C.3 Stormwater Technical Guidance

March 22, 2023

A handbook for developers, builders, and project applicants

Version 8

cleanwater PROGRAM

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Alameda County Flood Control and Water Conservation District

Zone 7 Water Agency

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GLOSSARY OF TERMS

Term	Definition
Alameda Countywide Clean Water Program (Clean Water Program)	The Alameda Countywide Clean Water Program is established by a memorandum of understanding among the 14 Alameda County cites, Alameda County, the Alameda County Flood Control and Water Conservation District, and the Zone 7 Water Agency. All these agencies are Permittees in the MRP. The Program implements common tasks and assists the member agencies to implement their local stormwater pollution prevention programs.
Base Course	A layer of constructed material (typically aggregate base – a construction aggregate typically composed of crushed rock or of recycled asphalt or concrete, capable of passing through a sieve with a certain pore diameter) located above the subbase course and/or subgrade course, and below the surface layer (which consists of a wearing course, and sometimes an extra binder course), applied to serve one or more functions, such as supporting the surface layer and distributing load.
Bay Area Hydrology Model (BAHM)	A computer software application to assist project applicants in sizing specialized stormwater detention facilities required by the hydromodification management provision (Provision C.3.g) of the MRP.
Best Management Practice (BMP)	Any program, technology, process, siting criteria, operational method or measure, or engineered system. BMPs in this context refer to water pollution prevention and controls that remove, and/or reduce pollutants in stormwater or the amount of stormwater runoff.
Bioinfiltration and Bioretention Areas	A type of low impact development (LID) treatment measure designed per the requirements of C.3. The system provides a surface ponding area to promote evapotranspiration and filtration of water through an engineered biotreatment soil media into layer of rock in which an underdrain is typically installed. Where soils have a hydraulic conductivity rate of 1.6 inches per hour, Water Quality Volume is treated by evapotranspiration and infiltration; where it is lower, runoff is treated by evapotranspiration, some infiltration, and filtering and release of the remaining amount into the underdrain. *Bioretention areas* may be lined with an impermeable layer while *bioinfiltration areas* are never lined with an impermeable layer.
Bioswale	This term is largely obsolete. Bioswales, also called vegetated swales or vegetated buffer strips, are defined by EPA as a broad, shallow channel with a dense stand of vegetation covering the side slopes and bottom. Swales can be natural or constructed and are designed to trap particulate pollutants like suspended solids and trace metals, promote infiltration and reduce the flow velocity of storm water runoff. Bioswales are not considered LID treatment measures under the MRP but may be used as site design measures.

Term	Definition
Biotreatment	A type of LID treatment measure designed to have a surface area no smaller than what is required to accommodate a 5 inches/hour stormwater runoff surface loading rate and uses biotreatment soil. Biotreatment includes bioinfiltration and bioretention.
Biotreatment Soil Media (BSM)	A soil blend designed to meet the specifications approved by the Regional Water Quality Control Board Executive Officer in 2016. The general requirements for BSM include: 1) Achieve in-place infiltration rate of at least 5 inches/hour over the life of the project; 2) Support vigorous plant growth; and 3) Consist of 60%-70% sand and 30%-40% compost measured by volume.
Bituminous Surface Treatment	A thin protective wearing surface, which can provide, among other services, a waterproof layer to protect underlying pavement and a filler for existing cracks or raveled surfaces. This includes, but is not limited to: • Chip seal – a single layer of asphalt emulsion binder that is covered by embedded aggregate; • Slurry seal – a thick, cold mix paving treatment that contains aggregates, asphalt emulsion, binder and fines, water, and additives; and • Seal coat – an emulsion containing liquid asphalt and/or coal tar, mineral fillers and other anti-oxidation additives and admixtures. • Cape seal – a chip seal covered with a slurry or micro-surface, applied to existing pavements. Micro-surfacing is a polymer-modified cold-mix paving system that begins as a mixture of dense-graded aggregate, asphalt emulsion, water, and mineral fillers.
C.3	The provision of the MRP that requires Permittees to use their planning authorities to include appropriate source control, site design, and stormwater treatment measures in new development and significant redevelopment projects to address stormwater runoff pollutant discharges and prevent increases in runoff flows from new development and redevelopment projects.
C.3.d Amount of Runoff	The amount of stormwater runoff from C.3 Regulated Projects that must receive stormwater treatment, as described by hydraulic sizing criteria in MRP Provision C.3.d.
California Stormwater Quality Association (CASQA)	Publisher of the California Stormwater Best Management Practices Handbooks, available at www.casqa.org.
Clean Water Act (CWA)	The Federal Water Pollution Prevention and Control Act, or Clean Water Act (33 U.S. Code 1251 et seq.) is intended to control or eliminate surface water pollution and establishes the National Pollutant Discharge Elimination System, which among other things regulates stormwater discharges from municipal storm drains, industrial facilities, and construction sites.
Complete Application	Applications that have been accepted by the Planning Department and have not received a letter within 30 calendar days stating that the application is incomplete (consistent with the Permit Streamlining Act).

Term	Definition
	Where an application has not been accepted by the Planning Department and the applicant has received a letter within 30 days stating that the application is incomplete, the application will be deemed complete if the additional requested information is submitted to the satisfaction of the Planning Department.
Conduit/Conveyance System/Culvert	Channels or pipes for collecting and directing the flow of water. Conduits and conveyance systems may be open channels, covered channels or pipes. Culverts are covered channels or large diameter pipes.
Constructed Wetlands	Constructed detention basins that have a permanent pool of water throughout the year and capacity for temporary additional storage of runoff that is released via an outlet structure. They differ from wet ponds in that they are typically shallower and have greater vegetation coverage.
Construction General Permit	A NPDES general permit issued by the State Water Resources Control Board (SWRCB) for the discharge of stormwater associated with construction activity.
Contiguous Impervious Area	The adjoining or connected impervious area on a project. Note that project areas interrupted by cross streets or intersections are considered contiguous.
Cumulative Impervious Area	The total amount of impervious area proposed for a project whether or not adjoining.
Design Storm	A hypothetical rainstorm defined by rainfall intensities and durations.
Detention	The temporary storage of stormwater runoff in ponds, vaults, within berms, or in depressed areas to allow treatment by sedimentation and metered discharge of runoff at reduced peak flow rates. See Infiltration and retention.
Detached Single-family Home Project	The building of one single new house or the addition and/or replacement of impervious surface associated with one single existing house, which is not part of a larger plan of development.
Development	Construction, rehabilitation, redevelopment, or reconstruction of any public or private residential project (whether single-family, multi-unit, or planned unit development); or industrial, commercial, retail, or other nonresidential project, including public agency projects.
Directly-Connected Impervious Area (DCIA)	The area covered by a building, impermeable pavement, and/or other impervious surfaces, which drains directly into the storm drain without first flowing across permeable land area (e.g., landscaped areas).
Directly Discharging	Outflow from a drainage conveyance system that is composed entirely or predominantly of flows from the subject property, development, subdivision, or industrial facility, and not commingled with flows from adjacent lands.
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.

Term	Definition
Discharge	A release or flow of stormwater or other substance from a conveyance system or storage container.
Discharger	Any responsible party or site owner or operator whose site or activity discharges stormwater runoff or a non- stormwater discharge.
Drawdown Time	The time required for a stormwater detention or infiltration BMP to drain and return to the dry-weather condition. For detention BMPs, drawdown time is a function of basin volume and outlet orifice size. For infiltration BMPs, drawdown time is a function of basin volume and infiltration rate.
Dry Weather Flow	Flows that occur during periods without rainfall. Dry weather flows in storm drains may result from human activities, such as over-irrigation.
Dry Well	Structure placed in an excavation or boring, or excavation filled with open-graded rock, that is designed to collect stormwater and infiltrate into the subsurface soil.
Erosion	The diminishing or wearing of land due to wind, or water. Often the eroded material (silt or sediment) becomes a pollutant via stormwater runoff. Erosion occurs naturally but can be intensified by land disturbing and grading activities such as construction, development, road building, agriculture, and timber harvesting.
Evapotranspiration	Evaporating water into the air directly or through plant transpiration.
Extended Detention Basin	Constructed basins with drainage outlets that are designed to detain runoff from a water quality design storm for some minimum time (e.g., 48 hours) to allow settling of sediment and pollutants.
Filter Fabric	Geotextile of relatively small mesh or pore size that is used to: (a) allow water to pass through while keeping sediment out (permeable); or (b) prevent both runoff and sediment from passing through (impermeable).
Floor Area Ratio	The ratio of the total floor area on all floors of all buildings at a project site (except structures or floors dedicated to parking) to the total project site area.
Flow-based Treatment Measures	Stormwater treatment measures that treat pollutants from a moving stream of water through filtration, infiltration, and/or biological processes.
Flow Duration	Either a) the total hours that surface flow from a watershed or drainage area occurs at a specified magnitude in response to a long-term time history of rainfall inputs, or b) the cumulative percentage of total hours that flows exceed the specified magnitude (as used in the BAHM). The overall distribution of flow durations is then expressed by a histogram or cumulative distribution curve, showing flow durations for equal subdivisions of the full range of flow magnitudes occurring over time.
Flow Duration Control	An approach to mitigating development-caused hydromodification which involves developing continuous simulation models of runoff from both pre-project and post-project site conditions, comparing flow durations for a designated range of flows, and designing specialized detention and

Term	Definition
	discharge structures to reduce excess post-project flow duration for flows in the designated range (See Chapter 7).
Flow-Through Planter Box	Structure designed to treat stormwater by intercepting rainfall and slowly draining it through filter media and out of planter.
Full Trash Capture Device	A Full Capture Device or System is a treatment control, or series of treatment controls, including, but not limited to, a multi-benefit project (as defined in the Trash Amendments) or a LID control that traps all particles that are 5 mm or greater, and has a design treatment capacity that is either: a) of not less than the peak flow rate, Q, resulting from a one-year, one-hour storm in the subdrainage area, or b) appropriately sized to, and designed to carry at least the same flows as, the corresponding storm drain.
Grading	The cutting and/or filling of the land surface to a desired shape or elevation.
Green Stormwater Infrastructure	Infrastructure that uses vegetation, soils, and natural processes to manage water and create healthier urban environments. Green stormwater infrastructure mimics nature by soaking up and storing water – providing a sustainable system that slows runoff by dispersing it to vegetated areas, harvests and uses runoff, promotes infiltration and evapotranspiration, and uses bioretention and other low impact development practices to clean stormwater runoff. Within the jurisdiction of the MRP, the term green stormwater infrastructure is typically used in connection with voluntary projects undertaken by public agencies, whereas the term LID is used for C.3 regulated projects.
Green Roof/Roof Garden	Vegetated roof systems that retain and filter stormwater prior to drainage off building rooftops.
Groundwater	Subsurface water that occurs in soils, and geologic formations that are fully saturated.
Hazardous Waste	By-products of human activities that can pose a substantial or potential hazard to human health or the environment when improperly managed. Possesses at least one of four characteristics (flammable, corrosivity, reactivity, or toxicity), or appears on special EPA lists.
Head	In hydraulics, energy is represented as a difference in elevation. In slow-flowing open systems, the difference in water surface elevation, e.g., between an inlet and outlet.
Heritage Tree	An individual tree of any size or species given the heritage tree designation as defined by a municipality's tree ordinance or other section of the municipal code.
High-Flow Bypass	In stormwater treatment measures, a pipe, outlet, or other structure designed to convey flood flows directly to the storm drain systems without entering the treatment measure.

