subwatershed that is highly developed (that is, 70% or more impervious).

The Contra Costa Clean Water Program is developing maps of exempt catchments. While these maps are being developed (completion is anticipated by 2018), applicants should consult with municipal staff regarding potential exemptions.

► **COMPLIANCE WITH HM REQUIREMENTS**

Projects subject to the Hydromodification Management (HM) compliance may employ one of the following options:

1. Use the LID Design Guide in Chapter 3 **to meet both treatment and flow-control requirements.**

2. Use a continuous simulation hydrologic computer model to simulate pre-project and post-project runoff. Show that post-project stormwater rates and durations match pre-project discharge rates and durations from 10 percent of the pre-project 2-year peak flow up to the pre-project 10-year peak flow. The post-project flow-duration curve shall not deviate above the pre-project flow duration curve by more than 10 percent over 10 percent of the length of the curve corresponding to this range of flows.

To use the second option, applicants must generally retain a qualified hydrologist experienced in such modeling, and also reimburse the jurisdiction's costs for retaining another qualified hydrologist to review the modeling report.

Offsite Compliance Options for Runoff Treatment

Experience has shown implementation of LID facilities, using the guidance in Chapter 3, is feasible on nearly all development sites. In lieu of incorporating facilities to treat runoff from impervious areas at the development project site, an applicant may propose a secondary project that will treat runoff from an equivalent amount of existing impervious area with LID (i.e., retrofit with LID) at another location within the same watershed.

To be considered, the secondary project must include construction, operation, and maintenance of facilities that meet the criteria in Chapter 3. Those facilities must treat runoff from an amount of impervious surface equivalent to, or greater than, the impervious surface that would be subject to requirements at the project location.

An applicant may propose to combine on-site and off-site facilities to add up to the equivalent amount of impervious area as would be required for only on-site treatment. **Drainage from equivalent existing impervious square footage on an adjacent parcel or public or private street may be used to offset drainage from on-site square footage that would be difficult or expensive to route to treatment.** An applicant may also propose to share in a larger project and be credited for a proportional amount of the impervious area for which runoff is treated by that project.

Consideration or acceptance of such proposals is at the discretion of the local municipality.

Chapter

2

Preparing Your Stormwater Control Plan

Step-by-step documentation of compliance for Regulated Projects

Your Stormwater Control Plan for a Regulated Project will demonstrate your project complies with all applicable requirements in the stormwater NPDES permit to:

- minimize imperviousness and reduce runoff
- slow runoff rates and retain or detain stormwater
- incorporate required source controls
- treat stormwater prior to discharge from the site
- control runoff rates and durations if required
- provide for operation and maintenance of stormwater facilities

The Stormwater Control Plan must be submitted with your application for discretionary approvals and must have sufficient detail to ensure the stormwater design, site plan, and landscaping plan are congruent.

A complete and thorough Stormwater Control Plan will facilitate quicker review and fewer cycles of review. Every Contra Costa municipality requires a Stormwater Control Plan for every applicable project.

Your Stormwater Control Plan will consist of a report and an exhibit.

Municipal staff may use the checklist on the following page to evaluate your Plan.

STORMWATER CONTROL PLAN CHECKLIST

CONTENTS OF EXHIBIT

Show all the following on drawings:

- ❒ Existing natural hydrologic features (depressions, watercourses, relatively undisturbed areas) and significant natural resources.
- ❒ Existing and proposed site drainage network and connections to drainage off-site.
- ❒ Layout of buildings, pavement, and landscaped areas.
- ❒ Impervious areas proposed (roof, plaza/sidewalk, and streets/parking) and area of each.
- ❒ Entire site divided into separate Drainage Management Areas, with each DMA identified as self-treating, self-retaining (zero-discharge), draining to a self-retaining area, or draining to an IMP. Each DMA has one surface type (roof, paving, or landscape), is labeled, and square footage noted.
- ❒ Locations, footprints, and square footage of proposed treatment and flow-control facilities.
- ❒ Potential pollutant source areas, including refuse areas, outdoor work and storage areas, etc. listed in Appendix C and corresponding required source controls.

CONTENTS OF REPORT

Include all the following in a report:

- ❒ Narrative analysis or description of site features and conditions that constrain, or provide opportunities for, stormwater control. Include soil types (including Hydrologic Soil Group), slopes, and depth to groundwater.
- ❒ Narrative description of site design characteristics that protect natural resources.
- ❒ Narrative description and/or tabulation of site design characteristics, building features, and pavement selections that minimize imperviousness of the site.
- ❒ Tabulation of DMAs, including self-treating areas, self-retaining areas, areas draining to self-retaining areas, and areas tributary to Integrated Management Practices (IMPs), in the format shown in Chapter 4. Output from the IMP Sizing Calculator may be used.
- ❒ Sketches and/or descriptions showing there is sufficient hydraulic head to route runoff into, through, and from each IMP to an approved discharge point.
- ❒ A table of identified pollutant sources and for each source, the source control measure(s) used to reduce pollutants to the maximum extent practicable. See Appendix D.
- ❒ General maintenance requirements for infiltration, treatment, and flow-control facilities.
- ❒ Means by which facility maintenance will be financed and implemented in perpetuity.
- ❒ Statement accepting responsibility for interim operation & maintenance of facilities.
- ❒ Identification of any conflicts with codes or requirements or other anticipated obstacles to implementing the Stormwater Control Plan.
- ❒ Construction Plan C.3 Checklist.
- ❒ Certification by a civil engineer, architect, and landscape architect.
- ❒ Appendix: Compliance with flow-control requirements
(if using an HM compliance option other than the design guidance in Chapter 3).

A template for a Stormwater Control Plan, in MS Word format, can be found on at the Contra Costa Clean Water Program's C.3 web pages. Follow the instructions in this *Guidebook* while using the template.

Project Data

The table in the Stormwater Control Plan template is shown below for reference. The table is formatted to facilitate compilation of the municipalities' annual reports.

TABLE 2-1. Format for reporting project data

Project Name/Number	
Application Submittal Date	[to be verified by municipal staff]
Project Location	[Street Address if available, or intersection and/or APN]
Name of Developer	
Project Phase No.	[If project is being constructed in phases, indicate the phase number. If not, enter "NA"]
Project Type and Description	[Example entries: "5-story office building," "Residential with 160 single-family homes with five 4-story buildings to contain 200 condominiums," "100-unit, 2-story shopping mall," "mixed use retail and residential development (apartments)", "Industrial warehouse."]
Project Watershed	[Request from municipal staff]
Total Project Site Area (acres)	
Total Area of Land Disturbed (acres)	
Total New Impervious Surface Area (sq. ft.)	
Total Replaced Impervious Surface Area	
Total Pre-Project Impervious Surface Area	
Total Post-Project Impervious Surface Area	
50% Rule[*]	[Applies or Doesn't Apply]
Project Density	[State DU/Acre and/or Floor Area Ratio]
Applicable Special Project Categories [Complete even if all treatment is LID]	[State A, B, C, or none. If "C", state basis for location credits, density, and parking credits.]
Percent LID and non-LID treatment	[State totals for project and provide details under "Documentation of Drainage Design."]
HMP Compliance [†]	State "applies" or explain reason for exemption.

* 50% rule applies if: Total Replaced Impervious Surface Area > 0.5 × Pre-Project Impervious Surface Area
† HMP applies if: (Total New Impervious Surface Area + Total Replaced Impervious Surface Area) ≥ 1 acre unless exempt. See page 9.

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 the square footage of existing impervious areas that will be covered with new impervious surfaces. See the example in Figure 2-1.

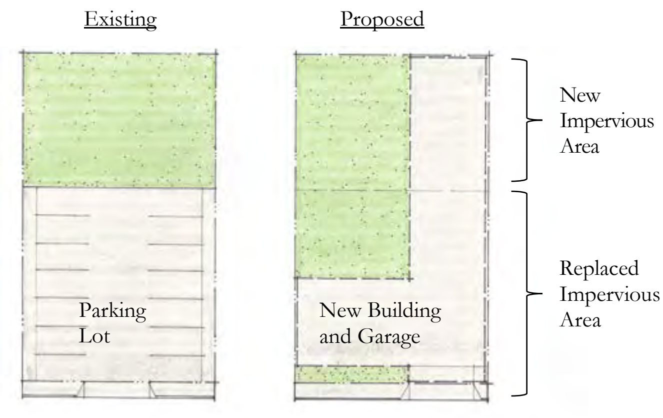

FIGURE 2-1. ILLUSTRATION OF REPLACED Impervious Area. The proposed building replaces impervious area on the existing parking lot. It also creates new impervious area. To complete the Project Data Table, measure, calculate, and enter the total new impervious area, total replaced impervious area, the pre-project impervious area, and the post-project impervious area.

Setting

Prepare a brief narrative placing the project in context. Discuss, as appropriate, the site location, division of parcels, planned land uses, zoning, setback and open space requirements, project phasing, number of residential units or square footage of office or retail, parking requirements, neighborhood character, project design objectives (for example LEED certification), and other notable project characteristics.

Include a vicinity map.

Existing Features and Site Conditions

In a well-organized narrative, describe:

- Project site size, shape, and existing topography, including the general direction of surface drainage, local high or low points or depressions, any outcrops or other significant geologic features, and any contiguous natural areas, wetlands, watercourses, seeps, or springs.
- Existing land use and current or proposed zoning, including requirements for setbacks and open space.
- Soil types (including hydrologic soil groups) and depth to groundwater.
- Existing and proposed site drainage, including connections to the municipal storm drain system. Describe any drainage from adjacent areas that runs on to the project area.
- Existing vegetative cover and impervious areas, if any.

Identify Constraints & Opportunities

Review the information compiled in Step 1. Identify the principal constraints on site design and selection of treatment and flow-control facilities as well as opportunities to reduce imperviousness and incorporate facilities into the site and landscape design. For example, **constraints** might include impermeable soils, high groundwater, groundwater pollution or contaminated soils, steep slopes, geotechnical instability, high-intensity land use, heavy pedestrian or vehicular traffic, utility locations, or safety concerns. **Opportunities** might include existing natural areas, low areas, oddly configured or otherwise unbuildable parcels, easements and landscape amenities including open space and buffers (which can double as locations for bioretention facilities), and differences in elevation (which can provide hydraulic head).

In your narrative, describe site opportunities and constraints. This narrative will help you as you proceed with LID design and explain your design decisions to others.

Low Impact Development Design Strategies

Use the Low Impact Development Design Guide (Chapter 3) to analyze your project for LID, design and document drainage, and specify preliminary design details for integrated management practices.

After analyzing your project for LID (see page 24), prepare a narrative overview of your design and how your design decisions:

- Optimize the site layout
- Use pervious surfaces where appropriate
- Disperse runoff to pervious (self-retaining) areas
- Drain impervious surfaces to bioretention facilities or other Integrated Management Practices (IMPs).

Documentation of Drainage Design

Chapter 3 includes calculation procedures and instructions for using the IMP Sizing Calculator to organize and present your calculations.

As shown in the checklist (page 12), your **Exhibit** must show:

- **The entire site divided into separate Drainage Management Areas (DMAs), with each area identified as self-treating, self-retaining, draining to a self-retaining area, or draining to an IMP.** Each area should be clearly marked with a unique identifier.
- For each drainage area, the types and square footage of impervious area proposed.

- Proposed locations and sizes of treatment and flow-control facilities. Each facility should be clearly marked with a unique identifier.

It's best to use the grading plan (screened) as background for the Exhibit. It may also be appropriate to show portions of the roofing plan (also screened) wherever roof ridges define Drainage Management Areas (DMAs).

Your Stormwater Control Plan **report** must include:

- Tabulation of proposed self-treating areas, self-retaining areas, areas draining to self-retaining areas, and areas draining to IMPs, and the corresponding IMPs identified on the Exhibit.

- Calculations, which can be prepared using the IMP Sizing Calculator, showing the minimum square footage required and proposed square footage for each IMP. If flow-control requirements apply, the required storage volume or volumes, and the diameters of each underdrain orifice, must also be shown.

Your Stormwater Control Plan must also include preliminary design information for each bioretention facility or other IMP. Depending on the complexity of the project and the stage of the design, reviewers may expect to see renderings or details, in plan and/or cross section, showing how the IMPs will be integrated into the site. This may include transitions between the flat, planted surface of bioretention facilities and the adjacent buildings, roadways, sidewalks, or landscapes, and planting plans consistent with the active or inactive uses of the planted bioretention area.

See Chapter 3 for design guidance and design criteria.

Also include in your Stormwater Control Plan report:

- A narrative briefly describing each DMA, its drainage, and where drainage will be directed.

- A narrative briefly describing each IMP. Include any special characteristics or features distinct from the design sheets in Chapter 3.

Group and consolidate descriptions, or provide additional detail, as necessary to help the reviewer understand your drainage design.

Source Control Measures

Some everyday activities – such as trash recycling/disposal and washing vehicles and equipment – generate pollutants that tend to find their way into storm drains. These pollutants can be minimized by applying source control Best Management Practices (BMPs).

Source control BMPs include **permanent**, structural features that may be required in your project plans—such as roofs over and berms around trash and recycling areas—and **operational** BMPs, such as regular sweeping and "housekeeping," that must be implemented by the site's occupant or user.

Use the following procedure to specify source control BMPs for your site:

Identify Pollutant Sources. Review the first column in the Pollutant Sources/Source Control Checklist (Appendix D). Check off the potential sources of pollutants that apply to your site.

Note Locations on Stormwater Control Plan Exhibit. Note the corresponding requirements listed in Column 2 of the Pollutant Sources/Source Control Checklist (Appendix D). Show the location of each pollutant source and each permanent source control BMP in your Stormwater Control Plan Exhibit.

Prepare a Table and Narrative. Check off the corresponding requirements listed in Column 3 in the Pollutant Sources/Source Control Checklist (Appendix D). Now, create a table using the format in Table 2-2. In the left column, list each potential source on your site (from Appendix D, Column 1). In the middle column, list the corresponding permanent, structural BMPs (from Columns 2 and 3, Appendix D) used to prevent pollutants from entering runoff. Accompany this table with a narrative that explains any special features, materials, or methods of construction that will be used to implement these permanent, structural BMPs.

Identify Operational Source Control BMPs. To complete your table, refer once again to the Pollutant Sources/Source Control Checklist (Appendix D, Column 4). List in the right column of your table the operational BMPs that should be implemented as long as the anticipated activities continue at the site. The local stormwater ordinance requires that these BMPs be implemented; the same BMPs may also be required as a condition of a use permit or other revocable discretionary approval for use of the site.

References and Resources

- Appendix D, Stormwater Pollutant Sources/Source Control Checklist
- Municipal Regional Permit Provision C.3.c.
- Bay-Friendly Landscape Guidelines (Stopwaste.org, 2008)
- *Start at the Source*, Section 6.7: Details, Outdoor Work Areas

TABLE 2-2. Format for table of permanent and operational source control measures.

Potential source of runoff pollutants	*Permanent source control BMPs*	*Operational source control BMPs*

Stormwater Facility Maintenance

As required by MRP Provision C.3.h, your local municipality will periodically verify that treatment and flow-control facilities on your site are maintained and continue to operate as designed.

To make this possible, your municipality will require that you include in your Stormwater Control Plan:

1. A means to finance and implement facility maintenance in perpetuity.

2. Acceptance of responsibility for maintenance from the time the facilities are constructed until responsibility for operation and maintenance is legally transferred. A warranty covering a period following construction may also be required.

3. An outline of general maintenance requirements for the treatment and flow-control facilities you have selected.

Your local municipality will also require that you prepare and submit a detailed Stormwater Facilities Operation and Maintenance Plan that sets forth a maintenance schedule for each of the treatment and flow-control facilities built on your site. An agreement assigning responsibility for maintenance and providing for inspections and certification may also be required.

Details of these requirements, and instructions for preparing a Stormwater Facilities Operation and Maintenance Plan, are in Chapter 5.

References and Resources

- *Chapter 5*
- *Model Stormwater Ordinance (CCCWP, 2012)*
- Model Operation and Maintenance Agreements

Construction Plan C.3 Checklist

When you submit construction plans for City review and approval, the plan checker will compare that submittal with your Stormwater Control Plan. By creating a Construction Plan C.3 Checklist for your project, you will facilitate the plan checker's comparison and speed review of your project.

Here's how:

1. Create a table similar to Table 2-3. Number and list each measure or BMP you have specified in your Stormwater Control Plan in Columns

1 and 2 of the table. Leave Column 3 blank. Incorporate the table into your Stormwater Control Plan.

2. When you submit construction plans, **duplicate the table** (by photocopy or electronically). Now fill in Column 3, identifying the plan sheets where the BMPs are shown. List all plan sheets on which the BMP appears. Submit the updated table with your construction plans.

Note that the updated table—or Construction Plan C.3 Checklist—is **only a reference tool** to facilitate comparison of the construction plans to your Stormwater Control Plan. Local municipal staff can advise you regarding the process required to propose changes to the approved Stormwater Control Plan.

See Chapter 3 for details of IMP construction to be included in construction plans.

TABLE 2-3. Format for Construction Plan C.3 Checklist.

Stormwater Control Plan Page #	*BMP Description*	*See Plan Sheet #s*

Certification

Your local municipality may require that your Stormwater Control Plan be certified by an architect, landscape architect, or civil engineer. See Appendix A.

Your certification should state: "The selection, sizing, and preliminary design of stormwater treatment and other control measures in this plan meet the requirements of Regional Water Quality Control Board Order R2-2015-0049."

Stormwater Control Plan Report Sample Outline

I. Project Data (table)

II. Setting

   A. Project Name, Location, Description

   B. Existing Site Features and Conditions

   C. Opportunities and Constraints for Stormwater Control

III. Low Impact Development Design Strategies

   A. Optimization of site layout

      (1) Limitation of development envelope

      (2) Preservation of natural drainage features

      (3) Setbacks from creeks, wetlands, and riparian habitats

      (4) Minimization of imperviousness

      (5) Use of drainage as a design element

   B. Use of Permeable Pavements

   C. Dispersal of Runoff to Pervious (Self-Retaining) Areas

   D. Integrated Management Practices

IV. Documentation of Drainage Design

   A. Description of each Drainage Management Area

   B. Tabulation and Sizing Calculations

V. Source Control Measures

   A. Description of site activities and potential sources of pollutants

   B. Table showing sources, permanent source controls, and operational source controls

   C. Features, Materials, and Construction of Source Control BMPs

VI. Stormwater Facility Maintenance

A. Ownership and responsibility for maintenance in perpetuity.

(1) Commitment to execute any necessary agreements and/or annex into a fee mechanism, per local requirements.

(2) Statement accepting responsibility for operation and maintenance of facilities until that responsibility is formally transferred.

B. Summary of maintenance requirements for each stormwater facility.

VII. Construction Plan C.3 Checklist

VIII. Certifications

Attachment: Stormwater Control Plan Exhibit

Appendix: Compliance with Flow-Control (Hydrograph Modification) requirements (if IMPs are not used to achieve flow control).

Stormwater Control Plan Template

A template with the above format and headings is available on the CCCWP website.

Example Stormwater Control Plans

Example Stormwater Control Plans are available on the CCCWP website.

Chapter 3

Low Impact Development Site Design Guide

Guidance for designing your site to include LID site drainage, stormwater treatment facilities, and flow-control facilities—and for documenting your site's compliance

Your Stormwater Control Plan must include an exhibit and calculations showing the site drainage and proposed treatment and flow-control facilities meet the criteria in this Guidebook.

This will require that you delineate the entire site into discrete Drainage Management Areas (DMAs), and for each DMA, characterize the square footage, surface type, and routing of the drainage. You will also need to show the locations, sizes, and types of proposed stormwater treatment and flow-control facilities.

This may be accomplished in two steps:

1. **Analyze your project** and identify and select options for meeting LID requirements and runoff treatment requirements—and flow-control requirements, if they apply.

2. **Design and document drainage** for the whole site and document how that design meets this Guidebook's stormwater treatment and flow-control criteria.

For most projects, you will need to iterate these two steps to converge on a workable design that complements site conditions and project objectives.

Before beginning your LID design, first determine which requirements apply to your site. See Chapter 1. Determine whether the 50% rule applies, and whether you will need to incorporate hydromodification management (flow control, or HM). The guidance in this chapter will enable you to size stormwater facilities (Integrated Management Practices, or IMPs) for treatment-only or for treatment plus HM.

Analyze Your Project for LID

Conceptually, there are four LID strategies for managing runoff from roofs and paving:

1. **Optimize the site layout** by preserving natural drainage features and designing buildings and circulation to minimize the amount of impervious surface.

2. **Use pervious surfaces** such as turf, gravel, or pervious pavement—or use surfaces that retain rainfall, such as "green roofs."

3. **Disperse runoff** from impervious surfaces on to adjacent pervious surfaces (e.g., direct a roof downspout to disperse runoff onto a lawn).

4. Drain impervious surfaces to engineered **Integrated Management Practices** (IMPs), which are typically bioretention facilities, sometimes augmented with additional storage. Other IMPs include flow-through planters and dry wells, which may be used in specific situations. IMPs evapotranspirate some runoff, infiltrate runoff to groundwater, and/or percolate runoff through engineered soil and allow it to drain away slowly.

With forethought in design, the four LID strategies can provide multiple, complementary benefits to your development. Pervious surfaces reduce heat island effects and temperature extremes. Landscaping improves air quality, creates a better place to live or work, and upgrades value for rental or sale. Retaining natural hydrology helps preserve and enhance the natural character of the area. LID drainage design can also conserve water and reduce the need for drainage infrastructure.

A combination of two or more strategies may work best for your project. Table 3-1 includes ideas for applying LID strategies to site conditions and types of development. It may be useful as a starting point for thinking through application of the four strategies.

► OPTIMIZE THE SITE LAYOUT

To minimize stormwater-related impacts, apply the following design principles to the layout of newly developed and redeveloped sites:

- Define the development envelope and protected areas, identifying areas that are most suitable for development and areas that should be left undisturbed.

- Set back development from creeks, wetlands, and riparian habitats.

- Preserve significant trees.

Where possible, conform the site layout along natural landforms, avoid excessive grading and disturbance of vegetation and soils, and replicate the site's natural drainage patterns.

Concentrate development on portions of the site with less permeable soils, and preserve areas that can promote infiltration.

For all types of development, **limit overall coverage** of paving and roofs. This can be accomplished by designing 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 site layout and circulation patterns and identify areas where landscaping can be substituted for pavement.

TABLE 3-1. Ideas for Runoff Management

Site Features/Issues	*Optimize Site Layout*	*Pervious Pavement*	*Green Roof*	*Disperse Runoff to Landscape*	*Bioretention Facility*	*Flow-through Planter*	*Cistern + bioretention*	*Bioretention + Vault*	*Dry Well*
Clayey native soils	✓		✓	✓	✓	✓	✓	✓	
Permeable native soils	✓	✓	✓	✓	✓	✓			✓
Very steep slopes	✓		✓			✓			
Shallow depth to groundwater	✓		✓			✓			
Roof drainage	✓			✓	✓	✓	✓		✓
Parking lots	✓	✓		✓	✓			✓	✓
Extensive landscaping	✓			✓	✓				
Densely developed sites with limited space/landscape		✓	✓			✓	✓	✓	✓

Detain and retain runoff throughout the site. On flatter sites, it typically works best to intersperse landscaped areas and IMPs among the buildings and paving. On hillside sites, drainage from upper areas may be collected in conventional catch basins and piped to landscaped areas and IMPs in lower areas. Or use low retaining walls to create terraces that can accommodate IMPs. Wherever possible, direct drainage from landscaped slopes offsite and not to IMPs.

Use drainage as a design element. Use depressed landscape areas, vegetated buffers, and bioretention facilities as amenities and focal points within the site and landscape design. Bioretention facilities can be almost any shape and should be located at low points.

► USE PERVIOUS SURFACES

Consider a green roof. Green roofs are growing (in popularity), and many have been built in the Bay Area in the last few years. Benefits include longer roof life, lower heating and cooling costs, and better sound insulation, in addition to air quality and water quality benefits.

However, initial costs are higher than for conventional roofs, and green roofs may add to the complexity of permitting, financing, and insuring new buildings. For C.3 compliance purposes, green roofs are considered not to produce increased runoff or runoff pollutants (that is, any runoff from a green roof requires no further treatment or detention) if the media is sufficiently deep to store an inch of rainfall (typically, a 3-inch media depth is sufficient) and also supports long-term health of vegetation.

Consider permeable pavements and surface treatments. Inventory paved areas on your preliminary site plan. Identify where permeable pavements, such as crushed aggregate, turf block, unit pavers, pervious concrete, or pervious asphalt could be substituted for impervious concrete or asphalt paving. Pervious pavement generally costs more and requires a deep base course for structural stability, especially in clay soils. Installation on slopes requires special design features. Depending on the site, the additional costs may be partially offset by reduced needs for drainage structures and for stormwater treatment and flow control. For C.3 compliance purposes, pervious pavements, when designed and constructed according to the criteria in Chapter 4, are considered to not produce increased runoff or runoff pollutants.

► DISPERSE RUNOFF TO ADJACENT PERVIOUS AREAS

Look for opportunities to direct runoff from impervious areas to adjacent landscaping ("self-retaining" or "zero-runoff" areas). The design, including slopes and soils, must reflect a reasonable expectation that an inch of rainfall will soak into the soil and produce no runoff. For example, a lawn or garden depressed 3-4" below surrounding walkways or driveways provides a simple but functional landscape design element.

For sites subject to stormwater treatment requirements only, a 2:1 maximum ratio of impervious to pervious area is acceptable. If flow-control requirements apply, the impervious-to-pervious ratio must be limited to 1:1. Be sure soils will drain adequately.

Under some circumstances, it may be allowable to direct runoff from impervious areas to pervious pavement (for example, from roof downspouts to a parking lot paved with crushed aggregate or turf block). The pore volume of pavement and base course must be enough to retain an inch of rainfall, including runoff from the tributary impervious area. The slopes and soils must be compatible with infiltrating that volume without producing runoff. This solution is most practical on flat sites with permeable soils.

References and Resources

- *Green Roofs for Stormwater Runoff Control* (USEPA, 2009a)
- *Technical Guidance on Implementing the Stormwater Runoff Requirements for Federal Projects under Section 438 of the Energy Independence and Security Act.* (USEPA, 2009b)
- *Porous Pavements* (Ferguson, 2005)
- *Green Roof Minimum Specifications* (BASMAA, 2011b)

► DIRECT RUNOFF TO BIORETENTION OR OTHER IMPS

The CCCWP has developed design criteria (See Chapter 4) for the following IMPs:

- **Bioretention facilities**, which can be configured to integrate with your landscape design.
- **Flow-through planters**, which can be used on elevated plazas or other circumstances where infiltration to native soils is not possible.
- **Cistern + bioretention** facilities, which use an upstream storage volume and metered flow to reduce the required square footage of a bioretention facility or flow-through planter.
- **Bioretention + vault** facilities, which capture a volume downstream of bioretention and meter outflows.
- **Dry wells** and other infiltration facilities, which can be used only where soils are permeable. See other restrictions in Appendix E.

Table 3-4 on page 36 shows the conditions under which each IMP may be used.

Finding the right location for bioretention or other facilities on your site involves a careful and creative integration of several factors:

- Put bioretention facilities in **high-visibility, well-trafficked areas** and make them a focal point in the landscape.

- Where possible, design site drainage so **only impervious roofs and pavement** drain to IMPs. This yields a simpler, more efficient design and also helps protect IMPs from becoming clogged by sediment.

- Place bioretention inlet elevations, and the top of the engineered soil layer, as high as possible (typically 6" to 12" below the surrounding ground surface elevation). Avoid walls and steep slopes adjacent to the bioretention soil surface. On flatter sites, **keep drainage runs short and use surface drainage**—sheet flow, valley gutters, or trench drains—to convey runoff from paved areas to the bioretention facility. It may be necessary, or helpful, to pipe runoff from roof gutters all the way to the facility.

- To make the most efficient use of the site and to maximize aesthetic value, **integrate IMPs with site landscaping**. Many local zoning codes may require landscape setbacks or buffers, or may specify that a minimum portion of the site be landscaped. It may be possible to locate some or all of your site's treatment and flow-control facilities within this same area, or within utility easements or other non-buildable areas.

- Bioretention facilities must be **level or nearly level** all the way around, so that the entire soil surface is wetted. Linear bioretention facilities (swales) must be designed with their opposite sides at the same elevation. In the linear direction, slopes must be terraced or provided with check dams.

- For effective, low-maintenance operation, **locate facilities so drainage into and out of the device is by gravity flow.** Pumped systems are feasible, but are expensive, require more maintenance, are prone to untimely failure, and can cause mosquito control problems. Most IMPs require 2 feet or more of **head**.

- Bioretention facilities and other IMPs require excavations three or more feet deep, which can **conflict with underground utilities**.

- If the property is being subdivided now or in the future, the facility should be in a **common, accessible area.** In particular, avoid locating facilities on private residential lots. Even if the facility will serve only one site owner or operator, make sure the facility is located for ready access by inspectors from the local municipality and the Contra Costa Mosquito and Vector Control District.

- The facility must be accessible to equipment needed for its maintenance. Bioretention facilities will typically need access for the same types of equipment used for landscape maintenance.

To complete your analysis, include in your Stormwater Control Plan a brief **narrative** documenting the site layout and site design decisions you made. This will provide background and context for how your design meets the quantitative LID criteria.

References and Resources

- *Central Coast Low Impact Development Center*
- *Start at the Source* (BASMAA, 1999)
- *Model Low Impact Development Strategies for Big Box Retail Stores* (King County, WA, 2007)
- *Urban Street Stormwater Guide* (National Association of City Transportation Officials, 2017)

Develop and Document Your LID Drainage Design

The CCCWP's **design documentation procedure** begins with careful delineation of pervious areas and impervious areas (including roofs) throughout the site. The procedure accounts for how runoff from each delineated area is managed. For areas draining to IMPs, the procedure ensures each IMP is appropriately sized.

The procedure results in a space-efficient, cost-efficient LID design for meeting C.3 requirements on most residential and commercial/industrial developments. The procedure arranges documentation of drainage design and IMP sizing in a consistent format for presentation and review.

This procedure is intended to facilitate, not substitute for, creative interplay among site design, landscape design, and drainage design. **Several iterations may be needed** to optimize your drainage design as well as aesthetics, circulation, and use of available area for your site.

You should be able to complete the needed calculations using only the project's site development plan. If your project requires hydromodification management (flow control or HM), you will also need to know the hydrologic soil group (A, B, C, or D) of site soils, and mean annual precipitation at the project location. Mean annual precipitation at locations in Contra Costa County can be determined using isohyetal maps accessible from the CCCWP's C.3 web page.

The CCCWP has created an **IMP Sizing Calculator** to facilitate the iterative calculations needed to create an optimal site design. The calculator is a stand-alone application and is available, along with instructions for its use, on the CCCWP's C.3 web pages. In addition to performing calculations, the IMP Sizing Calculator formats calculation results into a summary report. The summary report should be attached to your Stormwater Control Plan submittal.

When using the calculator, **be sure to read through the following instructions**, as they include key information you will need for design. These procedures and formulas can be used to **investigate, check, and verify** calculations made with the IMP Sizing Calculator.

► STEP 1: DELINEATE DRAINAGE MANAGEMENT AREAS

This is the key first step. You must divide the **entire project area** into individual, discrete Drainage Management Areas (DMAs). Typically, lines delineating DMAs follow grade breaks and roof ridge lines. The Exhibit, tables, text, and calculations in your Stormwater Control Plan will illustrate, describe, and account for runoff from each of these areas.

Use separate DMAs for each surface type (e.g., landscaping, pervious paving, or roofs). Each DMA must be assigned a single hydrologic soil group. Assign each DMA an identification number and determine its size in square feet.

► STEP 2: CLASSIFY DMAS AND DETERMINE RUNOFF FACTORS

Next, determine how drainage from each DMA will be handled. Each DMA will be one of the following four types—based on the DMA's drainage characteristics.

1. Self-treating areas.
2. Self-retaining areas (also called "zero-discharge" areas).
3. Areas that drain to self-retaining areas.
4. Areas that drain to IMPs.

Runoff from self-treating areas, self-retaining areas, and areas draining to self-retaining areas does not require any further treatment or flow control. Except for pervious pavement installations greater than 3,000 SF in area, there is no requirement for operation and maintenance inspections.

#1. Self-treating areas are landscaped or turf areas that do not drain to IMPs, 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 that drain off-site to an existing public street or storm drain. See Figure 3-1. In general, self-treating areas include no impervious areas, unless the impervious area is very small (5% or less) in relationship to the receiving pervious area, and slopes are gentle enough to ensure runoff from impervious areas will be absorbed into the vegetation and soil.

Rationale

Pollutants in rainfall and windblown dust will tend to become entrained in the vegetation and soils of landscaped areas, so no additional treatment is needed. It is assumed the self-treating landscaped areas will produce runoff less than or equal to the pre-project site condition.

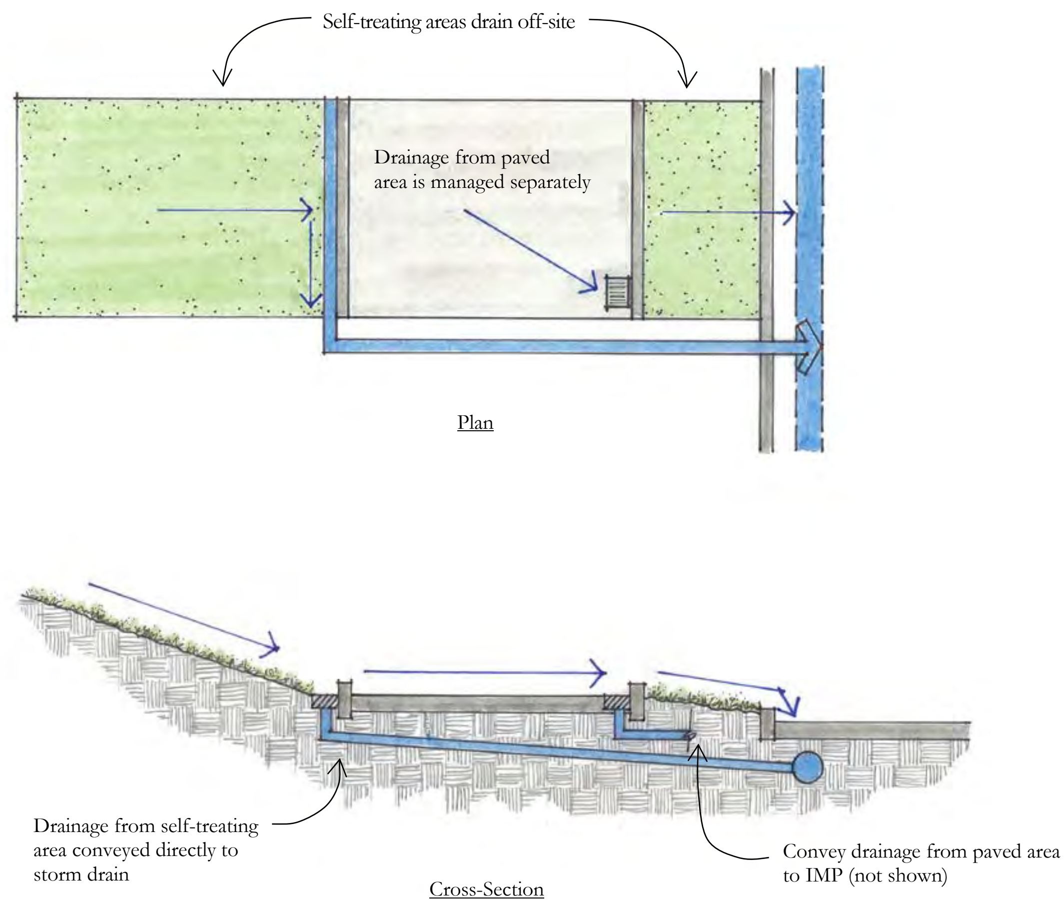

FIGURE 3-1. SELF-TREATING AREAS are landscaped or turf areas that drain directly off-site or to the storm drain system.

#2. Self-retaining areas are designed to retain the first one inch of rainfall without producing any runoff. The technique works best on flat, heavily landscaped sites. It may be used on mild slopes if there is a reasonable expectation that a one-inch rainfall event would produce no runoff. See Figure 3-2.

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. Grade slopes, if any, toward the center of the pervious area. Inlets of area drains, if any, should be set 3 inches above the low point to allow ponding.

Green roofs are considered self-retaining areas.

Pervious pavement (e.g., crushed stone, pervious asphalt, or pervious concrete) can be self-retaining if designed and constructed according to the criteria in Chapter 4.

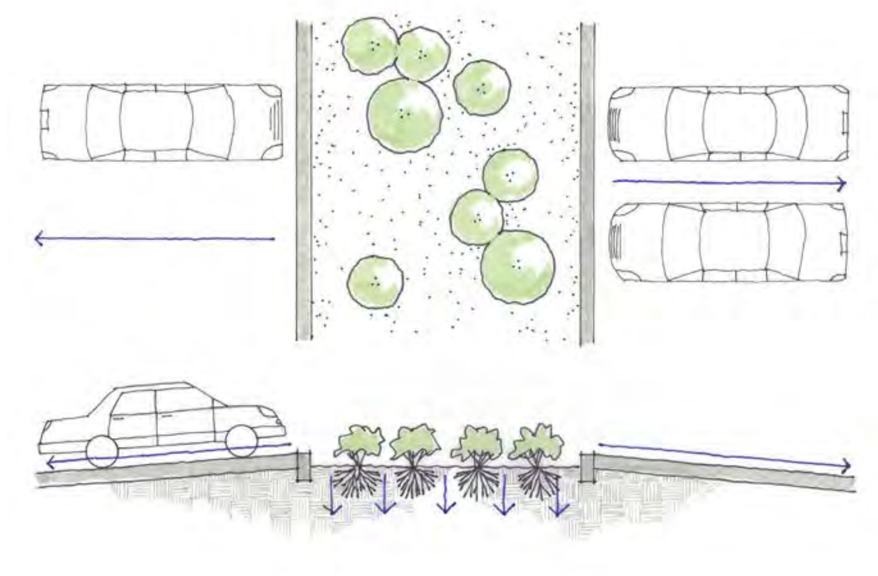

FIGURE 3-2. SELF-RETAINING AREAS are depressed pervious areas that produce no runoff.

#3. Areas draining to self-retaining areas. Runoff from impervious or partially pervious areas can be managed by routing it to self-retaining pervious areas. For example, roof downspouts can be directed to lawns, and driveways can be sloped toward landscaped areas. The maximum ratio is 2 parts impervious area for every 1 part pervious area if only treatment requirements apply to the development project. If flow-control requirements also apply, the maximum ratio is 1 part impervious area for every 1 part pervious area. 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 2 parts impervious area into 1 part pervious area is used, then the pervious area must absorb 3 inches of water over its surface before overflowing to an off-site drain.

Derivation of Criteria

A computer model was used to continuously simulate rainfall, infiltration, and runoff at an hourly time-step over 30 years. Results indicate drainage areas using the 1:1 ratio will not exceed pre-project peaks and durations.

Prolonged ponding is a potential problem at higher impervious/pervious ratios. In your design, ensure that the pervious area soils can handle the additional run-on and are sufficiently well-drained.

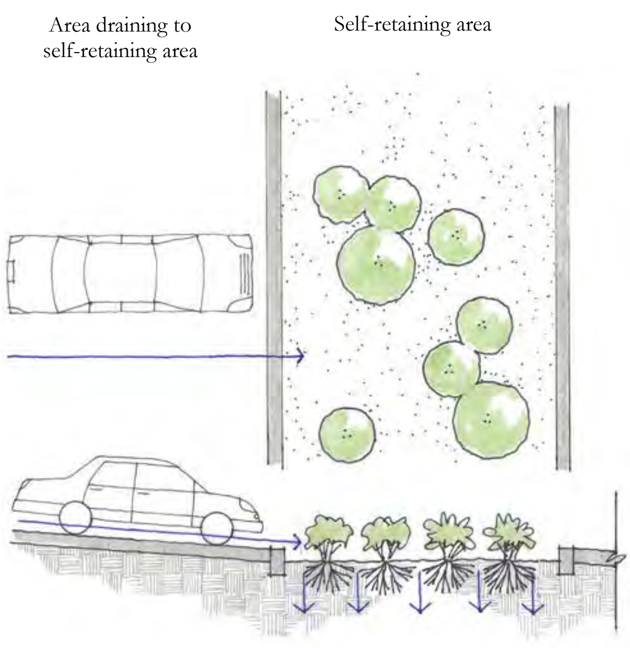

FIGURE 3-3. AREAS DRAINING TO SELF-RETAINING AREAS.
The maximum ratio is two parts impervious to one part impervious, or one-to-one if HM requirements apply.

If pervious pavement is designed and constructed to be self-retaining—that is, according to the criteria in Chapter 4—adjacent roofs or impervious pavement may drain on to the pervious pavement with the same maximum ratios. A gravel base course four or more inches deep will ensure an adequate proportion of rainfall is infiltrated into native soils (including clay soils) rather than producing runoff. Consult with a qualified engineer regarding infiltration rates, pavement stability, and suitability for the intended traffic, especially when considering draining impervious areas on to pervious pavement.

A partially pervious area may be drained to a self-retaining area. For example, a driveway composed of unit pavers may drain to an adjacent lawn. In this case, the maximum ratios are, for treatment-only sites:

(Runoff factor) x (tributary area) ≤ 2 x (self-retaining area) *Equation 3-1*

For sites subject to flow-control requirements:

(Runoff factor) x (tributary area) ≤ 1 x (self-retaining area) *Equation 3-2*

Use the runoff factors in Table 3-2.

TABLE 3-2. RUNOFF FACTORS for evaluating drainage to self-retaining areas and for sizing IMPs.

Surface	Treatment and Flow Control	Treatment only
Roofs	1.0	1.0
Concrete or Asphalt	1.0	1.0
Pervious Concrete	0.1	0.1
Porous Asphalt	0.1	0.1
Grouted Unit Pavers	1.0	1.0
Solid Unit Pavers Set in Sand	0.5	0.2
Open and Porous Pavers	0.1	0.1
Crushed Aggregate	0.1	0.1
Decomposed Granite*	0.1	0.1
Turfblock	0.1	0.1
Landscape, Group A Soil	0.1	0.1
Landscape, Group B Soil	0.3	0.1
Landscape, Group C Soil	0.5	0.1
Landscape, Group D Soil	0.7	0.1

* with no binder, uncompacted

#4. Areas draining to IMPs are used to calculate the required size of the bioretention facility or other IMP. On densely developed sites—such as commercial and mixed-use developments and small-lot residential subdivisions—most DMAs will drain to IMPs.

The CCCWP has developed sizing factors (ratios of IMP area to impervious DMA area). For each IMP design, factors are provided for:

- Treatment-only.
- Treatment-plus-flow-control.

Treatment-only IMPs are smaller and in some cases, are simpler in design.

More than one drainage management area can drain to the same IMP. However, because the minimum IMP sizes are determined by ratio to drainage area size, one drainage area may not drain to more than one IMP. See Figure 3-4.

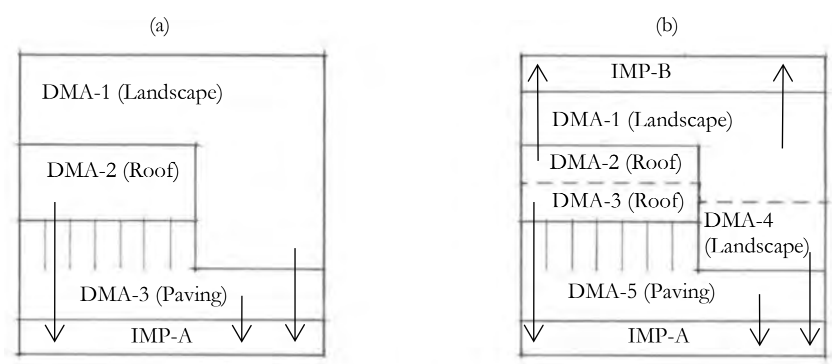

FIGURE 3-4. DELINEATE EACH SURFACE AS A SEPARATE DMA.
(a) More than one DMA can drain to an IMP. (b) If another IMP is added, divide the DMAs as necessary so that each DMA drains to only one IMP.

If it is necessary to include turf, landscaping, or pervious pavements within the area draining to an IMP, list each surface as a separate DMA. A runoff factor (similar to a "C" factor used in the rational method) is applied to account for the reduction in the quantity of runoff. For example, when a turf or landscaped drainage management area drains to an IMP, the resulting increment in IMP size is:

(pervious area) × (runoff factor) × (sizing factor).

Use the runoff factors in Table 3-2.

► STEP 3: TABULATE DRAINAGE MANAGEMENT AREAS

Prepare a table of DMAs, using the format in Table 3-3, and include it in your Stormwater Control Plan. Proceed to Step 4 to check that the IMPs can be sized to fit your preliminary site plan.

TABLE 3-3. Format for Tabulation of Drainage Management Areas

DMA Name	*DMA Type*	*Description*	*Area (square feet)*

► STEP 4: SELECT AND LAY OUT IMPS ON SITE PLAN

Select from the IMPs in Table 3-4. Note that flow-through planters may be used only on elevated plazas and other locations where it is not feasible to allow the facility to infiltrate to underlying soil.

TABLE 3-4. IMP SELECTION

	Treatment Only				Treatment + Flow Control			
Hydrologic Soil Group	A	B	C	D	A	B	C	D
Bioretention	✓	✓	✓	✓	✓	✓	✓	✓
Flow-through Planter	✓	✓	✓	✓			✓	✓
Dry Well	✓	✓			✓	✓		
Cistern + Bioretention					✓	✓	✓	✓
Bioretention + Vault					✓	✓	✓	✓

Descriptions, illustrations, designs, and design criteria for the IMPs are in Chapter 4. Once you have laid out the IMPs, calculate the square footage you have set aside on your site plan for each IMP.

► STEP 5: CALCULATE MINIMUM IMP AREA AND VOLUMES

For **treatment only**, the minimum IMP areas and volumes are determined by summing up the contributions of each tributary DMA and multiplying times the factors shown in Table 3-5.

Note that the minimum areas are the wetted area and do not include side slopes.

TABLE 3-5. MINIMUM IMP AREAS AND VOLUMES for treatment only

Hydrologic Soil Group	A	B	C	D
Bioretention Facility A	 0.04	 0.04	 0.04	 0.04
Flow-through Planter A	 0.04	 0.04	 0.04	 0.04
Dry Well (treatment only) A V	 0.02 0.068	 0.04 0.136	 N/A N/A	 N/A N/A
A = ft^2 of IMP footprint per ft^2 of impervious tributary area (unitless) V = ft^3 per ft^2 of tributary area (ft.) Apply runoff factors from Table 3-2 for landscape or other pervious surfaces.				

For **treatment-and-flow-control**, the minimum area and minimum storage volumes are found by summing up the contributions of each tributary DMA and applying sizing factors and equations. The configuration of area (A), surface reservoir volume (V_1) and subsurface reservoir volume (V_2) for bioretention facilities and flow-through planters is shown in Figure 3-5.

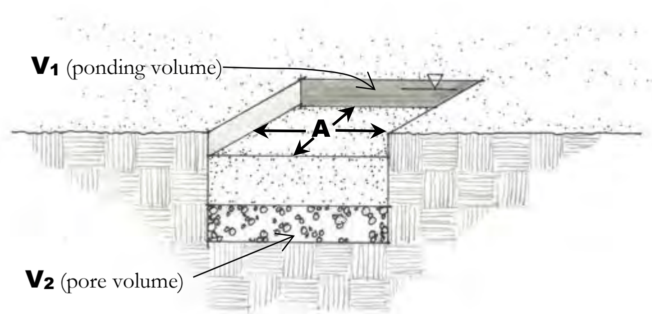

FIGURE 3-5. A, V_1, and V_2.
V_2 is the free pore volume. For gravel, use an assumed porosity of 0.4.

V_1 is the floodable volume above the soil layer (that is, the total volume of surface storage when the facility just begins to overflow). V_2 is the storage volume below the soil layer. If gravel fill is used, **multiply the volume of gravel by an assumed porosity of 0.4** to obtain the subsurface volume.

Sizing factors for treatment-only IMPs do not require any adjustment for differing rainfall patterns. Area (A) and volume (V_1, V_2) sizing factors for treatment-plus-flow-control IMPs, however, must be adjusted to account for the effects of differing rainfall patterns on pre-project and post-project runoff. Cisterns and dry wells have a single storage volume V.

Note these volumes can be configured in a variety of practical combinations of depth and area to best fit into your landscape design. For example, if a bioretention facility were designed with double the minimum value of A, then the depth of the surface reservoir and the depth of the subsurface reservoir could both be halved. Some other strategies to achieve the required minimum values of V1 and V2 are described in the design sheets in this chapter.

The minimum values of A, V_1, and V_2 are calculated by Equation 3-3. **These calculations are incorporated into the IMP Sizing Calculator** and are provided here for purposes of investigating and validating calculator results.

Equation 3-3

$$Min.\,IMP\;Area\;or\;Volume = \sum \begin{pmatrix} DMA & & DMA \\ Square & \times & Runoff \\ Footage & & Factor \end{pmatrix} \times \begin{pmatrix} IMP \\ Sizing \\ Factor \end{pmatrix} \times \begin{pmatrix} Rain \\ Adjustment \\ Factor \end{pmatrix}$$

IMP Sizing Factors and equations for calculating Rain Adjustment Factors are in Tables 3-6 and 3-7.

TABLE 3-6. FACTORS FOR CALCULATING IMP Area and Storage Volumes (Treatment-and-flow-control)

Facility Design	Soil Group	Area (ft^2/ft^2)	Volume V_1 (ft^3/ft^2)	Volume V_2 (ft^3/ft^2)	Rainfall Adjustment for Surface Area	Rainfall Adjustment for Storage Volume	Maximum Release Rate
Bioretention Facility	A	0.07	0.058	No min.	Eq. 3-6	Eq. 3-6	No orifice
	B	0.11	0.092	No min.	Eq. 3-7	Eq. 3-7	No orifice
	C	0.06	0.050	0.066	Eq. 3-8	Eq. 3-8	Eq. 3-10
	D	0.05	0.042	0.055	Eq. 3-9*	Eq. 3-9	Eq. 3-11
Flow-through Planter	A	Not permitted in "A" soils					
	B	Not permitted in "B" soils					
	C	0.06	0.050	0.066	Eq. 3-8	Eq. 3-8	Eq. 3-10
	D	0.05	0.042	0.055	Eq. 3-9*	Eq. 3-9	Eq. 3-11
Dry Well	A	0.05	0.130	N/A	Eq. 3-6	Eq. 3-6	No release
	B	0.06	0.204	N/A	Eq. 3-7	Eq. 3-7	No release
	C	Not permitted in "C" soils					
	D	Not permitted in "D" soils					
Cistern + Bioretention	A	0.020	0.193	N/A	Eq. 3-13	Eq. 3-6	Eq. 3-17
	B	0.009	0.210	N/A	Eq. 3-14	Eq. 3-7	Eq. 3-12
	C	0.013	0.105	N/A	Eq. 3-15	Eq. 3-8	Eq. 3-10
	D	0.017	0.063	N/A	Eq. 3-16	Eq. 3-9	Eq. 3-11
Bioretention + Vault	A	0.04	N/A	0.096	N/A	Eq. 3-6	No release
	B	0.04	N/A	0.220	N/A	Eq. 3-7	Eq. 3-12
	C	0.04	N/A	0.152	N/A	Eq. 3-8	Eq. 3-10
	D	0.04	N/A	0.064	N/A	Eq. 3-9	Eq. 3-11

A = ft^2 of IMP footprint per ft^2 of tributary impervious area (unitless)
V_1, V_2 = ft^3 per ft^2 of equivalent tributary impervious area (ft.) Cisterns, dry wells, and vaults have only one volume.
*If MAP is 25 inches or greater, this equation will yield a rainfall adjustment less than 0.8 and a bioretention facility area less than 0.04 times the tributary area. In that case, use 0.04 times the tributary area to calculate the minimum allowable bioretention facility area. Equation 3-9 may still be used to adjust minimum required storage volumes.

TABLE 3-7. EQUATIONS TO BE USED in calculating IMP sizes and outflow rates.*

Equation 3-6	$Rain\ Adjustment = \frac{0.0009 \times (MAP_{project\ site} - 20.2) + 0.07}{0.07}$
Equation 3-7	$Rain\ Adjustment = \frac{-0.0005 \times (MAP_{project\ site} - 20.2) + 0.11}{0.11}$
Equation 3-8	$Rain\ Adjustment = \frac{-0.0022 \times (MAP_{project\ site} - 20.2) + 0.06}{0.06}$
Equation 3-9	$Rain\ Adjustment = \frac{-0.0022 \times (MAP_{project\ site} - 20.2) + 0.05}{0.05}$
Equation 3-10	$Flow\ (cfs\ per\ ft^2) = \frac{0.093 \times (MAP_{project\ site} - 20.2) + 1.42}{10^6}$
Equation 3-11	$Flow\ (cfs\ per\ ft^2) = \frac{0.122 \times (MAP_{project\ site} - 20.2) + 1.85}{10^6}$
Equation 3-12	$Flow\ (cfs\ per\ ft^2) = \frac{0.071 \times (MAP_{project\ site} - 20.2) + 0.91}{10^6}$
Equation 3-13	$Area\ Ratio = \frac{0.151 \times (MAP_{project\ site} - 20.2) + 2.30}{2.30}$
Equation 3-14	$Area\ Ratio = \frac{0.071 \times (MAP_{project\ site} - 20.2) + 0.91}{0.91}$
Equation 3-15	$Area\ Ratio = \frac{0.093 \times (MAP_{project\ site} - 20.2) + 1.42}{1.42}$
Equation 3-16	$Area\ Ratio = \frac{0.122 \times (MAP_{project\ site} - 20.2) + 1.85}{1.85}$
Equation 3-17	$Flow\ (cfs\ per\ ft^2) = \frac{0.151 \times (MAP_{project\ site} - 20.2) + 2.30}{10^6}$

MAP = Mean Annual Precipitations, determined from Contra Costa County Public Works Figure B-166.
*There are no Equations 3-4 or 3-5 in this edition; this was done to preserve equation numbering from a previous edition.

► STEP 6: DETERMINE IF IMP AREA AND VOLUME ARE ADEQUATE

Sizing and configuring IMPs may be an iterative process. After computing the minimum IMP area using Steps 1–5, review the site plan to determine if the reserved IMP area is sufficient.

If so, the planned IMPs will meet the Provision C.3 sizing requirements. If not, revise the plan accordingly. Revisions may include:

- Reducing the overall imperviousness of the project site.
- Changing the grading and drainage to redirect some runoff toward other IMPs which may have excess capacity.
- Making tributary landscaped DMAs self-treating or self-retaining (may require changes to grading).
- Expanding IMP surface area.
- Using a different IMP. The cistern + bioretention and bioretention + vault options were created to achieve **flow control** in a smaller footprint than bioretention alone. Note these options are more costly and complex to build and operate.

Note revisions to square footage of an IMP typically require a corresponding revision to the square footage of the surrounding or adjacent DMA area.

Once a design with adequate area is achieved, review the IMP configuration to confirm the required minimum volumes are met. If not, revisions to V_1 may include adjusting depth or side slopes and extending the floodable storage area to include adjacent paved or landscaped areas. Revisions to V_2 may include adjusting width or depth, or incorporating buried pipes or arches in the gravel layer.

► STEP 7: COMPUTE MAXIMUM ORIFICE FLOW RATE

This step applies only to:

- **treatment-and-flow-control** bioretention facilities and flow-through planters built on native Group C and Group D soils.
- cistern + bioretention-facilities built in all soils.
- bioretention + vault facilities built on Group B, Group C, and Group D native soils.

See Table 3-4. The IMP Sizing Calculator performs this calculation.

Treatment-only bioretention facilities and flow-through planters are equipped with underdrains, but there is no restriction on the rate of outflow. For the **treatment-and-flow-control** IMPs, listed above, the underdrain has a flow control orifice sized to ensure rates and durations of flows do not exceed pre-project conditions.

For a cistern + bioretention-facility, the flow-control orifice is placed on the outlet from the cistern where it discharges to the bioretention facility. The bioretention facility must have an underdrain in B, C, and D soils, but no flow-control orifice is required on the underdrain.

For a bioretention + vault facility, the flow-control orifice is placed on the discharge from the vault.

Find the appropriate equation in Tables 3-6 and 3-7 to determine the maximum underdrain flow. Sum the total area draining to an IMP (including all tributary DMAs; **do not use runoff factors**. Compute the maximum orifice release rate, and then apply the orifice equation (Eq. 3-18) to determine the required orifice area. Then use Eq. 3-19 to determine the diameter of the flow control orifice.

Equation 3-18

$$Orifice\ Area\,(in\ \ feet) = \frac{UnderdrainMaxFlow}{c \times \sqrt{64.4 \times H}}$$

where c is the orifice coefficient, which may be approximated as 0.6. H is the height of the storage above the orifice.

Equation 3-19

$$Orifice\ Diameter\,(in\ inches) = 12 \times \sqrt{\frac{4 \times Orifice\ Area}{\pi}}$$

► STEP 8: PRESENT IMP SIZING CALCULATIONS

Review the output from the IMP Sizing Calculator. Coordinate and cross-check your presentation of DMAs and calculation of minimum IMP sizes with the Stormwater Control Plan Exhibit (labeled to show delineation of DMAs and locations of IMPs) and with your Stormwater Control Plan report, which should incorporate a brief description of each DMA and each IMP.

Tabulate and sum the total area of all DMAs and IMPs listed and show it is equal to the total project area. This step will include adjusting the square footage of some DMAs to account for area used for IMPs. **Note the minimum square footage for IMPs does not include the area of transitions or slopes adjacent to the IMP.**

Integrating Your LID Design into Your Project

Before completing your Stormwater Control Plan exhibit and report, perform another check to ensure your stormwater control design is fully coordinated with the site plan, grading plan, and landscaping plan being proposed for the site.

Information submitted and presentations to design review committees, planning commissions, and other decision-making bodies must incorporate relevant aspects of the stormwater design. In particular, ensure:

- Curb elevations, elevations, grade breaks, and other features of the drainage design are consistent with the delineation of DMAs.
- The top edge of each bioretention facility is level all around its perimeter—this is particularly important in parking lot medians.
- The resulting grading and drainage design is consistent with the design for parking and circulation.
- Bioretention facilities and other IMPs do not create conflicts with pedestrian access between parking and building entrances.
- Vaults and utility boxes will be accommodated outside bioretention facilities and will not be placed within bioretention facilities.
- The visual impact of stormwater facilities, including planter boxes at building foundations and any terracing or retaining walls required for the stormwater control design, is shown in renderings and other architectural drawings.
- Landscaping plans, including planting plans, show locations of bioretention facilities, and the plant requirements are consistent with the engineered soils and conditions in the bioretention facilities.
- Renderings and representation of street views incorporate any stormwater facilities located in street-side buffers and setbacks.
- Any potential conflicts with local development standards have been identified and resolved.

Review Chapter 4 to anticipate additional requirements for design and construction of IMPs.

Use of Non-LID Treatment Facilities

LID has been found to be feasible for nearly all development sites. If you believe LID design may be infeasible for part of or your entire development site, you should consult with municipal staff and seek additional technical assistance for incorporating LID into your site before considering non-LID options.

► SPECIAL PROJECTS

"Special Projects" that meet the criteria in Table 3-8 (page 46) may, subject to local staff review and approval—and subject to a demonstration that it is infeasible to use the LID to treat 100% of runoff—use the following non-LID treatment systems for up to the specified proportion of the total impervious area on the site:

- Tree-box-type high-flowrate biofilters.
- Vault-based high-flowrate media filters.

► TECHNICAL CRITERIA FOR NON-LID FACILITIES

Minimum design criteria for tree-box type high-flowrate biofilters and for vault-based high-flowrate media filters are in Appendix E.

If flow-control (HM) requirements apply, also review the options for compliance in Chapter One. Then consult with municipal staff before preparing an alternative design for stormwater treatment and HM.

► DEMONSTRATION OF INFEASIBILITY IS REQUIRED

For all non-LID designs, the applicant must submit a complete Stormwater Control Plan, including an exhibit showing the entire site divided into discrete Drainage Management Areas, and text and tables showing how drainage is routed from each DMA to a treatment facility.

In addition, to establish the **infeasibility of implementing LID on the entire site**, include in the Stormwater Control Plan an explanation of how routing of drainage has been optimized so that as much runoff as possible goes to LID features and facilities (if any). For DMAs draining to tree-box-type high-flow-rate biofilters and/or high-flow-rate media filters, briefly describe all areas not covered by buildings. Note the uses of all impervious paved areas and why LID treatment is precluded for these areas.

For any landscaped areas, note and briefly describe the following technical constraints as applicable:

- Inadequate size to accommodate bioretention facilities that meet sizing requirements for the tributary area

- Slopes too steep to terrace
- Environmental constraints (for example, landscaped area is within a riparian corridor and applicable regulations prohibit bioretention facilities within that corridor)
- High groundwater (within 2 feet of ground surface) or shallow bedrock
- Conflict with subsurface utilities
- Cap over polluted soil or groundwater
- Lack of head or routing path to route runoff to the landscaped area or from a bioretention underdrain to the municipal storm drain.
- Other conflicts, including required uses that preclude use for stormwater treatment (describe in detail)

Also include in your Stormwater Control Plan a narrative discussion of **infeasibility of offsite treatment**:

- Describe whether the project proponent owns or otherwise controls land within the same watershed of the project that can accommodate in perpetuity off-site bioretention facilities adequately sized to treat the runoff volume of the primary project.
- Identify any regional Low Impact Development stormwater mitigation programs available to the project for in-lieu C.3 compliance.

References and Resources

- *Municipal Regional Permit* Provision C.3.e.
- *Special Projects Proposal* (BASMAA, 2010)

TABLE 3-8. NON-LID TREATMENT SYSTEMS may be allowed in these "Special Projects," subject to a demonstration of the infeasibility of using 100% LID and local staff review and approval.
Note: This table is a summary only. Consult with local staff regarding applicability to your project.

Category	*Impervious Area*	*Project Characteristics*	*Criteria* (*Acreage refers to total site acreage*)	*LID Credit*	*Comments*
A Lot Line to Lot Line	X ≤ ½ Ac	Urban/Pedestrian design[1] in Business/ Downtown Districts[1]	No density criterion	100%	Zero surface parking[1] ≥ 85% Site Coverage[1]
B High Density	½ Ac ≤ X ≤ 2 Ac	Urban/Pedestrian design[1] in Business/ Downtown Districts[2]	Floor Area Ratio[1] (FAR) ≥ 2:1; OR for Residential (Res) projects, ≥ 50 Dwelling Units (DU)/Acre[1]; OR either for mixed-use projects.	50%	Zero surface parking[3] ≥ 85% Site Coverage[4]
			FAR ≥ 3:1; OR Res ≥ 75 DU/Acre	75%	
			FAR ≥ 4:1; OR Res ≥ 100 DU/Acre	100%	
C Transit Oriented	No limit	TOD characteristics Non-auto-use project FAR ≥ 2:1 OR Res ≥ 25 DU/Ac	*Location Credits (count only one)*		
			within ¼ mi of transit hub[1]	50%	50%+ of site w/in distance
			within ½ mi of transit hub[7]	25%	
			within a Priority Development Area	25%	100% of site w/in PDA
			Density/FAR Credits		
			FAR ≥ 2:1; OR Res ≥ 30 DU/Acre	10%	
			FAR ≥ 4:1; OR Res ≥ 60 DU/Acre	20%	
			FAR ≥ 6:1; OR Res ≥ 100 DU/Acre	30%	
			Minimized Parking Credits		
			≤ 10% at-grade surface parking	10%	Surface parking uses LID
			Zero surface parking[3]	20%	

[1] Built as part of a municipality's stated objective to preserve or enhance a pedestrian-oriented type of urban design.

[2] Located in a municipality's designated central business district, downtown core area or downtown core zoning district, neighborhood business district or comparable pedestrian-oriented commercial district, or historic preservation site and/or district.

[3] Incidental parking allowed: surface parking required for emergency vehicle access, ADA accessibility, and passenger and freight loading zones.

[4] Remaining portion to be used for safety access, parking structure entrances, trash and recycling service, utility access, pedestrian connections and public uses.

[5] Floor Area Ratio (FAR) is the ratio of total floor areas on all floors of all buildings at a project site (except structures, floors, or floor areas dedicated to parking) to the total project site area.

[6] Gross Density (DU/Acre) is the total number of residential units divided by the acreage of the entire site area, including land occupied by public ROW, recreational, civic, commercial, and other non-residential uses.

[7] Transit hub is a rail, light rail, or commuter rail station, or bus transfer station served by 3 or more bus routes. A bus stop with no supporting services does not qualify. A planned transit hub is a station on the Metropolitan Transportation Commission's Regional Transit Expansion Program's list.

Chapter

4

Design and Construction of Bioretention Facilities and Other Integrated Management Practices

Guidance for preparing construction documents and overseeing construction of Integrated Management Practices

Details of construction are critical to ensuring stormwater facilities work properly. A misplaced inlet, an overflow at the wrong elevation, or the wrong soil mix can make a bioretention facility useless or ineffective even before it comes on-line, and could result in delays to project approvals—and additional expense.

Your Stormwater Control Plan is intended for the planning phase and must contain, at minimum, enough detail to demonstrate your planned LID features and facilities are feasible and are coordinated with the project site plan, architectural renderings, landscape design, grading and drainage plan, and other information submitted with your application for development approvals.

At plan check, reviewers will examine the construction documents to ensure the site design features, and especially the construction of bioretention facilities and other IMPs, will meet the criteria in this chapter and throughout the *Guidebook*.

Following are design sheets for:

- Self-treating and self-retaining areas
- Pervious pavements
- Bioretention facilities

- Flow-through planters
- Dry wells
- Cisterns + bioretention
- Bioretention + vaults

These design sheets include recommended configurations and details, and example applications, for these features and facilities. **The information in these design sheets must be adapted and applied to the conditions specific to the development project.** Local planning, building, and public works officials have final review and approval authority over the project design.

Keep in mind that proper and functional design of features and facilities is the responsibility of the applicant. Effective operation of facilities throughout the project's lifetime will be the responsibility of the property owner.

What to Show on Construction Plans

With few exceptions, the plan set should include separate sheets specifically incorporating the features and facilities described in the Stormwater Control Plan. The information on these sheets must be carefully coordinated and made consistent with grading plans, utility plans, landscaping plans, and (in many cases) architectural plans.

On the grading and drainage plan, or on a separate stormwater control plan sheet showing the grading and drainage plan (and possibly the roof plan) screened as background, show how DMAs follow grade breaks, consistent with the grading plan and the Stormwater Control Plan.

► SHOW KEY ELEVATIONS

On the grading and drainage plan, or in a detailed plan view, call out the following elevations:

- Bottom of gravel layer (BGL, or the bottom of the excavation), top of gravel layer (TGL), and top of soil layer (TSL). Note that each of these is consistent (flat) throughout the facility.
- The top of curbs or walls surrounding the facility, and spot elevations of adjacent pavement.
- At curb cut inlets, show the top of paving, top of curb, and top of the bioretention soil layer (TSL).

- At overflow grates, show the grate elevation and the adjacent top of soil elevation (TSL).
- Call out elevations of piped inlets.

For treatment-and-flow-control IMPs, demonstrate how the minimum surface volume V_1 is attained by the design.

► SHOW HOW RUNOFF MOVES

As needed for clarity, show the direction of runoff flow across roofs and pavement and into IMPs. For runoff conveyed via pipes or channels, show locations, slopes, and elevations at the beginning and end of each run.

For roof drainage, show the routing of roof leaders. Use drawings or notes to make clear how drainage from leaders is routed under walkways, across pavement, through drainage pipes, or by other means to reach the IMP.

Show pipes or channels connecting the IMP underdrain and overflow to the site drainage system, municipal storm drain system, or other approved discharge point. Call out slopes and key elevations.

► SHOW IMPS IN CROSS-SECTION

For many installations, a not-to-scale cross section view can be used to illustrate the dimensions and placement of the soil and gravel layers, surrounding walls, and overflow structures. Where needed, use detailed, specific cross-section drawings to show edge treatments, inlet elevations, overflow grates, rock for energy dissipation, moisture barriers, and other information.

Call out references for the gravel (Class 2 perm) and specified soil mix layers.

The details in the design sheets may be used as a general guide.

► COORDINATE WITH THE LANDSCAPING PLAN

The landscaping plan must show the footprints of the IMPs precisely and should incorporate plants and irrigation appropriate to the facilities. See Appendix B.

Landscape plans should call out that no soil or amendments other than the specified soil mix are to be used within the boundaries of the IMPs and that the specified top of soil elevation is to be maintained following plant installation.

References and Resources

- San Francisco *Stormwater Management Requirements and Design Guidelines*
- Central Coast Low Impact Development Center *Bioretention Standard Details and Specifications*

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Runoff Reduction Measures

1. **Self-Treating Areas**
2. **Self-Retaining Areas**
3. **Areas Draining to Self-Retaining Areas**

Runoff-reduction site-design measures are the most effective and least expensive way to implement LID.

- Manage drainage from pervious landscaped areas separately, so that it doesn't run on to adjacent pavement.
- Further reduce runoff by dispersing runoff from impervious roofs and pavement to landscaped areas.

To incorporate these features into your project, **delineate and classify the Drainage Management Areas** (DMAs) appropriately on your Stormwater Control Plan Exhibit. See page 30.

Follow the criteria below in your Exhibit and grading and drainage plan.

Note: Runoff from drainage management areas that do not meet the criteria for self-treating areas, self-retaining areas, or areas draining to self-retaining areas must be directed to bioretention facilities or other IMPs.

Best Uses

- Sites with extensive landscaping

Advantages

- Low cost
- No maintenance verification requirement
- Complements site landscaping

Limitations

- Requires substantial square footage
- Grading requirements must be coordinated with landscape design

CONTRA COSTA CLEAN WATER PROGRAM

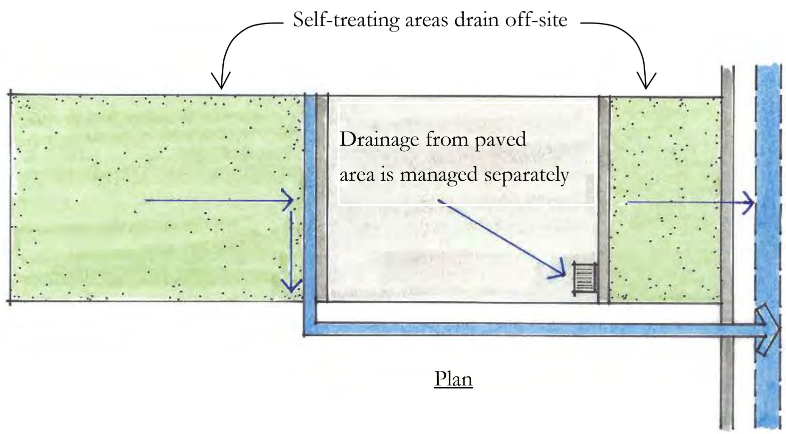
Stormwater C.3 Guidebook

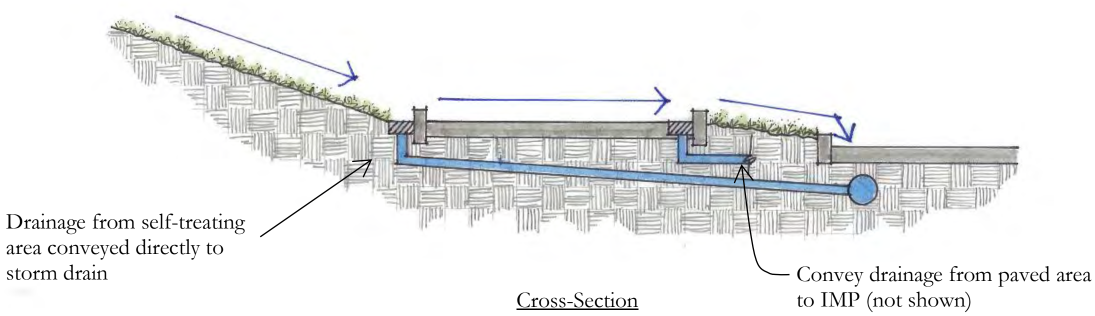
www.cccleanwater.org

1. Self-Treating Areas

Self-treating drainage management areas are natural, landscaped, or turf areas that drain directly off site or to the storm drain system. Examples include upslope undeveloped areas from which runoff is piped or ditched and drained around a development and grassed slopes that drain offsite to a street gutter. Self-treating areas must not drain on to adjacent paved areas within the project.

Drainage from self-treating areas must flow to off-site streets or storm drains without flowing on to paved areas within the project. Lawn or landscaped areas adjacent to streets can be considered self-treating areas. Pavement within a self-treating area must not exceed 5% of the total area.



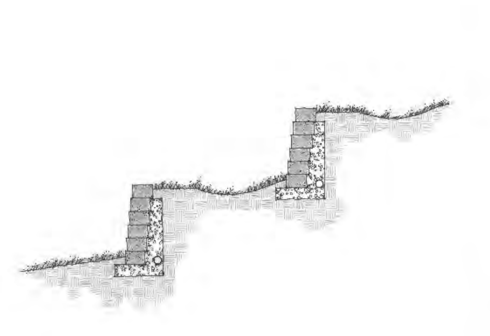


▶ CRITERIA FOR SELF-TREATING AREAS

- ❒ Runoff from the self-treating area does not enter an IMP or another drainage management area, but goes directly offsite or to the storm drain system.
- ❒ The self-treating area is at least 95% lawn or landscaping (not more than 5% impervious).
- ❒ Re-graded or re-landscaped areas have amended soils, vegetation, and irrigation as may be required to maintain soil stability and permeability.

2. Self-Retaining Areas

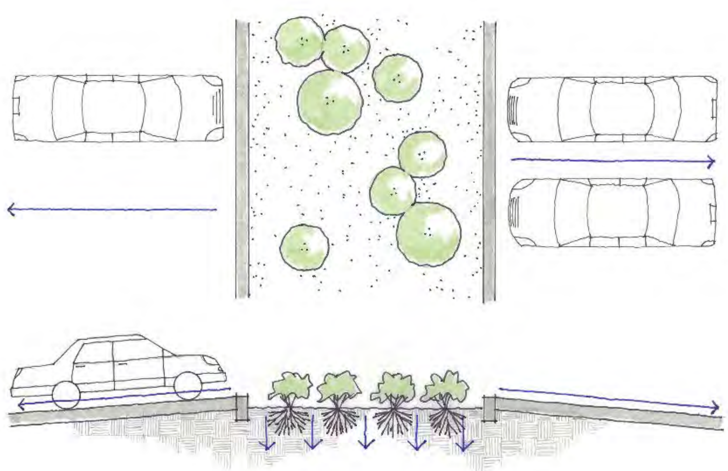
Where a landscaped area is upslope from or surrounded by paved areas, a self-retaining drajnage management area (also called a zero-discharge area) may be created. Self-retaining areas are designed to retain the first one inch of rainfall without producing any runoff. The technique works best on flat, heavily landscaped sites. It may be used on mild slopes if there is a reasonable expectation that the first inch of rainfall would produce no runoff.



Slope terraced to create a self-retaining area

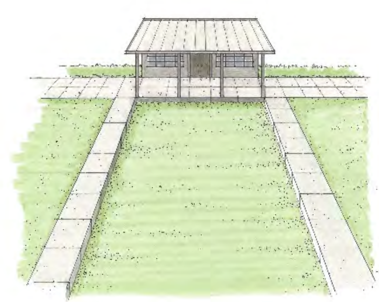
To create self-retaining turf and landscape areas in flat areas or on terraced slopes, berm the area or depress the grade into a concave cross-section so that these areas will retain the first inch of rainfall.

Self-retaining areas can also be created by depressing lawn and landscape below surrounding sidewalks and plazas. Leave enough reveal (elevation difference) to accommodate buildup of turf or mulch.



► CRITERIA FOR SELF-RETAINING AREAS

- ❒ Area is bermed all the way around or graded concave.
- ❒ Slopes do not exceed 4%.
- ❒ Entire area is lawn, landscaping, or pervious pavement (see criteria for pervious pavement).
- ❒ Area has amended soils, vegetation, and irrigation as may be required to maintain soil stability and permeability.
- ❒ Any area drain inlets are at least 3 inches above surrounding grade.
- ❒ Overflow (which may occur during high-intensity events) is conveyed safely.

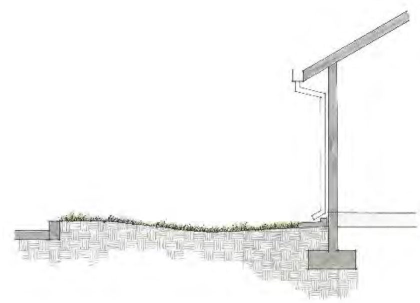


Lawn depressed to create a self-retaining area

3. Areas draining to self-retaining areas

Drainage from roofs and paving can be directed to self-retaining drainage management areas and allowed to infiltrate into the soil. The maximum ratios are:

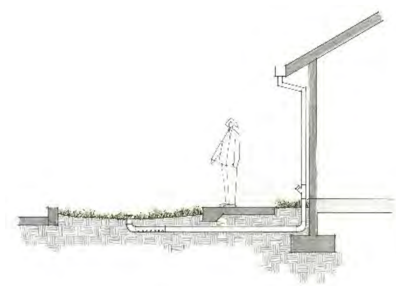
Site requirement	Maximum allowable ratio
Treatment only	2 parts impervious: 1 pervious
Treatment and flow-control	1 part impervious: 1 pervious



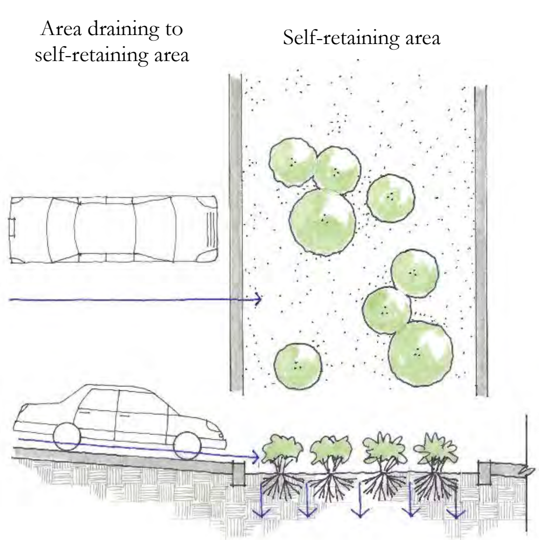
Roof runoff is directed to an adjacent self-retaining landscaped area.

The self-retaining area must be bermed or depressed to retain an inch of rainfall including the flow from the tributary impervious area. Inlets of area drains, if any, should be set 3 inches above the low point to allow ponding. Self-retaining areas should be designed to promote even distribution of ponded runoff over the area.

Runoff from walkways or driveways in parks and park-like areas can sheet-flow to self-retaining areas. Roof leaders can be connected to self-retaining areas by piping beneath plazas and walkways. If necessary, a "bubble-up" can be used.



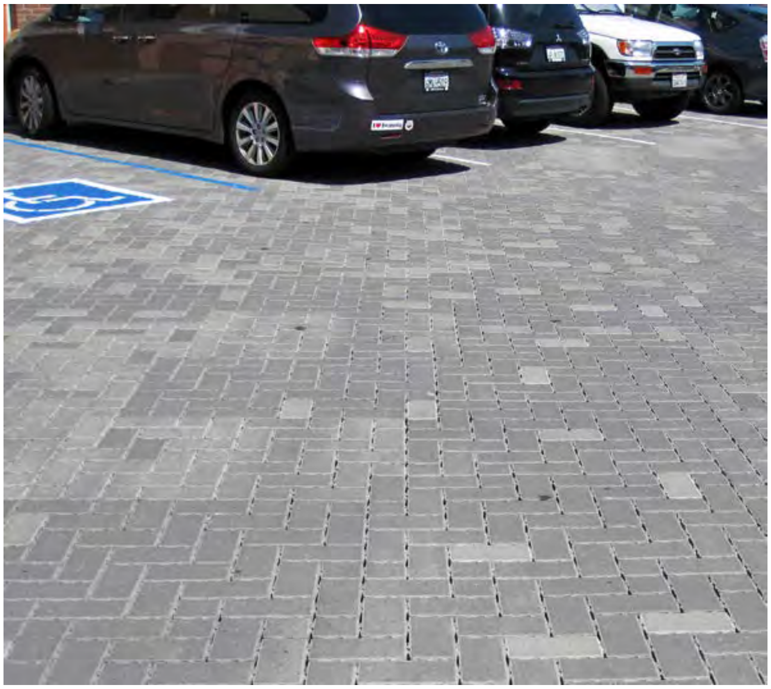
A roof leader extends to a bubble-up to convey roof runoff to a self-retaining area.



► CRITERIA FOR AREAS DRAINING TO SELF-RETAINING AREAS

- ❒ Ratio of tributary impervious area to self-retaining area is not greater than 2:1 (1:1 if flow-control requirements apply).
- ❒ Roof leaders collect runoff and route it to the self-retaining area.
- ❒ Paved areas are sloped so drainage is routed to the self-retaining area.
- ❒ If runoff is concentrated where it enters the self-retaining area, there are appropriate measures to protect against erosion and promote flow across the self-retaining area.

Pervious Pavements



Impervious roadways, driveways, and parking lots account for much of the hydrologic impact of land development. Pervious pavements allow rainfall to collect in a gravel or sand base course and infiltrate into native soil instead of creating runoff.

Pervious pavements are often costly to build and maintain when compared to conventional pavement draining to bioretention facilities. However, in some applications the aesthetic or practical benefits of a flat surface unbroken by drainage structures may be worth the additional cost.

Best Uses

- Flat areas (< 2% slope)
- Areas with competent, permeable native soils
- Low-traffic areas
- Where aesthetic quality can justify higher cost

Advantages

- No maintenance verification requirement for installations < 3000 SF
- Surface treatments can complement landscape design

Limitations

- Initial cost
- Placement requires specially trained crews
- Geotechnical concerns, especially in clay soils
- Concerns about pavement strength and surface integrity

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Pervious pavements are not treatment facilities. However, they may be configured as self-retaining areas. In specific, limited circumstances, pervious pavements configured as self-retaining areas may receive some runoff from roofs or conventional pavement—if it can be shown that the required amount of runoff, as well as rain falling on the pervious pavement, will infiltrate into the underlying soil.

Solid unit pavers—such as bricks, stone blocks, or precast concrete shapes—are considered to reduce runoff compared to impervious pavement, when the unit pavers are set in sand or gravel with $\frac{3}{8}$" gaps between the pavers. Joints must be filled with an open-graded aggregate free of fines.

If pervious pavement areas drain to IMPs, use the runoff factors in Table 3-2 when sizing the IMPs.

► DETAILS

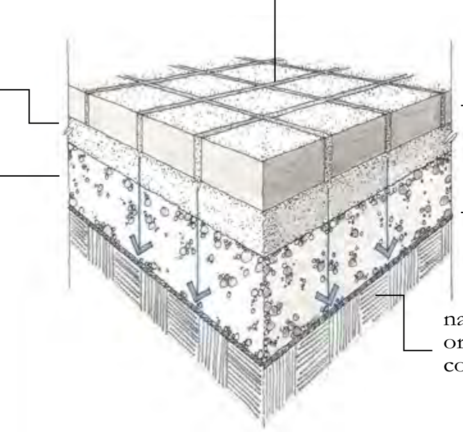
Permeable pavements can be used in clay soils; however, special design considerations, including an increased depth of base course, typically apply and will increase the cost of this option. Geotechnical fabric between the base course and underlying clay soil is recommended.

Permeable pavements are best used on grades from flat to approximately 2%. Installations on steeper grades, particularly on clay soils, require cut-off trenches lateral to the slope—to intercept, store, and infiltrate drainage from the base course.

Pavement strength and durability typically determines the required depth of base course. If underdrains are used, the outlet elevation must be a minimum of 3 inches above the bottom elevation of the base course.

Pervious concrete and porous asphalt must be installed by crews with special training and tools. Industry associations maintain lists of qualified contractors.

Parking lots with crushed aggregate or unit pavers may require signs or bollards to organize parking.



TYPICAL CONFIGURATION for a pervious pavement. The base course is a minimum 3" depth for runoff retention. A deeper base course is typically required for pavement stability.

► CRITERIA FOR PERVIOUS PAVEMENTS

- ❒ Installation is flat or < 2% grade.
- ❒ No erodible areas drain on to pavement.
- ❒ Subgrade is uniform and slopes are not so steep that subgrade is prone to erosion. Compaction is minimal.
- ❒ Reservoir base course is of open-graded crushed stone. Base depth is adequate to retain rainfall and support design loads.
- ❒ If a subdrain is provided, outlet elevation is a minimum of 3 inches above highest point of bottom of base course.
- ❒ Rigid edge is provided to retain granular pavements and unit pavers.
- ❒ Solid unit pavers, if used, are set in sand or gravel with minimum $\frac{3}{8}$" gaps between the pavers. Joints are filled with an open-graded aggregate free of fines.
- ❒ **Permeable concrete and porous asphalt, if used, are installed by qualified professionals according to vendor's recommendations.**
- ❒ Selection and location of pavements incorporates Americans with Disabilities Act requirements, site aesthetics, and uses.
- ❒ Pavement design and/or grading design incorporates management of design flows to avoid local flooding (typically a 10-year storm).

► RESOURCES

National Ready Mix Concrete Association
http://www.perviouspavement.org/

National Asphalt Pavement Association
www.asphaltpavement.org

Interlocking Concrete Pavement Institute
http://www.icpi.org/

Start at the Source Design Manual for Water Quality Protection, pp. 47-53. http://www.cccleanwater.org/c3-resources.html

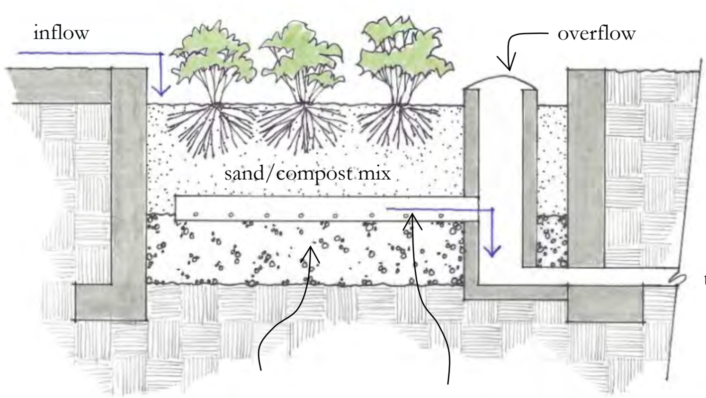
Porous Pavements, by Bruce K. Ferguson. 2005. ISBN 0-8493-2670-2.

Caltrans. 2014. *Pervious Pavement Design Guidance.* http://www.dot.ca.gov/hq/oppd/stormwtr/bmp/DG-Pervious-Pvm_082114.pdf

Bioretention Facilities

Bioretention facilities can be rectangular, linear, or nearly any shape.
Photo by Scott Wikstrom

Bioretention facilities capture runoff in a shallow reservoir on the soil surface, then filter the runoff through plant roots and a biologically active soil mix. The treated runoff then trickles into a subsurface gravel layer. Runoff is held in the gravel layer until it infiltrates it into the ground. If the entire gravel layer becomes saturated, an underdrain conveys excess treated runoff to a storm drain or to surface drainage.



Best Uses

- Commercial areas
- Residential subdivisions
- Industrial facilities
- Roadways
- Parking lots
- Fit in setbacks, medians, and other landscaped areas

Advantages

- Can be any shape
- Low maintenance

Limitations

- Require 4%-15% of tributary impervious square footage
- Typically require 3-4 feet of head
- Irrigation may be required

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LAYOUT AND SITE DRAINAGE

See the guidance on page 28 regarding how to incorporate bioretention facilities into your site. Also see "Integrating Your LID Design into Your Project" on page 42.

- Place bioretention facilities in visible, well-trafficked areas and make them a focal point in the landscape.

- On flatter sites, use surface drainage, rather than underground pipes, to convey runoff to the bioretention facility inlets. The top of soil elevation should be as high as possible—typically 6 to 12 inches below surrounding grade.