Term	Definition
Hydrodynamic Separator (HDS)	Mechanical stormwater treatment systems that are designed as flow-through structures with a settling or separation unit to remove sediment and other pollutants that settle to the bottom of the separation unit.
Hydrograph	A graph showing the rate of flow (discharge) versus time past a specific point in a river/creek or channel.
Hydromodification	Alteration to the hydrology of a landscape through development and increased impervious surfaces. This results in decreased water infiltration, increased water diversion to stormwater. This in turn creates short periods of increased stream flows during rain events. The effects of hydromodification include, but are not limited to, increased stream bed and bank erosion, loss of habitat, increased sediment transport and deposition, and increased flooding. MRP Provision C.3.g requires Hydromodification Management (HM) for projects that create and/or replace one acre or more of impervious surface with select exclusions including projects located in highly developed catchments. All HM Projects must meet the HM Standard of either Provision C.3.g.ii or Provision C.3.g.iii.
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	A surface covering or pavement of a developed parcel of land that prevents the land's natural ability to absorb and infiltrate rainfall/stormwater. Impervious surfaces include, but are not limited to, roof tops; walkways; patios; driveways; parking lots; storage areas; impervious concrete and asphalt; and any other continuous watertight pavement or covering. Landscaped soil and pervious pavement, including pavers with pervious openings and seams, underlain with pervious soil or pervious storage material, such as a gravel layer sufficient to hold at least the C.3.d volume of rainfall runoff are not impervious surfaces. Open, uncovered retention/detention facilities shall not be considered as impervious surfaces for purposes of determining whether a project is a Regulated Project under Provisions C.3.b. and C.3.g. Open, uncovered retention/detention facilities shall be considered impervious surfaces for purposes of runoff modeling and meeting the Hydromodification Standard.
Indirect Infiltration	Infiltration via facilities, such as swales and bioretention areas, that are expressly designed to hold runoff and allow it to percolate into surface soils. Runoff may reach groundwater indirectly or may be underdrained through subsurface pipes.
Infiltration	Seepage of precipitation or runoff through the soil column and into groundwater. See retention.
Infiltration Devices	Infiltration facilities that are deeper that they are wide and designed to infiltrate stormwater runoff into the subsurface and, as designed, bypass the natural groundwater protection afforded by surface soil. These

Term	Definition
	devices include dry wells, injection wells, and infiltration trenches (includes French drains).
Infiltration Facilities	A term that refers to both infiltration devices and measures.
Infiltration Measures	Infiltration facilities that are wider than they are deep (e.g., bioinfiltration, infiltration basins and shallow wide infiltration trenches).
Infiltration Trench	Long narrow trench filled with permeable material, designed to store runoff and infiltrate through the bottom and sides into the subsurface soil.
Inlet	An entrance into a ditch, storm sewer, or other waterway.
Integrated Pest Management (IPM)	An approach to pest control that uses regular monitoring to determine if and when treatments are needed and employs physical, mechanical, cultural, biological, and educational tactics to keep pest numbers low enough to prevent unacceptable damage or annoyance. See Bay-Friendly Landscaping and Gardening.
Joint Treatment Facility	A stormwater treatment facility built to treat the combined runoff from two or more Regulated Projects.
Low Impact Development (LID)	A land planning and engineering design approach with a goal of reducing stormwater runoff and mimicking a site's predevelopment hydrology by minimizing disturbed areas and impervious cover and then infiltrating, storing, detaining, evapotranspiring, and/or biotreating stormwater runoff close to its source, or onsite. As described in MRP Provision C.3.c, LID aims to create functional and appealing site drainage that treats stormwater as a resource, rather than a waste product.
Large Single-Family Home Projects	Large detached single family home projects are a type of Regulated Project.
Maintenance Plan	A plan detailing operation and maintenance requirements for stormwater treatment measures and/or structural hydromodification measures incorporated into a project.
Media Filter	Two-chambered system that includes a pretreatment settling basin and a filter bed filled with sand or other absorptive filtering media.
Mixed-use Development or Redevelopment	Development or redevelopment of property to be used for two or more different uses intended to be harmonious and complementary. An example is a high-rise building with retail shops on the first 2 floors, office space on floors 3 through 10, apartments on the next 10 floors, and a restaurant on the top floor.
Municipal Regional Stormwater Permit (MRP)	The Phase I municipal stormwater NPDES permit under which discharges are permitted from municipal separate storm sewer systems throughout Alameda County and other NPDES Phase I jurisdictions within the San Francisco Bay Region.

Term	Definition
National Pollutant Discharge Elimination System (NPDES) Permit	Permits that regulate point source discharges to "waters of the United States" as defined by the federal Clean Water Act. In California NPDES Permits are issued by the State Water Board and Regional Water Quality Control Boards.
New Development	Land disturbing activities; structural development, including construction or installation of a building or structure, creation of impervious surfaces, and/or land subdivision.
Non-Stormwater Discharge	Any discharge to municipal separate storm drain that is not composed entirely of stormwater. Some types of non-stormwater discharges may be authorized by NPDES permits and others prohibited.
Numeric Sizing Criteria	Sizing requirements for stormwater treatment controls established in MRP Provision C.3.d.
Offsite Project	A stormwater treatment facility that discharges into the same watershed as the Regulated Project and is located at a different public or private parcel or property (e.g., right-of-way) from the Regulated Project.
Operation and Maintenance (O&M)	Refers to requirements in the MRP to inspect stormwater treatment systems and hydromodification measures and implement preventative and corrective maintenance in perpetuity. The O&M phase of a project commences once construction is complete. See Chapter 10.
Operational Source Control Measure	Low technology, low-cost activities, procedures, or management practices designed to prevent pollutants associated with site functions and activities from being discharged with stormwater runoff. Examples include good housekeeping practices, employee training, standard operating practices, inventory control measures, etc.
Outfall/ Outlet	The point where stormwater discharges from a pipe, channel, ditch, or other conveyance to a waterway.
Percentile Rainfall Intensity	A method of designing flow-based treatment controls that ranks long-term hourly rainfall intensities and selects the 85^{th} percentile value, and then doubles this value.
Permeability	A property of soil that enables water or air to move through it. Usually expressed in inches/hour or inches/day.
Pervious Pavement	A pavement system consisting of permeable surface that passes runoff through the surface or joints into a gravel base that stores and infiltrates rainfall at a rate equal to immediately surrounding unpaved, landscaped areas, or that stores and infiltrates the rainfall runoff volume described in Provision C.3.d.
Pervious Surface	Permeable surface that allows surface runoff to infiltrate into surface soil (e.g., landscape, pervious pavement system).
Perviousness	The permeability of a surface that can be penetrated by stormwater to infiltrate the underlying soils.
Point of Compliance	For design to meet Flow Duration Control requirements for hydromodification management, the point at which pre-project runoff is

Term	Definition
	compared to post-project runoff, usually near the point where runoff leaves the project area.
Pollutant	A substance introduced into the environment that adversely affects or potentially affects the usefulness of a resource.
Post-Construction Stormwater Control	See Stormwater Control.
Pre-Project Runoff	Stormwater runoff conditions that exist onsite immediately before development activities occur. This definition is not intended to be interpreted as that period before any human-induced land activities occurred. This definition pertains to redevelopment as well as initial development.
Precipitation	Any form of rain or snow.
Provision C.3	A reference to the requirements in the MRP that requires control of the flow of stormwater and stormwater pollutants from new and redevelopment sites.
Public Development	The construction, rehabilitation, redevelopment, or reconstruction of any public agency project, including but not limited to, libraries, office buildings, roads, and highways.
Rational Method	A method of calculating runoff flows based on rainfall intensity and the amount of runoff from the tributary area.
Redevelopment	Land-disturbing activity that results in the creation, addition, or replacement of exterior impervious surface area on a site on which some past development has occurred. See Chapter 2 for a discussion of the regulated project types and threshold and MRP Provision C.3.b.ii for full details.
Regional Project	A regional or municipal stormwater treatment facility that captures runoff from a drainage area larger than the parcel on which it is located and discharges into the same watershed as the Regulated Project.
Regional Water Quality Control Board, San Francisco Bay Region (RWQCB or Regional Water Board)	One of nine California Regional Water Boards, the San Francisco Bay Regional Water Board is responsible for implementing pollution control provisions of the Clean Water Act and California Water Code within the area that drains to San Francisco Bay.
Regulated Projects	Public and private new development and redevelopment projects that create or replace impervious area, which are subject to stormwater treatment, site design, and source control requirements. Regulated projects are defined in MRP Provision C.3.b.ii. See Chapter 2 for a discussion of the regulated project types and threshold and MRP Provision C.3.b.ii for full details.
Residential Housing	Development of multiple single-family homes or of dwelling units intended for multiple families/households (e.g., subdivisions, apartments, condominiums, and town homes).

Term	Definition
Retention	The storage of stormwater to prevent it from leaving the development site.
Road Project	Development project conducted in the public right of way by public entities, including new streets, sidewalks and bicycle lanes built as part of the new streets or roads, widening of existing streets or roads with additional traffic lanes, and construction of impervious trails that are ≥ 10 feet wide or are within 50 feet of the top of a creek bank.
Runoff	Water originating from rainfall and other sources (e.g., sprinkler irrigation) that drains to the storm drainage system or surface waters (e.g., creeks, lakes, and the Bay).
Sedimentation	The process of depositing soil particles (clay, sand, or other sediments) that were picked up by runoff.
Sediments	Soil, sand, and minerals washed from land into water, usually after rain.
Self-Retaining Area	A portion of a development site is designed to retain the first one inch of rainfall (by ponding and infiltration, and/or evapotranspiration) without producing stormwater runoff. Self-retaining areas must have at least a 2:1 ratio of contributing area to a self-retaining area and a 3-inch ponding depth. Self-retaining areas may include graded depressions with landscaping or pervious pavement. Areas that Contribute Runoff to Self-Retaining Areas are impervious or partially pervious areas that drain to self-retaining areas.
Self-Treating Area	A portion of a development site in which infiltration, evapotranspiration, and other natural processes remove pollutants from stormwater. Self-treating areas may include conserved natural open areas, areas of landscaping, green roofs, and pervious pavement. Self-treating areas treat only the rain falling on them and do not receive runoff from other areas.
Site Design Measures	Site planning techniques to conserve natural spaces and/or limit the amount of impervious surface at new development and significant redevelopment projects to minimize runoff and the transport of pollutants in runoff.
Small Detached Single-Family Homes	Small detached single family home projects are a type of Small Project.
Small Projects	Public and private new development and redevelopment projects that create or replace impervious area, which are subject to site design, and source control requirements. Small Projects are defined in MRP Provision C.3.i. See Chapter 2 for a discussion of the Small Project thresholds and MRP Provision C.3.i for full details.
Source Control Measures	Land use, site planning practices, structural, and nonstructural measures used to prevent runoff pollution. Source control measures minimize the contact between pollutants and stormwater.
Special Projects	Certain types of development, specified in MRP Provision C.3.e.ii, that may qualify for LID treatment reduction credits and may be allowed to

Term	Definition
	use non-LID treatment measures (e.g., proprietary vault-based filtration devices).
State Water Resources Control Board (SWRCB or State Water Board)	Authorized by the California Water Code, the State Water Board is charged with protecting California's water resources by protecting water quality and allocating surface water rights. The State Water Board develops and issues statewide policies and statewide general permits.
Storm Drains	Above and belowground structures for transporting stormwater to creeks or outfalls for flood control purposes.
Stormwater	Water runoff resulting from precipitation including rain and snowmelt, excluding infiltration and irrigation tailwater.
Stormwater Control	A design feature of a development or redevelopment project, or a routinely-conducted activity that is intended to prevent, minimize, or treat pollutants in stormwater, or to reduce erosive flows during the life of the project. Stormwater control is a term that collectively refers to site designs to promote water quality, source control measures, stormwater treatment measures, and hydromodification management measures. Also referred to as post-construction stormwater control or post-construction stormwater measure.
Stormwater Pollution Prevention Plan (SWPPP)	A plan providing for temporary measures to control sediment and other pollutants during construction.
Stormwater Treatment Measure	Any engineered system designed to remove pollutants from stormwater runoff by settling, filtration, biological degradation, plant uptake, media absorption/adsorption or other physical, biological, or chemical processes. This includes landscape-based systems such as bioretention areas as well as proprietary systems. Sometimes called a treatment control, treatment control measure treatment system, or treatment control BMP.
Treatment	Any method, technique, or process designed to remove pollutants from stormwater runoff.
Vector Control	Any method to limit or eradicate vectors of vector borne diseases, for which the pathogen (e.g., virus or parasite) is transmitted by a vector which can be mammals, birds, or arthropods, especially insects, and more specifically mosquitoes. For the purposes of this document, vector control refers to mosquito control.
Vegetated Buffers	Vegetated buffers, also called vegetated swales or bioswales are defined by EPA as a broad, shallow channel with a dense stand of vegetation covering the side slopes and bottom. Vegetated buffers can be natural or constructed and are designed to trap particulate pollutants like suspended solids and trace metals, promote infiltration and reduce the flow velocity of storm water runoff. Vegetated buffers are not considered LID treatment measures under the MRP but may be used as site design measure.

Term	Definition
Volume-Based Stormwater Treatment Measure	Stormwater treatment measures that detain stormwater for a certain period and treat primarily through settling and infiltration.
Water Quality Inlet	Systems that contain one or more chambers that promote sedimentation and separation of undissolved oil and grease from stormwater. Also referred to as oil/water separators.
Water Quality Volume (WQV)	For stormwater treatment measures that depend on water detention: the volume of water that must be detained to achieve required pollutant removal. This volume of water must be detained for a specified drawdown time.
Wedge Grinding	The process of milling the asphalt areas directly adjacent to concrete curbs, gutter pans, and metal structures (e.g., utility access hole covers) to a specified width and depth. To tie into the elevations of the existing concrete and metal structures, asphalt is removed along the perimeter to allow proper depth of asphalt on the edge and to preserve the appropriate drainage patterns on the asphalt surface.
WEF Method	A method for determining the required volume of treatment BMPs, recommended by the Water Environment Federation and American Society of Civil Engineers. Described in Urban Runoff Quality Management (WEF/ASCE, 1998).

CREDITS

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The Clean Water Program gratefully acknowledges the public agencies whose post-construction stormwater guidance documents served as inspiration and models for this document including: the Contra Costa Countywide Clean Water Program's C.3 Stormwater Guidebook; the Milpitas C.3 Stormwater Guidebook, the Santa Clara Valley Urban Runoff Pollution Prevention Program's C.3 Stormwater Handbook; the Santa Rosa Area SUSMP Guidelines; Portland, Oregon's Stormwater Management Manual; and the San Mateo Countywide Water Pollution Prevention Program's C.3 Technical Guidance and Sustainable Green Streets and Parking Lots Design Guidebook.

1 INTRODUCTION / HOW TO USE THIS HANDBOOK

This Chapter describes the purpose of this handbook and gives an overview of its contents.

1.1 PURPOSE OF HANDBOOK

This handbook is meant to assist developers, builders, and project sponsors, including post-construction stormwater controls in their projects. Post-construction stormwater controls are required to meet local municipal requirements and state requirements in the Municipal Regional Stormwater Permit (MRP) and the Statewide Construction General Stormwater Permit (CGP).

The term post-construction stormwater control refers to permanent features included in a project to reduce pollutants in stormwater and erosive flows during the life of the project – after construction is completed. The term post-construction stormwater control encompasses low-impact development (LID), which reduces water quality impacts by preserving and re-creating natural landscape features, minimizing imperviousness, and using stormwater as a resource, rather than a waste product.

Post Construction Stormwater Controls are permanent features designed to reduce pollutants and runoff flows for the life of the development.

Post-construction stormwater controls are required for both private and public projects. Although this handbook is written primarily for sponsors of private development projects, its technical guidance also applies to publicly sponsored projects. Municipalities may also find the handbook useful for training municipal staff and consulting plan checkers.

1.2 WHAT IS THE CLEAN WATER PROGRAM

The Clean Water Program is an association of the agencies in Alameda County that manage storm drain systems and creek channels that discharge urban runoff to San Francisco Bay. The Clean Water Program has 17 member agencies: the 14 cities in the County, Unincorporated Alameda County, Zone 7 Water Agency, and the Alameda County Water Conservation and Flood Control District.

The Clean Water Program's member agencies and other agencies throughout the region are joint permit holders of the MRP. Each agency is individually responsible for implementing the MRP requirements but participating in the Clean Water Program helps them collaborate on initiatives that benefit all members. More information on the Program is available on its website, https://cleanwaterprogram.org/ list of local agency contacts is provided in **Appendix A. Local Contacts**.

1.3 HOW TO USE THE HANDBOOK

When using this handbook, keep in mind that some requirements may vary from one local jurisdiction to the next. In the early stages of project planning, contact the municipal planning staff to schedule a pre-application meeting to learn how the C.3 requirements – and other planning, zoning, and building requirements – will apply to your project. Also, because regulatory requirements may change, be sure to ask the municipal staff to provide any updates of information or requirements.

It is important to note that post-construction stormwater design requirements are complex and technical: most projects will require the assistance of a qualified civil engineer, architect, landscape architect, and/or geotechnical engineer.

Requirements may vary depending on the jurisdiction. This manual provides general guidance on implementing the C.3 requirements. Check with the local agency for specific requirements for your project.

To help you get started, a synopsis of the handbook's chapters and appendices is provided in **Table 1-1.**. Appendices provide supporting information and technical details and examples.

1.4 PRECEDENCE

In case of conflicting information between this handbook and the MRP, the MRP shall prevail. Any local ordinances, policies, procedures, or design standards that comply with the MRP also take precedence over the guidance in this handbook.

Table 1-1. Synopsis of Handbook Chapters

Chapter	Synopsis
2	Explains how development affects stormwater quality, how post-construction stormwater measures and Low Impact Development (LID) help reduce these impacts and gives a detailed explanation of Provision C.3 requirements.
3	Overviews how the post-construction stormwater requirements fit into a typical development review process and offers step-by-step instructions on incorporating LID designs into planning and building permit application submittals.
4	Outlines the requirements and process for regulated public agency projects.
5	Presents information on site design measures, including guidance for self-treating and self-retaining areas, which can help reduce the size of stormwater treatment measures.
6	Presents information on source control measures, which reduce the pollutants in stormwater.
7	Provides general technical guidance for stormwater treatment measures.
8	Gives technical guidance for specific types of stormwater treatment measures.
9	Explains the requirements for hydromodification management, which maintains pre-construction flow rates and volumes to minimize erosion in creeks.
10	Explains the operation and maintenance requirements for stormwater treatment measures.
11	Describes off-site alternative compliance options.
12	Provides references to regulatory and technical documents.

2 BACKGROUND AND REGULATORY REQUIREMENTS

This Chapter summarizes stormwater problems resulting from development and explains the post-construction requirements for development projects.

2.1 STORMWATER PROBLEMS IN DEVELOPED AREAS

Stormwater runoff is a leading source of pollutants entering water bodies throughout the country.[1] In the San Francisco Bay watershed, urban and agricultural runoff is generally considered to be the largest source of pollutants to aquatic systems.[2] Although stormwater runoff is part of the natural hydrologic cycle, human activities can alter the natural drainage patterns, introduce pollutants, and increase erosion, degrading the natural habitats.