- Where possible, design site drainage so only impervious roofs and pavement drain to the bioretention facility. Avoid high walls or steep slopes adjacent to bioretention facilities. Avoid side slopes within bioretention areas as much as possible. The bioretention soil mix will tend to rill even on very mild slopes (>8:1).

- Integrate bioretention facilities with the landscape design.

- Make the bioretention facilities level around their perimeter.

- Where possible, grade tributary paved areas to sheet flow runoff and disperse it among curb cuts, rather than concentrating flow at one inlet location.

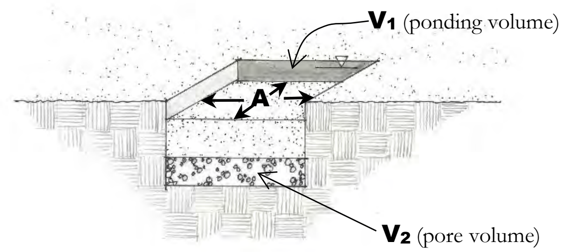
- Place each facility in a common, accessible area. Avoid locating facilities on private residential lots.

► DIMENSIONS AND MATERIALS

For development projects subject only to **runoff treatment requirements**, the following minimum dimensions apply.

Parameter	Criterion
Surface reservoir mean depth	6" minimum
Soil mix surface area	0.04 times tributary impervious area (or equivalent)
Soil mix depth	18" minimum
Gravel layer	12" min. Class 2 permeable
Underdrain discharge	At top of gravel layer

Where **flow-control requirements** also apply, the bioretention facility must be designed to meet the minimum surface area (A), surface volume (V_1), and subsurface volume (V_2) using Equation 3-3 and the sizing factors and equations in Tables 3-6 and 3-7. The IMP Sizing Calculator should be used.



Minimum subsurface volume. For treatment-and-flow-control facilities the minimum subsurface volume V_2 specified in Table 3-6 is the void space, not the entire volume of gravel. Where the native soils are Hydrologic Soil Group C or D, V_2 may be achieved by a 30" deep layer of gravel **of 40% porosity,** extending under the minimum footprint "A". Note that if the facility area is increased, the required depth to achieve the same volume is correspondingly decreased.

Gravel. "Class 2 permeable," Caltrans specification 68-2.02(F)(3), is preferred. Open-graded crushed rock, washed, may be used, but requires 4"-6" washed pea gravel be substituted at the top of the crushed rock layer. **Do not use filter fabric** to separate the soil mix from the gravel drainage layer or the gravel drainage layer from the native soil.

If desired, voids created by buried structures such as pipes or arches, may be substituted, as long as the voids are hydraulically interconnected and the minimum subsurface volume calculated by Equation 3-3 is achieved.

Soil mix. Criteria for the required mix of sand and compost are in Appendix B. It is similar to a loamy sand and must maintain a minimum percolation rate of 5" per hour throughout the life of the facility. It must be suitable for maintaining plant life with a minimum of fertilizer use. A list of suppliers is on the C.3 web pages.

► **FACILITY DETAILS**

Inlets. Curb cuts should be wide (12" is recommended) to avoid clogging with leaves or debris. Allow for a minimum reveal of 6" between the inlet and soil mix elevations to ensure turf or mulch buildup does not block the inlet. In addition, place an apron of stone or concrete, a foot square or larger, inside each inlet to prevent vegetation from growing up and blocking the inlet.

If the linear slope along the curb is greater than the orthogonal slope of the gutter pan, runoff flows will not enter the inlet efficiently. Use a drop inlet with a grate instead.

Where runoff is concentrated and conveyed to the facility in pipes or swales, protect the landscaping from high-velocity flows with energy-dissipating cobble of appropriate size. In larger installations, provide cobble-lined channels to better distribute flows throughout the facility.

"Bubble ups" can be used to dissipate energy when runoff is piped from roofs and up-gradient paved areas.

Surface storage and overflow. For treatment-only facilities, the surface reservoir should be a minimum 6" deep. In treatment-and-flow-control facilities, the overflow elevation must be set to achieve the minimum surface storage volume calculated using Equation 3-3 and the V_1 sizing factor.

Ensure the soil mix is installed level and at the specified elevation, and that the elevation does not change when plants are installed.

Overflow structure. A precast concrete catch basin or manhole is best. The overflow elevation is critical and must be designed to achieve the surface reservoir requirements. The outlet should be designed to exclude floating mulch and debris. Design in **freeboard** if needed to prevent flooding or protect adjacent structures.

Underdrains. Underdrains must have their discharge elevation set at the top of gravel layer elevation. Perforated pipe can be laid in a shallow groove dug across the top of the gravel layer, holes facing down, and connected to the overflow structure. Underdrains must be constructed of rigid pipe (SDR 35 or equivalent) and provided with a cleanout.

Flow-control orifice. For treatment-and-flow-control facilities, the underdrain must be routed through a device designed to limit flows to that specified in Equation 3-10 or 3-11 (page 40). Typically, a section of solid pipe is designed to protrude slightly into the overflow structure. The pipe is threaded and fitted with a standard cap; a hole of the specified diameter is drilled into the cap. The cap can then be easily removed for cleaning or adjustment and reinstalled.

▶ APPLICATIONS

Multi-purpose landscaped areas. Bioretention facilities are easily adapted to serve multiple purposes. The loamy sand soil mix will support either turf or a plant palette suitable to the location and a well-drained soil. See Appendix B for additional guidance on soil, plant selection, and irrigation.

Bioretention facility in El Cerrito with active and passive recreational uses.

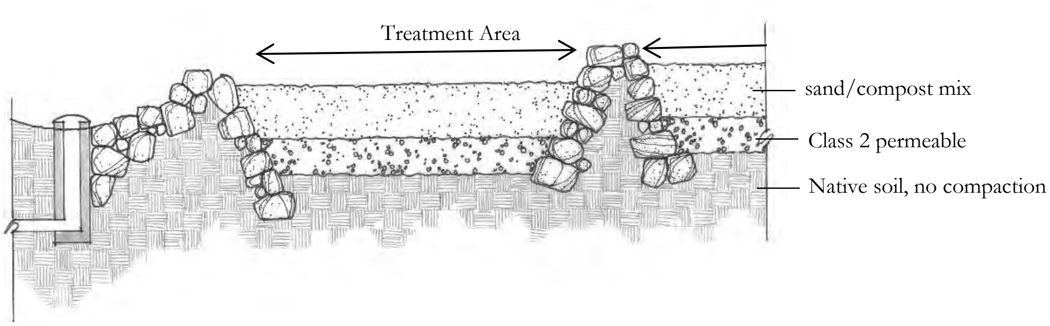
Residential subdivisions. In the design of many subdivisions, it has proven easiest and most effective to drain roofs and driveways to the streets (in the conventional manner) and then drain the streets to bioretention areas, with one bioretention area for each 1 to 10 lots, depending on subdivision layout and topography.

Bioretention areas can be placed on one or more separate, dedicated parcels with joint ownership.

Sloped sites. Bioretention facilities must be constructed as a basin or as a series of basins, with the circumference of each basin level.

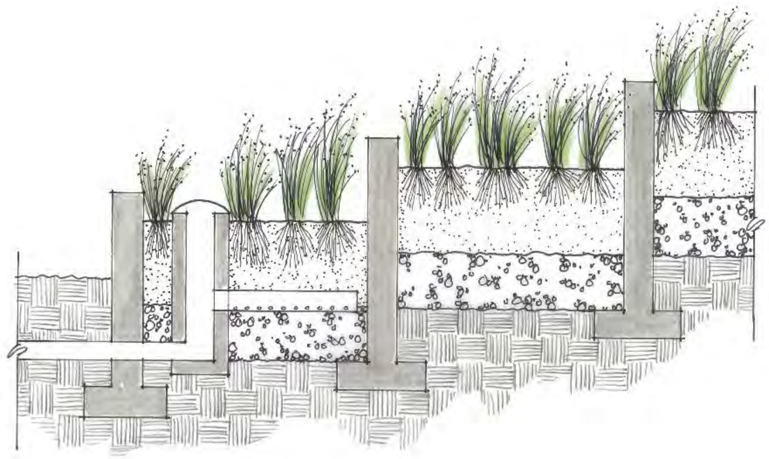
On the surface, a bioretention facility should be one level, shallow basin—or a series of basins. As runoff enters each basin, it should flood and fill throughout before runoff overflows to the outlet or to the next downstream basin. This helps prevent movement of surface mulch and soil mix.

Swales can be used on mild slopes. Check dams should be placed every 4 to 6 inches of elevation change and so that the lip of each dam is at least as high as the toe of the next upstream dam.

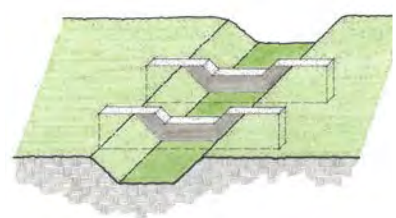


Swale with check dams. Not suitable for steeper slopes. Movement of soil can be a problem even at mild slopes. Design must ensure ponding behind each check dam.

A series of planters is a more robust solution and is required for steeper slopes.



Concrete check dams are a better solution on steeper slopes.



Key check dams into bottom and side slopes.

Solutions for surface storage. Placing a steep-sided depression in an urban landscape poses aesthetic challenges as well as practical challenges. First, use sheet flow, valley gutters, and trench drains, instead of pipes, to move runoff to the bioretention facility, so that inlets can be at or near ground level.

To further avoid the effects of high and steep drop offs, consider:

- Increasing the facility area and reducing the surface depth accordingly.
- Incorporating steps down into the facility.
- Specifying taller, woody plants to block or discourage entry.

Mulch can be mounded a few inches deeper at walkway edges to transition to the top of soil elevation.

Vaults, utility boxes, backflow preventers, and light standards. Utility features and structures must be located outside the bioretention facility—in adjacent walkways or in a separate area set aside for this purpose.

Emergency overflow. The site grading plan should anticipate extreme events and potential clogging of the overflow, and should route emergency overflows safely.

Trees. Bioretention areas can accommodate small or large trees within the minimum areas and volumes calculated by Equation 3-3. Tree canopies intercept rain, and tree roots maintain soil permeability and help retain runoff. Normal maintenance of a bioretention facility should not affect tree lifespan.

Consider the following when designing bioretention facilities to accommodate trees, especially large trees:

- The bioretention facility requires 18" of soil mix over the minimum surface area. Trees can be planted in this soil mix; the area occupied by the tree counts toward the minimum area requirement.

- Trees require sufficient rooting volume to thrive. Structural soils can be used below or around the soil mix.

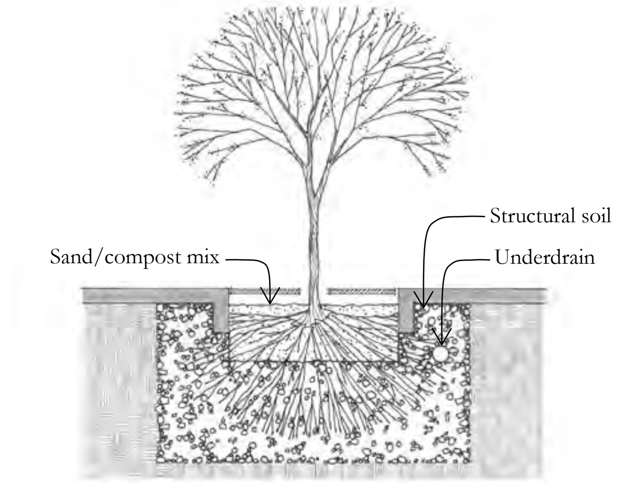
- Most tree roots extend horizontally near the soil surface.

- The bioretention soil mix has low moisture-holding capacity. Consider planning for tree roots to access native clay soils through the side walls as the tree grows. However, where needed, adjacent paving or structures can be protected with a root barrier.

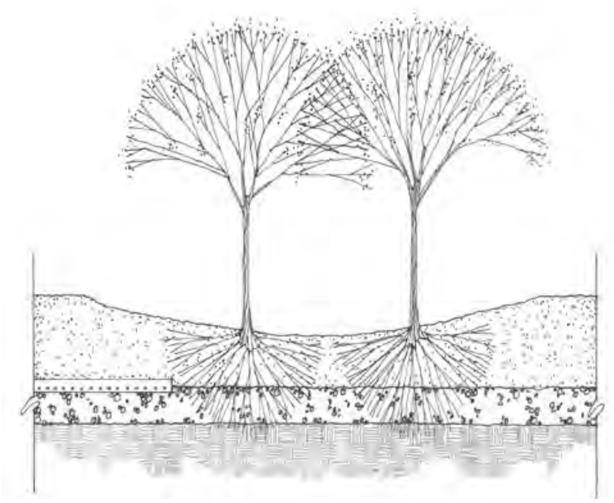
- A podium of native soil is sometimes constructed so that the root ball can be installed at the correct elevation (so that bioretention soil mix and mulch do not cover the tree's root collar).

- Large trees should be spaced appropriately for their size at maturity.

- Trees may need to be staked for longer because the bioretention soil mix provides little structural support against trees being toppled by wind.



Bioretention facility configured as a tree well.



Larger bioretention facility with trees.

Criteria for Bioretention

- ❒ Bioretention facilities are located in a visible, well-trafficked area where possible.
- ❒ Top of soil elevation is as high as possible. High walls and steep slopes adjacent to the facility are avoided.
- ❒ Location and footprint of facility are congruent on site plan, landscaping plan, and grading plan.
- ❒ Bioretention area is designed as a basin (level edges) or a series of basins, and grading plan is consistent with these elevations. Check dams, if any, are set so the lip or weir of each dam is at least as high as the toe of the next upstream dam.
- ❒ Volume or depth of surface reservoir meets or exceeds minimum. Freeboard above overflow (1"-2" recommended) is not included in surface reservoir volume.
- ❒ 18" depth specified soil mix (reference *Guidebook* Appendix B).
- ❒ Area of soil mix meets or exceeds minimum.
- ❒ Perforated pipe (PVC SDR 35 or approved equivalent) underdrain with discharge elevation **at the top** of the “Class 2 perm” layer. Holes facing downward. Connection and sufficient head to storm drain or approved discharge point.
- ❒ No filter fabric.
- ❒ Underdrain has a clean-out port consisting of a vertical, rigid, non-perforated PVC pipe, with a minimum diameter of 4 inches and a watertight cap.
- ❒ Curb inlets are 12" wide, have 4"-6" reveal and an apron or other provision to prevent blockage when vegetation grows in, and energy dissipation as needed.
- ❒ Overflow catch basin or manhole connected to a downstream storm drain or approved discharge point.
- ❒ Emergency spillage will be safely conveyed overland.
- ❒ Plantings are suitable to the climate, exposure, and a well-drained soil, and occasional inundation during large storm events.
- ❒ Irrigation system with connection to water supply, on a separate zone. See Appendix B.
- ❒ Vaults, utility boxes, backflow preventers, and light standards are located outside the minimum soil mix surface area.

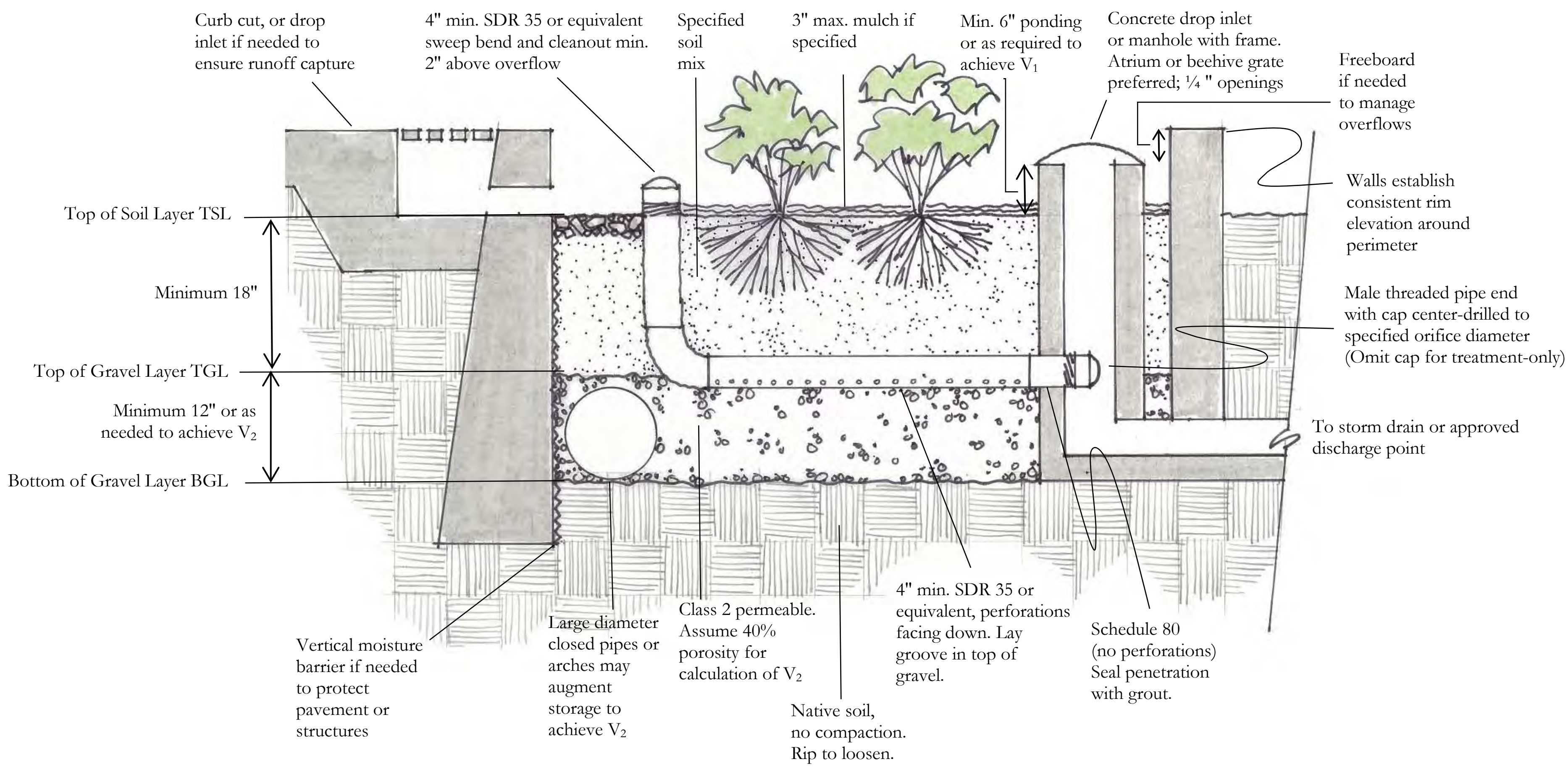
For treatment-and-flow-control facilities only

- ❒ Volume of surface storage meets or exceeds minimum (V_1).
- ❒ Volume of subsurface storage meets or exceeds minimum (V_2).
- ❒ In “C” and “D” native soils, underdrain is connected to discharge through an appropriately sized orifice or other flow-limiting device.

Bioretention Facility

Cross-section

Not to Scale



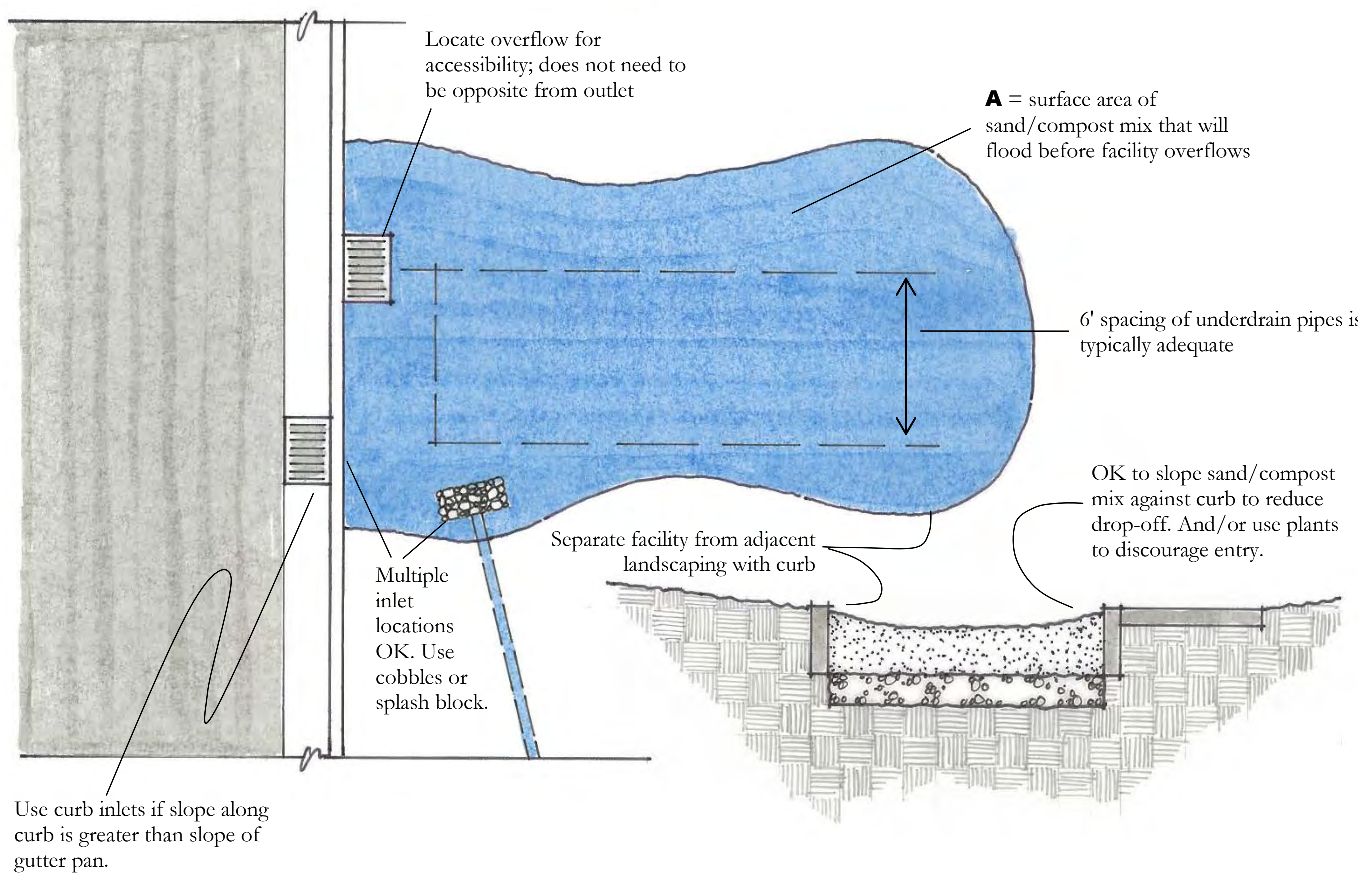
Notes:

- No liner, no filter fabric, no landscape cloth.
- Maintain BGL. TGL, TSL throughout facility area at elevations to be specified on drawing.
- Class 2 perm layer may extend below and underneath drop inlet.
- Elevation of perforated pipe underdrain is atop gravel layer.
- See Appendix B for soil mix specification, planting and irrigation guidance.
- See Chapter 3 for factors and equations used to calculate V_1 V_2 and orifice diameter.

Bioretention Facility

Plan

Not to Scale



Flow-through Planter

Unlike bioretention facilities, flow-through planters are designed to discharge all influent runoff following treatment, rather than infiltrating some treated runoff into the underlying soil.

Flow-through planters are contained within a concrete box, or plastic liners may be used on the sides and bottom. An underdrain is constructed with the discharge elevation near the bottom of the gravel layer (that is, there is no "dead" storage)."

Flow-through planters may be used as an alternative to bioretention under certain conditions:

- Upper-story plazas
- Where bioretention facilities could cause mobilization of pollutants in soil or groundwater.
- Other situations where infiltration is a concern, such as locations with potential geotechnical hazards that cannot be mitigated except by preventing infiltration.

Best Uses

- Management of roof runoff
- Podium-style developments
- On building plazas

Advantages

- Versatile
- Can be any shape
- Low maintenance

Limitations

- Can only be used where infiltration is not possible
- May not be used for flow control (HM) where underlying soils are Hydrologic Soil Group "A" or "B"
- Requires underdrain
- Requires 3-4 feet of head

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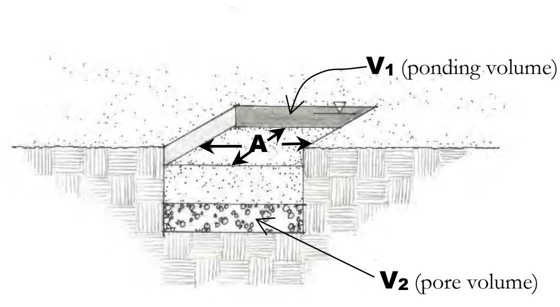
► DIMENSIONS AND MATERIALS

Treatment only. For development projects subject only to runoff treatment requirements, the following criteria apply:

Parameter	Criterion
Surface reservoir depth	6" minimum
Soil mix surface area	0.04 × tributary impervious area
Soil mix depth	18" minimum
Gravel layer	12" min. Class 2 permeable
Underdrain	At bottom of gravel layer

Where **flow-control requirements** also apply, the flow-through planter must be designed to meet the minimum surface area (A), surface volume (V_1), and subsurface volume (V_2) using Equation 3-3 and the sizing factors and equations in Tables 3-6 and 3-7. The IMP Sizing Calculator should be used.



Minimum surface and subsurface volume. In a vertical-sided box-like planter for treatment-and-flow-control with the minimum surface area A, the minimum surface volume V_1 can be achieved with an overflow height of 10" (12" total height of walls with 2" of freeboard).

For treatment-and-flow-control facilities the minimum subsurface volume V_2 specified in Table 3-8 is the void space, not the entire volume of gravel. The minimum subsurface volume V_2 can be achieved with a gravel (Class 2 permeable) depth of 30". This combination results in a planter approximately 5' high. The planter height can be reduced by incorporating void-creating underdrain pipes, other pipes, or arches, or by increasing the planter area so that the minimum V_2 is achieved.

Gravel. "Class 2 permeable," Caltrans specification 68-2.02(F)(3), is preferred. Open-graded crushed rock, washed, may be used, but requires 4"-6" washed pea gravel be substituted at the top of the crushed rock layer. **Do not use filter fabric** to separate the soil mix from the gravel drainage layer or the gravel drainage layer from the native soil.

If desired, voids created by buried structures such as pipes or arches may be substituted, as long as the voids are hydraulically interconnected and the minimum subsurface volume calculated by Equation 3-3 is achieved.

Soil mix. Criteria for the required mix of sand and compost are in Appendix B. It is similar to a loamy sand and must maintain a minimum percolation rate of 5" per hour throughout the life of the facility, and it must be suitable for maintaining plant life with a minimum of fertilizer use. A list of suppliers is on the C.3 web pages.

Underdrains. Underdrains must have their discharge elevation set as flush with the planter bottom as possible. Underdrains must be constructed of rigid pipe (SDR 35 or equivalent) and provided with a cleanout.

Flow-through planters on the plaza level of a podium-style development.

Flow-control orifice. For treatment-and-flow-control facilities, the underdrain must be routed through a device designed to limit flows to that specified in Equation 3-10 or 3-11 (page 38). Typically a section of solid pipe is designed to protrude slightly into the overflow structure. The pipe is threaded and fitted with a standard cap; a hole of the specified diameter is drilled into the cap. The cap can then be easily removed for cleaning or adjustment and reinstalled.

► **APPLICATIONS**

Bioretention facility adjacent to building. An impermeable cutoff wall between the facility and the building may be incorporated.

At plaza level. Flow-through planters have been successfully incorporated into podium-style developments, with the planters placed on the plaza level and receiving runoff from the tower roofs above. Runoff from the plaza level is typically managed separately by additional flow-through planters or bioretention facilities located at street level.

Adjacent to buildings. Designers should aim to use bioretention facilities (that is, facilities open at the bottom to allow infiltration) adjacent to buildings. An impermeable vertical cutoff wall between the facility and the building may be incorporated. Where it is not feasible to adjust the building and foundation design, flow-through planters may be used. Planter vegetation can soften the visual effect of the building wall. A setback with a raised planter box may be appropriate even in some neo-traditional pedestrian-oriented urban streetscapes.

Flow-through planter built into a hillside. Flows from the underdrain and overflow must be directed in accordance with local requirements.

Steep slopes. Flow-through planters provide a means to detain and treat runoff on very steep slopes that cannot accept infiltration from a bioretention facility. The planter can be built into the slope similar to a retaining wall. The design should consider the need to access the planter for maintenance. Flows from the planter underdrain and overflow must be directed in accordance with local requirements. It is sometimes possible to disperse these flows to the downgradient hillside.

Design Checklist for Flow-through Planter

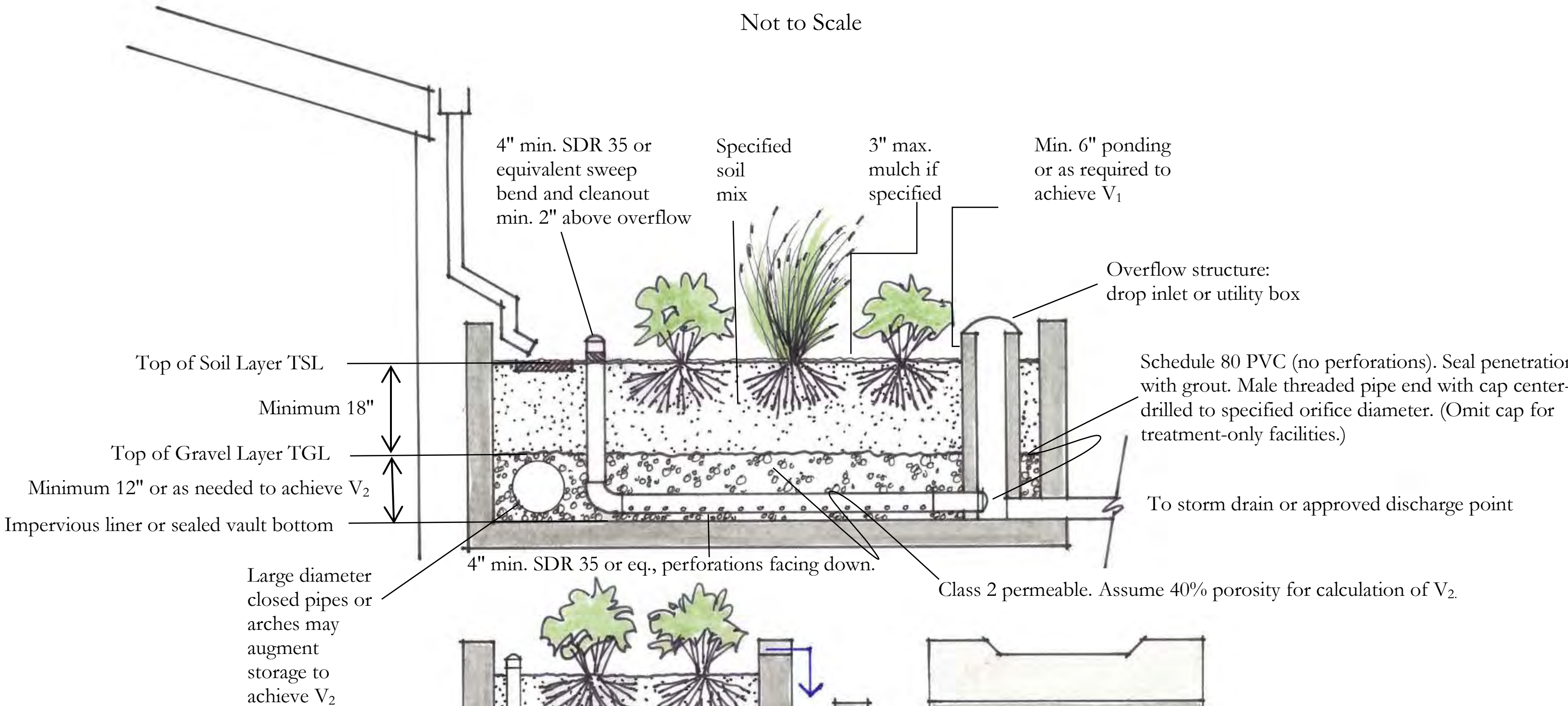
- ❒ Location and footprint of facility are shown on site plan and landscaping plan.
- ❒ Planter is set level.
- ❒ Location is on an upper-story plaza, adjacent to a building foundation, where mobilization of pollutants in soil or groundwater is a concern, or where potential geotechnical hazards are associated with infiltration
- ❒ Volume or depth of surface reservoir meets or exceeds minimum.
- ❒ 18" depth specified soil mix (reference *Guidebook* Appendix B).
- ❒ Area of soil mix meets or exceeds minimum.
- ❒ "Class 2 perm" drainage layer.
- ❒ No filter fabric.
- ❒ Perforated pipe (PVC SDR 35 or approved equivalent) underdrain with outlet located flush or nearly flush with planter bottom.
- ❒ Connection with sufficient head to storm drain or discharge point.
- ❒ Underdrain has a clean-out port consisting of a vertical, rigid, non-perforated PVC pipe, with a minimum diameter of 4" and a watertight cap.
- ❒ Overflow outlet connected to a downstream storm drain or approved discharge point.
- ❒ Emergency spillage will be safely conveyed overland.
- ❒ Plantings are suitable to the climate, exposure, and a well-drained soil.
- ❒ Irrigation system with connection to water supply, on a separate zone. See Appendix B.

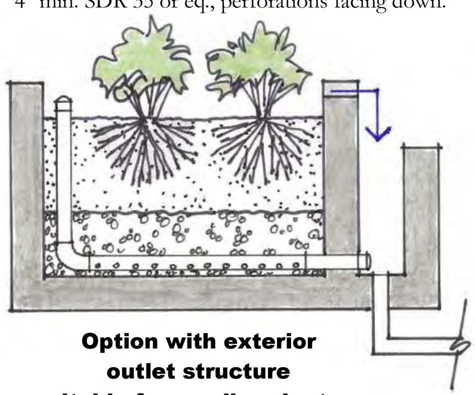
For treatment-and-flow-control flow-through planters only

- ❒ Volume of surface storage meets or exceeds minimum.
- ❒ Volume of subsurface storage meets or exceeds minimum.
- ❒ Underdrain is connected via an appropriately sized orifice or other flow-limiting device.

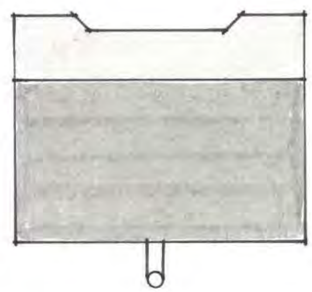
Flow-through Planter

Cross-section
Not to Scale





Option with exterior outlet structure suitable for smaller planters



Side view

Notes:

- Underdrain to be min. 4" PVC SDR 35 or equiv. with holes facing down.
- Locate undedrain as close as possible to bottom.
- No filter fabric, no landscape cloth.
- See Appendix B for soil mix specification, planting and irrigation guidance.
- See Chapter 3 for factors and equations used to calculate V_1 V_2 and orifice diameter.

Dry Wells and Infiltration Basins

The typical dry well is a prefabricated structure, such as an open-bottomed vault or box, placed in an excavation or boring. The vault may be empty, which provides maximum space efficiency, or may be filled with rock.

An infiltration basin has the same functional components—a volume to store runoff and sufficient area to infiltrate that volume into the native soil—but is open rather than covered.

► CRITERIA

Dry wells and infiltration basins must be designed with the minimum volume and infiltrative area calculated by Equation 3-3 using the sizing factors in Table 3-6.

Consult with the local municipal engineer regarding the need to verify soil permeability and other site conditions are suitable for dry wells and infiltration basins. Some proposed criteria are on Page 5-12 of Caltrans' 2004 *BMP Retrofit Pilot Study Final Report* (CTSW-RT-01-050).

► DETAILS

Dry wells should be sited to facilitate maintenance and allow for the potential future need for removal and replacement.

In locations where native soils are coarser than a medium sand, the area directly beneath the facility should be over-excavated by two feet and backfilled with sand as a groundwater protection measure.

Best Uses

- Projects on sites with permeable soils

Advantages

- Compact footprint
- Can be installed in paved areas

Limitations

- Can be used only on sites with Group "A" or Group "B" soils
- Requires minimum of 10' from bottom of facility to seasonal high groundwater
- Not suitable for drainage from some industrial areas or arterial roads
- Must be maintained to prevent clogging.
- Typically not as aesthetically pleasing as bioretention facilities

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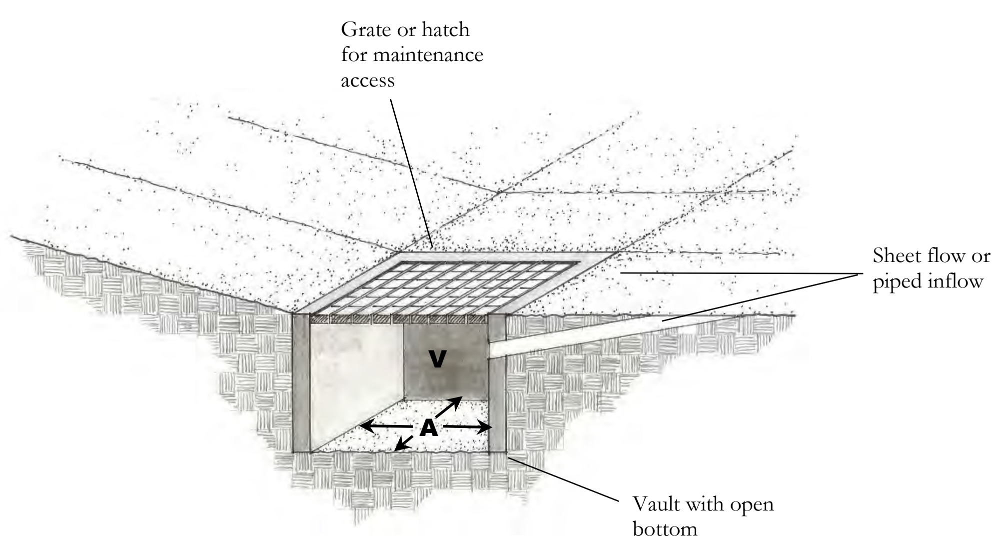
Criteria for Dry Wells and Infiltration Basins

- ❒ Volume (V) and infiltrative area (A) meet or exceed minimum.
- ❒ Emergency spillage will be safely conveyed overland.
- ❒ Depth from bottom of the facility to seasonally high groundwater elevation is ≥10'.
- ❒ Areas tributary to the facility do not include automotive repair shops; areas subject to high vehicular traffic (25,000 or greater average daily traffic on main roadway or 15,000 or more average daily traffic on intersecting roadway), car washes; fleet storage areas (bus, truck, etc.); nurseries, or other uses that may present an exceptional threat to groundwater quality.
- ❒ Underlying soils are in Hydrologic Soil Group A or B. Infiltration rate is sufficient to ensure a full basin will drain completely within 72 hours. Soil infiltration rate has been confirmed.
- ❒ 10' setback from structures or as recommended by structural or geotechnical engineer



Cistern + Bioretention Facility

A cistern in series with a bioretention facility or flow-through planter can meet treatment and flow-control requirements where space is limited. The cistern includes an orifice for flow control. The downstream bioretention facility or flow-through planter is sized to accommodate the maximum flow from the cistern orifice.

► CRITERIA

Cistern. Size the cistern using Equation 3-3 (page 38) and the factors and rainfall adjustment equations in Tables 3-6 and 3-7. The cistern must also include an orifice or other device to limit outflow to the calculated maximum release rate.

Bioretention facility. Size the bioretention facility or flow-through planter based on the cistern maximum release rate and a maximum surface loading rate of 5" per hour.

► DETAILS

Preventing mosquito harborage. Cisterns should be designed to drain completely, leaving no standing water. Drains should be located flush with the bottom of the cistern. Alternatively—or in addition—all entry and exit points should be provided with traps or sealed or screened to prevent mosquito entry. Note mosquitoes can enter through openings $\frac{1}{16}$" or larger and will fly for many feet through pipes as small as ¼".

Exclude debris. Provide leaf guards and/or screens to prevent debris from accumulating in the cistern.

Ensure access for maintenance. Design the cistern to allow for cleanout. Avoid creating the need for maintenance workers to enter a confined space. Ensure the outlet orifice can be easily accessed for cleaning and maintenance.

► APPLICATIONS

Shallow ponding on a flat roof. The "cistern" storage volume can be designed in any configuration, including simply storing rainfall on the roof where it falls and draining it away slowly. In sites with Group "D" soils, the required average depth amounts to about ¾".

Best Uses

- To meet flow-control requirements in limited space.
- Management of roof runoff
- Dense urban areas

Advantages

- Storage volume can be in any configuration
- Small footprint

Limitations

- Somewhat complex to design, build, and operate
- Requires head for both cistern and bioretention facility

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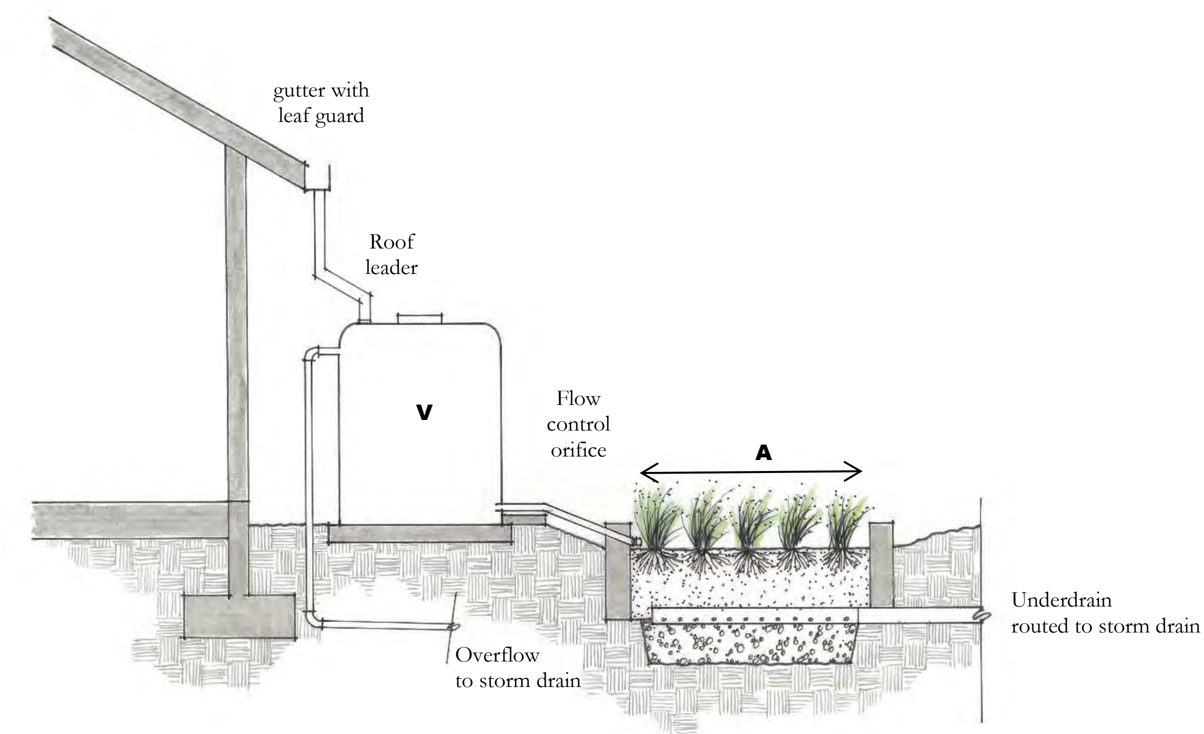
Cistern attached to a building and draining to a planter. This system for treatment-and-flow-control can be constructed with a flow-through planter at a height as low as 30".

Criteria for Cistern + Bioretention

- ❒ Cistern volume meets or exceeds calculated minimum V (Eq. 3-3).
- ❒ Cistern outlet with orifice or other flow-control device restricts flow to calculated maximum. A drilled, threaded cap is suggested for easy maintenance.
- ❒ Cistern outlet is piped to bioretention area or flow-through planter.
- ❒ Bioretention surface area meets or exceeds the calculated minimum.
- ❒ Except for surface area, bioretention facility is designed to the criteria for "treatment only" in the "Bioretention Facility" design sheet (p. 59) or "Flow-through Planter" design sheet (p. 69).
- ❒ Cistern is designed to drain completely and/or sealed to prevent mosquito harborage.
- ❒ Design provides for exclusion of debris and accessibility for maintenance.
- ❒ Overflow connected to a downstream storm drain or approved discharge point.
- ❒ Emergency spillage will be safely conveyed overland.



Bioretention + Vault

A bioretention facility in series with a vault can meet treatment and flow-control requirements where space is limited. In this configuration, the bioretention facility is sized to a minimum of 4% of the tributary impervious area. The underdrain and overflow from the bioretention facility are routed to a storage vault, which can be located beneath a plaza, sidewalk, or parking area. An orifice limits the rate of discharge from the vault to the storm drain system.

▶ CRITERIA

Bioretention facility. Size and design the bioretention facility to the treatment-only criteria (see Bioretention Facility design sheet, p. 69.)

Vault. Size the vault using Equation 3-3 (page 52) and the factors and rainfall adjustment equations in Tables 3-6 and 3-7. The vault must include an orifice or other device to limit outflow.

Dead storage in the bioretention facility (volume of the gravel pore space or other free volume below the elevation of the underdrain discharge) may be credited toward the required V_2.

▶ DETAILS

Preventing mosquito harborage. Vaults must be designed to drain completely, leaving no standing water, and have an open bottom to allow infiltration into the native soil.

Ensure access for maintenance. Design the vault to allow for cleanout. Avoid creating the need for maintenance workers to enter a confined space. Ensure the outlet orifice can be easily accessed for cleaning and maintenance.

▶ APPLICATIONS

Parking lot. Because the required landscaped bioretention facilities is only 4% of the tributary impervious area, the bioretention component can in many cases be integrated into parking lot medians and islands. The vault component can be located beneath aisles or driveways.

Best Uses

- To meet flow-control requirements in limited space
- Parking lots
- Dense urban areas

Advantages

- Smaller footprint than bioretention facility sized for flow control

Limitations

- Somewhat complex to design, build, and operate
- Requires head for both bioretention facility and vault

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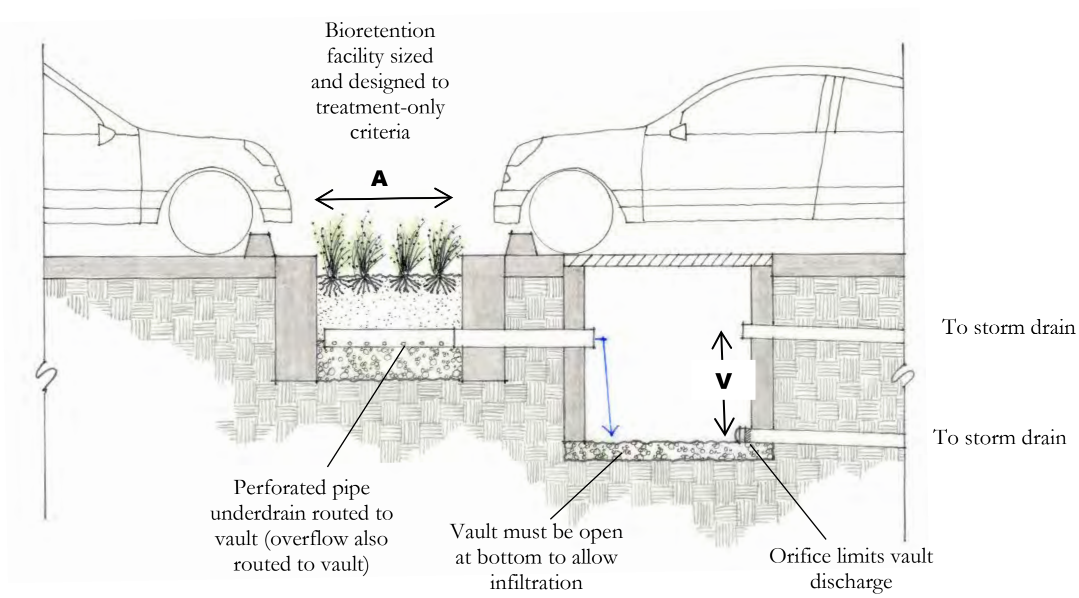
Multiple bioretention facilities draining to a single vault. Two or more bioretention areas can be connected to a single vault. The vault minimum volume and outlet maximum flow rate are the sum of those calculated for each individual bioretention facility.

Vault with pumped discharge. Where insufficient head exists, vaults may be equipped with pumps to discharge (at a rate no greater than the calculated maximum) to a storm drain or approved discharge point.

Design Checklist for Bioretention + Vault

- ❒ Bioretention facility is designed to the treatment-only criteria in the "Bioretention Facility" design sheet (pp. 59-68).
- ❒ Vault retention volume meets or exceeds calculated minimum.
- ❒ Vault outlet with orifice or other flow-control device restricts flow to calculated maximum.
- ❒ Bioretention facility underdrain is routed to the vault.
- ❒ Bioretention facility overflow is routed to the vault.
- ❒ Sufficient head exists to convey flow from the underdrain to the vault and from the vault to the discharge point.
- ❒ Bottom of vault is open to allow infiltration.
- ❒ Vault design provides for exclusion of debris and accessibility for maintenance.
- ❒ Vault outlet and overflow are connected to a downstream storm drain or approved discharge point.
- ❒ Emergency spillage will be safely conveyed overland.



Items to Be Inspected During Construction

Successful construction of IMPs requires attention to detail during **every stage** of the construction process, from initial layout to rough grading, installation of utilities, construction of buildings, paving, landscaping, and final clean-up and inspection.

Construction project managers need to understand the purpose and function of IMPs and know how to avoid common missteps that can occur during construction. For bioretention facilities, the following operating principles should be noted at a pre-construction meeting.

- Runoff flow from the intended tributary drainage management area must flow into the facility.
- The surface reservoir must fill to its intended volume during high inflows.
- Runoff must filter rapidly through the layer of imported soil mix.
- Filtered runoff must infiltrate into the native soil to the extent possible (or allowable).
- Remaining runoff must be captured and drained to a storm drain or other approved location.

See the model construction inspection checklist on the following pages.

IMP CONSTRUCTION CHECKLIST

LAYOUT (to be confirmed prior to beginning excavation)

- ❒ Square footage of the facility meets or exceeds minimum shown in Stormwater Control Plan
- ❒ Site grading and grade breaks are consistent with the boundaries of the tributary Drainage Management Area(s) (DMAs) shown in the Stormwater Control Plan
- ❒ Inlet elevation of the facility is low enough to receive drainage from the entire tributary DMA
- ❒ Locations and elevations of overland flow or piping, including roof leaders, from impervious areas to the facility have been laid out and any conflicts resolved
- ❒ Rim elevation of the facility is laid out to be level all the way around, or elevations are consistent with a detailed cross-section showing location and height of interior dams
- ❒ Locations for vaults, utility boxes, and light standards have been identified so that they will not conflict with the facility
- ❒ Facility is protected as needed from construction-phase runoff and sediment

EXCAVATION (to be confirmed prior to backfilling or pipe installation)

- ❒ Excavation conducted with materials and techniques to minimize compaction of soils within the facility area
- ❒ Excavation is to accurate area and depth
- ❒ Slopes or side walls protect from sloughing of native soils into the facility
- ❒ Moisture barrier, if specified, has been added to protect adjacent pavement or structures.
- ❒ Native soils at bottom of excavation are ripped or loosened to promote infiltration

OVERFLOW OR SURFACE CONNECTION TO STORM DRAINAGE
(to be confirmed prior to backfilling with any materials)

- ❒ Overflow is at specified elevation (typically no lower than two inches below facility rim)
- ❒ No knockouts or side inlets are in overflow riser
- ❒ Overflow location selected to minimize surface flow velocity (near, but offset from, inlet recommended)
- ❒ Grating excludes mulch and litter (beehive or atrium-style grates with ¼" openings recommended)
- ❒ Overflow is connected to storm drain via appropriately sized piping

UNDERGROUND CONNECTION TO STORM DRAIN/OUTLET ORIFICE
(to be confirmed prior to backfilling IMP with any materials)

- ❒ Perforated pipe underdrain (PVC SDR 35 or approved equivalent) is installed with holes facing down
- ❒ Perforated pipe is connected to storm drain (treatment only) or orifice (treatment-and-flow-control)
- ❒ Underdrain pipe is at elevation shown in plans. In facilities allowing infiltration, preferred elevation is above native soil but low enough to be covered by at least 2 inches of Class 2 perm; in sealed planter boxes or bioretention facilities with liners, preferred elevation is as near bottom as possible
- ❒ Cleanouts are in accessible locations and connected via sweeps
- ❒ Structures (arches or large diameter pipes) for additional surface storage are installed as shown in plans and specifications and have the specified volume

(continued)

IMP CONSTRUCTION CHECKLIST (CONTINUED)

DRAIN ROCK/SUBDRAIN (to be confirmed prior to installation of soil mix)

- ❒ Rock is installed as specified. Class 2 permeable, Caltrans specification 68-1.025 recommended, or 4"-6" pea gravel is installed at the top of the crushed rock layer
- ❒ Rock is smoothed to a consistent top elevation. Depth and top elevation are as shown in plans
- ❒ Slopes or side walls protect from sloughing of native soils into the facility
- ❒ No filter fabric is placed between the subdrain and soil mix layers

SOIL MIX

- ❒ Soil mix is as specified. Quality of mix is confirmed by delivery ticket or on-site testing as appropriate to the size and complexity of the facility
- ❒ Mix installed in lifts not exceeding 12"
- ❒ Mix is not compacted during installation but may be thoroughly wetted to encourage consolidation
- ❒ Mix is smoothed to a consistent top elevation. Depth of mix (18" min.) and top elevation are as shown in plans, accounting for depth of mulch to follow and required reservoir depth

IRRIGATION

- ❒ Irrigation system is installed so it can be controlled separately from other landscaped areas. Smart irrigation controllers and drip emitters are recommended
- ❒ Spray heads, if any, are positioned to avoid direct spray into outlet structures

PLANTING

- ❒ Plants are installed consistent with approved planting plan
- ❒ Any trees and large shrubs are staked securely
- ❒ No fertilizer is added; compost tea may be used
- ❒ No native soil or clayey material are imported into the facility with plantings
- ❒ 1"-2" mulch may be applied following planting; mulch selected to avoid floating
- ❒ Final elevation of soil mix maintained following planting
- ❒ Curb openings are free of obstructions

FINAL ENGINEERING INSPECTION

- ❒ Drainage Management Area(s) are free of construction sediment and landscaped areas are stabilized
- ❒ Inlets are installed to provide smooth entry of runoff from adjoining pavement, have sufficient reveal (drop from the adjoining pavement to the top of the mulch or soil mix, and are not blocked
- ❒ Inflows from roof leaders and pipes are connected and operable
- ❒ Temporary flow diversions are removed
- ❒ Rock or other energy dissipation at piped or surface inlets is adequate
- ❒ Overflow outlets are configured to allow the facility to flood and fill to near rim before overflow
- ❒ Plantings are healthy and becoming established
- ❒ Irrigation is operable
- ❒ Facility drains rapidly; no surface ponding is evident
- ❒ Any accumulated construction debris, trash, or sediment is removed from facility

Chapter

5

Operation & Maintenance of Stormwater Facilities

How to prepare a customized Stormwater Facilities Operation & Maintenance Plan for the treatment BMPs on your site.

Stormwater NPDES Permit Provision C.3.e requires each municipality verify stormwater treatment and flow-control facilities, and impervious pavement installations 3000 SF and greater in area, are adequately maintained. Municipalities must report the results of inspections to the Water Boards annually.

Facilities you install as part of your project will be incorporated into the local municipality's verification program. This is a six-stage process:

1. Determine **who will own** the facility and be responsible for its maintenance in perpetuity and document this in your Stormwater Control Plan. The Stormwater Control Plan must also identify the means by which ongoing maintenance will be assured (for example, a maintenance agreement that runs with the land).

2. Identify typical maintenance requirements, allow for these requirements in your project planning and preliminary design, and document the typical maintenance requirements in your Stormwater Control Plan.

3. Prepare an **Operation and Maintenance Plan** (O&M Plan) for the site incorporating detailed requirements for **each treatment and flow-control facility**. Typically, a draft O&M Plan must be submitted with the building permit application, and a final O&M Plan must be submitted for review and approved by the municipality prior to building permit final and issuance of a certificate of occupancy. **Local requirements vary as to schedule. Check with municipal staff.**

4. **Maintain** the facilities from the time they are constructed until ownership and maintenance responsibility is formally transferred.

5. **Formally transfer** operation and maintenance **responsibility** to the site owner or occupant. A warranty, secured by a bond, or other financial instrument, may be required to secure against lack of performance due to flaws in design or construction. A typical warranty period will cover two rainy seasons.

6. Maintain the facilities in perpetuity and comply with your municipality's self-inspection, reporting, and verification requirements.

See the schedule for these stages in Table 6-1. **Again, local requirements will vary.**

TABLE 5-1. SCHEDULE FOR PLANNING operation and maintenance of stormwater treatment and flow-control faciliites

Stage	*Description*	*Where documented*	*Schedule*
1	Determine facility ownership and maintenance responsibility	Stormwater Control Plan	Discuss with planning staff at pre-application meeting
2	Identify typical maintenance requirements	Stormwater Control Plan	Submit with planning & zoning application
3	Develop detailed operation and maintenance plan	O&M Plan	Submit draft with Building Permit application; final due before building permit final and applying for a Certificate of Occupancy
4	Interim operation and maintenance of facilities	As required by municipal O&M verification program	During and following construction including warranty period
5	Formal transfer of operation & maintenance responsibility	As required by municipal O&M verification program	On sale and transfer of property or permanent occupancy
6	Ongoing maintenance and compliance with inspection & reporting requirements	As required by municipal O&M verification program	In perpetuity

Stage 1: Ownership and Responsibility

Your Stormwater Control Plan must specify a means to **finance and implement maintenance** of treatment and flow-control facilities **in perpetuity.**

Depending on the intended use of your site and the policies of the local municipality, this may require one or more of the following:

- Execution of a maintenance agreement that "runs with the land."
- Creation of a homeowners association (HOA) and execution of an agreement by the HOA to maintain the facilities as well as an annual inspection fee.
- Formation of a new community facilities district or other special district, or addition of the properties to an existing special district.
- Dedication of fee title or easement transferring ownership of the facility (and the land under it) to the municipality.

Ownership and maintenance responsibility for treatment and flow-control facilities should be discussed at the **beginning of project planning**, typically at the pre-application meeting for planning and zoning review. Experience has shown provisions to finance and implement maintenance of treatment and flow-control facilities can be a major stumbling block to project approval, particularly for **small residential subdivisions**. (See "Applying C.3 to New Subdivisions" in Chapter 1.)

► PRIVATE OWNERSHIP AND MAINTENANCE

The municipality may require—as a condition of project approval—that a maintenance agreement be executed.

The CCCWP has prepared the following model agreements:

- Operation and Maintenance Agreement for a Single Parcel with a Stormwater Management Facility
- Operation and Maintenance Agreement for Subdivisions with Stormwater Management Facilities
- Operation and Maintenance Agreement for Subdivisions with Stormwater Management Facilities and a Homeowners Association
- CC&R and Subdivision Map Provisions for Subdivisions with Stormwater Management Facilities
- CC&R Provisions for Subdivisions with Stormwater Management Facilities and a Homeowners Association

The model agreements "run with the land," so the agreement executed by a developer is binding on the owners of the subdivided lots. The agreement must be recorded prior to conveyance of the subdivided property.

The model agreements provide the municipality may collect a management and/or inspection fee established by the standard fee schedule. In addition, the agreements provide that, if the property owner fails to maintain the stormwater facility, the municipality may enter the property, restore the stormwater facility to good working order and obtain reimbursement, including administrative costs, from the property owner.

To augment and enforce maintenance requirements, the County established a two-tiered Community Facilities District (Mello-Roos) throughout the unincorporated area to cover the costs of inspections, reporting to the Water Board and, if necessary, code enforcement and maintenance and repair of individual facilities. Some cities and towns may have similar districts.

► TRANSFER TO PUBLIC OWNERSHIP

Municipalities may sometimes choose to have a treatment and flow-control facility deeded to the public in fee or as an easement and maintain the facility as part of the municipal storm drain system. The municipality may recoup the costs of maintenance through a special tax, assessment district, or similar mechanism.

Locating an IMP in a public right-of-way or easement creates an additional design constraint—along with hydraulic grade, aesthetics, landscaping, and circulation. However, because sites typically drain to the street, it may be possible to locate a bioretention swale parallel with the edge of the parcel. The facility may complement, or substitute for, an underground storm drain system.

Local Requirements

Cities, towns, or the County may have requirements that differ from, or are in addition to, this countywide Guidebook. See Appendix A and check with local planning and community development staff.

Even if the facility is to be deeded or transferred to the municipality after construction is complete, it is still the responsibility of the builder to identify general operation and maintenance requirements, prepare a detailed operation and maintenance plan, and to maintain the facility until that responsibility is formally transferred.

Stage 2: General Maintenance Requirements

Include in your Stormwater Control Plan a general description of anticipated facility maintenance requirements. This will help ensure that:

- Ongoing costs of maintenance have been considered in your facility selection and design.

- Site and landscaping plans provide for access for inspections and by maintenance equipment.

- Landscaping plans incorporate irrigation requirements for facility plantings.
- Initial maintenance and replacement of facility plantings is incorporated into landscaping contracts and guarantees.

Fact sheets available on the CCCWP C.3 web page describe general maintenance requirements for the types of stormwater facilities featured in the LID Design Guide (Chapter 4). You can use this information to specify general maintenance requirements in your Stormwater Control Plan.

Maintenance fact sheets for conventional stormwater facilities are available in the California Stormwater BMP Handbooks.

Stage 3: Stormwater Facilities O&M Plan

Submit a **draft** O&M Plan with construction documents when you apply for permits to begin grading or construction on the site. **Revise** your draft O&M plan in response to any comments from your municipality, and incorporate new information and changes developed during project construction. Submit a revised, **final** O&M plan before construction is complete.

Your Final Stormwater Control O&M Plan must be submitted to and approved by your municipality before your building permit can be made final and a certificate of occupancy issued.

Your O&M Plan must be kept on-site for use by maintenance personnel and during site inspections. It is also recommended that a copy of the Stormwater Control Plan be kept onsite as a reference.

Municipal Regional Permit Provision C.3.h requires Contra Costa municipalities periodically verify operation and maintenance (O&M) of facilities installed in their jurisdiction. Each year, they must report to the Water Board the facilities inspected that year and the status of each.

The final O&M plan should incorporate solutions to any problems noted or changes that occurred during construction. For this reason, the final O&M plan may be submitted at the end of the construction period, before the application for final building permit and Certificate of Occupancy.

► TOOLS AND ASSISTANCE

The following step-by-step instructions—and forms available on the CCCWP website—will help you prepare your Stormwater Control Operation and Maintenance Plan. You may use, adapt, and assemble these documents to prepare your own Plan, which will be customized to the specific needs of your site.

These include:

- A form for stating or updating key contact information.
- An example Inspection and Maintenance Log.
- A format for an independent inspector's annual inspection report.
- An example maintenance matrix including necessary maintenance activities, recommended frequency of inspections of maintenance, and indications that maintenance is necessary.

Additional useful references, including links to additional documents, are available in "References and Resources" at the end of this chapter.

► YOUR O&M PLAN: STEP BY STEP

The following step-by-step guidance will help you prepare each required section of your Stormwater Control Operation and Maintenance Plan.

Preparation of the plan will require familiarity with your stormwater facilities as they have been constructed and a fair amount of "thinking through" plans for their operation and maintenance. The text and forms provided here will assist you, but are no substitute for thoughtful planning.

► STEP 1: DESIGNATE RESPONSIBLE INDIVIDUALS

To begin creating your O&M Plan, your organization must designate and identify:

- The individual who will have direct responsibility for the maintenance of stormwater controls. This individual should be the designated contact with municipal inspectors and should sign self-inspection reports and any correspondence with the municipality regarding verification inspections.
- Employees or contractors who will report to the designated contact and are responsible for carrying out BMP operation and maintenance.
- The corporate officer authorized to negotiate and execute any contracts that might be necessary for future changes to operation and maintenance or to implement remedial measures if problems occur.
- Your designated respondent to problems, such as clogged drains or broken irrigation mains, that would require immediate response should they occur during off-hours.

It is recommended to use the form available on the CCCWP website to list this information. **Updated contact information must be provided to the municipality immediately whenever a property is sold and whenever designated individuals or contractors change.** Complete a new form—and mail or fax a copy to the municipality—whenever this occurs.

Draw or sketch an **organization chart** to show the relationships of authority and responsibility between the individuals responsible for O&M. This need not be elaborate, particularly for smaller organizations.

Describe how **funding for BMP operation and maintenance** will be assured, including sources of funds, budget category for expenditures, process for establishing the annual maintenance budget, and process for obtaining authority should unexpected expenditures for major corrective maintenance be required.

Describe how your organization will accommodate initial **training** of staff or contractors regarding the purpose, mode of operation, and maintenance requirements for the stormwater facilities on your site. Also, describe how your organization will ensure ongoing training as needed and in response to staff changes.

► STEP 2: SUMMARIZE DRAINAGE AND BMPS

Incorporate the following information from your Stormwater Control Plan into your O&M Plan:

- Figures delineating and designating pervious and impervious areas.
- Figures showing locations of stormwater facilities on the site.
- Tables of pervious and impervious areas served by each facility.

Review the Stormwater Control Plan narrative that describes each facility and its tributary drainage area and update the text to incorporate any changes that may have occurred during planning and zoning review, building permit review, or construction. Incorporate the updated text into your O&M Plan.

► STEP 3: DOCUMENT FACILITIES "AS BUILT"

Include the following information from final construction drawings:

- Plans, elevations, and details of all facilities. Annotate if necessary with designations used in the Stormwater Control Plan.
- Design information or calculations submitted in the detailed design phase (i.e., not included in the Stormwater Control Plan)

- Specifications of construction for facilities, including sand or soil, compaction, pipe materials and bedding.

In the final O&M Plan, incorporate field changes to design drawings, including changes to any of the following:

- Location and layouts of inflow piping, flow splitter boxes, and piping to off-site discharge
- Depths and layering of soil, sand, or gravel
- Placement of filter fabric or geotextiles (not recommended between soil and gravel layers of bioretention facilities)
- Changes or substitutions in soil or other materials.
- Natural soils encountered (e.g. sand or clay lenses)

► STEP 4: PREPARE CUSTOMIZED MAINTENANCE PLANS

Prepare a maintenance plan, schedule, and inspection checklists (routine, annual, and after major storms) for each facility. Plans and schedules for two or more similar facilities on the same site may be combined.

Use the following resources to prepare your customized maintenance plan, schedule, and checklists.

- Specific information noted in Steps 2 and 3, above.
- Other input from the facility designer, municipal staff, or other sources.
- BMP Operation and Maintenance Fact Sheets (available on the CCCWP C.3 web page).

Note any particular characteristics or circumstances that could require attention in the future, and include any troubleshooting advice.

Also include manufacturer's data, operating manuals, and maintenance requirements for any:

- Pumps or other mechanical equipment.
- Proprietary devices used as or in conjunction with BMPs.

Manufacturers' publications should be referenced in the text (including models and serial numbers where available). Copies of the manufacturers' publications should be included as an attachment in the back of your O&M Plan or as a separate document.

To better organize your maintenance plan, consider using the "O&M Maintenance Matrix" available on the Program's C.3 web page to present inspection frequencies, observations, and appropriate maintenance response.

► STEP 5: COMPILE O&M PLAN

Your O&M Plan should follow this general outline:

I. Inspection and Maintenance Log

II. Updates, Revisions and Errata

III. Introduction

   A. Narrative overview describing the site; drainage areas, routing, and discharge points; and treatment and flow control facilities

IV. Responsibility for Maintenance

   A. General

      (1) Name and contact information for responsible individual(s).

      (2) Organization chart or charts showing organization of the maintenance function and location within the overall organization.

      (3) Reference to Operation and Maintenance Agreement (if any). A copy of the agreement should be attached.

      (4) Maintenance Funding

         (a) Sources of funds for maintenance

         (b) Budget category or line item

         (c) Description of procedure and process for ensuring adequate funding for maintenance

   B. Staff Training Program

   C. Records

   D. Safety

V. Summary of Drainage Areas and Stormwater Facilities

A. Drainage Areas

(1) Drawings showing pervious and impervious areas (copied or adapted from Stormwater Control Plan)

(2) Designation and description of each drainage area and how flow is routed to the corresponding facility.

B. Treatment and Flow Control Facilities

(1) Drawings showing location and type of each facility

(2) General description of each facility (Consider a table if more than two facilities)

(a) Area drained and routing of discharge.

(b) Facility type and size

VI. BMP Design Documentation

A. "As-built" drawings of each facility (design drawings in the draft Plan)

B. Manufacturer's data, manuals, and maintenance requirements for pumps, mechanical or electrical equipment, and proprietary facilities (include a "placeholder" in the draft plan for information not yet available).

C. Specific operation and maintenance concerns and troubleshooting

VII. Maintenance Schedule or Matrix

A. Maintenance Schedule for each facility with specific requirements for:

(1) Routine inspection and maintenance

(2) Annual inspection and maintenance

(3) Inspection and maintenance after major storms

B. Service Agreement Information

Assemble and make copies of your O&M Plan. One or more copies must be submitted to the municipality, and at least one copy kept on-site. Here are some suggestions for formatting the O&M Plan:

- Format plans to 8½" x 11" to facilitate duplication, filing, and handling.

- Include the revision date in the footer on each page.
- Scan graphics and incorporate with text into a single electronic file. Keep the electronic file backed-up so that copies of the O&M Plan can be made if the hard copy is lost or damaged.

► **STEP 6: UPDATES**

Your Stormwater Control Operation and Maintenance Plan will be **a living document**.

Operation and maintenance personnel may change; mechanical equipment may be replaced, and additional maintenance procedures may be needed. Throughout these changes, the O&M Plan must be kept up-to-date.

Updates may be transmitted to your municipality at any time. However, at a minimum, updates to the O&M Plan must accompany the annual inspection report. These updates should reference the sections of the Plan being changed and should be placed in reverse chronological order (most recent at the top) in Section II of the binder. If the entire O&M Plan is updated, as it should be from time to time, these updates should be removed from the first section, but may be filed (perhaps in the back of the binder) for possible future reference.

Stage 4: Interim Operation & Maintenance

In accordance with NPDES Permit Provision C.3.e.ii, include the following statement in your Stormwater Control Plan:

> The property owner accepts responsibility for interim operation and maintenance of stormwater treatment and flow-control facilities until such time as this responsibility is formally transferred to a subsequent owner.

Applicants will typically be required to warranty stormwater facilities against lack of performance due to flaws in design or construction for a minimum of two rainy seasons following completion of construction. The warranty may need to be secured by a bond or other financial instrument.

Stage 5: Transfer Responsibility

As part of the final O&M plan, note the expected date when responsibility for operation and maintenance will be transferred. Notify your municipality when this transfer of responsibility takes place.

Stage 6: Operation & Maintenance Verification

Each Contra Costa municipality will implement a Stormwater Treatment Measures Operation and Maintenance Verification Program, including periodic site inspections.

Local stormwater ordinances state municipalities may require an annual certificate of compliance certifying operation and maintenance of treatment and flow-control facilities. To obtain a certificate of compliance, the responsible party must request and pay for an inspection from the municipality each year. Alternatively, owners or lessees may arrange for inspection by a private company authorized by the municipality. Based on the results of the inspection, the municipality may issue a certificate, issue a conditional certificate requiring correction of noted deficiencies by a specific date, or deny the certificate.

Some municipalities have established alternative procedures. Check with local staff for requirements.

References and Resources

- *Model Stormwater Ordinance (CCCWP, 2005)*
- *Start at the Source* (BASMAA, 1999) pp. 139-145.
- *Urban Runoff Quality Management* (WEF/ASCE, 1998). pp 186-189.
- Contra Costa Clean Water Program *Vector Control Plan*

Bibliography

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BASMAA. 1999. Bay Area Stormwater Management Agencies Association. *Start at the Source: Design Guidance Manual for Stormwater Quality.* Tom Richman and Associates. 154 pp. plus appendix. (on CCCWP website)

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CCCWP. 2006. *Policy for C.3 Compliance for Subdivisions.* 15 February 2006, 3 pp.

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Prince George's County, Maryland. 2007. *Bioretention Manual.* Department of Environmental Resources, Programs and Planning Division.

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RWQCB. 2015. California Regional Water Quality Control Board for the San Francisco Bay Region. Municipal Regional Stormwater NPDES Permit. Order R2-2015-0074.

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StopWaste.org. 2008. *Bay Friendly Landscape Guidelines.*

USEPA. 2009a. *Green Roofs for Stormwater Runoff Control.*

USEPA. 2009b. *Technical Guidance on Implementing the Stormwater Runoff Requirements for Federal Projects under Section 438 of the Energy Independence and Security Act*. EPA 841-B-09-001

WEF/ASCE. 1998. Water Environment Foundation/American Society of Civil Engineers. Urban Runoff Quality Management. WEF Manual of Practice No. 23, ASCE Manual and Report on Engineering Practice No. 87. ISBN 1-57278-039-8 ISBN 0-7844-0174-8. 259 pp.

Appendix

A

Local Exceptions & Requirements

Municipality-specific procedures, policies, and submittal requirements.
Obtain from your municipal planning and community development department.

The Contra Costa Clean Water Program C.3 web page includes links to each Contra Costa municipality's C.3 information.

Appendix

B

Soils, Plantings, and Irrigation for Bioretention Facilities

Additional guidance for design and construction of bioretention facilities and flow-through planters

Bioretention facility owners are responsible for ensuring the following standards of performance are achieved throughout the life of the facility:

- Runoff must percolate through the imported bioretention soil mix at a minimum rate of 5" per hour.
- Plantings must be maintained in a healthy condition without use of conventional fertilizers or pesticides.
- Irrigation systems must minimize water use and be controlled to prevent overwatering and underdrain flow during dry weather.

As described in Chapter 5, municipalities will periodically verify these standards continue to be achieved. Operation and maintenance verification is required by the municipalities' stormwater NPDES permit issued by the Regional Water Quality Control Board.

The design criteria and checklists and other guidance in Chapter 3—including the design sheets—aim to ensure new bioretention facilities and planter boxes can reliably meet these standards of performance.

The additional guidance in this Appendix will assist applicants and their designers as they proceed from initial planning through design and construction.

Appendix B Contents

Responsibility for design, construction, maintenance, and performance of stormwater treatment and flow-control facilities and their components rests with the applicant or property owner.

Soils

Soils for bioretention facilities must meet the specifications proposed by BASMAA and accepted by Water Board staff. The current specifications were approved April 18, 2016. These specifications were adapted from specifications in the 5th Edition of this *Guidebook* (2010). The substantive change is the addition of particle size distribution for compost as well as for sand.

Use of the standard (rather than "alternative") soil mix is strongly encouraged. See the CCCWP C.3 web pages for a list of suppliers. These suppliers have submitted sample testing data to CCCWP. At their sole discretion, municipal construction inspectors may choose to accept test results and certification for a "brand-name" mix from a soil supplier.

► SUBMITTAL REQUIREMENTS AND PROCESS

It is recommended that permittees request applicants and soil suppliers to submit only the information specified in Attachment L when seeking approval to use a particular mix.

For the "specified" mix, the submittal requirements are:

- A sample of mixed bioretention soil.
- Certification that the mix meets the specification.
- Grain size analysis of the sand component.
- Quality analysis results for compost based on the US Composting Council's Seal of Testing Assurance standards
- Grain size analysis of the compost component
- Description of equipment and methods used to mix the sand and compost.
- Contact information for the testing laboratory, including qualifications and dates of current certifications

Attachment L explicitly allows municipalities to accept test results and certification for a "brand name" mix from a supplier in lieu of test results and certification specific to the development project.

For the specified mix, no infiltration rate testing is required. It is recommended this information not be included in submittals for the "specified" mix. (Infiltration rate tests are required with requests to approve "alternative" soil mixes.)

It is also common for the testing laboratory to provide information regarding soil fertility and recommended soil fertilizers or amendments. As fertilizers and amendments are not to be used in bioretention facilities, this information is potentially misleading to contractors and maintenance personnel and and should also be omitted from the submittal.

► PLACEMENT AND COMPACTION OF BIORETENTION SOILS

Place the bioretention soil in 8" to 12" lifts. Lifts are **not to be compacted** but are placed to reduce the possibility of excessive settlement. Allow time for natural compaction and settlement prior to planting. Bioretention soil may be watered to encourage compaction.

Plantings

► PLANT SELECTION GUIDELINES

The plants tabulated in Attachment B-1 were selected for the following characteristics:

- Adaptation to Contra Costa's climate
- Drought tolerance
- Adaptation to well-drained soils
- Adaptation to low soil fertility
- Allow infiltration
- Are not invasive weeds
- Do not have aggressive roots

Characteristics noted in the table, including irrigation preferences and ability to tolerate heat, coastal conditions, flooding, and wind should be considered when selecting plants.

This list is not comprehensive, nor will all these species succeed at every site. Selection for a particular site should be done by experienced professionals familiar with the plants and site conditions. Avoid planting species on the California Invasive Plant Council's invasive plant inventory list.

► PLANT INSTALLATION

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. Straps should be inspected once or twice a year and removed once trees are established to prevent girdling.

► FERTILIZATION

Due to the potential for conveying nutrients to storm drains, no fertilizer should be added to bioretention facilities or planter boxes. **Compost tea**, available from various nurseries and garden supply retailers, may be applied at a recommended rate of 5 gallons mixed with 15 gallons of water per acre.

Compost tea can be applied up to two weeks prior to planting and once per year between March and June. Application is not recommended when temperatures are below 50°F or above 90°F or when rain is forecast in the next 48 hours. Additional applications may be made as needed to correct nutrient deficiencies.

► MULCH

Mulch is not required but is recommended for the purpose of retaining moisture, preventing erosion and minimizing weed growth. Aged mulch, also called compost mulch, reduces the ability of weeds to establish, keeps soil moist, and replenishes soil nutrients. Aged mulch can be obtained through soil suppliers or directly from commercial recycling yards. Apply 1" to 2" of composted mulch, once a year, preferably in June following weeding.

Compared to bark mulch, aged mulch has somewhat less of a tendency to float into overflow inlets during intense storms. To reduce mulch entering overflow inlets, it is recommended to use atrium or beehive grates with ¼" openings over overflow inlets.

► WEED CONTROL

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

► PEST AND DISEASE CONTROL

Synthetic pesticides should not be used on bioretention facilities. Beneficial nematodes and non-toxic controls may be used. Acceptable natural pesticides include Safer® Aphid, Whitefly, and Mealybug Killer, Safer® Tree and Shrub Insect Attach, Safer® for Evergreens, and Neem oil.

Irrigation

Bioretention soils have a high infiltration rate and require a different irrigation system design than what is typically used for heavy clay soils in Contra Costa

County. Irrigation systems must be designed to minimize water use, avoid overwatering, and prevent the underdrain discharges during dry weather.

Bioretention facilities and planter boxes may need to be irrigated more than once a day. Irrigation controls should allow **separate control** of times and durations of irrigation for bioretention facilities and planter boxes vs. other landscape areas.

Smart irrigation controllers are strongly encouraged. Available controllers may 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.

Drip emitters are strongly recommended over spray irrigation. Use multiple, lower-flow (one-half to two gallons per hour) emitters in fast-draining bioretention soils. Use two or more emitters for perennials, ground covers, and bunchgrasses. Four to six emitters may be needed for larger shrubs and trees. Some types of emitters encourage horizontal distribution of water.

Spray heads must be positioned to **avoid direct spray** into bioretention facility or planter box outlet structures.

References and Resources

- Model Biotreatment Soil Media Specifications—MRP 2.0 Provision C.3.c.i.(2)(c)(ii)
- *Recommendations for Soils Specification, Planting, and Irrigation of Bioretention Facilities*, WRA Environmental Consultants, November 5, 2008.
- US Composting Council
- ASTM International
- *Plant List and Planting Guidance for Landscape-Based Stormwater Measures*. Appendix B in the *Alameda County Clean Water Program C.3 Technical Guidance* (2016).
- *Plants and Landscapes for Summer Dry Climates.* Nora Harlow, Ed. East Bay Municipal Utility District, Oakland
- *California Native Plants for Your Garden and Wildlife*, Las Pilitas Nursery, 2008.
- *Native Treasures: Gardening with the Plants of California.* M. Nevin Smith, 2016. University of California Press.
- *The Calflora Database, 2008.*
- California Invasive Plant Council
- *A Guide to Estimating Irrigation Water Needs of Landscape Plantings in California*, University of California Cooperative Extension and California Department of Water Resources
- Our Water Our World, website to developed to assist consumers in managing home and garden pests in a way that helps protect water.
- Bay-Friendly Best Practices for Landscape Professionals, a whole systems approach to the design, construction, and maintenance of the landscape to support the integrity of the San Francisco Bay watershed.
- University of California Statewide Integrated Pest Management (IPM) Program

Plant Recommendations for Bioretention Facilities and Planter Boxes

Grasses and Grass-like Plants

Scientific name Common name	Light Preference			Size (feet)		Watering				Tolerates				CA Native	Other Notes
	Sun	Part	Shade	Ht.	Width	L	M	H	Summer	Heat	Coast	Flood	Wind		
Bromus carinatus California brome	✓			2	1	✓			ok	✓		✓	✓	✓	
Bouteloua gracilis blue grama	✓			1.5	1	✓				✓		✓	✓		Tolerates no summer water, good for non-irrigated remote sites
Carex densa dense sedge	✓			1	1		✓	✓	✓	✓		✓		✓	
Carex obnupta slough sedge	✓			2	1		✓	✓	✓	✓	✓	✓	✓	✓	
Carex praegracilis clustered field sedge	✓	✓		1.5	1.5		✓	✓	✓	✓	✓	✓	✓	✓	
Carex subfusca rusty sedge	✓	✓		1	1		✓		ok	✓	✓	✓	✓	✓	Great for swales
Carex divulsa Berkeley sedge		✓	✓	1	1		✓		ok		✓	✓	✓	✓	AKA *Carex tumulicola*,. Full sun along coast.
Deschampsia cespitosa tufted hairgrass	✓			2	1		✓		ok			✓	✓	✓	Can look weedy
Distichlis spicata salt grass	✓			0.3	3		✓	✓	✓	✓	✓	✓	✓	✓	Looks like bermuda grass, withstands foot traffic, for soils with high salt
Eleocharis palustris creeping spikerush	✓			1	1		✓	✓	ok	✓	✓	✓	✓	✓	
Elymus glaucus blue wildrye	✓			1.5	2		✓	✓	ok	✓	✓	✓	✓	✓	good for grazing, difficult to mow, messy looking lawn
Festuca californica California fescue	✓	✓	✓	2	2	✓			ok	✓	✓		✓	✓	
Festuca idahoensis Idaho fescue	✓	✓		1	1	✓	✓		ok	✓	✓		✓	✓	Can mow. Needs light summer water at hot sites
Festuca rubra red fescue	✓	✓		1	1.5	✓	✓		ok	✓	✓	✓	✓	✓	Can mow. Lawn alternative
Festuca rubra 'molate' molate fescue	✓	✓		1	1.5	✓	✓		ok	✓	✓		✓	c	Can mow. Lawn alternative

Plant Recommendations for Bioretention Facilities and Planter Boxes

Hordeum brachyantherum meadow barley	✓	✓		1.5	1		✓	✓	ok	✓	✓		✓	✓	
Juncus patens blue rush	✓			2	1		✓	✓	✓	✓		✓		✓	
Leymus triticoides creeping wildrye	✓	✓		3	1	✓	✓		ok	✓	✓	✓	✓	✓	Can mow. Recommended for swales.
Melica californica California melica	✓	✓		1	1	✓				✓			✓	✓	
Melica imperfect melic	✓	✓		1	1	✓			ok		✓	✓		✓	Part shade inland, light water in Summer to keep green or goes dormant
Muhlenbergia rigens deergrass	✓			3	3	✓	✓		ok	✓		✓		✓	
Nasella pulchra purple needlegrass	✓	✓		2	1	✓	✓		ok	✓		✓	✓	✓	
Nassella lepida foothill needlegrass	✓	✓	✓	1.5	1	✓	✓		ok	✓	✓		✓	✓	
Phalaris californica California canarygrass		✓	✓	1.5	1		✓	✓	ok		✓	✓	✓	✓	Can be aggressive spreader

Plant Recommendations for Bioretention Facilities and Planter Boxes

Herbaceous Perennials and Groundcovers

Scientific name Common name	Light Preference			Size (feet)		Watering				Tolerates				CA Native	Other Notes
	Sun	Part	Shade	Ht.	Width	L	M	H	Summer	Heat	Coast	Flood	Wind		
Achillea filipendulina fernleaf yarrow	✓			3	3	✓			✓	✓					
Achillea millefolium common yarrow	✓			1.5	1	✓			ok	✓				✓	Good for hot sites
Achillea tomentosa woolly yarrow	✓	✓		1	1.5	✓	✓		ok	✓			✓		
Aloe striata coral aloe	✓	✓		2	2	✓			ok						Sun along coast, afternoon shade inland
Arctostaphylos hookeri Monterey manzanita	✓	✓		1	4	✓	✓		ok		✓		✓	✓	Better in part shade in hot sites
Arctostaphylos uva-ursi kinnick-kinnick	✓	✓		1	15	✓	✓		ok		✓		✓	✓	Full sun at coast, part shade inland. Cultivars to try include 'emerald carpet,' 'Point Reyes,' 'San Bruno Mountain' depending on site
Ceratostigma plumbaginoides dwarf plumbago		✓		0.75	5	✓	✓		✓	✓					
Epilobium canum California fuchsia	✓	✓		1	4	✓			ok					✓	
Eriogonum fasciculatum flattop buckwheat	✓			3	4	✓				✓				✓	
Eschscholzia californica California poppy	✓			1	1	✓			ok	✓	✓	✓	✓	✓	
Fragaria chiloensis beach strawberries	✓	✓	✓	0.3	2	✓			ok		✓			✓	
Gazania spp. treasure flower	✓			0.5	2	✓	✓		✓	✓			✓		
Iris douglasiana Douglas iris	✓	✓		1.5	2	✓	✓		ok	✓			✓	✓	Also, Iris hybrids
Scientific name	Light Preference			Size (feet)		Watering				Tolerates					Other Notes

Plant Recommendations for Bioretention Facilities and Planter Boxes

Common name	Sun	Part	Shade	Ht.	Width	L	M	H	Summer	Heat	Coast	Flood	Wind	CA Native	
Lotus scoparius deerweed	✓			4	3	✓				✓		✓		✓	
Lupinus bicolor miniature lupine	✓			1	1	✓					✓	✓		✓	Adds nitrogen
Mimulus aurantiacus common monkeyflower	✓	✓		3	3	✓			ok			✓		✓	
Mimulus cardinalis scarlet monkeyflower	✓	✓	✓	3	3	▯	✓	✓	✓			✓		✓	Aggressive seeder
Polygonum capitatum pink knotweed	✓	✓		0.5	4	✓			✓	✓	✓		✓		
Prunella vulgaris self heal	✓	✓				✓	✓		ok		✓	✓	✓	✓	
Rudebeckia californica California coneflower	✓			3	2	✓	✓		ok	✓		✓		✓	
Salvia clevelandii Cleveland sage						✓									
Scaevola 'mauve clusters' fan flower	✓	✓		1	4	✓				✓			✓		
Sedum spathulifolium stone crop	✓					✓			ok	✓			✓	varies	For above the high water line
Sisyrinchium bellum blue eyed grass				1	1	✓			ok	✓	✓	✓	✓	✓	
Sisyrinchium californicum yellow eyed grass	✓	✓		1	1		✓		✓	✓	✓	✓	✓	✓	
Solidago californica California goldenrod		✓		3	2	✓	✓		ok	✓		✓		✓	
Stachys byzantine lamb's ears	✓	✓		1	3	✓			ok	✓	✓		✓		
Verbena tenuisecta moss verbena	✓			0.5	5	✓			ok	✓	✓		✓		

Plant Recommendations for Bioretention Facilities and Planter Boxes

Small Shrubs

Scientific name Common name	Light Preference			Size (feet)		Watering				Tolerates				CA Native	Other Notes
	Sun	Part	Shade	Ht.	Width	L	M	H	Summer	Heat	Coast	Flood	Wind		
Artemisia californica California sagebrush	✓			2-5	4-5	✓				✓	✓		✓	✓	Will not tolerate sprinklers
Baccharis pilularis 'Twin Peaks' or Pigeon Point' dwarf coyote brush	✓			2	6	✓	✓		ok	✓	✓	✓	✓	c	
Cistus skanbergii hybrid rockrose	✓			3	5	✓	✓		✓	✓	✓	✓	✓		Best with annual shearing
Correa 'Carmine Bells' or 'ivory bells' Australian fuchsia	✓	✓		3	6	✓	✓		✓	✓			✓		Ivory bells does not tolerate wind. Attracts hummingbirds. Sunset Zones 16-17 (not recommended for E. Contra Costa)
Erigeron glaucus seaside daisy	✓			1	1.5				ok		✓			✓	
Eriogonum crocatum saffron buckwheat	✓			1.5	1.5	✓				✓	✓		✓	✓	
Eriogonum umbellatum sulfur buckwheat	✓			0.7	3	✓			ok	✓			✓	✓	
Grevillea lanigera woolly grevillea	✓			4	6	✓				✓			✓		Sunset Zones 15-24 (not recommended for E. Contra Costa)
Lavendula spp. lavender	✓			1.5	1.5	✓			ok	✓	✓				
Mahonia pinnata California holly grape	✓	✓	✓	4	4	✓	✓			✓		✓	✓	✓	
Mahonia repens creeping Oregon grape	✓	✓		2	3	✓	✓		ok		✓	✓		✓	
Rosmarinus officinalis rosemary	✓			2.5	5	✓			✓	✓	✓		✓		
Rubus ursinus California blackberry		✓	✓	3	5		✓	✓	ok	✓	✓	✓	✓	✓	Thorns. Harbors beneficial insects

Plant Recommendations for Bioretention Facilities and Planter Boxes

Symphorocarpos albus common snowberry	✓	✓	✓	4	4	✓	✓	✓	ok	✓				✓	Adaptable to many conditions
Westringia fruticosa coast rosemary	✓			4	8	✓				✓	✓		✓		
Whipplea modesta whipplevine		✓	✓	0.5	3		✓	✓	✓		✓	✓		✓	Sunset zones 16-17, 19-24 only (not recommended E. Contra Costa), best for moist shady spots

Large Shrubs

Scientific name	Light Preference			Size (feet)		Watering				Tolerates				CA	
Common name	Sun	Part	Shade	Ht.	Width	L	M	H	Summer	Heat	Coast	Flood	Wind	Native	Other Notes
Alyogyne huegelil blue hibiscus	✓			6	5	✓				✓					Very low water after second year, Sunset zones 15-17 & 20-24 (not recommended E. Contra Costa)
Arctostaphylos densiflora 'Howard Mcminn' McMinn manzanita	✓	✓		3	7	✓				✓			✓	c	
Baccharis pilularis coyote brush	✓			6	7	✓	✓		ok	✓	✓	✓	✓		Fast-growing, short-lived
Berberis darwinii Darwin's barberry	✓	✓		6	6	✓				✓		✓	✓		Sprinklers will kill foliage
Carpenteria californica Bush anemone	✓	✓		6	4	✓	✓		✓	✓				✓	Interior climate with occasional water otherwise low water needs
Ceanothus spp. Various ceanothus	✓	✓		varies	varies	✓			□	✓			✓	✓	fast-growing but short-lived
Cercis occidentalis western redbud	✓			12	8	✓			□	✓		✓	✓	✓	Prune low branches for small tree form, susceptible to disease if overwatered
Cotinus coggygia smoke bush	✓			15	15	✓			□			✓	✓		No water after second year
Eriogonum arborescens Santa Cruz Island buckwheat	✓			3	5	✓			✓	✓	✓	✓	✓	✓	Low water after second year

Plant Recommendations for Bioretention Facilities and Planter Boxes

Scientific name	Light Preference			Size (feet)		Watering				Tolerates				CA	
Common name	Sun	Part	Shade	Ht.	Width	L	M	H	Summer	Heat	Coast	Flood	Wind	Native	Other Notes
Eriogonum giganteum St. Catherines lace	✓			5	6	✓			[illegible]		✓	✓	✓	✓	best at coast, tolerant of unwatered inland garden
Fremontodendron californicum flannel bush	✓			20	14	✓			[illegible]	✓		✓		✓	Fast-growing, short-lived
Garrya elliptica Coast silktassel	✓	✓		8	8	✓	✓		✓	✓		✓	✓	✓	'Evie' is compact variety
Heteromeles arbutifolia toyon	✓	✓	✓	7	5	✓	✓		✓	✓	✓	✓		✓	Doesn't respond well to pruning low branches
Juniperus chinensis 'Mint Julep" mint julep juniper	✓	✓		3	6	✓	✓		✓	✓	✓	✓	✓		
Lonicera hispidula California honeysuckle	✓	✓	✓	4	2		✓	✓	✓		✓	✓		✓	Climbing vine-like. Best in part shade. Attracts birds
Lonicera involucrate twinberry honeysuckle	✓	✓	✓	6	3		✓	✓	✓		✓	✓		✓	Best in part shade. Attracts birds
Nandina domestica heavenly bamboo	✓	✓		4	3	✓	✓		✓	✓		✓			
Philadelphus coronaries sweet mock orange	✓	✓		10	10		✓		✓				✓		Best with annual pruning
Physocarpus capitatus Pacific ninebark	✓	✓		5	5	✓	✓	✓	ok		✓	✓		✓	Part shade and summer water required in hot locations
Pittosporum eugeniodes Pittosporum	✓	✓		40	15	✓	✓		✓	✓		✓	✓		shear to control height
Pittosporum tenuifolium Pittosporum	✓	✓		40	15	✓	✓		✓	✓		✓	✓		shear to control height
Prunus illicifolia holly leaf cherry	✓	✓		15	15	✓	✓			✓	✓	✓	✓	✓	
Prunus lyonii Catalina cherry	✓	✓		15	15	✓	✓			✓	✓	✓	✓	✓	
Rhamnus californica California coffeeberry	✓	✓		3-15	6	✓			✓	✓		✓	✓	✓	'Eve Case' is compact with broad foliage

Rhus integrifolia lemonade berry	✓	✓		8	6	✓			✓	✓			✓	✓	Shear to hedge if desired
Ribes malvaceum chaparral currant	✓	✓		5	5	✓	✓		ok	✓				✓	
Ribes sanguineum flowering currant		✓	✓	5-12	5-12	✓	✓		✓	✓	✓	✓		✓	Needs good air movement to avoid white fly
Ribes speciosum fuchsia-flowered gooseberry	✓	✓	✓	3-6	3-6	✓	✓		✓	✓	✓	✓		✓	
Rosa californica California wild rose	✓	✓		3	3-6		✓	✓	ok	✓	✓	✓	✓	✓	hooked thorns not compatible with foot traffic
Rosa gymnocarpa wood rose	✓	✓		2	3		✓		ok	✓	✓	✓		✓	
Vitis californica California grape	✓	✓		10	2-10	✓	✓		✓	✓	✓	✓	✓	✓	Climbing vine. Best in full sun. Can be aggressive in moist area.
Vitis girdiana desert grape	✓			8	2-11	✓	✓		✓	✓		✓	✓	✓	Climbing vine. May be more suited to biofilter soils than californica.

Small Trees

Scientific name Common name	Light Preference			Size (feet)		Watering				Tolerates				CA Native	Other Notes
	Sun	Part	Shade	Ht.	Width	L	M	H	Summer	Heat	Coast	Flood	Wind		
Acer Negundo box elder	✓	✓	✓	30	30	✓	✓		ok	✓	✓	✓	✓	✓	Tough shade tree, deciduous
Arbetus unedo strawberry tree	✓	✓				✓	✓		✓	✓	✓	✓			'Elfin King' is dwarf from 6' tall
Arctostaphylos manzanita common manzanita	✓			6-15	8-12	✓				✓			✓	✓	Prune to be small tree. "Dr. Hurd" is more tolerant of summer water.
Cercis occidentalis western redbud	✓	✓		12	8	✓				✓			✓	✓	Prune low branches for small tree form; susceptible to disease if overwatered.
Eriobotrya deflexa bronze loquat	✓	✓		18	25	✓	✓		✓	✓		✓			Monthly deep watering
Eriobotrya japonica Japanese loquat	✓	✓		25	20	✓	✓		✓	✓		✓			Susceptible to blight under stress
Fraxinus angustfolia Raywood ash	✓			30	30		✓		✓	✓					Fall color
Fraxinus dipetala California ash	✓	✓		20	20				ok	✓		✓		✓	

Plant Recommendations for Bioretention Facilities and Planter Boxes

Scientific name Common name	Light Preference			Size (feet)		Watering				Tolerates				CA Native	Other Notes
	Sun	Part	Shade	Ht.	Width	L	M	H	Summer	Heat	Coast	Flood	Wind		
Fraxinus latifolia Oregon ash	✓	✓	✓	30	25	✓			✓	✓	✓	✓		✓	
Fraxinus velutina velvet ash	✓			25	15	✓	✓		ok	✓		✓	✓		
Garrya elleptica coast silk tassel	✓	✓		20	20	✓	✓		ok		✓				Afternoon shade inland, responds well to pruning
Laurus 'Saratoga' hybrid laurel	✓	✓		12-40	12-40	✓				✓		✓	✓		prune for tree form
Myrica californica Pacific wax myrtle	✓	✓	✓	10-30	10-30	✓	✓				✓				best at coast
Pinus thumbergiana Japanese black pine	✓	✓		25	20	✓			✓	✓	✓			✓	Asymmetrical, often leaning habit
Pittosporum undulatum victorian box	✓	✓		15	15	✓	✓		✓	✓					Sunset zones 16-17, 21-24 only (not recommended E. Contra Costa. Prune low branches for tree form.
Prunus ilicifolia holly leaf cherry	✓	✓		15	15	✓	✓			✓	✓		✓	✓	
Prunus lyonii Catalina cherry	✓	✓		15	15	✓	✓			✓	✓		✓	✓	
Prunus serrulata "shirofugen' cherry	✓			25	25		✓				✓	✓	✓		Additional cultivars

Plant Recommendations for Bioretention Facilities and Planter Boxes

Key

Water Preference-Low/Moderate/High	We have provided recommendations for irrigation. All plants should be watered with more frequency during the first two years after planting. After this establishment period, Low water use plants will only need supplemental irrigation at the hottest and driest sites. Plants with Moderate irrigation needs will be best with occasional supplemental water (once per week to once per month) and plants with High irrigation needs will be best with more frequent watering especially during periods of drought in the cooler seasons.
Water Preference-Summer Irrigation	Plants with a check in this column will not withstand a long period of summer drought without irrigation. Plants with an 'ok' in this column are tolerant of, but do not require, frequent summer irrigation. Plants with nothing in this column may not tolerate summer irrigation.
Tolerates Heat	A check in the heat column indicates that the plant will tolerate hot sites. It should not be confused with a plants preference for sun. Absence of the check indicates it should only be used in areas close to the Bay or other cool sites.
Tolerates Coast	The coast column indicates plants that perform well within 1,000 feet of the ocean or bay. Most of these plants tolerate some amount of salt air, fog, and wind.
Tolerates Flooding	
Tolerates Wind	A check in the wind column means that the plant will tolerate winds of ten miles per hour or more.
CA Native - c	Cultivar of California native. Cultivars offer habitat benefits to native wildlife and are adapted to the local climate but have reduced genetic diversity.
Other Notes - Sunset Climate Zones	Under the Other Notes category, we have indicated appropriate Sunset Climate Zones only for plants that will not do well across all of Contra Costa County. Please refer to the *Sunset Western Garden Book* which defines climate zones in the Bay Area based on elevation, influence of the Pacific Ocean, presence of hills and other factors.

Appendix

C

Preparing a Stormwater Control Plan for a Small Land Development Project

Instructions and Template for Preparing a Submittal for a Project Creating or Replacing More than 2,500 Square Feet but less than 10,000 Square Feet of Impervious Area

The template is available in Word format on the Contra Costa Clean Water Program website.

Preparing a Stormwater Control Plan for a Small Land Development Project

Introduction

As of December 1, 2012, development projects that create or replace 2,500 square feet* or more of impervious surface (roofs or pavement) must incorporate one or more specified measures to reduce runoff. This requirement is part of municipalities' comprehensive effort to reduce runoff pollution. The requirement is mandated by Provision C.3.i. in the Municipal Regional Stormwater Permit issued by the California Regional Water Quality Control Boards for the San Francisco Bay Region and Central Valley Region.

It is fairly easy to achieve compliance with the stormwater requirements for small land development projects. Compliance for each project must be carefully documented. Please complete the following form and submit it as directed by municipal staff.

*All projects that create or replace 10,000 square feet or more of impervious surface—and auto service facilities, gas stations, restaurants, and uncovered parking lots that create or replace 5,000 square feet or more of impervious surface—are "Regulated Projects," and require a more comprehensive Stormwater Control Plan. See the Contra Costa Clean Water Program *Stormwater C.3 Guidebook*.

Step-by-Step Instructions

The steps are:

1. Fill out the Project Data Form (below) and select one or more runoff reduction measures.
2. Prepare a site plan or sketch. Specify and design the runoff reduction measure you will use to meet the stated minimum requirements.
3. Complete your submittal, which will include:
    - Project Data Form
    - Site Plan or Sketch
    - Completed checklist for each Runoff Reduction Measure selected

► STEP 1: PROJECT DATA FORM AND RUNOFF REDUCTION MEASURE SELECTION

Complete all fields.

Project Name/Number	
Application Submittal Date [to be verified by municipal staff]	
Project Location [Street Address if available, or intersection and/or APN]	
Name of Owner or Developer	
Project Type and Description [Examples: "Single Family Residence," "Parking Lot Addition," "Retail and Parking"]	
Total Project Site Area (acres)	
Total New Impervious Surface Area (square feet) [Sum of currently pervious areas that will be covered with new impervious surfaces]	
Total Replaced Impervious Surface Area [Sum of currently impervious areas that will be covered with new impervious surfaces.]	
Total Pre-Project Impervious Surface Area	
Total Post-Project Impervious Surface Area	
Runoff Reduction Measures Selected (Check one or more)	❑ 1. Disperse runoff to vegetated area ❑ 2. Pervious pavement ❑ 3. Cisterns or Rain Barrels ❑ 4. Bioretention Facility or Planter Box

► STEP 2: DELINEATE IMPERVIOUS AREAS AND LOCATIONS OF RUNOFF REDUCTION MEASURES

Delineate the impervious area. On a site plan or sketch, show the impervious area—for example, a roof, or portion of a roof, or a paved area—that will drain to your runoff reduction measure. Typically these delineations follow roof ridge lines or grade breaks. Alternatively, show the type and extent of pervious paving. An example sketch is attached.

Indicate the location and kind of runoff reduction measure you've selected. At least one option, designed to manage runoff from some amount of impervious area—or to avoid creating runoff—is required.

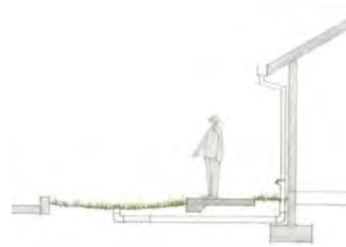
For each option selected, there is a brief checklist to confirm your design and your submittal meet minimum requirements.

► STEP 3: COMPLETE AND SUBMIT YOUR PLAN

Consult with municipal staff about when and how to submit your Stormwater Control Plan for Small Projects.

Option 1: Disperse runoff from roofs or pavement to vegetated areas.

This is the simplest option. Downspouts can be directed to vegetated areas adjacent to buildings, or extended via pipes to reach vegetated areas further away. Paved areas can be designed with curb cuts, or without curbs, to direct flow into surrounding vegetation.



Connecting a roof leader to a vegetated area. The head from the eave height makes it possible to route roof drainage some distance away from the building.

On the site plan, show:

- ❑ Each impervious area from which runoff will be directed, and its square footage.
- ❑ The vegetated areas that will receive runoff, and the approximate square footage of each.
- ❑ If necessary, explain in notes on the plan how runoff will be routed from impervious surfaces to vegetated areas.

Confirm the following standard specifications are met:

- ❑ Tributary impervious square footage in no instance exceeds twice the square footage of the receiving pervious area.
- ❑ Roof areas collect runoff and route it to the receiving pervious area via gutters and downspouts.
- ❑ Paved areas are sloped so drainage is routed to the receiving pervious area.
- ❑ Runoff is dispersed across the vegetated area (for example, with a splash block) to avoid erosion and promote infiltration.
- ❑ Vegetated area has amended soils, vegetation, and irrigation as required to maintain soil stability and permeability.
- ❑ Any drain inlets within the vegetated area are at least 3 inches above surrounding grade.

Option 2: Permeable Pavement

This option can be easy to install and maintain, cost-effective, and can add aesthetic value to your project. Permeable pavements may include pervious concrete, pervious asphalt, porous pavers, crushed aggregate, open pavers with grass or plantings, open pavers with gravel, or solid pavers.

Show on your site plan:

- ❑ Location, extent and types of pervious pavements.

Confirm the following standard specifications are met:

- ❑ No erodible areas drain on to permeable pavement.
- ❑ Subgrade compaction is minimal.
- ❑ Reservoir base course is of open-graded crushed stone. Base depth is adequate to retain rainfall (3 inches is adequate) 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 3 inches above bottom of base course.
- ❑ Subgrade is uniform 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.

Option 3: Cisterns or Rain Barrels

Use of cisterns or rain barrels to comply with this requirement is subject to municipality approval. Planning and Building Permits may be required for larger systems.

Show on your site plan:

- ❑ Impervious areas tributary to each cistern or rain barrel.
- ❑ Location of each cistern or rain barrel.

Confirm the following standard specifications are met:

- ❑ Rain barrels are sited at grade on a sound and level surface at or near gutter downspouts.
- ❑ Gutters tributary to rain barrels are screened with a leaf guard or maximum ½-inch to ¼-inch-minimum corrosion-resistant metallic hardware fabric.
- ❑ Water collected will be used for irrigation only.
- ❑ Openings are screened with a corrosion-resistant metallic fine mesh (1/16 inch or smaller) to prevent mosquito harborage.
- ❑ Large openings are secured to prevent entry by children.
- ❑ Rain barrels and gutters are to be cleaned annually.
- ❑ The Contra Costa Mosquito and Vector Control District is informed of the installation. The District will be provided additional information and/or rights of entry if they request.

Option 4: Bioretention Facility or Planter Box

An above-ground planter box may be appropriate if the development site lacks level landscaped areas for dispersion and pervious pavements are not practical. Planter boxes and bioretention facilities can treat runoff from impervious surfaces 25 times their area (sizing factor of 0.04).

Detailed design guidance for planter boxes and bioretention areas is in the *Contra Costa Clean Water Program Stormwater C.3 Guidebook*.

Flow-through planter built into a hillside. Flows from the underdrain and overflow must be directed in accordance with local requirements.

Show on your site plan:

- ❑ Impervious areas tributary to the planter box.
- ❑ Location and footprint of planter box.

Confirm the following standard specifications are met:

- ❑ Reservoir depth is 4"-6" minimum.
- ❑ 18" depth soil mix with minimum long-term infiltration rate of 5"/hour. See http://www.cccleanwater.org/c3-guidebook.html for a list of soil mix suppliers.
- ❑ Surface area of soil mix is a minimum 0.04 times the tributary impervious area.
- ❑ “Class 2 perm” drainage layer 12" deep.
- ❑ No filter fabric.
- ❑ Perforated pipe (PVC SDR 35 or approved equivalent) underdrain with outlet located flush or nearly flush with planter bottom.
- ❑ Connection with sufficient head to storm drain or discharge point.
- ❑ Underdrain has a clean-out port consisting of a vertical, rigid, non-perforated PVC pipe, connected to the underdrain via a sweep bend, with a minimum diameter of 4" and a watertight cap.
- ❑ Overflow outlet connected to a downstream storm drain or approved discharge point.
- ❑ Planter is set level.
- ❑ Emergency spillage will be safely conveyed overland.
- ❑ Plantings are suitable to the climate, exposure, and a well-drained soil.
- ❑ Irrigation system with connection to water supply, on a separate zone.

Useful Resources

The following references may be useful for design. Designs must meet the minimum standard specifications in this supplement to the *Stormwater C.3 Guidebook*.

Contra Costa Clean Water Program Stormwater C.3 Guidebook. Available at http://www.cccleanwater.org/c3-guidebook.html

Start At the Source: Design Guidance Manual for Stormwater Quality. Bay Area Stormwater Management Agencies Association, 1999. Available at http://www.cccleanwater.org/c3-resources.html

Stormwater Control for Small Projects Fact Sheets. Bay Area Stormwater Management Agencies Association, 2012. Available at http://www.cccleanwater.org/c3-resources.html

National Ready Mix Concrete Association
http://www.perviouspavement.org/

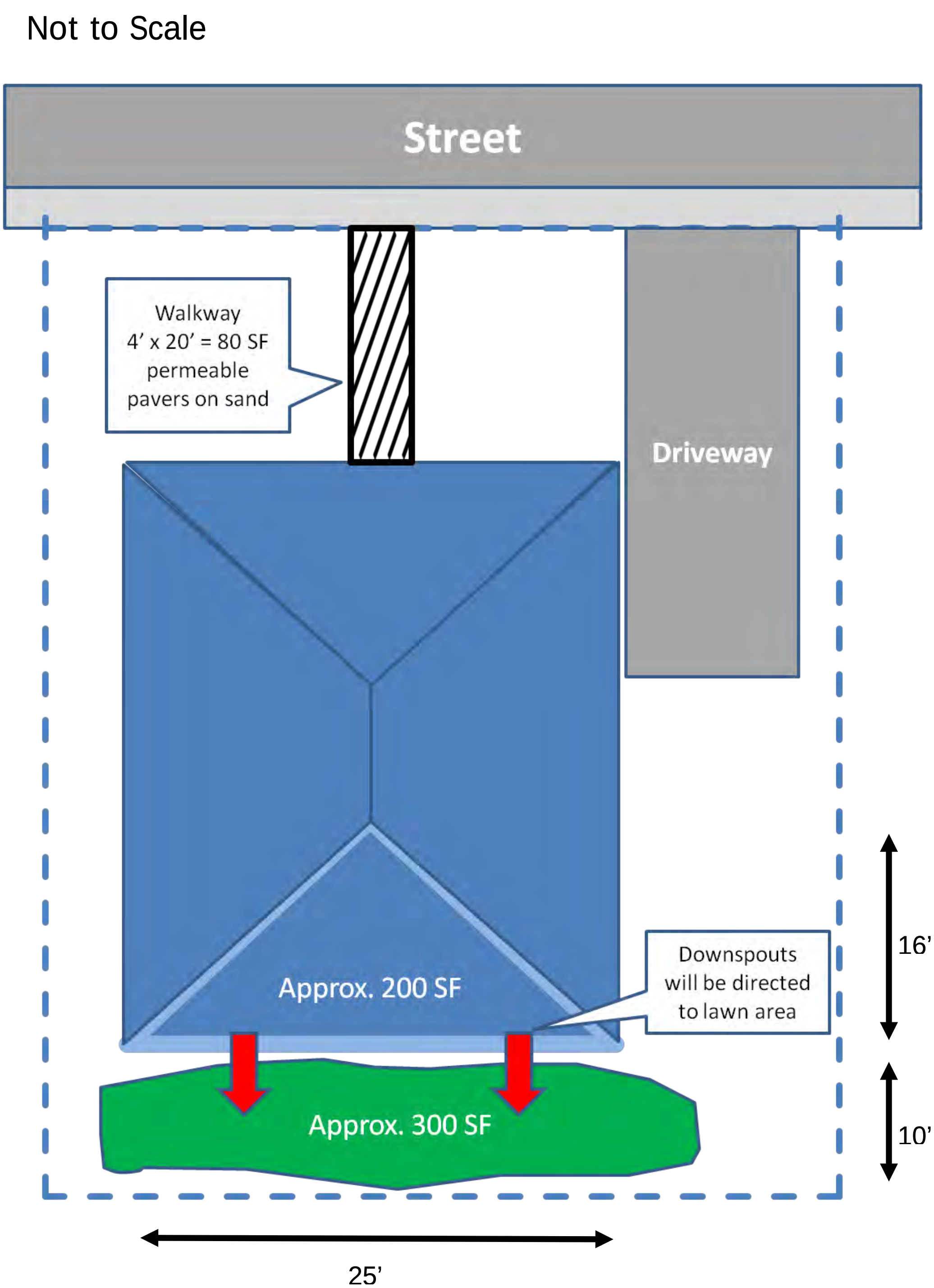
California Asphalt Pavement Association
http://www.californiapavements.org/stormwater.html

Interlocking Concrete Pavement Institute
http://www.icpi.org/

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

Example Sketch

The example below illustrates the level of detail required.



APPENDIX D—STORMWATER POLLUTANT SOURCES/SOURCE CONTROL CHECKLIST

How to use this worksheet (also see instructions on page 16 of the *Stormwater C.3 Guidebook*):

1. Review Column 1 and identify which of these potential sources of stormwater pollutants apply to your site. Check each box that applies.
2. Review Column 2 and incorporate all of the corresponding applicable BMPs in your Stormwater Control Plan drawings.
3. Review Columns 3 and 4 and incorporate all of the corresponding applicable permanent controls and operational BMPs in a table in your Stormwater Control Plan. Use the format shown in Table 3-1 on page 17 of the *Guidebook*. Describe your specific BMPs in an accompanying narrative, and explain any special conditions or situations that required omitting BMPs or substituting alternative BMPs for those shown here.

IF THESE SOURCES WILL BE ON THE PROJECT SITE …	**… THEN YOUR STORMWATER CONTROL PLAN SHOULD INCLUDE THESE SOURCE CONTROL BMPs**		
1 **Potential Sources of Runoff Pollutants**	**2** **Permanent Controls—Show on Stormwater Control Plan Drawings**	**3** **Permanent Controls—List in Stormwater Control Plan Table and Narrative**	**4** **Operational BMPs—Include in Stormwater Control Plan Table and Narrative**
❑ **A.** On-site storm drain inlets	❑ Locations of inlets.	❑ Mark all inlets with the words "No Dumping! Flows to Bay" or similar.	❑ Maintain and periodically repaint or replace inlet markings. ❑ Provide stormwater pollution prevention information to new site owners, lessees, or operators. ❑ See applicable operational BMPs in Fact Sheet SC-74, "Drainage System Maintenance," in the CASQA Stormwater Quality Handbooks ❑ Include the following in lease agreements: "Tenant shall not allow anyone to discharge anything to storm drains or to store or deposit materials so as to create a potential discharge to storm drains."
❑ **B.** Interior floor drains and elevator shaft sump pumps		❑ State that interior floor drains and elevator shaft sump pumps will be plumbed to sanitary sewer.	❑ Inspect and maintain drains to prevent blockages and overflow.

APPENDIX D—STORMWATER POLLUTANT SOURCES/SOURCE CONTROL CHECKLIST

IF THESE SOURCES WILL BE ON THE PROJECT SITE …	… THEN YOUR STORMWATER CONTROL PLAN SHOULD INCLUDE THESE SOURCE CONTROL BMPs		
1 **Potential Sources of Runoff Pollutants**	**2** **Permanent Controls—Show on Stormwater Control Plan Drawings**	**3** **Permanent Controls—List in Stormwater Control Plan Table and Narrative**	**4** **Operational BMPs—Include in Stormwater Control Plan Table and Narrative**
❑ **C.** Interior parking garages		❑ State that parking garage floor drains will be plumbed to the sanitary sewer.	❑ Inspect and maintain drains to prevent blockages and overflow.
❑ **D1.** Need for future indoor & structural pest control		❑ Note building design features that discourage entry of pests.	❑ Provide Integrated Pest Management information to owners, lessees, and operators.
❑ **D2.** Landscape/ Outdoor Pesticide Use	❑ Show locations of native trees or areas of shrubs and ground cover to be undisturbed and retained. ❑ Show self-retaining landscape areas, if any. ❑ Show stormwater treatment and hydrograph modification management BMPs. (See instructions in Chapter 3, Step 5 and guidance in Chapter 5.)	State that final landscape plans will accomplish all of the following. ❑ Preserve existing native trees, shrubs, and ground cover to the maximum extent possible. ❑ Design landscaping to minimize irrigation and runoff, to promote surface infiltration where appropriate, and to minimize the use of fertilizers and pesticides that can contribute to stormwater pollution. ❑ Where landscaped areas are used to retain or detain stormwater, specify plants that are tolerant of saturated soil conditions. ❑ Consider using pest-resistant plants, especially adjacent to hardscape. ❑ To insure successful establishment, select plants appropriate to site soils, slopes, climate, sun, wind, rain, land use, air movement, ecological consistency, and plant interactions.	❑ Maintain landscaping using minimum or no pesticides. ❑ See applicable operational BMPs in Fact Sheet SC-41, “Building and Grounds Maintenance,” in the CASQA Stormwater Quality Handbooks ❑ Provide IPM information to new owners, lessees and operators.

APPENDIX D—STORMWATER POLLUTANT SOURCES/SOURCE CONTROL CHECKLIST

IF THESE SOURCES WILL BE ON THE PROJECT SITE …	… THEN YOUR STORMWATER CONTROL PLAN SHOULD INCLUDE THESE SOURCE CONTROL BMPs		
1 **Potential Sources of Runoff Pollutants**	**2** **Permanent Controls—Show on Stormwater Control Plan Drawings**	**3** **Permanent Controls—List in Stormwater Control Plan Table and Narrative**	**4** **Operational BMPs—Include in Stormwater Control Plan Table and Narrative**
❑ **E.** Pools, spas, ponds, decorative fountains, and other water features.	❑ Show location of water feature and a sanitary sewer cleanout in an accessible area within 10 feet. (Exception: Public pools must be plumbed according to County Department of Environmental Health Guidelines.)	If the local municipality requires pools to be plumbed to the sanitary sewer, place a note on the plans and state in the narrative that this connection will be made according to local requirements.	❑ See applicable operational BMPs in Fact Sheet SC-72, "Fountain and Pool Maintenance," in the CASQA Stormwater Quality Handbooks
❑ **F.** Food service	❑ For restaurants, grocery stores, and other food service operations, show location (indoors or in a covered area outdoors) of a floor sink or other area for cleaning floor mats, containers, and equipment. ❑ On the drawing, show a note that this drain will be connected to a grease interceptor before discharging to the sanitary sewer.	❑ Describe the location and features of the designated cleaning area. ❑ Describe the items to be cleaned in this facility and how it has been sized to insure that the largest items can be accommodated.	❑ See the brochure, "Water Pollution Prevention Tips to Protect Water Quality and Keep Your Food Service Facility Clean." Provide this brochure to new site owners, lessees, and operators.

APPENDIX D—STORMWATER POLLUTANT SOURCES/SOURCE CONTROL CHECKLIST

IF THESE SOURCES WILL BE ON THE PROJECT SITE …	… THEN YOUR STORMWATER CONTROL PLAN SHOULD INCLUDE THESE SOURCE CONTROL BMPs		
1 **Potential Sources of Runoff Pollutants**	**2** **Permanent Controls—Show on Stormwater Control Plan Drawings**	**3** **Permanent Controls—List in Stormwater Control Plan Table and Narrative**	**4** **Operational BMPs—Include in Stormwater Control Plan Table and Narrative**
❑ **G.** Refuse areas	❑ Show where site refuse and recycled materials will be handled and stored for pickup. See local municipal requirements for sizes and other details of refuse areas. ❑ If dumpsters or other receptacles are outdoors, show how the designated area will be covered, graded, and paved to prevent run-on and show locations of berms to prevent runoff from the area. ❑ Any drains from dumpsters, compactors, and tallow bin areas shall be connected to a grease removal device before discharge to sanitary sewer.	❑ State how site refuse will be handled and provide supporting detail to what is shown on plans. ❑ State that signs will be posted on or near dumpsters with the words "Do not dump hazardous materials here" or similar.	❑ State how the following will be implemented: Provide adequate number of receptacles. Inspect receptacles regularly; repair or replace leaky receptacles. Keep receptacles covered. Prohibit/prevent dumping of liquid or hazardous wastes. Post "no hazardous materials" signs. Inspect and pick up litter daily and clean up spills immediately. Keep spill control materials available on-site. See Fact Sheet SC-34, "Waste Handling and Disposal" in the CASQA Stormwater Quality Handbooks
❑ **H.** Industrial processes.	❑ Show process area.	❑ If industrial processes are to be located on site, state: "All process activities to be performed indoors. No processes to drain to exterior or to storm drain system."	❑ See Fact Sheet SC-10, "Non-Stormwater Discharges" in the CASQA Stormwater Quality Handbooks

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❑ **I.** Outdoor storage of equipment or materials. (See rows J and K for source control measures for vehicle cleaning, repair, and maintenance.)	❑ Show any outdoor storage areas, including how materials will be covered. Show how areas will be graded and bermed to prevent run-on or run-off from area. ❑ Storage of non-hazardous liquids shall be covered by a roof and/or drain to the sanitary sewer system, and be contained by berms, dikes, liners, or vaults. ❑ Storage of hazardous materials and wastes must be in compliance with the local hazardous materials ordinance and a Hazardous Materials Management Plan for the site.	Include a detailed description of materials to be stored, storage areas, and structural features to prevent pollutants from entering storm drains. Where appropriate, reference documentation of compliance with the requirements of Contra Costa Hazardous Materials Programs for: ▪ Hazardous Waste Generation ▪ Hazardous Materials Release Response and Inventory ▪ California Accidental Release (CalARP) ▪ Aboveground Storage Tank ▪ Uniform Fire Code Article 80 Section 103(b) & (c) 1991 ▪ Underground Storage Tank www.cchealth.org/groups/hazmat/	❑ See the Fact Sheets SC-31, "Outdoor Liquid Container Storage" and SC-33, "Outdoor Storage of Raw Materials " in the CASQA Stormwater Quality Handbooks

APPENDIX D—STORMWATER POLLUTANT SOURCES/SOURCE CONTROL CHECKLIST

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❑ **J.** Vehicle and Equipment Cleaning	❑ Show on drawings as appropriate: (1) Commercial/industrial facilities having vehicle/equipment cleaning needs shall either provide a covered, bermed area for washing activities or discourage vehicle/equipment washing by removing hose bibs and installing signs prohibiting such uses. (2) Multi-dwelling complexes shall have a paved, bermed, and covered car wash area (unless car washing is prohibited on-site and hoses are provided with an automatic shut-off to discourage such use). (3) Washing areas for cars, vehicles, and equipment shall be paved, designed to prevent run-on to or runoff from the area, and plumbed to drain to the sanitary sewer. (4) Commercial car wash facilities shall be designed such that no runoff from the facility is discharged to the storm drain system. Wastewater from the facility shall discharge to the sanitary sewer, or a wastewater reclamation system shall be installed.	❑ If a car wash area is not provided, describe measures taken to discourage on-site car washing and explain how these will be enforced.	Describe operational measures to implement the following (if applicable): ❑ Washwater from vehicle and equipment washing operations shall not be discharged to the storm drain system. ❑ Car dealerships and similar may rinse cars with water only. See Fact Sheet SC-21, "Vehicle and Equipment Cleaning," in the CASQA Stormwater Quality Handbooks

APPENDIX D—STORMWATER POLLUTANT SOURCES/SOURCE CONTROL CHECKLIST

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❑ **K.** Vehicle/Equipment Repair and Maintenance	❑ Accommodate all vehicle equipment repair and maintenance indoors. Or designate an outdoor work area and design the area to prevent run-on and runoff of stormwater. ❑ Show secondary containment for exterior work areas where motor oil, brake fluid, gasoline, diesel fuel, radiator fluid, acid-containing batteries or other hazardous materials or hazardous wastes are used or stored. Drains shall not be installed within the secondary containment areas. ❑ Add a note on the plans that states either (1) there are no floor drains, or (2) floor drains are connected to wastewater pretreatment systems prior to discharge to the sanitary sewer and an industrial waste discharge permit will be obtained.	❑ State that no vehicle repair or maintenance will be done outdoors, or else describe the required features of the outdoor work area. ❑ State that there are no floor drains or if there are floor drains, note the agency from which an industrial waste discharge permit will be obtained and that the design meets that agency's requirements. ❑ State that there are no tanks, containers or sinks to be used for parts cleaning or rinsing or, if there are, note the agency from which an industrial waste discharge permit will be obtained and that the design meets that agency's requirements.	In the Stormwater Control Plan, note that all of the following restrictions apply to use the site: ❑ No person shall dispose of, nor permit the disposal, directly or indirectly of vehicle fluids, hazardous materials, or rinsewater from parts cleaning into storm drains. ❑ No vehicle fluid removal shall be performed outside a building, nor on asphalt or ground surfaces, whether inside or outside a building, except in such a manner as to ensure that any spilled fluid will be in an area of secondary containment. Leaking vehicle fluids shall be contained or drained from the vehicle immediately. ❑ No person shall leave unattended drip parts or other open containers containing vehicle fluid, unless such containers are in use or in an area of secondary containment.

APPENDIX D—STORMWATER POLLUTANT SOURCES/SOURCE CONTROL CHECKLIST

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❑ **L.** Fuel Dispensing Areas	❑ Fueling areas[1] shall have impermeable floors (i.e., portland cement concrete or equivalent smooth impervious surface) that are: a) graded at the minimum slope necessary to prevent ponding; and b) separated from the rest of the site by a grade break that prevents run-on of stormwater to the maximum extent practicable. ❑ Fueling areas shall be covered by a canopy that extends a minimum of ten feet in each direction from each pump. [Alternative: The fueling area must be covered and the cover's minimum dimensions must be equal to or greater than the area within the grade break or fuel dispensing area[1].] The canopy [or cover] shall not drain onto the fueling area.		❑ The property owner shall dry sweep the fueling area routinely.

[1] The fueling area shall be defined as the area extending a minimum of 6.5 feet from the corner of each fuel dispenser or the length at which the hose and nozzle assembly may be operated plus a minimum of one foot, whichever is greater.

APPENDIX D—STORMWATER POLLUTANT SOURCES/SOURCE CONTROL CHECKLIST

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❑ **M.** Loading Docks	❑ Show a preliminary design for the loading dock area, including roofing and drainage. Loading docks shall be covered and/or graded to minimize run-on to and runoff from the loading area. Roof downspouts shall be positioned to direct stormwater away from the loading area. Water from loading dock areas shall be drained to the sanitary sewer, or diverted and collected for ultimate discharge to the sanitary sewer. ❑ Loading dock areas draining directly to the sanitary sewer shall be equipped with a spill control valve or equivalent device, which shall be kept closed during periods of operation. ❑ Provide a roof overhang over the loading area or install door skirts (cowling) at each bay that enclose the end of the trailer.		❑ Move loaded and unloaded items indoors as soon as possible. ❑ See Fact Sheet SC-30, "Outdoor Loading and Unloading," in the CASQA Stormwater Quality Handbooks
❑ **N.** Fire Sprinkler Test Water		❑ Provide a means to drain fire sprinkler test water to the sanitary sewer.	❑ See the note in Fact Sheet SC-41, "Building and Grounds Maintenance," in the CASQA Stormwater Quality Handbooks

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O. Miscellaneous Drain or Wash Water or Other Sources ❑ Boiler drain lines ❑ Condensate drain lines ❑ Rooftop equipment ❑ Drainage sumps ❑ Roofing, gutters, and trim. ❑ Other sources		❑ Boiler drain lines shall be directly or indirectly connected to the sanitary sewer system and may not discharge to the storm drain system. ❑ Condensate drain lines may discharge to landscaped areas if the flow is small enough that runoff will not occur. Condensate drain lines may not discharge to the storm drain system. ❑ Rooftop equipment with potential to produce pollutants shall be roofed and/or have secondary containment. ❑ Any drainage sumps on-site shall feature a sediment sump to reduce the quantity of sediment in pumped water. ❑ Avoid roofing, gutters, and trim made of copper or other unprotected metals that may leach into runoff. ❑ Include controls for other sources as specified by local reviewer.	
❑ **P.** Plazas, sidewalks, and parking lots.			❑ Sweep plazas, sidewalks, and parking lots regularly to prevent accumulation of litter and debris. Collect debris from pressure washing to prevent entry into the storm drain system. Collect washwater containing any cleaning agent or degreaser and discharge to the sanitary sewer not to a storm drain.

Appendix E

Regulatory and Technical Background

Some background, including updates, on selected policies and criteria in the Guidebook 7th Edition

LAND development is a complex undertaking, and no two projects are the same. Municipal staff can and should exercise latitude and discretion, within the boundaries of permit compliance, when interpreting the C.3 requirements as they apply to a specific project. This appendix provides information and explanations of technical and regulatory issues which may help with decision-making.

Stormwater NPDES Permit History

In 1993, the Regional Water Board first issued a municipal stormwater NPDES permit to Contra Costa County, the 19 cities and towns within the County, and the Contra Costa Flood Control and Water Conservation District. The permit mandated a comprehensive program to prevent stormwater pollution. The comprehensive program includes measures to prevent pollution from municipal facilities and operations, identification and elimination of illicit discharges to storm drains, business inspections, public outreach, construction site inspections, monitoring and studies of stream health, and control of runoff pollutants from new developments and redevelopments.

In 2003, the Regional Water Board added Provision C.3, tightening requirements for new developments and redevelopments. The permittees began implementing the provision in 2005. The Regional

Appendix E Contents

Water Board added hydrograph modification management (flow control) requirements in 2006.

In October 2009, the Regional Water Board included Contra Costa municipalities in its first Municipal Regional Permit (MRP). The MRP applies to 77 municipal Bay Area permittees and supersedes the countywide stormwater NPDES permits. The MRP mandates a Low Impact Development (LID) approach similar to that developed by the CCCWP from 2003 through 2009. The Regional Water Board amended the MRP on November 28, 2011, detailing some exceptions for when LID treatment is required. The LID requirements went into effect December 1, 2011.

The MRP was reissued on November 19, 2015 (MRP 2.0) and is in effect for 5 years beginning January 1, 2016. MRP 2.0 included few new requirements; the minor changes have been incorporated in this 7th Edition of the *Guidebook*.

Regulatory Context and Roles

MRP Provision C.3 requires municipalities to condition development approvals with incorporation of specified stormwater controls. The municipalities' annual report to the Regional Water Board includes a list of development projects approved during the year and the specific stormwater controls that were required for each project. In the annual report, the municipalities also document their program to verify stormwater treatment and flow-control facilities are being adequately maintained. **The municipalities—not the Regional Board or its staff—are charged with ensuring development projects comply with the C.3 requirements.** (Regional Water Board staff sometimes reviews stormwater controls in connection with applications for Clean Water Act Section 401 water-quality certification, which is required for projects that involve work in streams, including dredging and filling.)

Municipal staff review the project proponent's Stormwater Control Plan for compliance with the requirements of Provision C.3. At the same time, they consider how the design of LID features and facilities integrates with the site design, landscape design, and building architecture to support municipal objectives such as design quality, consistency with neighborhood character and values, and contribution to natural qualities achievable within the urban context.

As discussed in Chapter 5, municipalities are responsible for inspecting and verifying the proper operation and maintenance of stormwater treatment facilities, and some pervious pavement installations, in perpetuity. Project proponents and municipalities share the aim of designing and building facilities that are low-maintenance and long-lasting.

Municipal reviewers have latitude and discretion to reject proposed C.3 compliance designs that, while meeting the specific requirements and numeric criteria in this *Guidebook* and the NPDES permit, don't reflect best practices or local values for urban design and architectural design, or are not sustainable.

Imperviousness

Schueler (1995) proposed **imperviousness** as a "unifying theme" for the efforts of planners, engineers, landscape architects, scientists, and local officials concerned with urban watershed protection. Schueler argued (1) that imperviousness is a useful indicator linking urban land development to the degradation of aquatic ecosystems, and (2) imperviousness can be quantified, managed, and controlled during land development.

Imperviousness has long been understood as the key variable in urban hydrology. Peak runoff flow and total runoff volume from small urban catchments is usually calculated as a function of the ratio of impervious area to total area **(rational method)**. The ratio correlates to the composite runoff factor, usually designated "C". Increased flows resulting from urban development tend to increase the frequency of small-scale flooding downstream.

Imperviousness links urban land development to degradation of aquatic ecosystems in two ways.

First, the combination of paved surfaces and piped runoff efficiently collects urban pollutants and transports them, in suspended or dissolved form, to surface waters. These pollutants may originate as airborne dust, be washed from the atmosphere during rains, or may be generated by automobiles and outdoor work activities.

Second, increased peak flows and runoff durations can cause erosion of stream banks and beds, transport of fine sediments, and disruption of aquatic habitat. Measures taken to control stream erosion, such as hardening banks with riprap or concrete, may permanently eliminate habitat. By reducing infiltration to groundwater, imperviousness may also reduce dry-weather stream flows.

Imperviousness has two major components: rooftops and transportation (including streets, highways, and parking areas). The transportation component is usually larger and is more likely to be **directly connected** to the storm drain system.

The effects of imperviousness can be mitigated by disconnecting impervious areas from the drainage system and by making drainage less efficient—that is, by encouraging detention and retention of runoff near the point where it is generated. Detention and retention reduce peak flows and volumes and allow pollutants to settle out or adhere to soils before they can be transported downstream.

Low Impact Development (LID)

MRP Provision C.3.c mandates the use of LID for stormwater treatment, with narrow exceptions. Techniques for implementing LID are detailed in Chapter 3 of this *Guidebook*.

LID aims to mimic a site's pre-development hydrology by minimizing imperviousness and then by detaining, infiltrating, and filtering runoff in landscape-based features—principally bioretention facilities.

► **DISTRIBUTE FACILITIES THROUGHOUT THE SITE.**

In subdivisions and other developments larger than one-half acre, LID should be implemented by distributing runoff to multiple facilities within a site rather than one facility serving the whole site. This practice helps mimic pre-development hydrology within the site and promotes integration of the facilities with the site landscape design. It also helps keep drainage runs short and promotes the use of surface drainage rather than underground pipes. Right-sized bioretention facilities, located in high-visibility, well-trafficked areas, are easy to inspect and more likely to be optimally maintained.

► **MAXIMIZE INFILTRATION**

Setting the underdrain discharge elevation at the top of a bioretention facility's gravel layer maximizes the amount of runoff that is captured and made to infiltrate into native soils rather than being discharged through the underdrain. This, in turn, minimizes the amount of pollutants discharged from the facility, particularly for soluble pollutants.

Where bioretention facilities are to be built close to foundations or pavement, or on steep slopes, the design of curbs, walls, footings, and other elements may need to incorporate consideration of additional soil moisture introduced by the facilities. In many cases, an impermeable cutoff wall is constructed between the bioretention facility and an adjacent foundation or pavement section, as recommended by the project geotechnical engineer.

Flow-through planters may be used as an alternative to bioretention only on upper-story plazas, where infiltration could cause mobilization of pollutants in soil or groundwater, and other situations where infiltration is a concern, such as locations with potential geotechnical hazards that cannot be mitigated except by preventing infiltration.

Limits on the Use of Infiltration Devices

MRP Provision C.3.d.iv. restricts the design and location of "infiltration devices" that, as designed, may bypass filtration through surface soils before reaching groundwater.

Infiltration devices include:

- Dry wells
- Infiltration basins
- Infiltration trenches

Infiltration devices do not include:

- Bioretention facilities
- Self-retaining or self-treating areas
- Pervious pavements

Infiltration devices may not be used in areas of industrial or light industrial activity; areas subject to high vehicular traffic (25,000 or greater average daily traffic on main roadway or 15,000 or more average daily traffic on any intersecting roadway); automotive repair shops; car washes; fleet storage areas (bus, truck, etc.); nurseries, or other areas with pollutant sources that could pose a high threat to water quality, as determined by municipal staff.

The vertical distance from the base of any infiltration device to the seasonal high groundwater mark shall be at least 10 feet. Infiltration devices shall be located a minimum of 100 feet horizontally from any known water supply wells.

In addition, infiltration devices are not recommended where:

- The infiltration device would receive drainage from areas where chemicals are used or stored, where vehicles or equipment are washed, or where refuse or wastes are handled.
- Surface soils or groundwater are polluted.
- The facility could receive sediment-laden runoff from disturbed areas or unstable slopes.
- Increased soil moisture could affect the stability of slopes of foundations.
- Soils are insufficiently permeable to allow the device to drain within 72 hours.

Stormwater Treatment Facility Sizing Criteria

Criteria for sizing stormwater treatment facilities are in MRP Provision C.3.d. All criteria are based on continuous simulation of runoff from a long-term (30-year or more) rainfall record. This is different from the “event-based” or “design storm” hydrology typically used to size drainage and flood-control facilities.

For **flow-based** facilities, the NPDES permit specifies the rational method be used to determine flow. The rational method uses the equation

Q = CiA, where

Q = flow

C = weighted runoff factor between 0 and 1

i = rainfall intensity

A = area

The permit identifies three alternatives for calculating rainfall intensity:

1. the intensity-duration-frequency method, with a hydrograph corresponding to a 50-year storm,
2. the 85th percentile rainfall intensity times two, and
3. 0.2 inches per hour.

An analysis conducted for the CCCWP determined all three methods yielded similar results.

The CCCWP used the 0.2 inches per hour criterion to develop a consistent countywide sizing factor for bioretention facilities when used for stormwater treatment only (i.e., not for flow control). The factor is based on a design maximum surface loading rate of 5 inches per hour (now mandated by MRP Provision C.3.c.i.(2)(b)(iv)). The sizing factor is the ratio of the design intensity of rainfall on tributary impervious surfaces (0.2 inches/hour) to the design percolation rate in the facility (5 inches/hour), or **0.04** (dimensionless).

For **volume-based** treatment facilities, MRP Provision C.3.d. references two methods, the **WEF method** and the **California BMP method.** Both the WEF and California BMP methods are based on continuous simulation of runoff from a hypothetical one-acre area entering a basin designed to draw down in 48 hours. Local rainfall data and the California BMP method were formerly used for sizing detention basins in Contra Costa County. The simulation was iterated to find the unit basin size that detains about 80% of the total runoff during the simulation period. The unit basin storage size is expressed as a depth which varies from about 0.45" to 0.85" in Contra Costa County. The results of the method are presented in a nomograph. The technical background is available in a 2005 technical memo.

Since the MRP 2011 amendments took effect, **detention basins may not be used to meet stormwater treatment requirements for Regulated Projects.** The WEF method and California BMP method were included in the 2011 amendments and in the subsequent MRP 2.0, but are **obsolete**.

In 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."

Like the other options, this third option is best analyzed by using continuous simulation of runoff, based on a local long-term hourly rainfall record. Applied to a bioretention facility with standard cross-section dimensions (p. 67) this method could be used to track inflows, storage, and outflows for each time-step during the simulation. Results might demonstrate that sizing factors smaller than 0.04 could be used to calculate the minimum footprint, depending on bioretention facility's location. BASMAA intends to conduct such a study in 2017.

Technical Criteria for Non-LID Treatment Facilities

Non-LID Treatment Facilities may be either tree-box-type high-flowrate biofilters or vault-based high-flowrate media filters.

► GENERAL

- Inflow rate is that generated by a continuous rainfall intensity of 0.2 inches per hour.
- Landscape and non-impervious surfaces should be made self-treating or self-retaining and not drain to treatment facilities, if feasible.
- Use the runoff factors in Table 3-2.
- The applicant's Stormwater Control Plan (Plan) must include as an attachment a letter from the manufacturer stating the manufacturer has reviewed the Plan, the proposed device meets these technical criteria, and the manufacturer will provide a warranty for two years following activation of the facility.

► HIGH-FLOWRATE TREE-BOX-TYPE BIOFILTERS

- Maximum design surface loading rate of 50 inches per hour.
- Precast concrete construction.
- Inlet design to capture flows at least up to the maximum design surface loading rate and to bypass high flows.
- Minimum media depth of 1.8 feet (may be reduced, but maintaining the same media volume, if required because of inadequate head to discharge point).
- Media and facility configuration supports a healthy tree or other vegetation.

► VAULT-BASED HIGH-FLOWRATE MEDIA FILTERS

- Replaceable cartridge filters.
- Maximum design filter surface loading rate of 1 gpm/ft2

- Storage volume detains runoff and allows settling of coarse solids prior to filtration.

- Flow through the cartridge filters is controlled by an orifice or other device so that the design surface loading rate is not exceeded.

► **EXAMPLE CALCULATIONS:**

Given a project with the following Drainage Management Areas draining to a non-LID facility:

DMA 1: 2050 SF Roof, runoff factor 1.0
DMA 2: 3035 SF Asphalt, runoff factor 1.0
DMA 3: 250 SF Solid Unit Pavers Set in Sand, runoff factor 0.5

High-Flowrate Tree-Box-Type Biofilter

Equivalent Impervious Area = (2050 + 3035) × 1.0 + (250 × 0.5) = 5,210 SF
Sizing factor = 0.2"/hr ÷ 50"/hr = 0.004
Minimum biofilter surface area = 0.004 × 5,210 SF = 20.84 SF

Vault-Based High-Flowrate Media Filter

Design flowrate = ((3035 + 2050) ft2 × 1.0 + (250 ft2 × 0.5)) × 0.2"/hr × 1 ft/12" × 1 hr./60 min. × 7.48 gal/ft3 = 54 gpm

Cartridge surface area = 10.7 SF/cartridge (obtain from manufacturer and verify)

No. of cartridges required = 54 gpm/1 gpm/ft2 ÷ 10.7 ft2/cartridge = 5.04 cartridges (round to 5)

Flow-Control (Hydromodification Management)

MRP Provision C.3.g. specifies:

> Stormwater discharges from HM projects shall not cause an increase in the erosion potential of the receiving stream over the pre-project (existing) condition. Increases in runoff flow and volume shall be managed so that post-project runoff shall not exceed pre-project rates and durations, where such increased flow and/or volume is likely to cause increased potential for erosion of creek beds and banks, silt pollutant generation, or other adverse impacts on beneficial uses due to increased erosive force.

Comparison of post-project to pre-project flows is based on continuous simulation of runoff over a period of 30 years or more, using local hourly rainfall data, and statistical analysis of the cumulative duration of flows.

As required by a 2003 amendment to the previous NPDES permit, the CCCWP submitted a **Hydrograph Modification Management Plan (HMP)** in July 2005. CCCWP's HMP included design criteria for Low Impact Development **Integrated Management Practices** (IMPs). Applicants for development approvals can comply with both treatment and HM requirements by incorporating IMPs into the project drainage design. The IMPs and IMP design criteria were updated in early 2009.

The flow-control standard was retained in the MRP issued in October 2009. MRP 2.0, issued in November 2015, requires the CCCWP municipalities to update their designs. Current criteria may be applied for projects that receive final planning entitlements on or before 3 January 2018.

Applicability and Exemptions. The flow-control standard applies to projects which create or replace one acre or more of impervious area and for which applications for development approvals were deemed complete after 14 October 2006. See Chapter 1, including Table 1-1.

Projects may be exempted from HM requirements if any of the following apply:

- The post-project impervious area is less than, or the same as, the pre-project impervious area.
- The project is located in a catchment that drains to pipes or hardened channels, or tidally influenced channels that extend continuously to the Bay, Delta, or a flow-controlled reservoir.
- The project is located in a catchment or subwatershed that is highly developed (that is, 70% or more impervious).

The CCCWP is developing maps of exempt catchments. While these maps are being developed, applicants should consult with municipal staff regarding potential exemptions. As general guidance, and as will be reflected in the maps, "hardened" channels are channels where the channel design and materials have been engineered and constructed, typically with concrete. This does not include engineered earthen channels, nor does it include natural channels where riprap, grade control structures, or bank stabilization structures have been added to control erosion.

Sites that Are Already Partially Developed. At the discretion of municipal staff, on HM projects applicants may provide treatment-only controls for an impervious square footage that is less than or equal to the pre-project impervious square footage. Treatment + HM controls must be provided for the remaining impervious square footage.

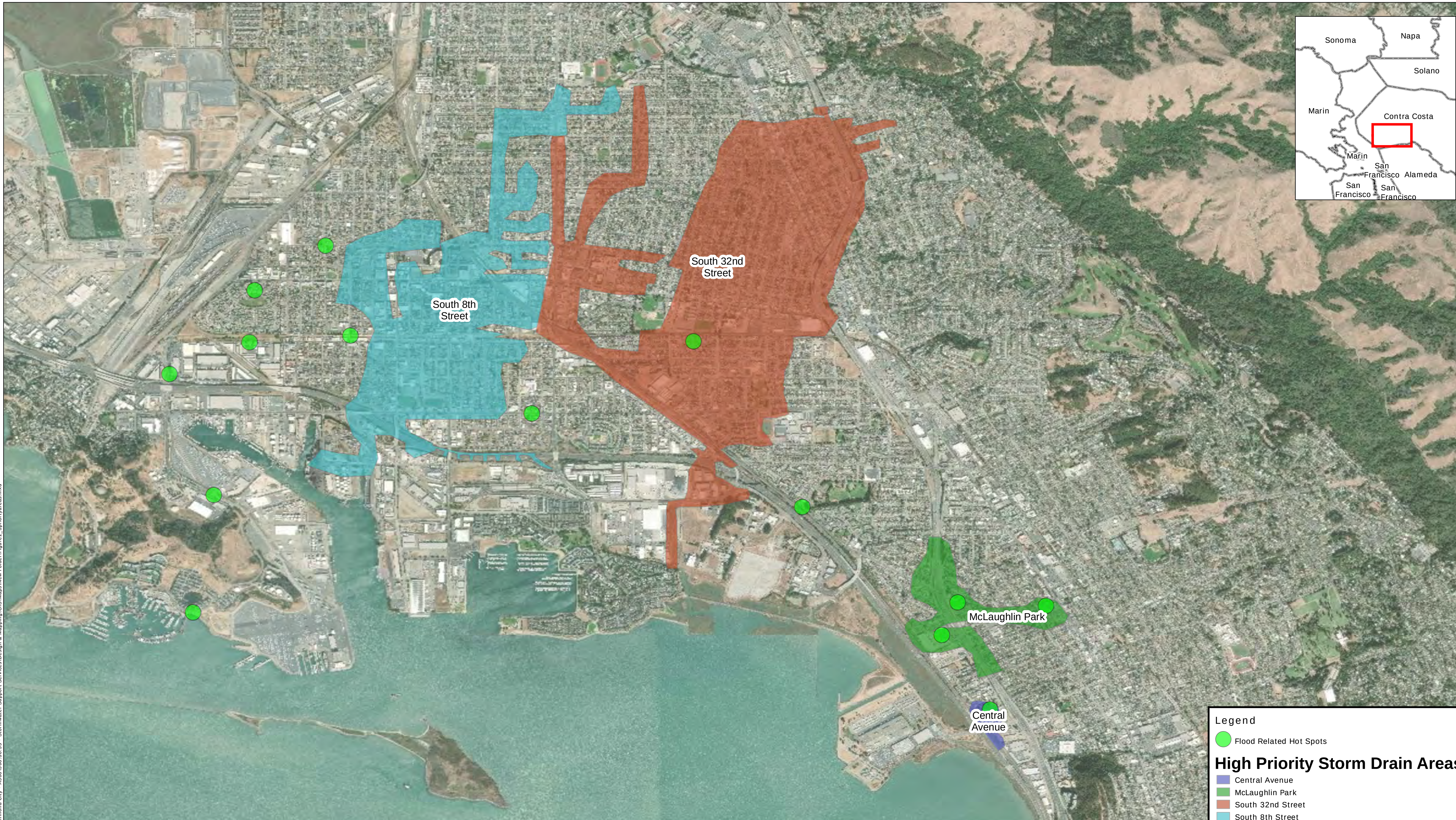
The rationale for this guidance is that the combination of treatment-only and treatment + HM controls will meet the Permit requirement that runoff flow and volume be managed so that post-project runoff doesn't exceed estimated pre-project rates and durations. The rationale is detailed in a 10 March 2009 memo, "Guidance on Flow Control for Development Projects on Sites that are Already Partially Developed," available on the CCCWP website.

Selection and Design of HM Controls. The LID design procedure and criteria in Chapter 3 have been developed and refined, progressively for over a decade, to meet the needs of Contra Costa development projects. In addition to meeting the HM standard, projects designed using Chapter 3 will also meet the LID goals and principles in MRP Provision C.3.c.

Most projects use a combination of site design measures (self-treating and self-retaining areas) and bioretention facilities to meet runoff treatment and flow-control requirements. Design guidance and criteria for more complex options with smaller surface footprints—"cistern + bioretention" and "bioretention + vault"—are in Chapter 3 and may be used if space on the site is constrained.

Previous editions of the *Stormwater C.3 Guidebook* provided guidance on using site-specific hydrologic modeling as an alternative method to demonstrate compliance with HM requirements. An update to this guidance is pending. In the interim, proposals to use this method will be considered case-by-case.

APPENDIX B



City of Richmond Storm Drain Master Plan

High Priority Areas

N

1 inch = 0.5 miles

0 0.5 1 Miles

FIGURE

1.4

SOURCE	JOB NUMBER	DRAWN	DATE	REVISED	APPROVED
ESRI World Imagery basemap	568.38.55	Mhorvath	12/02/2018	NA	NA

Document Path: P:\Active Projects\Richmond City - A568\568.38.55 - Stormwater Support Services\Design & Mapping\GIS\Maps\New Folder\Figure1_3priorityareas.mxd

APPENDIX C

City of Richmond Municipal Code

Chapter 12.22 - STORMWATER MANAGEMENT AND DISCHARGE CONTROL

Sections:

12.22.010 - Intent and purpose.

(a)

The intent of this chapter is to protect and enhance the water quality in the City of Richmond's watercourses pursuant to, and consistent with the Porter-Cologne Water Quality Control Act (Water Code Section 13000 et seq.) and the Federal Clean Water Act (33 U.S.C. Section 1251 et seq.).

(b)

This chapter also carries out the conditions in the City's National Pollutant Discharge Elimination System (NPDES) permit that require implementation of appropriate source control and site design measures and stormwater treatment measures for development projects.

(c)

It is the purpose of the City Council in enacting this chapter to protect the health, safety and general welfare of Richmond's citizens by:

(1)

Minimizing non-stormwater discharges, whose pollutants would otherwise degrade the water quality of local streams, to the stormwater system;

(2)

Minimizing increases in nonpoint source pollution caused by stormwater runoff from development that would otherwise degrade local water quality;

(3)

Controlling the discharge to the City's stormwater system from spills, dumping or disposal of materials other than stormwater; and

(4)

Reducing stormwater runoff rates and volumes and nonpoint source pollution whenever possible, through stormwater management controls and ensuring that these management controls are properly maintained and pose no threat to public safety.

12.22.020 - Definitions.

The following words and phrases when used in this chapter shall be as defined herein. Words and phrases in this chapter and not otherwise defined shall be interpreted as defined in the regulations issued by the U.S. Environmental Protection Agency to implement the provisions of the Federal Clean Water Act, and as defined by the State Water Resources Control Board to implement the Porter-Cologne Act:

(1)

"Best management practices" or "BMP" are structural devices, measures, stormwater management facilities or activities that help to meet development runoff requirements at the premises. BMP also include schedules of activities, prohibitions or practices, general good housekeeping, pollution prevention practices, maintenance procedures and other management practices, to prevent or reduce the discharge of pollutants directly or indirectly to watercourses, water bodies, and wetlands.

(2)

"City's NPDES permit" means the National Pollutant Discharge Elimination System permit issued to the City of Richmond, Permit No. CAS612008, and any subsequent amendment, reissuance or successor to this NPDES permit.

(3)

"Development runoff requirements" means the provisions in the City's NPDES permit that contain performance standards to address both the construction and post-construction phase impacts of new projects and redeveloped projects on stormwater quality.

(4)

"Enforcement officer" or "Officer" means those individuals designated by the City Manager to act as authorized enforcement officers.

(5)

"Guidebook" means the most recent version of the Contra Costa Clean Water Program Stormwater C. 3. Guidebook.

(6)

"Non-stormwater discharge" means any addition of any pollutant to the City's stormwater system, except discharges pursuant to a NPDES permit, or discharges further exempted in Sections 12.22.060(c) and (d) of this chapter.

(7)

"Pollutant" means any material other than stormwater including, but not limited to, petroleum products or by-products, solid waste, incinerator residue, sewage, sewage sludge, heat, chemical waste, biological materials, radioactive materials, wrecked or discarded equipment, rock, sand, soil and industrial, municipal or agricultural waste discharged into the water or stormwater system.

(8)

"Premises" means any building, structure, facility, or installation, (including a building's grounds or other appurtenances), and adjacent sidewalks and parking strips.

(9)

"Responsible person" means the owner or occupant of any premises or who engages in any activity from which there is or may be a non-stormwater discharge or any person who releases pollutants to the City's stormwater system.

(10)

"Stormwater" means flow on the surface of the ground resulting from precipitation.

(11)

"Stormwater management facility" means any device that utilizes detention, retention, filtration, harvest for reuse, evapotranspiration or infiltration to provide treatment (and/or control volume, flows and durations) of stormwater for purposes of compliance with development runoff requirements.

(12)

"Stormwater control plan" means a plan that meets those criteria contained in the most recent version of the Contra Costa Clean Water Program Stormwater C. 3. Guidebook.

(13)

"Stormwater system" means that system of facilities by which stormwater may be conveyed to any stream, watercourse, other body of water or wetlands, including flood control channels, any roads with drainage systems, city streets, catch basins, curbs, gutters, ditches, improved channels, storm drains or storm drain system, which are not part of a Publicly Owned Treatment Works ("POTW") as that term is defined in 40 CFR Section 122.2.

12.22.030 - Responsibility for administration.

The City Manager or his designee shall administer this chapter for the City.

12.22.040 - Construction and application.

This chapter shall be construed consistent with the requirements of the Federal Clean Water Act and amendments thereto or applicable implementing regulations and the City's NPDES permit.

12.22.050 - Stormwater control plan required.

(a)

In accordance with thresholds and effective dates in the City's NPDES Permit, every application for a development project, including but not limited to a rezoning, tentative map, parcel map, conditional use permit, variance, site development permit, design review, or building permit that is subject to the development runoff requirements in the City's NPDES permit shall be accompanied by a stormwater control plan that meets the criteria in the most recent version of the Contra Costa Clean Water Program Stormwater C. 3. Guidebook.

(b)

Implementation of an approved stormwater control plan and submittal of an approved stormwater control operation and maintenance plan by the applicant shall be a condition precedent to the issuance of a certificate of occupancy for a project subject to this section.

(c)

All stormwater management facilities shall be designed in a manner to minimize the need for maintenance and reduce the chances of failure. Design guidelines are outlined in the guidebook.

(d)

All stormwater management facilities shall be maintained according to the guidebook and the approved stormwater control operation and maintenance plan. The person(s) or organization(s) responsible for maintenance shall be designated in the plan. Unless a different time period is provided for in the plan, those responsible for maintenance shall inspect the stormwater management facility at least annually. The plan shall also describe how the maintenance costs will be funded. Upon the failure of a responsible person to maintain a stormwater management facility in accordance with this chapter or the plan, the City may perform the maintenance and recover its costs from the responsible person as provided in Sections 12.22.170 and 12.22.180.

(e)

For access to stormwater management facilities for inspections and maintenance, recorded covenants or easements shall be provided by the property owner for access by the City, the Contra Costa Mosquito and Vector Control District, and the Regional Water Quality Control Board.

12.22.060 - Prohibited discharges.

(a)

The release of non-stormwater discharges to the City stormwater system and watercourses is prohibited.

(b)

The discharge of stormwater from premises or an activity that causes or contributes to a violation of receiving water limitations in the City's NPDES permit is prohibited.

(c)

The following discharges are exempt from the prohibition set forth in subsection (a) above:

(1)

Any discharge in compliance with a NPDES permit issued to the discharger; and

(2)

Flows from riparian habitats and wetlands, diverted stream flows, springs, rising groundwater and uncontaminated groundwater infiltration.

(d)

The following discharges are exempt from the prohibition set forth in subsection (a) above if and only if the discharges are in accordance with the specific conditions for each type of discharge set forth in Section C.15 of the City’s NPDES permit: pumped groundwater from non-drinking-water aquifers; pumped groundwater from other sources, foundation drains, and water from crawl space pumps and footing drains; air conditioning condensate; planned discharges from routine operation and maintenance activities in the potable water distribution system; unplanned discharges from breaks, leaks, overflows, fire hydrant shearing, or emergency flushing of the potable water distribution system; emergency discharges of the potable water distribution system as a result of firefighting, unauthorized hydrant openings, or natural or man-made disasters; individual residential car washing; swimming pool, hot tub, spa, and fountain water discharges, and discharges from irrigation water, landscape irrigation, and lawn or garden watering.

12.22.070 - Discharge in violation of NPDES permit.

Any discharge that would result in or contribute to a violation of the City's NPDES permit either separately considered or when combined with other discharges, is prohibited. Liability for any such discharge shall be the responsibility of the person causing or responsible for the discharge, and such person shall defend, indemnify and hold harmless the City in any administrative or judicial enforcement action relating to such discharge.

12.22.080 - Unlawful discharge and unlawful connections.

(a)

It is unlawful to establish, use, maintain or continue unauthorized drainage connections to the City's stormwater system and watercourses, and to commence or continue any unauthorized discharges to the City's stormwater system and watercourses.

(b)

No discharge shall cause the following conditions, create a nuisance or adversely affect beneficial uses of waters of the state:

(1)

Floating, suspended or deposited macroscopic matter or foam;

(2)

Bottom deposits or aquatic growth;

(3)

Alterations of temperature, sediment load, nutrient load, or dissolved oxygen, which cause significant adverse impacts to native aquatic biota;

(4)

Visible, floating, suspended or deposited oil or products of petroleum origin; or

(5)

Substances present in concentrations or quantities which cause deleterious effects on aquatic biota, wildlife or waterfowl, or which render any of these unfit for human consumption.

12.22.090 - Best management practices and standards.

(a)

Generally. Any person owning or operating premises that may contribute pollutants to the City's stormwater system shall undertake best management practices to reduce the potential for pollutants entering the system to the maximum extent practicable. Examples of such premises include, but are not limited to, parking lots, gasoline stations, industrial facilities, paved private streets or roads, and other commercial enterprises. The City reserves the right to permit facilities that potentially contribute pollutants to stormwater, and to require business to hold polluted stormwater from entering the City Municipal Stormwater system when the City may violate its NPDES permit until the discharge meets accepted discharge standards.

(b)

Litter. No person shall throw, deposit, leave, keep or permit to be thrown, deposited, placed, left or maintained, any refuse, rubbish, garbage or other discarded or abandoned objects, articles or other litter in or upon any street, alley, sidewalk, business place, creek, stormwater system, fountain, pool, lake, stream, river or any other body of water, or upon any public or private parcel of land so that the same might become a pollutant, except in containers or in lawfully established waste disposal facilities.

(c) Covered Loads. No person shall drive or move any vehicle with an open cab/trailer within the City unless such contents are secured by a tarp over the contents or the material being transported is constructed and loaded to ensure that all litter is prevented from being blown or deposited upon any street, alley or other public or private place.

(d)

Sidewalks. The occupant or tenant, or in the absence of occupant or tenant, the owner or proprietor of any real property in front of which there is a paved sidewalk shall maintain said sidewalk free of dirt or litter to the maximum extent practicable. Sweepings from the sidewalk shall not be swept or otherwise made or allowed to go into the gutter or roadway, but shall be disposed of in receptacles maintained as required for the disposal of solid waste.

(e)

Parking Lots, Paved Areas and Related Stormwater Systems. Persons owning, operating or maintaining a paved parking lot, the paved areas of a gasoline station, a paved private street or road, and related stormwater systems shall clean those premises as frequently and thoroughly as practicable in a manner that does not result in the discharge of pollutants to the City's stormwater system.

(f)

Maintenance of Facilities and Landscaped Areas. Best Management Practices shall be implemented to minimize the release of pesticides, herbicides, and other related materials used to maintain landscaping and facilities.

(g)

Construction Activities. All construction shall conform to the requirements of the CASQA Stormwater Best Management Practices Handbooks for Construction Activities and New Development and Redevelopment, the ABAG Manual of Standards for Erosion & Sediment Control Measures, the City's grading and erosion control ordinance and other generally accepted engineering practices for erosion control as required by the City Manager when undertaking construction activities. The City Manager may establish controls on the rate of stormwater runoff from new developments and redevelopment as may be appropriate to minimize the discharge and transport of pollutants.

(h)

Notification of Intent and Compliance with General Permits. Each discharger associated with construction activity or other discharger described in any general stormwater permit addressing discharges, as may be adopted by the United States Environmental Protection Agency, the State Water Resources Control Board, or the California Regional Water Quality Control Board, San Francisco Bay Region, shall provide the City Manager with the notice of intent, comply with and undertake all other activities required by any general stormwater permit applicable to such dischargers. Each discharger identified in an individual NPDES permit relating to stormwater discharges shall comply with and undertake all activities required by the permit.

(i)

Development Runoff Requirements. For each new development and redevelopment project subject to the development runoff requirements, every applicant will submit a stormwater control plan and implement conditions of approval that reduce stormwater pollutant discharges through the construction, operation and maintenance of treatment measures and other appropriate source control and site design measures. Similarly, increases in runoff volume and flows shall be managed in accordance with the development runoff requirements.

(j)

Compliance with Best Management Practices. Where best management practices guidelines or requirements have been adopted by any federal, state, regional, city or county agency, for any activity, or operation of premises which may cause or contribute to non-stormwater discharges, every person undertaking such activity, operation or owning and operating such premises shall comply with such guidelines or requirements. Failure to implement and maintain best management practices included in a stormwater permit are subject to administrative citations.

(k)

Stormwater Pollution Prevention Plan. The City Manager may require any business or utility in the City that is engaged in activities that may result in non-stormwater discharges or runoff pollutants to develop and implement a stormwater pollution prevention plan, which must include an employee training program. Business activities which may require a stormwater pollution prevention plan include maintenance, storage, manufacturing, assembly, equipment operations, vehicle loading, fueling, vehicle maintenance, food handling or processing, or cleanup procedures which are carried out partially or wholly out of doors. Failure to implement and maintain best management practices included in a stormwater pollution prevention plan are subject to administrative citations.

(l)

Coordination with Hazardous Material Release Response and Inventory Plans. Any business subject to the Hazardous Material Release Response and Inventory Plan, Division 20, Chapter 6.95 of the California Health and Safety Code (commencing with Section 25500), shall include, in that plan, provision for compliance with this chapter, including the prohibitions of non-stormwater discharges and the requirement to reduce release of pollutants to the maximum extent practicable.

12.22.100 - Compliance certificates for stormwater management facilities.

(a)

Every person who owns, leases or operates any premises containing a stormwater management facility or facilities is required to obtain annually a valid operation and maintenance certificate of compliance certifying to the inspection of and the proper operation and maintenance of the treatment measures and other appropriate source control and site design measures. Each responsible person subject to this requirement shall request an inspection from the City every 12 months. Upon the filing of such request, and the payment of a fee covering the cost of inspection, the City shall inspect the property and shall either issue such certificate upon a determination by the inspector that all treatment measures and other appropriate source control and site design measures have been properly maintained and are in good condition, or shall issue a conditional certificate noting deficiencies that must be corrected within a time indicated on the certificate, or shall deny the certificate. A certificate shall be valid for one year from the date of issuance. The City Council may by resolution establish the fee for the inspection and certificate.

(b)

In lieu of a City inspection, such person may arrange for an inspection from a private company authorized to conduct inspections by the City. Such company shall use a City-approved inspection form that shall be executed under penalty of perjury. Should such inspection form establish that the treatment measures and other appropriate source control and site design measures have been properly maintained and are in good condition, the City may issue an operation and maintenance certificate of compliance or the City may at its cost re-inspect the property and proceed as described in subsection (a). The filing of a false inspection report shall be a misdemeanor.

12.22.110 - Authority to inspect.

(a)

Generally. Routine scheduled or unannounced inspections shall be based upon as reasonable a selection process as may be deemed necessary to carry out the intent of this chapter, including, but not limited to, random sampling or sampling in areas with evidence of stormwater contamination, evidence of the discharge of non-stormwater to the stormwater system, or similar activities. Inspections may also be conducted in conjunction with routine scheduled or unannounced inspections conducted by other public agencies or special district, including but not limited to the Central Contra Costa Sanitary District, the Contra Costa County Fire Protection District, County Environmental Health Department, the Contra Costa Mosquito and Vector Control District, or the Regional Water Quality Control Board.

(b)

Authority to Sample and Establish Sampling Devices. With the consent of the owner or occupant, or pursuant to a search or inspection warrant, any officer may establish on any property such devices as are necessary to conduct sampling or metering operations. During all authorized inspections, the officer may take any sample deemed necessary to aid in the pursuit of the inquiry or in the recordation of the activities on site.

(c)

Notification of Spills. All persons in charge of the premises or responsible for emergency response for the premises have a responsibility to train premises' personnel and maintain notification procedures to ensure that immediate notification is provided to the City of Richmond any suspected, confirmed or unconfirmed release of pollutants creating a risk of non-stormwater discharge into the City stormwater system.

As soon as any person in charge of the premises or responsible for emergency response for the premises has knowledge of any suspected, confirmed or unconfirmed release of non-stormwater discharge entering the City stormwater system, such person shall take all necessary steps to ensure the detection and containment and clean up of such release and shall notify the City of Richmond of the occurrence by telephoning the City Manager. This notification requirement is in addition to and not in lieu of other required notifications.

(d)

Requirement to Test or Monitor. Any officer may require that any person engaged in any activity or owning or operating any premises that may cause or contribute to non-stormwater discharges, undertake such monitoring activities or analysis and furnish such reports as the officer may specify. The burden, including costs of these activities, analysis and reports shall bear a reasonable relationship to the need for the monitoring, analysis and reports and the benefits to be obtained. The recipient of such request shall undertake and provide the monitoring, analysis and reports required.

12.22.120 - Violations constituting misdemeanors.

The violation of any provision of this chapter, or failure to comply with any of the mandatory requirements of this article shall constitute a misdemeanor, except that notwithstanding any other provisions of this article, any violation constituting a misdemeanor under this chapter may, at the discretion of the officer or City Attorney, be charged and prosecuted as an infraction.

12.22.130 - Penalty for violation.

(a)

Upon conviction of a misdemeanor, a person shall be subject to payment of a fine, or imprisonment, or both, not to exceed the limits set forth in California Government Code Section 36901.

(b)

Upon conviction of an infraction, a person shall be subject to payment of a fine, not to exceed the limits set forth in California Government Code Section 36900.

(c)

Administrative citations shall be $250 for the first issuance, $500 for the second issuance, and $1,000 for the third and all subsequent issuances. Administrative citation procedures are set forth in Section 2.62.

12.22.140 - Continuing violation.

Every day that any violation of this chapter shall continue shall constitute a separate offense.

12.22.150 - Concealment.

Concealing, aiding or abetting a violation of any provision of this chapter shall constitute a violation of such provision.

12.22.160 - Acts potentially resulting in violation of the Federal Clean Water Act or Porter-Cologne Act.

Any person who violates any provision of this chapter, or the provisions of any permit issued pursuant to this chapter, or who releases a non-stormwater discharge, or who violates any cease and desist order, prohibition or effluent limitation, may also be in violation of the Federal Clean Water Act or the Porter-Cologne Act and may be subject to the enforcement provisions of those acts, including civil and criminal penalties. Any enforcement actions authorized pursuant to this chapter may also include notice to the violator of such potential liability pursuant to federal or state law.

12.22.170 - Violations deemed a public nuisance.

In addition to the penalties provided herein, any condition caused or permitted to exist in violation of any of the provisions of this chapter is a threat to the public health, safety and welfare. Such condition is hereby declared and deemed to be a public nuisance, which may be abated as provided in Chapter IX (commencing with Section 9.22.100) of this Code, including the assessment of the costs of abatement which may be collected at the same time and in the same manner as ordinary municipal taxes as provided by Government Code Section 38773.5, and by civil action to abate, enjoin or otherwise compel the cessation of such nuisance by the City Attorney.

12.22.180 - Civil actions.

(a)

In addition to any other remedies provided in this chapter, any violation of this chapter may be enforced by civil action brought by the City. In any such action, the City may seek, as appropriate, any and all of the following remedies:

(1)

A temporary restraining order, preliminary injunction and permanent injunction; and/or

(2)

An action for an unlawful business practice pursuant to Business and Professions Code Section 17206.

(b)

In addition any person violating this chapter shall be liable for:

(1)

Reimbursement for the costs of any investigation, inspection or monitoring which led to the discovery of the violation;

(2)

Costs incurred in removing, correcting, or terminating the adverse effect(s) resulting from the violation;

(3)

Compensatory damages for the loss of, or destruction to, water quality, wildlife, fish or aquatic life. Costs and damages under this subsection shall be paid to the City and shall be used exclusively for costs associated with monitoring and establishing a stormwater discharge pollution control system and implementing or enforcing the provisions of this chapter;

(4)

The cost of maintenance and repair of any BMP or stormwater management facility that is not maintained in accordance with the guidebook or the stormwater control plan; and

(5) The reasonable costs of preparing and bringing administrative action under this chapter.

12.22.190 - Remedies not exclusive.

The remedies identified in this chapter are in addition to, and do not supersede or limit, any and all other remedies, administrative, civil or criminal. The remedies provided for herein shall be cumulative and not exclusive.

12.22.200 - Notice of violation.

Any person required to perform monitoring, analysis, reporting or corrective activity by any officer may be informed of such decision, in writing, by a notice of violation. Any person aggrieved by the decision of the officer, may file a written appeal of the notice of violation to the City Manager within 10 (ten) days following the date of the notice of violation. Upon receipt of such request, the City Manager shall request a report and recommendation from the officer and shall set the matter for hearing at the earliest practical date. At said hearing, all evidence and testimony deemed relevant and admissible by the City Manager shall be considered, and the City Manager may reject, affirm, or modify the officer's decision. Formal rules of evidence shall not apply. The decisions of the City Manager shall be final. Failure to request a hearing or appear at the hearing shall constitute a waiver and failure to exhaust administrative remedies.

12.22.210 - Judicial review.

The provisions of Code of Civil Procedure Section 1094.5 are applicable to judicial review of determinations made by the City Manager pursuant to this chapter.

12.22.220 – Performance of work by the City

In the event that a City Source Control Inspector or Supervisor determines that there is an immediate need for repair or maintenance of the storm drain collection system, including but not limited to cleaning lines from illicit discharges, the City Manager or his/her designee may take any necessary action to correct the condition, and shall bill the person who the City Source Control Inspector or Supervisor determines has created the condition to reimburse the City for costs incurred. In the event such costs are not paid within thirty days after receiving written notice therefor, the City Manager or his/her designee may notify the County Assessor who shall enter the amount due for the said work upon the assessment rolls of Contra Costa County and to collect said amount in the same manner as real property taxes are collected.

APPENDIX D

RICHMOND, CALIFORNIA, June 6, 2017

The Richmond City Council Evening Open Session was called to order at 5:03 p.m.

ROLL CALL

Present: Councilmembers Ben Choi, Eduardo Martinez, Gayle McLaughlin, Melvin Willis, Vice Mayor Jovanka Beckles, and Mayor Thomas K. Butt. **Absent:** Councilmember Jael Myrick arrived after the roll was called.

PUBLIC COMMENT

The city clerk announced that the purpose of the Open Session was for the City Council to hear public comments on the following items to be discussed in Closed Session:

CITY COUNCIL

CONFERENCE WITH LEGAL COUNSEL - ANTICIPATED LITIGATION (Significant exposure to litigation pursuant to Subdivision (b) of Government Code Section 54956.9):

One Case

CONFERENCE WITH REAL PROPERTY NEGOTIATOR (Government Code Section 54956.8):

Property: General Warehouse - Port of Richmond
Agency negotiators: Bill Lindsay and Jim Matzorkis
Negotiating party: (i) Orton Development; and (ii) Richmond Grown LLC
Under negotiation: Price and terms of payments

Property: (former) Cafeteria Building - Port of Richmond
Agency negotiators: Bill Lindsay, Jim Matzorkis
Negotiating parties: (i) Power Plant LLC; and (ii) Golden Gate Meat Company/Up & Under Pub and Grill
Under negotiation: Price and terms of payment

Nathan Trivers and Rick Benson gave comments regarding the Cafeteria Building.

(Mayor Butt recused himself from the negotiation regarding the Cafeteria Building due to a conflict of interest).

The Open Session adjourned to Closed Session at 5:16 p.m. Closed Session adjourned at 6:51 p.m.

The Regular Meeting of the Richmond City Council was called to order at 6:54 p.m., by Mayor Butt, who led the Pledge of Allegiance to the Flag.

ROLL CALL

Present: Councilmembers Choi, Martinez, McLaughlin, Willis, and Mayor Butt. **Absent:** Councilmember Myrick and Vice Mayor Beckles arrived after the roll was called.

(Mayor Butt announced that members of the public may address the Council on consent calendar items during Open Forum).

STATEMENT OF CONFLICT OF INTEREST

None.

AGENDA REVIEW

None.

REPORT FROM THE CITY ATTORNEY OF FINAL DECISIONS MADE DURING CLOSED SESSION

City Attorney Bruce Goodmiller stated that there were no final actions taken.

REPORT FROM THE CITY MANAGER

City Manager Bill Lindsay reported on the conclusion of the Richmond Police Department Community Safety Academy and graduation ceremony held June 5, 2017.

OPEN FORUM FOR PUBLIC COMMENT

Conrad Baldwin distributed documents and a resolution to the Council requesting the immediate release of false imprisonment victims. Mr. Baldwin requested the Council to place the resolution on its next meeting agenda and send it to Governor Jerry Brown.

Mark Lindquist inquired about the General Warehouse negotiation closed session item. Mayor Butt advised Mr. Lindquist to consult with City Attorney Bruce Goodmiller directly regarding this matter.

Mark Wassberg gave comments regarding illegal immigration and the presidential executive order to build a wall along the United States-Mexico border (referenced in item H-18).

Naomi Williams made the following announcements: The Commission on Aging was hosting a bus trip to the Red Hawk Casino, departing from 24th Street and Barrett Avenue on June 7, 2017, at 8:30 a.m. The Juneteenth Festival was held on June 17, 2017, at Nichol Park. The Commission on Aging was in need of new commissioners to fill vacancies.

K. Harley, Rick, Patricia, and Julie Perez gave comments regarding the Pedie Perez case and investigation. Mr. Perez gave comments regarding a sting operation conducted by Union Pacific Railroad and Richmond police officers at the Carlson and Cutting Boulevards intersection. Mr. Perez reported an alleged incident concerning Richmond police officers displaying inappropriate conduct. Ms. Harley gave comments regarding the Oscar Grant Committee meeting held on June 5, 2017. Ms. Harley encouraged the Council to support her proposed 'Value Human Life Bill.' Patricia Perez expressed concerns that police officers were protected and was not subjected to the same scrutiny as civilians following officer involved shootings. Patricia Perez gave comments regarding the Law Enforcement Officers' Bill of Rights. Julie Perez gave comments regarding community policing.

Andrés Soto expressed his support to the Perez Family. Mr. Soto announced that the Bay Area Air Quality Management District (BAAQMD) Board of Directors voted 16 to 3 endorsing a rule placing a cap on greenhouse gas emissions by oil refineries. Mr. Soto announced that the BAAQMD board was casting the final vote on the rule on June 21, 2017, and the California Air Resources Board was considering a suite of rules to apply statewide. Mr. Soto expressed his gratitude for the Council's leadership on the issue.

Ruscal Cayangyang announced his stand against hateful, racial, and personal attacks made by others. Mr. Cayangyang gave comments in support of the City of Richmond being a 'safe haven' community. Mr. Cayangyang expressed his gratitude to Councilmembers McLaughlin, Willis, and Vice Mayor Beckles for resolutions placed on the agenda.

CITY COUNCIL CONSENT CALENDAR

On motion of Councilmember McLaughlin, seconded by Councilmember Martinez, the item(s) marked with an (*) were approved by the following vote: **Ayes:** Councilmembers Choi, Martinez, McLaughlin, Willis, Vice Mayor Beckles, and Mayor Butt. **Noes:** None. **Abstentions:** None. **Absent:** Councilmember Myrick.