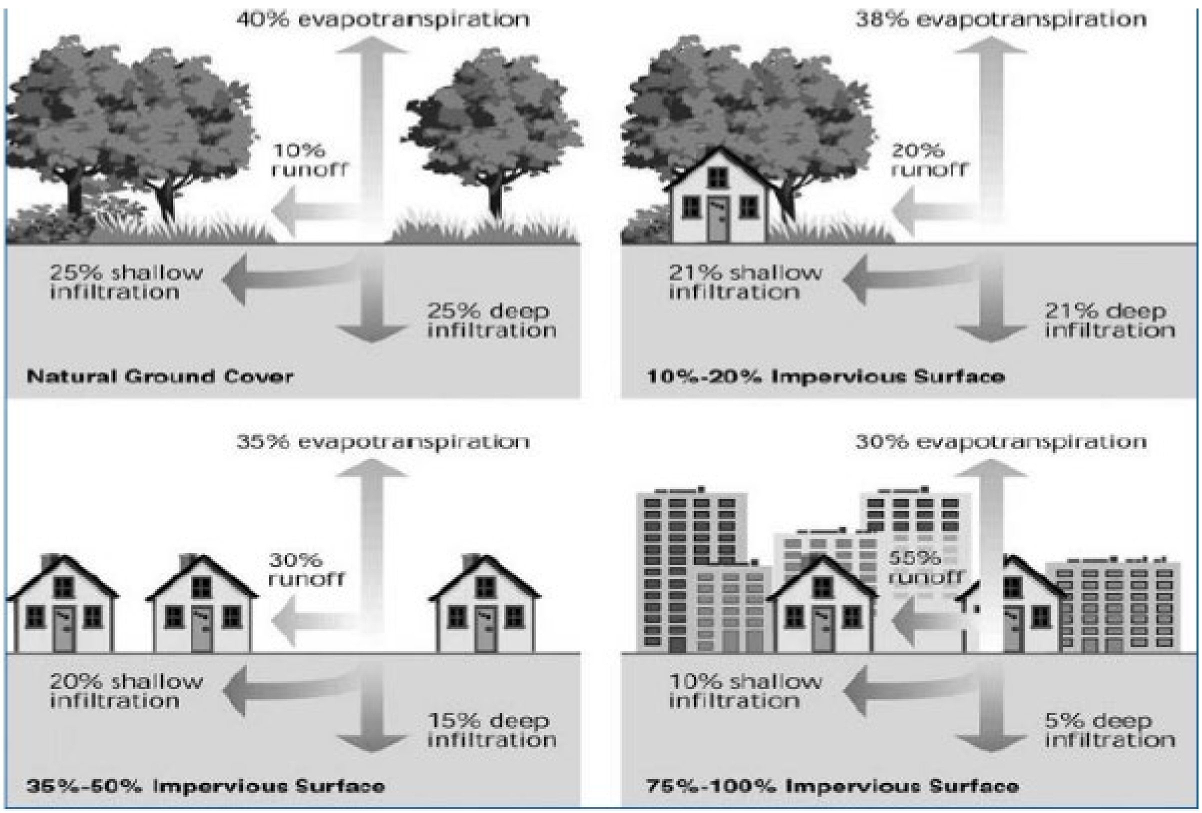

Figure 2-1. Runoff changes resulting from development.

Source: USEPA, Protecting Water Resources with Higher-Density Development, EPA 231-R-06-001.

[1] See USEPA's NPDES Stormwater Program webpage, at https://www.epa.gov/npdes/npdes-stormwater-program

[2] San Francisco Bay Regional Water Quality Control Board, Basin Plan, 2004

2.2 POST-CONSTRUCTION STORMWATER CONTROLS

Various permanent control measures have been developed to reduce the long-term impacts of development on stormwater quality and creek channels. These permanent control measures are often called post-construction stormwater controls, low impact development (LID), or post construction best management practices (BMPs) to distinguish them from the temporary construction BMPs that are used to control sedimentation and erosion while a project is being constructed. (See **Section 2.4** for a summary of construction phase requirements.)

LID reduces water quality impacts by preserving and re-creating natural landscape features, minimizing imperviousness, and then infiltrating, storing, detaining, evapotranspiring (evaporating stormwater into the air directly or through plant transpiration), and/or biotreating stormwater runoff close to its source, or onsite.

Post-construction stormwater control measures can be divided into four categories: site design measures, source control measures, stormwater treatment measures, and hydromodification management measures.

Figure 2-2. Hydromodification impacts on a creek (left) and Creek with natural banks (right).

2.2.1 Site Design Measures

Site design measures are site planning techniques that help reduce stormwater pollutants and prevent increases in the peak runoff flow and duration by protecting existing natural resources and reducing impervious surfaces of development projects. These measures are described in **Chapter 5**.

2.2.2 Source Control Measures

Source control measures consist of either structural project features or operational "good housekeeping" practices that prevent pollutant discharge and runoff at the source and keep pollutants from coming into contact with stormwater. These measures are described in **Chapter 6**.

2.2.3 Stormwater Treatment Measures

Stormwater treatment measures are engineered systems that are designed to remove pollutants from stormwater using processes such as filtration, infiltration, flotation, and sedimentation. Stormwater treatment measures must be sized to comply with the MRP's hydraulic design criteria described in **Section 7.1**. **Chapter 8** provides technical guidance for specific treatment measures.

The MRP stormwater treatment requirements must be met by using evapotranspiration, infiltration, rainwater harvesting and use, or biotreatment. Media filters and high flow rate tree well filters are allowed only in Special Projects. See **Chapter 7** for more information on stormwater treatment requirements and **Appendix J**Appendix J. Special Projects for more information on Special Projects.

2.2.4 Hydromodification Management Measures

Hydromodification management (HM) measures include site design and stormwater treatment measures that promote infiltration or otherwise minimize the change in the rate and flow of runoff, when compared to the pre-development condition. HM measures also include constructed facilities (such as basins, ponds, or vaults) that manage the flow rates of stormwater leaving a site, and under some conditions, can also include re-engineering of at-risk channels downstream from the site. In some cases, a single stormwater treatment measure may be used to meet both the treatment and HM objectives for a project. A dual-use measure of this type is sometimes called an integrated management practice, or IMP.

2.3 MUNICIPAL STORMWATER PERMIT REQUIREMENTS

The development or redevelopment of property represents an opportunity to incorporate post-construction controls that can reduce water quality impacts over the life of the project. Since the first countywide municipal stormwater permit was adopted in 1991, municipal agencies have required new development and redevelopment projects to incorporate post-construction stormwater site design, source control, and treatment measures in their projects.

The MRP includes prescriptive requirements for incorporating post-construction stormwater control/LID measures into new development and redevelopment projects. These requirements are in MRP Provision C.3, which can be found at:

https://www.waterboards.ca.gov/sanfranciscobay/board_decisions/adopted_orders/2022/R2-2022-0018.pdf

2.3.1 Do the C.3 Requirements Affect My Project?

Provision C.3.b establishes impervious area thresholds at which new development and redevelopment projects must comply with Provisions C.3.c and C.3.d. These projects are referred to as Regulated Projects. The thresholds for determining whether a project is a Regulated

> Regardless of the applicability of Provision C.3, municipalities apply **standard stormwater conditions of approval** as part development process.

Project are based on the amount of impervious surface that is created and/or replaced and the type of project described in **Table 2-1**. A flow chart is provided in **Figure 2-3.**.

Table 2-1. Regulated Project Thresholds

Project Type	Impervious Area Created or Replaced	MRP Provision
Parcel Based Projects (Cumulative Impervious Area)		
Public or Private Parcel-Based Development and Redevelopment Projects	5,000 SF	C.3.b.ii.(1), (2), (3)
Detached single-family home not part of a larger plan of development including addition of an ADU	10,000 SF	C.3.b.ii.(6)
New or Widened Road Projects (Contiguous Impervious Area)[1]		
New roads, including sidewalks and bike lanes	5,000 SF	C.3.b.ii.(4)
Adding traffic lanes to an existing road	5,000 SF	C.3.b.ii.(4)
New stand-alone trail projects ≥10 feet wide	5,000 SF	C.3.b.ii.(4)
Road Reconstruction Projects (Contiguous Impervious Area)[1]		
Reconstructing existing roads, including sidewalks and bicycle lanes	1 acre	C.3.b.ii.(5)
Extending roadway edge (e.g., lane widening, safety improvement, paving a graveled shoulder)	1 acre	C.3.b.ii.(5)
Utility trenching projects ≥ 8 feet wide on average over the length of project	1 acre	C.3.b.ii.(5)

[1] *Project areas interrupted by cross streets or intersections are considered contiguous.*

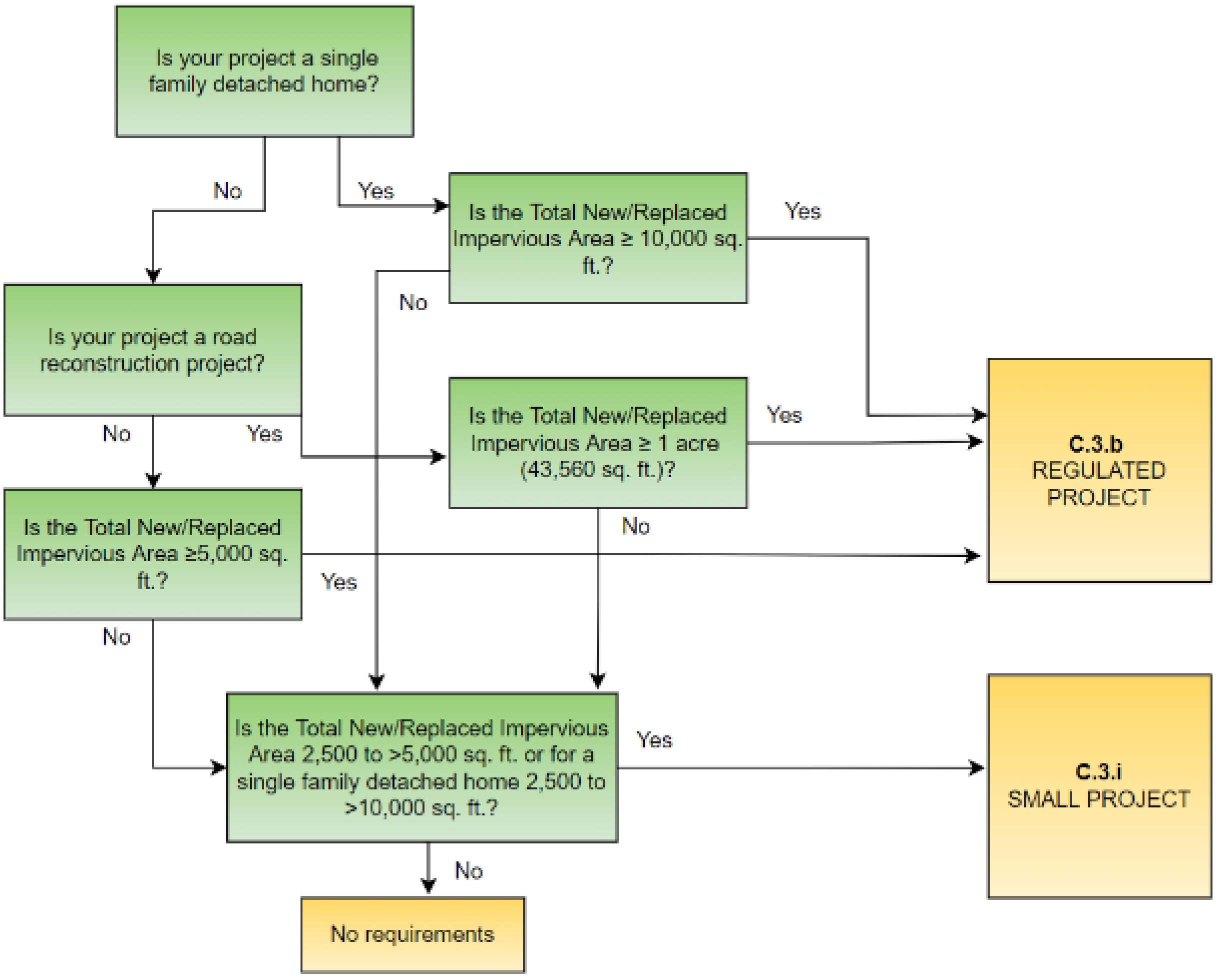

Figure 2-3. Regulated Project Flow Chart.

2.3.1.1 Projects Approved Prior to July 1, 2023

The thresholds described in **Table 2-1.** are effective as of July 1, 2023. The MRP provides exceptions for projects approved before this effective date.

1. Any Regulated Project that has been approved with stormwater treatment measures in compliance with Provision C.3.d (numeric sizing criteria) under a previous municipal stormwater permit is exempt from the requirements of Provision C.3.c.
2. Any Regulated Project that was approved with no Provision C.3 stormwater treatment requirements under a previous municipal stormwater permit and that has not begun construction by the effective date, is required to fully comply with the requirements of the Provisions C.3.c and C.3.d. The local agencies may grant exemptions from this requirement as follows:
    a. Exemptions may be granted to:
        i. Any Regulated Project that was previously approved with a tentative vesting map that confers a vested right 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, as allowed by state law.

ii. Any Regulated Project for which the local agency has no legal authority to require changes to previously granted approvals, such as projects that have been granted building permits.

b. This exemption from the LID requirements of Provision C.3.c. may be granted to any Regulated Project as long as stormwater treatment with media filters is provided that comply with the hydraulic sizing requirements of Provision C.3.d.

3. Any pending Regulated Project that has not yet been approved as of June 30, 2023, and for which a Permittee has no legal authority to require new requirements under Government Code sections 66474.2 or 65589.5., subd. (o), is subject to the Provision C.3 requirements in effect on the Permit's effective date.

2.3.1.2 Other Excluded Projects

Provision C.3.b of the MRP excludes specific types of development and redevelopment projects from Provision C.3.c requirements for stormwater treatment, source controls, and site design measures, even if the thresholds described above are met or exceeded. The list of excluded project types is shown in **Table 2-2..** However, project proponents need to confirm the exclusion with the local agency.

Table 2-2. Projects Excluded from Provision C.3 Numerically Sized Treatment Requirements

Excluded Redevelopment Projects
Interior Remodel
Exterior wall replacement or maintenance
Roof repair or replacement
Excluded Pavement Maintenance Projects
Pothole and square patching
Overlaying existing asphalt or concrete pavement with asphalt or concrete without expanding the area of coverage
Shoulder grading
Reshaping/regrading drainage systems
Crack sealing
Pavement preservation activities that do not expand the road prism
Upgrading from a bituminous surface treatment (e.g., chip seal) with an overlay of asphalt or concrete, without expanding the area of coverage, including wedge grinding that is implemented as part of the upgrade project, so long as the area of coverage is not expanded
Applying a bituminous surface treatment to existing asphalt or concrete pavement, without expanding the area of coverage;
Vegetation maintenance
Layering gravel over an existing gravel road, without expanding the area of coverage

2.3.1.3 Construction of Impervious Surface over Existing Impervious Surfaces

In some cases, the construction of impervious surface over existing impervious surface may be considered a Regulated Project; in some cases, it would not. Please see the following examples:

- **Examples projects that would be Regulated Projects**
  - The construction of a highway overpass that creates 5,000 square feet or more of impervious surface over an existing roadway or rail line, since stormwater runoff from the new overpass would be collected and discharged to the storm drain system.
  - A parking garage that is constructed over an existing parking lot. Although this would not change the use (parking), it would intensify the use.
  - Removing and replacing an asphalt or concrete pavement to the top of the base course or lower or repairing the pavement base (including repair of the pavement base in preparation for bituminous surface treatment, such as chip seal), as these are considered replaced impervious surfaces.
  - Resurfacing by upgrading from dirt to gravel, to a bituminous surface treatment (e.g., chip seal), to asphalt, or to concrete; or upgrading from gravel to a bituminous surface treatment, to asphalt, or to concrete, as these are considered new impervious surfaces.
- **Examples of projects that would not be Regulated Projects**
  - The construction of a roof over existing parking spaces unless the project changes the footprint, grade, layout, or configuration of the parking lot surface.
  - The construction of solar panels over existing pavement unless the project changes the footprint, grade, layout, or configuration of the paved surface.

2.3.1.4 Construction of Impervious Surface over Existing Pervious Surfaces

In most cases, the construction of an impervious surface over an existing pervious surface is considered a Regulated Project; in some cases where the new surface is not watertight i.e., allows water to reach the underlying pervious surface, it may not be regulated. Please see the following examples:

- Installation of a raised deck over a pervious surface would not be a Regulated Project unless the deck has a water-tight surface.
- Installation of awnings and solar panels over a pervious area would not be a Regulated Project since they do not provide a water-tight covering of land.

2.3.2 Hydromodification Management Projects

Provision C.3.g establishes hydromodification management (HM) requirements for Regulated Projects that create or replace 1 acre or more of impervious area and increase impervious surface area over the pre-project condition if the project is in an area susceptible to hydromodification. See **Chapter 9** for more information.

2.3.3 Site Design Requirements for Small Projects and Small Detached Single-Family Homes

Provision C.3.i establishes requirements for Small Projects and Small Detached Single-Family Homes. Effective July 1, 2023,[3] the following thresholds apply:

- Small Projects create or replace between 2,500 to less than 5,000 square feet (SF) of impervious area.
- Small Detached Single-Family Homes create or replace between 2,500 to less than 10,000 SF of impervious area.

Projects approved prior to July 1, 2023, are subject to the thresholds in the previous MRP (Order R2-2015-0049).

Small Projects and Small Detached Single-Family Homes meeting the threshold above must implement at least one of the site design measures listed below.

- Direct roof runoff into cisterns or rain barrels for use.·
- Direct roof runoff onto vegetated areas.·
- Direct runoff from sidewalks, walkways, and/or patios onto vegetated areas.
- Direct runoff from driveways and/or uncovered parking lots onto vegetated areas.
- Construct sidewalks, walkways, and/or patios with permeable surfaces.
- Construct bike lanes, driveways, and/or uncovered parking lots with permeable surfaces.

2.4 CONSTRUCTION PHASE STORMWATER REQUIREMENTS

In addition to the MRP C.3 requirements, proposed development projects must control erosion and the discharge of sediment during the construction phase of the project. All projects must prepare and submit an erosion control plan to the local agency and must implement site-specific and seasonally- and phase-appropriate construction BMPs in accordance with MRP Provision C.6.c and C.6.d. The erosion control plan addressing the six categories of BMPs listed in **Table 2-3**, must be submitted prior to the issuance of the grading permit. The erosion control plan also needs to include appropriate scheduling or erosion and sediment control BMPs to protect the permanent stormwater controls during the construction phase (see **Chapter 8**).

Development projects that result in the disturbance of an acre or more of land are subject to the State Water Board's General Permit for Discharges of Storm Water Associated with Construction and Land Disturbance Activities[4] (Construction General Permit or CGP). The local agency will verify that coverage under the CGP has been obtained prior to issuing grading permits.

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[3] Projects approved prior to July 1, 2023, are subject to the thresholds in the previous MRP (Order R2-2015-0049: all development projects, which create and/or replace > 2,500 SF to < 10,000 SF of impervious surface, and detached single-family home projects, which create and/or replace 2,500 square feet or more of impervious surface.

[4] See https://www.waterboards.ca.gov/water_issues/programs/stormwater/construction.html for the current CGP.

Table 2-3. C.6 Construction Phase Best Management Practices

BMP
Erosions Controls
Run-on and Runoff Controls
Sediment Controls (including entrance/exit and perimeter controls)
Active Treatment Systems (as needed)
Good Site Management, including materials and waste management

3 PREPARING PERMIT APPLICATION SUBMITTALS

This Chapter outlines the development review process and gives step-by-step instructions for preparing C.3 stormwater submittals for planning and building permit applications.

3.1 THE DEVELOPMENT REVIEW PROCESS

The municipalities have integrated their review of post-construction stormwater controls into the development review process. If the C.3 requirements for site design measures, source controls, and stormwater treatment measures apply to your project, your planning permit application submittal must show how you have incorporated the required post-construction stormwater controls. **Section 3.2** gives step-by-step instructions on how to do this, beginning at the earliest phases of project planning. Some smaller projects may not require planning permits; see **Section 3.4** for simple instructions for small sites.

Preparing the preliminary design of stormwater controls simultaneously with the preliminary site plan and the landscaping plan is advised to achieve the following benefits:

- Maximize the stormwater benefits of project landscaping.
- Reduce overall project costs.
- Improve site aesthetics and produce a better-quality project.
- Speed project review times.
- Avoid unnecessary redesign.

After the municipality issues your planning permit, you will need to incorporate the required stormwater controls into your building permit application submittal. **Section 3.3** gives step-by-step instructions for preparing this submittal. A simplified diagram of a sample development review process is shown in **Figure 3-1** Please note that the actual development review process in any of the municipalities may differ from the example.

Preparing the preliminary design of stormwater control in parallel with the preliminary site and landscaping plans can help reduce overall project costs.