*H-1. Approved the Green Infrastructure Framework as an outline of the Green Infrastructure Plan which addresses pollutants of concerns from urban storm-water runoff, in order to maintain compliance with the Municipal Regional Permit.

*H-2. Received a report on the Richmond Municipal Sewer District for the month of April 2017.

*H-3. Adopted **Resolution No. 57-17** to accept and appropriate $83,155 in funding from the Edward Byrne Memorial Justice Assistance Grant (JAG) Program awarded to the Richmond Police Department for the purchase of police safety equipment.

*H-4. Adopted **Resolution No. 58-17** authorizing submittal of the Measure J 2014 and 2015 "Growth Management Program Compliance Checklist" to the Contra Costa County Transportation Authority (CCTA) to allow the City of Richmond to receive its allocation of Fiscal

Year 2015-16 and 2016-17 Local Street Maintenance and Improvement Funds.

*H-5. Designated Mayor Tom Butt as voting delegate to represent the City of Richmond at the Annual Business Meeting of the League of California Cities' 2017 Annual Conference, to be held at the Convention Center in Sacramento, Wednesday, September 13 through Friday, September 15, 2017.

*H-6. Approved the minutes of the May 16, 2017, regular meeting of the Richmond City Council.

*H-7. Adopted **Resolution No. 59-17** renewing and continuing the local emergency on Rifle Range Road due to landslide damage, which was first adopted by the City Council on March 7, 2017.

*H-8. Adopted **Resolution No. 60-17** renewing and continuing the local emergency on Via Verdi due to landslide damage, which was first adopted by the City Council on February 28, 2017.

*H-9. Approved an on-call contract for concrete sidewalk repair services with Precision Concrete Cutting in an amount not to exceed $100,000 per year for three years from fiscal year 2017/18 to 2019/20.

*H-10. Received the Investment and Cash Balance Report for the month of April 2017.

*H-11. Introduced an ordinance (first reading) setting the tax rate for the Tax Override Pension Fund for Fiscal Year 2017-18 at 0.14%.

*H-12. Adopted **Resolution No. 61-17** authorizing a twelve-month Business License Tax Amnesty Program from July 2017 through June 2018 allowing businesses with unpaid business license taxes and transient occupancy taxes, including hotels, motels, and short term rentals such as Airbnb rentals, the opportunity to comply with Richmond Municipal Code (RMC) Section VII, Chapters 7.04 and 7.88, without the necessity of paying penalties and interest.

*H-13. Approved actions to update the Economic Development Commission; Appointed Demnlus Johnson, new appointment, seat #1, filling an unexpired term with an expiration date of March 30, 2018.

*H-14. Approved actions to update the Design Review Board; Appointed Michael Hannah, new appointment, seat #1, expiration date March 17, 2019, Bhavin Khatri, new appointment, seat #2, expiration date March 17, 2019, Jonathan Livingston, re-appointment, seat #4, expiration date March 17, 2019.

*H-15. Approved actions to update the Commission on Aging; Appointed Rose Brooks, re-appointment, seat #6, expiration date of May 19, 2019.

*H-16. Approved actions to update the Youth Council; Appointed Nayeli Hernandez, new appointment, seat #4, expiration date October 1, 2017.

*H-17. Adopted **Resolution No. 62-17** in support of Assembly Bill 1360, Assembly Bill 1478, and Senate Bill 808 in the California State Legislature to assure charter school accountability and transparency, and to address local control of charter schools in California.

*H-18. Adopted **Resolution No. 63-17** denouncing the presidential executive order to build a wall along the U.S. - Mexico border and recommending that the City of Richmond not do business with or contract with any companies involved in the construction of a border wall.

BUDGET SESSION

I-1. The matter to receive presentations from department representatives, providing an overview of their proposed operating budgets for Fiscal Year (FY) 2017-18, and the Capital Improvement Plan for FY 2017-18 - FY 2021-22; initiate a policy review of the operating and capital budgets, and provide direction to staff was introduced by Finance Director Belinda Warner. Ms. Warner presented a Powerpoint presentation that highlighted the following: The Housing and Community Development Department's mission; FY 2017-18 goals; housing staff; non-General Fund budget; and city-wide capital improvement projects. Discussion ensued. Senior Management Analyst LaShonda White presented a Powerpoint presentation for the proposed FY 2017-18 Environmental Community Investment Agreement (ECIA) budget that highlighted the following: background; 10-year projection; proposed FY 2017-18 budget; greenhouse gas reduction programs; community based programs; and tracking and reporting. Discussion ensued. Revenue Manager Antonio Banuelos presented the FY 2017-18 General Fund revenue. Discussion ensued. Budget Analyst Markisha Guillory presented the FY 2017-18 General Fund expenditures and budget adjustments. Discussion ensued. The Council requested staff to research the use of deep green 100% renewable energy. Steve Paskowitz gave comments.

PUBLIC HEARINGS

J-1. The City Clerk announced that it was time, pursuant to public notice, to hold a public hearing to introduce an ordinance regarding the City's intent to grant to Santa Fe Pacific Pipelines Partners, L.P. (SFPP) a 10 year franchise agreement to use or lay and use oil pipes and appurtenances for the purpose of transmitting and distributing oil and oil products within the City's rights-of-way for a period of ten years. Engineering and Capital Improvements Director Yader Bermudez gave an oral report. Discussion ensued. Mayor Butt declared the public hearing open. Andrés Soto gave comments in favor. Mayor Butt declared the public hearing closed. On motion of Councilmember Martinez, seconded by Councilmember McLaughlin, said ordinance received first reading and was laid over for two weeks by the unanimous vote of the City Council.

J-2. The City Clerk announced that it was time, pursuant to public notice, to hold a public hearing to introduce an ordinance (first reading) establishing certain fees for the proposed Master Fee Schedule. Revenue Manager Antonio Banuelos provided an oral report. Discussion ensued. The Council requested staff to verify that a policy was in effect to waive tow charges for the first 48 hours, for Richmond resident victims of stolen vehicles, if the vehicle was towed by a Richmond Police Department towing contractor. The Council requested staff to research if other cities charged vehicle impoundment fees when the driver was arrested. The Council requested staff to research fines and penalties for illegal dumping. On motion of Councilmember Myrick, seconded by Councilmember Willis, said ordinance received first reading, excluding the impoundment fee for arrested drivers for consideration at a later date, and was laid over for two weeks by the unanimous vote of the City Council.

RESOLUTIONS

K-1. The matter to adopt a resolution in support of Assembly Bill 1578 (Jones-Sawyer), which would prohibit a state or local agency from assisting a federal agency to investigate, detain, detect, report or arrest a person for marijuana activity that is authorized by law in the State of California and transferring an individual to federal law enforcement authorities for purposes of marijuana enforcement, unless directed to do so by a court order was introduced by Councilmember Willis and Vice Mayor Beckles. Mark Wassberg, James Hinton, and Ruscal Cayangyang gave comments. A motion by Councilmember Willis, seconded by Councilmember Martinez, adopted **Resolution No. 64-17** directing staff to send a copy of the resolution to the Senate, by the unanimous vote of the City Council.

COUNCIL AS A WHOLE

L-1. The matter to consider extending the minimum wage phase-in period and increasing the minimum wage to $15/hour in Richmond and direct staff to present draft amendments to Ordinance No. 11-14 N.S. at the first City Council meeting in July was introduced by Councilmembers Willis and McLaughlin. Discussion ensued. A proposal by Mayor Butt to place the item on a future agenda as a study session after outreach to business owners was not accepted by the item's sponsors. Tina Sandoval, Heriberto Aranda, James Hinton, and Bea Roberson gave comments. On motion of Councilmember Willis, seconded by Councilmember Beckles, directed staff to return to City Council on July 18, 2017, with an extension on the minimum wage that increases the wage by the year 2019 with a phase-in period starting in the year 2018; remove all exemptions from the previous minimum wage ordinance except for Youth WORKS; and replace the text under the *"waiver through collective bargaining"* section of the ordinance from "*to the extent required by law"* to *"to the extent required by law or permitted that all* *or any positions of applicable requirements of the charter may be waivered”*, by the following vote: **Ayes:** Councilmembers Choi, Martinez, McLaughlin, Myrick, Willis, and Vice Mayor Beckles. **Noes:** Mayor Butt. **Abstentions:** None. **Absent:** None.

L-2. The matter to direct the city manager to enter into a license agreement with Waterside Workshops for use of Building 87 at Pt. Molate Beach Park to expand their vocational training program targeted at underserved Richmond youth, with final terms to be approved by the city manager, and with approval as to form by the city attorney was introduced by Councilmember McLaughlin. Discussion ensued. Don Gosney gave comments. On motion of Councilmember McLaughlin, seconded by Councilmember Choi, authorized said license agreement for use of Building 87 at Pt. Molate Beach Park or a suitable alternative, by the unanimous vote of the City Council.

REPORTS OF OFFICERS: REFERRALS TO STAFF, AND GENERAL REPORTS (INCLUDING AB 1234 REPORTS)

Councilmember Martinez reported on attendance to the Inner City Capital Connections meeting on May 31, 2017, and its scholarship program for businesses along the capitol corridor.

Mayor Butt reported attendance to the Association of Bay Area Governments (ABAG) General Assembly meeting on June 5, 2017; where members voted on a budget and work program to move the ABAG-Metropolitan Transportation Commission merger into the next phase.

Councilmember McLaughlin reported on attendance to the Boards and Commissions Leadership Institute.

ADJOURNMENT

There being no further business, the meeting adjourned at 9:33 p.m., in memory of Richmond resident Lil Williamson, Executive Assistant to the City Manager Sue Kadlec’s mother Pat Robertson, and youth coach Bishop Johnson, to meet again on Tuesday, June 20, 2017, at 6:30 p.m.

Pamela Christian
Clerk of the City of Richmond

(SEAL)

Approved:

Tom Butt
Mayor

CITY OF RICHMOND

Green Infrastructure Plan Framework

Order R2-2015-0049 MRP Provision C.3.j.i.(1)

ACRONYMS

ABAG	Association of Bay Area Governments
BASMAA	Bay Area Stormwater Management Agencies Association
CCCWP	Contra Costa Clean Water Program
CCWSRP	Contra Costa Watersheds Stormwater Resource Plan
GI	Green Infrastructure
GIS	Geographic Information System
IRWMP	Integrated Regional Water Management Plan
MRP	Municipal Regional Stormwater Permit
MTC	Metropolitan Transportation Commission
NPDES	National Pollutant Discharge Elimination System
PCB	Polychlorinated Biphenyl
TMDL	Total Maximum Daily Load

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0 ▪ Summary

The California Regional Water Quality Control Board for the San Francisco Bay Region directed Bay Area municipalities to implement the Clean Water Act by incorporating green infrastructure into the development and renewal of the urban landscape.

Green Infrastructure refers to the construction and retrofit of storm drainage to reduce runoff volumes, disperse runoff to vegetated areas, harvest and use runoff where feasible, promote infiltration and evapotranspiration, and use bio-retention and other natural systems to detain and treat runoff before it reaches our creeks and the San Francisco Bay (the Bay). Green infrastructure facilities include, but are not limited to, pervious pavement, infiltration basins, bio-retention facilities or "raingardens," green roofs, and rainwater harvesting systems. These facilities can be incorporated into construction on new and previously developed parcels, as well as new and rebuilt streets, roads, and other infrastructure within the public right-of-way.

This Framework outlines the tasks, schedule, and budget necessary for the City of Richmond to develop a Green Infrastructure Plan (GI Plan). The GI Plan for the City of Richmond (the City) is required by the San Francisco Bay Region Municipal Regional Stormwater NPDES Permit (MRP)[1], and must be submitted to the California Regional Water Quality Control Board for the San Francisco Bay Region by September 2019.

The Framework describes required elements of the GI Plan, including the following:

- Staff coordination and public outreach
- Mapped and prioritized areas for potential and planned projects
- Targets for the amount of impervious surface to be retrofit over time
- A system for tracking and mapping completed projects
- Guidelines for project design, and standard designs and specifications
- Requirements for sizing Green Infrastructure projects
- Integration with existing planning documents
- Methods and results for estimating the load reductions to be achieved
- Evaluation of funding options

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[1] Order R2-2015-0049.

Some of these elements will be developed collaboratively with other Contra Costa municipalities through the Contra Costa Clean Water Program (CCCWP) or regionally through the Bay Area Stormwater Management Agencies Association (BASMAA).

The City has included $350,000 in its FY 2017-2018 budget to update its Stormwater Master Plan (Master Plan) dated November, 2006. The Master Plan will be updated to include the GI Plan as a chapter to address green infrastructure planning citywide, and to meet the goals and objectives of the City adopted Climate Action Plan. If necessary, the City will include additional funding in its FY 2018-2019 budget to ensure the completion of the Stormwater Master Plan and the GI Plan.

1 · Purpose

1.1 Regulatory Requirements

The City is one of 76 Bay Area municipalities covered by the Municipal Regional Stormwater NPDES Permit (MRP) issued by the California Regional Water Quality Control Board for the San Francisco Bay Region.

Provision C.3.j.i. in the MRP requires that each Permittee prepare and submit a Green Infrastructure Plan. Required elements of the GI Plan are specified. The GI Plan is to be submitted with the Annual Report due September 30, 2019.

The provision further specifies that each Permittee prepare a framework or workplan that describes specific tasks and timeframes for development of the GI Plan. The City of Richmond must approve the framework or workplan by June 30, 2017. This document fulfills that requirement.

Provisions C.11 and C.12 in the MRP requires Contra Costa Permittees (Contra Costa County and its 19 cities and towns) to reduce estimated PCB loading by 23 grams/year and estimated mercury loading by 9 grams/year using Green Infrastructure by June 30, 2020. Regionally, Permittees must also project the load reductions achieved via Green Infrastructure by 2020, 2030, and 2040, showing that collectively, reductions will amount to 3 kg/year PCBs and 10 kg/year mercury by 2040. The GI Plan will provide estimates of the reductions in the quantity of these pollutants based on implementation of the elements outlined in the GI Plan.

1.2 Purpose of the Green Infrastructure Plan

The City's GI Plan will guide a shift from conventional "collect and convey" storm drain infrastructure to more resilient, sustainable stormwater management that reduces runoff volumes, disperses runoff to vegetated areas, harvests and uses runoff where feasible, promotes infiltration and evapotranspiration, and uses natural processes to detain and treat runoff. Green Infrastructure features and facilities include, but are not limited to, pervious pavement, infiltration basins, and bioretention facilities ("rain gardens"), green roofs, and rainwater harvesting systems.

As required by Provisions C.3.a. through C.3.i. in the MRP, these "Low Impact Development" practices are currently implemented on land development regulated projects in the City jurisdiction. Specific methods and design criteria are spelled out in the Contra Costa Clean Water Program's *Stormwater C.3 Guidebook,* which the City has referenced in Chapter 12.22 of its Municipal Code.

The proposed GI Plan will detail how similar methods will be incorporated to retrofit existing storm drainage infrastructure, including streets, roads, and storm drains, using facilities constructed on public and private parcels and within the public right-of-way.

To prepare the GI Plan, the City will:

- Review planned capital projects to identify the potential to incorporate Low Impact Development drainage design.
- Identify and prioritize areas and projects within the City to implement additional Green Infrastructure projects.
- Coordinate within and between the City's departments to develop concepts for integrated projects that serve multiple objectives (e.g., multi-modal transportation, recreation, streetscape improvements, and parks, as well as green infrastructure).
- Document resources and a process for completing conceptual designs.
- Document a funding strategy for future projects, including a process to pursue funding and align project funding sources and schedules to successfully build integrated projects.
- Develop and implement a system to track Green Infrastructure projects, including land development projects subject to the Provision C.3.a. through C.3.i. requirements, and project future implementation.
- Evaluate and predict the resulting reductions in the quantity of pollutants—including PCBs, mercury, and trash—transported to creeks and the Bay.

1.3 Countywide and Regional Collaboration

Several of the elements required for preparation of the City's GI Plan will be developed collaboratively through its participation in the CCCWP and/or regionally through participation in BASMAA.

2. Plan Elements and Approach

2.1 Interdepartmental Coordination and Community Outreach

To be successful, the GI Plan must engage a wide variety of stakeholders in plan, policy, and project concept development. Planned projects with multiple benefits may be proposed for streets, parks, schools or other public parcels. A successful green infrastructure planning team will include representatives from the municipal departments who plan and implement projects on these streets and parcels.

A successful planning approach will also include a robust plan for engagement of both municipal staff and the community members who live, work, and play near proposed green infrastructure projects.

2.1.1 Interdepartmental Coordination

The City has developed a strategy for engagement and education of municipal staff on the purposes and goals of green infrastructure, the required elements of the GI Plan, and the steps needed to develop and implement the Plan.

The City has also begun convening an interdepartmental committee under the leadership of the City Director of Water Resource Recovery to oversee and implement the process of preparing the Plan.

The City's interdepartmental committee consists of the following departments and staff representatives:

Table 1. Interdepartmental Green Infrastructure Planning Committee

Staff	Department & Title
Yader Bermudez	Engineering and Capital Improvement Project, City Engineer
Lina Valesco	Planning, Project Manager II

Vrenesia Ward	Finance, Budget Analyst
Adam Lenz	City Manager's Office, Environmental Manager
Tim Higares Greg Hardesty	Infrastructure Maintenance and Operations, Director of Infrastructure Maintenance and Operations Parks and Landscaping Superintendent
Ryan Smith Joanne Le Patrick Phelan	Water Resource Recovery Direct of Water Resource Recovery Source Control Superintendent Infrastructure Administrator

The interdepartmental committee met twice in FY 16/17 to discuss the required elements and development of City's GI Plan.

2.1.2 Community Engagement and Outreach

The City will develop education strategy and encourage community engagement in order to educate public stakeholders on green infrastructure benefits and requirements in City's Plan. Outreach will include general outreach and targeted outreach and training for professionals involved in infrastructure planning and design. This effort is ongoing and will be coordinated countywide with the CCCWP.

2.2 Green Infrastructure Project Identification and Prioritization

The GI Plan must describe the mechanism(s) by which the City will identify, prioritize and map potential and planned projects that incorporate green infrastructure components. These include public and private projects that may be implemented over the long term, with milestones for implementation by 2020, 2030, and 2040. The mechanism(s) must include the criteria for prioritization and outputs that can be incorporated into the City's long-term planning and capital improvement processes.

The GI Plan must also contain the outputs resulting from the identification and prioritization mechanism(s) described above, including the prioritization criteria as well as lists and maps of prioritized projects and timeframes for implementation.

The City will use the following mechanisms to identify, prioritize, and map future green infrastructure projects:

2.2.1 Review of Capital Improvement Program Projects

The City will prepare and maintain a list of public and private GI projects planned for implementation during the permit term, and public projects that have potential for GI measures. The City has begun this process and an initial list was submitted with the FY 15-16 Annual Report.

The creation and maintenance of this list is supported by guidance developed by BASMAA: "Guidance for Identifying Green Infrastructure Potential in Municipal Capital Improvement Projects" (May 6, 2016).

The GI Plan will document current implementation of this process within the City and will identify planned changes or needed improvements. Resultant project lists will be used to provide potential projects for incorporation into the GI Plan. The GI Plan will also include a work plan to complete prioritized projects identified through this process.

2.2.2 The City Tools and Processes for GI Project Identification and Prioritization

City staff is developing a process and resources for identifying and pursuing, on an ongoing basis, additional opportunities to construct green infrastructure projects in the City. This process and resources will be documented in the GI Plan and will address how multi-objective projects will be identified through a collaborative interdepartmental planning process.

Currently, plans for new private projects are routed to the Department of Water Resources Recovery (the Department) for review and comments. Department staff have been trained to identify potential opportunities of green infrastructure during this review process. For public projects City staff track and review projects for green infrastructure opportunities through the Capital Improvement Project (CIP) list.

Moreover, City staff is working on a pilot project with the San Francisco Estuary Institute (SFEI), utilizing the GreenPlanIT Tool to identify and prioritize GI projects using City specific GIS layers.

2.2.3 Use of Contra Costa Watersheds Stormwater Resource Plan Tools and Project Lists

The Contra Costa Clean Water Program has obtained a planning grant from the State Water Resources Control Board to develop a Stormwater Resource Plan for Contra Costa County. The Contra Costa Watersheds Stormwater Resources Plan (CCWSRP) will support the development and implementation of GI Plans within the Basin through identification of local and regional opportunities for GI projects and development of modeling tools for estimating pollutant load reductions over future timeframes. The resulting maps and tools will be available for local use by Contra Costa municipalities.

The CCWSRP will also produce a list of prioritized GI projects. The CCWSRP will identify and prioritize multi-benefit GI projects throughout the County, using a metrics based approach for quantifying project benefits such as volume of stormwater infiltrated and/or treated and quantity of pollutants removed. The metrics-based analysis will be conducted using hydrologic/hydraulic and water quality models coupled with GIS resources and other tools. Project concepts will also be assessed for additional benefits such as flood control, community greening, and habitat creation. The product of these analyses will be a map of opportunity areas for GI projects throughout the County, an initial prioritized list of potential projects, and strategies for implementation of these and future projects. The tools, maps, and list of potential projects developed through this process will be available for incorporation into the City its GI Plan.

2.3 Evaluating Pollutant Load Reductions

The project prioritization criteria will consider opportunities to reduce loads of trash, mercury, PCBs, and other pollutants. It is anticipated that mercury and PCB pollutant load reductions for will be evaluated for each project using a regionally developed Interim Accounting Methodology which is based on watershed locations and historic land uses. A draft of this regionally developed methodology was submitted to the Regional Board in the 2016 Annual Report. Furthermore, it is anticipated that a Reasonable Assurance Analysis will be developed in cooperation with both regional and countywide partners to demonstrate that reductions will be achieved in the time frame required by the Mercury TMDL (2006) and the PCBs TMDL (2008). The City’s GI Plan will include a description of these two methodologies and the results of this methodologies will be incorporated the planning process.

It is also anticipated that these two methodologies will be used to help develop and/or confirm targets for the amount of impervious surface, from both public and private projects, within the City which will need to be converted or “retrofit” to drain to green infrastructure features, such as vegetated area or stormwater treatment facility, or converted to pervious surfaces, by the MRP's 2020, 2030, and 2040 milestones. The City's GI Plan will include these targets as well as a description of the analyses used to develop them.

2.4 Projecting Green Infrastructure Implementation

To develop the Reasonable Assurance Analysis demonstrating that pollutant load reductions will be achieved in the required time frames, the GI Plan will include an estimate of the pace of future GI Implementation on public and private parcels.

To estimate the pace of future implementation, the City will participate in development of a consistent countywide or regional methodology for projecting private development in future decades. The projections will likely incorporate or adapt regional scenarios created by the Association of Bay Area Governments/Metropolitan Transportation Commission (ABAG/MTC) to estimate future implementation of GI in each municipality. This subject has only been broached in BASMAA level discussions, and no work has yet been done. The final framework should include an update, to be provided, on the status of this effort.

2.5 Completed Project Tracking System

The GI Plan will describe the City's process for tracking and mapping completed public and private projects and making the information available to the public.

Through CCCWP, the City is participating in development of a GIS that will allow spatial tracking and representation (maps) of green infrastructure projects and associated tributary drainage areas. The database will be used for tracking and reporting public projects, Regulated Projects (MRP Provision C.3.b.) including Special Projects (MRP Provision C.3.e.) and tracking operation and maintenance verification inspections of installed stormwater treatment facilities (MRP Provision C.3.h.).

The City is partnering SFEI on the tracking feature of the GreenPlanIT tool. This feature tracks and reports public projects, Regulated Projects (MRP Provision C.3.b.) including Special Projects (MRP Provision C.3.e.) and tracks operation and maintenance verification inspections of installed stormwater treatment facilities (MRP Provision C.3.h.).

The City's GI Plan will include an update on this countywide/regional project, and cooperation with SFEI and SFEP, the City's status and plans for integrating these tools into its processes for implementing green infrastructure.

These projects are currently underway, with cooperation and cost-sharing between the CCCWP and the Alameda Countywide Clean Water Program (ACCWP), and cooperation with SFEI and SFEP.

2.6 Design Guidance and Specifications for Green Infrastructure Projects

The GI Plan must include general design and construction guidelines, as well as standard specifications and details (or references to those documents) for incorporating green infrastructure components into projects within the City. These guidelines and specifications should address the different street and project types within the City, as defined by its land use and transportation characteristics, and allow projects to provide a range of functions and benefits, such as stormwater management, bicycle and pedestrian mobility and safety, public green space, urban forestry, etc.

The City will collaborate with other Permittees, countywide and regionally, to compile, reference, and/or develop this design guidance. Questions to be addressed in the review and compilation period include:

- Does existing design guidance address local needs? Are there local conditions or characteristics that require different guidance?
- To what extent would additional guidance, if developed, address the needs of multiple projects? Or are the design issues presented by local Green Infrastructure projects so site-specific that designs must be developed individually for each project?

The results of this review, and the status of design guidance to be used in future projects, will be discussed and presented in the GI Plan.

2.7 Sizing Requirements for Green Infrastructure Projects

The City's GI Plan must include a requirement that projects be designed to meet the treatment and hydromodification sizing requirements in MRP Provisions C.3.c. and C.3.d. The Permittees may collectively propose an approach on how to proceed should project constraints in non-regulated right of way projects preclude fully meeting the C.3.d. sizing requirements.

A BASMAA project is currently underway to analyze hydrologic data and bioretention facility performance under different sizing scenarios. It is anticipated that this project will result in recommendations for sizing Green Infrastructure in non-regulated right of way projects. The City's GI Plan will describe the outcomes of BASMAA's efforts and how those outcomes have been incorporated into local GI planning and design practices. BASMAA's guidance may include criteria to assist Permittees to determine when higher-rate tree-box-type biofilters may be a more practical and effective mode of treatment than bioretention.

3 ▪ Integration with Existing Plans

3.1 Updates to Planning Documents

The GI Plan must describe its relationship to other planning documents and efforts within the City and how those planning documents have been updated or modified, if needed, to support and incorporate the green infrastructure requirements. If any necessary updates or modifications have not been accomplished by the completion of the GI Plan, the GI Plan must include a work plan and schedule to complete them.

The City has conducted a preliminary review of existing municipal planning documents and identified which documents need to be updated or modified to support and/or be consistent with the GI Plan. A summary of the results of the municipal plan review and a schedule for updates or modifications is in Table 2.

The GI Plan will also describe a process or processes, including criteria, to ensure future planning documents are consistent with its policies, processes, and tasks.

Table 2. Municipal Plans Requiring Updates to Support Green Infrastructure Implementation

Name of Plan	**Responsible Department/Staff**	**Last Updated**	**Next Projected Update**
Richmond General Plan	Planning	April, 2012	As needed
City Center Specific Plan	Planning	January, 2001	FBC will repeal by Fall 2017
Bicycle Master Plan	Planning	November, 2011	As needed
Pedestrian Master Plans	Planning	February, 2017	As needed
Storm Drain Master Plan	Water Resource Recovery	November, 2006	2019
Urban Greening Master Plan	Planning	April, 2017	As needed
Parks Master Plan	Planning	December, 2010	As needed
Richmond Bay Specific Plan	Planning	December, 2016	As needed

3.2 Adoption of Policies, Ordinances and Other Legal Mechanisms to Support Green Infrastructure

The City will review its existing policies, ordinances, and other legal mechanisms to identify which documents may need to be updated or modified to help implement the GI Plan, and the timing for those actions. All needed updates, modifications, or new mechanism(s) will be completed and adopted, and included in the GI Plan which is due by September 30, 2019.

Staff will also collaborate with other Permittees, countywide and regionally, to ensure policies, ordinances, and other legal mechanisms are consistent with those of other Permittees countywide and regionally, while being tailored to the specific needs and characteristics of the City.

4 ▪ Evaluation of Funding Options

The GI Plan must include an evaluation of funding options for design, construction, and long-term maintenance of prioritized green infrastructure projects, considering local, state and federal funding sources. The City will analyze possible funding options to raise additional revenue for the projects that will eventually be included in the agency's GI Plan, including capital and operation and maintenance (O&M) costs of these projects. The evaluation for capital costs will include, but not be limited to: alternative compliance funds, grants – including transportation project grants, new taxes or other levies, existing resources, and other resources of funds.

5 ▪ Task List, Timeframes, and Budget

5.1 Tasks and Timeframes

The tasks identified in this Framework are shown in Table 3 below.

5.2 Budget

The City has included $350,000 in its FY 2017-2018 budget to update its Stormwater Master Plan (Master Plan) dated November, 2006. The Master Plan will be updated to include the GI Plan as a chapter to address green infrastructure planning citywide, and to meet the goals and objectives of the City adopted Climate Action Plan. If necessary, the City will include additional funding in its FY 2018-2019 budget to ensure the completion of the Stormwater Master Plan and the GI Plan.

Table 3. Green Infrastructure Planning Tasks, Roles, and Timeframes

#		**Task Description** (and reference to the specific sub-provision within Provision C.3.j. that is addressed by the task)	**Lead** **Local**	 **CCCWP**	 **BASMAA**	**Estimated Timeframe for Completion**	**Resources and Notes** The task list and schedule is a living document and will be refined over the course of the GI Plan development process.
		Tasks to complete July 1, 2017 – September 30, 2019					
1		**Draft Green Infrastructure Plan (C.3.j.i.(2))**					
	A	Review and revise schedule for provision of resources to be provided countywide or regionally		●		Jul.-Aug. 2017	
	B	Obtain consultant resources to assist with Plan preparation	●			June 2017	
	C	Create a detailed schedule for completion and approval of the Green Infrastructure Plan, and for submittal with the 2019 Annual Report	●			Jul. 2017	
	D	Prepare a Green Infrastructure Plan Template		●		Dec. 2017	The scope of this deliverable will be discussed with the CCCWP Development Committee in Spring 2017.
	E	Draft the Green Infrastructure Plan	●			Jul. 2017 – Dec. 2019	The Green Infrastructure Plan will include locally originated elements and adaptation of resources produced countywide and regionally (see tasks below).
	F	Circulate, obtain comments and revise the draft Plan	●			Jan. - Mar. 2019	
	G	Council or Board action to approve the Green Infrastructure Plan and any policies required to	●			May 2019	

#	Task Description (and reference to the specific sub-provision within Provision C.3.j. that is addressed by the task)		Lead: Local	Lead: CCCWP	Lead: BASMAA	Estimated Timeframe for Completion	**Resources and Notes** The task list and schedule is a living document and will be refined over the course of the GI Plan development process.
		implement the Plan					
	H	Submit the Green Infrastructure Plan	●			Sept. 2019	
2	**Mechanism for Identifying and Prioritizing Projects**						
	A	Create or adopt a mechanism to locate, prioritize, and map areas for potential and planned public projects on a drainage-area-specific basis (C.3.j.i.(2)(a))		●		Oct. 2017*	*Tasks 4.4 in CCSWRP Scope of Work. It is currently anticipated that the quantitative methodologies for this analysis will be developed by Oct 2017.
	B	Identify targets for the amount of impervious surface to be retrofitted by 2020, 2030, and 2040 (C.3.j.i.(2)(c))	●	●		Dec. 2018	The task will be further discussed with the CCCWP Development Committee in 2017. It is assumed that the CCCWP will, at a minimum, provide guidance on the methodology to complete this task.
	C	Identify and prioritize projects and/or areas for potential projects for implementation by 2020, 2030, and 2040, consistent with the Reasonable Assurance Analysis (C.3.j.i.(2)(b) and C.3.j.iv.(1))	●	●		Dec. 2018	The task will be further discussed with the CCCWP Development Committee in 2017. It is assumed that the CCCWP will, at a minimum, provide guidance on the methodology to complete this task.
3	**Project Amount and Locations of Private Development (C.3.j.i.(2)(c))**						
	A	Identify or develop a methodology for projecting amount and locations of private development		●		Sep. 2017	CCCWP will coordinate with other countywide stormwater programs with the aim of making methodologies consistent regionally.

#		Task Description (and reference to the specific sub-provision within Provision C.3.j. that is addressed by the task)	Lead: Local	Lead: CCCWP	Lead: BASMAA	Estimated Timeframe for Completion	Resources and Notes The task list and schedule is a living document and will be refined over the course of the GI Plan development process.
	B	Apply methodology and revise/validate projections of private development based on local understanding and knowledge of development patterns	●			Dec. 2018	
4	List of Prioritized Projects (C.3.j.i.(2)(b))						
	A	Develop list of project concepts and prioritize based on evaluation of multiple benefits		●		Jan. 2018*	*Task 4.5 in the CCSWRP Scope of Work. A draft project list for review is currently anticipated by Jan 2018.
	B	Revise/validate project lists based on local knowledge	●			Jul.- Dec. 2018	
	C	Identify projects, if any, that may be candidates for grant funding, including funding under Round 2 of the Prop. 1 Stormwater Grant Program	●			Feb.- Mar. 2018	And ongoing.
5	**Early Implementation**						
	A	Prepare a program to complete prioritized projects produced from capital improvement program review (C.3.j.i.(2)(j))	●			Ongoing	A program of work should be produced following reporting of projects in Annual Report and in time for consideration in following year's budget.
	B	Prepare a program of work for additional staff-identified Green Infrastructure projects	●			Ongoing	
	C	Incorporate the lists of early implementation projects and additional staff-identified projects and associated programs into the Green	●			Jan. 2019	

#	Task Description (and reference to the specific sub-provision within Provision C.3.j. that is addressed by the task)		Lead: Local	Lead: CCCWP	Lead: BASMAA	Estimated Timeframe for Completion	Resources and Notes The task list and schedule is a living document and will be refined over the course of the GI Plan development process.
		Infrastructure Plan					
6	**Supporting Elements and Associated Tasks**						
	A	Develop a model ordinance, policy or policies for Green Infrastructure Plan Implementation (C.3.j.i.(3))		●		Dec. 2018	The need for CCCWP assistance with this task, and the scope of any resulting deliverables, will be discussed with the CCCWP Development Committee in 2017 and 2018.
	B	Review local ordinances, policies, and resolutions and determine if updates are needed to support implementation of Green Infrastructure. Document this review in the 2019 Annual Report (C.3.j.i.(5)(c))	●			Jul. - Dec. 2018	
	C	Prepare an analysis of potential funding options for Green Infrastructure Projects (C.3.j.i.(2))		●		Dec. 2018	The scope of this deliverable will be further discussed with the CCCWP Development Committee in Spring 2017.
	D	Analyze funding options for Green Infrastructure Projects and applicability to local conditions (C.3.j.i.(2)(k))	●			Ongoing	
	E	Develop Green Infrastructure Design Guidelines for streetscapes and other public infrastructure (C.3.j.i.(2)(e))		●		Dec. 2018	The scope and schedule for this deliverable will be further discussed with the CCCWP Development Committee in Spring 2017.
	F	Develop specifications and typical design details for Green Infrastructure (C.3.j.i.(2)(f))		●		Dec. 2018	The scope and schedule for this deliverable will be further discussed with

#		Task Description (and reference to the specific sub-provision within Provision C.3.j. that is addressed by the task)	Lead: Local	Lead: CCCWP	Lead: BASMAA	Estimated Timeframe for Completion	Resources and Notes The task list and schedule is a living document and will be refined over the course of the GI Plan development process.
							the CCCWP Development Committee in Spring 2017.
	G	Develop sizing criteria for Green Infrastructure facilities in non-Regulated right-of-way projects (C.3.j.i.(2)(g))			●	Sep. 2017	See BASMAA's December 2016 RFP to analyze hydrologic data and bioretention facility performance.
	H	Develop regionally consistent methods to track and report implementation of green infrastructure measures, including load reductions achieved (C.3.j.iv.(1))			●	Dec. 2017	Being developed in cooperation with ACCWP.
7	Update Planning Documents (C.3.j.i.(2)(h))						
	A	Review planning documents and identify potentially needed updates	●			June 2017	
	B	Update planning documents.	●			As opened for amendment	The Plan will identify the updates that are required for each planning document. However, the identified plans will not be updated until the entire document is opened for amendment.
	C	Identify remaining updates and reference in Green Infrastructure Plan (C.3.j.i.(2)(i))	●			March 2019	
8	**Outreach and Education (C.3.j.i.(4))**						
	A	Participate in countywide and regional Green Infrastructure outreach and education efforts, including general outreach and targeted		●		Jan. 2016 – Jun. 2019	

#		Task Description (and reference to the specific sub-provision within Provision C.3.j. that is addressed by the task)	Lead: Local	Lead: CCCWP	Lead: BASMAA	Estimated Timeframe for Completion	**Resources and Notes** The task list and schedule is a living document and will be refined over the course of the GI Plan development process.
		outreach and training for professionals involved in infrastructure planning and design (C.3.j.iii.)					
	B	Implement Green Infrastructure outreach and education in connection with planning, economic development and design of green infrastructure projects (C.3.j.i.(4)(a))	●			Jan. 2016 – Jun. 2019	And ongoing.
	C	Develop a stakeholder education and engagement strategy/plan for Green Infrastructure Plan development, including outreach and education about the required Green Infrastructure Plan elements.	●			Dec. 2017	CCCWP to assist with content.
	D	Incorporate Green Infrastructure outreach on municipal websites	●			Now – Jun. 2019	CCCWP to assist with content.
	E	Provide updates to elected officials on Green Infrastructure requirements and methods of implementation (C.3.j.i.(4)(c))	●			Periodic	CCCWP to assist with content.

APPENDIX E

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DRAFT Memorandum

Date:	May 1, 2019
To:	Courtney Riddle and Lucile Paquette, Contra Costa Clean Water Program
Copy:	Dan Cloak, Dan Cloak Environmental Consulting
From:	Lisa Austin, Principal; Kelly Havens, Senior Engineer; and Austin Orr, Professional Engineer
Subject:	Reasonable Assurance Analysis Countywide Attainment Strategy Geosyntec Project Number: WW2407

1. BACKGROUND

1.1 Regulatory Requirements

Provisions C.11/12.c.ii.(2) of the Municipal Regional Permit (MRP) require Permittees to prepare Reasonable Assurance Analyses (RAA) for mercury and PCBs, respectively, that achieve the following objectives:

a) Quantify the relationship between areal extent of green infrastructure (GI) implementation and load reductions, taking into consideration the scale of contamination of the treated area as well as the pollutant removal effectiveness of likely GI strategies;

b) Estimate the amount and characteristics of land area that will be treated through GI by 2020, 2030, and 2040;

c) Estimate the amount of load reductions that will result from GI implementation by 2020, 2030, and 2040; and

d) Quantitatively demonstrate that PCBs reductions of at least 0.5 kg/yr and mercury reductions of 1.7 kg/yr will be realized within Contra Costa County by 2040 through implementation of GI projects.

1.2 Preliminary RAA Findings

Geosyntec Consultants (Geosyntec) is conducting RAA modeling for the Contra Costa Clean Water Program (CCCWP) as required by the MRP for submittal with the 2020 Annual Report. In

Fiscal Year 2018/19, Geosyntec conducted RAA modeling to assist the Permittees with GI planning[1].

As part of the preliminary RAA modeling conducted to assist Permittees with GI Planning, a "Countywide Attainment Scenario" was modeled which examined PCBs loads reduced by each project opportunity incorporated in the Contra Costa Watersheds Storm Water Resource Plan (CCW SWRP). This scenario focused on PCBs, consistent with the MRP's emphasis on measures designed to reduce PCBs, while also evaluating opportunities for mercury reduction. CCCWP has drafted this Countywide Attainment Scenario memorandum to summarize these results and further the Permittees' group discussion of how PCBs load reduction goals could be achieved on a countywide basis.

The results of this analysis demonstrate that the public GI retrofit opportunities that have the highest potential to reduce PCBs loads are concentrated within a small subset of Contra Costa Permittee area due to the pattern of pre-1980 industrial development within the region. (Note that GI implementation feasibility was not field-evaluated as part of development of the CCW SWRP, thus the feasibility of implementation for these potential project locations has yet to receive a site-specific evaluation.) Conversely, many Contra Costa Permittees have no or very few opportunities to contribute significantly toward achievement of countywide PCBs loading reductions via implementation of GI in their communities. Further, if load reductions are not achieved on a regional or countywide scale, and load reductions are allocated at a local level (by population), these Permittees would not be able to achieve those load reduction allocations due to a lack of opportunity.

Thus, given these findings, the Contra Costa Permittees, collectively, believe that a countywide strategy would be the best way to achieve the PCBs load reduction goals in a more efficient and effective manner. For the purposes of creating their local GI Plans, Contra Costa Permittees have prioritized their GI projects based on achieving other multiple benefits. These other benefits include controlling other stormwater pollutants, preserving and enhancing local stream hydrology, reducing localized flooding, helping communities adapt to climate change by increasing the resiliency of water supply, ancillary benefits that derive from adding landscaped areas within the urbanized environment, and mitigating the urban heat island effect.

This Countywide Attainment Strategy memorandum is referenced in the Permittees' GI Plans for information only, and it does not represent, in any way, an intent to implement the strategy or any

[1] The results of this RAA modeling are preliminary. The CCCWP is in the process, in collaboration with BASMAA, of having the RAA modeling approach peer-reviewed. The RAA modeling results are subject to revision depending on the outcome of the peer review process.

of the projects listed herein. For projects for which potential implementation will be pursued, refer to each Permittee's individual GI Plan project list and prioritization.

This memorandum describes the approach used to model the Countywide Attainment scenario and presents the results of the analysis, in addition to potential next steps for Contra Costa County Permittees to implement projects collectively in an effort to meet the load reduction requirements included in the MRP.

2. COUNTYWIDE ATTAINMENT SCENARIO METHODOLOGY

2.1 Methodology Overview

To conduct the RAA Countywide Attainment Scenario modeling, calculations were performed, and inputs procured or developed, as follows:

1. Baseline modeling was conducted to estimate the baseline (i.e., 2003) load of PCBs and mercury for Contra Costa County.
2. Using the resulting baseline load, calculations were performed to establish the MRP-required load reduction through GI for 2040.
3. GIS inputs were obtained or finalized for existing redevelopment and public GI projects and future private (i.e., C.3.d) projects, as follows:
   a. New development and redevelopment projects from 2003 – 2018 were compiled from existing AGOL[2] project data, and
   b. UrbanSim[3] redevelopment projections for 2020, 2030, and 2040 were confirmed or revised by the Permittees.
4. The GI load reduction model was applied to the existing development (through 2018) and predicted future private redevelopment (2019 – 2040) to assess the PCBs loads reduced by these projects.

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[2] The CCCWP's stormwater GIS platform, created using ESRI's ArcGIS Online (AGOL) for Organizations environment. The *C.3 Project Tracking and Load Reduction Accounting Tool* is used for tracking GI projects implemented under C.3 within the CCCWP AGOL system.

[3] A model developed by the Urban Analytics Lab at the University of California under contract to the Bay Area MTC. The Bay Area's application of UrbanSim was developed specifically to support the development of Plan Bay Area, the Bay Area's Sustainable Communities planning effort. MTC forecasts growth in households and jobs and uses the UrbanSim model to identify development and redevelopment sites to satisfy future demand. This model was applied to Contra Costa County to project new and redevelopment for the RAA model timeframes.

5. A countywide PCBs public retrofit load reduction goal was then calculated by subtracting the load reduced by the existing and projected future private redevelopment load from the countywide goal established in Step 2.
6. The GI load reduction model was applied to the CCW SWRP project opportunities list to assess PCBs loads reduced by each project opportunity.

Additional detail is provided in the following sections.

2.2 Baseline Modeling

The countywide baseline model was developed as described in the *Quantitative Relationship Between GI Implementation and PCBs/Mercury Load Reductions* report (CCCWP, 2018).

A GIS analysis was conducted to apportion the modeled baseline load to areas above and below dams, within the San Francisco Bay Regional Water Quality Control Board (Region 2) versus Central Valley Regional Water Quality Control Board (Region 5), and other NPDES permittee area (i.e., parcels associated with individual NPDES permits, Industrial General Permit facilities, and Phase 2 permittee areas). The TMDLs were calculated for all urban areas draining to San Francisco Bay (thus only Region 2) and for areas below dams (as it is assumed that the dams capture sediments and prevent them from carrying pollutants to the Bay). Additionally, the parcel area associated with other NPDES permits was removed to estimate the baseline load attributable to the MS4 permit area only. Thus, the baseline countywide PCBs load below dams, within Region 2, was used to establish the PCBs load reduction goal for the MS4 permit area.

The results of the baseline modeling are presented in Table 1 below. The baseline countywide load used to establish the PCBs load reduction goal for the Permittee area is shown in bold.

Table 1: RAA Baseline PCBs Load Allocation Table (grams)

RWQCB Region	Above/Below Dam	Permit	Baseline Load PCBs (grams)
Region 2	**Below Dam**	**MRP**	**1,581.0**
		NPDES	776.7
		Phase 2	13.7
	Above Dam	MRP	41.4
		NPDES	0.1
		Phase 2	0
Region 5	Below Dam	MRP	133.0
		NPDES	14.8
		Phase 2	0.6
	Above Dam	MRP	1.0
		NPDES	0
		Phase 2	0
		Total	2,562.2

2.3 Load Reduction Goal Calculations

Calculations were conducted to develop the load reduction goals for 2020, 2030, and 2040, as described in the *Bay Area RAA Guidance Document* (BASMAA, 2017). The calculation methodology is summarized below.

<u>TMDL Attainment Load Reduction (2030)</u>

LR_{goal} = Baseline – WLA (kg/yr)

Where:

LR_{goal} = The load reduction goal (kg/yr)

Baseline = The baseline pollutant loading as calculated through the RAA

WLA = The population-based wasteload allocation

The TMDL population-based wasteload allocations for Contra Costa County is provided Table 2.

Table 2: TMDL Population-Based Wasteload Allocations for Contra Costa County

Stormwater Improvement Goal	Mercury (kg/yr)	PCBs (kg/yr)
Contra Costa County	11	0.3

Per the equation above, the revised load reduction goal for Contra Costa County is 1.281 kg/yr.

<u>MRP Load Reduction through GI by 2040</u>

The PCBs load reduction required to be achieved through GI by 2040 (i.e., 3 kg/yr MRP area-wide or 0.5 kg/yr for Contra Costa County) should be adjusted to reflect the RAA-calculated baseline load (i.e., 1.581 kg/yr). The MRP load reduction requirement for GI for all permittees (3 kg/yr) represents 20.8% of the overall required TMDL load reduction. Therefore, the adjusted countywide load reduction through GI can be calculated as:

$LR_{MRP, GI, 2040} = LR_{goal} * 20.8\%$

The adjusted countywide PCBs load reduction goal through GI by 2040 was calculated to be 0.266 kg/yr.

2.4 Finalize GIS Inputs for Existing and Future Redevelopment

New development and redevelopment projects completed between 2003 – 2018 were compiled from the existing AGOL project data entered by the Permittees into their respective AGOL C.3 Tracking Tool databases.

UrbanSim redevelopment projections for 2020, 2030, and 2040, as confirmed or revised by the Permittees, were used to model future C.3 projects. The UrbanSim projections for 2020 only included parcels that were predicted to have been redeveloped from 2019 – 2020.

2.5 Develop Countywide Attainment Scenario

The 2040 PCBs load reduction goal for the Countywide Attainment scenario is calculated as the countywide load reduction goal (0.266 kg/yr) minus the load reduced by the current, projected private, and planned CIP/public retrofit GI projects through 2040. Table 3 indicates the remaining load reduction target for 2040 is approximately 56 grams per year.

Table 3: Load Reduction Goal for Contra Costa Countywide Attainment Scenario

PCBs 2040 Load Reduction Goal (kg/yr)	PCBs Load Reduction Achieved by Public and Private GI 2003 -2020 (kg/yr)	Projected PCBs Load Reduction Achieved by Public and Private GI 2003 - 2030 (kg/yr)	Projected PCBs Load Reduction Achieved by Public and Private GI 2003 - 2040 (kg/yr)	Load Reduction Target for Public GI by 2040 PCBs (kg/yr)
0.266	0.118	0.133	0.211	0.056

The baseline model produces a PCBs and mercury "load production" GIS layer that estimates the load corresponding with each parcel and ROW segment within the county (note that individual parcel loadings are representative of the 'average tendency' of loading for similar parcels). This "load production" layer was combined in GIS with the public retrofit project opportunities (parcels, regional project drainage areas, and ROW segments) listed in the CCW SWRP to estimate the potential load reduced by each project opportunity, assuming standard bioretention treatment.

3. COUNTYWIDE ATTAINMENT SCENARIO RESULTS

The modeled load reduction associated with each project opportunity from the CCW SWRP that is not included as a planned GI project in a Permittee's GI Plan are listed in the table included in Attachment 1. This table only includes those projects achieving at least 0.01 grams of PCBs load reduction per year, based on the model output. For each project opportunity, the total area and impervious area treated[4], baseline PCBs yield, and PCBs loads reduced are presented.

[4] The SWRP did not include delineation of actual off-site tributary drainage areas for the regional project opportunities. Therefore, the pollutant load reduction for these projects was calculated for this Countywide Attainment scenario using the project opportunity parcel area only and the estimated load reduction is less than it would be for the full tributary area.

To achieve the load reduction goal through GI by 2040 of 56 grams per year would require treating, at a minimum, 350 acres of the highest-load-producing project area in 170 projects across the county (pending feasibility evaluations, and requiring implementation primarily focused in a few Permittee jurisdictions) and would require much more area and projects using less-load-reducing projects.

4. COUNTYWIDE ATTAINMENT STRATEGY

To allow for the most efficient implementation of GI to achieve the MRP-stipulated load reduction goal, some Contra Costa Permittees have been actively investigating ways that communities without opportunities to reduce PCBs via GI might potentially fund GI projects in communities that do have such opportunities. This has included consideration of funding streams derived from new developments (for example, in-lieu fees charged when only a portion of on-site C.3 compliance is achieved). However, the legal and administrative requirements are complex, would require considerable effort to resolve, and may not ultimately be resolvable.

The Permittees will continue to consider how to balance the goals of efficient PCBs load reduction via GI (which has been demonstrated to be highly location-specific, and not obtainable by all Permittees) versus the other benefits of GI. This consideration will include participation, with Water Board staff, in ongoing discussions of GI and PCBs load reduction requirements that may be included in MRP 3.0. The Permittees, collectively, will also consider the outcomes of these discussions when preparing the "reasonable assurance analysis to demonstrate quantitatively that PCBs reductions of 3 kg/year will be realized by 2040 through implementation of green infrastructure projects," which is due in September 2020 as specified in Provision C.12.iii.(3).

Because resources are limited, there will ultimately be trade-offs between the goals of PCBs load reduction via GI versus the other benefits of GI. In the majority of Contra Costa communities, which have few or no locations where PCB loads could be efficiently reduced via GI, the pursuit of a potential Countywide Attainment Strategy would require trade-offs, including minimizing the opportunities to build community engagement and local support for GI. A similar trade-off exists within the communities that do have locations where PCBs loads could be efficiently reduced via GI, as the highest-ranked load-reduction locations rarely coincide with locations where other benefits to the community would be maximized.

5. REFERENCES

Bay Area Stormwater Management Agencies Association (BASMAA), 2017. Bay Area Reasonable Assurance Analysis Guidance Document. Prepared by Geosyntec Consultants and Paradigm Environmental for BASMAA. June 30, 2017.

Contra Costa Clean Water Program (CCCWP), 2018. Quantitative Relationship Between Green Infrastructure Implementation and PCBs/Mercury Load Reductions. Prepared by Geosyntec Consultants for the CCCWP. August 22, 2018.

* * * * *

Attachment 1
Countywide Attainment Scenario
Load Reduction Results Table

Jurisdiction	Permit	Project ID	Project Type	Area (Acres)	Impervious Area (Acres)	Percent Impervious	PCBs Yield (g/acre)	PCBs Mass reduced (g)
Clayton	2	ROW_4341	ROW Opportunity	26.22	12.30	47%	0.001	0.072
Clayton	2	Parcel_283666	Parcel-Based Opportunity	6.77	2.04	30%	0.002	0.034
Clayton	2	ROW_3872	ROW Opportunity	2.82	1.25	44%	0.003	0.026
Clayton	2	ROW_11618	ROW Opportunity	1.61	0.77	48%	0.004	0.022
Clayton	2	ROW_5783	ROW Opportunity	1.29	0.56	43%	0.005	0.021
Clayton	2	ROW_12947	ROW Opportunity	1.05	0.43	41%	0.004	0.017
Clayton	2	ROW_11934	ROW Opportunity	10.54	5.01	48%	0.001	0.015
Clayton	2	ROW_13056	ROW Opportunity	8.81	3.84	44%	0.001	0.014
Clayton	2	ROW_13758	ROW Opportunity	5.93	1.49	25%	0.001	0.012
Clayton	2	ROW_19397	ROW Opportunity	5.73	2.58	45%	0.001	0.010
Concord	2	Parcel_376303	Parcel-Based Opportunity	494.22	25.30	5%	0.004	8.822
Concord	2	Parcel_376306	Parcel-Based Opportunity	208.83	10.65	5%	0.004	3.719
Concord	2	Parcel_177920	Parcel-Based Opportunity	18.60	14.13	76%	0.041	3.276
Concord	2	Parcel_324333	Parcel-Based Opportunity	163.95	8.57	5%	0.003	1.752
Concord	2	ROW_16900	ROW Opportunity	20.40	9.18	45%	0.016	1.300
Concord	2	ROW_21618	ROW Opportunity	37.07	24.40	66%	0.008	1.039
Concord	2	Parcel_184135	Parcel-Based Opportunity	5.35	3.96	74%	0.041	0.920
Concord	2	ROW_21616	ROW Opportunity	27.30	18.24	67%	0.008	0.799
Concord	2	ROW_1201	ROW Opportunity	20.53	13.24	64%	0.010	0.746
Concord	2	Parcel_192657	Parcel-Based Opportunity	5.89	3.00	51%	0.029	0.722
Concord	2	Parcel_244879	Parcel-Based Opportunity	66.94	3.41	5%	0.003	0.722
Concord	2	ROW_5707	ROW Opportunity	18.71	11.09	59%	0.009	0.650
Concord	2	ROW_17557	ROW Opportunity	5.80	3.71	64%	0.023	0.558
Concord	2	ROW_1712	ROW Opportunity	12.97	8.30	64%	0.010	0.500
Concord	2	ROW_7508	ROW Opportunity	5.32	3.73	70%	0.021	0.454
Concord	2	ROW_4583	ROW Opportunity	4.46	3.26	73%	0.024	0.437
Concord	2	ROW_20084	ROW Opportunity	2.97	2.10	71%	0.027	0.328
Concord	2	ROW_5817	ROW Opportunity	3.19	2.16	68%	0.023	0.295
Concord	2	Parcel_338478	Parcel-Based Opportunity	38.88	1.98	5%	0.002	0.292
Concord	2	ROW_19024	ROW Opportunity	2.48	1.34	54%	0.028	0.291
Concord	2	Parcel_191035	Regional Opportunity	2.32	1.16	50%	0.028	0.278
Concord	2	ROW_8864	ROW Opportunity	1.38	0.97	70%	0.037	0.214
Concord	2	ROW_5806	ROW Opportunity	7.28	4.91	67%	0.008	0.213
Concord	2	ROW_15327	ROW Opportunity	31.55	17.19	54%	0.002	0.211
Concord	2	ROW_4439	ROW Opportunity	1.97	1.40	71%	0.025	0.205
Concord	2	ROW_7624	ROW Opportunity	6.85	4.66	68%	0.008	0.204
Concord	2	ROW_9455	ROW Opportunity	4.02	2.74	68%	0.013	0.190
Concord	2	ROW_3954	ROW Opportunity	1.94	1.42	73%	0.024	0.185
Concord	2	ROW_21113	ROW Opportunity	48.19	24.40	51%	0.002	0.182
Concord	2	Parcel_186608	Regional Opportunity	1.06	0.73	69%	0.038	0.171
Concord	2	ROW_8938	ROW Opportunity	1.26	1.03	82%	0.032	0.169
Concord	2	Parcel_229694	Parcel-Based Opportunity	6.43	3.65	57%	0.007	0.166
Concord	2	Parcel_235175	Parcel-Based Opportunity	6.15	3.59	58%	0.007	0.160
Concord	2	ROW_2934	ROW Opportunity	5.33	3.63	68%	0.008	0.159
Concord	2	ROW_12379	ROW Opportunity	5.60	3.63	65%	0.008	0.157
Concord	2	ROW_7623	ROW Opportunity	1.90	1.39	73%	0.020	0.155
Concord	2	Parcel_205735	Parcel-Based Opportunity	4.42	3.53	80%	0.010	0.154
Concord	2	Parcel_198247	Parcel-Based Opportunity	5.13	3.94	77%	0.009	0.153
Concord	2	ROW_4349	ROW Opportunity	1.39	1.03	74%	0.025	0.141
Concord	2	ROW_11894	ROW Opportunity	16.04	9.24	58%	0.003	0.139
Concord	2	ROW_10734	ROW Opportunity	2.73	1.85	68%	0.013	0.136
Concord	2	ROW_19586	ROW Opportunity	32.40	16.40	51%	0.002	0.136
Concord	2	ROW_11140	ROW Opportunity	0.69	0.57	83%	0.045	0.132
Concord	2	ROW_4621	ROW Opportunity	21.49	10.65	50%	0.002	0.130
Concord	2	Parcel_240615	Parcel-Based Opportunity	14.13	8.79	62%	0.003	0.122
Concord	2	ROW_16782	ROW Opportunity	10.53	5.42	51%	0.004	0.122
Concord	2	Parcel_242414	Parcel-Based Opportunity	4.67	2.72	58%	0.007	0.121
Concord	2	ROW_10221	ROW Opportunity	14.29	7.61	53%	0.003	0.118
Concord	2	ROW_14417	ROW Opportunity	7.27	4.56	63%	0.005	0.113
Concord	2	ROW_20964	ROW Opportunity	9.96	4.91	49%	0.004	0.112
Concord	2	ROW_17558	ROW Opportunity	0.91	0.61	67%	0.029	0.109
Concord	2	Parcel_232269	Parcel-Based Opportunity	3.76	2.45	65%	0.008	0.108
Concord	2	ROW_14842	ROW Opportunity	15.90	7.68	48%	0.002	0.108
Concord	2	ROW_4342	ROW Opportunity	43.01	22.81	53%	0.001	0.106
Concord	2	ROW_545	ROW Opportunity	12.27	5.54	45%	0.003	0.106
Concord	2	ROW_1200	ROW Opportunity	9.75	5.67	58%	0.004	0.105
Concord	2	Parcel_203140	Parcel-Based Opportunity	3.46	2.29	66%	0.008	0.100
Concord	2	ROW_18045	ROW Opportunity	13.09	7.25	55%	0.003	0.099
Concord	2	ROW_14001	ROW Opportunity	12.47	6.86	55%	0.003	0.094
Concord	2	ROW_21494	ROW Opportunity	29.51	15.04	51%	0.001	0.094
Concord	2	ROW_8159	ROW Opportunity	9.23	5.02	54%	0.003	0.094
Concord	2	ROW_12852	ROW Opportunity	22.99	12.35	54%	0.002	0.092
Concord	2	ROW_12856	ROW Opportunity	2.03	1.22	60%	0.011	0.088
Concord	2	ROW_15146	ROW Opportunity	5.50	3.01	55%	0.005	0.084
Concord	2	ROW_4608	ROW Opportunity	4.23	2.67	63%	0.006	0.084
Concord	2	ROW_7622	ROW Opportunity	1.50	1.10	73%	0.015	0.084
Concord	2	ROW_1470	ROW Opportunity	1.70	1.14	67%	0.013	0.081
Concord	2	Parcel_247239	Regional Opportunity	2.44	1.71	70%	0.009	0.077
Concord	2	ROW_4619	ROW Opportunity	13.13	6.40	49%	0.002	0.076
Concord	2	ROW_8157	ROW Opportunity	13.11	7.08	54%	0.002	0.076
Concord	2	ROW_6819	ROW Opportunity	1.92	1.26	66%	0.011	0.075
Concord	2	Parcel_144216	Parcel-Based Opportunity	40.90	18.50	45%	0.001	0.074
Concord	2	ROW_4618	ROW Opportunity	18.48	9.41	51%	0.002	0.074
Concord	2	Parcel_231090	Parcel-Based Opportunity	3.71	1.58	43%	0.006	0.073
Concord	2	ROW_13705	ROW Opportunity	11.05	5.52	50%	0.002	0.071
Concord	2	ROW_1577	ROW Opportunity	2.98	1.51	51%	0.007	0.071
Concord	2	Parcel_192425	Parcel-Based Opportunity	0.48	0.28	58%	0.033	0.067
Concord	2	Parcel_291299	Parcel-Based Opportunity	40.01	16.11	40%	0.001	0.066
Concord	2	ROW_1474	ROW Opportunity	7.02	3.51	50%	0.003	0.066
Concord	2	ROW_20692	ROW Opportunity	4.78	2.17	45%	0.004	0.064
Concord	2	ROW_5673	ROW Opportunity	11.65	5.87	50%	0.002	0.063
Concord	2	ROW_4514	ROW Opportunity	4.22	2.32	55%	0.005	0.062
Concord	2	ROW_12217	ROW Opportunity	9.08	4.78	53%	0.002	0.058
Concord	2	ROW_21132	ROW Opportunity	2.04	1.36	67%	0.008	0.058

Jurisdiction	Permit	Project ID	Project Type	Area (Acres)	Impervious Area (Acres)	Percent Impervious	PCBs Yield (g/acre)	PCBs Mass reduced (g)
Concord	2	Parcel_214703	Parcel-Based Opportunity	3.81	1.22	32%	0.004	0.057
Concord	2	ROW_11820	ROW Opportunity	2.06	1.02	50%	0.008	0.057
Concord	2	ROW_6785	ROW Opportunity	2.52	1.66	66%	0.007	0.056
Concord	2	Parcel_190759	Regional Opportunity	1.26	1.11	88%	0.012	0.055
Concord	2	Parcel_251412	Parcel-Based Opportunity	3.12	1.06	34%	0.005	0.054
Concord	2	Parcel_376302	Parcel-Based Opportunity	42.06	12.85	31%	0.001	0.054
Concord	2	ROW_4137	ROW Opportunity	7.10	3.61	51%	0.003	0.053
Concord	2	ROW_13078	ROW Opportunity	4.96	2.60	52%	0.003	0.052
Concord	2	ROW_9759	ROW Opportunity	1.82	1.20	66%	0.008	0.051
Concord	2	ROW_13704	ROW Opportunity	9.77	5.13	53%	0.002	0.050
Concord	2	ROW_5392	ROW Opportunity	0.92	0.65	71%	0.014	0.050
Concord	2	ROW_4966	ROW Opportunity	6.49	2.88	44%	0.003	0.049
Concord	2	Parcel_290823	Regional Opportunity	1.29	1.10	85%	0.010	0.048
Concord	2	planned_203	Planned Creek/Marsh Restoration	131.53	18.22	14%	0.000	0.048
Concord	2	ROW_20635	ROW Opportunity	5.04	2.60	52%	0.003	0.048
Concord	2	Parcel_214282	Parcel-Based Opportunity	30.73	11.51	37%	0.001	0.047
Concord	2	ROW_7731	ROW Opportunity	2.11	1.48	70%	0.007	0.047
Concord	2	ROW_8996	ROW Opportunity	2.02	1.16	57%	0.007	0.046
Concord	2	Parcel_233711	Regional Opportunity	1.41	1.00	71%	0.009	0.044
Concord	2	ROW_6856	ROW Opportunity	15.51	7.43	48%	0.001	0.044
Concord	2	ROW_12679	ROW Opportunity	7.36	3.68	50%	0.002	0.043
Concord	2	ROW_4968	ROW Opportunity	15.10	7.32	48%	0.001	0.043
Concord	2	ROW_13077	ROW Opportunity	6.74	3.68	55%	0.002	0.042
Concord	2	ROW_14213	ROW Opportunity	3.96	2.09	53%	0.004	0.042
Concord	2	ROW_2389	ROW Opportunity	7.58	3.81	50%	0.002	0.041
Concord	2	ROW_9299	ROW Opportunity	2.01	1.31	65%	0.006	0.040
Concord	2	ROW_1445	ROW Opportunity	15.65	7.47	48%	0.001	0.039
Concord	2	ROW_19589	ROW Opportunity	1.50	0.88	59%	0.007	0.039
Concord	2	ROW_20799	ROW Opportunity	9.69	4.87	50%	0.002	0.039
Concord	2	ROW_8514	ROW Opportunity	2.14	1.69	79%	0.006	0.039
Concord	2	ROW_14399	ROW Opportunity	1.15	0.88	77%	0.009	0.038
Concord	2	ROW_8633	ROW Opportunity	2.16	1.19	55%	0.005	0.038
Concord	2	Parcel_206674	Regional Opportunity	1.53	0.90	59%	0.007	0.037
Concord	2	ROW_1496	ROW Opportunity	9.68	4.76	49%	0.002	0.037
Concord	2	ROW_11474	ROW Opportunity	13.96	6.70	48%	0.001	0.036
Concord	2	ROW_2707	ROW Opportunity	3.07	1.72	56%	0.004	0.036
Concord	2	ROW_19429	ROW Opportunity	2.86	1.57	55%	0.004	0.035
Concord	2	ROW_7830	ROW Opportunity	5.91	2.96	50%	0.002	0.035
Concord	2	ROW_8405	ROW Opportunity	0.88	0.57	65%	0.011	0.035
Concord	2	ROW_14485	ROW Opportunity	3.31	1.63	49%	0.003	0.034
Concord	2	ROW_15145	ROW Opportunity	3.60	1.90	53%	0.003	0.034
Concord	2	Parcel_143398	Parcel-Based Opportunity	17.79	8.05	45%	0.001	0.032
Concord	2	ROW_10594	ROW Opportunity	12.05	5.90	49%	0.001	0.032
Concord	2	ROW_14712	ROW Opportunity	2.42	1.43	59%	0.004	0.032
Concord	2	ROW_19358	ROW Opportunity	10.05	5.04	50%	0.001	0.032
Concord	2	ROW_19557	ROW Opportunity	0.29	0.17	59%	0.026	0.032
Concord	2	ROW_3955	ROW Opportunity	3.56	1.78	50%	0.003	0.032
Concord	2	planned_422	Planned Unlined Bioretention	2.14	1.20	56%	0.004	0.030
Concord	2	ROW_12567	ROW Opportunity	14.87	7.28	49%	0.001	0.030
Concord	2	ROW_13167	ROW Opportunity	11.13	5.31	48%	0.001	0.030
Concord	2	ROW_18933	ROW Opportunity	1.85	1.04	56%	0.005	0.030
Concord	2	ROW_686	ROW Opportunity	3.34	1.70	51%	0.003	0.030
Concord	2	ROW_7347	ROW Opportunity	1.22	0.93	76%	0.007	0.030
Concord	2	Parcel_189589	Regional Opportunity	1.31	0.64	49%	0.006	0.029
Concord	2	ROW_12422	ROW Opportunity	2.70	1.38	51%	0.004	0.029
Concord	2	ROW_9241	ROW Opportunity	1.67	0.80	48%	0.005	0.029
Concord	2	Parcel_215855	Regional Opportunity	1.37	0.61	45%	0.006	0.028
Concord	2	ROW_13981	ROW Opportunity	3.75	1.83	49%	0.002	0.028
Concord	2	ROW_330	ROW Opportunity	7.40	3.68	50%	0.002	0.028
Concord	2	ROW_4033	ROW Opportunity	3.71	1.78	48%	0.003	0.028
Concord	2	Parcel_231516	Regional Opportunity	1.44	0.59	41%	0.005	0.027
Concord	2	ROW_14000	ROW Opportunity	1.10	0.63	57%	0.007	0.027
Concord	2	ROW_4609	ROW Opportunity	1.62	1.09	67%	0.005	0.027
Concord	2	ROW_6347	ROW Opportunity	1.82	0.92	51%	0.004	0.027
Concord	2	ROW_6349	ROW Opportunity	7.25	3.95	54%	0.002	0.027
Concord	2	ROW_9635	ROW Opportunity	3.66	1.68	46%	0.003	0.027
Concord	2	ROW_11942	ROW Opportunity	2.12	1.16	55%	0.004	0.026
Concord	2	ROW_14482	ROW Opportunity	2.43	1.00	41%	0.003	0.026
Concord	2	ROW_15994	ROW Opportunity	7.13	3.36	47%	0.001	0.026
Concord	2	ROW_1867	ROW Opportunity	3.65	1.92	53%	0.003	0.026
Concord	2	ROW_2690	ROW Opportunity	4.41	2.49	56%	0.002	0.026
Concord	2	ROW_4136	ROW Opportunity	3.43	1.60	47%	0.003	0.026
Concord	2	Parcel_208247	Regional Opportunity	0.79	0.57	72%	0.009	0.025
Concord	2	ROW_1535	ROW Opportunity	3.62	2.07	57%	0.002	0.025
Concord	2	ROW_15747	ROW Opportunity	1.16	0.75	65%	0.006	0.025
Concord	2	ROW_16947	ROW Opportunity	13.34	6.33	47%	0.001	0.025
Concord	2	ROW_663	ROW Opportunity	3.78	1.89	50%	0.002	0.025
Concord	2	Parcel_228202	Regional Opportunity	0.75	0.54	72%	0.009	0.024
Concord	2	ROW_18838	ROW Opportunity	1.39	0.79	57%	0.005	0.024
Concord	2	ROW_18934	ROW Opportunity	1.22	0.76	62%	0.006	0.024
Concord	2	ROW_20559	ROW Opportunity	10.08	4.59	46%	0.001	0.024
Concord	2	ROW_20591	ROW Opportunity	5.62	3.00	53%	0.002	0.024
Concord	2	ROW_21160	ROW Opportunity	12.09	5.95	49%	0.001	0.024
Concord	2	ROW_7875	ROW Opportunity	8.98	4.45	50%	0.001	0.024
Concord	2	ROW_9740	ROW Opportunity	9.01	4.21	47%	0.001	0.024
Concord	2	Parcel_214996	Parcel-Based Opportunity	8.68	5.91	68%	0.001	0.023
Concord	2	ROW_12594	ROW Opportunity	1.04	0.65	63%	0.007	0.023
Concord	2	ROW_12595	ROW Opportunity	1.05	0.64	61%	0.006	0.023
Concord	2	ROW_1269	ROW Opportunity	3.07	1.61	52%	0.003	0.023
Concord	2	ROW_15782	ROW Opportunity	1.11	0.70	63%	0.006	0.023
Concord	2	ROW_19980	ROW Opportunity	1.29	0.65	50%	0.005	0.023
Concord	2	ROW_20290	ROW Opportunity	2.46	1.49	61%	0.003	0.023
Concord	2	ROW_20752	ROW Opportunity	2.19	1.61	74%	0.004	0.023
Concord	2	ROW_7581	ROW Opportunity	1.16	0.71	61%	0.006	0.023

Jurisdiction	Permit	Project ID	Project Type	Area (Acres)	Impervious Area (Acres)	Percent Impervious	PCBs Yield (g/acre)	PCBs Mass reduced (g)
Concord	2	ROW_8121	ROW Opportunity	8.21	3.76	46%	0.001	0.023
Concord	2	Parcel_140573	Parcel-Based Opportunity	9.15	5.56	61%	0.001	0.022
Concord	2	Parcel_196927	Regional Opportunity	0.93	0.65	70%	0.007	0.022
Concord	2	Parcel_231203	Parcel-Based Opportunity	14.55	5.28	36%	0.001	0.022
Concord	2	planned_421	Planned Unlined Bioretention	2.87	1.58	55%	0.003	0.022
Concord	2	ROW_1178	ROW Opportunity	4.47	2.20	49%	0.002	0.022
Concord	2	ROW_7635	ROW Opportunity	2.74	1.32	48%	0.003	0.022
Concord	2	Parcel_148570	Parcel-Based Opportunity	10.29	5.19	50%	0.001	0.021
Concord	2	ROW_1480	ROW Opportunity	1.83	1.02	56%	0.004	0.021
Concord	2	ROW_16608	ROW Opportunity	10.91	5.23	48%	0.001	0.021
Concord	2	ROW_231	ROW Opportunity	1.44	0.80	56%	0.004	0.021
Concord	2	ROW_6904	ROW Opportunity	8.33	3.99	48%	0.001	0.021
Concord	2	Parcel_282436	Parcel-Based Opportunity	11.78	4.88	41%	0.001	0.020
Concord	2	Parcel_298561	Parcel-Based Opportunity	38.95	5.79	15%	0.000	0.020
Concord	2	ROW_2388	ROW Opportunity	5.15	2.44	47%	0.002	0.020
Concord	2	ROW_272	ROW Opportunity	3.17	1.68	53%	0.002	0.020
Concord	2	ROW_5431	ROW Opportunity	11.51	5.65	49%	0.001	0.020
Concord	2	ROW_6270	ROW Opportunity	10.98	5.38	49%	0.001	0.020
Concord	2	ROW_6428	ROW Opportunity	3.11	1.75	56%	0.002	0.020
Concord	2	ROW_7665	ROW Opportunity	4.31	2.22	52%	0.002	0.020
Concord	2	Parcel_220285	Parcel-Based Opportunity	9.96	4.72	47%	0.001	0.019
Concord	2	ROW_12020	ROW Opportunity	4.76	2.29	48%	0.002	0.019
Concord	2	ROW_12340	ROW Opportunity	8.43	4.07	48%	0.001	0.019
Concord	2	ROW_16428	ROW Opportunity	8.29	3.98	48%	0.001	0.019
Concord	2	ROW_3778	ROW Opportunity	1.34	0.88	66%	0.005	0.019
Concord	2	ROW_472	ROW Opportunity	0.82	0.45	55%	0.007	0.019
Concord	2	Parcel_186686	Regional Opportunity	0.75	0.45	60%	0.007	0.018
Concord	2	Parcel_202503	Parcel-Based Opportunity	5.94	4.60	77%	0.001	0.018
Concord	2	Parcel_209956	Regional Opportunity	0.66	0.42	64%	0.008	0.018
Concord	2	ROW_16285	ROW Opportunity	4.76	2.23	47%	0.002	0.018
Concord	2	ROW_17122	ROW Opportunity	7.41	3.30	45%	0.001	0.018
Concord	2	ROW_4335	ROW Opportunity	9.00	4.52	50%	0.001	0.018
Concord	2	ROW_4353	ROW Opportunity	9.22	4.47	48%	0.001	0.018
Concord	2	ROW_4354	ROW Opportunity	4.55	2.23	49%	0.002	0.018
Concord	2	ROW_6786	ROW Opportunity	0.62	0.41	66%	0.008	0.018
Concord	2	Parcel_166238	Parcel-Based Opportunity	7.81	3.85	49%	0.001	0.017
Concord	2	Parcel_167541	Regional Opportunity	0.73	0.37	51%	0.006	0.017
Concord	2	Parcel_204041	Parcel-Based Opportunity	0.49	0.42	86%	0.010	0.017
Concord	2	Parcel_238207	Parcel-Based Opportunity	9.03	4.20	47%	0.001	0.017
Concord	2	Parcel_288737	Regional Opportunity	0.93	0.40	43%	0.005	0.017
Concord	2	ROW_13364	ROW Opportunity	9.62	4.24	44%	0.001	0.017
Concord	2	ROW_13763	ROW Opportunity	1.83	1.14	62%	0.003	0.017
Concord	2	ROW_14442	ROW Opportunity	1.54	0.81	53%	0.004	0.017
Concord	2	ROW_17045	ROW Opportunity	8.58	4.24	49%	0.001	0.017
Concord	2	ROW_18989	ROW Opportunity	1.44	0.71	49%	0.004	0.017
Concord	2	ROW_4337	ROW Opportunity	8.58	4.26	50%	0.001	0.017
Concord	2	ROW_5444	ROW Opportunity	7.67	3.18	41%	0.001	0.017
Concord	2	ROW_5808	ROW Opportunity	1.41	0.85	60%	0.004	0.017
Concord	2	ROW_7088	ROW Opportunity	5.53	2.70	49%	0.001	0.017
Concord	2	ROW_8374	ROW Opportunity	6.24	2.74	44%	0.001	0.017
Concord	2	Parcel_189945	Parcel-Based Opportunity	9.41	4.05	43%	0.001	0.016
Concord	2	Parcel_209201	Regional Opportunity	0.96	0.36	38%	0.005	0.016
Concord	2	Parcel_231117	Parcel-Based Opportunity	9.30	3.93	42%	0.001	0.016
Concord	2	ROW_11295	ROW Opportunity	1.02	0.63	62%	0.005	0.016
Concord	2	ROW_13815	ROW Opportunity	4.98	2.54	51%	0.001	0.016
Concord	2	ROW_14488	ROW Opportunity	2.78	1.40	50%	0.002	0.016
Concord	2	ROW_16235	ROW Opportunity	4.82	2.25	47%	0.001	0.016
Concord	2	ROW_18426	ROW Opportunity	5.82	3.22	55%	0.001	0.016
Concord	2	ROW_19300	ROW Opportunity	6.58	3.21	49%	0.001	0.016
Concord	2	ROW_3418	ROW Opportunity	8.49	3.91	46%	0.001	0.016
Concord	2	Parcel_149994	Parcel-Based Opportunity	10.00	3.69	37%	0.001	0.015
Concord	2	Parcel_193540	Parcel-Based Opportunity	7.39	3.59	49%	0.001	0.015
Concord	2	Parcel_200676	Parcel-Based Opportunity	5.03	3.86	77%	0.001	0.015
Concord	2	Parcel_210557	Regional Opportunity	0.59	0.34	58%	0.007	0.015
Concord	2	Parcel_211022	Parcel-Based Opportunity	7.84	3.86	49%	0.001	0.015
Concord	2	Parcel_228429	Parcel-Based Opportunity	8.15	3.64	45%	0.001	0.015
Concord	2	ROW_10926	ROW Opportunity	8.71	4.01	46%	0.001	0.015
Concord	2	ROW_12001	ROW Opportunity	6.33	4.11	65%	0.001	0.015
Concord	2	ROW_12464	ROW Opportunity	6.99	3.40	49%	0.001	0.015
Concord	2	ROW_14169	ROW Opportunity	7.12	3.63	51%	0.001	0.015
Concord	2	ROW_14214	ROW Opportunity	1.27	0.73	57%	0.004	0.015
Concord	2	ROW_14589	ROW Opportunity	8.26	3.76	46%	0.001	0.015
Concord	2	ROW_15996	ROW Opportunity	1.51	0.82	54%	0.003	0.015
Concord	2	ROW_16812	ROW Opportunity	3.85	1.82	47%	0.002	0.015
Concord	2	ROW_16832	ROW Opportunity	4.69	2.13	45%	0.001	0.015
Concord	2	ROW_19307	ROW Opportunity	5.38	3.83	71%	0.001	0.015
Concord	2	ROW_21441	ROW Opportunity	7.99	3.70	46%	0.001	0.015
Concord	2	ROW_4958	ROW Opportunity	5.71	2.74	48%	0.001	0.015
Concord	2	ROW_5672	ROW Opportunity	2.80	1.35	48%	0.002	0.015
Concord	2	ROW_7089	ROW Opportunity	5.57	2.70	48%	0.001	0.015
Concord	2	ROW_9096	ROW Opportunity	7.26	3.76	52%	0.001	0.015
Concord	2	Parcel_198111	Regional Opportunity	1.88	0.30	16%	0.003	0.014
Concord	2	Parcel_205796	Regional Opportunity	0.51	0.35	69%	0.008	0.014
Concord	2	Parcel_212241	Parcel-Based Opportunity	10.42	3.26	31%	0.001	0.014
Concord	2	Parcel_245777	Regional Opportunity	0.52	0.31	60%	0.008	0.014
Concord	2	Parcel_306186	Regional Opportunity	9.66	3.42	35%	0.001	0.014
Concord	2	planned_423	Planned Unlined Bioretention	0.45	0.32	71%	0.009	0.014
Concord	2	ROW_10430	ROW Opportunity	3.97	1.89	48%	0.001	0.014
Concord	2	ROW_11163	ROW Opportunity	0.60	0.49	82%	0.007	0.014
Concord	2	ROW_11347	ROW Opportunity	7.18	3.36	47%	0.001	0.014
Concord	2	ROW_13157	ROW Opportunity	10.52	4.40	42%	0.001	0.014
Concord	2	ROW_15822	ROW Opportunity	4.36	2.16	50%	0.001	0.014
Concord	2	ROW_17904	ROW Opportunity	2.21	1.14	52%	0.002	0.014
Concord	2	ROW_19257	ROW Opportunity	4.31	3.48	81%	0.001	0.014

Jurisdiction	Permit	Project ID	Project Type	Area (Acres)	Impervious Area (Acres)	Percent Impervious	PCBs Yield (g/acre)	PCBs Mass reduced (g)
Concord	2	ROW_5809	ROW Opportunity	0.74	0.49	66%	0.006	0.014
Concord	2	ROW_9449	ROW Opportunity	5.91	2.94	50%	0.001	0.014
Concord	2	Parcel_172659	Parcel-Based Opportunity	8.26	3.21	39%	0.001	0.013
Concord	2	Parcel_176235	Parcel-Based Opportunity	0.43	0.29	67%	0.009	0.013
Concord	2	Parcel_198956	Regional Opportunity	1.88	0.31	16%	0.002	0.013
Concord	2	Parcel_200446	Regional Opportunity	1.05	0.58	55%	0.004	0.013
Concord	2	Parcel_202662	Parcel-Based Opportunity	4.54	3.47	76%	0.001	0.013
Concord	2	Parcel_203482	Parcel-Based Opportunity	0.44	0.28	64%	0.008	0.013
Concord	2	Parcel_207366	Parcel-Based Opportunity	0.44	0.35	80%	0.009	0.013
Concord	2	Parcel_245349	Parcel-Based Opportunity	0.50	0.29	58%	0.007	0.013
Concord	2	Parcel_283640	Parcel-Based Opportunity	8.85	3.17	36%	0.001	0.013
Concord	2	ROW_13215	ROW Opportunity	10.87	4.95	46%	0.000	0.013
Concord	2	ROW_15854	ROW Opportunity	6.90	3.41	49%	0.001	0.013
Concord	2	ROW_3470	ROW Opportunity	3.85	1.96	51%	0.001	0.013
Concord	2	ROW_425	ROW Opportunity	3.93	1.83	47%	0.001	0.013
Concord	2	ROW_6675	ROW Opportunity	3.24	1.53	47%	0.002	0.013
Concord	2	ROW_9266	ROW Opportunity	3.06	1.20	39%	0.002	0.013
Concord	2	Parcel_304455	Parcel-Based Opportunity	9.99	2.87	29%	0.001	0.012
Concord	2	ROW_10746	ROW Opportunity	5.86	2.84	48%	0.001	0.012
Concord	2	ROW_12239	ROW Opportunity	6.14	3.06	50%	0.001	0.012
Concord	2	ROW_12681	ROW Opportunity	6.89	3.12	45%	0.001	0.012
Concord	2	ROW_13166	ROW Opportunity	2.36	1.19	50%	0.002	0.012
Concord	2	ROW_14679	ROW Opportunity	6.33	3.08	49%	0.001	0.012
Concord	2	ROW_17761	ROW Opportunity	3.82	2.04	53%	0.001	0.012
Concord	2	ROW_18425	ROW Opportunity	2.25	1.39	62%	0.002	0.012
Concord	2	ROW_19367	ROW Opportunity	5.72	2.91	51%	0.001	0.012
Concord	2	ROW_19741	ROW Opportunity	15.61	6.71	43%	0.000	0.012
Concord	2	ROW_311	ROW Opportunity	4.66	2.30	49%	0.001	0.012
Concord	2	ROW_4967	ROW Opportunity	6.62	3.00	45%	0.001	0.012
Concord	2	ROW_7274	ROW Opportunity	5.67	2.85	50%	0.001	0.012
Concord	2	ROW_9397	ROW Opportunity	6.20	3.03	49%	0.001	0.012
Concord	2	Parcel_205395	Parcel-Based Opportunity	0.41	0.29	71%	0.008	0.011
Concord	2	ROW_1026	ROW Opportunity	6.02	2.70	45%	0.001	0.011
Concord	2	ROW_10444	ROW Opportunity	1.27	0.76	60%	0.003	0.011
Concord	2	ROW_13801	ROW Opportunity	3.61	1.92	53%	0.001	0.011
Concord	2	ROW_14604	ROW Opportunity	6.37	2.78	44%	0.001	0.011
Concord	2	ROW_15422	ROW Opportunity	3.73	1.82	49%	0.001	0.011
Concord	2	ROW_16761	ROW Opportunity	5.65	2.77	49%	0.001	0.011
Concord	2	ROW_19961	ROW Opportunity	5.36	2.71	51%	0.001	0.011
Concord	2	ROW_20887	ROW Opportunity	1.92	1.00	52%	0.002	0.011
Concord	2	ROW_2166	ROW Opportunity	4.72	3.21	68%	0.001	0.011
Concord	2	ROW_4343	ROW Opportunity	5.13	2.65	52%	0.001	0.011
Concord	2	ROW_6655	ROW Opportunity	5.76	2.88	50%	0.001	0.011
Concord	2	ROW_7547	ROW Opportunity	1.93	1.08	56%	0.002	0.011
Concord	2	ROW_840	ROW Opportunity	4.32	2.13	49%	0.001	0.011
Concord	2	ROW_9171	ROW Opportunity	5.93	2.70	46%	0.001	0.011
Concord	2	ROW_9371	ROW Opportunity	5.95	2.73	46%	0.001	0.011
Concord	2	Parcel_219241	Parcel-Based Opportunity	5.43	2.56	47%	0.001	0.010
Concord	2	ROW_10733	ROW Opportunity	0.86	0.41	48%	0.004	0.010
Concord	2	ROW_11477	ROW Opportunity	5.28	2.53	48%	0.001	0.010
Concord	2	ROW_13104	ROW Opportunity	2.83	1.42	50%	0.002	0.010
Concord	2	ROW_1509	ROW Opportunity	5.06	2.54	50%	0.001	0.010
Concord	2	ROW_17227	ROW Opportunity	3.24	2.61	81%	0.001	0.010
Concord	2	ROW_18867	ROW Opportunity	0.57	0.30	53%	0.005	0.010
Concord	2	ROW_18875	ROW Opportunity	5.49	2.53	46%	0.001	0.010
Concord	2	ROW_1942	ROW Opportunity	5.76	2.61	45%	0.001	0.010
Concord	2	ROW_4931	ROW Opportunity	5.95	2.64	44%	0.001	0.010
Concord	2	ROW_6969	ROW Opportunity	1.44	0.74	51%	0.003	0.010
Concord	2	ROW_7644	ROW Opportunity	3.34	2.69	81%	0.001	0.010
Concord	2	ROW_8954	ROW Opportunity	3.65	1.80	49%	0.001	0.010
Concord	2	ROW_9917	ROW Opportunity	5.57	2.54	46%	0.001	0.010
Danville	2	ROW_16936	ROW Opportunity	26.83	15.18	57%	0.009	0.752
Danville	2	ROW_3153	ROW Opportunity	22.64	11.45	51%	0.005	0.352
Danville	2	ROW_19015	ROW Opportunity	21.63	9.10	42%	0.004	0.264
Danville	2	ROW_10363	ROW Opportunity	15.72	7.19	46%	0.006	0.255
Danville	2	ROW_8645	ROW Opportunity	6.22	3.02	49%	0.012	0.252
Danville	2	ROW_5779	ROW Opportunity	29.66	12.29	41%	0.003	0.236
Danville	2	ROW_15495	ROW Opportunity	5.40	2.73	51%	0.013	0.235
Danville	2	ROW_6494	ROW Opportunity	13.53	5.65	42%	0.003	0.123
Danville	2	ROW_7569	ROW Opportunity	4.67	1.77	38%	0.008	0.114
Danville	2	ROW_20439	ROW Opportunity	5.29	2.56	48%	0.007	0.105
Danville	2	ROW_6553	ROW Opportunity	22.66	7.42	33%	0.002	0.101
Danville	2	ROW_10751	ROW Opportunity	6.96	2.81	40%	0.005	0.088
Danville	2	Parcel_3595	Regional Opportunity	1.32	0.94	71%	0.018	0.081
Danville	2	ROW_16231	ROW Opportunity	1.61	0.79	49%	0.013	0.071
Danville	2	ROW_11030	ROW Opportunity	4.72	1.69	36%	0.005	0.063
Danville	2	ROW_2419	ROW Opportunity	1.41	0.74	52%	0.014	0.063
Danville	2	Parcel_84842	Regional Opportunity	2.50	1.28	51%	0.007	0.061
Danville	2	ROW_15065	ROW Opportunity	3.30	1.46	44%	0.006	0.061
Danville	2	ROW_8646	ROW Opportunity	1.33	0.71	53%	0.013	0.058
Danville	2	planned_56	Planned Creek/Marsh Restoration	28.05	7.45	27%	0.001	0.054
Danville	2	ROW_13678	ROW Opportunity	1.73	0.69	40%	0.009	0.051
Danville	2	ROW_6273	ROW Opportunity	1.21	0.60	50%	0.012	0.049
Danville	2	ROW_4229	ROW Opportunity	1.02	0.47	46%	0.013	0.043
Danville	2	ROW_7541	ROW Opportunity	4.06	1.59	39%	0.004	0.043
Danville	2	ROW_8647	ROW Opportunity	1.24	0.61	49%	0.011	0.042
Danville	2	ROW_11350	ROW Opportunity	4.15	1.41	34%	0.003	0.035
Danville	2	ROW_5386	ROW Opportunity	10.48	3.17	30%	0.001	0.032
Danville	2	ROW_17662	ROW Opportunity	4.65	1.54	33%	0.003	0.030
Danville	2	ROW_8243	ROW Opportunity	17.78	6.46	36%	0.001	0.028
Danville	2	ROW_1278	ROW Opportunity	2.38	1.11	47%	0.004	0.027
Danville	2	ROW_20482	ROW Opportunity	4.27	1.25	29%	0.002	0.026
Danville	2	ROW_6485	ROW Opportunity	27.58	10.93	40%	0.000	0.026
Danville	2	ROW_7899	ROW Opportunity	5.60	1.66	30%	0.002	0.026

Jurisdiction	Permit	Project ID	Project Type	Area (Acres)	Impervious Area (Acres)	Percent Impervious	PCBs Yield (g/acre)	PCBs Mass reduced (g)
Danville	2	ROW_14380	ROW Opportunity	10.15	3.63	36%	0.001	0.025
Danville	2	ROW_2772	ROW Opportunity	8.71	2.89	33%	0.001	0.025
Danville	2	ROW_5569	ROW Opportunity	8.89	2.11	24%	0.001	0.025
Danville	2	ROW_6880	ROW Opportunity	4.97	1.50	30%	0.002	0.025
Danville	2	ROW_17254	ROW Opportunity	0.58	0.26	45%	0.012	0.024
Danville	2	ROW_3171	ROW Opportunity	9.06	3.83	42%	0.001	0.024
Danville	2	ROW_10398	ROW Opportunity	8.60	2.53	29%	0.001	0.023
Danville	2	ROW_18078	ROW Opportunity	4.08	1.19	29%	0.002	0.023
Danville	2	ROW_4663	ROW Opportunity	14.21	5.41	38%	0.001	0.023
Danville	2	ROW_6934	ROW Opportunity	7.87	2.54	32%	0.001	0.023
Danville	2	ROW_12934	ROW Opportunity	9.74	3.39	35%	0.001	0.021
Danville	2	ROW_16006	ROW Opportunity	3.00	1.95	65%	0.003	0.020
Danville	2	ROW_21104	ROW Opportunity	3.41	0.72	21%	0.002	0.020
Danville	2	ROW_13883	ROW Opportunity	5.95	1.96	33%	0.001	0.018
Danville	2	ROW_3169	ROW Opportunity	27.83	11.62	42%	0.000	0.018
Danville	2	Parcel_7023	Parcel-Based Opportunity	4.47	2.08	47%	0.002	0.017
Danville	2	ROW_19889	ROW Opportunity	2.38	0.83	35%	0.003	0.017
Danville	2	ROW_4459	ROW Opportunity	4.95	1.71	35%	0.001	0.017
Danville	2	ROW_6502	ROW Opportunity	3.58	1.36	38%	0.002	0.017
Danville	2	ROW_20045	ROW Opportunity	6.37	1.75	27%	0.001	0.016
Danville	2	ROW_7490	ROW Opportunity	5.22	2.31	44%	0.001	0.016
Danville	2	ROW_8595	ROW Opportunity	10.06	3.71	37%	0.001	0.016
Danville	2	Parcel_2847	Parcel-Based Opportunity	0.35	0.16	46%	0.012	0.015
Danville	2	ROW_10387	ROW Opportunity	4.17	1.86	45%	0.002	0.015
Danville	2	ROW_13940	ROW Opportunity	6.12	2.31	38%	0.001	0.015
Danville	2	Parcel_2825	Parcel-Based Opportunity	0.35	0.14	40%	0.011	0.014
Danville	2	ROW_3111	ROW Opportunity	6.77	1.67	25%	0.001	0.014
Danville	2	ROW_7016	ROW Opportunity	3.24	0.99	31%	0.002	0.014
Danville	2	ROW_10801	ROW Opportunity	10.37	3.70	36%	0.001	0.013
Danville	2	ROW_8639	ROW Opportunity	5.23	1.56	30%	0.001	0.013
Danville	2	ROW_12473	ROW Opportunity	2.77	0.92	33%	0.002	0.012
Danville	2	ROW_13144	ROW Opportunity	6.32	2.32	37%	0.001	0.012
Danville	2	ROW_14418	ROW Opportunity	7.93	2.81	35%	0.001	0.012
Danville	2	ROW_3170	ROW Opportunity	17.87	7.49	42%	0.000	0.012
Danville	2	ROW_8231	ROW Opportunity	3.49	1.32	38%	0.002	0.012
Danville	2	ROW_9408	ROW Opportunity	3.29	1.31	40%	0.002	0.012
Danville	2	Parcel_2786	Parcel-Based Opportunity	0.34	0.13	38%	0.009	0.011
Danville	2	Parcel_7198	Regional Opportunity	2.07	1.46	71%	0.003	0.011
Danville	2	ROW_11870	ROW Opportunity	3.31	0.88	27%	0.002	0.011
Danville	2	ROW_12945	ROW Opportunity	3.98	1.15	29%	0.001	0.011
Danville	2	ROW_3876	ROW Opportunity	2.83	1.65	58%	0.002	0.011
Danville	2	ROW_7424	ROW Opportunity	1.50	1.04	69%	0.003	0.011
Danville	2	Parcel_8521	Regional Opportunity	0.89	0.19	21%	0.003	0.010
Danville	2	ROW_2262	ROW Opportunity	4.76	1.72	36%	0.001	0.010
Danville	2	ROW_3224	ROW Opportunity	6.67	2.37	36%	0.001	0.010
El Cerrito	2	ROW_57	ROW Opportunity	20.16	12.24	61%	0.008	0.521
El Cerrito	2	ROW_55	ROW Opportunity	8.61	5.54	64%	0.008	0.227
El Cerrito	2	ROW_15171	ROW Opportunity	5.98	3.48	58%	0.010	0.215
El Cerrito	2	planned_99	Planned Unlined Bioretention	3.97	2.99	75%	0.011	0.152
El Cerrito	2	ROW_17243	ROW Opportunity	5.47	3.28	60%	0.007	0.129
El Cerrito	2	planned_131	Planned Unlined Bioretention	10.94	5.84	53%	0.004	0.113
El Cerrito	2	Parcel_120972	Parcel-Based Opportunity	4.68	2.01	43%	0.006	0.100
El Cerrito	2	ROW_9948	ROW Opportunity	3.37	2.16	64%	0.008	0.083
El Cerrito	2	Parcel_121635	Parcel-Based Opportunity	2.11	1.58	75%	0.010	0.071
El Cerrito	2	ROW_3506	ROW Opportunity	4.25	2.52	59%	0.006	0.070
El Cerrito	2	planned_98	Planned Unlined Bioretention	14.94	10.23	68%	0.002	0.068
El Cerrito	2	ROW_10275	ROW Opportunity	2.52	1.58	63%	0.008	0.065
El Cerrito	2	Parcel_120393	Parcel-Based Opportunity	2.79	1.19	43%	0.006	0.060
El Cerrito	2	planned_122	Planned Unlined Bioretention	2.79	1.19	43%	0.006	0.060
El Cerrito	2	ROW_9949	ROW Opportunity	8.99	5.41	60%	0.003	0.056
El Cerrito	2	ROW_20173	ROW Opportunity	1.18	0.68	58%	0.012	0.053
El Cerrito	2	ROW_3882	ROW Opportunity	7.74	4.70	61%	0.003	0.053
El Cerrito	2	ROW_6997	ROW Opportunity	2.01	1.26	63%	0.008	0.053
El Cerrito	2	ROW_5240	ROW Opportunity	14.23	7.45	52%	0.002	0.051
El Cerrito	2	ROW_12667	ROW Opportunity	7.60	4.07	54%	0.003	0.048
El Cerrito	2	ROW_15194	ROW Opportunity	2.45	1.67	68%	0.006	0.044
El Cerrito	2	Parcel_108912	Parcel-Based Opportunity	19.52	10.10	52%	0.001	0.042
El Cerrito	2	ROW_13601	ROW Opportunity	9.94	5.69	57%	0.002	0.038
El Cerrito	2	ROW_18539	ROW Opportunity	3.28	1.97	60%	0.004	0.038
El Cerrito	2	ROW_4566	ROW Opportunity	9.09	4.81	53%	0.002	0.037
El Cerrito	2	Parcel_128153	Parcel-Based Opportunity	2.55	1.76	69%	0.005	0.036
El Cerrito	2	planned_389	Planned Creek/Marsh Restoration	1.00	0.66	66%	0.011	0.035
El Cerrito	2	ROW_9950	ROW Opportunity	2.05	1.31	64%	0.006	0.035
El Cerrito	2	Parcel_133358	Regional Opportunity	1.27	0.75	59%	0.008	0.034
El Cerrito	2	ROW_13602	ROW Opportunity	7.52	4.21	56%	0.002	0.033
El Cerrito	2	ROW_11539	ROW Opportunity	0.79	0.54	68%	0.011	0.029
El Cerrito	2	ROW_13367	ROW Opportunity	8.37	4.33	52%	0.002	0.029
El Cerrito	2	ROW_3041	ROW Opportunity	1.55	0.94	61%	0.006	0.029
El Cerrito	2	ROW_6936	ROW Opportunity	9.70	5.56	57%	0.001	0.029
El Cerrito	2	ROW_1264	ROW Opportunity	6.94	3.84	55%	0.002	0.028
El Cerrito	2	ROW_2251	ROW Opportunity	4.66	2.74	59%	0.003	0.028
El Cerrito	2	Parcel_118487	Parcel-Based Opportunity	1.00	0.55	55%	0.008	0.027
El Cerrito	2	planned_89	Planned Unlined Bioretention	80.88	5.47	7%	0.000	0.026
El Cerrito	2	ROW_20541	ROW Opportunity	1.08	0.66	61%	0.008	0.026
El Cerrito	2	ROW_16009	ROW Opportunity	1.55	0.96	62%	0.005	0.025
El Cerrito	2	ROW_15096	ROW Opportunity	6.18	3.20	52%	0.002	0.024
El Cerrito	2	ROW_6938	ROW Opportunity	6.31	3.67	58%	0.002	0.024
El Cerrito	2	Parcel_129420	Parcel-Based Opportunity	9.98	5.33	53%	0.001	0.023
El Cerrito	2	Parcel_137929	Parcel-Based Opportunity	5.49	2.41	44%	0.002	0.023
El Cerrito	2	ROW_10958	ROW Opportunity	7.39	4.41	60%	0.001	0.023
El Cerrito	2	ROW_15895	ROW Opportunity	9.74	5.57	57%	0.001	0.023
El Cerrito	2	ROW_20026	ROW Opportunity	0.68	0.54	79%	0.010	0.023
El Cerrito	2	ROW_15894	ROW Opportunity	9.10	5.36	59%	0.001	0.022
El Cerrito	2	ROW_11691	ROW Opportunity	5.62	3.28	58%	0.002	0.021

Jurisdiction	Permit	Project ID	Project Type	Area (Acres)	Impervious Area (Acres)	Percent Impervious	PCBs Yield (g/acre)	PCBs Mass reduced (g)
El Cerrito	2	ROW_20328	ROW Opportunity	4.46	2.50	56%	0.002	0.021
El Cerrito	2	ROW_3523	ROW Opportunity	5.21	2.90	56%	0.002	0.021
El Cerrito	2	ROW_539	ROW Opportunity	6.98	3.97	57%	0.001	0.021
El Cerrito	2	ROW_10929	ROW Opportunity	5.36	3.22	60%	0.002	0.018
El Cerrito	2	ROW_11011	ROW Opportunity	4.83	2.80	58%	0.002	0.018
El Cerrito	2	ROW_14649	ROW Opportunity	0.60	0.40	67%	0.009	0.018
El Cerrito	2	ROW_6691	ROW Opportunity	7.35	4.29	58%	0.001	0.018
El Cerrito	2	ROW_10097	ROW Opportunity	6.15	3.70	60%	0.001	0.017
El Cerrito	2	ROW_15535	ROW Opportunity	4.95	2.77	56%	0.002	0.017
El Cerrito	2	ROW_20028	ROW Opportunity	0.50	0.39	78%	0.010	0.017
El Cerrito	2	ROW_20526	ROW Opportunity	4.64	2.70	58%	0.002	0.017
El Cerrito	2	ROW_6694	ROW Opportunity	6.59	3.78	57%	0.001	0.017
El Cerrito	2	planned_130	Planned Unlined Bioretention	0.45	0.37	82%	0.011	0.016
El Cerrito	2	ROW_6234	ROW Opportunity	1.67	0.95	57%	0.003	0.016
El Cerrito	2	ROW_6998	ROW Opportunity	2.36	1.37	58%	0.003	0.016
El Cerrito	2	Parcel_134601	Parcel-Based Opportunity	5.18	3.92	76%	0.001	0.015
El Cerrito	2	ROW_16809	ROW Opportunity	4.87	2.71	56%	0.002	0.015
El Cerrito	2	ROW_21519	ROW Opportunity	3.43	2.17	63%	0.002	0.015
El Cerrito	2	ROW_3495	ROW Opportunity	0.56	0.36	64%	0.008	0.015
El Cerrito	2	ROW_6367	ROW Opportunity	0.63	0.42	67%	0.007	0.015
El Cerrito	2	ROW_6911	ROW Opportunity	3.73	2.13	57%	0.002	0.015
El Cerrito	2	ROW_15196	ROW Opportunity	0.57	0.35	61%	0.007	0.014
El Cerrito	2	ROW_16545	ROW Opportunity	1.24	0.82	66%	0.004	0.014
El Cerrito	2	ROW_5254	ROW Opportunity	1.74	1.09	63%	0.003	0.014
El Cerrito	2	ROW_7864	ROW Opportunity	5.06	2.85	56%	0.001	0.014
El Cerrito	2	ROW_10953	ROW Opportunity	4.85	2.82	58%	0.001	0.013
El Cerrito	2	ROW_10955	ROW Opportunity	4.39	2.60	59%	0.001	0.013
El Cerrito	2	ROW_13600	ROW Opportunity	0.67	0.42	63%	0.006	0.013
El Cerrito	2	ROW_4340	ROW Opportunity	5.48	3.03	55%	0.001	0.013
El Cerrito	2	ROW_4650	ROW Opportunity	0.62	0.37	60%	0.007	0.013
El Cerrito	2	Parcel_376467	Parcel-Based Opportunity	5.15	2.93	57%	0.001	0.012
El Cerrito	2	ROW_10802	ROW Opportunity	4.97	2.88	58%	0.001	0.012
El Cerrito	2	ROW_13910	ROW Opportunity	0.48	0.28	58%	0.008	0.012
El Cerrito	2	ROW_1672	ROW Opportunity	5.53	3.07	56%	0.001	0.012
El Cerrito	2	ROW_5917	ROW Opportunity	4.58	2.67	58%	0.001	0.012
El Cerrito	2	ROW_6511	ROW Opportunity	3.16	1.88	59%	0.002	0.012
El Cerrito	2	ROW_9947	ROW Opportunity	0.92	0.61	66%	0.004	0.012
El Cerrito	2	Parcel_140018	Parcel-Based Opportunity	0.39	0.05	13%	0.008	0.011
El Cerrito	2	ROW_10930	ROW Opportunity	3.54	2.10	59%	0.001	0.011
El Cerrito	2	ROW_6968	ROW Opportunity	0.48	0.36	75%	0.007	0.011
El Cerrito	2	ROW_9065	ROW Opportunity	2.03	1.20	59%	0.002	0.011
El Cerrito	2	Parcel_120884	Regional Opportunity	0.59	0.21	36%	0.005	0.010
El Cerrito	2	ROW_15090	ROW Opportunity	4.58	2.54	55%	0.001	0.010
Hercules	2	Parcel_253834	Parcel-Based Opportunity	6.24	3.65	58%	0.034	0.860
Hercules	2	Parcel_258137	Parcel-Based Opportunity	11.26	2.85	25%	0.015	0.661
Hercules	2	ROW_1743	ROW Opportunity	11.16	4.37	39%	0.013	0.535
Hercules	2	ROW_15756	ROW Opportunity	4.43	2.04	46%	0.028	0.522
Hercules	2	ROW_13267	ROW Opportunity	3.21	1.44	45%	0.027	0.369
Hercules	2	ROW_20166	ROW Opportunity	8.49	3.53	42%	0.011	0.360
Hercules	2	ROW_16990	ROW Opportunity	5.25	1.32	25%	0.016	0.333
Hercules	2	Parcel_257979	Parcel-Based Opportunity	5.62	1.27	23%	0.013	0.303
Hercules	2	ROW_16634	ROW Opportunity	3.21	1.39	43%	0.022	0.290
Hercules	2	ROW_16909	ROW Opportunity	15.96	6.87	43%	0.005	0.260
Hercules	2	ROW_16911	ROW Opportunity	3.92	1.61	41%	0.016	0.247
Hercules	2	ROW_16090	ROW Opportunity	2.62	1.05	40%	0.022	0.243
Hercules	2	Parcel_257367	Parcel-Based Opportunity	3.87	0.86	22%	0.014	0.224
Hercules	2	ROW_14290	ROW Opportunity	6.27	2.06	33%	0.009	0.223
Hercules	2	ROW_6342	ROW Opportunity	2.63	0.75	29%	0.019	0.206
Hercules	2	ROW_19139	ROW Opportunity	3.17	0.80	25%	0.015	0.195
Hercules	2	ROW_18985	ROW Opportunity	21.38	7.42	35%	0.003	0.173
Hercules	2	Parcel_258157	Regional Opportunity	2.96	0.60	20%	0.014	0.168
Hercules	2	ROW_10622	ROW Opportunity	1.33	0.63	47%	0.028	0.160
Hercules	2	ROW_10623	ROW Opportunity	2.15	1.01	47%	0.017	0.153
Hercules	2	ROW_15482	ROW Opportunity	1.75	0.48	27%	0.020	0.141
Hercules	2	ROW_20676	ROW Opportunity	1.62	0.73	45%	0.021	0.140
Hercules	2	ROW_20171	ROW Opportunity	1.96	0.83	42%	0.016	0.125
Hercules	2	ROW_15483	ROW Opportunity	5.37	1.35	25%	0.006	0.115
Hercules	2	Parcel_257429	Regional Opportunity	1.90	0.43	23%	0.015	0.111
Hercules	2	ROW_1748	ROW Opportunity	1.51	0.38	25%	0.018	0.108
Hercules	2	Parcel_256321	Parcel-Based Opportunity	2.36	0.25	11%	0.010	0.097
Hercules	2	ROW_19622	ROW Opportunity	2.25	0.81	36%	0.011	0.095
Hercules	2	ROW_1435	ROW Opportunity	1.57	0.35	22%	0.014	0.086
Hercules	2	ROW_13170	ROW Opportunity	0.60	0.27	45%	0.026	0.067
Hercules	2	Parcel_257692	Regional Opportunity	1.04	0.24	23%	0.015	0.064
Hercules	2	ROW_1791	ROW Opportunity	1.59	0.35	22%	0.009	0.058
Hercules	2	ROW_7393	ROW Opportunity	1.06	0.36	34%	0.014	0.057
Hercules	2	ROW_7699	ROW Opportunity	0.56	0.19	34%	0.023	0.054
Hercules	2	ROW_17257	ROW Opportunity	0.40	0.21	53%	0.030	0.052
Hercules	2	ROW_10624	ROW Opportunity	0.39	0.17	44%	0.027	0.044
Hercules	2	ROW_7341	ROW Opportunity	0.35	0.15	43%	0.026	0.039
Hercules	2	ROW_11067	ROW Opportunity	7.45	2.66	36%	0.002	0.035
Hercules	2	ROW_1079	ROW Opportunity	0.90	0.39	43%	0.010	0.033
Hercules	2	ROW_6380	ROW Opportunity	0.41	0.24	59%	0.018	0.029
Hercules	2	ROW_365	ROW Opportunity	0.21	0.11	52%	0.029	0.026
Hercules	2	Parcel_257844	Parcel-Based Opportunity	0.43	0.10	23%	0.015	0.025
Hercules	2	ROW_11619	ROW Opportunity	0.42	0.12	29%	0.015	0.024
Hercules	2	Parcel_257823	Parcel-Based Opportunity	0.37	0.08	22%	0.015	0.022
Hercules	2	Parcel_257685	Parcel-Based Opportunity	0.34	0.08	24%	0.015	0.020
Hercules	2	Parcel_260776	Parcel-Based Opportunity	11.52	2.65	23%	0.001	0.019
Hercules	2	ROW_19683	ROW Opportunity	0.49	0.17	35%	0.010	0.019
Hercules	2	Parcel_254443	Parcel-Based Opportunity	8.83	1.56	18%	0.001	0.016
Hercules	2	ROW_2481	ROW Opportunity	0.15	0.07	47%	0.022	0.014
Hercules	2	Parcel_255602	Parcel-Based Opportunity	13.98	5.74	41%	0.000	0.013
Hercules	2	ROW_21077	ROW Opportunity	1.10	0.21	19%	0.003	0.012

Jurisdiction	Permit	Project ID	Project Type	Area (Acres)	Impervious Area (Acres)	Percent Impervious	PCBs Yield (g/acre)	PCBs Mass reduced (g)
Hercules	2	ROW_17543	ROW Opportunity	0.12	0.04	33%	0.022	0.011
Hercules	2	Parcel_253250	Parcel-Based Opportunity	0.32	0.10	31%	0.008	0.010
Lafayette	2	ROW_8037	ROW Opportunity	4.09	2.48	61%	0.014	0.183
Lafayette	2	ROW_2243	ROW Opportunity	1.43	1.06	74%	0.032	0.167
Lafayette	2	ROW_12876	ROW Opportunity	6.73	3.27	49%	0.008	0.153
Lafayette	2	ROW_151	ROW Opportunity	3.55	2.15	61%	0.014	0.153
Lafayette	2	ROW_397	ROW Opportunity	10.95	2.47	23%	0.004	0.132
Lafayette	2	ROW_10450	ROW Opportunity	2.88	1.58	55%	0.013	0.126
Lafayette	2	ROW_8546	ROW Opportunity	30.28	4.86	16%	0.002	0.126
Lafayette	2	ROW_8982	ROW Opportunity	8.86	3.34	38%	0.004	0.097
Lafayette	2	ROW_2803	ROW Opportunity	2.21	1.37	62%	0.012	0.079
Lafayette	2	Parcel_375734	Parcel-Based Opportunity	29.49	9.07	31%	0.001	0.077
Lafayette	2	ROW_235	ROW Opportunity	2.40	1.49	62%	0.011	0.075
Lafayette	2	Parcel_22842	Parcel-Based Opportunity	26.65	4.08	15%	0.001	0.061
Lafayette	2	Parcel_38918	Parcel-Based Opportunity	17.79	6.51	37%	0.001	0.056
Lafayette	2	ROW_5749	ROW Opportunity	2.62	1.31	50%	0.007	0.051
Lafayette	2	ROW_16160	ROW Opportunity	13.26	2.44	18%	0.002	0.050
Lafayette	2	ROW_18657	ROW Opportunity	1.15	0.72	63%	0.013	0.045
Lafayette	2	ROW_6188	ROW Opportunity	2.68	1.13	42%	0.006	0.042
Lafayette	2	ROW_8493	ROW Opportunity	5.88	1.11	19%	0.003	0.041
Lafayette	2	Parcel_45274	Regional Opportunity	0.74	0.44	59%	0.016	0.040
Lafayette	2	ROW_12869	ROW Opportunity	11.00	2.85	26%	0.002	0.039
Lafayette	2	ROW_12445	ROW Opportunity	4.44	0.97	22%	0.003	0.037
Lafayette	2	ROW_17249	ROW Opportunity	4.54	1.96	43%	0.003	0.037
Lafayette	2	ROW_18068	ROW Opportunity	1.26	0.64	51%	0.010	0.037
Lafayette	2	ROW_15000	ROW Opportunity	1.59	0.80	50%	0.007	0.036
Lafayette	2	ROW_7204	ROW Opportunity	0.97	0.35	36%	0.011	0.034
Lafayette	2	ROW_17831	ROW Opportunity	14.18	3.00	21%	0.001	0.033
Lafayette	2	ROW_21105	ROW Opportunity	1.83	0.76	42%	0.006	0.030
Lafayette	2	Parcel_376452	Parcel-Based Opportunity	9.70	3.28	34%	0.001	0.029
Lafayette	2	Parcel_40931	Parcel-Based Opportunity	6.84	3.62	53%	0.002	0.029
Lafayette	2	Parcel_43618	Parcel-Based Opportunity	7.13	3.51	49%	0.002	0.029
Lafayette	2	ROW_18408	ROW Opportunity	7.32	1.94	27%	0.002	0.029
Lafayette	2	ROW_3774	ROW Opportunity	0.85	0.48	56%	0.011	0.029
Lafayette	2	ROW_7943	ROW Opportunity	9.50	1.66	17%	0.001	0.029
Lafayette	2	ROW_8461	ROW Opportunity	0.61	0.39	64%	0.015	0.029
Lafayette	2	ROW_13640	ROW Opportunity	2.39	0.70	29%	0.004	0.028
Lafayette	2	planned_546	Planned Creek/Marsh Restoration	2.12	0.60	28%	0.005	0.027
Lafayette	2	ROW_19821	ROW Opportunity	13.08	2.06	16%	0.001	0.027
Lafayette	2	ROW_8508	ROW Opportunity	1.56	0.60	38%	0.006	0.027
Lafayette	2	ROW_20225	ROW Opportunity	1.46	0.47	32%	0.006	0.026
Lafayette	2	ROW_11383	ROW Opportunity	8.22	1.99	24%	0.001	0.022
Lafayette	2	ROW_680	ROW Opportunity	1.59	0.67	42%	0.005	0.022
Lafayette	2	ROW_9300	ROW Opportunity	1.68	0.70	42%	0.005	0.022
Lafayette	2	ROW_12963	ROW Opportunity	5.60	1.60	29%	0.002	0.021
Lafayette	2	ROW_2256	ROW Opportunity	0.32	0.25	78%	0.020	0.021
Lafayette	2	Parcel_41948	Regional Opportunity	0.54	0.21	39%	0.011	0.020
Lafayette	2	ROW_155	ROW Opportunity	2.84	1.02	36%	0.003	0.020
Lafayette	2	ROW_2070	ROW Opportunity	2.66	1.20	45%	0.003	0.020
Lafayette	2	ROW_21071	ROW Opportunity	0.48	0.22	46%	0.012	0.018
Lafayette	2	ROW_14991	ROW Opportunity	0.74	0.22	30%	0.007	0.017
Lafayette	2	ROW_20798	ROW Opportunity	1.38	0.59	43%	0.005	0.017
Lafayette	2	ROW_18029	ROW Opportunity	5.83	1.14	20%	0.001	0.015
Lafayette	2	ROW_20971	ROW Opportunity	0.57	0.22	39%	0.008	0.015
Lafayette	2	Parcel_40526	Parcel-Based Opportunity	0.40	0.12	30%	0.010	0.014
Lafayette	2	ROW_7898	ROW Opportunity	7.71	1.06	14%	0.001	0.014
Lafayette	2	ROW_18768	ROW Opportunity	4.41	1.13	26%	0.001	0.013
Lafayette	2	ROW_2955	ROW Opportunity	3.77	0.91	24%	0.002	0.013
Lafayette	2	Parcel_43103	Parcel-Based Opportunity	8.38	2.44	29%	0.001	0.012
Lafayette	2	ROW_14844	ROW Opportunity	3.47	0.54	16%	0.002	0.012
Lafayette	2	ROW_20581	ROW Opportunity	2.06	0.66	32%	0.002	0.012
Lafayette	2	ROW_3114	ROW Opportunity	4.89	1.20	25%	0.001	0.012
Lafayette	2	Parcel_104404	Parcel-Based Opportunity	7.73	0.73	9%	0.001	0.011
Lafayette	2	ROW_11327	ROW Opportunity	5.07	1.07	21%	0.001	0.011
Lafayette	2	ROW_13216	ROW Opportunity	5.56	0.90	16%	0.001	0.011
Lafayette	2	ROW_16250	ROW Opportunity	2.49	0.97	39%	0.002	0.011
Lafayette	2	ROW_16635	ROW Opportunity	5.34	0.92	17%	0.001	0.011
Lafayette	2	ROW_18973	ROW Opportunity	3.41	0.90	26%	0.001	0.011
Lafayette	2	ROW_9365	ROW Opportunity	3.71	1.19	32%	0.001	0.011
Lafayette	2	ROW_2177	ROW Opportunity	4.87	0.90	18%	0.001	0.010
Lafayette	2	ROW_4253	ROW Opportunity	0.63	0.32	51%	0.005	0.010
Lafayette	2	ROW_5759	ROW Opportunity	4.91	0.98	20%	0.001	0.010
Martinez	2	planned_7	Planned Creek/Marsh Restoration	94.31	39.77	42%	0.018	6.741
Martinez	2	ROW_11847	ROW Opportunity	18.15	11.75	65%	0.030	2.289
Martinez	2	ROW_9312	ROW Opportunity	15.70	8.30	53%	0.019	1.200
Martinez	2	Parcel_256879	Parcel-Based Opportunity	4.53	3.61	80%	0.045	0.840
Martinez	2	Parcel_258271	Regional Opportunity	11.25	3.16	28%	0.016	0.738
Martinez	2	ROW_2615	ROW Opportunity	4.67	2.85	61%	0.029	0.568
Martinez	2	ROW_17609	ROW Opportunity	3.03	1.75	58%	0.034	0.432
Martinez	2	ROW_1199	ROW Opportunity	10.11	5.56	55%	0.009	0.350
Martinez	2	ROW_12654	ROW Opportunity	2.07	1.21	58%	0.034	0.301
Martinez	2	Parcel_224745	Parcel-Based Opportunity	12.27	5.56	45%	0.006	0.275
Martinez	2	Parcel_256618	Regional Opportunity	1.53	1.15	75%	0.042	0.271
Martinez	2	ROW_9751	ROW Opportunity	3.95	1.31	33%	0.016	0.264
Martinez	2	ROW_1704	ROW Opportunity	2.43	1.03	42%	0.025	0.262
Martinez	2	ROW_613	ROW Opportunity	44.88	20.72	46%	0.002	0.257
Martinez	2	Parcel_257598	Parcel-Based Opportunity	4.12	0.90	22%	0.014	0.241
Martinez	2	ROW_11018	ROW Opportunity	1.72	0.97	56%	0.033	0.238
Martinez	2	ROW_2610	ROW Opportunity	2.98	0.86	29%	0.017	0.219
Martinez	2	ROW_6722	ROW Opportunity	3.14	1.29	41%	0.017	0.214
Martinez	2	ROW_7179	ROW Opportunity	6.44	3.23	50%	0.008	0.194
Martinez	2	ROW_14509	ROW Opportunity	5.63	2.94	52%	0.009	0.175
Martinez	2	ROW_12653	ROW Opportunity	1.13	0.68	60%	0.035	0.165
Martinez	2	ROW_1198	ROW Opportunity	20.20	10.22	51%	0.003	0.158

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Martinez	2	Parcel_257469	Parcel-Based Opportunity	1.47	0.63	43%	0.025	0.155
Martinez	2	ROW_2021	ROW Opportunity	3.08	1.19	39%	0.012	0.154
Martinez	2	Parcel_257037	Parcel-Based Opportunity	1.31	0.60	46%	0.027	0.148
Martinez	2	ROW_11846	ROW Opportunity	1.07	0.66	62%	0.032	0.140
Martinez	2	ROW_6258	ROW Opportunity	1.28	0.54	42%	0.025	0.138
Martinez	2	ROW_13093	ROW Opportunity	19.22	8.75	46%	0.003	0.135
Martinez	2	ROW_15102	ROW Opportunity	1.17	0.49	42%	0.026	0.126
Martinez	2	ROW_12899	ROW Opportunity	23.68	11.07	47%	0.002	0.123
Martinez	2	ROW_6843	ROW Opportunity	7.57	3.72	49%	0.005	0.119
Martinez	2	ROW_12656	ROW Opportunity	1.13	0.45	40%	0.024	0.114
Martinez	2	Parcel_259273	Parcel-Based Opportunity	53.06	7.74	15%	0.001	0.110
Martinez	2	planned_375	Planned Unlined Bioretention	0.69	0.47	68%	0.036	0.104
Martinez	2	Parcel_256439	Parcel-Based Opportunity	6.52	4.34	67%	0.005	0.101
Martinez	2	ROW_11617	ROW Opportunity	6.23	3.68	59%	0.005	0.098
Martinez	2	ROW_3734	ROW Opportunity	10.53	5.59	53%	0.003	0.090
Martinez	2	ROW_4932	ROW Opportunity	2.88	1.64	57%	0.008	0.089
Martinez	2	ROW_15103	ROW Opportunity	0.78	0.33	42%	0.026	0.085
Martinez	2	Parcel_257604	Parcel-Based Opportunity	5.42	1.42	26%	0.004	0.080
Martinez	2	ROW_7416	ROW Opportunity	0.97	0.55	57%	0.020	0.078
Martinez	2	ROW_2023	ROW Opportunity	6.59	0.76	12%	0.003	0.076
Martinez	2	ROW_12901	ROW Opportunity	3.64	1.75	48%	0.005	0.070
Martinez	2	ROW_20611	ROW Opportunity	5.63	3.27	58%	0.004	0.069
Martinez	2	ROW_2910	ROW Opportunity	0.47	0.34	72%	0.035	0.069
Martinez	2	Parcel_229067	Regional Opportunity	2.22	1.53	69%	0.008	0.068
Martinez	2	ROW_14854	ROW Opportunity	1.55	1.06	68%	0.012	0.067
Martinez	2	ROW_10676	ROW Opportunity	2.73	1.61	59%	0.007	0.065
Martinez	2	ROW_7853	ROW Opportunity	7.02	3.11	44%	0.003	0.064
Martinez	2	ROW_15451	ROW Opportunity	4.14	2.09	50%	0.005	0.062
Martinez	2	ROW_19814	ROW Opportunity	0.70	0.24	34%	0.021	0.062
Martinez	2	ROW_629	ROW Opportunity	5.08	1.83	36%	0.004	0.060
Martinez	2	ROW_12109	ROW Opportunity	0.35	0.24	69%	0.039	0.058
Martinez	2	Parcel_259114	Parcel-Based Opportunity	9.40	2.23	24%	0.002	0.056
Martinez	2	ROW_11811	ROW Opportunity	3.12	1.63	52%	0.005	0.054
Martinez	2	Parcel_256442	Regional Opportunity	1.80	1.30	72%	0.008	0.053
Martinez	2	Parcel_251682	Parcel-Based Opportunity	32.13	8.78	27%	0.001	0.045
Martinez	2	Parcel_256990	Regional Opportunity	1.38	0.32	23%	0.008	0.043
Martinez	2	ROW_6892	ROW Opportunity	1.90	1.20	63%	0.006	0.040
Martinez	2	Parcel_232523	Regional Opportunity	1.40	0.76	54%	0.007	0.039
Martinez	2	ROW_15020	ROW Opportunity	9.04	2.92	32%	0.002	0.039
Martinez	2	ROW_8221	ROW Opportunity	6.16	3.05	50%	0.002	0.039
Martinez	2	ROW_3856	ROW Opportunity	20.44	8.96	44%	0.001	0.034
Martinez	2	ROW_610	ROW Opportunity	15.31	6.60	43%	0.001	0.034
Martinez	2	planned_372	Planned Unlined Bioretention	1.66	0.92	55%	0.006	0.033
Martinez	2	Parcel_256108	Regional Opportunity	0.92	0.73	79%	0.010	0.032
Martinez	2	Parcel_258236	Parcel-Based Opportunity	0.33	0.22	67%	0.024	0.032
Martinez	2	Parcel_222314	Regional Opportunity	1.35	0.61	45%	0.006	0.030
Martinez	2	ROW_6905	ROW Opportunity	1.95	0.94	48%	0.005	0.030
Martinez	2	Parcel_255702	Regional Opportunity	0.92	0.66	72%	0.009	0.029
Martinez	2	Parcel_256354	Regional Opportunity	0.89	0.65	73%	0.009	0.029
Martinez	2	ROW_8871	ROW Opportunity	2.44	1.23	50%	0.004	0.028
Martinez	2	Parcel_256320	Regional Opportunity	0.91	0.61	67%	0.008	0.027
Martinez	2	Parcel_256422	Regional Opportunity	0.76	0.50	66%	0.010	0.027
Martinez	2	ROW_6891	ROW Opportunity	7.35	3.61	49%	0.002	0.027
Martinez	2	Parcel_253376	Regional Opportunity	1.62	0.94	58%	0.005	0.026
Martinez	2	Parcel_254721	Regional Opportunity	1.16	0.53	46%	0.006	0.024
Martinez	2	Parcel_224949	Regional Opportunity	0.86	0.49	57%	0.008	0.023
Martinez	2	Parcel_237827	Regional Opportunity	0.71	0.52	73%	0.009	0.023
Martinez	2	Parcel_253818	Parcel-Based Opportunity	13.01	5.66	44%	0.001	0.023
Martinez	2	Parcel_256502	Parcel-Based Opportunity	0.42	0.31	74%	0.014	0.023
Martinez	2	ROW_7604	ROW Opportunity	2.87	1.45	51%	0.003	0.023
Martinez	2	ROW_14857	ROW Opportunity	17.86	8.48	47%	0.000	0.022
Martinez	2	ROW_20289	ROW Opportunity	7.12	3.17	45%	0.001	0.022
Martinez	2	ROW_7211	ROW Opportunity	6.08	2.85	47%	0.002	0.022
Martinez	2	Parcel_258083	Parcel-Based Opportunity	35.65	4.18	12%	0.000	0.021
Martinez	2	Parcel_243866	Parcel-Based Opportunity	14.00	5.43	39%	0.001	0.020
Martinez	2	ROW_2025	ROW Opportunity	9.51	4.84	51%	0.001	0.020
Martinez	2	Parcel_223914	Regional Opportunity	0.85	0.39	46%	0.006	0.019
Martinez	2	Parcel_258983	Regional Opportunity	122.27	7.70	6%	0.000	0.019
Martinez	2	ROW_14205	ROW Opportunity	6.33	3.34	53%	0.001	0.019
Martinez	2	ROW_20345	ROW Opportunity	5.01	2.30	46%	0.002	0.019
Martinez	2	ROW_9574	ROW Opportunity	1.17	0.62	53%	0.005	0.019
Martinez	2	Parcel_255585	Regional Opportunity	0.57	0.42	74%	0.009	0.018
Martinez	2	ROW_16176	ROW Opportunity	9.36	4.21	45%	0.001	0.018
Martinez	2	ROW_631	ROW Opportunity	3.69	1.73	47%	0.002	0.018
Martinez	2	Parcel_225041	Regional Opportunity	0.74	0.35	47%	0.007	0.017
Martinez	2	ROW_6965	ROW Opportunity	3.36	1.76	52%	0.002	0.017
Martinez	2	ROW_9879	ROW Opportunity	0.73	0.41	56%	0.007	0.017
Martinez	2	Parcel_253606	Parcel-Based Opportunity	0.49	0.36	73%	0.009	0.016
Martinez	2	Parcel_255151	Regional Opportunity	0.55	0.35	64%	0.008	0.016
Martinez	2	planned_376	Planned Unlined Bioretention	0.53	0.37	70%	0.009	0.016
Martinez	2	Parcel_225722	Parcel-Based Opportunity	0.34	0.06	18%	0.011	0.015
Martinez	2	ROW_12471	ROW Opportunity	5.06	2.37	47%	0.001	0.015
Martinez	2	ROW_12911	ROW Opportunity	4.33	2.19	51%	0.002	0.015
Martinez	2	ROW_12492	ROW Opportunity	5.90	2.58	44%	0.001	0.014
Martinez	2	ROW_14285	ROW Opportunity	3.17	1.67	53%	0.002	0.014
Martinez	2	ROW_14410	ROW Opportunity	0.55	0.30	55%	0.007	0.014
Martinez	2	ROW_1464	ROW Opportunity	1.92	0.74	39%	0.003	0.014
Martinez	2	ROW_20556	ROW Opportunity	1.78	0.79	44%	0.003	0.014
Martinez	2	ROW_7828	ROW Opportunity	1.92	0.94	49%	0.003	0.014
Martinez	2	ROW_9180	ROW Opportunity	1.23	0.59	48%	0.004	0.014
Martinez	2	Parcel_255587	Parcel-Based Opportunity	0.37	0.29	78%	0.010	0.013
Martinez	2	ROW_12005	ROW Opportunity	1.77	0.96	54%	0.003	0.013
Martinez	2	ROW_4933	ROW Opportunity	2.81	1.45	52%	0.002	0.013
Martinez	2	Parcel_214775	Parcel-Based Opportunity	9.97	2.81	28%	0.001	0.012

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Martinez	2	Parcel_238844	Parcel-Based Opportunity	14.31	3.94	28%	0.000	0.012
Martinez	2	ROW_14540	ROW Opportunity	0.51	0.25	49%	0.007	0.012
Martinez	2	ROW_15897	ROW Opportunity	3.30	1.73	52%	0.002	0.012
Martinez	2	ROW_20804	ROW Opportunity	4.55	2.34	51%	0.001	0.012
Martinez	2	ROW_4230	ROW Opportunity	1.56	0.52	33%	0.003	0.012
Martinez	2	ROW_6703	ROW Opportunity	0.74	0.43	58%	0.005	0.012
Martinez	2	Parcel_240285	Parcel-Based Opportunity	11.54	3.74	32%	0.000	0.011
Martinez	2	Parcel_252998	Parcel-Based Opportunity	8.29	4.83	58%	0.000	0.011
Martinez	2	Parcel_255494	Parcel-Based Opportunity	0.28	0.25	89%	0.011	0.011
Martinez	2	Parcel_256903	Parcel-Based Opportunity	0.23	0.11	48%	0.013	0.011
Martinez	2	planned_373	Planned Unlined Bioretention	1.59	0.50	31%	0.002	0.011
Martinez	2	ROW_12317	ROW Opportunity	0.64	0.34	53%	0.005	0.011
Martinez	2	ROW_16580	ROW Opportunity	1.80	0.75	42%	0.002	0.011
Martinez	2	ROW_20704	ROW Opportunity	5.72	2.55	45%	0.001	0.011
Martinez	2	Parcel_255781	Parcel-Based Opportunity	0.46	0.23	50%	0.006	0.010
Martinez	2	ROW_19347	ROW Opportunity	0.79	0.42	53%	0.004	0.010
Moraga	2	ROW_17250	ROW Opportunity	11.07	3.64	33%	0.016	0.647
Moraga	2	planned_1316	Planned Unlined Bioretention	2.98	1.05	35%	0.026	0.293
Moraga	2	Parcel_10950	Regional Opportunity	1.14	0.34	30%	0.041	0.185
Moraga	2	Parcel_10961	Regional Opportunity	1.15	0.30	26%	0.037	0.170
Moraga	2	ROW_12878	ROW Opportunity	4.53	1.88	42%	0.008	0.111
Moraga	2	Parcel_26092	Parcel-Based Opportunity	38.99	10.31	26%	0.001	0.106
Moraga	2	ROW_12881	ROW Opportunity	11.85	3.71	31%	0.003	0.072
Moraga	2	Parcel_12163	Parcel-Based Opportunity	43.07	7.49	17%	0.001	0.069
Moraga	2	Parcel_13537	Parcel-Based Opportunity	50.27	8.81	18%	0.000	0.067
Moraga	2	Parcel_7723	Parcel-Based Opportunity	24.01	5.65	24%	0.001	0.056
Moraga	2	ROW_3145	ROW Opportunity	19.33	5.50	28%	0.001	0.049
Moraga	2	ROW_10626	ROW Opportunity	13.66	3.97	29%	0.001	0.041
Moraga	2	ROW_4748	ROW Opportunity	14.73	3.93	27%	0.001	0.041
Moraga	2	ROW_3392	ROW Opportunity	10.09	4.09	41%	0.002	0.032
Moraga	2	Parcel_6384	Parcel-Based Opportunity	9.48	3.19	34%	0.002	0.030
Moraga	2	ROW_19295	ROW Opportunity	9.79	2.99	31%	0.001	0.030
Moraga	2	ROW_15965	ROW Opportunity	9.83	3.12	32%	0.001	0.028
Moraga	2	ROW_16744	ROW Opportunity	10.16	2.83	28%	0.001	0.027
Moraga	2	ROW_16992	ROW Opportunity	8.35	2.44	29%	0.001	0.023
Moraga	2	planned_150	Planned Creek/Marsh Restoration	9.22	0.93	10%	0.001	0.015
Moraga	2	Parcel_12154	Parcel-Based Opportunity	7.49	1.19	16%	0.001	0.013
Moraga	2	ROW_3874	ROW Opportunity	4.29	1.72	40%	0.001	0.013
Moraga	2	Parcel_12566	Parcel-Based Opportunity	19.96	2.68	13%	0.000	0.012
Moraga	2	Parcel_13376	Parcel-Based Opportunity	9.49	0.66	7%	0.001	0.012
Moraga	2	Parcel_13461	Parcel-Based Opportunity	4.70	1.31	28%	0.001	0.012
Moraga	2	ROW_20532	ROW Opportunity	3.80	1.22	32%	0.002	0.012
Moraga	2	ROW_5547	ROW Opportunity	4.78	1.26	26%	0.001	0.012
Moraga	2	ROW_5710	ROW Opportunity	4.70	1.16	25%	0.001	0.012
Moraga	2	Parcel_9225	Parcel-Based Opportunity	6.43	1.25	19%	0.001	0.011
Moraga	2	ROW_20599	ROW Opportunity	3.96	1.17	30%	0.001	0.011
Moraga	2	ROW_3147	ROW Opportunity	3.36	1.24	37%	0.002	0.011
Moraga	2	Parcel_3748	Parcel-Based Opportunity	8.12	0.56	7%	0.001	0.010
Moraga	2	ROW_12598	ROW Opportunity	3.52	1.17	33%	0.001	0.010
Orinda	2	ROW_21614	ROW Opportunity	31.32	10.62	34%	0.002	0.104
Orinda	2	Parcel_44823	Parcel-Based Opportunity	16.20	4.76	29%	0.001	0.046
Orinda	2	Parcel_46205	Parcel-Based Opportunity	22.26	2.96	13%	0.001	0.041
Orinda	2	ROW_9556	ROW Opportunity	15.77	2.91	18%	0.001	0.034
Orinda	2	Parcel_13835	Parcel-Based Opportunity	11.63	3.16	27%	0.001	0.030
Orinda	2	Parcel_49552	Parcel-Based Opportunity	28.42	2.67	9%	0.000	0.029
Orinda	2	Parcel_29088	Parcel-Based Opportunity	6.41	1.86	29%	0.001	0.018
Orinda	2	ROW_1107	ROW Opportunity	7.07	1.26	18%	0.001	0.018
Orinda	2	ROW_11198	ROW Opportunity	11.30	1.45	13%	0.001	0.018
Orinda	2	ROW_19957	ROW Opportunity	9.06	1.12	12%	0.001	0.017
Orinda	2	ROW_9077	ROW Opportunity	7.88	1.15	15%	0.001	0.017
Orinda	2	ROW_4721	ROW Opportunity	6.01	1.19	20%	0.001	0.015
Orinda	2	Parcel_47119	Parcel-Based Opportunity	10.58	0.76	7%	0.001	0.014
Orinda	2	Parcel_36062	Parcel-Based Opportunity	3.19	1.35	42%	0.002	0.013
Orinda	2	ROW_7202	ROW Opportunity	5.07	0.93	18%	0.001	0.011
Pinole	2	Parcel_254723	Parcel-Based Opportunity	4.41	2.14	49%	0.030	0.532
Pinole	2	ROW_16912	ROW Opportunity	10.96	5.87	54%	0.008	0.283
Pinole	2	ROW_19218	ROW Opportunity	7.85	3.87	49%	0.006	0.158
Pinole	2	ROW_14911	ROW Opportunity	4.68	2.63	56%	0.009	0.147
Pinole	2	ROW_14916	ROW Opportunity	9.85	4.50	46%	0.005	0.141
Pinole	2	ROW_20585	ROW Opportunity	1.13	0.71	63%	0.027	0.122
Pinole	2	ROW_1018	ROW Opportunity	2.13	1.30	61%	0.008	0.059
Pinole	2	ROW_15540	ROW Opportunity	8.95	3.99	45%	0.003	0.059
Pinole	2	Parcel_230897	Regional Opportunity	2.72	1.22	45%	0.006	0.056
Pinole	2	ROW_15484	ROW Opportunity	0.95	0.39	41%	0.014	0.052
Pinole	2	ROW_18207	ROW Opportunity	0.78	0.47	60%	0.017	0.050
Pinole	2	ROW_14605	ROW Opportunity	2.38	1.39	58%	0.006	0.047
Pinole	2	Parcel_230869	Regional Opportunity	1.51	0.94	62%	0.009	0.044
Pinole	2	Parcel_232274	Parcel-Based Opportunity	22.08	9.87	45%	0.001	0.040
Pinole	2	ROW_6874	ROW Opportunity	9.82	4.43	45%	0.002	0.038
Pinole	2	ROW_7727	ROW Opportunity	0.61	0.33	54%	0.014	0.033
Pinole	2	Parcel_221780	Regional Opportunity	3.09	1.00	32%	0.003	0.032
Pinole	2	ROW_7150	ROW Opportunity	2.17	1.19	55%	0.005	0.030
Pinole	2	Parcel_245647	Regional Opportunity	0.88	0.67	76%	0.010	0.029
Pinole	2	Parcel_247794	Parcel-Based Opportunity	0.30	0.08	27%	0.019	0.023
Pinole	2	Parcel_245383	Regional Opportunity	0.65	0.49	75%	0.010	0.022
Pinole	2	ROW_12194	ROW Opportunity	3.86	1.94	50%	0.002	0.022
Pinole	2	ROW_3363	ROW Opportunity	5.11	2.55	50%	0.002	0.022
Pinole	2	ROW_5887	ROW Opportunity	13.54	5.22	39%	0.001	0.022
Pinole	2	ROW_5599	ROW Opportunity	1.98	1.15	58%	0.004	0.021
Pinole	2	Parcel_243023	Parcel-Based Opportunity	9.49	5.01	53%	0.001	0.020
Pinole	2	ROW_15034	ROW Opportunity	1.70	0.94	55%	0.004	0.020
Pinole	2	ROW_13497	ROW Opportunity	6.04	3.06	51%	0.001	0.019
Pinole	2	ROW_17159	ROW Opportunity	7.51	3.24	43%	0.001	0.019
Pinole	2	Parcel_219618	Parcel-Based Opportunity	13.15	4.37	33%	0.001	0.018

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Pinole	2	Parcel_247475	Parcel-Based Opportunity	0.12	0.08	67%	0.038	0.018
Pinole	2	ROW_5886	ROW Opportunity	4.30	2.40	56%	0.002	0.018
Pinole	2	ROW_1742	ROW Opportunity	4.13	1.95	47%	0.002	0.017
Pinole	2	ROW_11596	ROW Opportunity	0.67	0.39	58%	0.007	0.016
Pinole	2	ROW_15440	ROW Opportunity	1.90	0.96	51%	0.003	0.016
Pinole	2	ROW_4012	ROW Opportunity	1.39	0.72	52%	0.004	0.016
Pinole	2	ROW_306	ROW Opportunity	1.68	0.94	56%	0.003	0.015
Pinole	2	ROW_1017	ROW Opportunity	0.97	0.42	43%	0.005	0.014
Pinole	2	ROW_13999	ROW Opportunity	0.44	0.22	50%	0.009	0.014
Pinole	2	ROW_293	ROW Opportunity	2.06	1.13	55%	0.003	0.014
Pinole	2	ROW_15441	ROW Opportunity	0.57	0.38	67%	0.007	0.013
Pinole	2	ROW_15478	ROW Opportunity	1.37	0.77	56%	0.003	0.013
Pinole	2	ROW_16159	ROW Opportunity	1.46	0.86	59%	0.003	0.013
Pinole	2	Parcel_244914	Parcel-Based Opportunity	0.42	0.28	67%	0.009	0.012
Pinole	2	Parcel_249339	Regional Opportunity	0.52	0.26	50%	0.007	0.012
Pinole	2	ROW_14913	ROW Opportunity	3.64	1.88	52%	0.002	0.012
Pinole	2	ROW_16077	ROW Opportunity	1.72	0.80	47%	0.003	0.012
Pinole	2	ROW_7141	ROW Opportunity	1.41	0.78	55%	0.003	0.012
Pinole	2	ROW_1021	ROW Opportunity	1.11	0.49	44%	0.003	0.011
Pinole	2	ROW_14440	ROW Opportunity	1.13	0.42	37%	0.003	0.011
Pinole	2	ROW_4571	ROW Opportunity	5.72	2.53	44%	0.001	0.011
Pinole	2	Parcel_246543	Parcel-Based Opportunity	0.40	0.23	58%	0.008	0.010
Pinole	2	Parcel_249605	Parcel-Based Opportunity	4.61	0.72	16%	0.001	0.010
Pinole	2	ROW_646	ROW Opportunity	4.57	2.48	54%	0.001	0.010
Pittsburg	2	Parcel_352273	Parcel-Based Opportunity	22.24	7.16	32%	0.020	1.973
Pittsburg	2	ROW_6199	ROW Opportunity	17.07	9.41	55%	0.023	1.681
Pittsburg	2	ROW_13238	ROW Opportunity	17.62	9.84	56%	0.016	1.119
Pittsburg	2	ROW_11361	ROW Opportunity	11.26	7.09	63%	0.019	0.890
Pittsburg	2	ROW_7663	ROW Opportunity	8.79	5.55	63%	0.024	0.887
Pittsburg	2	ROW_4315	ROW Opportunity	3.78	2.84	75%	0.040	0.661
Pittsburg	2	ROW_14954	ROW Opportunity	7.36	4.19	57%	0.020	0.642
Pittsburg	2	ROW_2265	ROW Opportunity	3.43	2.47	72%	0.038	0.568
Pittsburg	2	ROW_14958	ROW Opportunity	4.91	3.47	71%	0.026	0.548
Pittsburg	2	Parcel_366531	Parcel-Based Opportunity	6.87	2.53	37%	0.015	0.449
Pittsburg	2	ROW_14798	ROW Opportunity	3.48	2.15	62%	0.028	0.412
Pittsburg	2	ROW_1954	ROW Opportunity	2.50	1.71	68%	0.037	0.401
Pittsburg	2	ROW_11359	ROW Opportunity	13.31	7.75	58%	0.007	0.342
Pittsburg	2	ROW_3090	ROW Opportunity	5.95	3.72	63%	0.014	0.342
Pittsburg	2	Parcel_356238	Parcel-Based Opportunity	10.36	3.44	33%	0.008	0.326
Pittsburg	2	ROW_7525	ROW Opportunity	2.93	1.85	63%	0.026	0.326
Pittsburg	2	Parcel_350839	Parcel-Based Opportunity	14.33	6.63	46%	0.006	0.316
Pittsburg	2	ROW_6215	ROW Opportunity	2.16	1.40	65%	0.033	0.310
Pittsburg	2	ROW_6741	ROW Opportunity	2.05	1.30	63%	0.034	0.304
Pittsburg	2	ROW_9457	ROW Opportunity	1.88	1.26	67%	0.036	0.296
Pittsburg	2	ROW_17711	ROW Opportunity	1.60	1.28	80%	0.042	0.292
Pittsburg	2	ROW_7526	ROW Opportunity	5.46	3.95	72%	0.013	0.279
Pittsburg	2	ROW_8562	ROW Opportunity	2.35	1.45	62%	0.027	0.275
Pittsburg	2	ROW_20368	ROW Opportunity	6.68	4.19	63%	0.010	0.251
Pittsburg	2	Parcel_367743	Regional Opportunity	2.24	1.01	45%	0.025	0.247
Pittsburg	2	ROW_8561	ROW Opportunity	7.93	4.62	58%	0.008	0.236
Pittsburg	2	ROW_1955	ROW Opportunity	1.47	0.99	67%	0.036	0.231
Pittsburg	2	ROW_6257	ROW Opportunity	21.27	11.80	55%	0.003	0.231
Pittsburg	2	ROW_21116	ROW Opportunity	8.88	4.83	54%	0.007	0.228
Pittsburg	2	ROW_6280	ROW Opportunity	5.74	3.46	60%	0.010	0.227
Pittsburg	2	ROW_11974	ROW Opportunity	1.43	0.96	67%	0.036	0.226
Pittsburg	2	ROW_8563	ROW Opportunity	12.59	7.66	61%	0.005	0.220
Pittsburg	2	ROW_9582	ROW Opportunity	2.15	1.25	58%	0.023	0.212
Pittsburg	2	Parcel_349390	Parcel-Based Opportunity	6.79	4.68	69%	0.008	0.207
Pittsburg	2	ROW_6226	ROW Opportunity	4.40	2.71	62%	0.011	0.194
Pittsburg	2	ROW_7859	ROW Opportunity	7.77	4.29	55%	0.007	0.191
Pittsburg	2	ROW_6505	ROW Opportunity	3.76	2.13	57%	0.011	0.170
Pittsburg	2	ROW_15499	ROW Opportunity	1.44	1.06	74%	0.027	0.169
Pittsburg	2	ROW_18481	ROW Opportunity	1.15	0.71	62%	0.033	0.166
Pittsburg	2	ROW_3328	ROW Opportunity	1.31	0.78	60%	0.029	0.165
Pittsburg	2	ROW_3327	ROW Opportunity	1.14	0.65	57%	0.031	0.154
Pittsburg	2	Parcel_363475	Parcel-Based Opportunity	7.77	3.26	42%	0.005	0.150
Pittsburg	2	ROW_8520	ROW Opportunity	3.06	1.75	57%	0.011	0.135
Pittsburg	2	ROW_11360	ROW Opportunity	7.80	4.64	59%	0.005	0.133
Pittsburg	2	ROW_6737	ROW Opportunity	0.93	0.57	61%	0.033	0.133
Pittsburg	2	ROW_20440	ROW Opportunity	1.02	0.53	52%	0.028	0.126
Pittsburg	2	ROW_2855	ROW Opportunity	24.34	12.97	53%	0.002	0.117
Pittsburg	2	ROW_6736	ROW Opportunity	0.84	0.50	60%	0.032	0.117
Pittsburg	2	ROW_6237	ROW Opportunity	2.47	1.38	56%	0.011	0.110
Pittsburg	2	Parcel_362143	Regional Opportunity	0.99	0.41	41%	0.026	0.109
Pittsburg	2	ROW_4561	ROW Opportunity	4.16	2.43	58%	0.007	0.108
Pittsburg	2	ROW_18479	ROW Opportunity	0.76	0.45	59%	0.032	0.106
Pittsburg	2	Parcel_373150	Parcel-Based Opportunity	5.22	2.26	43%	0.005	0.103
Pittsburg	2	ROW_15210	ROW Opportunity	11.75	7.22	61%	0.003	0.093
Pittsburg	2	Parcel_367785	Regional Opportunity	1.98	1.79	90%	0.011	0.078
Pittsburg	2	ROW_21076	ROW Opportunity	0.54	0.34	63%	0.033	0.078
Pittsburg	2	ROW_3879	ROW Opportunity	7.88	4.73	60%	0.003	0.075
Pittsburg	2	ROW_8564	ROW Opportunity	9.90	5.38	54%	0.003	0.074
Pittsburg	2	Parcel_361465	Parcel-Based Opportunity	9.00	2.11	23%	0.002	0.072
Pittsburg	2	ROW_5091	ROW Opportunity	19.64	10.50	53%	0.001	0.072
Pittsburg	2	ROW_20894	ROW Opportunity	1.00	0.63	63%	0.017	0.071
Pittsburg	2	ROW_11324	ROW Opportunity	1.53	1.00	65%	0.012	0.070
Pittsburg	2	ROW_17896	ROW Opportunity	0.57	0.34	60%	0.028	0.070
Pittsburg	2	ROW_9581	ROW Opportunity	1.45	0.88	61%	0.012	0.070
Pittsburg	2	Parcel_362407	Regional Opportunity	2.93	1.49	51%	0.006	0.068
Pittsburg	2	ROW_1336	ROW Opportunity	3.78	2.22	59%	0.005	0.068
Pittsburg	2	Parcel_371128	Parcel-Based Opportunity	14.11	3.86	27%	0.002	0.067
Pittsburg	2	Parcel_362118	Regional Opportunity	2.29	1.41	62%	0.008	0.063
Pittsburg	2	ROW_7571	ROW Opportunity	10.34	5.77	56%	0.002	0.063
Pittsburg	2	ROW_15487	ROW Opportunity	2.36	1.45	61%	0.007	0.062

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Pittsburg	2	ROW_6193	ROW Opportunity	3.97	2.52	63%	0.005	0.060
Pittsburg	2	Parcel_362980	Parcel-Based Opportunity	29.43	14.40	49%	0.001	0.058
Pittsburg	2	ROW_1284	ROW Opportunity	0.36	0.25	69%	0.036	0.057
Pittsburg	2	ROW_5206	ROW Opportunity	3.75	2.42	65%	0.005	0.057
Pittsburg	2	ROW_15053	ROW Opportunity	2.48	1.28	52%	0.006	0.055
Pittsburg	2	Parcel_374906	Parcel-Based Opportunity	6.68	4.37	65%	0.003	0.054
Pittsburg	2	ROW_18482	ROW Opportunity	0.42	0.22	52%	0.029	0.054
Pittsburg	2	Parcel_356104	Regional Opportunity	2.28	1.53	67%	0.007	0.053
Pittsburg	2	Parcel_370086	Regional Opportunity	1.37	1.18	86%	0.010	0.052
Pittsburg	2	ROW_6195	ROW Opportunity	6.47	3.95	61%	0.003	0.052
Pittsburg	2	Parcel_362426	Regional Opportunity	1.89	1.15	61%	0.007	0.051
Pittsburg	2	ROW_434	ROW Opportunity	0.36	0.23	64%	0.033	0.051
Pittsburg	2	ROW_11734	ROW Opportunity	3.49	2.06	59%	0.004	0.050
Pittsburg	2	Parcel_358872	Regional Opportunity	1.52	1.10	72%	0.009	0.048
Pittsburg	2	ROW_17448	ROW Opportunity	2.84	1.45	51%	0.005	0.047
Pittsburg	2	ROW_3086	ROW Opportunity	0.45	0.29	64%	0.023	0.045
Pittsburg	2	Parcel_363463	Regional Opportunity	2.26	0.96	42%	0.005	0.044
Pittsburg	2	ROW_16768	ROW Opportunity	0.36	0.19	53%	0.028	0.044
Pittsburg	2	Parcel_363309	Parcel-Based Opportunity	6.78	2.01	30%	0.002	0.043
Pittsburg	2	ROW_810	ROW Opportunity	0.26	0.18	69%	0.037	0.043
Pittsburg	2	Parcel_371346	Parcel-Based Opportunity	0.24	0.18	75%	0.039	0.041
Pittsburg	2	ROW_5831	ROW Opportunity	3.02	1.89	63%	0.004	0.041
Pittsburg	2	ROW_6214	ROW Opportunity	3.42	2.08	61%	0.004	0.041
Pittsburg	2	ROW_5428	ROW Opportunity	4.76	2.60	55%	0.003	0.037
Pittsburg	2	ROW_6228	ROW Opportunity	4.44	2.89	65%	0.003	0.037
Pittsburg	2	ROW_11833	ROW Opportunity	3.89	2.24	58%	0.003	0.036
Pittsburg	2	ROW_762	ROW Opportunity	6.64	3.55	53%	0.002	0.036
Pittsburg	2	Parcel_372570	Regional Opportunity	1.35	0.77	57%	0.007	0.035
Pittsburg	2	ROW_18594	ROW Opportunity	8.91	5.04	57%	0.002	0.035
Pittsburg	2	Parcel_374691	Parcel-Based Opportunity	11.06	5.22	47%	0.001	0.034
Pittsburg	2	ROW_18048	ROW Opportunity	4.41	2.71	61%	0.003	0.034
Pittsburg	2	Parcel_368250	Parcel-Based Opportunity	0.32	0.18	56%	0.024	0.033
Pittsburg	2	ROW_1733	ROW Opportunity	1.96	0.93	47%	0.005	0.033
Pittsburg	2	Parcel_348794	Parcel-Based Opportunity	20.29	7.64	38%	0.001	0.032
Pittsburg	2	ROW_2115	ROW Opportunity	1.76	0.97	55%	0.005	0.032
Pittsburg	2	ROW_17251	ROW Opportunity	8.95	5.16	58%	0.001	0.031
Pittsburg	2	ROW_394	ROW Opportunity	1.85	1.05	57%	0.005	0.031
Pittsburg	2	ROW_15726	ROW Opportunity	3.11	1.83	59%	0.003	0.030
Pittsburg	2	ROW_21525	ROW Opportunity	5.44	2.94	54%	0.002	0.030
Pittsburg	2	ROW_20465	ROW Opportunity	38.58	20.17	52%	0.000	0.029
Pittsburg	2	Parcel_361545	Parcel-Based Opportunity	18.57	6.68	36%	0.001	0.028
Pittsburg	2	ROW_14014	ROW Opportunity	1.80	0.94	52%	0.005	0.028
Pittsburg	2	ROW_15496	ROW Opportunity	2.11	1.33	63%	0.004	0.028
Pittsburg	2	ROW_3866	ROW Opportunity	1.39	0.66	47%	0.006	0.028
Pittsburg	2	ROW_6218	ROW Opportunity	1.32	0.86	65%	0.006	0.028
Pittsburg	2	Parcel_351544	Parcel-Based Opportunity	13.19	6.68	51%	0.001	0.027
Pittsburg	2	Parcel_358992	Parcel-Based Opportunity	3.66	2.32	63%	0.003	0.027
Pittsburg	2	Parcel_374956	Parcel-Based Opportunity	7.22	2.76	38%	0.002	0.027
Pittsburg	2	ROW_2172	ROW Opportunity	3.63	2.26	62%	0.003	0.027
Pittsburg	2	ROW_1734	ROW Opportunity	4.43	2.52	57%	0.002	0.026
Pittsburg	2	ROW_20003	ROW Opportunity	12.36	6.63	54%	0.001	0.026
Pittsburg	2	Parcel_342146	Parcel-Based Opportunity	12.50	6.01	48%	0.001	0.025
Pittsburg	2	ROW_6217	ROW Opportunity	1.01	0.70	69%	0.007	0.025
Pittsburg	2	Parcel_348459	Parcel-Based Opportunity	12.96	5.96	46%	0.001	0.024
Pittsburg	2	Parcel_372876	Regional Opportunity	1.32	0.53	40%	0.005	0.024
Pittsburg	2	Parcel_373402	Regional Opportunity	1.03	0.53	51%	0.006	0.024
Pittsburg	2	ROW_11064	ROW Opportunity	3.96	2.19	55%	0.002	0.024
Pittsburg	2	ROW_14856	ROW Opportunity	3.11	1.80	58%	0.002	0.024
Pittsburg	2	ROW_16225	ROW Opportunity	4.64	2.66	57%	0.002	0.024
Pittsburg	2	ROW_20398	ROW Opportunity	0.77	0.43	56%	0.008	0.024
Pittsburg	2	Parcel_352244	Parcel-Based Opportunity	10.05	5.65	56%	0.001	0.023
Pittsburg	2	Parcel_362344	Parcel-Based Opportunity	14.44	5.98	41%	0.001	0.023
Pittsburg	2	ROW_11358	ROW Opportunity	1.06	0.49	46%	0.006	0.023
Pittsburg	2	ROW_11872	ROW Opportunity	2.97	1.69	57%	0.003	0.023
Pittsburg	2	ROW_12501	ROW Opportunity	4.54	2.65	58%	0.002	0.023
Pittsburg	2	ROW_20394	ROW Opportunity	1.63	0.97	60%	0.004	0.023
Pittsburg	2	ROW_20627	ROW Opportunity	4.36	2.57	59%	0.002	0.023
Pittsburg	2	ROW_2826	ROW Opportunity	4.45	2.57	58%	0.002	0.023
Pittsburg	2	ROW_4032	ROW Opportunity	2.50	1.16	46%	0.003	0.023
Pittsburg	2	ROW_6219	ROW Opportunity	1.46	0.92	63%	0.005	0.023
Pittsburg	2	Parcel_366285	Parcel-Based Opportunity	26.81	4.81	18%	0.000	0.022
Pittsburg	2	ROW_894	ROW Opportunity	4.26	2.49	58%	0.002	0.022
Pittsburg	2	Parcel_336890	Parcel-Based Opportunity	9.19	5.25	57%	0.001	0.021
Pittsburg	2	Parcel_357792	Regional Opportunity	1.23	1.04	85%	0.006	0.021
Pittsburg	2	ROW_11969	ROW Opportunity	0.49	0.26	53%	0.011	0.021
Pittsburg	2	ROW_14500	ROW Opportunity	0.21	0.12	57%	0.024	0.021
Pittsburg	2	ROW_6695	ROW Opportunity	1.68	0.92	55%	0.004	0.021
Pittsburg	2	Parcel_355971	Parcel-Based Opportunity	0.38	0.12	32%	0.012	0.020
Pittsburg	2	Parcel_364979	Parcel-Based Opportunity	10.21	5.56	54%	0.001	0.020
Pittsburg	2	Parcel_367368	Parcel-Based Opportunity	11.66	4.87	42%	0.001	0.020
Pittsburg	2	Parcel_372224	Regional Opportunity	0.54	0.37	69%	0.010	0.020
Pittsburg	2	ROW_12237	ROW Opportunity	8.69	4.66	54%	0.001	0.020
Pittsburg	2	ROW_1520	ROW Opportunity	2.90	1.59	55%	0.002	0.019
Pittsburg	2	ROW_3686	ROW Opportunity	2.00	0.51	26%	0.003	0.019
Pittsburg	2	ROW_6221	ROW Opportunity	1.24	0.79	64%	0.005	0.019
Pittsburg	2	ROW_8940	ROW Opportunity	6.24	4.08	65%	0.001	0.019
Pittsburg	2	ROW_14011	ROW Opportunity	0.79	0.44	56%	0.006	0.018
Pittsburg	2	ROW_20795	ROW Opportunity	3.72	2.00	54%	0.002	0.018
Pittsburg	2	ROW_5463	ROW Opportunity	0.90	0.54	60%	0.006	0.018
Pittsburg	2	ROW_6045	ROW Opportunity	0.75	0.42	56%	0.007	0.018
Pittsburg	2	ROW_6805	ROW Opportunity	0.65	0.36	55%	0.008	0.018
Pittsburg	2	Parcel_348698	Regional Opportunity	0.48	0.40	83%	0.010	0.017
Pittsburg	2	Parcel_372393	Regional Opportunity	0.60	0.37	62%	0.008	0.017
Pittsburg	2	Parcel_374571	Regional Opportunity	0.54	0.38	70%	0.009	0.017

Jurisdiction	Permit	Project ID	Project Type	Area (Acres)	Impervious Area (Acres)	Percent Impervious	PCBs Yield (g/acre)	PCBs Mass reduced (g)
Pittsburg	2	ROW_11603	ROW Opportunity	1.42	0.34	24%	0.003	0.017
Pittsburg	2	ROW_14658	ROW Opportunity	5.25	3.04	58%	0.001	0.017
Pittsburg	2	ROW_20383	ROW Opportunity	5.64	3.31	59%	0.001	0.017
Pittsburg	2	ROW_21083	ROW Opportunity	7.55	4.13	55%	0.001	0.017
Pittsburg	2	ROW_4764	ROW Opportunity	1.16	0.71	61%	0.005	0.017
Pittsburg	2	ROW_5824	ROW Opportunity	2.16	1.07	50%	0.003	0.017
Pittsburg	2	Parcel_359451	Parcel-Based Opportunity	11.40	4.60	40%	0.001	0.016
Pittsburg	2	Parcel_364198	Parcel-Based Opportunity	10.22	3.89	38%	0.001	0.016
Pittsburg	2	ROW_11370	ROW Opportunity	0.33	0.21	64%	0.013	0.016
Pittsburg	2	ROW_17388	ROW Opportunity	1.59	0.88	55%	0.003	0.016
Pittsburg	2	ROW_5853	ROW Opportunity	1.28	0.74	58%	0.004	0.016
Pittsburg	2	ROW_6194	ROW Opportunity	2.19	1.29	59%	0.002	0.016
Pittsburg	2	ROW_6238	ROW Opportunity	0.61	0.36	59%	0.007	0.016
Pittsburg	2	Parcel_349343	Regional Opportunity	1.12	0.32	29%	0.004	0.015
Pittsburg	2	ROW_13380	ROW Opportunity	0.48	0.23	48%	0.008	0.015
Pittsburg	2	ROW_17358	ROW Opportunity	6.93	3.73	54%	0.001	0.015
Pittsburg	2	ROW_3583	ROW Opportunity	6.04	3.35	55%	0.001	0.015
Pittsburg	2	ROW_6223	ROW Opportunity	2.68	1.66	62%	0.002	0.015
Pittsburg	2	ROW_9712	ROW Opportunity	6.85	3.87	56%	0.001	0.015
Pittsburg	2	ROW_9726	ROW Opportunity	6.75	3.66	54%	0.001	0.015
Pittsburg	2	Parcel_368854	Parcel-Based Opportunity	0.36	0.31	86%	0.011	0.014
Pittsburg	2	ROW_11832	ROW Opportunity	1.52	0.86	57%	0.003	0.014
Pittsburg	2	ROW_11900	ROW Opportunity	3.22	1.71	53%	0.002	0.014
Pittsburg	2	ROW_17755	ROW Opportunity	3.00	1.60	53%	0.002	0.014
Pittsburg	2	Parcel_351110	Parcel-Based Opportunity	107.94	43.80	41%	0.000	0.013
Pittsburg	2	Parcel_358978	Parcel-Based Opportunity	0.25	0.18	72%	0.013	0.013
Pittsburg	2	Parcel_361603	Parcel-Based Opportunity	0.48	0.31	65%	0.008	0.013
Pittsburg	2	Parcel_371237	Parcel-Based Opportunity	0.43	0.30	70%	0.009	0.013
Pittsburg	2	planned_431	Planned Unlined Bioretention	0.48	0.31	65%	0.008	0.013
Pittsburg	2	ROW_11357	ROW Opportunity	3.17	1.95	62%	0.002	0.013
Pittsburg	2	ROW_12433	ROW Opportunity	6.02	3.27	54%	0.001	0.013
Pittsburg	2	ROW_1329	ROW Opportunity	8.23	4.37	53%	0.001	0.013
Pittsburg	2	Parcel_372099	Parcel-Based Opportunity	0.41	0.26	63%	0.008	0.012
Pittsburg	2	ROW_10175	ROW Opportunity	6.76	3.47	51%	0.001	0.012
Pittsburg	2	ROW_12638	ROW Opportunity	0.12	0.07	58%	0.025	0.012
Pittsburg	2	ROW_15237	ROW Opportunity	2.52	1.28	51%	0.002	0.012
Pittsburg	2	ROW_20371	ROW Opportunity	5.02	3.02	60%	0.001	0.012
Pittsburg	2	ROW_20402	ROW Opportunity	3.81	2.21	58%	0.001	0.012
Pittsburg	2	ROW_20411	ROW Opportunity	4.81	2.95	61%	0.001	0.012
Pittsburg	2	ROW_20801	ROW Opportunity	3.20	1.94	61%	0.002	0.012
Pittsburg	2	ROW_5843	ROW Opportunity	5.08	3.01	59%	0.001	0.012
Pittsburg	2	ROW_6299	ROW Opportunity	5.53	2.99	54%	0.001	0.012
Pittsburg	2	ROW_6474	ROW Opportunity	3.61	1.94	54%	0.001	0.012
Pittsburg	2	Parcel_353346	Parcel-Based Opportunity	7.56	2.47	33%	0.001	0.011
Pittsburg	2	ROW_1196	ROW Opportunity	1.56	0.85	54%	0.002	0.011
Pittsburg	2	ROW_14319	ROW Opportunity	5.30	2.79	53%	0.001	0.011
Pittsburg	2	ROW_15497	ROW Opportunity	0.90	0.77	86%	0.004	0.011
Pittsburg	2	ROW_16028	ROW Opportunity	5.20	2.77	53%	0.001	0.011
Pittsburg	2	ROW_20374	ROW Opportunity	3.94	2.27	58%	0.001	0.011
Pittsburg	2	ROW_2952	ROW Opportunity	5.23	2.80	54%	0.001	0.011
Pittsburg	2	ROW_9735	ROW Opportunity	4.76	2.79	59%	0.001	0.011
Pleasant Hill	2	ROW_19233	ROW Opportunity	2.08	1.67	80%	0.043	0.382
Pleasant Hill	2	ROW_4670	ROW Opportunity	17.32	8.32	48%	0.005	0.280
Pleasant Hill	2	ROW_19166	ROW Opportunity	30.21	13.52	45%	0.003	0.239
Pleasant Hill	2	Parcel_198405	Parcel-Based Opportunity	96.46	48.68	50%	0.001	0.203
Pleasant Hill	2	Parcel_181521	Parcel-Based Opportunity	9.56	4.74	50%	0.006	0.193
Pleasant Hill	2	ROW_2970	ROW Opportunity	9.37	5.99	64%	0.006	0.181
Pleasant Hill	2	ROW_9267	ROW Opportunity	3.51	1.89	54%	0.012	0.170
Pleasant Hill	2	ROW_20243	ROW Opportunity	2.99	1.93	65%	0.013	0.148
Pleasant Hill	2	ROW_8317	ROW Opportunity	12.17	5.45	45%	0.003	0.111
Pleasant Hill	2	ROW_15010	ROW Opportunity	21.53	8.73	41%	0.002	0.110
Pleasant Hill	2	ROW_12076	ROW Opportunity	2.39	1.40	59%	0.012	0.106
Pleasant Hill	2	ROW_4673	ROW Opportunity	4.72	2.27	48%	0.006	0.103
Pleasant Hill	2	Parcel_150985	Regional Opportunity	0.77	0.41	53%	0.030	0.098
Pleasant Hill	2	ROW_4671	ROW Opportunity	5.14	2.67	52%	0.006	0.098
Pleasant Hill	2	Parcel_161733	Parcel-Based Opportunity	3.53	2.11	60%	0.008	0.094
Pleasant Hill	2	Parcel_142700	Parcel-Based Opportunity	3.60	2.10	58%	0.007	0.093
Pleasant Hill	2	ROW_17670	ROW Opportunity	6.18	3.50	57%	0.004	0.084
Pleasant Hill	2	ROW_5047	ROW Opportunity	3.17	1.88	59%	0.007	0.084
Pleasant Hill	2	Parcel_186000	Parcel-Based Opportunity	4.15	1.73	42%	0.005	0.079
Pleasant Hill	2	ROW_13734	ROW Opportunity	8.72	3.90	45%	0.003	0.079
Pleasant Hill	2	Parcel_185324	Parcel-Based Opportunity	4.04	1.69	42%	0.005	0.077
Pleasant Hill	2	ROW_12853	ROW Opportunity	4.72	2.76	58%	0.005	0.072
Pleasant Hill	2	ROW_2494	ROW Opportunity	14.34	6.19	43%	0.002	0.072
Pleasant Hill	2	ROW_6872	ROW Opportunity	1.64	0.99	60%	0.012	0.072
Pleasant Hill	2	ROW_6671	ROW Opportunity	3.95	1.92	49%	0.005	0.067
Pleasant Hill	2	ROW_13220	ROW Opportunity	3.76	2.25	60%	0.005	0.062
Pleasant Hill	2	Parcel_189822	Parcel-Based Opportunity	26.23	15.34	58%	0.001	0.061
Pleasant Hill	2	ROW_4672	ROW Opportunity	2.09	1.06	51%	0.008	0.060
Pleasant Hill	2	Parcel_173214	Regional Opportunity	2.92	1.24	42%	0.006	0.059
Pleasant Hill	2	ROW_4280	ROW Opportunity	2.43	1.23	51%	0.007	0.058
Pleasant Hill	2	ROW_4377	ROW Opportunity	9.02	4.33	48%	0.002	0.056
Pleasant Hill	2	ROW_5054	ROW Opportunity	2.66	1.53	58%	0.006	0.055
Pleasant Hill	2	planned_143	Planned Water Quality Basin	38.26	17.06	45%	0.001	0.054
Pleasant Hill	2	Parcel_146724	Parcel-Based Opportunity	30.26	12.96	43%	0.001	0.053
Pleasant Hill	2	Parcel_155831	Regional Opportunity	1.32	1.23	93%	0.011	0.053
Pleasant Hill	2	ROW_4886	ROW Opportunity	2.01	1.26	63%	0.007	0.048
Pleasant Hill	2	ROW_19602	ROW Opportunity	1.97	1.24	63%	0.007	0.047
Pleasant Hill	2	ROW_8079	ROW Opportunity	14.00	3.93	28%	0.001	0.045
Pleasant Hill	2	ROW_8193	ROW Opportunity	9.91	3.96	40%	0.002	0.045
Pleasant Hill	2	ROW_13735	ROW Opportunity	2.08	1.04	50%	0.006	0.040
Pleasant Hill	2	Parcel_142400	Regional Opportunity	1.85	0.83	45%	0.006	0.039
Pleasant Hill	2	ROW_13554	ROW Opportunity	6.29	2.86	45%	0.002	0.039
Pleasant Hill	2	Parcel_185980	Regional Opportunity	1.25	0.79	63%	0.008	0.035

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Pleasant Hill	2	ROW_14564	ROW Opportunity	7.82	3.13	40%	0.002	0.035
Pleasant Hill	2	Parcel_131105	Regional Opportunity	1.45	0.72	50%	0.007	0.034
Pleasant Hill	2	ROW_17048	ROW Opportunity	1.65	0.76	46%	0.006	0.034
Pleasant Hill	2	ROW_7753	ROW Opportunity	3.18	1.28	40%	0.003	0.034
Pleasant Hill	2	ROW_9560	ROW Opportunity	0.50	0.19	38%	0.017	0.034
Pleasant Hill	2	Parcel_185990	Regional Opportunity	1.68	0.71	42%	0.005	0.032
Pleasant Hill	2	ROW_11390	ROW Opportunity	7.82	3.29	42%	0.002	0.031
Pleasant Hill	2	ROW_9880	ROW Opportunity	3.49	1.47	42%	0.003	0.029
Pleasant Hill	2	Parcel_156974	Parcel-Based Opportunity	9.89	3.33	34%	0.001	0.028
Pleasant Hill	2	ROW_13741	ROW Opportunity	1.00	0.63	63%	0.008	0.028
Pleasant Hill	2	ROW_13736	ROW Opportunity	4.01	1.82	45%	0.002	0.027
Pleasant Hill	2	ROW_19478	ROW Opportunity	1.79	0.76	42%	0.004	0.027
Pleasant Hill	2	ROW_6668	ROW Opportunity	4.38	1.90	43%	0.002	0.027
Pleasant Hill	2	Parcel_149937	Regional Opportunity	2.29	1.03	45%	0.004	0.026
Pleasant Hill	2	Parcel_131108	Regional Opportunity	0.82	0.54	66%	0.008	0.024
Pleasant Hill	2	Parcel_187984	Parcel-Based Opportunity	23.59	5.41	23%	0.000	0.024
Pleasant Hill	2	ROW_20206	ROW Opportunity	11.06	5.11	46%	0.001	0.023
Pleasant Hill	2	ROW_2045	ROW Opportunity	2.31	1.12	48%	0.003	0.022
Pleasant Hill	2	ROW_4500	ROW Opportunity	3.13	1.84	59%	0.003	0.022
Pleasant Hill	2	ROW_6670	ROW Opportunity	1.70	0.79	46%	0.004	0.022
Pleasant Hill	2	ROW_11085	ROW Opportunity	3.49	1.68	48%	0.002	0.021
Pleasant Hill	2	ROW_12762	ROW Opportunity	3.17	1.40	44%	0.002	0.021
Pleasant Hill	2	ROW_287	ROW Opportunity	1.37	0.44	32%	0.004	0.021
Pleasant Hill	2	ROW_4178	ROW Opportunity	7.51	3.18	42%	0.001	0.021
Pleasant Hill	2	Parcel_168841	Regional Opportunity	0.97	0.44	45%	0.006	0.020
Pleasant Hill	2	ROW_15029	ROW Opportunity	3.85	1.58	41%	0.002	0.019
Pleasant Hill	2	ROW_17703	ROW Opportunity	4.38	1.92	44%	0.002	0.019
Pleasant Hill	2	ROW_5754	ROW Opportunity	1.34	0.80	60%	0.004	0.019
Pleasant Hill	2	Parcel_167223	Parcel-Based Opportunity	10.92	4.29	39%	0.001	0.018
Pleasant Hill	2	ROW_12009	ROW Opportunity	2.27	1.14	50%	0.003	0.018
Pleasant Hill	2	ROW_17057	ROW Opportunity	2.52	1.13	45%	0.002	0.018
Pleasant Hill	2	ROW_4611	ROW Opportunity	0.64	0.40	63%	0.008	0.018
Pleasant Hill	2	ROW_6669	ROW Opportunity	1.68	0.82	49%	0.003	0.018
Pleasant Hill	2	Parcel_155751	Regional Opportunity	1.57	0.26	17%	0.003	0.017
Pleasant Hill	2	ROW_15355	ROW Opportunity	0.64	0.38	59%	0.008	0.017
Pleasant Hill	2	ROW_15358	ROW Opportunity	3.11	1.40	45%	0.002	0.017
Pleasant Hill	2	ROW_3210	ROW Opportunity	7.85	3.33	42%	0.001	0.017
Pleasant Hill	2	Parcel_155321	Regional Opportunity	0.56	0.36	64%	0.008	0.016
Pleasant Hill	2	ROW_11244	ROW Opportunity	6.29	2.71	43%	0.001	0.016
Pleasant Hill	2	ROW_12046	ROW Opportunity	9.42	3.82	41%	0.001	0.016
Pleasant Hill	2	ROW_1343	ROW Opportunity	1.64	0.72	44%	0.003	0.016
Pleasant Hill	2	ROW_533	ROW Opportunity	2.07	0.90	43%	0.003	0.016
Pleasant Hill	2	Parcel_178916	Parcel-Based Opportunity	3.76	2.58	69%	0.002	0.015
Pleasant Hill	2	ROW_5767	ROW Opportunity	2.66	1.19	45%	0.002	0.015
Pleasant Hill	2	ROW_5966	ROW Opportunity	3.55	1.52	43%	0.002	0.015
Pleasant Hill	2	planned_144	Planned Unlined Swale	13.98	6.95	50%	0.000	0.014
Pleasant Hill	2	planned_145	Planned Unlined Swale	13.97	6.95	50%	0.000	0.014
Pleasant Hill	2	planned_146	Planned Unlined Bioretention	13.97	6.95	50%	0.000	0.014
Pleasant Hill	2	ROW_13223	ROW Opportunity	1.24	0.62	50%	0.004	0.014
Pleasant Hill	2	ROW_1583	ROW Opportunity	0.88	0.41	47%	0.005	0.014
Pleasant Hill	2	ROW_1578	ROW Opportunity	0.11	0.06	55%	0.028	0.013
Pleasant Hill	2	ROW_21619	ROW Opportunity	0.42	0.30	71%	0.009	0.013
Pleasant Hill	2	ROW_9265	ROW Opportunity	3.88	1.63	42%	0.001	0.013
Pleasant Hill	2	ROW_9827	ROW Opportunity	0.83	0.55	66%	0.005	0.013
Pleasant Hill	2	Parcel_160193	Parcel-Based Opportunity	7.87	2.98	38%	0.001	0.012
Pleasant Hill	2	ROW_16415	ROW Opportunity	6.78	2.96	44%	0.001	0.012
Pleasant Hill	2	ROW_19765	ROW Opportunity	5.47	2.26	41%	0.001	0.012
Pleasant Hill	2	ROW_20458	ROW Opportunity	1.53	0.73	48%	0.003	0.012
Pleasant Hill	2	ROW_20779	ROW Opportunity	1.73	0.65	38%	0.002	0.012
Pleasant Hill	2	ROW_6601	ROW Opportunity	2.26	1.12	50%	0.002	0.012
Pleasant Hill	2	Parcel_140820	Parcel-Based Opportunity	6.41	2.61	41%	0.001	0.011
Pleasant Hill	2	Parcel_156885	Regional Opportunity	1.48	0.76	51%	0.003	0.011
Pleasant Hill	2	ROW_20849	ROW Opportunity	6.60	2.63	40%	0.001	0.011
Pleasant Hill	2	ROW_4526	ROW Opportunity	1.86	0.90	48%	0.002	0.011
Pleasant Hill	2	ROW_5980	ROW Opportunity	2.92	1.23	42%	0.002	0.011
Pleasant Hill	2	ROW_6634	ROW Opportunity	6.62	2.81	42%	0.001	0.011
Pleasant Hill	2	Parcel_176573	Parcel-Based Opportunity	4.87	2.62	54%	0.001	0.010
Pleasant Hill	2	Parcel_182562	Parcel-Based Opportunity	5.49	2.50	46%	0.001	0.010
Pleasant Hill	2	ROW_1108	ROW Opportunity	6.39	2.49	39%	0.001	0.010
Richmond	2	ROW_20822	ROW Opportunity	39.83	15.26	38%	0.035	5.536
Richmond	2	Parcel_129049	Parcel-Based Opportunity	22.09	16.69	76%	0.043	3.838
Richmond	2	Parcel_127810	Parcel-Based Opportunity	42.57	8.26	19%	0.018	3.044
Richmond	2	ROW_3504	ROW Opportunity	23.46	15.79	67%	0.030	2.744
Richmond	2	ROW_7696	ROW Opportunity	16.17	10.80	67%	0.034	2.163
Richmond	2	Parcel_123788	Parcel-Based Opportunity	11.85	7.18	61%	0.042	1.971
Richmond	2	Parcel_120807	Parcel-Based Opportunity	9.67	6.99	72%	0.049	1.882
Richmond	2	Parcel_124519	Parcel-Based Opportunity	19.03	5.78	30%	0.024	1.772
Richmond	2	GIP_00181 / ROW_8576	ROW Opportunity (aspirational)	15.12	9.82	65%	0.028	1.643
Richmond	2	GIP_00144 / planned_485	Parcel-Based Opportunity (aspirational)	17.80	11.62	65%	0.022	1.526
Richmond	2	ROW_11830	ROW Opportunity	12.26	7.59	62%	0.029	1.377
Richmond	2	GIP_00128 / planned_175	Parcel-Based Opportunity (aspirational)	12.22	6.77	55%	0.026	1.249
Richmond	2	planned_499	Planned Creek/Marsh Restoration	14.17	5.11	36%	0.022	1.243
Richmond	2	Parcel_128990	Parcel-Based Opportunity	6.86	5.17	75%	0.043	1.191
Richmond	2	Parcel_125155	Parcel-Based Opportunity	6.08	4.04	66%	0.047	1.140
Richmond	2	Parcel_163241	Parcel-Based Opportunity	7.34	4.87	66%	0.038	1.127
Richmond	2	ROW_13188	ROW Opportunity	10.46	6.45	62%	0.024	0.978
Richmond	2	GIP_00136 / planned_469	Parcel-Based Opportunity (aspirational)	7.99	4.10	51%	0.030	0.968
Richmond	2	ROW_7811	ROW Opportunity	7.27	4.20	58%	0.031	0.908
Richmond	2	ROW_21445	ROW Opportunity	6.74	4.73	70%	0.034	0.902
Richmond	2	ROW_20428	ROW Opportunity	8.97	5.45	61%	0.026	0.900
Richmond	2	ROW_16598	ROW Opportunity	5.68	3.88	68%	0.038	0.858
Richmond	2	ROW_13906	ROW Opportunity	10.89	7.33	67%	0.021	0.852
Richmond	2	ROW_20478	ROW Opportunity	5.90	3.53	60%	0.035	0.838
Richmond	2	ROW_15751	ROW Opportunity	5.55	3.33	60%	0.037	0.817