Although the development review process may vary from one municipality to the next, **Figure 3-1** highlights the steps in the development review process at which municipalities typically require submittals showing how your project incorporates post-construction stormwater controls. These submittals are incorporated into your planning permit and building permit applications. Remember that the C.3 submittals show how the project will incorporate post-construction stormwater controls, to reduce pollutant loading and prevent increases in creek channel erosion during long-term project operations. The municipality will require you to prepare separate documents to show how sediment and erosion will be controlled during the construction phase of the project.

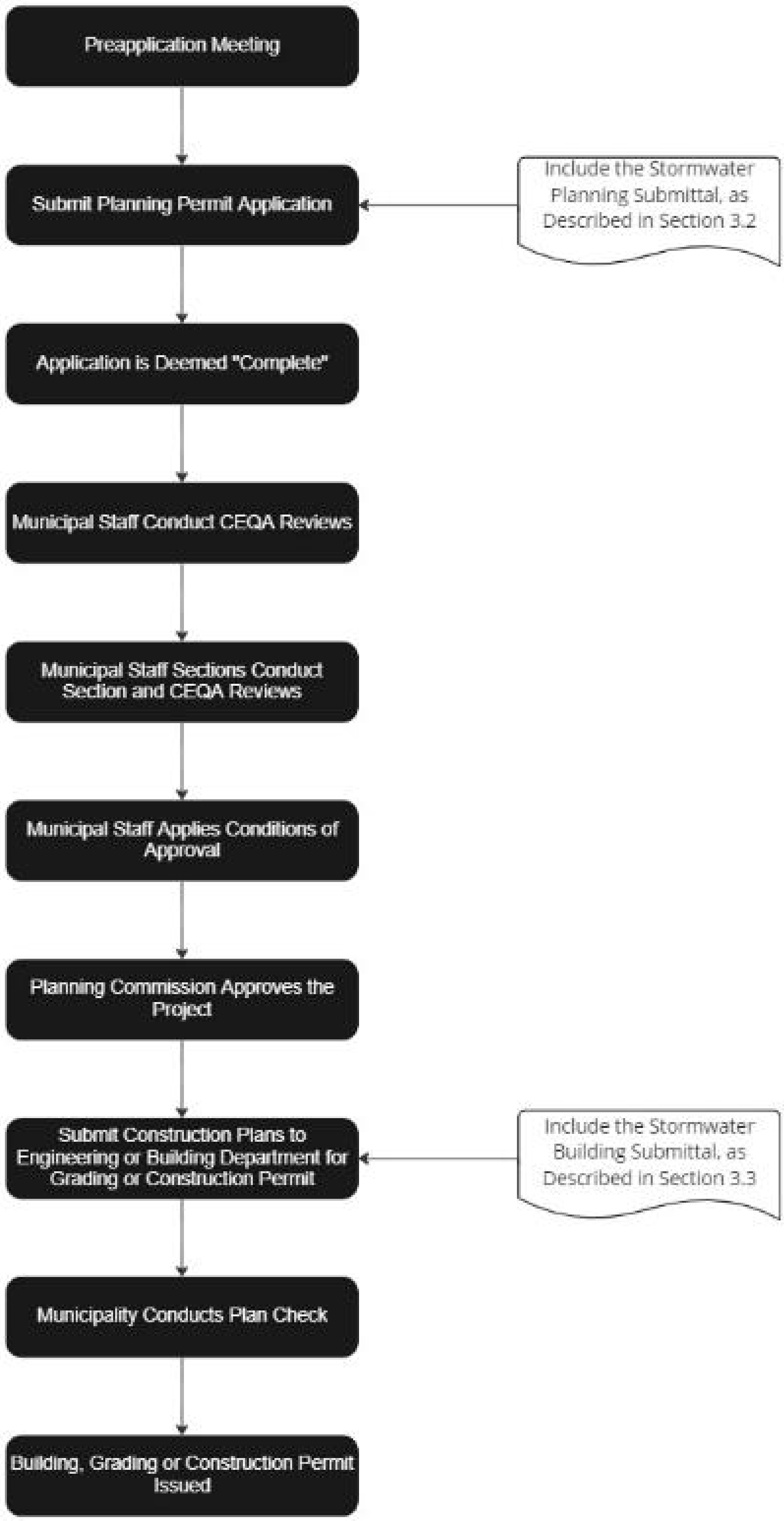


Figure 3-1. Sample Development Review Process for Regulated Projects.

3.2 HOW TO PREPARE PLANNING PERMIT SUBMITTALS

3.2.1 The Planning Permit Submittal Checklist

Table 3-1. presents a checklist of C.3 post-construction stormwater information that is typically submitted with planning permit applications. Please note that if runoff from your site discharges directly to a creek or wetland without flowing through a municipality-owned storm drain, you may need to submit additional information. Municipal staff may use this checklist to determine whether your submittal is complete, or some jurisdictions may use a modified checklist. The items included in this checklist are important to demonstrate that your project will:

- Incorporate site design measures to reduce impervious surfaces, promote infiltration and reduce water quality impacts;
- Apply source control measures to keep pollutants out of stormwater runoff;
- Use stormwater treatment measures to remove pollutants from stormwater; and
- Where applicable, manage hydromodification (erosion-inducing flows) by reducing the rate and amount of runoff.

Table 3-1. Planning Permit Submittal Checklist

Required?[1]		Information on Project Drawings	Corresponding Planning Step (Section 3.2)
Yes	No		
❏	❏	Existing natural hydrologic features (depressions, watercourses, relatively undisturbed areas) and significant natural resources.	Step 1
❏	❏	Depth to groundwater and soil saturated hydraulic conductivity or soil types.	Step 1
❏	❏	Existing and proposed site drainage network and connections to drainage offsite.	Step 1
❏	❏	For more complex drainage networks, show separate drainage management areas in the existing and proposed site drainage network.	Step 1
❏	❏	Existing condition, including pervious and impervious areas, for each drainage management area.	Step 1
❏	❏	Proposed pervious surfaces, including sensitive natural areas to be preserved and protected from development (for each drainage management area).	Steps 2 and 3
❏	❏	Proposed impervious surfaces, e.g., roof, plaza, sidewalk, street, parking lot (for each drainage management area).	Step 4
❏	❏	Proposed site design measures to minimize impervious surfaces and promote infiltration[2], which will affect the size of treatment measures.	Step 4

Required?[1]		Information on Project Drawings	Corresponding Planning Step (Section 3.2)
Yes	No		
❑	❑	Proposed locations and approximate sizes of stormwater treatment measures (1 per drainage management area) and, if 1 acre or more of impervious surface is created, hydromodification management measures. Elevations should show sufficient hydraulic head for the treatment measures to work.[2]	Steps 5-9
❑	❑	Sizing calculations for stormwater treatment measure and pervious pavement systems.	Step 8
❑	❑	Design details for stormwater treatment measures and pervious pavement systems. If applicable, design details for any Flow Duration Controls.	Step 8
❑	❑	Conceptual planting palette for stormwater treatment measures.	Step 10
❑	❑	Pollutant source areas – including loading docks; food service areas; refuse areas; outdoor processes and storage; vehicle cleaning, repair, or maintenance; fuel dispensing; equipment washing; etc. – and corresponding source controls from the local source control list.	Step 12
❑	❑	Written Information on Municipal Forms or in Report Format	
❑	❑	Completed stormwater requirements form provided by local agency.	Step 4
❑	❑	Preliminary calculations for each treatment and hydromodification management measure.	Step 9
❑	❑	Preliminary maintenance plan for stormwater treatment measures.	Step 11
❑	❑	List of source control measures included in the project.	Step 12

[1] Every item is not necessarily required for every project. Municipal staff may check the boxes in the "Required" column to indicate which items will be required for your project.

[2] Site design and treatment measures that promote stormwater infiltration should be consistent with recommendations of the project geotechnical engineer based on the soils boring data, drainage pattern and the current requirements for stormwater controls.

3.2.2 Planning Permit Submittals: Step-by-Step

Step-by-step instructions are offered below to help incorporate post-construction stormwater controls into your project from the very beginning of permit planning. The step-by-step instructions are intended to help you prepare the materials you will need to submit along with the planning permit application.

Step 1: Collect Needed Information

Collecting the appropriate information is essential to selecting and siting post-construction stormwater measures. A list of the most commonly needed information is provided below, but municipal staff may request additional information as well.

- Existing natural features, especially hydrologic features including creeks, wetlands, watercourses, seeps, springs, ponds, lakes, areas of 100-year floodplain, and any contiguous natural areas. This information may be obtained by site inspections, a topographic survey of the site, and existing maps such as US Geologic Survey (USGS) quadrangle maps, Federal Emergency Management Agency (FEMA) floodplain maps, and US Fish and Wildlife Service (USFWS) wetland inventory maps.
- Existing site topography, including the general direction of surface drainage, local high or low points or depressions, any steep slopes, outcrops, or other significant geologic features. This may be obtained from topographic maps and site inspections.
- Existing site drainage. For undeveloped sites, this would be identified based on the topographic information described above. For previously developed sites, information on drainage and storm drain connections may be obtained from municipal storm drain maps, plans for previous development, and site inspections.
- Soil types (including hydrologic soil groups) and depth to groundwater. If a soils report is not required for the project, planning-level information may be obtained from the Natural Resources Conservation Service (NRCS) Soils Survey. This information is used in determining the feasibility of onsite infiltration of stormwater.
- Existing impervious areas. Measuring the area of existing impervious surface is necessary to calculate the amount of impervious surface that will be replaced. The MRP requires that redevelopment projects that replace 50 percent or more of the existing impervious surfaces treat the stormwater runoff from the entire site, not just the redeveloped area. If less than 50 percent of existing impervious surface is replaced, and the existing development was not subject to stormwater treatment measures, then only the affected portion must be included in treatment measure design.
- Zoning information, including but not limited to requirements for setbacks and open space.

> **Constraints** may include impermeable soils, high groundwater, steep slopes, geotechnical instability, or heavy vehicle traffic. **Opportunities** may include existing natural areas, low areas, oddly configured parcels, or landscape amenities.

Review the information collected in Step 1. Identify the principal constraints for site design and stormwater treatment measure selection, as well as opportunities to reduce imperviousness and incorporate stormwater controls into the site and landscape design. For example, constraints might include impermeable soils, high groundwater, steep slopes, geotechnical instability, high-intensity land use, heavy vehicular traffic, or safety concerns. Opportunities might include existing natural areas, low areas, oddly configured of otherwise unbuildable parcels, landscape amenities including open space and buffers (which can double as locations for stormwater treatment measures) and differences in elevation (which can provide hydraulic head for treatment measures). Prepare a table or brief written summary of constraints and opportunities can prove helpful in selecting and siting stormwater controls.