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Richmond	2	ROW_2597	ROW Opportunity	6.82	3.55	52%	0.030	0.815
Richmond	2	ROW_12288	ROW Opportunity	4.84	3.24	67%	0.039	0.758
Richmond	2	Parcel_170010	Parcel-Based Opportunity	4.52	3.14	69%	0.041	0.737
Richmond	2	ROW_10536	ROW Opportunity	4.37	2.57	59%	0.042	0.737
Richmond	2	Parcel_113348	Parcel-Based Opportunity	6.69	1.91	29%	0.028	0.694
Richmond	2	ROW_11839	ROW Opportunity	4.37	2.51	57%	0.039	0.691
Richmond	2	ROW_3732	ROW Opportunity	5.46	4.24	78%	0.032	0.685
Richmond	2	ROW_16560	ROW Opportunity	3.78	2.59	69%	0.044	0.672
Richmond	2	ROW_6855	ROW Opportunity	3.69	2.65	72%	0.041	0.607
Richmond	2	ROW_8567	ROW Opportunity	3.74	2.04	55%	0.040	0.602
Richmond	2	ROW_14144	ROW Opportunity	3.21	2.59	81%	0.046	0.586
Richmond	2	ROW_11498	ROW Opportunity	21.21	14.65	69%	0.008	0.577
Richmond	2	ROW_3742	ROW Opportunity	3.63	2.47	68%	0.039	0.577
Richmond	2	GIP_00180 / ROW_5241	ROW Opportunity (aspirational)	21.59	14.60	68%	0.008	0.574
Richmond	2	ROW_18209	ROW Opportunity	3.51	2.46	70%	0.040	0.567
Richmond	2	ROW_15876	ROW Opportunity	5.16	2.25	44%	0.027	0.566
Richmond	2	ROW_17007	ROW Opportunity	3.15	1.90	60%	0.043	0.546
Richmond	2	ROW_8889	ROW Opportunity	7.45	5.28	71%	0.020	0.542
Richmond	2	Parcel_118976	Parcel-Based Opportunity	7.69	1.60	21%	0.017	0.537
Richmond	2	ROW_20886	ROW Opportunity	2.41	1.89	78%	0.053	0.515
Richmond	2	ROW_16532	ROW Opportunity	3.19	2.11	66%	0.039	0.499
Richmond	2	ROW_15749	ROW Opportunity	4.74	2.94	62%	0.027	0.497
Richmond	2	ROW_7809	ROW Opportunity	11.56	3.25	28%	0.011	0.496
Richmond	2	Parcel_114973	Regional Opportunity	2.84	1.61	57%	0.042	0.471
Richmond	2	ROW_18134	ROW Opportunity	3.07	1.56	51%	0.038	0.469
Richmond	2	ROW_8456	ROW Opportunity	2.87	1.60	56%	0.040	0.459
Richmond	2	ROW_17719	ROW Opportunity	2.63	1.56	59%	0.042	0.446
Richmond	2	ROW_15166	ROW Opportunity	2.88	1.95	68%	0.038	0.445
Richmond	2	ROW_6827	ROW Opportunity	2.89	2.10	73%	0.037	0.429
Richmond	2	ROW_12287	ROW Opportunity	2.82	1.98	70%	0.038	0.424
Richmond	2	ROW_1670	ROW Opportunity	19.48	13.28	68%	0.007	0.422
Richmond	2	ROW_14670	ROW Opportunity	3.12	1.33	43%	0.033	0.410
Richmond	2	Parcel_159148	Regional Opportunity	2.48	1.76	71%	0.041	0.407
Richmond	2	ROW_1342	ROW Opportunity	12.99	5.89	45%	0.009	0.401
Richmond	2	ROW_6275	ROW Opportunity	3.46	1.24	36%	0.029	0.401
Richmond	2	ROW_16455	ROW Opportunity	2.53	1.71	68%	0.038	0.384
Richmond	2	GIP_00122 / Parcel_152787	Regional Opportunity (aspirational)	2.53	1.64	65%	0.037	0.380
Richmond	2	Parcel_171579	Parcel-Based Opportunity	3.65	2.87	79%	0.027	0.380
Richmond	2	ROW_4530	ROW Opportunity	3.12	1.81	58%	0.030	0.380
Richmond	2	ROW_4590	ROW Opportunity	2.11	1.33	63%	0.045	0.376
Richmond	2	ROW_20441	ROW Opportunity	5.49	3.04	55%	0.018	0.374
Richmond	2	GIP_00147 / planned_491	Parcel-Based Opportunity (aspirational)	3.12	1.99	64%	0.030	0.369
Richmond	2	ROW_16485	ROW Opportunity	2.63	1.92	73%	0.035	0.369
Richmond	2	ROW_11379	ROW Opportunity	2.04	1.65	81%	0.045	0.368
Richmond	2	ROW_15485	ROW Opportunity	2.06	1.37	67%	0.044	0.363
Richmond	2	ROW_355	ROW Opportunity	2.64	1.88	71%	0.034	0.354
Richmond	2	ROW_3738	ROW Opportunity	2.58	1.82	71%	0.034	0.346
Richmond	2	Parcel_114963	Parcel-Based Opportunity	4.22	1.02	24%	0.021	0.345
Richmond	2	ROW_1767	ROW Opportunity	1.96	1.18	60%	0.044	0.343
Richmond	2	Parcel_153008	Parcel-Based Opportunity	10.59	7.84	74%	0.010	0.340
Richmond	2	Parcel_126231	Regional Opportunity	1.65	1.47	89%	0.050	0.334
Richmond	2	ROW_14678	ROW Opportunity	6.63	4.45	67%	0.014	0.333
Richmond	2	ROW_15193	ROW Opportunity	6.84	4.72	69%	0.014	0.333
Richmond	2	ROW_15752	ROW Opportunity	2.85	1.93	68%	0.029	0.328
Richmond	2	ROW_16472	ROW Opportunity	2.17	1.54	71%	0.037	0.324
Richmond	2	ROW_15877	ROW Opportunity	4.92	2.81	57%	0.017	0.323
Richmond	2	ROW_9595	ROW Opportunity	2.77	2.08	75%	0.029	0.312
Richmond	2	ROW_3292	ROW Opportunity	2.05	1.67	81%	0.038	0.306
Richmond	2	ROW_3744	ROW Opportunity	3.85	2.44	63%	0.020	0.299
Richmond	2	planned_487	Planned Unlined Bioretention	22.60	15.02	66%	0.005	0.296
Richmond	2	ROW_17305	ROW Opportunity	1.92	0.98	51%	0.038	0.295
Richmond	2	planned_496	Planned Creek/Marsh Restoration	3.90	2.25	58%	0.020	0.294
Richmond	2	GIP_00140 / planned_479	Parcel-Based Opportunity (aspirational)	12.83	8.77	68%	0.007	0.291
Richmond	2	ROW_333	ROW Opportunity	9.12	6.07	67%	0.009	0.290
Richmond	2	ROW_3883	ROW Opportunity	8.72	5.79	66%	0.010	0.282
Richmond	2	ROW_6859	ROW Opportunity	2.12	0.59	28%	0.033	0.279
Richmond	2	ROW_9722	ROW Opportunity	1.69	1.17	69%	0.041	0.276
Richmond	2	ROW_16528	ROW Opportunity	2.22	1.27	57%	0.031	0.273
Richmond	2	Parcel_115416	Regional Opportunity	1.53	0.93	61%	0.044	0.270
Richmond	2	ROW_17316	ROW Opportunity	1.73	0.90	52%	0.039	0.268
Richmond	2	ROW_12193	ROW Opportunity	5.91	4.11	70%	0.013	0.264
Richmond	2	ROW_7332	ROW Opportunity	1.62	1.25	77%	0.041	0.263
Richmond	2	ROW_11831	ROW Opportunity	1.49	1.14	77%	0.044	0.262
Richmond	2	Parcel_167791	Parcel-Based Opportunity	3.42	2.71	79%	0.020	0.261
Richmond	2	ROW_6828	ROW Opportunity	1.71	1.18	69%	0.038	0.261
Richmond	2	ROW_12952	ROW Opportunity	3.16	1.44	46%	0.021	0.259
Richmond	2	ROW_12328	ROW Opportunity	2.62	0.81	31%	0.024	0.258
Richmond	2	ROW_14807	ROW Opportunity	2.63	1.88	71%	0.026	0.255
Richmond	2	ROW_156	ROW Opportunity	4.72	3.23	68%	0.015	0.255
Richmond	2	ROW_13420	ROW Opportunity	5.29	3.71	70%	0.013	0.252
Richmond	2	ROW_6274	ROW Opportunity	4.20	2.48	59%	0.016	0.252
Richmond	2	ROW_16487	ROW Opportunity	1.47	1.09	74%	0.042	0.249
Richmond	2	ROW_9163	ROW Opportunity	3.60	2.25	63%	0.018	0.245
Richmond	2	planned_495	Planned Water Quality Basin	1.91	1.10	58%	0.032	0.242
Richmond	2	ROW_15892	ROW Opportunity	14.20	7.48	53%	0.005	0.239
Richmond	2	ROW_1795	ROW Opportunity	1.37	1.03	75%	0.043	0.239
Richmond	2	ROW_18184	ROW Opportunity	1.61	0.80	50%	0.037	0.238
Richmond	2	Parcel_116238	Parcel-Based Opportunity	1.29	0.82	64%	0.045	0.234
Richmond	2	ROW_11883	ROW Opportunity	1.42	0.98	69%	0.041	0.231
Richmond	2	planned_497	Planned Creek/Marsh Restoration	1.59	0.97	61%	0.036	0.230
Richmond	2	ROW_1792	ROW Opportunity	1.33	0.97	73%	0.042	0.227
Richmond	2	ROW_6971	ROW Opportunity	1.62	1.15	71%	0.035	0.224
Richmond	2	ROW_18110	ROW Opportunity	2.22	1.56	70%	0.026	0.223
Richmond	2	ROW_16442	ROW Opportunity	3.16	0.67	21%	0.017	0.220

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Richmond	2	ROW_18395	ROW Opportunity	2.05	0.89	43%	0.026	0.213
Richmond	2	ROW_15167	ROW Opportunity	1.76	1.21	69%	0.030	0.211
Richmond	2	ROW_16436	ROW Opportunity	1.97	1.36	69%	0.027	0.211
Richmond	2	ROW_16535	ROW Opportunity	2.13	1.38	65%	0.025	0.211
Richmond	2	ROW_16488	ROW Opportunity	1.32	0.96	73%	0.039	0.209
Richmond	2	Parcel_110613	Regional Opportunity	1.25	0.72	58%	0.042	0.208
Richmond	2	ROW_17259	ROW Opportunity	1.63	0.69	42%	0.032	0.207
Richmond	2	ROW_15285	ROW Opportunity	1.06	0.71	67%	0.048	0.205
Richmond	2	ROW_1765	ROW Opportunity	1.21	0.71	59%	0.042	0.204
Richmond	2	ROW_863	ROW Opportunity	1.39	0.86	62%	0.036	0.204
Richmond	2	planned_531	Planned Water Quality Basin	75.78	38.92	51%	0.001	0.202
Richmond	2	ROW_16441	ROW Opportunity	2.29	1.59	69%	0.023	0.202
Richmond	2	ROW_5443	ROW Opportunity	1.01	0.88	87%	0.049	0.200
Richmond	2	Parcel_111210	Regional Opportunity	1.27	0.90	71%	0.040	0.197
Richmond	2	ROW_4125	ROW Opportunity	2.29	1.49	65%	0.022	0.197
Richmond	2	ROW_13349	ROW Opportunity	1.13	0.84	74%	0.043	0.196
Richmond	2	ROW_1468	ROW Opportunity	2.21	1.56	71%	0.023	0.196
Richmond	2	ROW_6857	ROW Opportunity	1.59	0.64	40%	0.031	0.196
Richmond	2	ROW_14518	ROW Opportunity	1.76	1.15	65%	0.028	0.195
Richmond	2	ROW_1731	ROW Opportunity	1.11	0.83	75%	0.044	0.193
Richmond	2	ROW_3731	ROW Opportunity	1.22	0.82	67%	0.040	0.191
Richmond	2	Parcel_162407	Regional Opportunity	1.21	0.82	68%	0.039	0.190
Richmond	2	ROW_289	ROW Opportunity	1.43	0.78	55%	0.033	0.188
Richmond	2	ROW_1770	ROW Opportunity	8.43	5.33	63%	0.007	0.187
Richmond	2	ROW_15757	ROW Opportunity	1.18	0.64	54%	0.039	0.186
Richmond	2	GIP_00165 / planned_534	Parcel-Based Opportunity (aspirational)	2.20	1.33	60%	0.022	0.183
Richmond	2	ROW_318	ROW Opportunity	2.13	1.41	66%	0.022	0.183
Richmond	2	Parcel_134412	Parcel-Based Opportunity	4.34	3.50	81%	0.012	0.181
Richmond	2	ROW_11890	ROW Opportunity	0.99	0.79	80%	0.046	0.181
Richmond	2	Parcel_198059	Parcel-Based Opportunity	6.65	3.60	54%	0.008	0.180
Richmond	2	ROW_17324	ROW Opportunity	1.23	0.80	65%	0.036	0.178
Richmond	2	Parcel_166327	Regional Opportunity	2.29	1.75	76%	0.020	0.174
Richmond	2	ROW_2766	ROW Opportunity	1.36	0.86	63%	0.032	0.174
Richmond	2	ROW_15468	ROW Opportunity	1.02	0.75	74%	0.042	0.171
Richmond	2	ROW_16520	ROW Opportunity	1.38	0.79	57%	0.031	0.171
Richmond	2	ROW_16913	ROW Opportunity	16.07	8.93	56%	0.004	0.171
Richmond	2	Parcel_169252	Regional Opportunity	1.01	0.72	71%	0.042	0.169
Richmond	2	ROW_161	ROW Opportunity	1.86	1.31	70%	0.024	0.169
Richmond	2	ROW_17298	ROW Opportunity	0.91	0.59	65%	0.046	0.168
Richmond	2	ROW_1749	ROW Opportunity	0.97	0.72	74%	0.043	0.168
Richmond	2	ROW_16840	ROW Opportunity	6.87	4.81	70%	0.008	0.166
Richmond	2	ROW_14810	ROW Opportunity	0.89	0.58	65%	0.046	0.165
Richmond	2	ROW_70	ROW Opportunity	3.96	2.77	70%	0.012	0.165
Richmond	2	ROW_20040	ROW Opportunity	2.45	1.53	62%	0.018	0.164
Richmond	2	ROW_21242	ROW Opportunity	1.27	0.83	65%	0.032	0.160
Richmond	2	Parcel_169551	Parcel-Based Opportunity	3.47	2.76	80%	0.013	0.157
Richmond	2	Parcel_238663	Parcel-Based Opportunity	50.69	7.21	14%	0.001	0.156
Richmond	2	ROW_3740	ROW Opportunity	1.92	1.15	60%	0.021	0.156
Richmond	2	Parcel_120883	Regional Opportunity	0.95	0.54	57%	0.040	0.154
Richmond	2	ROW_16482	ROW Opportunity	1.10	0.73	66%	0.035	0.154
Richmond	2	ROW_9124	ROW Opportunity	8.76	4.50	51%	0.006	0.154
Richmond	2	ROW_16456	ROW Opportunity	1.03	0.65	63%	0.037	0.151
Richmond	2	ROW_7328	ROW Opportunity	7.44	4.86	65%	0.006	0.149
Richmond	2	Parcel_112907	Regional Opportunity	2.04	0.43	21%	0.018	0.147
Richmond	2	ROW_176	ROW Opportunity	0.99	0.68	69%	0.037	0.147
Richmond	2	ROW_16976	ROW Opportunity	0.83	0.62	75%	0.043	0.146
Richmond	2	Parcel_193343	Parcel-Based Opportunity	0.62	0.27	44%	0.058	0.145
Richmond	2	planned_527	Planned Unlined Bioretention	4.44	3.26	73%	0.010	0.143
Richmond	2	ROW_20689	ROW Opportunity	0.90	0.49	54%	0.040	0.143
Richmond	2	ROW_16452	ROW Opportunity	0.92	0.62	67%	0.038	0.142
Richmond	2	ROW_1766	ROW Opportunity	0.85	0.49	58%	0.041	0.141
Richmond	2	ROW_3022	ROW Opportunity	1.28	0.85	66%	0.028	0.141
Richmond	2	ROW_173	ROW Opportunity	2.06	1.39	67%	0.018	0.140
Richmond	2	ROW_233	ROW Opportunity	4.88	3.24	66%	0.009	0.139
Richmond	2	ROW_344	ROW Opportunity	3.21	2.36	74%	0.012	0.139
Richmond	2	ROW_6305	ROW Opportunity	0.95	0.58	61%	0.036	0.138
Richmond	2	Parcel_144553	Parcel-Based Opportunity	4.24	3.16	75%	0.010	0.137
Richmond	2	ROW_2543	ROW Opportunity	0.87	0.46	53%	0.039	0.137
Richmond	2	planned_484	Planned Unlined Bioretention	3.36	2.28	68%	0.011	0.136
Richmond	2	ROW_20415	ROW Opportunity	1.09	0.78	72%	0.031	0.135
Richmond	2	ROW_11849	ROW Opportunity	4.83	3.30	68%	0.008	0.134
Richmond	2	GIP_00166 / planned_535	Parcel-Based Opportunity (aspirational)	4.59	3.21	70%	0.009	0.133
Richmond	2	Parcel_225180	Parcel-Based Opportunity	4.05	3.00	74%	0.010	0.133
Richmond	2	ROW_10967	ROW Opportunity	0.87	0.44	51%	0.038	0.133
Richmond	2	ROW_17276	ROW Opportunity	0.72	0.47	65%	0.046	0.133
Richmond	2	ROW_3965	ROW Opportunity	0.72	0.47	65%	0.046	0.133
Richmond	2	Parcel_172178	Parcel-Based Opportunity	3.68	2.88	78%	0.010	0.129
Richmond	2	ROW_16559	ROW Opportunity	0.85	0.56	66%	0.038	0.129
Richmond	2	ROW_7673	ROW Opportunity	1.89	0.92	49%	0.018	0.128
Richmond	2	ROW_9823	ROW Opportunity	0.70	0.54	77%	0.045	0.126
Richmond	2	ROW_16531	ROW Opportunity	3.40	2.29	67%	0.011	0.125
Richmond	2	ROW_17258	ROW Opportunity	0.77	0.43	56%	0.040	0.125
Richmond	2	ROW_20486	ROW Opportunity	4.18	2.56	61%	0.009	0.124
Richmond	2	Parcel_155701	Regional Opportunity	0.77	0.53	69%	0.039	0.123
Richmond	2	ROW_17037	ROW Opportunity	4.87	3.10	64%	0.008	0.123
Richmond	2	ROW_3505	ROW Opportunity	0.88	0.62	70%	0.035	0.123
Richmond	2	ROW_12830	ROW Opportunity	1.15	0.73	63%	0.027	0.121
Richmond	2	ROW_74	ROW Opportunity	2.79	1.80	65%	0.012	0.120
Richmond	2	ROW_16434	ROW Opportunity	1.25	0.88	70%	0.025	0.119
Richmond	2	ROW_6803	ROW Opportunity	1.00	0.69	69%	0.030	0.119
Richmond	2	ROW_226	ROW Opportunity	3.03	2.02	67%	0.011	0.117
Richmond	2	ROW_15830	ROW Opportunity	8.70	6.19	71%	0.005	0.115
Richmond	2	ROW_15989	ROW Opportunity	4.07	2.72	67%	0.008	0.112
Richmond	2	ROW_17301	ROW Opportunity	0.65	0.48	74%	0.043	0.112

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Richmond	2	ROW_168	ROW Opportunity	5.27	3.69	70%	0.007	0.110
Richmond	2	ROW_291	ROW Opportunity	0.71	0.46	65%	0.038	0.110
Richmond	2	ROW_11622	ROW Opportunity	7.40	4.72	64%	0.005	0.109
Richmond	2	Parcel_125476	Regional Opportunity	0.74	0.37	50%	0.036	0.108
Richmond	2	ROW_11840	ROW Opportunity	0.65	0.37	57%	0.041	0.107
Richmond	2	ROW_15750	ROW Opportunity	1.48	0.80	54%	0.019	0.107
Richmond	2	ROW_4528	ROW Opportunity	1.18	0.55	47%	0.023	0.107
Richmond	2	ROW_4784	ROW Opportunity	0.68	0.50	74%	0.039	0.107
Richmond	2	ROW_16464	ROW Opportunity	3.55	2.42	68%	0.009	0.106
Richmond	2	Parcel_196459	Parcel-Based Opportunity	0.43	0.19	44%	0.058	0.101
Richmond	2	ROW_10962	ROW Opportunity	0.54	0.35	65%	0.045	0.100
Richmond	2	ROW_17311	ROW Opportunity	0.62	0.43	69%	0.040	0.100
Richmond	2	ROW_6267	ROW Opportunity	0.66	0.42	64%	0.037	0.100
Richmond	2	ROW_15881	ROW Opportunity	11.64	6.16	53%	0.003	0.097
Richmond	2	ROW_11062	ROW Opportunity	2.50	1.26	50%	0.011	0.096
Richmond	2	ROW_1732	ROW Opportunity	0.52	0.33	63%	0.046	0.096
Richmond	2	Parcel_129221	Regional Opportunity	0.56	0.33	59%	0.042	0.095
Richmond	2	Parcel_163884	Regional Opportunity	0.60	0.41	68%	0.039	0.095
Richmond	2	Parcel_212172	Parcel-Based Opportunity	3.35	2.09	62%	0.009	0.095
Richmond	2	planned_463	Planned Unlined Bioretention	3.35	2.09	62%	0.008	0.095
Richmond	2	ROW_15232	ROW Opportunity	0.63	0.46	73%	0.038	0.095
Richmond	2	ROW_8095	ROW Opportunity	5.10	2.61	51%	0.006	0.095
Richmond	2	ROW_3104	ROW Opportunity	0.60	0.46	77%	0.039	0.094
Richmond	2	ROW_5507	ROW Opportunity	0.52	0.32	62%	0.045	0.094
Richmond	2	GIP_00121 / Parcel_144341	Regional Opportunity (aspirational)	2.87	2.15	75%	0.010	0.093
Richmond	2	ROW_9164	ROW Opportunity	0.62	0.40	65%	0.037	0.093
Richmond	2	ROW_17006	ROW Opportunity	1.13	0.60	53%	0.022	0.092
Richmond	2	ROW_73	ROW Opportunity	0.59	0.40	68%	0.039	0.092
Richmond	2	planned_199	Planned Creek/Marsh Restoration	3.43	1.93	56%	0.008	0.091
Richmond	2	ROW_11378	ROW Opportunity	3.08	1.99	65%	0.009	0.091
Richmond	2	ROW_16846	ROW Opportunity	0.61	0.44	72%	0.037	0.091
Richmond	2	ROW_187	ROW Opportunity	1.62	1.06	65%	0.015	0.091
Richmond	2	ROW_17720	ROW Opportunity	0.53	0.32	60%	0.043	0.090
Richmond	2	ROW_5467	ROW Opportunity	0.76	0.29	38%	0.030	0.090
Richmond	2	ROW_254	ROW Opportunity	7.15	4.85	68%	0.004	0.088
Richmond	2	ROW_3103	ROW Opportunity	0.47	0.38	81%	0.047	0.088
Richmond	2	Parcel_119238	Parcel-Based Opportunity	3.39	1.91	56%	0.008	0.087
Richmond	2	ROW_16465	ROW Opportunity	0.60	0.44	73%	0.036	0.087
Richmond	2	Parcel_110802	Regional Opportunity	0.82	0.25	30%	0.026	0.085
Richmond	2	Parcel_170769	Regional Opportunity	2.46	1.96	80%	0.010	0.085
Richmond	2	ROW_2596	ROW Opportunity	1.62	1.11	69%	0.015	0.085
Richmond	2	ROW_5180	ROW Opportunity	0.47	0.29	62%	0.045	0.085
Richmond	2	ROW_16552	ROW Opportunity	3.51	2.33	66%	0.007	0.084
Richmond	2	Parcel_155487	Regional Opportunity	3.02	1.80	60%	0.008	0.083
Richmond	2	ROW_16445	ROW Opportunity	1.04	0.70	67%	0.021	0.083
Richmond	2	ROW_6721	ROW Opportunity	0.50	0.36	72%	0.041	0.083
Richmond	2	Parcel_116278	Regional Opportunity	0.91	0.24	26%	0.022	0.082
Richmond	2	Parcel_117353	Regional Opportunity	2.33	0.81	35%	0.010	0.082
Richmond	2	ROW_21198	ROW Opportunity	0.41	0.29	71%	0.050	0.082
Richmond	2	ROW_15197	ROW Opportunity	0.50	0.35	70%	0.040	0.081
Richmond	2	Parcel_119884	Regional Opportunity	0.64	0.27	42%	0.032	0.080
Richmond	2	ROW_116	ROW Opportunity	2.56	1.74	68%	0.009	0.080
Richmond	2	ROW_200	ROW Opportunity	5.74	3.95	69%	0.005	0.080
Richmond	2	ROW_9162	ROW Opportunity	4.57	3.10	68%	0.006	0.080
Richmond	2	Parcel_124307	Regional Opportunity	0.46	0.28	61%	0.043	0.079
Richmond	2	Parcel_165219	Regional Opportunity	1.77	1.40	79%	0.013	0.078
Richmond	2	ROW_21073	ROW Opportunity	3.56	2.16	61%	0.007	0.078
Richmond	2	ROW_2162	ROW Opportunity	9.38	6.41	68%	0.003	0.078
Richmond	2	ROW_9937	ROW Opportunity	2.83	1.11	39%	0.008	0.078
Richmond	2	GIP_00153 / planned_512	Parcel-Based Opportunity (aspirational)	4.34	2.92	67%	0.006	0.077
Richmond	2	ROW_16538	ROW Opportunity	1.07	0.58	54%	0.019	0.077
Richmond	2	ROW_20633	ROW Opportunity	4.94	2.89	59%	0.005	0.077
Richmond	2	ROW_16467	ROW Opportunity	2.66	1.79	67%	0.009	0.076
Richmond	2	ROW_16496	ROW Opportunity	4.37	2.90	66%	0.006	0.076
Richmond	2	Parcel_375479	Parcel-Based Opportunity	68.51	8.98	13%	0.000	0.075
Richmond	2	ROW_13581	ROW Opportunity	0.59	0.26	44%	0.032	0.075
Richmond	2	ROW_10098	ROW Opportunity	6.38	4.15	65%	0.004	0.074
Richmond	2	ROW_1830	ROW Opportunity	1.38	0.93	67%	0.015	0.074
Richmond	2	ROW_82	ROW Opportunity	0.80	0.60	75%	0.024	0.074
Richmond	2	ROW_92	ROW Opportunity	4.38	3.00	68%	0.006	0.073
Richmond	2	ROW_12125	ROW Opportunity	5.50	3.66	67%	0.005	0.072
Richmond	2	Parcel_115970	Regional Opportunity	0.55	0.12	22%	0.032	0.070
Richmond	2	Parcel_144098	Regional Opportunity	1.08	0.98	91%	0.018	0.070
Richmond	2	ROW_2164	ROW Opportunity	1.27	0.90	71%	0.015	0.070
Richmond	2	ROW_16394	ROW Opportunity	0.51	0.23	45%	0.034	0.069
Richmond	2	ROW_16563	ROW Opportunity	4.10	2.78	68%	0.006	0.069
Richmond	2	ROW_16866	ROW Opportunity	3.52	2.37	67%	0.006	0.069
Richmond	2	ROW_7810	ROW Opportunity	0.59	0.27	46%	0.029	0.069
Richmond	2	Parcel_115590	Regional Opportunity	0.98	0.21	21%	0.017	0.068
Richmond	2	Parcel_116661	Regional Opportunity	0.52	0.13	25%	0.033	0.068
Richmond	2	ROW_16544	ROW Opportunity	4.83	3.31	69%	0.005	0.068
Richmond	2	ROW_16480	ROW Opportunity	1.96	1.32	67%	0.010	0.067
Richmond	2	ROW_195	ROW Opportunity	5.26	3.67	70%	0.005	0.067
Richmond	2	ROW_11623	ROW Opportunity	5.63	3.78	67%	0.004	0.066
Richmond	2	ROW_5903	ROW Opportunity	0.39	0.28	72%	0.042	0.066
Richmond	2	ROW_9784	ROW Opportunity	0.50	0.22	44%	0.033	0.066
Richmond	2	Parcel_129781	Parcel-Based Opportunity	0.46	0.22	48%	0.036	0.065
Richmond	2	Parcel_174262	Parcel-Based Opportunity	2.11	1.19	56%	0.009	0.065
Richmond	2	ROW_17728	ROW Opportunity	0.42	0.22	52%	0.039	0.065
Richmond	2	ROW_2163	ROW Opportunity	3.02	2.13	71%	0.007	0.065
Richmond	2	ROW_16504	ROW Opportunity	0.99	0.61	62%	0.017	0.064
Richmond	2	ROW_17527	ROW Opportunity	9.09	4.79	53%	0.003	0.064
Richmond	2	ROW_20751	ROW Opportunity	0.72	0.52	72%	0.023	0.064
Richmond	2	ROW_8571	ROW Opportunity	3.24	2.28	70%	0.006	0.064

Jurisdiction	Permit	Project ID	Project Type	Area (Acres)	Impervious Area (Acres)	Percent Impervious	PCBs Yield (g/acre)	PCBs Mass reduced (g)
Richmond	2	GIP_00171 / ROW_16561	ROW Opportunity (aspirational)	4.64	3.09	67%	0.005	0.063
Richmond	2	Parcel_117968	Regional Opportunity	0.56	0.24	43%	0.028	0.063
Richmond	2	ROW_147	ROW Opportunity	0.82	0.56	68%	0.020	0.062
Richmond	2	ROW_21231	ROW Opportunity	0.41	0.21	51%	0.037	0.062
Richmond	2	GIP_00125 / planned_138	Parcel-Based Opportunity (aspirational)	39.35	14.16	36%	0.001	0.061
Richmond	2	Parcel_154186	Parcel-Based Opportunity	0.39	0.26	67%	0.039	0.061
Richmond	2	ROW_105	ROW Opportunity	2.41	1.61	67%	0.008	0.061
Richmond	2	ROW_1763	ROW Opportunity	0.34	0.21	62%	0.044	0.061
Richmond	2	ROW_3733	ROW Opportunity	0.47	0.25	53%	0.032	0.061
Richmond	2	ROW_6864	ROW Opportunity	0.36	0.26	72%	0.042	0.061
Richmond	2	ROW_15878	ROW Opportunity	3.44	1.96	57%	0.006	0.060
Richmond	2	ROW_19023	ROW Opportunity	1.43	0.96	67%	0.012	0.060
Richmond	2	ROW_9166	ROW Opportunity	0.45	0.28	62%	0.033	0.060
Richmond	2	Parcel_118569	Parcel-Based Opportunity	0.46	0.19	41%	0.031	0.059
Richmond	2	ROW_15195	ROW Opportunity	6.51	4.28	66%	0.003	0.059
Richmond	2	ROW_18037	ROW Opportunity	4.29	2.74	64%	0.005	0.059
Richmond	2	ROW_2697	ROW Opportunity	2.39	1.65	69%	0.008	0.059
Richmond	2	ROW_1794	ROW Opportunity	0.32	0.25	78%	0.046	0.058
Richmond	2	ROW_19952	ROW Opportunity	0.87	0.59	68%	0.018	0.058
Richmond	2	ROW_20453	ROW Opportunity	0.55	0.39	71%	0.027	0.058
Richmond	2	Parcel_116468	Parcel-Based Opportunity	0.74	0.29	39%	0.019	0.057
Richmond	2	Parcel_133667	Parcel-Based Opportunity	25.54	14.75	58%	0.001	0.057
Richmond	2	ROW_16116	ROW Opportunity	0.32	0.20	63%	0.044	0.057
Richmond	2	ROW_16539	ROW Opportunity	1.03	0.59	57%	0.015	0.057
Richmond	2	ROW_886	ROW Opportunity	9.50	6.34	67%	0.003	0.057
Richmond	2	ROW_16475	ROW Opportunity	2.52	1.67	66%	0.007	0.056
Richmond	2	ROW_4147	ROW Opportunity	0.75	0.48	64%	0.020	0.056
Richmond	2	ROW_9755	ROW Opportunity	0.36	0.24	67%	0.038	0.056
Richmond	2	ROW_17721	ROW Opportunity	0.32	0.19	59%	0.044	0.055
Richmond	2	ROW_3294	ROW Opportunity	0.50	0.34	68%	0.028	0.055
Richmond	2	ROW_16486	ROW Opportunity	0.67	0.40	60%	0.021	0.054
Richmond	2	ROW_18476	ROW Opportunity	1.55	1.08	70%	0.010	0.054
Richmond	2	Parcel_150073	Regional Opportunity	1.80	1.20	67%	0.009	0.053
Richmond	2	ROW_13891	ROW Opportunity	0.41	0.18	44%	0.032	0.053
Richmond	2	Parcel_176154	Parcel-Based Opportunity	27.12	13.35	49%	0.001	0.052
Richmond	2	ROW_18074	ROW Opportunity	3.67	2.41	66%	0.005	0.052
Richmond	2	Parcel_236849	Parcel-Based Opportunity	260.54	3.37	1%	0.000	0.051
Richmond	2	ROW_18477	ROW Opportunity	2.41	1.65	68%	0.007	0.051
Richmond	2	ROW_9129	ROW Opportunity	3.29	1.38	42%	0.005	0.051
Richmond	2	Parcel_118639	Parcel-Based Opportunity	0.45	0.10	22%	0.028	0.050
Richmond	2	Parcel_150614	Regional Opportunity	2.05	1.74	85%	0.008	0.049
Richmond	2	ROW_13905	ROW Opportunity	3.58	2.15	60%	0.005	0.049
Richmond	2	ROW_21154	ROW Opportunity	2.44	1.79	73%	0.007	0.049
Richmond	2	ROW_11838	ROW Opportunity	0.29	0.17	59%	0.041	0.048
Richmond	2	ROW_3859	ROW Opportunity	7.00	4.53	65%	0.003	0.048
Richmond	2	Parcel_255238	Parcel-Based Opportunity	611.35	20.49	3%	0.000	0.047
Richmond	2	ROW_20475	ROW Opportunity	1.12	0.76	68%	0.012	0.047
Richmond	2	ROW_9125	ROW Opportunity	2.59	0.93	36%	0.005	0.047
Richmond	2	ROW_98	ROW Opportunity	2.55	1.75	69%	0.006	0.047
Richmond	2	ROW_15754	ROW Opportunity	0.35	0.22	63%	0.033	0.046
Richmond	2	ROW_16440	ROW Opportunity	0.58	0.41	71%	0.021	0.046
Richmond	2	ROW_16512	ROW Opportunity	1.89	1.24	66%	0.008	0.046
Richmond	2	ROW_3979	ROW Opportunity	11.15	7.70	69%	0.002	0.046
Richmond	2	ROW_3728	ROW Opportunity	0.28	0.19	68%	0.040	0.045
Richmond	2	ROW_7216	ROW Opportunity	2.32	1.56	67%	0.006	0.045
Richmond	2	Parcel_132474	Regional Opportunity	1.13	0.87	77%	0.011	0.044
Richmond	2	Parcel_149687	Regional Opportunity	1.43	1.00	70%	0.009	0.044
Richmond	2	planned_326	Planned Creek/Marsh Restoration	2.22	0.57	26%	0.006	0.044
Richmond	2	ROW_14433	ROW Opportunity	1.36	0.88	65%	0.010	0.044
Richmond	2	ROW_247	ROW Opportunity	13.62	8.74	64%	0.002	0.044
Richmond	2	ROW_5190	ROW Opportunity	0.35	0.14	40%	0.031	0.044
Richmond	2	ROW_785	ROW Opportunity	6.19	3.83	62%	0.003	0.044
Richmond	2	ROW_9939	ROW Opportunity	0.37	0.14	38%	0.029	0.044
Richmond	2	GIP_00112 / Parcel_133196	Regional Opportunity (aspirational)	1.20	1.00	83%	0.011	0.043
Richmond	2	planned_296	Planned Creek/Marsh Restoration	83.80	11.53	14%	0.000	0.043
Richmond	2	ROW_17312	ROW Opportunity	0.27	0.14	52%	0.040	0.043
Richmond	2	ROW_8642	ROW Opportunity	3.74	2.42	65%	0.004	0.043
Richmond	2	GIP_00120 / Parcel_143826	Regional Opportunity (aspirational)	1.04	0.89	86%	0.012	0.042
Richmond	2	GIP_00179 / ROW_3507	ROW Opportunity (aspirational)	9.06	5.66	62%	0.002	0.042
Richmond	2	Parcel_188482	Parcel-Based Opportunity	7.05	3.25	46%	0.002	0.042
Richmond	2	ROW_13417	ROW Opportunity	5.44	3.72	68%	0.003	0.042
Richmond	2	ROW_16211	ROW Opportunity	8.14	5.41	66%	0.002	0.042
Richmond	2	ROW_175	ROW Opportunity	3.50	2.49	71%	0.004	0.042
Richmond	2	Parcel_113228	Parcel-Based Opportunity	0.23	0.14	61%	0.044	0.041
Richmond	2	Parcel_149904	Regional Opportunity	1.45	0.91	63%	0.008	0.041
Richmond	2	Parcel_211565	Regional Opportunity	1.57	0.88	56%	0.008	0.041
Richmond	2	ROW_16555	ROW Opportunity	3.26	2.17	67%	0.004	0.041
Richmond	2	GIP_00123 / Parcel_152927	Regional Opportunity (aspirational)	3.09	1.99	64%	0.005	0.040
Richmond	2	Parcel_139167	Regional Opportunity	0.87	0.70	80%	0.013	0.040
Richmond	2	ROW_100	ROW Opportunity	3.68	2.57	70%	0.004	0.040
Richmond	2	ROW_10892	ROW Opportunity	0.90	0.53	59%	0.012	0.040
Richmond	2	ROW_14676	ROW Opportunity	1.05	0.73	70%	0.011	0.040
Richmond	2	ROW_2159	ROW Opportunity	3.17	2.21	70%	0.004	0.040
Richmond	2	ROW_245	ROW Opportunity	12.24	7.96	65%	0.002	0.040
Richmond	2	ROW_273	ROW Opportunity	9.08	6.04	67%	0.002	0.040
Richmond	2	ROW_66	ROW Opportunity	1.53	1.13	74%	0.008	0.040
Richmond	2	Parcel_116652	Parcel-Based Opportunity	0.23	0.13	57%	0.042	0.039
Richmond	2	ROW_16507	ROW Opportunity	1.11	0.73	66%	0.010	0.039
Richmond	2	ROW_248	ROW Opportunity	6.87	4.50	66%	0.002	0.039
Richmond	2	ROW_11363	ROW Opportunity	9.37	6.08	65%	0.002	0.038
Richmond	2	ROW_126	ROW Opportunity	1.73	1.12	65%	0.007	0.038
Richmond	2	ROW_15753	ROW Opportunity	0.77	0.46	60%	0.014	0.038
Richmond	2	ROW_16503	ROW Opportunity	2.40	1.57	65%	0.005	0.038
Richmond	2	ROW_16557	ROW Opportunity	3.91	2.61	67%	0.004	0.038

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Richmond	2	ROW_212	ROW Opportunity	7.21	4.69	65%	0.002	0.038
Richmond	2	ROW_257	ROW Opportunity	9.16	6.03	66%	0.002	0.038
Richmond	2	ROW_69	ROW Opportunity	1.85	1.26	68%	0.007	0.038
Richmond	2	GIP_00145 / planned_486	Parcel-Based Opportunity (aspirational)	5.73	3.84	67%	0.003	0.037
Richmond	2	Parcel_375480	Parcel-Based Opportunity	39.00	23.68	61%	0.000	0.037
Richmond	2	ROW_16208	ROW Opportunity	2.13	1.44	68%	0.006	0.037
Richmond	2	ROW_16518	ROW Opportunity	2.48	1.62	65%	0.005	0.037
Richmond	2	ROW_211	ROW Opportunity	4.70	3.08	66%	0.003	0.037
Richmond	2	Parcel_126574	Regional Opportunity	0.58	0.15	26%	0.016	0.036
Richmond	2	ROW_11885	ROW Opportunity	0.22	0.15	68%	0.041	0.036
Richmond	2	ROW_19949	ROW Opportunity	0.81	0.55	68%	0.013	0.036
Richmond	2	Parcel_133977	Regional Opportunity	1.28	0.66	52%	0.008	0.035
Richmond	2	Parcel_137626	Regional Opportunity	1.25	0.75	60%	0.008	0.035
Richmond	2	Parcel_146294	Parcel-Based Opportunity	14.14	9.02	64%	0.001	0.035
Richmond	2	Parcel_195923	Parcel-Based Opportunity	0.15	0.06	40%	0.059	0.035
Richmond	2	ROW_16433	ROW Opportunity	1.10	0.75	68%	0.009	0.035
Richmond	2	ROW_16437	ROW Opportunity	3.09	2.10	68%	0.004	0.035
Richmond	2	ROW_16443	ROW Opportunity	3.11	2.01	65%	0.004	0.035
Richmond	2	ROW_246	ROW Opportunity	0.43	0.31	72%	0.022	0.035
Richmond	2	ROW_3755	ROW Opportunity	0.29	0.11	38%	0.030	0.035
Richmond	2	Parcel_234570	Parcel-Based Opportunity	21.31	2.72	13%	0.001	0.034
Richmond	2	ROW_11014	ROW Opportunity	5.98	3.95	66%	0.002	0.034
Richmond	2	ROW_15831	ROW Opportunity	9.53	6.34	67%	0.002	0.034
Richmond	2	ROW_17021	ROW Opportunity	0.48	0.20	42%	0.019	0.034
Richmond	2	ROW_283	ROW Opportunity	6.12	4.23	69%	0.002	0.034
Richmond	2	ROW_56	ROW Opportunity	1.53	1.09	71%	0.007	0.034
Richmond	2	Parcel_111332	Parcel-Based Opportunity	0.26	0.11	42%	0.032	0.033
Richmond	2	Parcel_120275	Regional Opportunity	1.53	0.52	34%	0.006	0.033
Richmond	2	Parcel_154534	Parcel-Based Opportunity	0.21	0.14	67%	0.039	0.033
Richmond	2	ROW_191	ROW Opportunity	1.46	1.08	74%	0.007	0.033
Richmond	2	ROW_21542	ROW Opportunity	8.21	5.22	64%	0.002	0.033
Richmond	2	ROW_239	ROW Opportunity	10.01	6.58	66%	0.002	0.033
Richmond	2	ROW_6159	ROW Opportunity	6.69	4.35	65%	0.002	0.033
Richmond	2	ROW_85	ROW Opportunity	0.84	0.56	67%	0.011	0.033
Richmond	2	GIP_00148 / planned_492	Parcel-Based Opportunity (aspirational)	2.50	1.76	70%	0.005	0.032
Richmond	2	ROW_243	ROW Opportunity	9.52	6.21	65%	0.002	0.032
Richmond	2	ROW_282	ROW Opportunity	5.99	4.14	69%	0.002	0.032
Richmond	2	GIP_00146 / planned_488	Parcel-Based Opportunity (aspirational)	2.69	1.81	67%	0.004	0.031
Richmond	2	Parcel_119762	Regional Opportunity	1.08	0.35	32%	0.008	0.031
Richmond	2	Parcel_125511	Parcel-Based Opportunity	0.17	0.11	65%	0.047	0.031
Richmond	2	Parcel_142243	Regional Opportunity	0.79	0.65	82%	0.012	0.031
Richmond	2	Parcel_207080	Parcel-Based Opportunity	11.36	4.54	40%	0.001	0.031
Richmond	2	ROW_19630	ROW Opportunity	2.57	0.92	36%	0.004	0.031
Richmond	2	ROW_259	ROW Opportunity	7.70	5.06	66%	0.002	0.031
Richmond	2	ROW_298	ROW Opportunity	5.20	3.55	68%	0.003	0.031
Richmond	2	ROW_323	ROW Opportunity	5.79	3.97	69%	0.002	0.031
Richmond	2	ROW_16432	ROW Opportunity	0.17	0.13	76%	0.042	0.030
Richmond	2	ROW_16444	ROW Opportunity	1.83	1.25	68%	0.005	0.030
Richmond	2	ROW_16533	ROW Opportunity	0.59	0.36	61%	0.014	0.030
Richmond	2	ROW_5978	ROW Opportunity	1.46	0.86	59%	0.007	0.030
Richmond	2	ROW_80	ROW Opportunity	0.96	0.68	71%	0.009	0.030
Richmond	2	Parcel_198527	Parcel-Based Opportunity	7.70	0.55	7%	0.002	0.029
Richmond	2	ROW_11807	ROW Opportunity	9.05	5.81	64%	0.001	0.029
Richmond	2	ROW_12123	ROW Opportunity	8.06	5.15	64%	0.002	0.029
Richmond	2	ROW_12145	ROW Opportunity	8.39	5.45	65%	0.002	0.029
Richmond	2	ROW_21089	ROW Opportunity	2.88	1.39	48%	0.003	0.029
Richmond	2	GIP_00159 / planned_519	Parcel-Based Opportunity (aspirational)	7.69	5.20	68%	0.002	0.028
Richmond	2	Parcel_120253	Parcel-Based Opportunity	0.33	0.14	42%	0.021	0.028
Richmond	2	Parcel_150301	Regional Opportunity	0.90	0.66	73%	0.009	0.028
Richmond	2	ROW_10074	ROW Opportunity	9.03	5.68	63%	0.001	0.028
Richmond	2	ROW_10718	ROW Opportunity	7.91	4.98	63%	0.002	0.028
Richmond	2	ROW_16439	ROW Opportunity	1.16	0.76	66%	0.008	0.028
Richmond	2	ROW_16546	ROW Opportunity	2.59	1.81	70%	0.004	0.028
Richmond	2	ROW_7714	ROW Opportunity	6.37	4.16	65%	0.002	0.028
Richmond	2	GIP_00157 / planned_517	Parcel-Based Opportunity (aspirational)	6.85	4.64	68%	0.002	0.027
Richmond	2	ROW_13419	ROW Opportunity	1.62	1.06	65%	0.006	0.027
Richmond	2	ROW_16451	ROW Opportunity	5.28	3.42	65%	0.002	0.027
Richmond	2	ROW_16525	ROW Opportunity	1.21	0.69	57%	0.007	0.027
Richmond	2	ROW_20279	ROW Opportunity	6.17	4.13	67%	0.002	0.027
Richmond	2	ROW_241	ROW Opportunity	7.41	4.90	66%	0.002	0.027
Richmond	2	ROW_280	ROW Opportunity	6.70	4.42	66%	0.002	0.027
Richmond	2	ROW_7716	ROW Opportunity	5.73	3.73	65%	0.002	0.027
Richmond	2	Parcel_150205	Regional Opportunity	0.89	0.61	69%	0.009	0.026
Richmond	2	Parcel_375468	Parcel-Based Opportunity	0.97	0.09	9%	0.009	0.026
Richmond	2	ROW_11626	ROW Opportunity	0.14	0.09	64%	0.044	0.026
Richmond	2	ROW_16463	ROW Opportunity	6.46	4.31	67%	0.002	0.026
Richmond	2	ROW_238	ROW Opportunity	0.20	0.14	70%	0.033	0.026
Richmond	2	ROW_7717	ROW Opportunity	2.09	1.39	67%	0.004	0.026
Richmond	2	ROW_8365	ROW Opportunity	9.43	5.05	54%	0.001	0.026
Richmond	2	ROW_8849	ROW Opportunity	6.28	4.11	65%	0.002	0.026
Richmond	2	ROW_9165	ROW Opportunity	0.31	0.19	61%	0.021	0.026
Richmond	2	ROW_9347	ROW Opportunity	8.44	5.50	65%	0.001	0.026
Richmond	2	Parcel_227484	Parcel-Based Opportunity	150.23	0.93	1%	0.000	0.025
Richmond	2	ROW_12098	ROW Opportunity	3.92	2.44	62%	0.003	0.025
Richmond	2	ROW_13064	ROW Opportunity	12.19	6.07	50%	0.001	0.025
Richmond	2	ROW_169	ROW Opportunity	0.64	0.50	78%	0.011	0.025
Richmond	2	ROW_190	ROW Opportunity	1.00	0.73	73%	0.008	0.025
Richmond	2	ROW_207	ROW Opportunity	0.87	0.60	69%	0.009	0.025
Richmond	2	ROW_252	ROW Opportunity	5.36	3.50	65%	0.002	0.025
Richmond	2	ROW_16476	ROW Opportunity	0.55	0.32	58%	0.012	0.024
Richmond	2	ROW_16495	ROW Opportunity	2.25	1.50	67%	0.004	0.024
Richmond	2	ROW_188	ROW Opportunity	1.08	0.78	72%	0.007	0.024
Richmond	2	ROW_9992	ROW Opportunity	2.54	1.65	65%	0.003	0.024
Richmond	2	GIP_00111 / Parcel_132965	Regional Opportunity (aspirational)	0.59	0.46	78%	0.011	0.023

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Richmond	2	GIP_00114 / Parcel_133558	Regional Opportunity (aspirational)	0.63	0.52	83%	0.011	0.023
Richmond	2	GIP_00131 / planned_186	Parcel-Based Opportunity (aspirational)	18.01	5.20	29%	0.001	0.023
Richmond	2	GIP_00135 / planned_468	Parcel-Based Opportunity (aspirational)	18.01	5.20	29%	0.001	0.023
Richmond	2	GIP_00161 / planned_521	Parcel-Based Opportunity (aspirational)	5.57	3.75	67%	0.002	0.023
Richmond	2	planned_174	Planned Unlined Swale	0.69	0.47	68%	0.010	0.023
Richmond	2	ROW_11010	ROW Opportunity	5.64	3.65	65%	0.002	0.023
Richmond	2	ROW_11852	ROW Opportunity	0.88	0.58	66%	0.008	0.023
Richmond	2	ROW_128	ROW Opportunity	3.64	2.51	69%	0.003	0.023
Richmond	2	ROW_14749	ROW Opportunity	1.79	0.86	48%	0.004	0.023
Richmond	2	ROW_16490	ROW Opportunity	2.47	1.59	64%	0.003	0.023
Richmond	2	ROW_216	ROW Opportunity	5.26	3.39	64%	0.002	0.023
Richmond	2	ROW_284	ROW Opportunity	4.68	3.14	67%	0.002	0.023
Richmond	2	ROW_345	ROW Opportunity	7.17	4.37	61%	0.001	0.023
Richmond	2	ROW_4274	ROW Opportunity	0.75	0.51	68%	0.009	0.023
Richmond	2	ROW_59	ROW Opportunity	1.06	0.68	64%	0.007	0.023
Richmond	2	ROW_7798	ROW Opportunity	3.24	2.02	62%	0.003	0.023
Richmond	2	ROW_862	ROW Opportunity	0.62	0.49	79%	0.011	0.023
Richmond	2	GIP_00113 / Parcel_133528	Regional Opportunity (aspirational)	0.61	0.50	82%	0.011	0.022
Richmond	2	GIP_00164 / planned_529	Parcel-Based Opportunity (aspirational)	8.35	3.96	47%	0.001	0.022
Richmond	2	Parcel_177214	Parcel-Based Opportunity	11.57	5.65	49%	0.001	0.022
Richmond	2	Parcel_197712	Parcel-Based Opportunity	0.34	0.05	15%	0.017	0.022
Richmond	2	Parcel_231444	Parcel-Based Opportunity	9.82	5.16	53%	0.001	0.022
Richmond	2	planned_514	Planned Unlined Swale	0.26	0.17	65%	0.022	0.022
Richmond	2	ROW_14348	ROW Opportunity	4.73	2.85	60%	0.002	0.022
Richmond	2	ROW_16540	ROW Opportunity	3.11	1.96	63%	0.003	0.022
Richmond	2	ROW_16547	ROW Opportunity	3.20	2.06	64%	0.003	0.022
Richmond	2	ROW_4556	ROW Opportunity	4.85	2.97	61%	0.002	0.022
Richmond	2	ROW_6276	ROW Opportunity	0.11	0.08	73%	0.051	0.022
Richmond	2	ROW_6850	ROW Opportunity	5.70	3.79	66%	0.002	0.022
Richmond	2	ROW_7554	ROW Opportunity	4.93	2.93	59%	0.002	0.022
Richmond	2	ROW_8344	ROW Opportunity	2.79	1.43	51%	0.003	0.022
Richmond	2	ROW_9354	ROW Opportunity	4.61	2.81	61%	0.002	0.022
Richmond	2	Parcel_136865	Regional Opportunity	0.56	0.40	71%	0.011	0.021
Richmond	2	Parcel_142495	Regional Opportunity	1.67	1.01	60%	0.004	0.021
Richmond	2	Parcel_150789	Regional Opportunity	0.68	0.49	72%	0.009	0.021
Richmond	2	ROW_16459	ROW Opportunity	3.83	2.58	67%	0.002	0.021
Richmond	2	ROW_20540	ROW Opportunity	1.86	1.20	65%	0.004	0.021
Richmond	2	ROW_4128	ROW Opportunity	0.53	0.40	75%	0.011	0.021
Richmond	2	ROW_4276	ROW Opportunity	1.18	0.85	72%	0.006	0.021
Richmond	2	ROW_4470	ROW Opportunity	5.90	3.81	65%	0.002	0.021
Richmond	2	ROW_68	ROW Opportunity	3.20	2.16	68%	0.003	0.021
Richmond	2	Parcel_164500	Regional Opportunity	1.15	0.45	39%	0.005	0.020
Richmond	2	planned_187	Planned Unlined Bioretention	0.48	0.29	60%	0.012	0.020
Richmond	2	ROW_12816	ROW Opportunity	5.38	3.23	60%	0.002	0.020
Richmond	2	ROW_13418	ROW Opportunity	2.49	1.71	69%	0.003	0.020
Richmond	2	ROW_16450	ROW Opportunity	5.38	3.61	67%	0.002	0.020
Richmond	2	ROW_16677	ROW Opportunity	4.69	2.78	59%	0.002	0.020
Richmond	2	ROW_18208	ROW Opportunity	1.75	1.14	65%	0.004	0.020
Richmond	2	ROW_1991	ROW Opportunity	7.58	4.72	62%	0.001	0.020
Richmond	2	ROW_20007	ROW Opportunity	6.72	4.21	63%	0.001	0.020
Richmond	2	ROW_501	ROW Opportunity	5.00	3.06	61%	0.002	0.020
Richmond	2	ROW_6847	ROW Opportunity	5.45	3.61	66%	0.002	0.020
Richmond	2	ROW_7333	ROW Opportunity	3.29	2.13	65%	0.003	0.020
Richmond	2	ROW_7747	ROW Opportunity	4.04	2.68	66%	0.002	0.020
Richmond	2	ROW_9126	ROW Opportunity	1.07	0.38	36%	0.005	0.020
Richmond	2	GIP_00126 / planned_141	Parcel-Based Opportunity (aspirational)	18.40	3.20	17%	0.000	0.019
Richmond	2	Parcel_196851	Parcel-Based Opportunity	4.96	0.08	2%	0.002	0.019
Richmond	2	ROW_12536	ROW Opportunity	2.88	1.31	45%	0.003	0.019
Richmond	2	ROW_16534	ROW Opportunity	1.86	1.27	68%	0.004	0.019
Richmond	2	ROW_17129	ROW Opportunity	10.19	4.51	44%	0.001	0.019
Richmond	2	ROW_3972	ROW Opportunity	0.65	0.40	62%	0.009	0.019
Richmond	2	ROW_6954	ROW Opportunity	0.73	0.55	75%	0.008	0.019
Richmond	2	GIP_00118 / Parcel_140096	Parcel-Based Opportunity (aspirational)	6.62	4.81	73%	0.001	0.018
Richmond	2	GIP_00152 / planned_511	Parcel-Based Opportunity (aspirational)	2.00	1.36	68%	0.003	0.018
Richmond	2	GIP_00162 / planned_522	Parcel-Based Opportunity (aspirational)	5.90	4.00	68%	0.001	0.018
Richmond	2	Parcel_126885	Regional Opportunity	1.12	0.39	35%	0.005	0.018
Richmond	2	Parcel_151124	Parcel-Based Opportunity	0.47	0.35	74%	0.011	0.018
Richmond	2	Parcel_151604	Regional Opportunity	0.50	0.42	84%	0.011	0.018
Richmond	2	Parcel_152942	Regional Opportunity	0.52	0.42	81%	0.010	0.018
Richmond	2	ROW_160	ROW Opportunity	4.58	3.15	69%	0.002	0.018
Richmond	2	ROW_16470	ROW Opportunity	2.55	1.66	65%	0.003	0.018
Richmond	2	ROW_20777	ROW Opportunity	1.92	1.28	67%	0.003	0.018
Richmond	2	ROW_213	ROW Opportunity	5.91	3.79	64%	0.001	0.018
Richmond	2	ROW_2915	ROW Opportunity	4.41	2.90	66%	0.002	0.018
Richmond	2	ROW_2928	ROW Opportunity	3.99	2.40	60%	0.002	0.018
Richmond	2	ROW_3295	ROW Opportunity	0.13	0.06	46%	0.035	0.018
Richmond	2	ROW_4531	ROW Opportunity	0.29	0.15	52%	0.016	0.018
Richmond	2	ROW_6066	ROW Opportunity	0.37	0.11	30%	0.013	0.018
Richmond	2	ROW_67	ROW Opportunity	1.78	1.28	72%	0.004	0.018
Richmond	2	Parcel_209985	Parcel-Based Opportunity	7.78	4.24	54%	0.001	0.017
Richmond	2	planned_489	Planned Unlined Bioretention	1.91	1.34	70%	0.003	0.017
Richmond	2	ROW_16453	ROW Opportunity	4.49	2.90	65%	0.002	0.017
Richmond	2	ROW_16524	ROW Opportunity	0.17	0.12	71%	0.027	0.017
Richmond	2	ROW_16920	ROW Opportunity	0.89	0.46	52%	0.006	0.017
Richmond	2	ROW_17076	ROW Opportunity	4.77	2.85	60%	0.002	0.017
Richmond	2	ROW_290	ROW Opportunity	1.30	0.94	72%	0.005	0.017
Richmond	2	ROW_4396	ROW Opportunity	2.92	1.91	65%	0.002	0.017
Richmond	2	GIP_00141 / planned_480	Parcel-Based Opportunity (aspirational)	3.92	2.68	68%	0.002	0.016
Richmond	2	Parcel_150106	Parcel-Based Opportunity	0.47	0.36	77%	0.010	0.016
Richmond	2	Parcel_50787	Parcel-Based Opportunity	0.13	0.09	69%	0.032	0.016
Richmond	2	planned_94	Planned Creek/Marsh Restoration	4.16	2.12	51%	0.002	0.016
Richmond	2	ROW_115	ROW Opportunity	3.74	2.52	67%	0.002	0.016
Richmond	2	ROW_1385	ROW Opportunity	0.62	0.34	55%	0.008	0.016
Richmond	2	ROW_250	ROW Opportunity	2.22	1.47	66%	0.003	0.016

Jurisdiction	Permit	Project ID	Project Type	Area (Acres)	Impervious Area (Acres)	Percent Impervious	PCBs Yield (g/acre)	PCBs Mass reduced (g)
Richmond	2	ROW_314	ROW Opportunity	4.06	2.72	67%	0.002	0.016
Richmond	2	ROW_3741	ROW Opportunity	0.59	0.40	68%	0.008	0.016
Richmond	2	ROW_4398	ROW Opportunity	3.21	2.08	65%	0.002	0.016
Richmond	2	ROW_4866	ROW Opportunity	5.85	3.86	66%	0.001	0.016
Richmond	2	GIP_00124 / planned_137	Parcel-Based Opportunity (aspirational)	9.66	3.71	38%	0.001	0.015
Richmond	2	Parcel_160376	Parcel-Based Opportunity	4.81	4.00	83%	0.001	0.015
Richmond	2	ROW_12101	ROW Opportunity	1.93	1.31	68%	0.003	0.015
Richmond	2	ROW_16447	ROW Opportunity	3.16	2.13	67%	0.002	0.015
Richmond	2	ROW_16479	ROW Opportunity	0.89	0.59	66%	0.006	0.015
Richmond	2	ROW_17605	ROW Opportunity	7.60	3.45	45%	0.001	0.015
Richmond	2	ROW_18926	ROW Opportunity	4.43	2.72	61%	0.002	0.015
Richmond	2	ROW_20542	ROW Opportunity	0.72	0.51	71%	0.007	0.015
Richmond	2	ROW_20895	ROW Opportunity	0.46	0.22	48%	0.009	0.015
Richmond	2	ROW_21152	ROW Opportunity	4.90	3.36	69%	0.002	0.015
Richmond	2	ROW_258	ROW Opportunity	0.55	0.39	71%	0.008	0.015
Richmond	2	ROW_6047	ROW Opportunity	4.81	3.21	67%	0.001	0.015
Richmond	2	ROW_78	ROW Opportunity	0.84	0.63	75%	0.006	0.015
Richmond	2	ROW_81	ROW Opportunity	1.73	1.19	69%	0.003	0.015
Richmond	2	ROW_93	ROW Opportunity	5.91	3.85	65%	0.001	0.015
Richmond	2	Parcel_136418	Regional Opportunity	0.51	0.31	61%	0.008	0.014
Richmond	2	Parcel_139156	Regional Opportunity	2.90	1.37	47%	0.002	0.014
Richmond	2	Parcel_139599	Parcel-Based Opportunity	5.30	3.53	67%	0.001	0.014
Richmond	2	Parcel_143456	Parcel-Based Opportunity	0.42	0.32	76%	0.010	0.014
Richmond	2	Parcel_143637	Regional Opportunity	0.71	0.32	45%	0.006	0.014
Richmond	2	Parcel_191941	Parcel-Based Opportunity	7.01	0.25	4%	0.000	0.014
Richmond	2	Parcel_375481	Parcel-Based Opportunity	4.63	2.18	47%	0.002	0.014
Richmond	2	Parcel_47763	Parcel-Based Opportunity	4.66	2.90	62%	0.001	0.014
Richmond	2	ROW_11012	ROW Opportunity	2.36	1.46	62%	0.002	0.014
Richmond	2	ROW_129	ROW Opportunity	0.42	0.29	69%	0.010	0.014
Richmond	2	ROW_14437	ROW Opportunity	13.77	3.20	23%	0.000	0.014
Richmond	2	ROW_16491	ROW Opportunity	1.26	0.81	64%	0.004	0.014
Richmond	2	ROW_16494	ROW Opportunity	2.27	1.51	67%	0.003	0.014
Richmond	2	ROW_16611	ROW Opportunity	1.02	0.78	76%	0.005	0.014
Richmond	2	ROW_19951	ROW Opportunity	4.44	2.66	60%	0.002	0.014
Richmond	2	ROW_20316	ROW Opportunity	2.88	1.90	66%	0.002	0.014
Richmond	2	ROW_286	ROW Opportunity	2.29	1.57	69%	0.003	0.014
Richmond	2	ROW_89	ROW Opportunity	1.38	0.90	65%	0.004	0.014
Richmond	2	ROW_9417	ROW Opportunity	2.08	1.34	64%	0.003	0.014
Richmond	2	GIP_00127 / planned_171	Parcel-Based Opportunity (aspirational)	16.16	2.93	18%	0.000	0.013
Richmond	2	GIP_00138 / planned_475	Parcel-Based Opportunity (aspirational)	16.16	2.93	18%	0.000	0.013
Richmond	2	GIP_00149 / planned_508	Parcel-Based Opportunity (aspirational)	3.47	2.33	67%	0.002	0.013
Richmond	2	GIP_00175 / ROW_17569	ROW Opportunity (aspirational)	2.96	1.75	59%	0.002	0.013
Richmond	2	Parcel_112290	Regional Opportunity	1.12	0.16	14%	0.005	0.013
Richmond	2	Parcel_155750	Parcel-Based Opportunity	0.43	0.30	70%	0.009	0.013
Richmond	2	ROW_12140	ROW Opportunity	0.81	0.58	72%	0.006	0.013
Richmond	2	ROW_163	ROW Opportunity	5.21	3.41	65%	0.001	0.013
Richmond	2	ROW_194	ROW Opportunity	4.22	2.78	66%	0.001	0.013
Richmond	2	ROW_2595	ROW Opportunity	1.07	0.42	39%	0.004	0.013
Richmond	2	ROW_6848	ROW Opportunity	2.21	1.46	66%	0.002	0.013
Richmond	2	ROW_7330	ROW Opportunity	5.35	3.48	65%	0.001	0.013
Richmond	2	ROW_8151	ROW Opportunity	4.36	2.94	67%	0.001	0.013
Richmond	2	GIP_00160 / planned_520	Parcel-Based Opportunity (aspirational)	2.35	1.60	68%	0.002	0.012
Richmond	2	Parcel_147723	Parcel-Based Opportunity	0.34	0.27	79%	0.010	0.012
Richmond	2	Parcel_150072	Parcel-Based Opportunity	0.36	0.27	75%	0.010	0.012
Richmond	2	Parcel_211418	Parcel-Based Opportunity	9.02	2.38	26%	0.001	0.012
Richmond	2	Parcel_225370	Parcel-Based Opportunity	25.07	3.05	12%	0.000	0.012
Richmond	2	Parcel_375470	Parcel-Based Opportunity	57.79	1.88	3%	0.000	0.012
Richmond	2	ROW_132	ROW Opportunity	1.65	1.13	68%	0.003	0.012
Richmond	2	ROW_13338	ROW Opportunity	1.01	0.70	69%	0.004	0.012
Richmond	2	ROW_14167	ROW Opportunity	4.84	3.18	66%	0.001	0.012
Richmond	2	ROW_14369	ROW Opportunity	0.27	0.09	33%	0.012	0.012
Richmond	2	ROW_16466	ROW Opportunity	3.17	2.13	67%	0.002	0.012
Richmond	2	ROW_16474	ROW Opportunity	2.85	1.84	65%	0.002	0.012
Richmond	2	ROW_16502	ROW Opportunity	2.06	1.33	65%	0.002	0.012
Richmond	2	ROW_204	ROW Opportunity	4.79	3.07	64%	0.001	0.012
Richmond	2	ROW_253	ROW Opportunity	4.86	3.10	64%	0.001	0.012
Richmond	2	ROW_281	ROW Opportunity	0.38	0.28	74%	0.010	0.012
Richmond	2	ROW_4277	ROW Opportunity	0.43	0.27	63%	0.008	0.012
Richmond	2	ROW_5573	ROW Opportunity	1.06	0.63	59%	0.004	0.012
Richmond	2	ROW_6101	ROW Opportunity	4.34	2.67	62%	0.001	0.012
Richmond	2	ROW_6558	ROW Opportunity	1.87	1.00	53%	0.002	0.012
Richmond	2	ROW_7748	ROW Opportunity	4.34	2.86	66%	0.001	0.012
Richmond	2	ROW_913	ROW Opportunity	0.22	0.10	45%	0.015	0.012
Richmond	2	ROW_9680	ROW Opportunity	2.49	1.58	63%	0.002	0.012
Richmond	2	GIP_00133 / planned_193	Parcel-Based Opportunity (aspirational)	0.97	0.27	28%	0.004	0.011
Richmond	2	GIP_00150 / planned_509	Parcel-Based Opportunity (aspirational)	3.02	2.04	68%	0.002	0.011
Richmond	2	GIP_00151 / planned_510	Parcel-Based Opportunity (aspirational)	2.11	1.43	68%	0.002	0.011
Richmond	2	Parcel_112193	Parcel-Based Opportunity	0.18	0.07	39%	0.016	0.011
Richmond	2	Parcel_116931	Parcel-Based Opportunity	11.22	0.40	4%	0.000	0.011
Richmond	2	Parcel_121594	Parcel-Based Opportunity	3.20	1.53	48%	0.002	0.011
Richmond	2	Parcel_128233	Parcel-Based Opportunity	3.85	2.80	73%	0.001	0.011
Richmond	2	Parcel_145759	Parcel-Based Opportunity	0.34	0.25	74%	0.010	0.011
Richmond	2	Parcel_149557	Parcel-Based Opportunity	0.35	0.25	71%	0.009	0.011
Richmond	2	Parcel_150416	Parcel-Based Opportunity	0.32	0.27	84%	0.011	0.011
Richmond	2	Parcel_152538	Parcel-Based Opportunity	0.37	0.26	70%	0.009	0.011
Richmond	2	Parcel_167393	Parcel-Based Opportunity	4.98	2.79	56%	0.001	0.011
Richmond	2	Parcel_243861	Parcel-Based Opportunity	33.58	2.75	8%	0.000	0.011
Richmond	2	ROW_111	ROW Opportunity	3.22	2.10	65%	0.002	0.011
Richmond	2	ROW_11660	ROW Opportunity	0.34	0.18	53%	0.010	0.011
Richmond	2	ROW_13123	ROW Opportunity	1.20	0.83	69%	0.003	0.011
Richmond	2	ROW_14811	ROW Opportunity	0.29	0.19	66%	0.011	0.011
Richmond	2	ROW_16446	ROW Opportunity	1.36	0.89	65%	0.003	0.011
Richmond	2	ROW_16468	ROW Opportunity	3.10	2.04	66%	0.002	0.011
Richmond	2	ROW_16483	ROW Opportunity	2.83	1.77	63%	0.002	0.011

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Richmond	2	ROW_19203	ROW Opportunity	3.74	2.18	58%	0.001	0.011
Richmond	2	ROW_19688	ROW Opportunity	4.52	2.76	61%	0.001	0.011
Richmond	2	ROW_20469	ROW Opportunity	2.29	1.56	68%	0.002	0.011
Richmond	2	ROW_249	ROW Opportunity	4.36	2.85	65%	0.001	0.011
Richmond	2	ROW_322	ROW Opportunity	4.52	3.02	67%	0.001	0.011
Richmond	2	ROW_3981	ROW Opportunity	2.93	1.87	64%	0.002	0.011
Richmond	2	ROW_4397	ROW Opportunity	3.99	2.39	60%	0.001	0.011
Richmond	2	ROW_9967	ROW Opportunity	5.27	2.53	48%	0.001	0.011
Richmond	2	GIP_00115 / Parcel_135904	Parcel-Based Opportunity (aspirational)	8.78	2.30	26%	0.001	0.010
Richmond	2	planned_490	Planned Unlined Bioretention	3.29	2.20	67%	0.001	0.010
Richmond	2	ROW_106	ROW Opportunity	2.85	1.90	67%	0.002	0.010
Richmond	2	ROW_12330	ROW Opportunity	0.08	0.04	50%	0.032	0.010
Richmond	2	ROW_14072	ROW Opportunity	1.98	1.16	59%	0.002	0.010
Richmond	2	ROW_16841	ROW Opportunity	3.01	1.97	65%	0.002	0.010
Richmond	2	ROW_17073	ROW Opportunity	3.30	2.03	62%	0.002	0.010
Richmond	2	ROW_17322	ROW Opportunity	0.62	0.22	35%	0.005	0.010
Richmond	2	ROW_3014	ROW Opportunity	0.11	0.07	64%	0.025	0.010
Richmond	2	GIP_00110 / Parcel_109368	Parcel-Based Opportunity (aspirational)	3.40	2.17	64%	0.001	0.009
Richmond	2	GIP_00169 / ROW_15040	ROW Opportunity (aspirational)	1.55	0.99	64%	0.003	0.009
Richmond	2	GIP_00172 / ROW_16800	ROW Opportunity (aspirational)	3.21	1.91	60%	0.001	0.008
Richmond	2	GIP_00130 / planned_185	Parcel-Based Opportunity (aspirational)	6.84	1.74	25%	0.001	0.007
Richmond	2	GIP_00134 / planned_467	Parcel-Based Opportunity (aspirational)	6.84	1.74	25%	0.001	0.007
Richmond	2	GIP_00143 / planned_482	Parcel-Based Opportunity (aspirational)	2.83	1.88	66%	0.001	0.007
Richmond	2	GIP_00168 / ROW_12341	ROW Opportunity (aspirational)	2.99	1.76	59%	0.001	0.007
Richmond	2	GIP_00156 / planned_516	Parcel-Based Opportunity (aspirational)	2.16	1.44	67%	0.001	0.006
Richmond	2	GIP_00176 / ROW_2981	ROW Opportunity (aspirational)	2.42	1.41	58%	0.001	0.006
Richmond	2	GIP_00117 / Parcel_137234	Regional Opportunity (aspirational)	2.25	0.99	44%	0.001	0.004
Richmond	2	GIP_00119 / Parcel_140108	Regional Opportunity (aspirational)	1.53	1.06	69%	0.001	0.004
Richmond	2	GIP_00154 / planned_513	Parcel-Based Opportunity (aspirational)	1.69	1.13	67%	0.001	0.004
Richmond	2	GIP_00132 / planned_192	Parcel-Based Opportunity (aspirational)	2.19	0.73	33%	0.001	0.003
Richmond	2	GIP_00137 / planned_474	Parcel-Based Opportunity (aspirational)	2.19	0.73	33%	0.001	0.003
Richmond	2	GIP_00155 / planned_515	Parcel-Based Opportunity (aspirational)	1.39	0.94	68%	0.001	0.003
Richmond	2	GIP_00158 / planned_518	Parcel-Based Opportunity (aspirational)	1.02	0.69	68%	0.001	0.003
Richmond	2	GIP_00163 / planned_525	Parcel-Based Opportunity (aspirational)	1.23	0.77	63%	0.001	0.003
Richmond	2	GIP_00116 / Parcel_136910	Regional Opportunity (aspirational)	0.65	0.27	42%	0.001	0.001
Richmond	2	GIP_00129 / planned_184	Parcel-Based Opportunity (aspirational)	0.01	0.01	100%	0.002	0.000
San Pablo	2	GIP_10057 / ROW_7812	ROW Opportunity (aspirational)	7.18	4.82	67%	0.038	1.114
San Pablo	2	ROW_16921	ROW Opportunity	12.99	7.46	57%	0.008	0.353
San Pablo	2	planned_36	Planned Flood Control Basin	38.92	17.91	46%	0.002	0.256
San Pablo	2	planned_162	Planned Unlined Bioretention	53.22	35.34	66%	0.002	0.246
San Pablo	2	ROW_16388	ROW Opportunity	7.27	5.13	71%	0.010	0.245
San Pablo	2	planned_302	Planned Creek/Marsh Restoration	3.18	1.46	46%	0.019	0.235
San Pablo	2	ROW_20797	ROW Opportunity	1.05	0.93	89%	0.051	0.214
San Pablo	2	ROW_7812	ROW Opportunity	1.06	0.70	66%	0.038	0.162
San Pablo	2	ROW_16905	ROW Opportunity	5.86	3.97	68%	0.007	0.138
San Pablo	2	ROW_16907	ROW Opportunity	7.77	5.24	67%	0.005	0.126
San Pablo	2	ROW_16903	ROW Opportunity	4.25	2.88	68%	0.008	0.119
San Pablo	2	ROW_6559	ROW Opportunity	12.76	7.53	59%	0.003	0.114
San Pablo	2	planned_304	Planned Creek/Marsh Restoration	28.94	14.49	50%	0.002	0.105
San Pablo	2	GIP_10065 / SD_MasterPlan	ROW Opportunity (aspirational)	29.73	19.48	66%	0.001	0.094
San Pablo	2	ROW_4126	ROW Opportunity	0.60	0.43	72%	0.038	0.092
San Pablo	2	ROW_19846	ROW Opportunity	6.35	3.77	59%	0.004	0.076
San Pablo	2	ROW_2698	ROW Opportunity	8.13	5.52	68%	0.003	0.074
San Pablo	2	ROW_2767	ROW Opportunity	1.26	0.75	60%	0.015	0.070
San Pablo	2	GIP_10055 / ROW_11891	ROW Opportunity (aspirational)	7.98	5.43	68%	0.003	0.068
San Pablo	2	ROW_189	ROW Opportunity	3.45	2.35	68%	0.006	0.068
San Pablo	2	ROW_2769	ROW Opportunity	5.25	2.83	54%	0.004	0.063
San Pablo	2	ROW_7219	ROW Opportunity	1.16	0.79	68%	0.014	0.061
San Pablo	2	ROW_9756	ROW Opportunity	3.58	2.30	64%	0.006	0.060
San Pablo	2	ROW_6033	ROW Opportunity	7.68	5.03	65%	0.003	0.055
San Pablo	2	ROW_77	ROW Opportunity	0.39	0.30	77%	0.034	0.052
San Pablo	2	ROW_4227	ROW Opportunity	4.63	2.97	64%	0.004	0.047
San Pablo	2	ROW_192	ROW Opportunity	3.68	2.55	69%	0.004	0.045
San Pablo	2	ROW_18421	ROW Opportunity	9.68	6.08	63%	0.002	0.039
San Pablo	2	ROW_786	ROW Opportunity	5.66	3.27	58%	0.003	0.039
San Pablo	2	ROW_16914	ROW Opportunity	2.49	1.66	67%	0.005	0.037
San Pablo	2	ROW_16014	ROW Opportunity	5.29	3.53	67%	0.003	0.036
San Pablo	2	ROW_18397	ROW Opportunity	2.76	1.78	64%	0.004	0.035
San Pablo	2	ROW_4228	ROW Opportunity	2.60	1.68	65%	0.005	0.035
San Pablo	2	GIP_10056 / ROW_18927	ROW Opportunity (aspirational)	6.33	4.23	67%	0.002	0.033
San Pablo	2	ROW_18924	ROW Opportunity	0.25	0.19	76%	0.033	0.032
San Pablo	2	ROW_16015	ROW Opportunity	1.34	0.88	66%	0.007	0.031
San Pablo	2	ROW_15641	ROW Opportunity	4.30	2.76	64%	0.003	0.030
San Pablo	2	ROW_4668	ROW Opportunity	2.52	1.68	67%	0.004	0.030
San Pablo	2	ROW_12843	ROW Opportunity	2.13	1.52	71%	0.005	0.029
San Pablo	2	ROW_167	ROW Opportunity	6.95	4.63	67%	0.002	0.028
San Pablo	2	ROW_6930	ROW Opportunity	0.90	0.64	71%	0.009	0.028
San Pablo	2	ROW_15350	ROW Opportunity	1.12	0.66	59%	0.007	0.027
San Pablo	2	ROW_19954	ROW Opportunity	3.17	2.07	65%	0.003	0.027
San Pablo	2	ROW_20000	ROW Opportunity	1.97	1.36	69%	0.005	0.027
San Pablo	2	ROW_165	ROW Opportunity	5.88	3.79	64%	0.002	0.026
San Pablo	2	ROW_17042	ROW Opportunity	5.45	3.63	67%	0.002	0.025
San Pablo	2	ROW_11891	ROW Opportunity	1.83	1.26	69%	0.005	0.024
San Pablo	2	ROW_12558	ROW Opportunity	8.04	4.68	58%	0.001	0.023
San Pablo	2	ROW_16390	ROW Opportunity	1.74	1.08	62%	0.005	0.023
San Pablo	2	ROW_4473	ROW Opportunity	1.50	0.88	59%	0.005	0.022
San Pablo	2	Parcel_177888	Regional Opportunity	0.72	0.48	67%	0.009	0.021
San Pablo	2	ROW_12611	ROW Opportunity	2.08	1.46	70%	0.004	0.021
San Pablo	2	ROW_4651	ROW Opportunity	1.36	0.86	63%	0.005	0.021
San Pablo	2	ROW_21121	ROW Opportunity	4.48	2.81	63%	0.002	0.020
San Pablo	2	ROW_52	ROW Opportunity	3.36	1.97	59%	0.002	0.020
San Pablo	2	Parcel_174149	Regional Opportunity	1.30	0.40	31%	0.004	0.019
San Pablo	2	planned_155	Planned Creek/Marsh Restoration	0.31	0.18	58%	0.016	0.019
San Pablo	2	ROW_10495	ROW Opportunity	2.74	1.83	67%	0.003	0.019

Jurisdiction	Permit	Project ID	Project Type	Area (Acres)	Impervious Area (Acres)	Percent Impervious	PCBs Yield (g/acre)	PCBs Mass reduced (g)
San Pablo	2	ROW_4471	ROW Opportunity	1.20	0.64	53%	0.005	0.019
San Pablo	2	planned_325	Planned Unlined Bioretention	5.36	1.64	31%	0.001	0.018
San Pablo	2	ROW_11364	ROW Opportunity	0.57	0.40	70%	0.009	0.018
San Pablo	2	ROW_11808	ROW Opportunity	0.75	0.49	65%	0.008	0.018
San Pablo	2	ROW_125	ROW Opportunity	4.82	3.00	62%	0.002	0.018
San Pablo	2	ROW_12612	ROW Opportunity	2.24	1.38	62%	0.003	0.018
San Pablo	2	ROW_171	ROW Opportunity	3.11	1.99	64%	0.002	0.018
San Pablo	2	ROW_18927	ROW Opportunity	0.12	0.08	67%	0.039	0.018
San Pablo	2	ROW_65	ROW Opportunity	6.84	4.46	65%	0.001	0.018
San Pablo	2	ROW_13089	ROW Opportunity	1.15	0.81	70%	0.005	0.016
San Pablo	2	ROW_16916	ROW Opportunity	0.68	0.48	71%	0.007	0.016
San Pablo	2	ROW_2963	ROW Opportunity	3.78	2.51	66%	0.002	0.016
San Pablo	2	Parcel_190737	Parcel-Based Opportunity	11.43	3.64	32%	0.001	0.015
San Pablo	2	ROW_108	ROW Opportunity	3.27	2.07	63%	0.002	0.015
San Pablo	2	ROW_14830	ROW Opportunity	3.59	2.40	67%	0.002	0.015
San Pablo	2	ROW_170	ROW Opportunity	4.03	2.63	65%	0.002	0.015
San Pablo	2	ROW_19776	ROW Opportunity	2.43	1.55	64%	0.002	0.014
San Pablo	2	planned_172	Planned Unlined Swale	2.97	1.38	46%	0.002	0.013
San Pablo	2	planned_303	Planned Creek/Marsh Restoration	2.48	1.06	43%	0.002	0.013
San Pablo	2	planned_342	Planned Creek/Marsh Restoration	3.00	1.41	47%	0.002	0.013
San Pablo	2	planned_343	Planned Habitat Restoration	3.01	1.41	47%	0.002	0.013
San Pablo	2	planned_413	Planned Unlined Bioretention	2.97	1.38	46%	0.002	0.013
San Pablo	2	ROW_16389	ROW Opportunity	1.15	0.78	68%	0.004	0.013
San Pablo	2	ROW_3087	ROW Opportunity	3.36	2.28	68%	0.002	0.013
San Pablo	2	ROW_2765	ROW Opportunity	0.45	0.32	71%	0.008	0.012
San Pablo	2	ROW_7319	ROW Opportunity	0.65	0.48	74%	0.006	0.012
San Pablo	2	planned_159	Planned Flood Control	0.94	0.44	47%	0.004	0.011
San Pablo	2	planned_160	Planned Flood Control	0.94	0.44	47%	0.004	0.011
San Pablo	2	ROW_114	ROW Opportunity	2.62	1.66	63%	0.002	0.011
San Pablo	2	ROW_14301	ROW Opportunity	3.39	2.13	63%	0.002	0.011
San Pablo	2	ROW_15832	ROW Opportunity	0.35	0.24	69%	0.009	0.011
San Pablo	2	ROW_20998	ROW Opportunity	2.84	1.84	65%	0.002	0.011
San Pablo	2	ROW_11348	ROW Opportunity	1.55	1.05	68%	0.003	0.010
San Pablo	2	ROW_18545	ROW Opportunity	1.13	0.78	69%	0.003	0.010
San Pablo	2	ROW_604	ROW Opportunity	2.68	1.72	64%	0.002	0.010
San Ramon	2	ROW_16937	ROW Opportunity	14.91	8.01	54%	0.008	0.404
San Ramon	2	ROW_5150	ROW Opportunity	17.26	9.38	54%	0.006	0.361
San Ramon	2	Parcel_1429	Parcel-Based Opportunity	7.08	3.05	43%	0.012	0.288
San Ramon	2	ROW_16938	ROW Opportunity	44.75	26.81	60%	0.002	0.202
San Ramon	2	Parcel_1424	Parcel-Based Opportunity	3.25	2.00	62%	0.016	0.177
San Ramon	2	ROW_13922	ROW Opportunity	5.32	2.95	55%	0.010	0.166
San Ramon	2	ROW_5023	ROW Opportunity	5.42	2.58	48%	0.009	0.161
San Ramon	2	Parcel_74168	Parcel-Based Opportunity	4.28	3.30	77%	0.010	0.154
San Ramon	2	ROW_19140	ROW Opportunity	13.00	6.76	52%	0.003	0.112
San Ramon	2	ROW_560	ROW Opportunity	48.47	23.77	49%	0.001	0.102
San Ramon	2	ROW_14434	ROW Opportunity	2.77	1.52	55%	0.011	0.095
San Ramon	2	ROW_16426	ROW Opportunity	1.39	0.84	60%	0.016	0.077
San Ramon	2	ROW_13536	ROW Opportunity	15.98	8.39	53%	0.002	0.068
San Ramon	2	Parcel_59728	Parcel-Based Opportunity	40.01	15.74	39%	0.001	0.066
San Ramon	2	ROW_9268	ROW Opportunity	1.38	0.82	59%	0.013	0.060
San Ramon	2	ROW_19361	ROW Opportunity	0.95	0.61	64%	0.015	0.052
San Ramon	2	ROW_5451	ROW Opportunity	24.69	12.16	49%	0.001	0.049
San Ramon	2	Parcel_74549	Regional Opportunity	0.89	0.57	64%	0.015	0.048
San Ramon	2	ROW_7238	ROW Opportunity	5.09	2.65	52%	0.003	0.047
San Ramon	2	ROW_2693	ROW Opportunity	27.57	13.61	49%	0.001	0.046
San Ramon	2	ROW_14869	ROW Opportunity	14.80	6.94	47%	0.001	0.043
San Ramon	2	ROW_19759	ROW Opportunity	3.77	1.87	50%	0.004	0.043
San Ramon	2	Parcel_1440	Regional Opportunity	2.20	0.24	11%	0.005	0.039
San Ramon	2	ROW_14030	ROW Opportunity	3.62	2.17	60%	0.004	0.039
San Ramon	2	ROW_20234	ROW Opportunity	3.27	1.89	58%	0.004	0.037
San Ramon	2	ROW_2149	ROW Opportunity	14.02	7.03	50%	0.001	0.036
San Ramon	2	Parcel_54308	Regional Opportunity	1.18	0.65	55%	0.008	0.032
San Ramon	2	Parcel_73130	Regional Opportunity	1.30	0.32	25%	0.007	0.030
San Ramon	2	ROW_2328	ROW Opportunity	0.92	0.30	33%	0.009	0.030
San Ramon	2	ROW_5995	ROW Opportunity	8.73	3.50	40%	0.002	0.030
San Ramon	2	Parcel_1133	Parcel-Based Opportunity	9.50	2.66	28%	0.001	0.025
San Ramon	2	Parcel_56107	Parcel-Based Opportunity	16.67	5.24	31%	0.001	0.024
San Ramon	2	Parcel_56619	Parcel-Based Opportunity	11.96	4.45	37%	0.001	0.021
San Ramon	2	ROW_7425	ROW Opportunity	5.04	2.86	57%	0.002	0.020
San Ramon	2	Parcel_54147	Parcel-Based Opportunity	11.94	4.08	34%	0.001	0.019
San Ramon	2	ROW_11940	ROW Opportunity	5.68	2.26	40%	0.002	0.019
San Ramon	2	ROW_12822	ROW Opportunity	14.95	7.56	51%	0.000	0.019
San Ramon	2	ROW_3355	ROW Opportunity	4.30	1.88	44%	0.002	0.019
San Ramon	2	Parcel_56925	Parcel-Based Opportunity	10.03	3.99	40%	0.001	0.018
San Ramon	2	ROW_5148	ROW Opportunity	0.88	0.42	48%	0.007	0.018
San Ramon	2	ROW_17356	ROW Opportunity	7.97	3.72	47%	0.001	0.016
San Ramon	2	ROW_558	ROW Opportunity	2.14	1.25	58%	0.003	0.016
San Ramon	2	ROW_10130	ROW Opportunity	0.82	0.51	62%	0.005	0.014
San Ramon	2	ROW_10239	ROW Opportunity	6.36	3.22	51%	0.001	0.014
San Ramon	2	ROW_14016	ROW Opportunity	5.41	2.19	40%	0.001	0.014
San Ramon	2	ROW_17472	ROW Opportunity	3.74	1.78	48%	0.002	0.014
San Ramon	2	ROW_19366	ROW Opportunity	7.37	3.52	48%	0.001	0.014
San Ramon	2	ROW_6768	ROW Opportunity	2.05	1.31	64%	0.003	0.013
San Ramon	2	ROW_7432	ROW Opportunity	4.06	1.64	40%	0.001	0.013
San Ramon	2	ROW_18224	ROW Opportunity	5.30	2.56	48%	0.001	0.012
San Ramon	2	ROW_3115	ROW Opportunity	3.26	1.35	41%	0.002	0.012
San Ramon	2	ROW_14638	ROW Opportunity	5.32	2.59	49%	0.001	0.011
San Ramon	2	ROW_20860	ROW Opportunity	3.04	1.64	54%	0.002	0.011
San Ramon	2	ROW_6884	ROW Opportunity	4.99	2.61	52%	0.001	0.011
San Ramon	2	ROW_3070	ROW Opportunity	4.82	2.40	50%	0.001	0.010
San Ramon	2	ROW_3632	ROW Opportunity	4.57	2.38	52%	0.001	0.010
Unincorporated	2	planned_32	Planned Unlined Bioretention	460.01	217.16	47%	0.005	8.311
Unincorporated	2	Parcel_234358	Regional Opportunity	437.95	212.62	49%	0.005	8.269
Unincorporated	2	planned_426	Planned Creek/Marsh Restoration	11.44	3.32	29%	0.012	0.573

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Unincorporated	2	Parcel_253891	Parcel-Based Opportunity	31.99	2.26	7%	0.005	0.466
Unincorporated	2	ROW_18993	ROW Opportunity	4.03	1.35	33%	0.019	0.330
Unincorporated	2	Parcel_257160	Regional Opportunity	27.71	15.65	56%	0.004	0.312
Unincorporated	2	planned_928	Planned Unlined Bioretention	12.72	5.77	45%	0.006	0.285
Unincorporated	2	ROW_326	ROW Opportunity	5.29	3.11	59%	0.012	0.232
Unincorporated	2	planned_845	Planned Unlined Bioretention	9.56	4.74	50%	0.006	0.193
Unincorporated	2	planned_1251	Planned Unlined Bioretention	6.65	3.60	54%	0.008	0.180
Unincorporated	2	ROW_4127	ROW Opportunity	4.13	2.65	64%	0.012	0.180
Unincorporated	2	planned_134	Planned Unlined Bioretention	7.12	4.36	61%	0.007	0.172
Unincorporated	2	planned_1128	Planned Unlined Bioretention	18.84	6.19	33%	0.003	0.171
Unincorporated	2	planned_813	Planned Unlined Bioretention	6.43	3.65	57%	0.007	0.166
Unincorporated	2	ROW_336	ROW Opportunity	1.33	0.82	62%	0.031	0.166
Unincorporated	2	ROW_18095	ROW Opportunity	1.02	0.74	73%	0.040	0.164
Unincorporated	2	planned_834	Planned Unlined Bioretention	6.15	3.59	58%	0.007	0.160
Unincorporated	2	planned_1158	Planned Unlined Bioretention	4.47	2.62	59%	0.008	0.127
Unincorporated	2	Parcel_231873	Regional Opportunity	4.42	2.78	63%	0.008	0.126
Unincorporated	2	planned_922	Planned Unlined Bioretention	4.80	2.79	58%	0.007	0.124
Unincorporated	2	ROW_7003	ROW Opportunity	3.09	0.99	32%	0.009	0.116
Unincorporated	2	planned_910	Planned Unlined Bioretention	0.77	0.41	53%	0.030	0.098
Unincorporated	2	ROW_3884	ROW Opportunity	4.07	2.27	56%	0.007	0.098
Unincorporated	2	planned_921	Planned Unlined Bioretention	3.60	2.10	58%	0.007	0.093
Unincorporated	2	planned_944	Planned Unlined Bioretention	7.39	1.26	17%	0.003	0.091
Unincorporated	2	ROW_15893	ROW Opportunity	2.97	1.65	56%	0.008	0.078
Unincorporated	2	ROW_18461	ROW Opportunity	1.29	0.56	43%	0.015	0.077
Unincorporated	2	ROW_7816	ROW Opportunity	1.63	0.34	21%	0.011	0.074
Unincorporated	2	planned_948	Planned Unlined Bioretention	2.32	1.60	69%	0.009	0.072
Unincorporated	2	planned_951	Planned Unlined Bioretention	2.22	1.53	69%	0.008	0.068
Unincorporated	2	planned_715	Planned Unlined Bioretention	4.86	2.45	50%	0.004	0.067
Unincorporated	2	Parcel_373409	Regional Opportunity	46.53	17.47	38%	0.001	0.061
Unincorporated	2	ROW_9938	ROW Opportunity	0.86	0.53	62%	0.019	0.061
Unincorporated	2	Parcel_212559	Regional Opportunity	2.98	1.31	44%	0.005	0.057
Unincorporated	2	planned_1159	Planned Unlined Bioretention	2.41	1.29	54%	0.007	0.057
Unincorporated	2	planned_824	Planned Unlined Bioretention	2.98	1.31	44%	0.005	0.057
Unincorporated	2	Parcel_234658	Regional Opportunity	1.95	1.27	65%	0.008	0.056
Unincorporated	2	planned_1120	Planned Unlined Bioretention	2.72	1.22	45%	0.006	0.056
Unincorporated	2	planned_932	Planned Unlined Bioretention	1.95	1.27	65%	0.008	0.056
Unincorporated	2	ROW_14235	ROW Opportunity	1.05	0.63	60%	0.013	0.055
Unincorporated	2	planned_1145	Planned Unlined Bioretention	1.80	1.30	72%	0.008	0.053
Unincorporated	2	Parcel_238562	Regional Opportunity	12.03	6.43	53%	0.002	0.052
Unincorporated	2	planned_950	Planned Unlined Bioretention	1.69	1.17	69%	0.008	0.052
Unincorporated	2	Parcel_233114	Regional Opportunity	1.76	1.09	62%	0.008	0.050
Unincorporated	2	Parcel_227066	Regional Opportunity	1.84	0.99	54%	0.007	0.047
Unincorporated	2	Parcel_183600	Regional Opportunity	2.16	1.04	48%	0.006	0.046
Unincorporated	2	planned_1234	Planned Unlined Bioretention	2.16	1.04	48%	0.006	0.046
Unincorporated	2	planned_965	Planned Unlined Bioretention	6.89	2.96	43%	0.002	0.042
Unincorporated	2	ROW_8370	ROW Opportunity	3.43	2.12	62%	0.004	0.042
Unincorporated	2	Parcel_227359	Regional Opportunity	1.61	0.86	53%	0.007	0.041
Unincorporated	2	planned_949	Planned Unlined Bioretention	1.37	0.93	68%	0.008	0.041
Unincorporated	2	planned_1160	Planned Unlined Bioretention	1.68	0.89	53%	0.007	0.040
Unincorporated	2	ROW_17780	ROW Opportunity	2.96	1.24	42%	0.004	0.040
Unincorporated	2	planned_18	Planned Lined Bioretention	1.52	0.87	57%	0.007	0.038
Unincorporated	2	ROW_10003	ROW Opportunity	1.69	0.37	22%	0.006	0.036
Unincorporated	2	planned_1295	Planned Unlined Bioretention	1.25	0.75	60%	0.008	0.035
Unincorporated	2	planned_13	Planned Lined Bioretention	2.14	0.72	34%	0.005	0.035
Unincorporated	2	planned_1161	Planned Unlined Bioretention	1.41	0.66	47%	0.006	0.032
Unincorporated	2	Parcel_218901	Regional Opportunity	1.82	1.15	63%	0.005	0.030
Unincorporated	2	planned_829	Planned Unlined Bioretention	1.82	1.15	63%	0.005	0.030
Unincorporated	2	planned_927	Planned Unlined Bioretention	1.35	0.61	45%	0.006	0.030
Unincorporated	2	Parcel_251699	Regional Opportunity	1.25	0.63	50%	0.007	0.029
Unincorporated	2	Parcel_40021	Regional Opportunity	17.61	7.00	40%	0.001	0.029
Unincorporated	2	planned_1138	Planned Unlined Bioretention	0.92	0.66	72%	0.009	0.029
Unincorporated	2	planned_1144	Planned Unlined Bioretention	0.89	0.65	73%	0.009	0.029
Unincorporated	2	planned_890	Planned Unlined Bioretention	1.14	0.66	58%	0.007	0.029
Unincorporated	2	planned_714	Planned Unlined Bioretention	18.57	6.68	36%	0.001	0.028
Unincorporated	2	planned_818	Planned Unlined Bioretention	1.37	0.61	45%	0.006	0.028
Unincorporated	2	ROW_302	ROW Opportunity	4.48	2.58	58%	0.002	0.027
Unincorporated	2	planned_1132	Planned Unlined Bioretention	1.16	0.53	46%	0.006	0.024
Unincorporated	2	planned_955	Planned Unlined Bioretention	0.82	0.54	66%	0.008	0.024
Unincorporated	2	Parcel_11752	Regional Opportunity	10.67	2.59	24%	0.001	0.023
Unincorporated	2	Parcel_225283	Regional Opportunity	10.44	5.50	53%	0.001	0.023
Unincorporated	2	planned_1249	Planned Unlined Bioretention	8.27	3.84	46%	0.001	0.023
Unincorporated	2	planned_947	Planned Unlined Bioretention	0.86	0.49	57%	0.008	0.023
Unincorporated	2	planned_1297	Planned Unlined Bioretention	0.62	0.12	19%	0.010	0.021
Unincorporated	2	planned_1188	Planned Unlined Bioretention	2.05	0.21	10%	0.003	0.020
Unincorporated	2	planned_843	Planned Unlined Bioretention	0.97	0.44	45%	0.006	0.020
Unincorporated	2	planned_1056	Planned Unlined Bioretention	2.73	1.12	41%	0.003	0.019
Unincorporated	2	planned_19	Planned Lined Bioretention	0.94	0.40	43%	0.006	0.019
Unincorporated	2	planned_926	Planned Unlined Bioretention	0.85	0.39	46%	0.006	0.019
Unincorporated	2	Parcel_190589	Regional Opportunity	7.24	4.65	64%	0.001	0.018
Unincorporated	2	Parcel_190676	Regional Opportunity	2.81	1.39	49%	0.002	0.018
Unincorporated	2	planned_1148	Planned Unlined Bioretention	0.57	0.42	74%	0.009	0.018
Unincorporated	2	planned_1248	Planned Unlined Bioretention	2.81	1.39	49%	0.002	0.018
Unincorporated	2	Parcel_134621	Regional Opportunity	5.52	4.38	79%	0.001	0.017
Unincorporated	2	Parcel_18653	Regional Opportunity	10.01	4.18	42%	0.001	0.017
Unincorporated	2	Parcel_211551	Regional Opportunity	0.70	0.38	54%	0.007	0.017
Unincorporated	2	Parcel_248771	Regional Opportunity	8.72	4.17	48%	0.001	0.017
Unincorporated	2	Parcel_260347	Regional Opportunity	13.69	3.71	27%	0.001	0.017
Unincorporated	2	planned_825	Planned Unlined Bioretention	0.70	0.38	54%	0.007	0.017
Unincorporated	2	planned_854	Planned Unlined Bioretention	0.73	0.37	51%	0.006	0.017
Unincorporated	2	Parcel_185725	Regional Opportunity	0.67	0.37	55%	0.007	0.016
Unincorporated	2	Parcel_204352	Regional Opportunity	0.50	0.37	74%	0.010	0.016
Unincorporated	2	Parcel_214683	Regional Opportunity	0.82	0.32	39%	0.005	0.016
Unincorporated	2	Parcel_234760	Regional Opportunity	10.17	3.71	36%	0.001	0.016
Unincorporated	2	Parcel_261278	Regional Opportunity	7.47	4.01	54%	0.001	0.016

Jurisdiction	Permit	Project ID	Project Type	Area (Acres)	Impervious Area (Acres)	Percent Impervious	PCBs Yield (g/acre)	PCBs Mass reduced (g)
Unincorporated	2	Parcel_363962	Regional Opportunity	8.03	3.75	47%	0.001	0.016
Unincorporated	2	planned_1099	Planned Unlined Bioretention	7.47	4.01	54%	0.001	0.016
Unincorporated	2	planned_1232	Planned Unlined Bioretention	0.67	0.37	55%	0.007	0.016
Unincorporated	2	planned_817	Planned Unlined Bioretention	9.30	3.93	42%	0.001	0.016
Unincorporated	2	planned_827	Planned Unlined Bioretention	0.82	0.32	39%	0.005	0.016
Unincorporated	2	Parcel_221126	Regional Opportunity	7.83	3.50	45%	0.001	0.015
Unincorporated	2	Parcel_259820	Regional Opportunity	8.72	3.46	40%	0.001	0.015
Unincorporated	2	Parcel_373937	Regional Opportunity	9.10	4.03	44%	0.001	0.015
Unincorporated	2	planned_1047	Planned Unlined Bioretention	4.54	1.79	39%	0.002	0.015
Unincorporated	2	planned_820	Planned Unlined Bioretention	0.59	0.34	58%	0.007	0.015
Unincorporated	2	Parcel_236835	Regional Opportunity	11.70	2.62	22%	0.001	0.014
Unincorporated	2	Parcel_25124	Regional Opportunity	10.84	2.77	26%	0.001	0.014
Unincorporated	2	Parcel_260232	Regional Opportunity	0.64	0.31	48%	0.006	0.014
Unincorporated	2	Parcel_262723	Regional Opportunity	10.53	3.23	31%	0.001	0.014
Unincorporated	2	planned_838	Planned Unlined Bioretention	0.51	0.35	69%	0.008	0.014
Unincorporated	2	Parcel_180679	Regional Opportunity	0.58	0.29	50%	0.007	0.013
Unincorporated	2	Parcel_368650	Regional Opportunity	7.51	3.18	42%	0.001	0.013
Unincorporated	2	planned_1065	Planned Unlined Bioretention	7.95	2.46	31%	0.001	0.013
Unincorporated	2	planned_837	Planned Unlined Bioretention	0.44	0.28	64%	0.008	0.013
Unincorporated	2	planned_905	Planned Unlined Bioretention	0.92	0.52	57%	0.004	0.013
Unincorporated	2	ROW_19675	ROW Opportunity	4.36	2.48	57%	0.001	0.013
Unincorporated	2	Parcel_186716	Regional Opportunity	0.53	0.28	53%	0.007	0.012
Unincorporated	2	Parcel_373408	Regional Opportunity	12.02	4.26	35%	0.000	0.012
Unincorporated	2	planned_1231	Planned Unlined Bioretention	0.53	0.28	53%	0.007	0.012
Unincorporated	2	Parcel_20770	Regional Opportunity	7.74	2.72	35%	0.001	0.011
Unincorporated	2	Parcel_234439	Parcel-Based Opportunity	0.38	0.25	66%	0.009	0.011
Unincorporated	2	planned_1026	Planned Unlined Bioretention	7.74	2.72	35%	0.001	0.011
Unincorporated	2	planned_1134	Planned Unlined Bioretention	0.23	0.11	48%	0.013	0.011
Unincorporated	2	planned_1281	Planned Unlined Bioretention	0.34	0.25	74%	0.010	0.011
Unincorporated	2	planned_839	Planned Unlined Bioretention	0.41	0.29	71%	0.008	0.011
Unincorporated	2	planned_909	Planned Unlined Bioretention	1.48	0.76	51%	0.003	0.011
Unincorporated	2	planned_953	Planned Unlined Bioretention	0.38	0.06	16%	0.008	0.011
Unincorporated	2	ROW_10414	ROW Opportunity	5.41	0.94	17%	0.001	0.011
Unincorporated	2	Parcel_244216	Regional Opportunity	2.77	1.14	41%	0.002	0.010
Unincorporated	2	planned_1029	Planned Unlined Bioretention	0.89	0.19	21%	0.003	0.010
Unincorporated	2	planned_1055	Planned Unlined Bioretention	2.12	1.35	64%	0.002	0.010
Unincorporated	2	planned_1176	Planned Unlined Bioretention	0.40	0.23	58%	0.008	0.010
Walnut Creek	2	GIP_10032 / planned_213	Parcel-Based Opportunity (planned)	8.96	6.84	76%	0.010	0.302
Walnut Creek	2	GIP_10042 / ROW_12633	ROW Opportunity (planned)	5.92	2.96	50%	0.009	0.209
Walnut Creek	2	GIP_10049 / Parcel_120162	Parcel-Based Opportunity (planned)	4.71	3.32	70%	0.009	0.160
Walnut Creek	2	GIP_10044 / ROW_17453	ROW Opportunity (planned)	8.19	4.13	50%	0.006	0.156
Walnut Creek	2	GIP_10047 / ROW_1225	ROW Opportunity (planned)	4.45	3.00	67%	0.010	0.149
Walnut Creek	2	GIP_10024	Regional Opportunity (planned)	15.64	4.86	31%	0.003	0.123
Walnut Creek	2	ROW_13263	ROW Opportunity	1.31	0.40	31%	0.019	0.104
Walnut Creek	2	GIP_10052	Regional Opportunity (planned)	180.53	56.43	31%	0.000	0.073
Walnut Creek	2	GIP_10048 / Parcel_113464	Regional Opportunity (planned)	1.99	1.41	71%	0.010	0.072
Walnut Creek	2	GIP_10051	Regional Opportunity (planned)	68.22	18.26	27%	0.000	0.051
Walnut Creek	2	GIP_10040 / Parcel_49020	Regional Opportunity (planned)	1.77	1.13	64%	0.008	0.049
Walnut Creek	2	GIP_10038 / Parcel_128594	Regional Opportunity (planned)	2.40	0.93	39%	0.005	0.043
Walnut Creek	2	GIP_10041 / Parcel_129611	Regional Opportunity (planned)	2.32	0.89	38%	0.005	0.041
Walnut Creek	2	GIP_10037 / Parcel_136845	Regional Opportunity (planned)	1.46	0.72	49%	0.007	0.036
Walnut Creek	2	GIP_10053	Regional Opportunity (planned)	21.50	7.65	36%	0.001	0.034
Walnut Creek	2	GIP_10025	Regional Opportunity (planned)	10.70	3.02	28%	0.001	0.015
Walnut Creek	2	GIP_10045 / Parcel_45368	Parcel-Based Opportunity (planned)	0.42	0.33	79%	0.010	0.014
Walnut Creek	2	GIP_10050	Regional Opportunity (planned)	6.92	2.68	39%	0.001	0.011
Walnut Creek	2	GIP_10046 / Parcel_111176	Parcel-Based Opportunity (planned)	0.28	0.19	68%	0.010	0.010
Walnut Creek	2	GIP_10028	Regional Opportunity (planned)	6.82	1.76	26%	0.001	0.008
Walnut Creek	2	GIP_10022 / ROW_13709	ROW Opportunity (planned)	6.59	2.78	42%	0.000	0.007
Walnut Creek	2	GIP_10029	Regional Opportunity (planned)	6.59	1.71	26%	0.000	0.007
Walnut Creek	2	GIP_10021 / ROW_13708	ROW Opportunity (planned)	6.65	2.50	38%	0.000	0.006
Walnut Creek	2	GIP_10023	Regional Opportunity (planned)	25.68	4.00	16%	0.000	0.004
Walnut Creek	2	GIP_10026	Regional Opportunity (planned)	159.56	6.60	4%	0.000	0.003
Walnut Creek	2	GIP_10027	Regional Opportunity (planned)	3.45	0.46	13%	0.000	0.002
Walnut Creek	2	GIP_10039 / Parcel_125621	Regional Opportunity (planned)	1.73	0.48	28%	0.001	0.002
Walnut Creek	2	GIP_10043 / Parcel_135339	Regional Opportunity (planned)	1.32	0.02	2%	0.000	0.000

APPENDIX F

BASMAA Development Committee

Guidance for Identifying Green Infrastructure Potential
in Municipal Capital Improvement Program Projects
May 6, 2016

Background

In the recently reissued Municipal Regional Stormwater Permit ("MRP 2.0"), Provision C.3.j. requires Permittees to develop and implement Green Infrastructure Plans to reduce the adverse water quality impacts of urbanization on receiving waters over the long term. Provisions C.11 and C.12 require the Permittees to reduce discharges of Mercury and PCBs, and portion of these load reductions must be achieved by implementing Green Infrastructure. Specifically, Permittees collectively must implement Green Infrastructure to reduce mercury loading by 48 grams/year and PCB loading by 120 grams/year by 2020, and plan for substantially larger reductions in the following decades. Green Infrastructure on both public and private land will help to meet these load reduction requirements, improve water quality, and provide multiple other benefits as well. Implementation on private land is achieved by implementing stormwater requirements for new development and redevelopment (Provision C.3.a. through Provision C.3.i.). These requirements were carried forward, largely unchanged, from MRP 1.0.

MRP 2.0 defines Green Infrastructure as:

> Infrastructure that uses vegetation, soils, and natural processes to manage water and create healthier urban environments. At the scale of a city or county, green infrastructure refers to the patchwork of natural areas that provides habitat, flood protection, cleaner air, and cleaner water. At the scale of a neighborhood or site, green infrastructure refers to stormwater management systems that mimic nature by soaking up and storing water.

In practical terms, most green infrastructure will take the form of diverting runoff from existing streets, roofs, and parking lots to one of two stormwater management strategies:

1. Dispersal to vegetated areas, where sufficient landscaped area is available and slopes are not too steep.
2. LID (bioretention and infiltration) facilities, built according to criteria similar to those currently required for regulated private development and redevelopment projects under Provision C.3.

In some cases, the use of tree-box-type biofilters may be appropriate[1]. In other cases, where conditions are appropriate, existing impervious pavements may be removed and replaced with pervious pavements.

In MRP 2.0, Provision C.3.j. includes requirements for Green Infrastructure planning and implementation. Provision C.3.j. has two main elements to be implemented by municipalities:

1. Preparation of a Green Infrastructure Plan for the inclusion of LID drainage design into storm drain infrastructure on public and private land, including streets, roads, storm drains, etc.
2. Early implementation of green infrastructure projects ("no missed opportunities"),

This guidance addresses the second of these requirements. The intent of the "no missed opportunities" requirement is to ensure that no major infrastructure project is built without assessing the opportunity for incorporation of green infrastructure features.

Provision C.3.j.ii. requires that each Permittee prepare and maintain a list of green infrastructure projects, public and private, that are already planned for implementation during the permit term (not including C.3-regulated projects), and infrastructure projects planned for

[1] Standard proprietary tree-box-type biofilters are considered to be non-LID treatment and will only be allowed under certain circumstances. Guidance on use and sizing of these facilities will be provided in a separate document.

implementation during the permit term that have potential for green infrastructure measures. The list must be submitted with each Annual Report, including:

> "… a summary of how each public infrastructure project with green infrastructure potential will include green infrastructure measures to the maximum extent practical during the permit term. For any public infrastructure project where implementation of green infrastructure measures is not practicable, submit a brief description for the project and the reasons green infrastructure measures were impracticable to implement".

This requirement has no specified start date; "during the permit term" means beginning January 1, 2016 and before December 31, 2020. The first Annual Report submittal date will be September 30, 2016.

Note that this guidance primarily addresses the review of proposed or planned public projects for green infrastructure opportunities. The Permittee may also be aware of proposed or planned private projects, not subject to LID treatment requirements, that may have the opportunity to incorporate green infrastructure. These should be addressed in the same way as planned public projects, as described below.

Procedure for Review of Planned Public Projects and Annual Reporting

The municipality's Capital Improvement Program (CIP) project list provides a good starting point for review of proposed public infrastructure projects. Review of other lists of public infrastructure projects, such as those proposed within separately funded special districts (e.g., lighting and landscape districts, maintenance districts, and community facilities districts), may also be appropriate. This section describes a two-part procedure for conducting the review.

Part 1 – Initial Screening

The first step in reviewing a CIP or other public project list is to screen out certain types of projects from further consideration. For example, some projects (e.g., interior remodels, traffic signal replacement) can be readily identified as having no green infrastructure potential. Other projects may appear on the list with only a title, and it may be too early to identify whether green infrastructure could be included. Still others have already progressed past the point where the design can reasonably be changed (this will vary from project to project, depending on available budget and schedule).

Some "projects" listed in a CIP may provide budget for multiple maintenance or minor construction projects throughout the jurisdiction or a portion of the jurisdiction, such as a tree planting program, curb and sidewalk repair/upgrade, or ADA curb/ramp compliance. It is recommended that these types of projects not be included in the review process described herein. The priority for incorporating green infrastructure into these types of projects needs to be assessed as part of the Permittees' development of Green Infrastructure Plans, and standard details and specifications need to be developed and adopted. During this permit term, Permittees will evaluate select projects, project types, and/or groups of projects as case studies and develop an approach as part of Green Infrastructure planning.

The projects removed through the initial screening process do not need to be reported to the Water Board in the Permittee's Annual Report. However, the process should be documented and records kept as to the reason the project was removed from further consideration. Note that projects that were determined to be too early to assess will need to be reassessed during the next fiscal year's review.

The following categories of projects may be screened out of the review process in a given fiscal year:

1. **Projects with No Potential -** The project is identified in initial screening as having no green infrastructure potential based on the type of project. For example, the project does not include any exterior work. Attachment 1 provides a suggested list of such projects that Permittees may use as a model for their own internal process.

2. **Projects Too Early to Assess –** There is not yet enough information to assess the project for green infrastructure potential, or the project is not scheduled to begin design within the permit term (January 2016 – December 2020). If the project is scheduled to begin within the permit term, an assessment will be conducted if and when the project moves forward to conceptual design.
3. **Projects Too Late to Change –** The project is under construction or has moved to a stage of design in which changes cannot be made. The stage of design at which it is too late to incorporate green infrastructure measures varies with each project, so a "percent-complete" threshold has not been defined. Some projects may have funding tied to a particular conceptual design and changes cannot be made even early in the design process, while others may have adequate budget and time within the construction schedule to make changes late in the design process. Agencies will need to make judgments on a case-by-case basis.
4. **Projects Consisting of Maintenance or Minor Construction Work Orders –** The "project" includes budgets for multiple maintenance or minor construction work orders throughout the jurisdiction or a portion of the jurisdiction. These types of projects will not be individually reviewed for green infrastructure opportunity but will be considered as part of a municipality's Green Infrastructure Plan.

Part 2 – Assessment of Green Infrastructure Potential

After the initial screening, the remaining projects either already include green infrastructure or will need to go through an assessment process to determine whether or not there is potential to incorporate green infrastructure. A recommended process for conducting the assessment is provided later in this guidance. As a result of the assessment, the project will fall into one of the following categories with associated annual reporting requirements. Attachment 2 provides the relevant pages of the FY 15-16 Annual Report template for reference.

- **Project is a C.3-regulated project and will include LID treatment.**

  Reporting: Follow current C.3 guidance and report the project in Table C.3.b.iv.(2) of the Annual Report for the fiscal year in which the project is approved.

- **Project already includes green infrastructure and is funded**.

  Reporting: List the project in "Table B-Planned Green Infrastructure Projects" in the Annual Report, indicate the planning or implementation status, and describe the green infrastructure measures to be included.

- **Project may have green infrastructure potential** pending further assessment of feasibility, incremental cost, and availability of funding.

  Reporting: If the feasibility assessment is not complete and/or funding has not been identified, list the project in "Table A-Public Projects Reviewed for Green Infrastructure" in the Annual Report. In the "GI Included?" column, state either "TBD" (to be determined) if the assessment is not complete, or "Yes" if it has been determined that green infrastructure is feasible. In the rightmost column, describe the green infrastructure measures considered and/or proposed, and note the funding and other contingencies for inclusion of green infrastructure in the project. Once funding for the project has been identified, the project should be moved to "Table B-Planned Green Infrastructure Projects" in future Annual Reports.

- **Project does not have green infrastructure potential.** A project-specific assessment has been completed, and Green Infrastructure is impracticable.

  Reporting: In the Annual Report, list the project in "Table A-Public Projects Reviewed for Green Infrastructure". In the "GI Included?" column, state "No." Briefly state the reasons for the determination in the rightmost column. Prepare more detailed documentation of the reasons for the determination and keep it in the project files.

Process for Assessing Green Infrastructure Potential of a Public Infrastructure Project

Initial Assessment of Green Infrastructure Potential

Consider opportunities that may be associated with:

- Alterations to roof drainage from existing buildings
- New or replaced pavement or drainage structures (including gutters, inlets, or pipes)
- Concrete work
- Landscaping, including tree planting
- Streetscape improvements and intersection improvements (other than signals)

Step 1: Information Collection/Reconnaissance

For projects that include alterations to building drainage, identify the locations of roof leaders and downspouts, and where they discharge or where they are connected to storm drains.

For street and landscape projects:

- Evaluate potential opportunities to substitute pervious pavements for impervious pavements.
- Identify and locate drainage structures, including storm drain inlets or catch basins.
- Identify and locate drainage pathways, including curb and gutter.

Identify landscaped areas and paved areas that are adjacent to, or down gradient from, roofs or pavement. These are potential facility locations. *If there are any such locations, continue to the next step.* Note that the project area boundaries may be, but are not required to be, expanded to include potential green infrastructure facilities.

Step 2: Preliminary Sizing and Drainage Analysis

Beginning with the potential LID facility locations that seem most feasible, identify possible pathways to direct drainage from roofs and/or pavement to potential LID facility locations—by sheet flow, valley gutters, trench drains, or (where gradients are steeper) via pipes, based on existing grades and drainage patterns. Where existing grades constrain natural drainage to potential facilities, the use of pumps may be considered (as a less preferable option).

Delineate (roughly) the drainage area tributary to each potential LID facility location. Typically, this requires site reconnaissance, which may or may not include the use of a level to measure relative elevations.

Use the following preliminary sizing factor (facility area/tributary area) for the potential facility location and determine which of the following could be constructed within the existing right-of-way or adjacent vacant land. Note that these sizing factors are guidelines (not strict rules, but targets):

- Sizing factor ≥ 0.5 for dispersal to landscape or pervious pavement[2] (i.e., a maximum 2:1 ratio of impervious area to pervious area)
- Sizing factor ≥ 0.04 for bioretention
- Sizing factor ≥ 0.004 (or less) for tree-box-type biofilters

For bioretention facilities requiring underdrains and tree-box-type biofilters, note if there are potential connections from the underdrain to the storm drain system (typically 2.0 feet below soil surface for bioretention facilities, and 3.5 feet below surface for tree-box-type biofilters).

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[2] Note that pervious pavement systems are typically designed to infiltrate only the rain falling on the pervious pavement itself, with the allowance for small quantities of runoff from adjacent impervious areas. If significant runoff from adjacent areas is anticipated, preliminary sizing considerations should include evaluation of the depth of drain rock layer needed based on permeability of site soils.

If, in this step, you have confirmed there may be feasible potential facility locations, *continue to the next step*.

Step 3: Barriers and Conflicts

Note that barriers and conflicts do not necessarily mean implementation is infeasible; however, they need to be identified and taken into account in future decision-making, as they may affect cost or public acceptance of the project.

Note issues such as:

- Confirmed or potential conflicts with subsurface utilities
- Known or unknown issues with property ownership, or need for acquisition or easements
- Availability of water supply for irrigation, or lack thereof
- Extent to which green infrastructure is an “add on” vs. integrated with the rest of the project

Step 4: Project Budget and Schedule

Consider sources of funding that may be available for green infrastructure. It is recognized that lack of budget may be a serious constraint for the addition of green infrastructure in public projects. For example, acquisition of additional right-of-way or easements for roadway projects is not always possible. Short and long term maintenance costs also need to be considered, and jurisdictions may not have a funding source for landscape maintenance, especially along roadways. The objective of this process is to identify opportunities for green infrastructure, so that if and when funding becomes available, implementation may be possible.

Note any constraints on the project schedule, such as a regulatory mandate to complete the project by a specific date, grant requirements, etc., that could complicate aligning a separate funding stream for the green infrastructure element. Consider whether cost savings could be achieved by integrating the project with other planned projects, such as pedestrian or bicycle safety improvement projects, street beautification, etc., if the schedule allows.

Step 5: Assessment—Does the Project Have Green Infrastructure Potential?

Consider the ancillary benefits of green infrastructure, including opportunities for improving the quality of public spaces, providing parks and play areas, providing habitat, urban forestry, mitigating heat island effects, aesthetics, and other valuable enhancements to quality of life.

Based on the information above, would it make sense to include green infrastructure into this project—*if funding were available for the potential incremental costs of including green infrastructure in the project?* Identify any additional conditions that would have to be met for green infrastructure elements to be constructed consequent with the project.

Attachment 1

Examples of Projects with No Potential for Green Infrastructure

- ☐ Projects with no exterior work (e.g., interior remodels)
- ☐ Projects involving exterior building upgrades or equipment (e.g., HVAC, solar panels, window replacement, roof repairs and maintenance)
- ☐ Projects related to development and/or continued funding of municipal programs or related organizations
- ☐ Projects related to technical studies, mapping, aerial photography, surveying, database development/upgrades, monitoring, training, or update of standard specs and details
- ☐ Construction of new streetlights, traffic signals or communication facilities
- ☐ Minor bridge and culvert repairs/replacement
- ☐ Non-stormwater utility projects (e.g., sewer or water main repairs/replacement, utility undergrounding, treatment plant upgrades)
- ☐ Equipment purchase or maintenance (including vehicles, street or park furniture, equipment for sports fields and golf courses, etc.)
- ☐ Irrigation system installation, upgrades or repairs

Attachment 2

Excerpts from the C.3 Section of the FY 15-16 Annual Report Template: Tables for Reporting C.3-Regulated Projects and Green Infrastructure Projects

C.3.b.iv.(2) ►Regulated Projects Reporting Table (part 1) – Projects Approved During the Fiscal Year Reporting Period

Project Name Project No.	Project Location[9], Street Address	Name of Developer	Project Phase No.[10]	Project Type & Description[11]	Project Watershed[12]	Total Site Area (Acres)	Total Area of Land Disturbed (Acres)	Total New Impervious Surface Area (ft^2)[13]	Total Replaced Impervious Surface Area (ft^2)[14]	Total Pre-Project Impervious Surface Area[15] (ft^2)	Total Post-Project Impervious Surface Area[16] (ft^2)
Private Projects											
Public Projects											
Comments: **Guidance: If necessary, provide any additional details or clarifications needed about listed projects in this box. Do not leave any cells blank.**											

[9]Include cross streets
[10]If a project is being constructed in phases, indicate the phase number and use a separate row entry for each phase. If not, enter "NA".
[11]Project Type is the type of development (i.e., new and/or redevelopment). Example descriptions of development are: 5-story office building, residential with 160 single-family homes with five 4-story buildings to contain 200 condominiums, 100 unit 2-story shopping mall, mixed use retail and residential development (apartments), industrial warehouse.
[12]State the watershed(s) in which the Regulated Project is located. Downstream watershed(s) may be included, but this is optional.
[13]All impervious surfaces added to any area of the site that was previously existing pervious surface.
[14]All impervious surfaces added to any area of the site that was previously existing impervious surface.
[15]For redevelopment projects, state the pre-project impervious surface area.
[16]For redevelopment projects, state the post-project impervious surface area.

C.3.b.iv.(2) ►Regulated Projects Reporting Table (part 2) – Projects Approved During the Fiscal Year Reporting Period (public projects)

Project Name Project No.	Approval Date[29]	Date Construction Scheduled to Begin	Source Control Measures[30]	Site Design Measures[31]	Treatment Systems Approved[32]	Operation & Maintenance Responsibility Mechanism[33]	Hydraulic Sizing Criteria[34]	Alternative Compliance Measures[35/36]	Alternative Certification[37]	HM Controls[38/39]
Public Projects										

Comments:

Guidance: If necessary, provide any additional details or clarifications needed about listed projects in this box. Note that MRP Provision C.3.c. contains specific requirements for LID site design and source control measures, as well as treatment measures, for all Regulated Projects. Entries in these columns should not be "None" or "NA". Do not leave any cells blank.

[29]For public projects, enter the plans and specifications approval date.
[30]List source control measures approved for the project. Examples include: properly designed trash storage areas; storm drain stenciling or signage; efficient landscape irrigation systems; etc.
[31]List site design measures approved for the project. Examples include: minimize impervious surfaces; conserve natural areas, including existing trees or other vegetation, and soils; construct sidewalks, walkways, and/or patios with permeable surfaces, etc.
[32]List all approved stormwater treatment system(s) to be installed onsite or at a joint stormwater treatment facility (e.g., flow through planter, bioretention facility, infiltration basin, etc.).
[33]List the legal mechanism(s) (e.g., maintenance plan for O&M by public entity, etc…) that have been or will be used to assign responsibility for the maintenance of the post-construction stormwater treatment systems.
[34]See Provision C.3.d.i. "Numeric Sizing Criteria for Stormwater Treatment Systems" for list of hydraulic sizing design criteria. Enter the corresponding provision number of the appropriate criterion (i.e., 1.a., 1.b., 2.a., 2.b., 2.c., or 3).
[35]For Alternative Compliance at an offsite location in accordance with Provision C.3.e.i.(1), on a separate page, give a discussion of the alternative compliance site including the information specified in Provision C.3.b.v.(1)(m)(i) for the offsite project.
[36]For Alternative Compliance by paying in-lieu fees in accordance with Provision C.3.e.i.(2), on a separate page, provide the information specified in Provision C.3.b.v.(1)(m)(ii) for the Regional Project.
[37]Note whether a third party was used to certify the project design complies with Provision C.3.d.
[38]If HM control is not required, state why not.
[39]If HM control is required, state control method used (e.g., method to design and size device(s) or method(s) used to meet the HM Standard, and description of device(s) or method(s) used, such as detention basin(s), biodetention unit(s), regional detention basin, or in-stream control).

C.3.j.ii.(2) ► Table A - Public Projects Reviewed for Green Infrastructure

Project Name and Location[43]	Project Description	Status[44]	GI Included?[45]	Description of GI Measures Considered and/or Proposed or Why GI is Impracticable to Implement[46]
EXAMPLE: Storm drain retrofit, Stockton and Taylor	Installation of new storm drain to accommodate the 10-yr storm event	Beginning planning and design phase	TBD	Bioretention cells (i.e., linear bulb-outs) will be considered when street modification designs are incorporated

C.3.j.ii.(2) ► Table B - Planned Green Infrastructure Projects

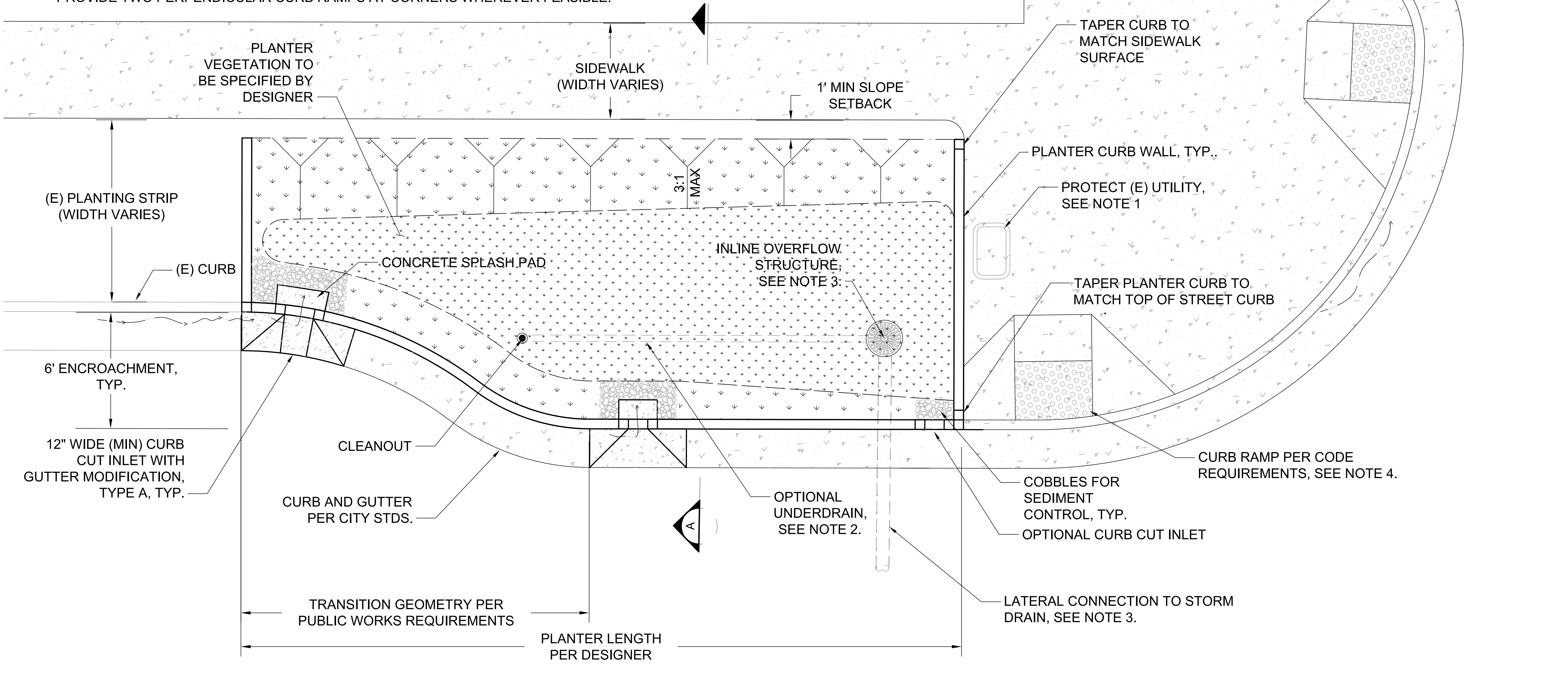
Project Name and Location[47]	Project Description	Planning or Implementation Status	Green Infrastructure Measures Included
EXAMPLE: Martha Gardens Green Alleys Project	Retrofit of degraded pavement in urban alleyways lacking good drainage	Construction completed October 17, 2015	The project drains replaced concrete pavement and existing adjacent structures to a center strip of pervious pavement and underlying infiltration trench.

[43] List each public project that is going through your agency's process for identifying projects with green infrastructure potential.
[44] Indicate status of project, such as: beginning design, under design (or X% design), projected completion date, completed final design date, etc.
[45] Enter "Yes" if project will include GI measures, "No" if GI measures are impracticable to implement, or "TBD" if this has not yet been determined.
[46] Provide a summary of how each public infrastructure project with green infrastructure potential will include green infrastructure measures to the maximum extent practicable during the permit term. If review of the project indicates that implementation of green infrastructure measures is not practicable, provide the reasons why green infrastructure measures are impracticable to implement.
[47] List each planned (and expected to be funded) public and private green infrastructure project that is not also a Regulated Project as defined in Provision C.3.b.ii. Note that funding for green infrastructure components may be anticipated but is not guaranteed to be available or sufficient.

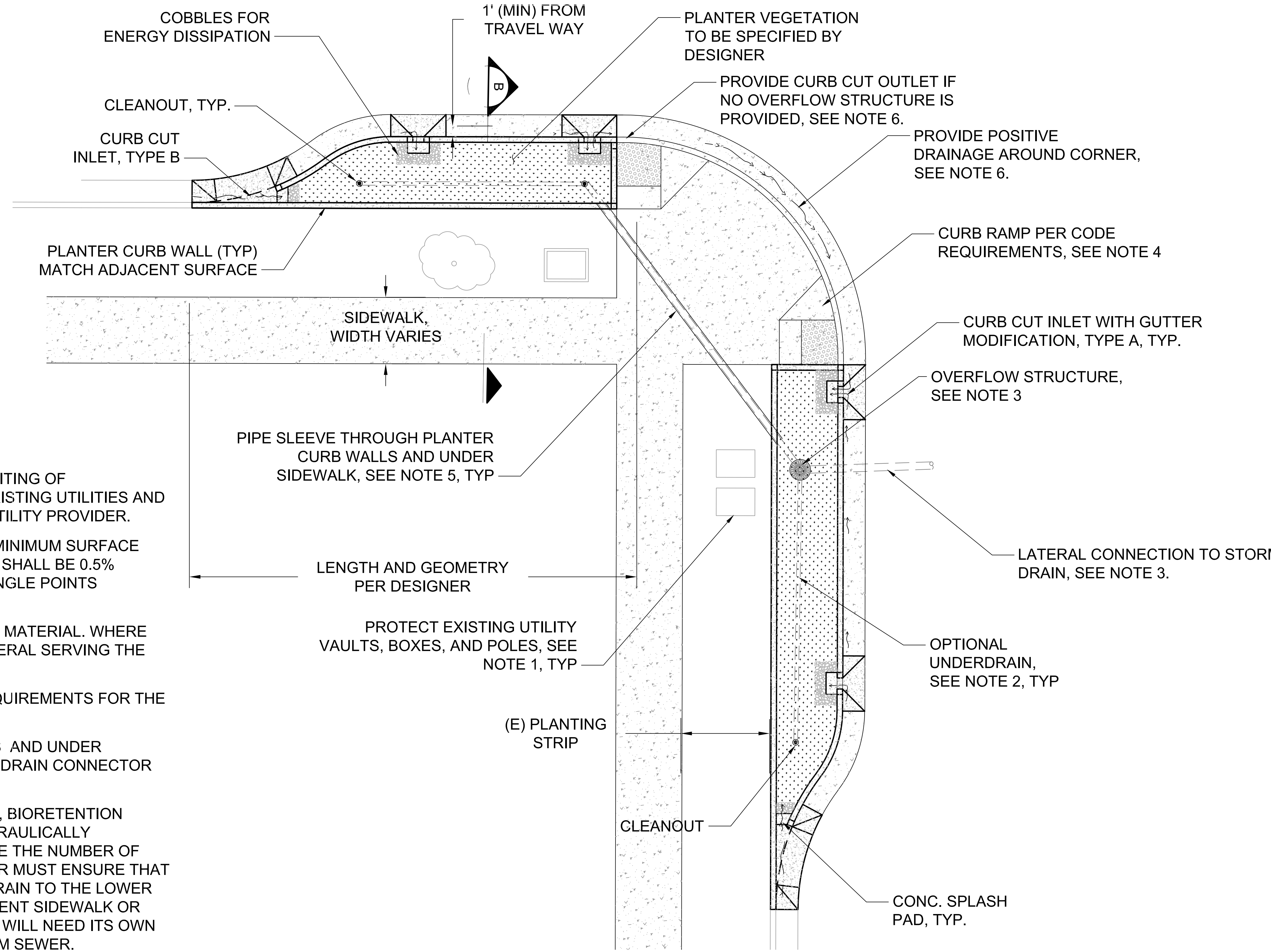
APPENDIX G

NOTES:

1. PROTECT EXISTING UTILITIES AND MAINTAIN MINIMUM SETBACKS AS REQUIRED BY LOCAL UTILITY PROVIDER.
2. PROVIDE UNDERDRAIN WHERE REQUIRED TO MEET THE MINIMUM SURFACE WATER DRAWDOWN TIME. LONGITUDINAL SLOPE OF PIPE SHALL BE 0.5% MINIMUM.
3. DESIGNER TO SPECIFY OVERFLOW STRUCTURE SIZE AND MATERIAL. WHERE FEASIBLE, CONNECT TO THE EXISTING STORM DRAIN LATERAL SERVING THE CORNER CATCH BASIN BEING REMOVED, IF ANY.
4. ADHERE TO ALL LOCAL AND FEDERAL ACCESSIBILITY REQUIREMENTS FOR THE SIDEWALK AND CURB RAMP DESIGNS. PROVIDE TWO PERPENDICULAR CURB RAMPS AT CORNERS WHEREVER FEASIBLE.



BASMAA URBAN GREENING TYPICAL GI DETAILS BULBOUT ALTERNATIVE 1 *SLOPED SIDES, INLINE OVERFLOW STRUCTURE, CURB CUT INLET TYPE A*	SCALE: 1"=5' DRAWN BY: BF CHECKED BY: SD	DATE : APRIL 14, 2017 SHEET NUMBER C-1.1



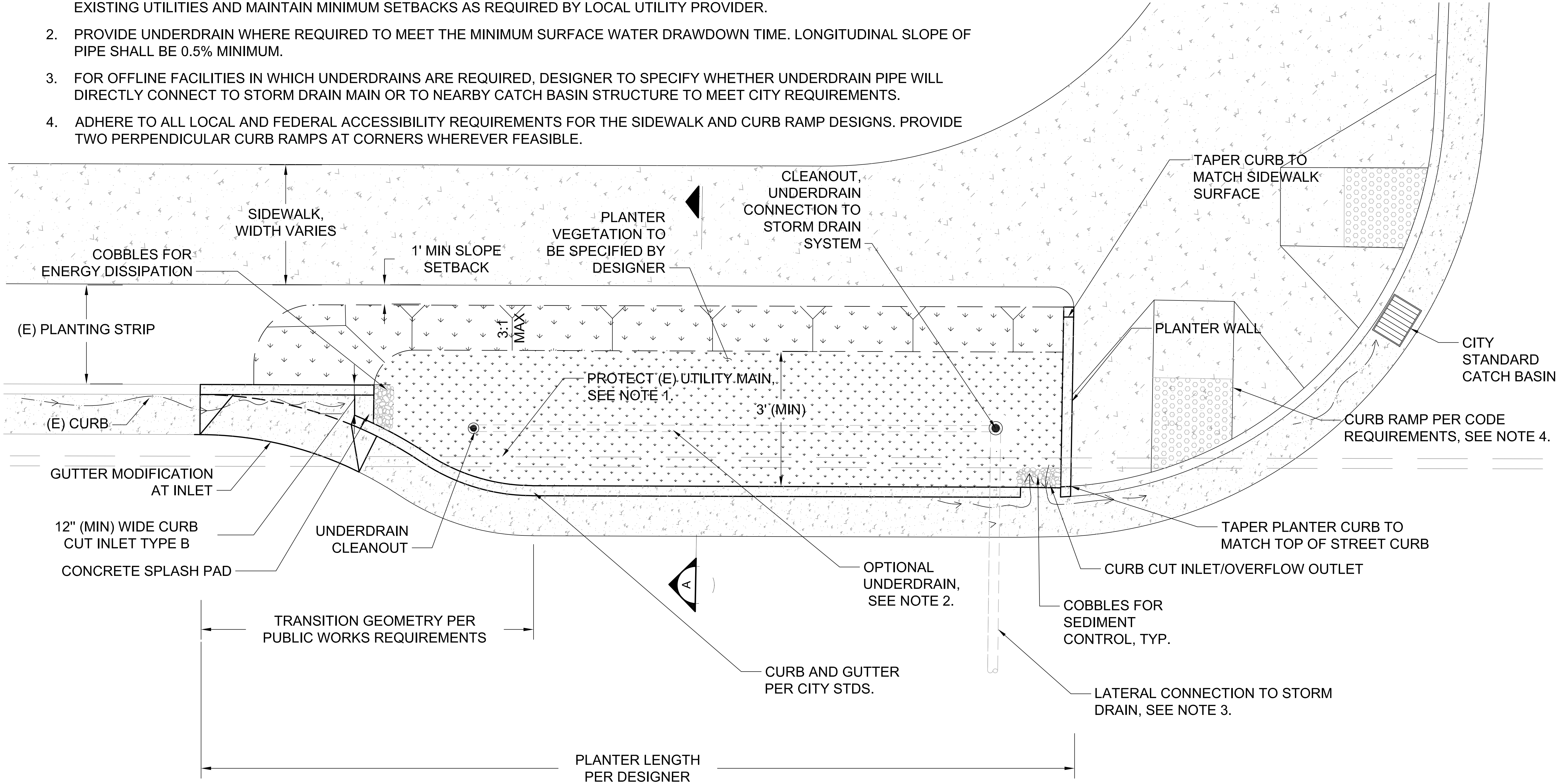
NOTES:

1. AVOID UTILITY CONFLICTS WHEREVER FEASIBLE IN THE SITING OF BIORETENTION PLANTERS. IF UNAVOIDABLE, PROTECT EXISTING UTILITIES AND MAINTAIN MINIMUM SETBACKS AS REQUIRED BY LOCAL UTILITY PROVIDER.
2. PROVIDE UNDERDRAIN WHERE REQUIRED TO MEET THE MINIMUM SURFACE WATER DRAWDOWN TIME. LONGITUDINAL SLOPE OF PIPE SHALL BE 0.5% MINIMUM. PROVIDE CLEANOUT AT UPSTREAM END AND ANGLE POINTS EXCEEDING 45 DECREES.
3. DESIGNER TO SPECIFY OVERFLOW STRUCTURE SIZE AND MATERIAL. WHERE FEASIBLE, CONNECT TO THE EXISTING STORM DRAIN LATERAL SERVING THE CORNER CATCH BASIN BEING REMOVED, IF ANY.
4. ADHERE TO ALL LOCAL AND FEDERAL ACCESSIBILITY REQUIREMENTS FOR THE SIDEWALK AND CURB RAMP DESIGNS.
5. PROVIDE PIPE SLEEVES THROUGH PLANTER CURB WALLS AND UNDER SIDEWALK TO ALLOW FOR THE PASSING OF SOLID UNDERDRAIN CONNECTOR PIPES.
6. IF THE GRADES AND EXISTING SITE CONSTRAINTS ALLOW, BIORETENTION PLANTERS ON EITHER SIDE OF THE CORNER CAN BE HYDRAULICALLY CONNECTED TO OPTIMIZE TREATMENT AREA AND REDUCE THE NUMBER OF CONNECTIONS TO THE STORM SEWER SYSTEM. DESIGNER MUST ENSURE THAT THE HIGHER BIORETENTION PLANTER CAN POSITIVELY DRAIN TO THE LOWER BIORETENTION PLANTER WITHOUT FLOODING THE ADJACENT SIDEWALK OR ROADWAY. IF INFEASIBLE, EACH BIORETENTION PLANTER WILL NEED ITS OWN OVERFLOW STRUCTURE AND CONNECTION TO THE STORM SEWER.

BASMAA URBAN GREENING TYPICAL GI DETAILS BULBOUT ALTERNATIVE 2 *WALLED BIORETENTION ON BOTH SIDES OF CORNER, CURB CUT INLETS TYPE A & B*	SCALE: 1"=10' DRAWN BY: BF CHECKED BY: SD	DATE : APRIL 14, 2017 SHEET NUMBER C-1.2

NOTES:

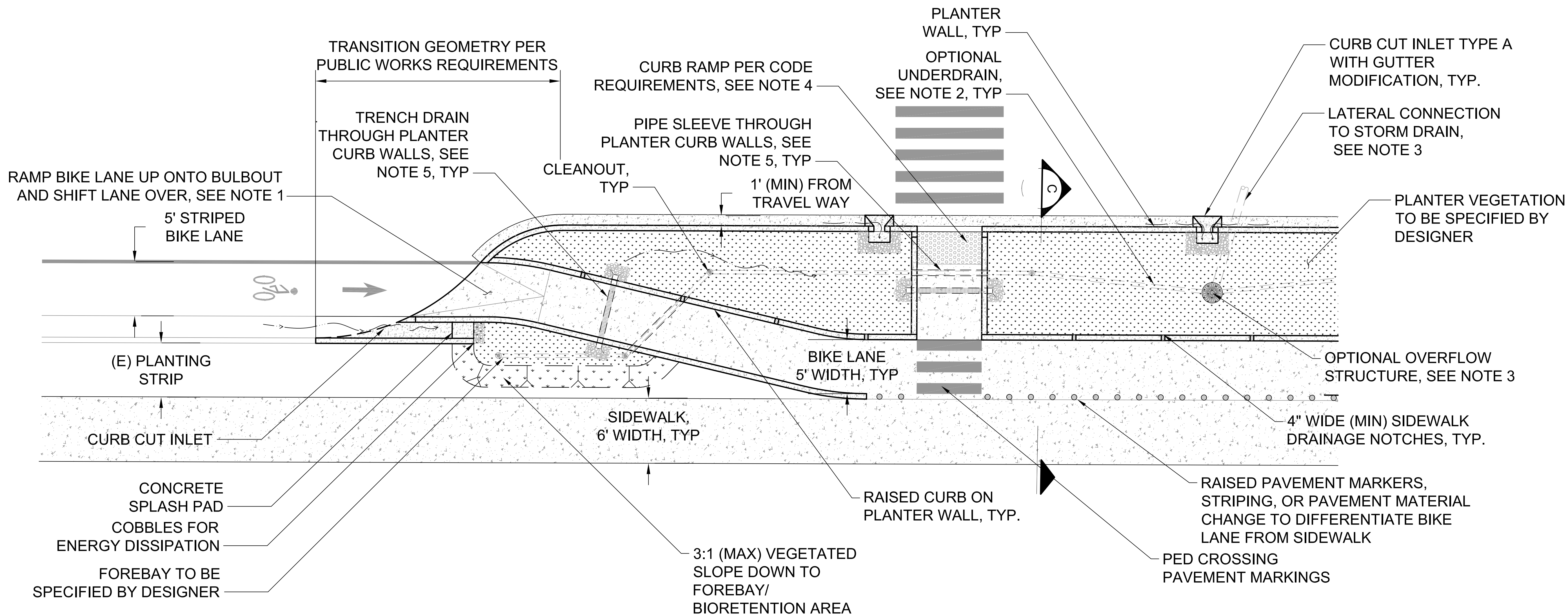
1. AVOID UTILITY CONFLICTS WHENEVER POSSIBLE IN THE SITING OF BIORETENTION PLANTERS. IF UNAVOIDABLE, PROTECT EXISTING UTILITIES AND MAINTAIN MINIMUM SETBACKS AS REQUIRED BY LOCAL UTILITY PROVIDER.
2. PROVIDE UNDERDRAIN WHERE REQUIRED TO MEET THE MINIMUM SURFACE WATER DRAWDOWN TIME. LONGITUDINAL SLOPE OF PIPE SHALL BE 0.5% MINIMUM.
3. FOR OFFLINE FACILITIES IN WHICH UNDERDRAINS ARE REQUIRED, DESIGNER TO SPECIFY WHETHER UNDERDRAIN PIPE WILL DIRECTLY CONNECT TO STORM DRAIN MAIN OR TO NEARBY CATCH BASIN STRUCTURE TO MEET CITY REQUIREMENTS.
4. ADHERE TO ALL LOCAL AND FEDERAL ACCESSIBILITY REQUIREMENTS FOR THE SIDEWALK AND CURB RAMP DESIGNS. PROVIDE TWO PERPENDICULAR CURB RAMPS AT CORNERS WHEREVER FEASIBLE.



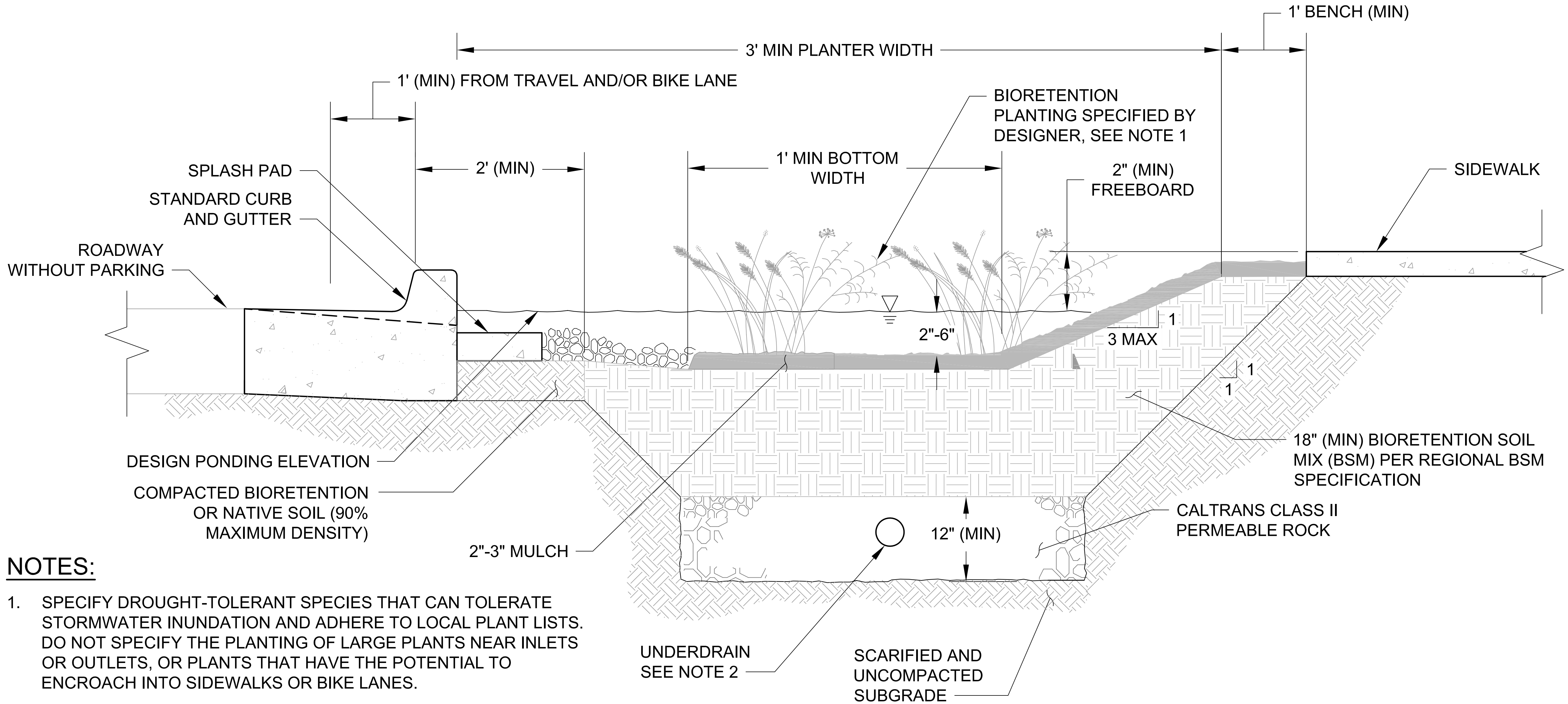
BASMAA URBAN GREENING TYPICAL GI DETAILS BULBOUT ALTERNATIVE 3 *SLOPED AND WALLED SIDES, CURB CUT INLET TYPE B, CURB CUT OVERFLOW ONLY*	SCALE: 1"=5' DRAWN BY: BF CHECKED BY: SD	DATE : APIRL 14, 2017 SHEET NUMBER C-1.3

NOTES:

1. FOR HORIZONTAL BIKE LANE SHIFT, PROVIDE MAXIMUM 1:5 TRANSITION RATE.
2. PROVIDE UNDERDRAIN WHERE REQUIRED TO MEET THE MINIMUM SURFACE WATER DRAWDOWN TIME. LONGITUDINAL SLOPE OF PIPE SHALL BE 0.5% MINIMUM. PROVIDE CLEANOUT AT UPSTREAM END AND ANGLE POINTS EXCEEDING 45 DEGREES.
3. DESIGNER TO SPECIFY OVERFLOW STRUCTURE SIZE AND MATERIAL. WHERE FEASIBLE, CONNECT TO THE EXISTING STORM DRAIN LATERAL SERVING THE CORNER CATCH BASIN BEING REMOVED, IF ANY.
4. ADHERE TO ALL LOCAL AND FEDERAL ACCESSIBILITY REQUIREMENTS FOR THE SIDEWALK AND CURB RAMP DESIGNS.
5. PROVIDE TRENCH DRAINS THROUGH PLANTER CURB WALLS TO ALLOW FOR THE HYDRAULIC CONNECTION OF SEPARATED BIORETENTION PLANTERS AND PIPE SLEEVES FOR THE PASSING OF SOLID UNDERDRAIN CONNECTOR PIPES.



BASMAA URBAN GREENING TYPICAL GI DETAILS BULBOUT ALTERNATIVE 4 *MIDBLOCK BULBOUT WITH RAISED BIKE LANE AND PEDESTRIAN CROSSING*	SCALE: 1"=10' DRAWN BY: BF CHECKED BY: SD	DATE : APRIL 14, 2017 SHEET NUMBER C-1.4



NOTES:

1. SPECIFY DROUGHT-TOLERANT SPECIES THAT CAN TOLERATE STORMWATER INUNDATION AND ADHERE TO LOCAL PLANT LISTS. DO NOT SPECIFY THE PLANTING OF LARGE PLANTS NEAR INLETS OR OUTLETS, OR PLANTS THAT HAVE THE POTENTIAL TO ENCROACH INTO SIDEWALKS OR BIKE LANES.
2. UNDERDRAIN PLACEMENT IS DEPENDENT ON SUBGRADE SOIL CONDITIONS. FOR TYPE B/C SOILS, THE UNDERDRAIN MAY BE ELEVATED TOWARDS THE TOP OF THE AGGREGATE STORAGE LAYER, APPROXIMATELY 3" BELOW BOTTOM OF BIORETENTION SOIL. FOR TYPE D SOILS, THE UNDERDRAIN SHALL BE PLACED 2" ABOVE THE SUBGRADE.

BIORETENTION BULBOUT SECTION (A)

BASMAA URBAN GREENING TYPICAL GI DETAILS
SECTION A-A
SLOPED SIDES / NO CURB WALLS

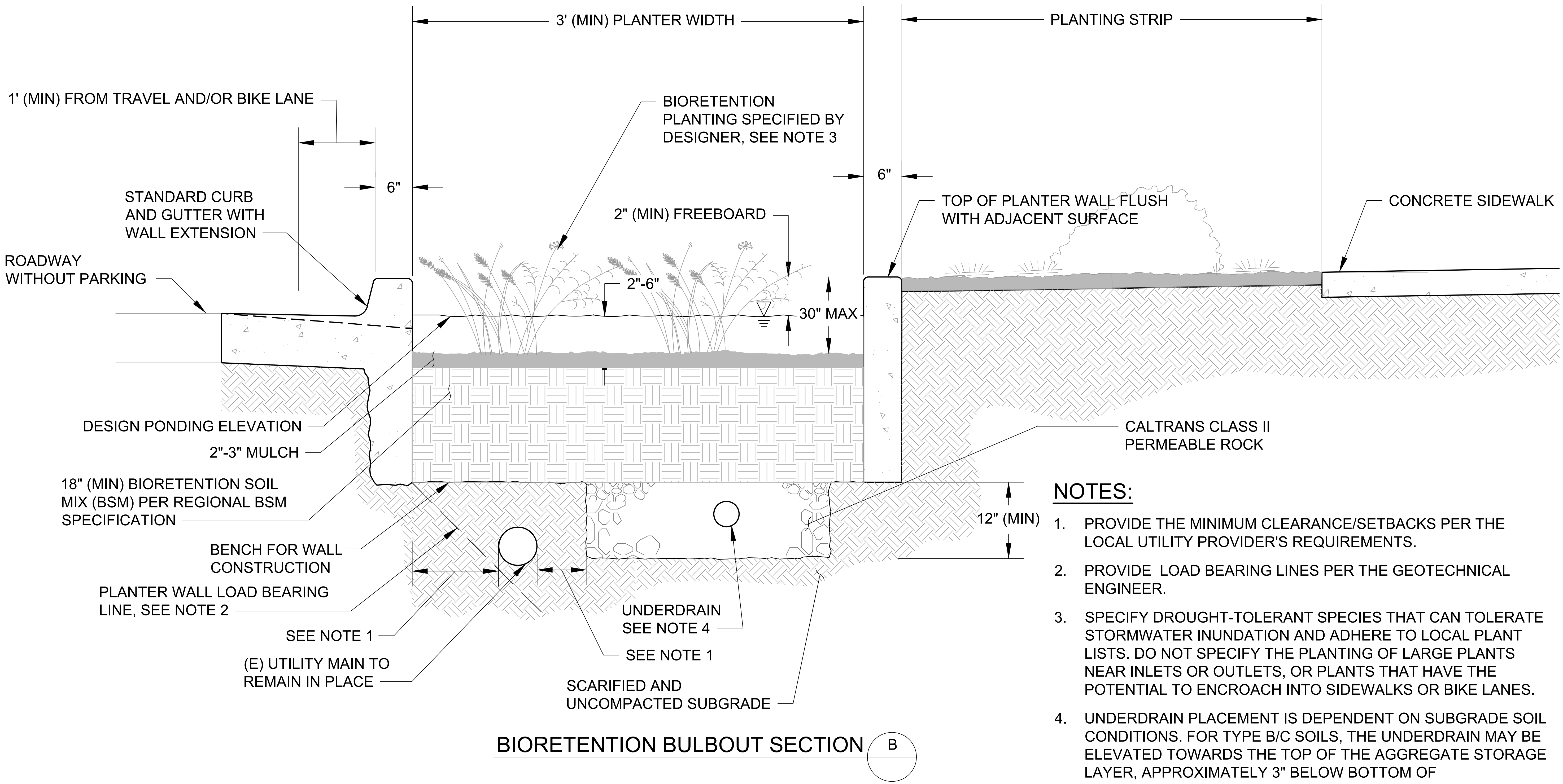
SCALE: 3/4"=1'

DRAWN BY: BF

CHECKED BY: SD

DATE : APRIL 14, 2017

SHEET NUMBER S-A-A

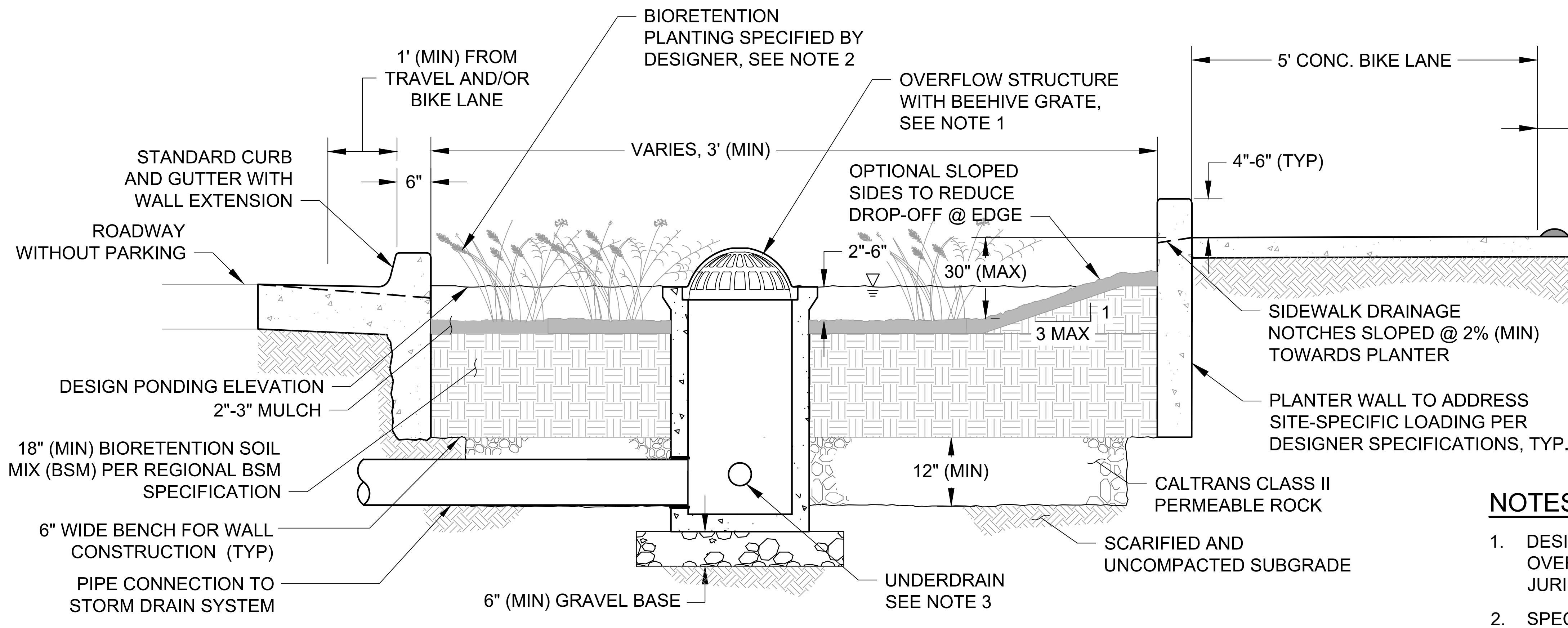


BIORETENTION BULBOUT SECTION B

NOTES:

1. PROVIDE THE MINIMUM CLEARANCE/SETBACKS PER THE LOCAL UTILITY PROVIDER'S REQUIREMENTS.
2. PROVIDE LOAD BEARING LINES PER THE GEOTECHNICAL ENGINEER.
3. SPECIFY DROUGHT-TOLERANT SPECIES THAT CAN TOLERATE STORMWATER INUNDATION AND ADHERE TO LOCAL PLANT LISTS. DO NOT SPECIFY THE PLANTING OF LARGE PLANTS NEAR INLETS OR OUTLETS, OR PLANTS THAT HAVE THE POTENTIAL TO ENCROACH INTO SIDEWALKS OR BIKE LANES.
4. UNDERDRAIN PLACEMENT IS DEPENDENT ON SUBGRADE SOIL CONDITIONS. FOR TYPE B/C SOILS, THE UNDERDRAIN MAY BE ELEVATED TOWARDS THE TOP OF THE AGGREGATE STORAGE LAYER, APPROXIMATELY 3" BELOW BOTTOM OF BIORETENTION SOIL. FOR TYPE D SOILS, THE UNDERDRAIN SHALL BE PLACED 2" ABOVE THE SUBGRADE.

BASMAA URBAN GREENING TYPICAL GI DETAILS SECTION B-B *WALLS ON BOTH SIDES, UTILITY MAIN PROTECTION*	SCALE: 3/4"=1' DRAWN BY: BF CHECKED BY: SD	DATE : April 14, 2017 SHEET NUMBER S-B-B



MIDBLOCK BULBOUT SECTION C

NOTES:

1. DESIGNER TO SPECIFY SIZE AND DEPTH OF OVERFLOW STRUCTURE THAT ADHERES TO LOCAL JURISDICTIONAL REQUIREMENTS.
2. SPECIFY DROUGHT-TOLERANT SPECIES THAT CAN TOLERATE STORMWATER INUNDATION AND ADHERE TO LOCAL PLANT LISTS. DO NOT SPECIFY THE PLANTING OF LARGE PLANTS NEAR INLETS OR OUTLETS, OR PLANTS THAT HAVE THE POTENTIAL TO ENCROACH INTO SIDEWALKS OR BIKE LANES.
3. UNDERDRAIN PLACEMENT IS DEPENDENT ON SUBGRADE SOIL CONDITIONS. FOR TYPE B/C SOILS, THE UNDERDRAIN MAY BE ELEVATED TOWARDS THE TOP OF THE AGGREGATE STORAGE LAYER, APPROXIMATELY 3" BELOW BOTTOM OF BIORETENTION SOIL. FOR TYPE D SOILS, THE UNDERDRAIN SHALL BE PLACED 2" ABOVE THE SUBGRADE.

BASMAA URBAN GREENING TYPICAL GI DETAILS SECTION C-C *RAISED BIKE LANE, OVERFLOW STRUCTURE*	SCALE: 1"=2' DRAWN BY: BF CHECKED BY: SD	DATE : April 14, 2017 SHEET NUMBER S-C-C

APPENDIX H

Guidance for Sizing Green Infrastructure Facilities in Street Projects

with companion analysis:

Green Infrastructure Facility Sizing for Non-Regulated Street Projects

BASMAA
Bay Area
Stormwater Management
Agencies Association

Prepared by
Dan Cloak Environmental Consulting
EOA, Inc.

June 2019

Introduction and Regulatory Background

Provision C.3.j. in the reissued Municipal Regional Stormwater Permit[1] (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* <u>*single approach*</u> *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.

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[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 Methodology[i] or the applicable Reasonable Assurance Analysis[ii].

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.

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[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

[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

Bay Area Stormwater Management Agencies Association

Green Infrastructure Facility Sizing For Non-Regulated Street Projects

Prepared by:
Dubin Environmental
December 13, 2017

BASMAA
Bay Area Stormwater Management Agencies Association

DUBIN Environmental

1. Introduction

The San Francisco Bay Regional Water Quality Control Board's reissued Phase I Municipal Regional Stormwater Permit (Order No. R2-2015-0049, issued 11/19/2015 and referred to as "MRP 2.0") includes a requirement that Permittees complete and implement green infrastructure plans to promote the increased use of green infrastructure in urban areas. These plans will guide the integration of green stormwater facilities into streets, parking lots, parks, building rooftops and similar places where there is an opportunity to retrofit traditional gray infrastructure systems and increase the removal of pollutants and improve water quality.

Provision C.3.j states:

> *Over the long term, the (Green Infrastructure) Plan is intended to describe how the Permittees will shift their impervious surfaces and storm drain infrastructure from gray, or traditional storm drain infrastructure where runoff flows directly into the storm drain and then the receiving water, to green—that is, to a more-resilient, sustainable system that slows runoff by dispersing it to vegetated areas, harvests and uses runoff, promotes infiltration and evapotranspiration, and uses bioretention and other green infrastructure practices to clean stormwater runoff.*

Provision C.3.j.i.(2)(g) requires that projects be designed to meet the treatment and hydromodification sizing requirements in Provisions C.3.c. and C.3.d. However, the provision further states that for street projects that are not 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.*

To address this provision and further define the C.3.d sizing requirements for green infrastructure projects, the Bay Area Stormwater Management Agencies Association (BASMAA) contracted with Dubin Environmental to conduct continuous simulation hydrologic modeling to evaluate relationships of facility size (e.g., area, depth, flow rate) to facility performance. The BASMAA Development Committee, and BASMAA member agencies, intend to use these relationships to develop and justify an approach, to be created by the Development Committee, for implementing green street projects when there are constraints on facility size.

This report describes the modeling analysis that was performed to better understand the relationship between bioretention configuration and annual runoff treatment across the different BASMAA stormwater agencies and their climate zones. Long-term continuous modeling was used to compute stormwater runoff, simulate bioretention hydraulics, and estimate the annual percentage of stormwater that is treated. The analysis was performed for 10 different rain gauges that together represent the full range of climate conditions across the BASMAA member agency area. The analysis also considered different bioretention configurations and treatment goals. BASMAA member agencies can use these results to help establish policies and design guidelines to include in their green infrastructure plans.

2. Project Approach

The performance of bioretention facilities was modeled using HSPF (Hydrologic Simulation Program Fortran), which is a physically based, hydrologic model that is maintained and distributed by the US EPA.

HSPF has been used since the 1970s to conduct hydrologic analyses and size stormwater and flood control facilities. For this project, an HSPF model was developed to simulate runoff from a fully paved, 1-acre reference site and route this flow through a bioretention facility. This section describes the rain gauge selection and the HSPF modeling approach. Section 3 describes the modeling results.

2.1 Rainfall and Evapotranspiration Data

There are more than two dozen rain gauges with long-term, hourly data located within the BASMAA area. A list of candidate gauges was prepared from the National Center for Environmental Information (NCEI; formerly the National Climate Data Center or NCDC) network and then evaluated for inclusion. The evaluation focused on gauge data that could downloaded directly from EPA's National Stormwater Calculator, because these datasets have been reviewed and missing records filled with data from available nearby stations (similar to the data included with the EPA BASINS software). The list of candidate gauges was narrowed to 19 locations with 35+ years of data that are geographically distributed through the BASMAA area. The rain gauges were organized into tables that show a) mean annual precipitation (MAP) and b) 6-month, 1-year, and 2-year accumulations for 1-year and 24-hour durations. The different storm depth statistics were used to identify any outliers among the rain gauge data that could indicate problems that would hinder the effort to create regressions among the model results. The rain gauge locations were also plotted in ArcGIS.

The recommended sites were presented to the BASMAA project work group who provided helpful input about their preferences and experiences with different rain gauges. Based on this input, six stations were selected for inclusion in the modeling analysis. After developing the HSPF input and output routines, the number of gauges was increased to 10 by including higher rainfall locations to allow development of regression relationships that span the rainfall characteristics at any likely project location. Table 1 lists the candidate rain gauges included in the modeling analysis. For all gauges, a common 37 year period was used to eliminate the influence of drought and wet periods that occurred when some gauges were operational but not others. Figure 1 shows the mean annual rainfall and Figure 2 shows their locations. The 1-year and 24-hour storm durations are included in Appendix A.