Step 2: Minimize Site Disturbance and Protect Sensitive Areas

Design the site layout to minimize changes to the natural topography. Using the information collected in Step 1, identify any existing sensitive natural resources on the site that will be protected and preserved from development. These may include the following types of areas:

- Set development back from creeks and riparian habitat as required by the local jurisdiction. If your project involves impacts to creeks and riparian habitat, contact the Regional Water Board staff regarding permit and mitigation requirements.
- If the project includes wetlands subject to Section 404 of the federal Clean Water Act, or habitat for special-status species protected by federal or state laws, these areas should be indicated, and evidence should be provided to demonstrate compliance with the applicable laws.
- The project will need to comply with any local tree preservation ordinances and other policies protecting heritage or significant trees. Mature trees offer substantial community benefits, and their preservation is recommended, where feasible, even if it is not required by law.
- The project needs to comply with any local restrictions on development of steep slopes and soils that are susceptible to erosion. Even where not required by law, the avoidance of such areas is advisable to reduce stormwater impacts.

Site Design Measures that reduce the impervious surfaces can **reduce the size** of the required stormwater treatment measures.

Step 3: Incorporate Site Design Measures

Design the project to minimize the overall coverage of impervious paving and roofs, with a special focus on reducing the amount of impervious area that is directly connected to the storm drain system.

Using site design measures to reduce impervious surfaces on your site can reduce the size of stormwater treatment measures that you will need to install. But remember even vegetated areas will generate some runoff. If runoff from landscaped areas flows to a stormwater treatment measure, that treatment measure will need to be sized to handle these relatively small amounts of runoff, as well as runoff from impervious surfaces. The use of self-treating areas (described below) can reduce the size of treatment measures even further.

Some examples of site design measures are shown in **Figure 3-2** and **Figure 3-3**. More information on site design measures is provided in **Chapter 5** and **Appendix L**. A range of site design examples is described in the following list:

- Use alternative site layout techniques to reduce the total amount of impervious area. This may include designing compact, multi-story structures or clustering buildings. Some cities may allow narrow streets and (in very low-density neighborhoods) sidewalks on only one side of the street.

Figure 3-2. Example of a narrow street with parking pull-outs.

- Minimize surface parking areas, in terms of the number and size of parking spaces.
- Use rainwater as a resource. Capturing and retaining roof runoff in cisterns can be a practical way to reduce the amount of runoff from the site and store rainwater for use in on-site irrigation. Stormwater storage provided by cisterns may be used to reduce the amount of stormwater that must be treated and, where applicable, retained on-site to meet hydromodification management requirements.
- Use drainage as a design element. Vegetated swales, depressed landscape areas, vegetated buffers, and bioretention areas can serve as visual amenities and focal points in the landscape design of your site.

Figure 3-3. Pleasanton Sports Park includes a turf block fire access road.

- Maximize choices for mobility. Vehicles are a major source of pollutants in stormwater runoff. Projects should promote, or at least accommodate, modes of transportation other than automobiles.
- Identify self-treating areas. Some portions of your site may provide "self-treatment" if properly designed and drained. Such areas may include conserved natural spaces, large landscaped areas (such as parks and lawns), green roofs and properly designed areas of pervious paving or artificial turf. These areas are considered "self-treating" because infiltration and natural processes that occur in these areas remove pollutants from stormwater. Your drainage design may direct the runoff from self-treating areas directly to the storm drain system or other receiving water. See **Section** Error! Reference source not found. for more information.
- Direct runoff to depressed landscaped areas. You may be able to design an area within your site to function as a "self-retaining area," in which the amount of stormwater runoff that is required to be treated is infiltrated or retained in depressed landscaped areas. A 2:1 ratio of impervious area to the receiving pervious area may be acceptable, where soils permit. See **Section 5.1** for more information.

Step 4: Measure Pervious and Impervious Surfaces

The Stormwater Requirements Checklist or equivalent form that is provided by the local jurisdiction must be completed as part of the planning permit application submittal. This checklist is used to identify project site design measures and source controls, to calculate the amount of impervious surface that will be created and/or replaced, and to determine whether treatment and/or HM measures are required. The checklist also identifies construction phase requirements.

Impervious surfaces prevent water from infiltrating into the ground and cause runoff. Impervious surfaces include:

- Footprints of all buildings and structures, including garages, carports, sheds, etc.;
- Driveways, patios, parking lots, decking; and
- Streets and sidewalks.

Areas of pervious paving or artificial turf that are underlain with pervious storage material, such as a gravel layer sufficient to hold at least the Provision C.3.d volume of rainfall runoff, are not considered impervious surfaces and can be excluded from the calculation of impervious surfaces.

Use the impervious surface thresholds in **Table 2-1.** to determine the stormwater control requirements that apply to your project.

HM is required for projects that create and/or replace one acre or more of impervious surface, increase the amount of impervious area over the pre-project condition, AND are located in susceptible areas identified in the Hydromodification Management Susceptibility Map (see **Appendix I**). See **Section 9** for more information on the HM map and exceptions.

Step 5: Determine If Special Project LID Treatment Reduction Credits Apply

LID treatment reduction credits can be applied to Special Projects that meet the criteria defined in MRP Provision C.3.e.ii (See **Appendix J)**. Contact municipal staff to determine whether your project meets the criteria to be considered a Special Project.

Step 6: Select Stormwater Treatment and HM Measures

Stormwater treatment requirements must be met using LID measures that provide stormwater treatment using evapotranspiration, infiltration, rainwater harvesting and use, and/or biotreatment – except for limited exceptions for Special Projects that meet specific criteria. There are many types of treatment measures, each with advantages and disadvantages, and new innovative solutions continue to be developed. **Chapter 8** provides technical guidance for specific types of stormwater treatment measures that are commonly used in Alameda County. While other treatment measures may be approved, it may be possible to expedite the review of your project by closely following the guidance provided in **Chapter 8**.

Selecting the appropriate treatment measure(s) for a specific site is a matter of professional judgment. Some general factors to consider are offered below:

- LID treatment measures are required, except for a limited number of locations and types of development, referred to as Special Projects, as described above.
- Is Hydromodification management (HM) required? If your project needs to meet both treatment and HM requirements, it is recommended, to the extent feasible, that stormwater control measures be designed to meet both treatment and HM needs.
- Soil suitability. Soils are classified into four hydrologic soil groups – A, B, C, and D – with the soils in each group having similar runoff potential under similar storm and cover conditions. Group A soils generally have the lowest runoff potential, and group D have the greatest. Treatment measures that rely primarily on infiltration, such as infiltration trenches, are more challenging in group D soils (clay loam, sandy clay, and clay) and group C (silt loam) soils. Bioretention areas installed in group C and D soils typically require subdrains.
- Site slope. LID treatment measures need to be carefully selected and designed for use on steep slopes, because infiltration of stormwater runoff can cause geotechnical instability. Depending on site conditions, it may be possible to design bioretention areas using check dams for projects on sites with some slope constraints.
- Considerations for larger sites. Larger sites can be divided into separate drainage management areas with one stormwater treatment measure per drainage management area. This allows a variety of stormwater treatment measures to be dispersed throughout the site. It may also be possible to route the stormwater runoff from an individual drainage area to a cistern for non-potable use, such as irrigation or flushing toilets (see **Section 5.3**, Rainwater Harvesting and Use).
- Consider maintenance requirements. The amount of maintenance that a stormwater treatment measure will require should be considered when selecting treatment measures. As described in **Section 3.3**, you will need to prepare and submit a maintenance plan for stormwater treatment measures with the building permit application. **Chapter 10** provides information regarding the maintenance requirements for various treatment measures. Maintenance plan templates are provided in **Appendix H**.
- Avoid mosquito problems. The mosquito control guidance provided in **Appendix G** needs to be implemented for all stormwater treatment measures, with special consideration given to treatment measures that are designed to include standing water.
- Potential for groundwater contamination. Before selecting an infiltration device, such as an infiltration trench, infiltration basin, or French drain, review the infiltration considerations presented in **Appendix F** to protect groundwater from contamination by pollutants in stormwater runoff.

Mosquito control guidance (Appendix G) needs to be implemented for all stormwater water treatment measures, with special consideration for any that include standing water.

Step 7: Locate Stormwater Treatment and HM Measures on the Site

Review the existing and proposed site drainage network and connections to drainage offsite, which were collected in Step 1. Selecting appropriate locations for treatment and HM measures involves several important factors, including the following:

- Design for gravity flow. If possible, treatment/HM measures should be designed so that drainage into and out of the treatment measure is by gravity flow. This promotes effective, low-maintenance operation and helps avoid mosquito problems. Pumped systems can be feasible, but they are more expensive, require more maintenance, and can introduce sources of underground standing water that attract mosquito breeding.
- Determine final ownership and maintenance responsibility. Treatment measures need to be accessible by maintenance workers, municipal inspectors, and staff from the Alameda County Mosquito Abatement District or the Alameda County Vector Control District. If the property will be subdivided, locate shared treatment measures in a common, accessible area – not on a private residential lot.
- Incorporate treatment measures in the landscape design. Almost every project includes landscaped areas. Most zoning districts require a certain amount of open space, and some require landscaped setbacks or buffers. It may be possible to locate some or all your project's stormwater treatment and HM measures within required landscape areas.

Figure 3-4 This sports field in Dublin also functions as a stormwater detention area.

- Plan for maintenance. Stormwater treatment measures need to be accessible to the largest piece of equipment required for maintenance. For example, bioretention areas and vegetated swales need access for the types of machinery used for landscape maintenance. Large extended detention basins need to have a perimeter access road accessible by heavy vehicles for sediment removal and controlling emergent vegetation. Underground treatment measures and media filters may require special equipment for periodic cleanout and media replacement.

Step 8: Preliminary Design of Stormwater Treatment and HM Measures

Perform preliminary design of the stormwater treatment measures you have selected using the hydraulic sizing criteria in **Section 0** and the technical guidance for specific types of treatment measures in **Chapter 8**. The technical guidance in this handbook is compatible with the Bay Area Hydrology Model (BAHM), a tool for sizing HM measures, developed by the Clean Water Program in cooperation with the other countywide stormwater programs. See **Chapter 9** for more information on BAHM and the design of HM measures.

Detailed construction drawings are typically not required for planning permit submittals, but drawings or sketches need to be included to illustrate the proposed design and sizing information based on runoff calculations.