TABLE 1. SELECTED RAIN GAUGES FOR GREEN INFRASTRUCTURE MODELING

2	Name	County/Agency	Years of Record	Mean Annual Rain (in)
049001	Tracy Pumping Plant	Contra Costa	37	12.7
047821	San Jose	Santa Clara	37	15.2
045378	Martinez Water Plant	Contra Costa	37	19.6
047769	SF Airport	San Francisco	37	20.4
047772	SF Downtown	San Francisco	37	21.9
046336	Oakland Museum	Alameda	37	22.8
042934	Fairfield	Fairfield-Suisun	37	24.1
043714	Half Moon Bay	San Mateo	37	28.6
047807	San Gregorio	San Mateo	37	30.0
044500	Kentfield	Marin	37	48.1

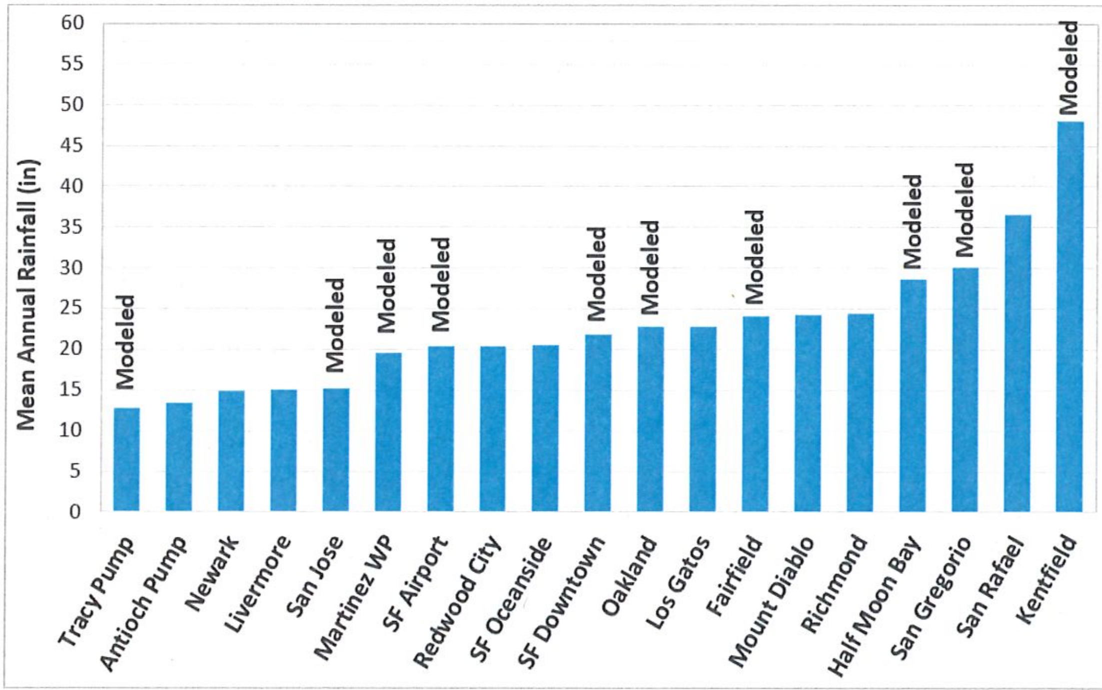
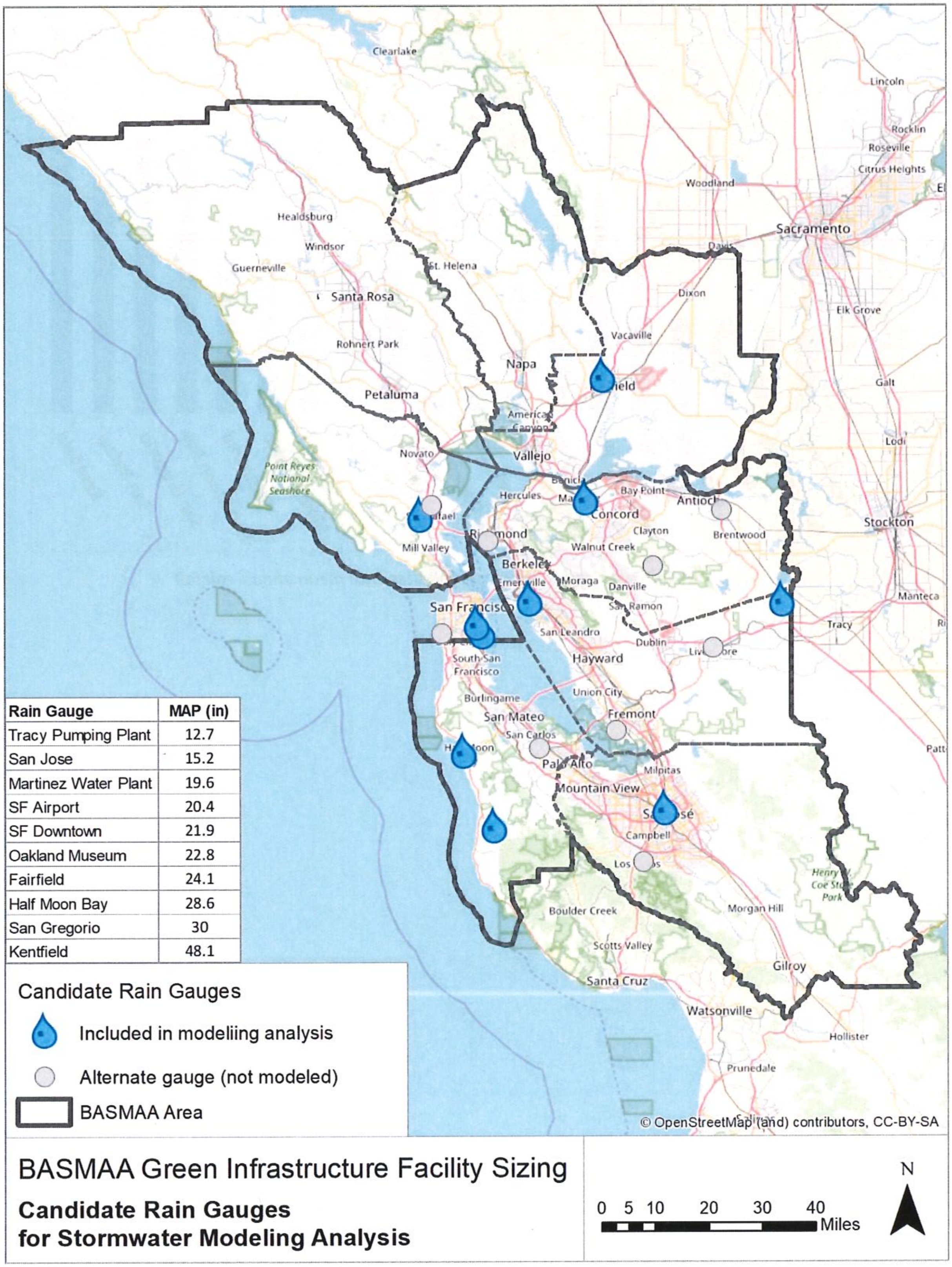


Figure 1. Candidate and selected rainfall sites with mean annual rainfall



Rain Gauge	MAP (in)
Tracy Pumping Plant	12.7
San Jose	15.2
Martinez Water Plant	19.6
SF Airport	20.4
SF Downtown	21.9
Oakland Museum	22.8
Fairfield	24.1
Half Moon Bay	28.6
San Gregorio	30
Kentfield	48.1

Figure 2. Location of rain gauges used in the modeling analysis

2.2 HSPF Model Setup

An HSPF model was developed to simulate runoff from a fully paved, 1-acre reference area and route this flow through a bioretention facility. The model outputs were then evaluated to determine the fraction of incoming stormwater receiving water quality treatment (defined as the fraction filtered through the bioretention media, evaporated or transpired). The HSPF model was developed with Excel/VBA-based code that enabled us to easily modify the rain gauge, bioretention area, and surface reservoir depth to determine how these watershed and configuration parameters affect the fraction of stormwater being treated.

The model parameters and approach to simulating bioretention hydraulics are discussed in detail below:

- Stormwater runoff flows across the reference 1-acre paved area and enters the bioretention facility. This water is initially detained in a shallow surface reservoir and then infiltrates to the bioretention media.
- Stormwater infiltrates through the bioretention media into an underlying gravel layer. The saturated soil permeability was set to 5 inches per hour (based on the media specification). For unsaturated soils, the relationship between soil moisture and permeability was based on monitoring data collected at three installations in Pittsburg (Contra Costa, 2013). The data showed very little infiltration occurs until the soil reaches about two-thirds saturation, and then infiltration increases roughly linearly until reaching 5 inches per hour at 90 percent saturation. Evapotranspiration also occurs in this layer.
- Stormwater within the gravel layer can move freely and infiltrate to surrounding soils, based on their capacity. If runoff enters the gravel layer more rapidly than it infiltrates, the saturation level in the gravel layer will rise until it reaches the elevation of a perforated pipe underdrain. When this occurs, water will flow through the underdrain to a downstream discharge point (typically the municipal storm drainage system).
- The surface reservoir is also equipped with an overflow structure that will become active if runoff enters the surface reservoir more rapidly than it infiltrates through the bioretention media and the surface reservoir fills to its maximum depth. Water discharged via the overflow relief structure does not receive treatment.

The bioretention configuration was based on the water quality treatment design criteria listed in the MRP 2.0 and accepted design practice in the Bay Area. Table 2 lists the dimensions of the bioretention layers as modeled in HPSF.

TABLE 2. BIORETENTION CHARACTERISTICS IN HSPF MODEL

Component	Characteristics
Surface reservoir	• Area = bioretention area (varies from 0.5% to 5% of upstream impervious area) • Depth = 6 or 12 inches with overflow relief set 2 inches from top of reservoir
Bioretention soil media	• Area = bioretention area • Depth = 18 inches • Saturated permeability = 5 inches per hour • Unsaturated permeability = variable, based on Contra Costa's 2013 monitoring data
Storage (gravel) layer	• Area = bioretention area • Depth = 12 inches • Permeability of surrounding soils = 0.024 inches per hour
Underdrain	• Located at top of gravel layer • Assumed 4-in diameter pipe

2.3 Model QA/QC Process

The HSPF input files and initial model results were carefully examined during the QA/QC process. Model errors and warnings were systematically eliminated and then the results were compared with the results generated from three independent calculation methods:

1. An Excel-based bioretention hydraulics calculator
2. A Matlab-based bioretention algorithm that was used for bioretention modeling in the Central Coast region
3. An EPA SWMM model using the LID module to represent bioretention hydraulics

The comparison was performed for the San Jose and Fairfield gauges with a bioretention sizing factor of 0.02 (i.e., bioretention surface area equal to 2 percent of the upstream impervious area). The estimated annual runoff treatment percentages agreed to within 3 percent, which confirmed the HSPF model was performing as intended.

3. Modeling Scenarios and Results

The HSPF modeling analysis was used to develop bioretention sizing criteria and support policy decisions. Working collaboratively with the BASMAA Development Committee, the modeling analysis addressed the following issues, which are presented in this section:

1. Bioretention area necessary to treat 80 percent of annual stormwater runoff
2. Relationships for estimating annual stormwater treatment percentage across a range of bioretention sizes and mean annual precipitation depths
3. Relationships for estimating annual stormwater treatment percentage for bioretention facilities without an underdrain
4. Bioretention treatment percentage for facilities with no infiltration to surrounding soils
5. Bioretention treatment percentage for facilities with lower bioretention media permeability

The results are summarized graphically here. The full set of results and underlying data were provided separately to the BAASMA Development Committee on 7/28/2017 and are available from BASMAA upon request.

3.1 Bioretention Sizing for Treatment of 80 Percent of Annual Runoff

The performance of bioretention facilities was modeled for 10 different rain gauges and bioretention footprint areas, ranging from 0.5 to 5.0 percent of the upstream tributary area, using the approach described in Section 2. Bioretention configurations with 6-inch and 12-inch deep surface reservoirs were modeled. For each of the model runs, the runoff treatment percentage was computed, and the results were plotted. Figure 3 shows an example for the San Jose gauge. Appendix B shows results for the other rain gauges.

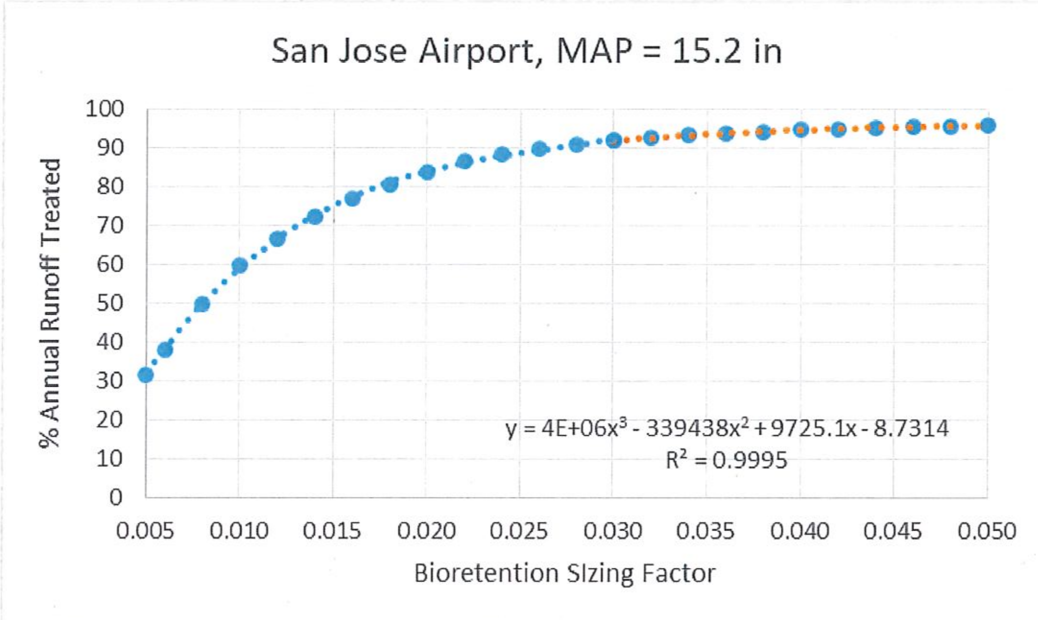


Figure 3. Percent of annual runoff treated for range of bioretention facility sizes using San Jose rain gauge

Using a polynomial regression equation, the model results for each rain gauge/surface reservoir depth scenario were interpolated to estimate the bioretention sizing factor needed to provide 80 percent annual runoff treatment, which is the treatment criterion for regulated water quality projects in the MRP 2.0. The results across the 10 rain gauges showed a clear linear relationship between mean annual rainfall and the bioretention footprint needed for 80 percent annual runoff treatment. Figure 4 and Figure 5 show the results for the 6-inch and 12-inch surface reservoir configurations, respectively.

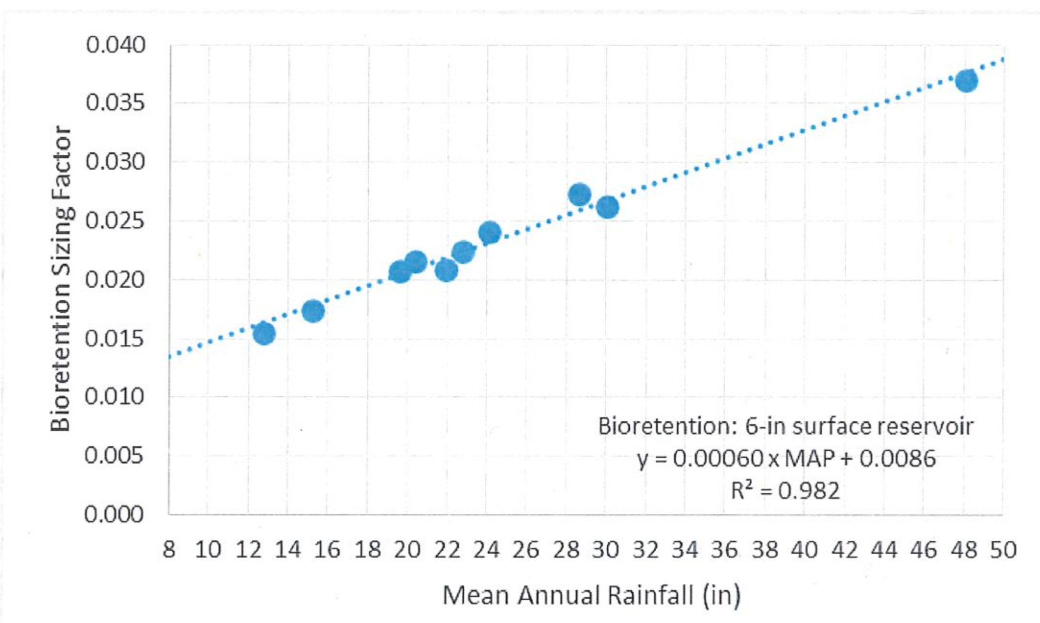


Figure 4. Bioretention size needed to provide treatment of 80 percent of annual runoff; 6-in surface reservoir

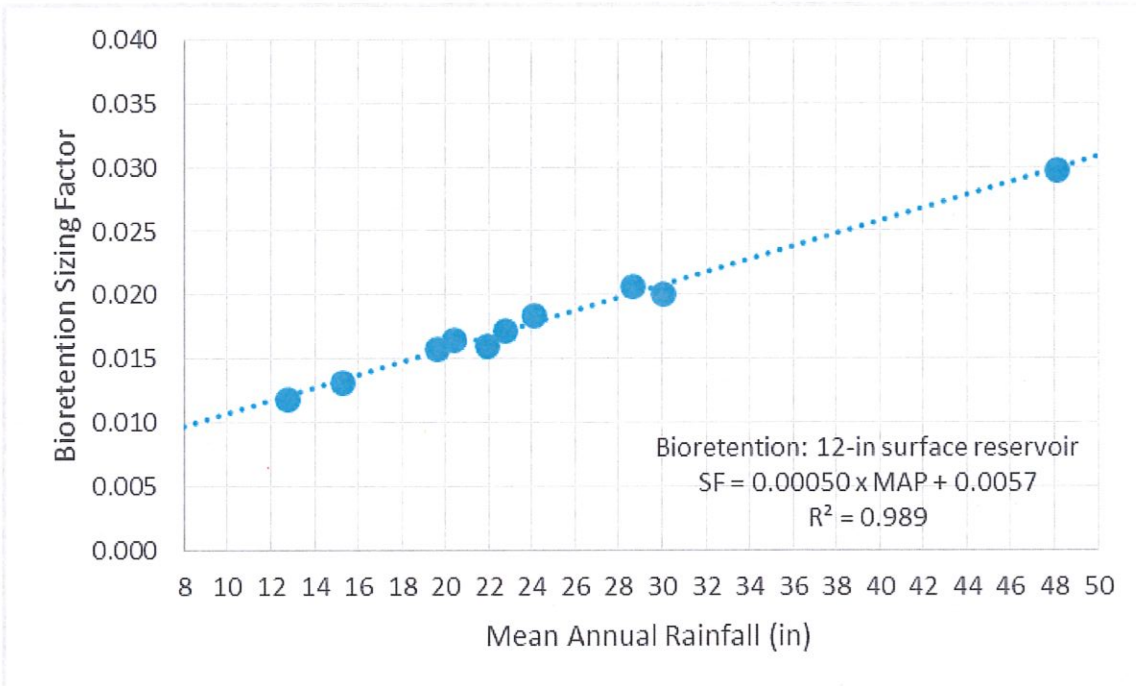


Figure 5. Bioretention size needed to provide treatment of 80 percent of annual runoff; 12-in surface reservoir

The results shown above could be used by BASMAA agencies to set minimum bioretention sizing criteria for projects that must provide treatment of 80 percent of annual runoff. The following equations could be included in BASMAA guidance for green infrastructure manuals.

For bioretention with 6-in surface reservoir configuration:

$$SizingFactor = 0.00060 \times MAP(in) + 0.0086$$

For bioretention with 12-in surface reservoir configuration:

$$SizingFactor = 0.00050 \times MAP(in) + 0.0057$$

3.2 Relationship Among Bioretention Sizing, Annual Precipitation, and Percent of Annual Runoff Treated

The modeling results generated in the previous section were then further evaluated to develop more general relationships among a) bioretention sizing factor, b) mean annual rainfall, and c) annual runoff treatment percentages. The following steps were used for the 6-inch and 12-inch reservoir depth configurations:

1. A polynomial regression was fit to the annual runoff treatment results for each of the 10 rain gauges (see example in Figure 3 above) and surface reservoir depths of 6 and 12 inches.
2. For each rain gauge/surface reservoir depth combination, the regression equation was used to estimate the sizing factors needed to provide 50, 60, 70, 80, 90, and 95 percent annual runoff treatment. This step generated 10 pairs of mean annual rainfall/bioretention sizing factor data for each rain gauge/surface reservoir depth combination (120 pairs in total). Excel's solver function was used for these calculations.

3. For each runoff treatment percentage level (50 percent, 60 percent, etc.), the mean annual rainfall (x-axis) and computed sizing factor (y-axis) were plotted and a linear regression was fit to the data in a manner similar to Figure 4 and Figure 5 above.
4. The linear regressions created for each runoff treatment level (50 percent, 60 percent, etc.) and surface reservoir depth were then plotted together to create a nomograph. Figure 6 and Figure 7 show nomographs for the 6-inch and 12-inch reservoir depths, respectively.

These nomographs are simple but powerful tools that municipal planners can use to estimate the annual treatment percentage for any bioretention facility within the BASMAA member agency area that uses the standard bioretention configuration (i.e., 6-in or 12-in reservoir, 18-in soil media, 12-in gravel layer, underdrain at top of gravel layer). The nomographs should be read as follows:

<u>Step 1:</u> Find the mean annual rainfall for the project location along the horizontal axis

<u>Step 2:</u> Move vertically up the chart to the bioretention sizing factor for the project/installation (note: this step assumes the tributary impervious area and bioretention area have already been planned)

<u>Step 3:</u> Visually interpolate between the closest two "treatment lines" to estimate the percent of annual runoff treated for this location/project.

These nomographs and instructions could be included in BASMAA guidance for green infrastructure manuals and used to a) evaluate the water quality benefits of proposed projects or b) evaluate the treatment provided by existing facilities with the layer depths described above.

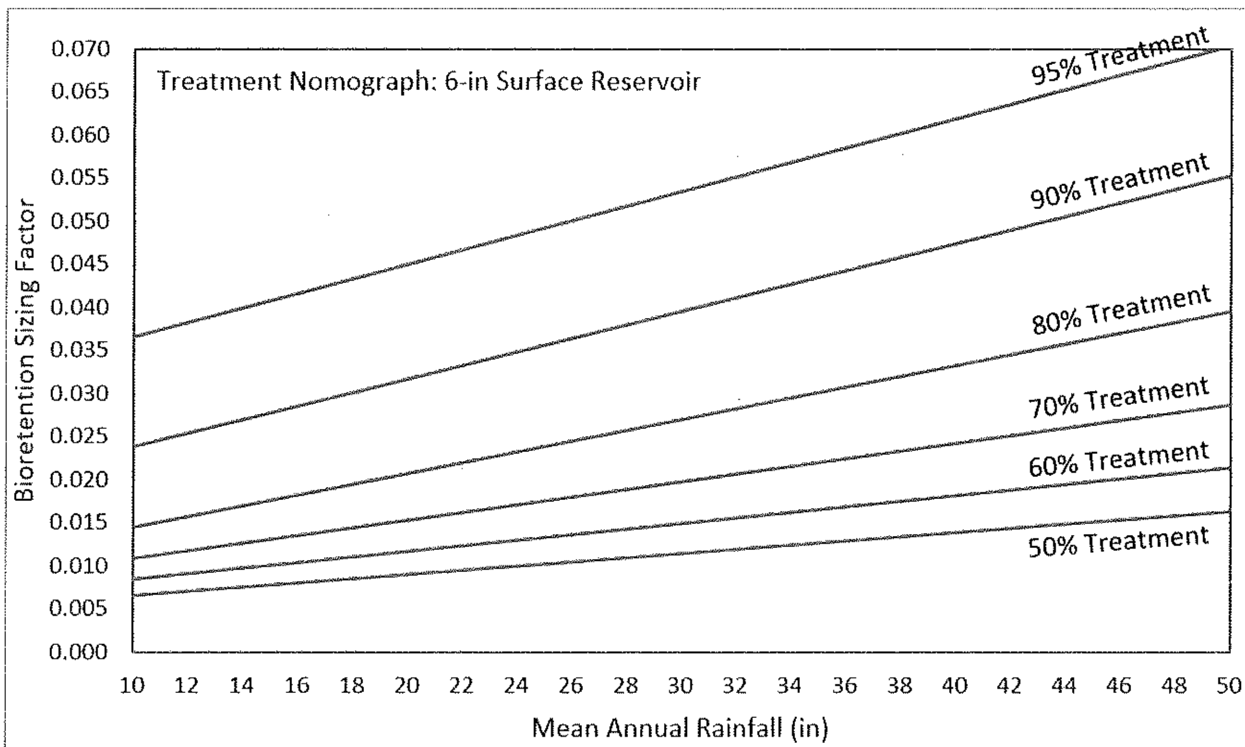


Figure 6. Percent of annual runoff treatment nomograph for bioretention facility with 6-in surface reservoir

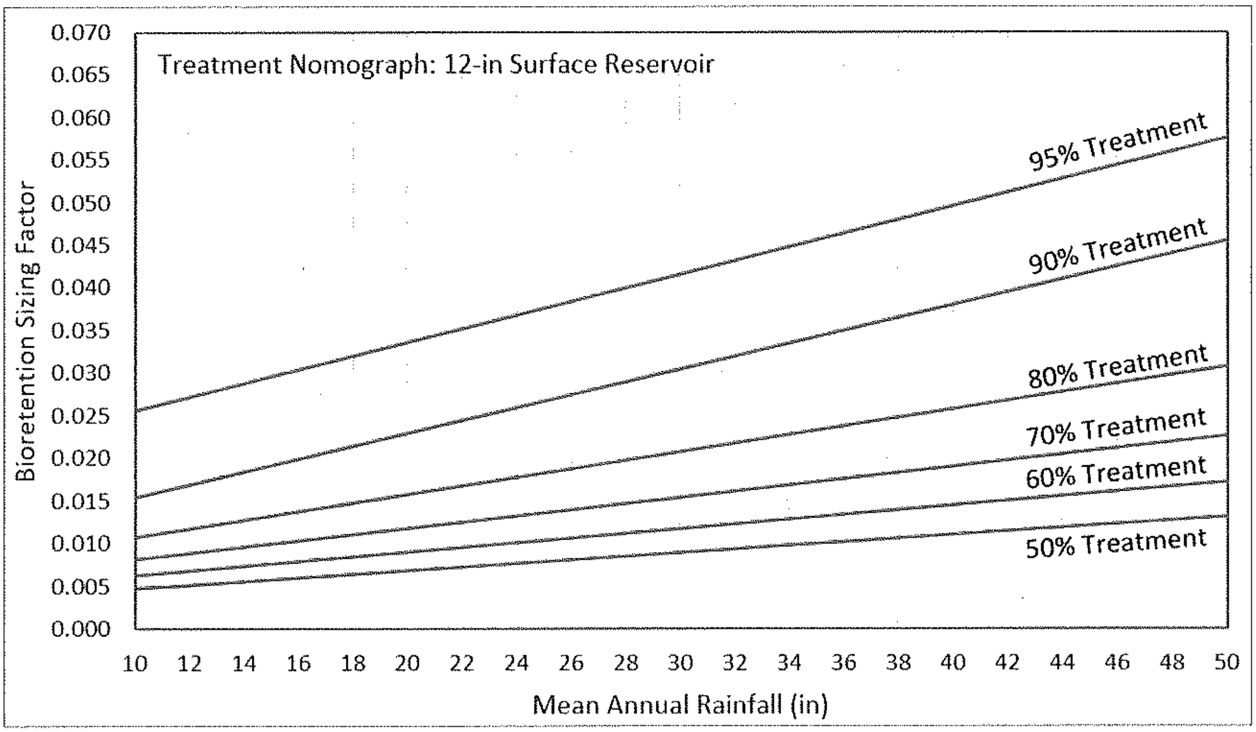


Figure 7. Percent of annual runoff treatment nomograph for bioretention facility with 12-in surface reservoir

3.3 Percent of Annual Runoff Treated by Bioretention Facilities with No Underdrain

Bioretention facilities are occasionally designed with no underdrain, including bioretention facilities in the following conditions:

- High permeability of surrounding (native) soils
- Isolated projects with no downstream drainage system for the underdrain connection
- Small projects that would not justify the additional design and construction costs associated with underdrains and cleanouts
- Projects that were designed and built prior to the development of the current standards

The HSPF model setup was modified to eliminate the underdrain outflows and allow the permeability of the surrounding soils to vary. The annual runoff treatment percentage was computed for a) three rain gauges representing drier, average and wetter than average conditions, b) six rates of permeability of surrounding soils, and c) two bioretention surface reservoir depths (Table 3).

TABLE 3. BIORETENTION WITH NO UNDERDRAIN SCENARIOS

Component	Characteristics
Rain gauges	• San Jose (MAP = 15.2 in) • San Francisco Airport (MAP = 20.4 in) • Fairfield (MAP = 24.1 in)
Permeability of surrounding (native) soils	• 0.2, 0.5, 1.0, 2.0, 3.0, 4.0 inches per hour • Underdrain results also plotted

TABLE 3. BIORETENTION WITH NO UNDERDRAIN SCENARIOS

Component	Characteristics
Surface reservoir depths	• Depth = 6 inches • Depth = 12 inches
Bioretention sizing factors	• Area = 0.5% to 5.0% of upstream impervious acre

Figure 8, Figure 9 and Figure 10 show the modeled annual runoff treatment results for the three rain gauges and a surface reservoir depth of 6 inches. Results for the 12-inch surface reservoir are shown in Appendix C. For rates of permeability of 4 inches per hour, there is little drop off in performance. The annual runoff treatment percentage declines gradually between rates of permeability of 2 to 4 inches per hour and then declines more rapidly for rates of permeability of 1 inch per hour or less. The reduction in performance is more pronounced in wetter areas (as seen in the Fairfield results). These results could be incorporated into the BASMAA guidance for green infrastructure manuals to assess the general performance of existing facilities that were installed with no underdrain.

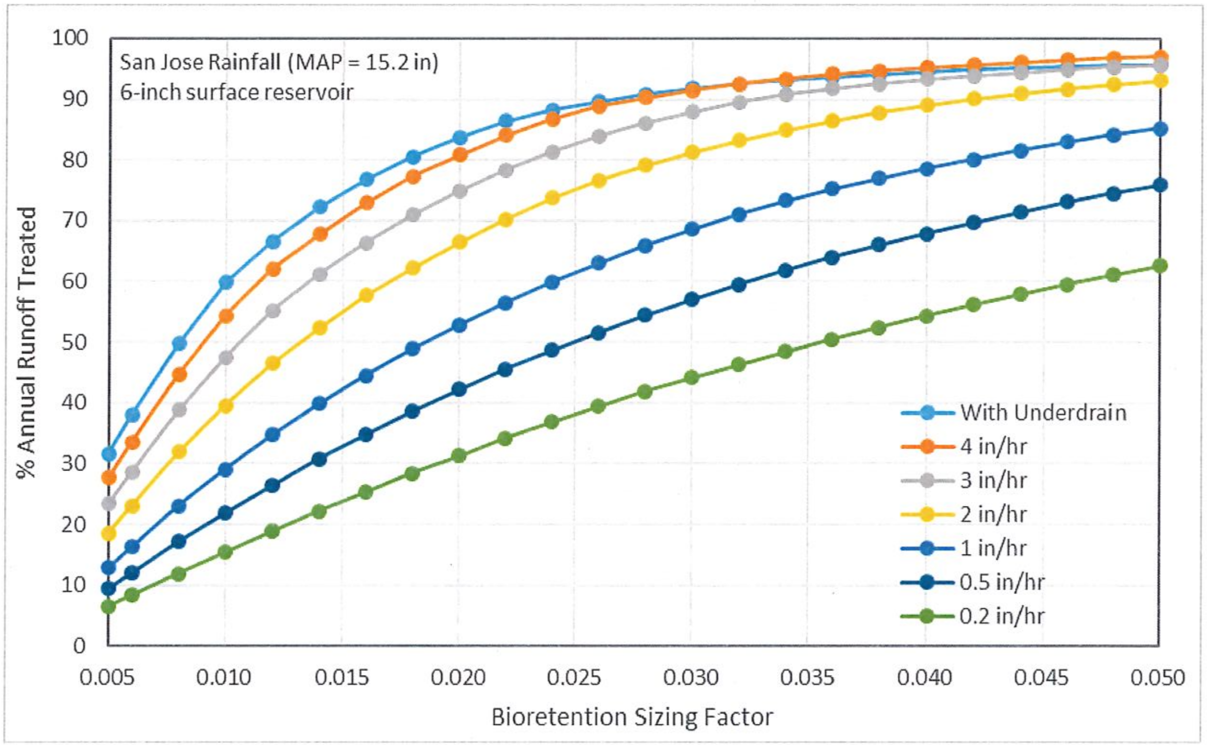


Figure 8. Treatment results for bioretention with no underdrain, San Jose gauge (MAP = 15.2 in), for varying rates of permeability of surrounding soils

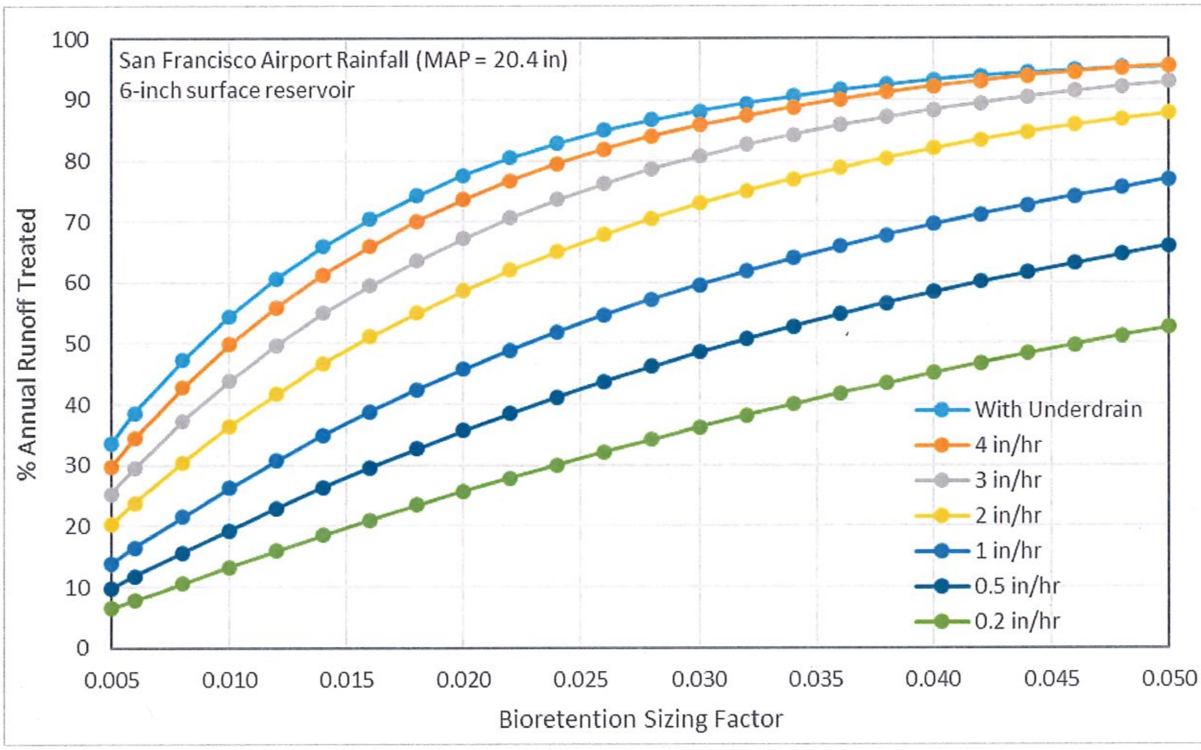


Figure 9. Treatment results for bioretention with no underdrain, San Francisco Airport gauge (MAP = 20.4 in), for varying rates of permeability of surrounding soils

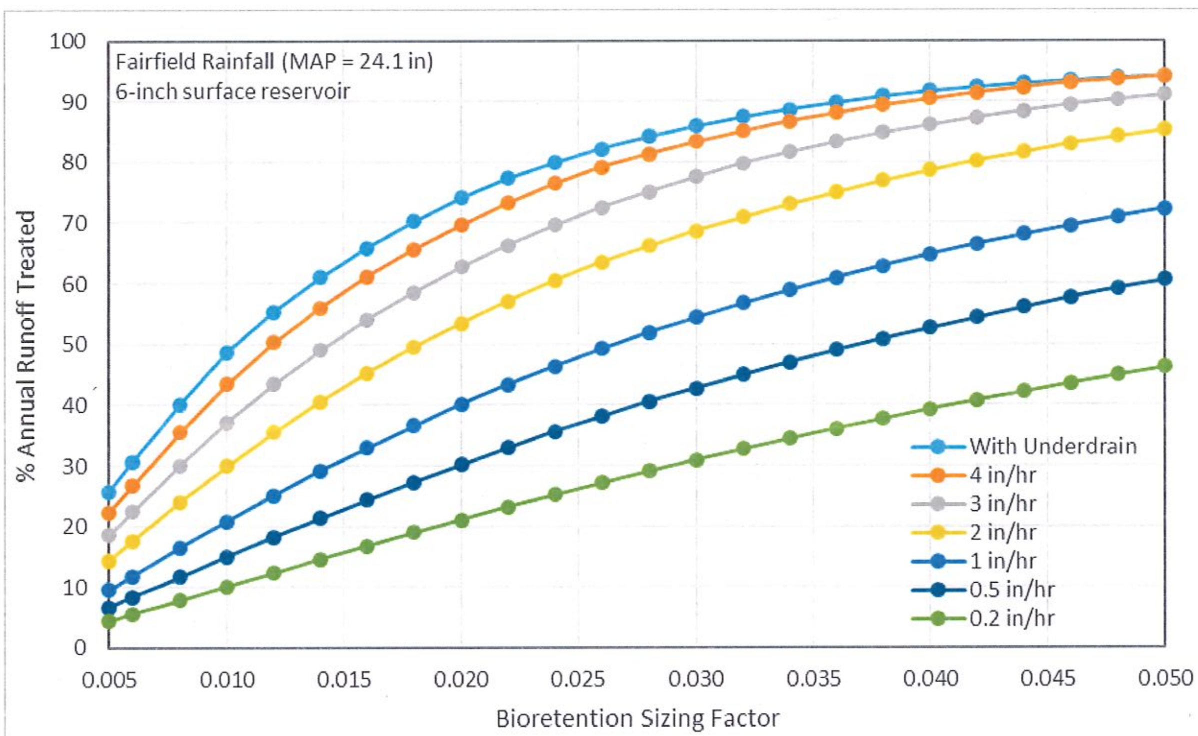


Figure 10. Treatment results for bioretention with no underdrain, Fairfield gauge (MAP = 24.1 in), for varying rates of permeability of surrounding soils

3.4 Percent of Annual Runoff Treated for Bioretention Facilities with No Infiltration to Surrounding Soils

The previous simulations described in Sections 3.1 and 3.2 were conducted for bioretention facilities located in NRCS hydrologic soil group D soils, which are low permeability soils, such as clays. These model simulations used a conservative permeability of 0.024 inches per hour from the bioretention gravel layer to surrounding soils. It was assumed the permeability of surrounding soils would have a negligible effect on the results because the hydraulic capacity of the underdrain is much higher than the permeability of D soils and that when the bioretention media becomes saturated, stormwater would exit mostly via the underdrain. If this assumption is correct, a lined bioretention facility or flow-through planter with no infiltration into surrounding soils should have similar performance.

This assumption was tested directly by running a limited number of simulations with the permeability of the surrounding soils set to a value of zero (i.e., an impervious layer directly below the bioretention facility). The annual treatment percentages were then compared to the previous modeling results (with D soil permeability set to 0.024 inches per hour). These simulations were performed for the Fairfield rain gauge and a bioretention facility with a 6-inch surface reservoir for sizing factors ranging from 0.005 to 0.050.

Figure 11 shows the two sets of model results. For the impermeable bottom scenario, the annual treatment percentage was on average 0.8 percent less the scenarios with a D soil permeability of 0.024 inches per hour (minimum difference = 0.4 percent; maximum difference = 1.5 percent). Therefore, the sizing curves and nomographs in Figure 4 through Figure 7 can be used for lined facilities with no infiltration.

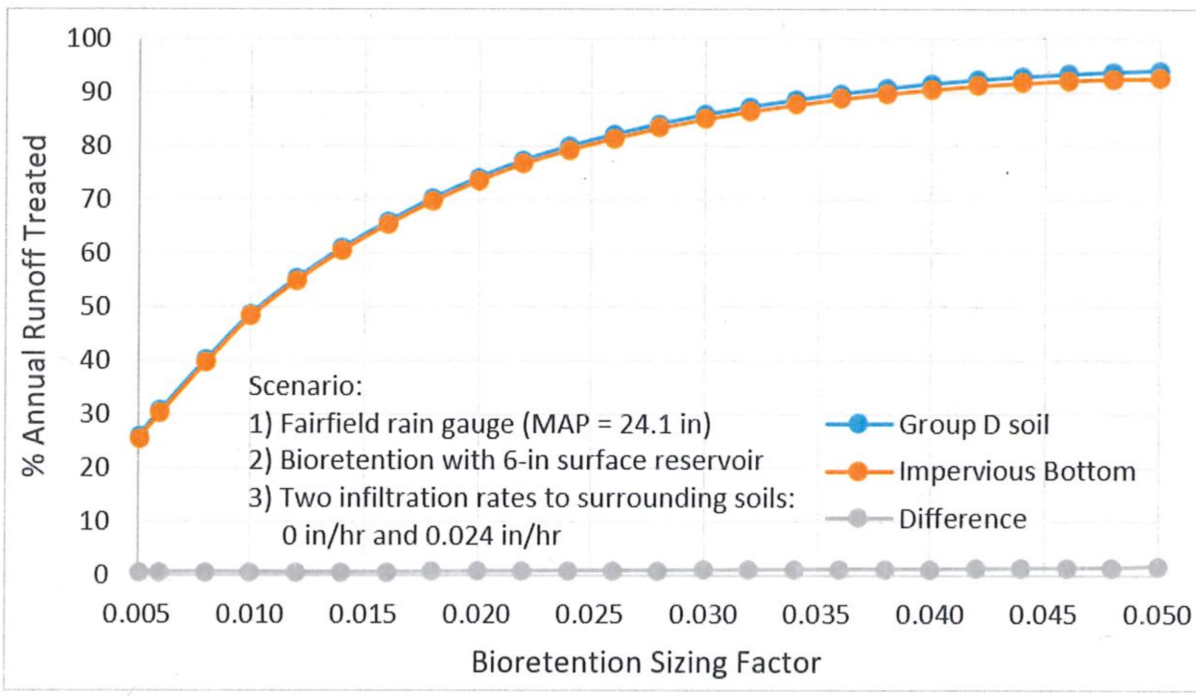


Figure 11. Comparison of model results for Group D soils and impermeable bottom scenarios

3.5 Percent of Annual Runoff Treated for Bioretention Facilities with Lower Media Permeability

The final modeling analysis examined the effect of modifying the bioretention media properties to reduce its saturated permeability from 5 inches per hour to 2 or 3 inches per hour. A lower permeability media would expand the list of available plantings and provide additional flexibility for landscape designers. However, the lower permeability would also reduce the bioretention's capacity for treating runoff during intense storms.

Due to budgetary constraints, this modeling analysis was limited to two scenarios: San Jose rain gauge, 6-inch surface reservoir depth, sizing factors ranging from 0.005 to 0.05, and saturated bioretention media permeability of 2 and 3 inches per hour. Figure 12 shows the percentage of annual runoff treated across the range of bioretention sizing factors and permeability rates. All of the scenarios include an underdrain, so the media permeability is the facility characteristic that controls the treatment percentage (i.e., the rate limiting step). The reduction in treatment percentage could be significant, particularly for smaller facilities. For example, the percent of annual runoff treated for a bioretention facility with a sizing factor of 0.02 would be reduced from 84 percent to 74 or 65 percent (for media permeability rates of 3 and 2 inches per hour, respectively).

Another way to consider the effect of lower media permeability is to estimate *how much larger a facility would need to be* to treat 80 percent of annual runoff. For the San Jose gauge, a sizing factor of 0.017 is needed with the standard bioretention media specification. If the media permeability were reduced to 3 or 2 inches per hour, the sizing factor needed to treat 80 percent of annual runoff would be 0.024 or 0.030, respectively, which represents a 37 to 75 percent increase in the facility footprint.

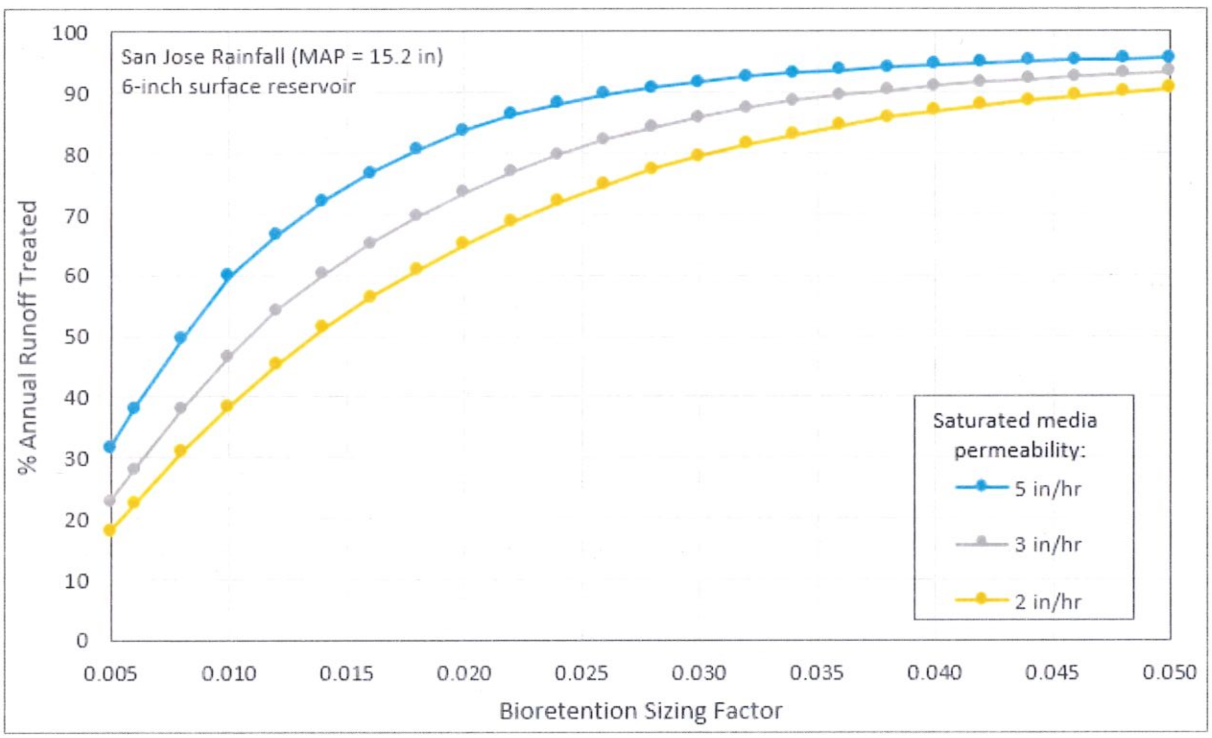


Figure 12. Treatment results for bioretention with variable media permeability, San Jose gauge (MAP = 15.2 in)

As a final note, the media permeability modeling was limited to two scenarios (one rain gauge, one facility configuration, two permeability rates). However, these results could be extended by noting that they are generally similar to the "no underdrain" results shown in Section 3.3 (e.g., comparing the results for a media permeability of 2 inches per hour to a 2-inch per hour permeability of surrounding soil). When comparing the two sets of results, the percent of annual runoff treated for the lower media permeability is a little lower (0.5 to 2.5 percent) than the corresponding "no underdrain" scenario and the shape of the curve in Figure 12 is similar to the Figure 8 in Section 3.3.

4. Summary and Conclusions

Bioretention facilities are a useful and flexible approach for improving stormwater quality in urban areas. This project developed a set of useful tools that will help municipal staff plan green infrastructure projects in constrained public rights-of-way and assess the effectiveness of existing facilities.

1. Bioretention Sizing Criteria for 80 Percent Annual Runoff Treatment

   The modeling analysis in Section 3.1 showed that bioretention facility performance is closely related to mean annual rainfall. For most locations, the bioretention area necessary to treat 80 percent of annual stormwater ranges from 1.5 to 2.5 percent of the connected upstream impervious area. The precise bioretention area necessary for any project within the BASMAA area (under the guidelines to be developed by BASMAA) can be calculated using the regression equations in Section 3.1.

2. General Sizing Relationships that Apply Throughout the BASMAA Area

   The modeling analysis in Section 3.2 developed nomographs that estimate the annual stormwater treatment percentage across a range of bioretention facility sizes and mean annual rainfall depths. These nomographs can be used to estimate the annual treatment percentages for retrofit projects with space constraints and will enable municipal staff to compare bioretention with other treatment technologies. These nomographs can also be used to assess the effectiveness of existing facilities.

3. Performance of Bioretention Facilities with No Underdrain and Varying Rates of Permeability of Surrounding Soils

   The modeling analysis in Section 3.3 demonstrated the relationship between stormwater treatment percentage and level of permeability of surrounding soils for bioretention facilities without an underdrain. Graphics were developed for rain gauges in wetter and drier areas. The results of this analysis can help assess existing installations and also inform designers about the benefits and tradeoffs of constructing bioretention with no underdrain.

4. Performance of Bioretention Facilities with No Infiltration

   The modeling analysis in Sections 3.1 and 3.2 included the conservative assumption that bioretention facilities were installed in NRCS Group D soils with a very low permeability. The modeling analysis in Section 3.4 compared these results to bioretention facilities with no infiltration to surrounding soils (e.g., facilities with a liner or concrete bottom). The results were very similar, which confirms that the sizing guidance developed in Sections 3.1 and 3.2 can apply to flow-through planters or similar facilities that do not infiltrate to surrounding soils.

5. Sizing Criteria for Facilities with Lower Permeability Soil Media

   The modeling analysis in Section 3.5 demonstrated the relationship between percent of annual runoff treated and bioretention soil media permeability. Reducing media permeability would allow for a wider range of bioretention plantings but would also result in a reduction in the percent of annual runoff treated for the same size drainage area. The reduction would be particularly notable for bioretention facilities with smaller sizing factors. The results of the bioretention media permeability analysis were similar to the no underdrain scenarios in Section 3.3 The Section 3.3 results could be used to estimate how reducing media permeability would influence treatment percentages across a wider range of scenarios.

In general, the bioretention surface area sizing criteria for treating 80% of the annual runoff derived from the modeling analyses described herein are significantly lower than the sizing factors that municipalities in the Bay Area have been requiring regulated projects to meet for compliance with permit requirements for some time. As stated in the Introduction (Section 1), the BASMAA Development Committee and BASMAA member agencies intend to use these sizing relationships to develop and justify a "single approach" for implementing non-regulated green street projects when there are constraints on facility size. A work group of the Development Committee was formed to develop policies and guidelines for implementing the new sizing criteria and addressing other related issues. These include defining the conditions, constraints, and types of projects for which the reduced sizing factors can be used; the method for applying the sizing factors; guidelines for when dimensions of other components such as media depths can be adjusted; how the design of other types of green infrastructure measures may be modified; the effectiveness of smaller or modified green infrastructure facilities in terms of pollutant load reduction; and other considerations.

5. References

Contra Costa Clean Water Program (CCCWP). 2006. Hydrograph Modification Management Plan. April 16, 2006.

Contra Costa Clean Water Program (CCCWP). 2013. IMP Monitoring Report, IMP Model Calibration and Validation Report. September 20, 2013.

Appendix A: Storm Depths for 1-Hour and 24-Hour Durations

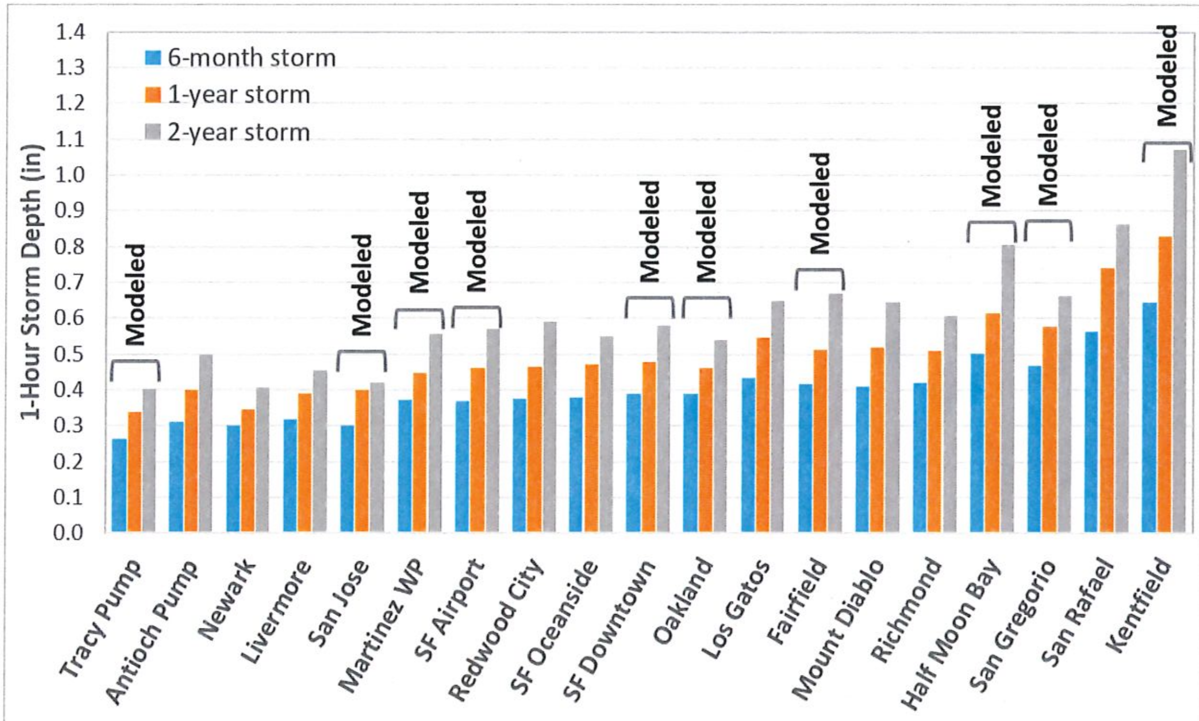


Figure 13. Storm depths for 1-hour duration

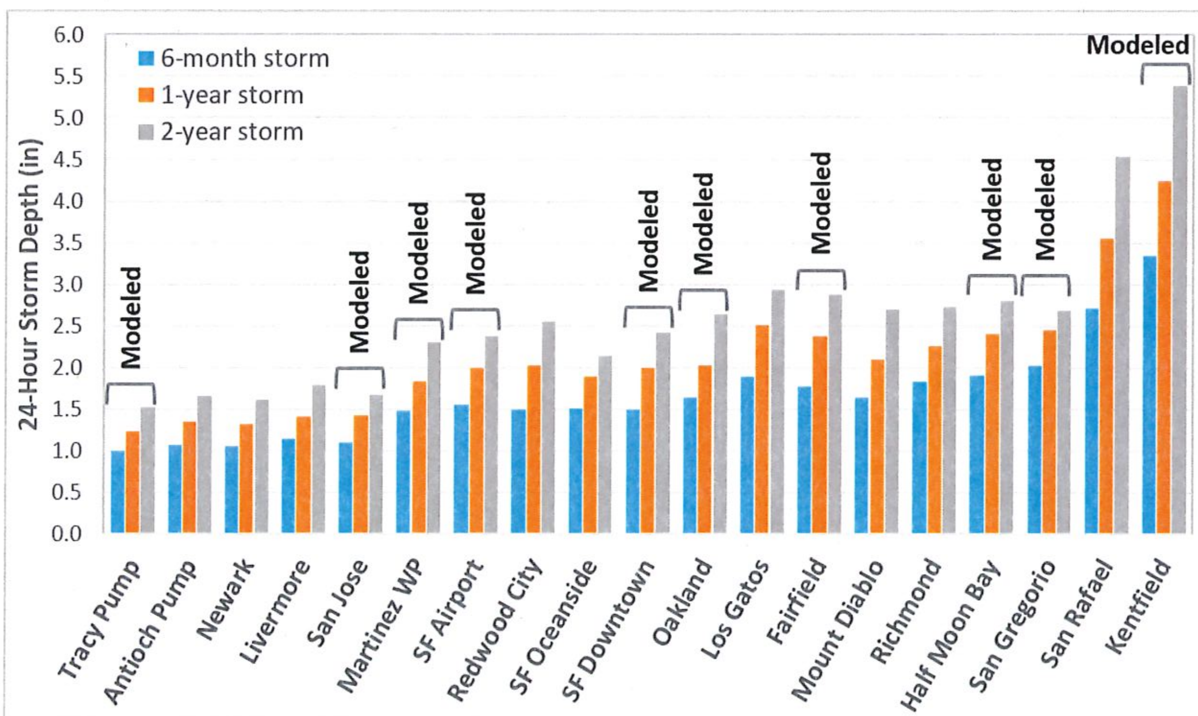


Figure 14. Storm depths for 24-hour duration

Appendix B: Treatment Percentage Results Graphics for All Rain Gauges

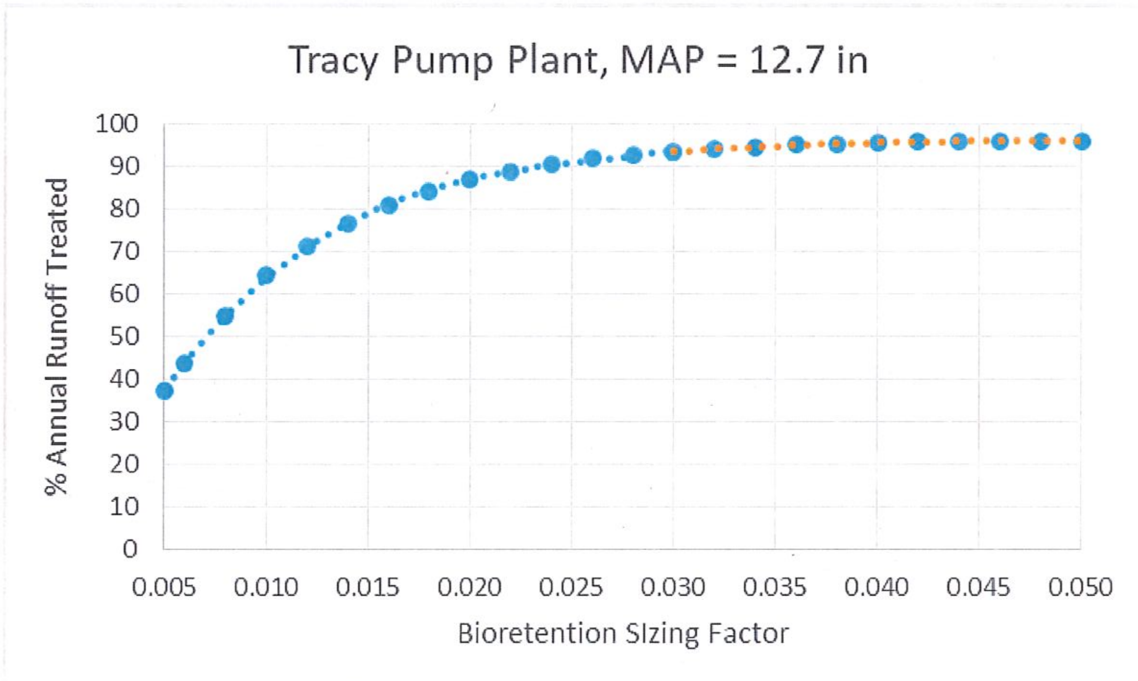


Figure 15. Annual treatment percentage for the Tracy Pump Plant rain gauge

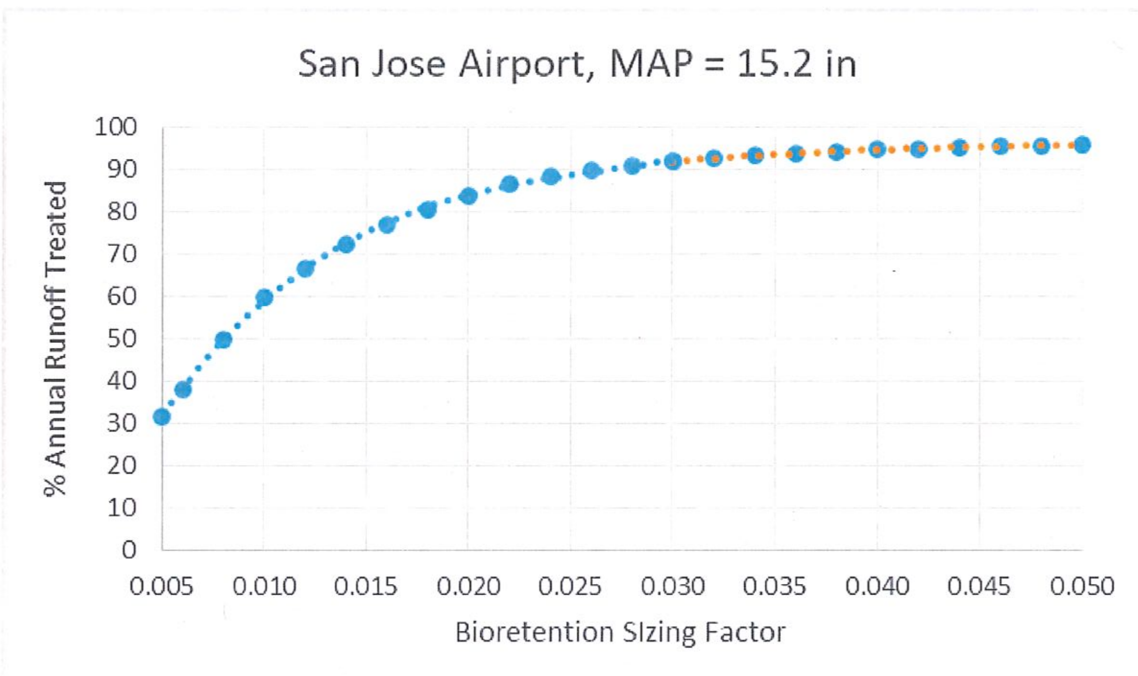


Figure 16. Annual treatment percentage for the San Jose rain gauge

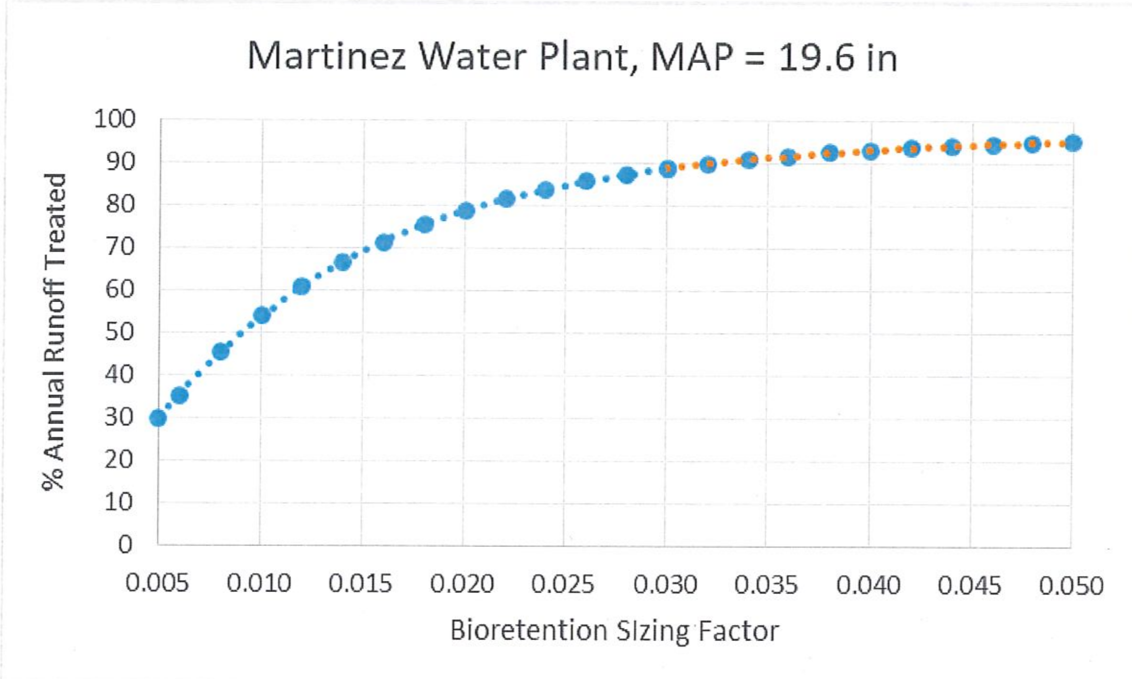


Figure 17. Annual treatment percentage for the Martinez Water Plant rain gauge

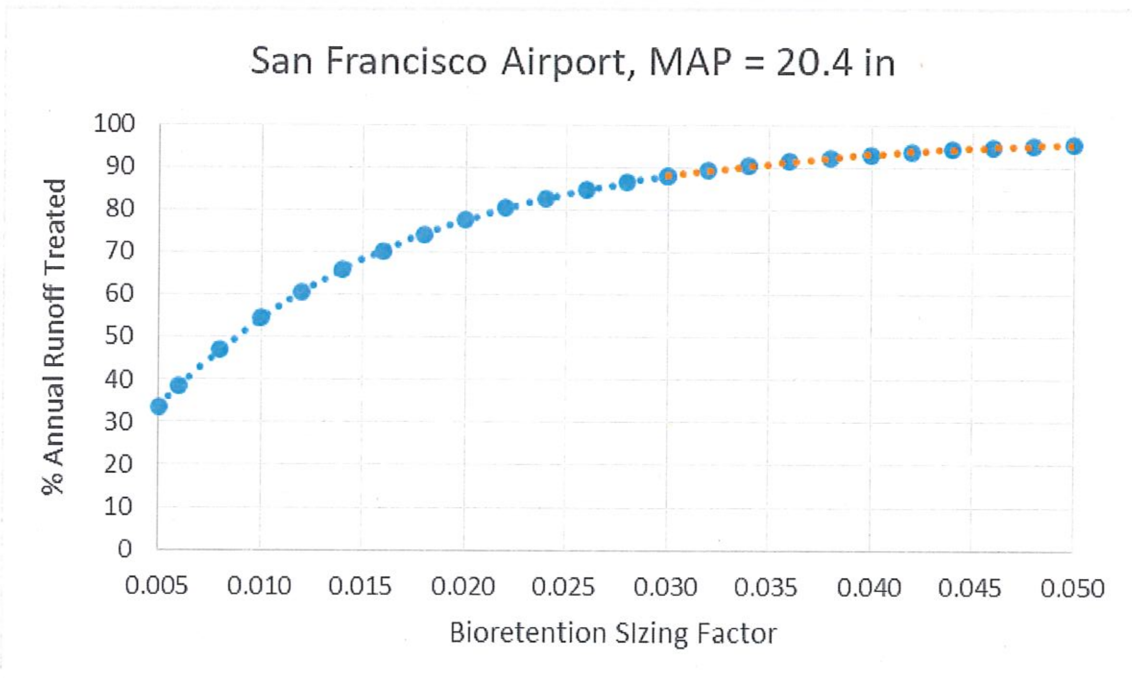


Figure 18. Annual treatment percentage for the San Francisco Airport rain gauge

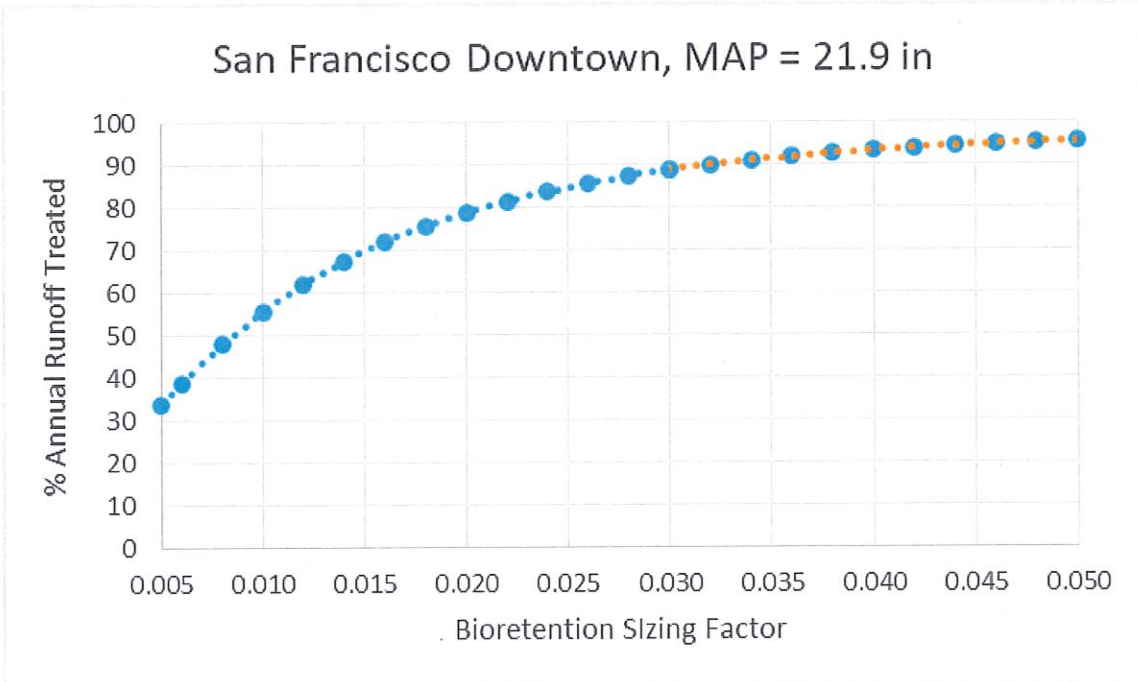


Figure 19. Annual treatment percentage for the San Francisco Downtown rain gauge

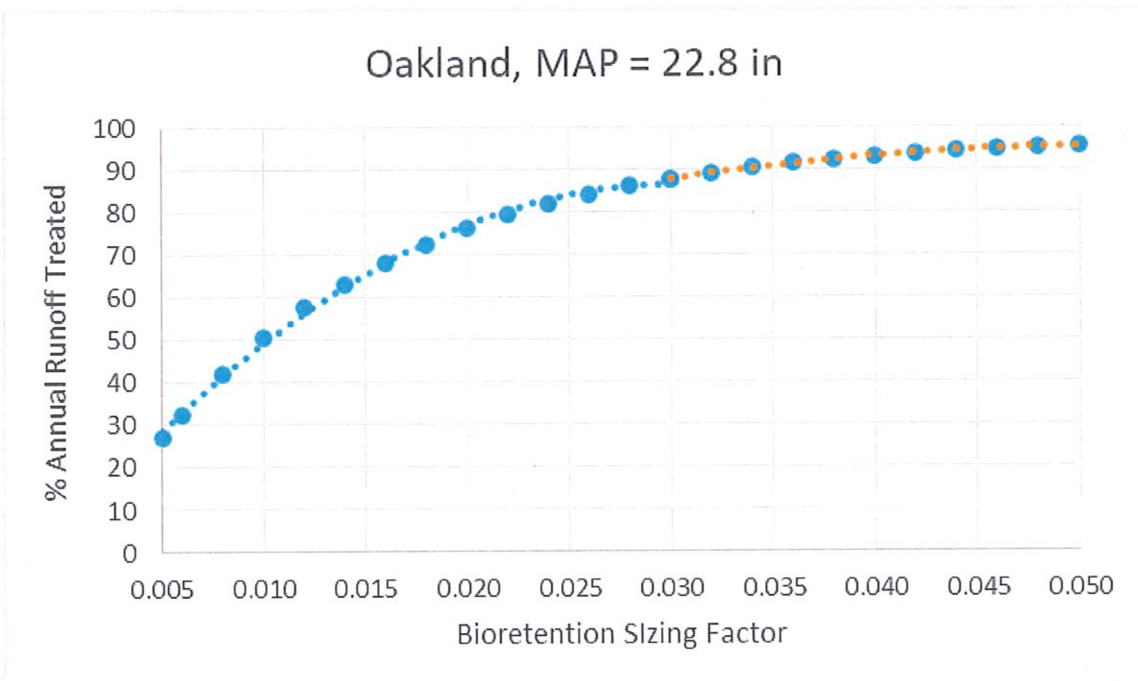


Figure 20. Annual treatment percentage for the Oakland rain gauge

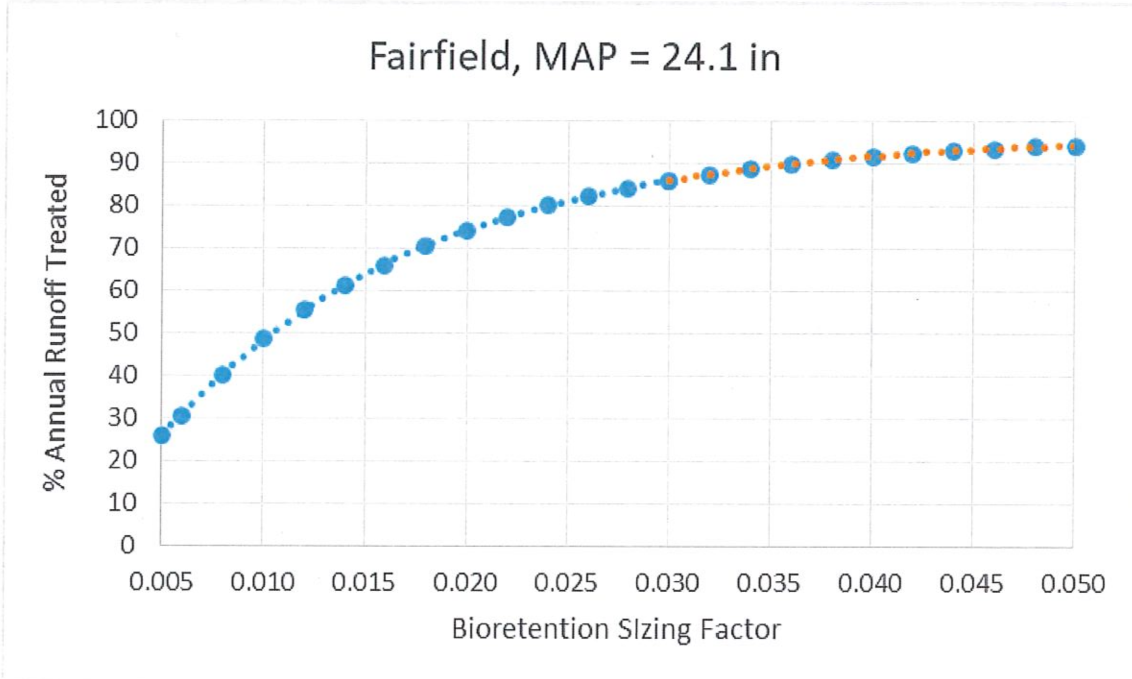


Figure 21. Annual treatment percentage for the Fairfield rain gauge

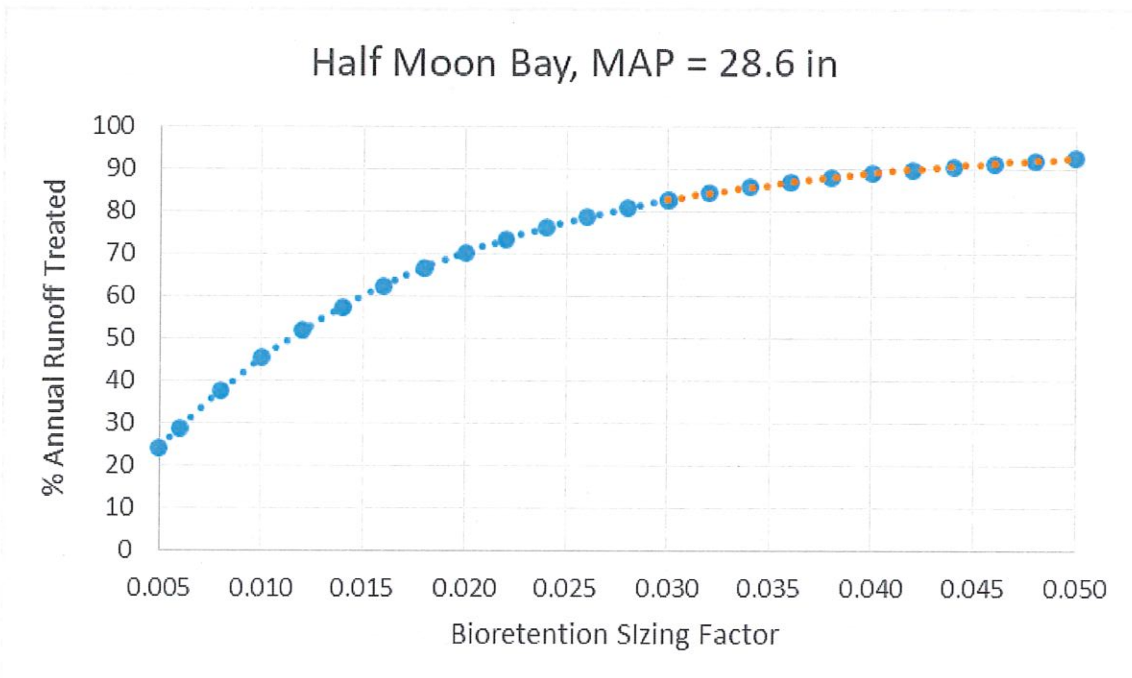


Figure 22. Annual treatment percentage for the Half Moon Bay rain gauge

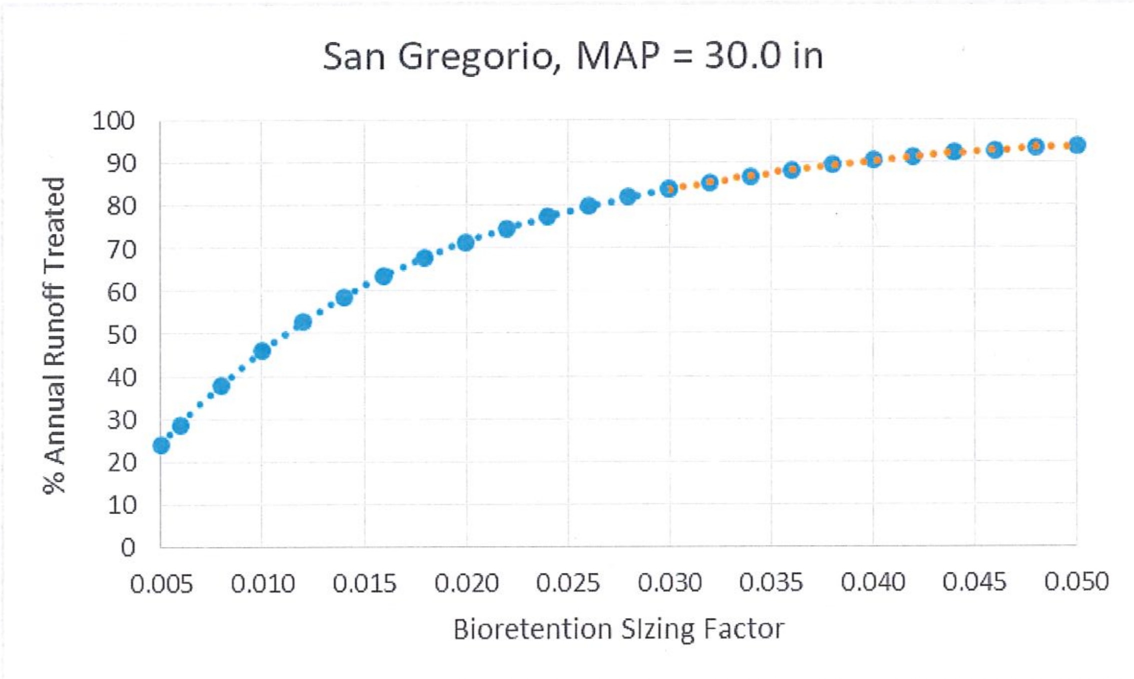


Figure 23. Annual treatment percentage for the San Gregorio rain gauge

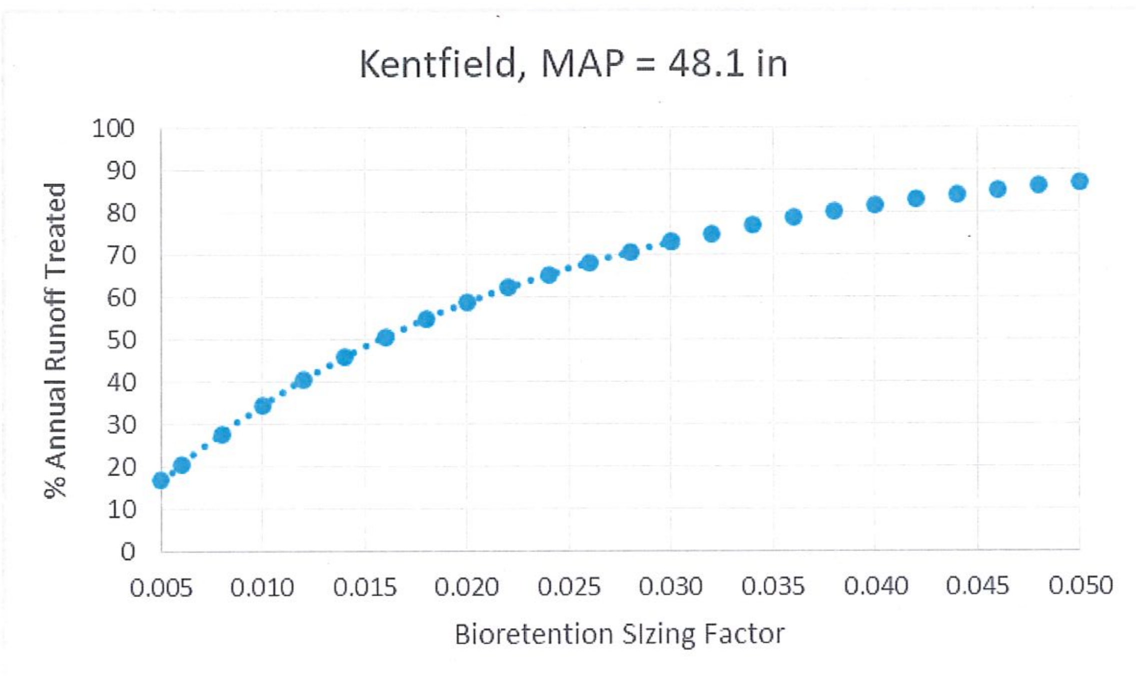


Figure 24. Annual treatment percentage for the Kentfield rain gauge

Appendix C: Bioretention with No Underdrain, 12-inch Surface Reservoir Results

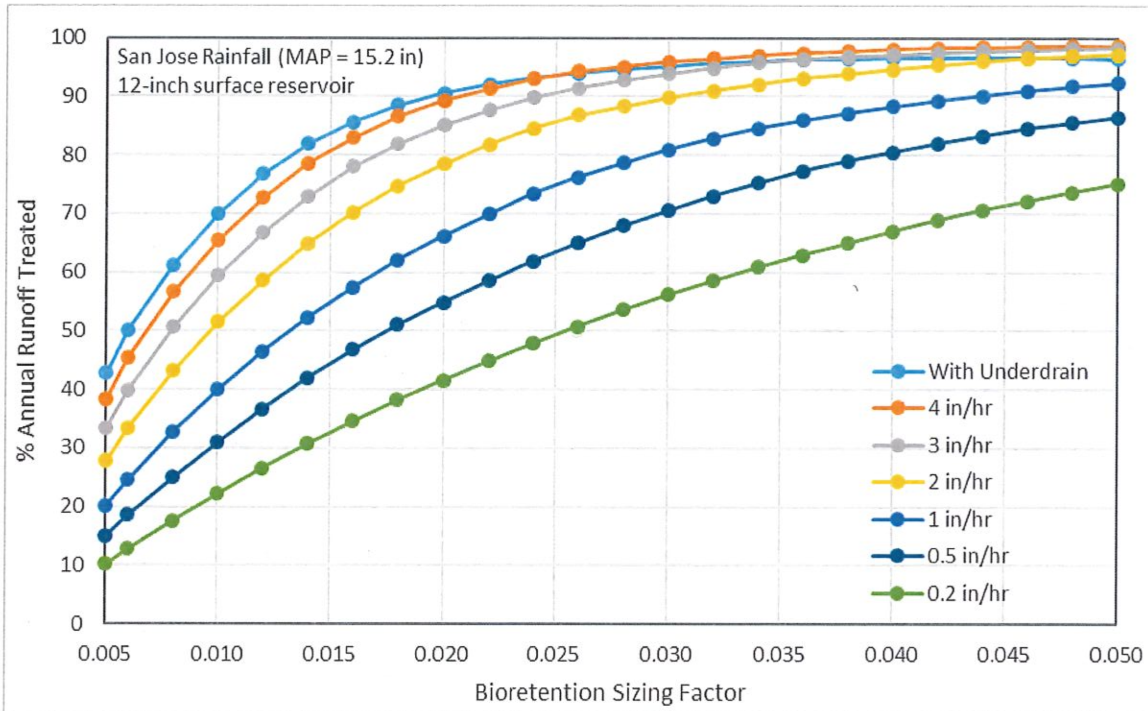


Figure 25. Treatment results for bioretention with no underdrain, San Jose gauge (MAP = 15.2 in)

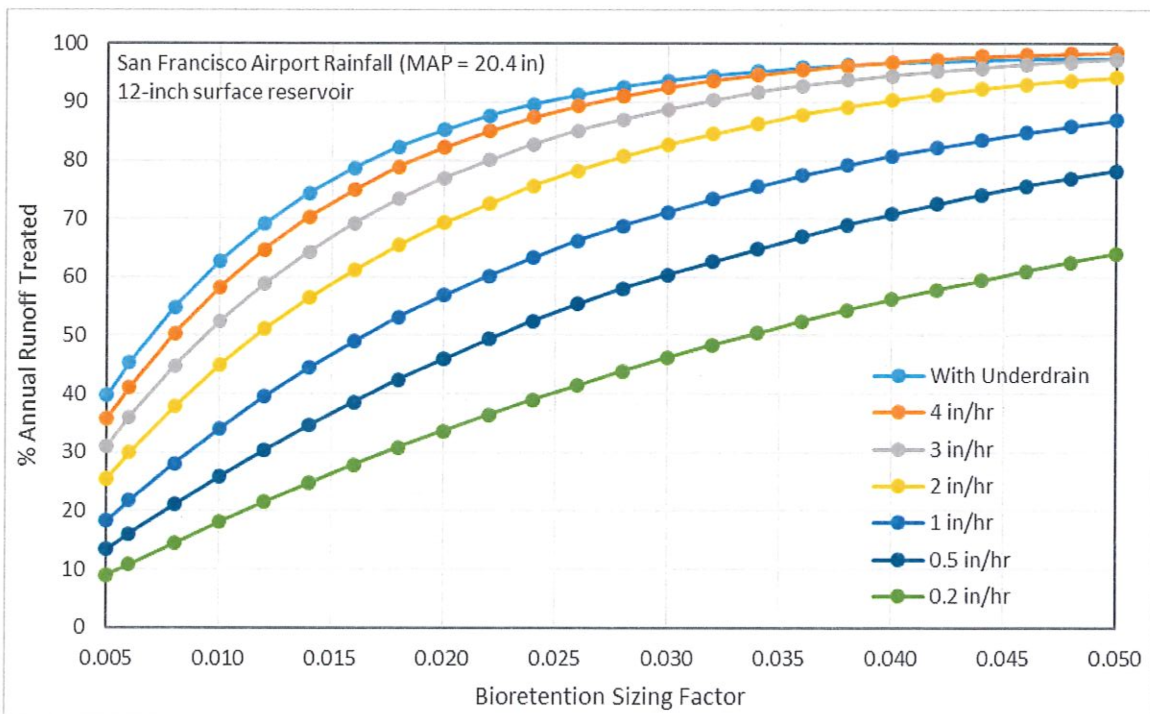


Figure 26. Treatment results for bioretention with no underdrain, San Jose gauge (MAP = 15.2 in)

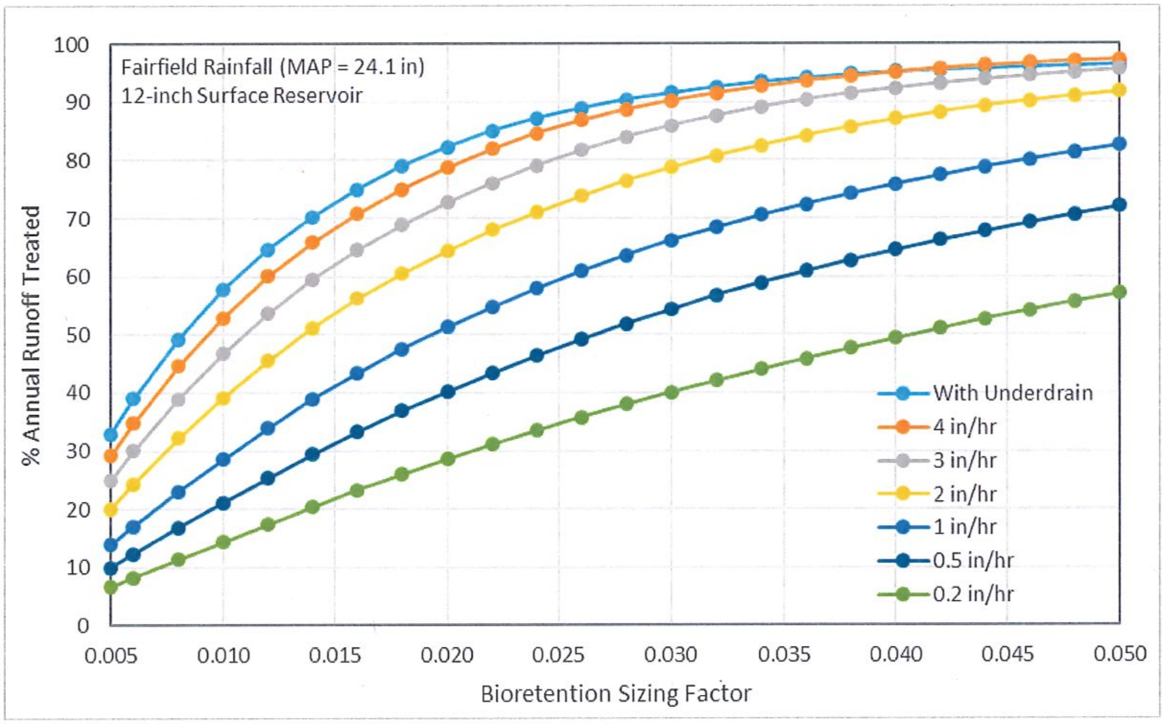


Figure 27. Treatment results for bioretention with no underdrain, San Jose gauge (MAP = 15.2 in)