Step 9: Consider Planting Palettes for Stormwater Treatment Measures

The selection of appropriate plant materials is an important part of designing a successful landscape-based stormwater treatment measure. Plants need to be hardy, low-maintenance, tolerant of both dry and saturated soils, and selecting plants that can survive long periods with little or no rainfall will help reduce irrigation requirements, although irrigation systems are typically required for stormwater treatment measures. At the planning permit phase of the project a detailed planting plan is typically not required, but many municipalities require a conceptual planting palette. **Chapter 7** and **Appendix B** provide guidance regarding the selection of plant materials for landscape-based treatment measures.

Selecting plants that can survive long periods with little or no rain will **help reduce irrigation requirements.**

Step 10: Prepare a Preliminary Maintenance Plan

A maintenance plan describes how stormwater treatment measures will be maintained during the years and decades after construction is completed. In some cases, a municipality may require the submittal of a maintenance plan as part of the planning permit submittal. Otherwise, a maintenance plan is required as part of the building permit submittal. Check with your local jurisdiction regarding the requirements for your project.

A maintenance plan identifies the proposed maintenance activities, and the intervals at which they will be conducted, for each stormwater treatment measure included in the project. Applicants will also need to provide information that will be included in a maintenance agreement between the local municipality and the property owner. **Chapter 10** provides more information about stormwater treatment measure operation and maintenance. Maintenance plan templates for various stormwater treatment measures are included in **Appendix H**.

Step 11: Use Applicable Source Control Measures

Pollutants are generated by many common activities that will occur after construction is completed. See **Chapter 6** for information on common source control measures. Each local jurisdiction has specific pollutant source control requirements for projects that include landscaping, swimming pools, vehicle washing areas, trash/recycling areas, and other sources of pollutants. These requirements are identified in the agency's Local Source Control Measures List. Be sure to obtain the current list from your local jurisdiction.

Step 12: Coordinate with Other Project Requirements

When submitting the C.3 stormwater drawings with the planning permit submittal, the stormwater site design, source control, treatment and HM measures may be shown on a separate stormwater plan, or combined with the site plan, landscaping plan, or drainage plan – depending on the complexity of the project. Whether plans are combined or separate, there are several issues that must be carefully coordinated with other aspects of the project design. Some typical coordination considerations are listed below.

- Balance of Cut and Fill. When calculating the overall project balance of cut and fill, be sure to include the excavation of stormwater treatment measures (including the need to replace existing clay soils with group A or B soils).
- Soil Compaction during Construction. Compaction from construction traffic can severely restrict the infiltration capacity of soils at your site. In the construction staging plan, protect and limit operation in those portions of the site that will accommodate self-treating areas or stormwater treatment measures that rely on infiltration.
- Building Drainage. Building codes require that drainage from roofs and other impervious areas be directed away from the building. The codes also specify minimum sizes and slopes for roof leaders and drain piping. Any stormwater measure located in or on the building, or that may affect building foundations, must be designed to meet the minimum building code requirements. Stormwater treatment measures are also required to meet the requirements for detention or flow described in **Section 0**.
- Control of Elevations. Getting runoff to flow from impervious surfaces to landscaped surfaces may require greater attention to detailed slopes and elevations in grading and landscaping plans. For example:
- Provide Adequate Change in Elevation between the pavement and vegetated areas. The landscaped area needs to be low enough so that runoff will flow into it even after the turf or other vegetation has grown up. If adequate reveal is not provided, runoff will tend to pond on the edge of the paved surface.
- Provide for Differential Settlement. While the soil in landscaped-based stormwater treatment measures and self-treating areas must be left loose and uncompacted, concrete structures (such as inlets and outlets) must be supported on a firm foundation. If not, they may settle more than the surrounding ground, creating depressions that can hold standing water and contribute to mosquito breeding.
- Prevent Erosion. Erosion may occur at points where the stormwater runoff flows from impervious areas into landscape-based treatment measures. Include in the project plans any proposed erosion controls, such as cobbles or splash blocks.
- Drainage Plans. The local building or engineering department may require a drainage plan, which typically focuses on preventing street flooding during a 10-year storm and demonstrating that flooding from 100-year storms can be managed. To meet the drainage plan requirements, it may be necessary to

Figure 3-5. Drain rock is used to prevent erosion of this vegetated swale at Zone 7 Water Agency's office building.

include high flow bypasses in the design of stormwater treatment measures, in order to route flood flows directly to the storm drain system. Check with your local jurisdiction regarding the need to prepare a drainage plan, and whether it is required only as part of the building permit submittal, or if a preliminary drainage plan is needed with the planning permit submittal.

- Signage for Traffic and Parking. If your project includes depressed landscaped areas next to parking lots, driveways, or roadways, it may be necessary to include bollards, striping or signs to guide traffic, especially if curbs are flush with the pavement. Traffic striping may not be practical for pervious pavements such as crushed aggregate and unit pavers. In these areas, signs and bollards may be needed to help direct traffic.

Step 13: Submit Planning Permit Application

Assemble all the items listed in **Table 3-1.** that municipal staff indicates are required for your project and include them as attachments to the planning permit application for your project.

3.3 HOW TO PREPARE BUILDING PERMIT SUBMITTALS

Except for projects on small sites, the principal differences between planning permit submittals and building permit submittals are:

- Construction level detail is needed, rather than preliminary plans;
- Highlight and explain changes if plans differ from the planning permit submittal;
- Include detailed maintenance plans and documentation for maintenance agreement.

If your project does not require a planning permit, submit items from **Table 3-1** and **Table 3-2** with the Building Permit application.

Table 0-1. provides a list of materials that may be required at this stage in the project, followed by brief step-by-step instructions.

Table 3-2 Building Permit Submittal Checklist

Required?		Information on Project Drawings	Corresponds to Building Step (Sect. 3.3)
Yes	No		
☐	☐	Sensitive natural areas to be preserved and protected from development. – highlighting any changes since the planning permit submittal.	Step 1
☐	☐	Proposed impervious surfaces, e.g., roof, sidewalk, street, parking lot (for each drainage area) – highlight any changes since the planning permit submittal.	Step 1
☐	☐	Site design measures to minimize impervious surfaces and promote infiltration – construction level detail.	Step 1

Required? Yes	Required? No	Information on Project Drawings	Corresponds to Building Step (Sect. 3.3)
☐	☐	Construction level detail of stormwater treatment measures and (if 1 acre or more of impervious surface is created) hydromodification management measures.	Step 1
☐	☐	Pollutant source areas and corresponding structural source controls from local source control list – construction level detail and a list of any changes since the planning permit submittal.	Step 1
☐	☐	Landscaping plan for stormwater treatment measures--construction level detail.	Step 1
☐	☐	Letter-sized conceptual plan or site plan showing locations of stormwater treatment measures, for inclusion in the Maintenance Agreement.	Step 2
Written Information on Municipal Forms or in Report Format			
☐	☐	Completed Stormwater Requirements Checklist, showing any changes since planning permit submittal.	Step 1
☐	☐	Detailed hydraulic sizing calculations for each treatment and/or hydromodification management measure.	Step 1
☐	☐	Design details for treatment measures, pervious pavement systems, and Flow Duration Controls.	Step 1
☐	☐	Detailed maintenance plan for stormwater treatment measures, including inspection checklists, as appropriate.	Step 2
☐	☐	A standard treatment measure O&M report form, to be attached to the Maintenance Agreement	Step 2

Step 1: Update Project Documentation

Information regarding the design of stormwater measures that was submitted with the planning permit application must be updated, as necessary, for submittal with the building permit application. Specific requirements may vary in the various jurisdictions, but this is anticipated to include the following:

- Incorporate all stormwater-related conditions of approval that were applied during planning permit review.
- Highlight and explain any other stormwater-related changes that have been made since the planning review. This may include: changes in the boundaries of sensitive areas to be protected, changes in the amount of impervious surface to be created/replaced, changes in the stormwater pollutant source areas, changes in the location or design of stormwater measures, etc.
- Prepare construction level detail for all stormwater measures included in the project.

- Prepare detailed hydraulic sizing calculations for stormwater treatment and HM measures, using the hydraulic sizing guidance provided in **Section 0**and **Section 9.4**.
- Prepare construction-level planting plans for landscape-based stormwater treatment measures.

NOTE: Some smaller projects may not require a planning permit. If this is true for your project, your building permit application submittal will need to include items listed in both **Table 3-1.** and **Table 0-1.**. Ask the building department staff to help you identify the specific items needed for your submittal.

Step 2: Prepare Maintenance Documentation

Property owners are responsible for assuring the long-term operation and maintenance of a project's stormwater treatment measures unless the applicable municipality approves other specific arrangements. Details may vary from one jurisdiction to another, but maintenance agreements generally require the property owner to assure that all stormwater treatment measures receive proper maintenance in accordance with an approved maintenance plan; that municipal, Regional Water Board, Mosquito Abatement District, and Vector Control District staff be granted access, as needed, to ensure proper maintenance and operation; and if the property owner fails to maintain the treatment measure, municipal staff be allowed to enter the property, perform necessary emergency repairs, and charge the property owner for the necessary emergency repairs. Project applicants are typically required to provide the following documentation to support the maintenance agreement:

- A conceptual plan or site plan that is legible on letter-sized paper (8.5-by-11 inches) and that shows the locations of the stormwater treatment measures that will be subject to the agreement. Some municipalities have specific requirements for these plans, such as requiring a conceptual plan that includes only the stormwater treatment measures. If more than one stormwater treatment measure is used, the treatment measures should be numbered for ease of identification (for example, Bioretention Area 1, Bioretention Area 2, etc.)
- A maintenance plan that includes specific long-term maintenance tasks and a schedule. Section 10.2 provides guidance for preparing a maintenance plan, and Appendix H features maintenance plan templates to use when preparing a maintenance plan. If a preliminary maintenance plan was submitted with the planning permit application, this plan should be updated to respond to municipal staff comments and include a sufficient level of detail for implementation.
  - A Standard Treatment Measure Operation and Maintenance Inspection Report Form, which some municipalities require the property owner to complete and submit to the municipality each year. The purpose of the annual report is to help the municipality verify that appropriate O&M is occurring. A template for preparing this report form is included in **Appendix H**.

Step 3: Submit Building Permit Application

Assemble all the items listed in **Table 0-1.** that municipal staff have indicated are required for your project and include them as attachments to your building permit application.

3.4 SIMPLE INSTRUCTIONS FOR SMALL SITES SUBJECT TO STORMWATER TREATMENT REQUIREMENTS

Some developers of smaller projects may be less familiar with requirements to incorporate stormwater treatment measures. If you are a licensed engineer, architect, or landscape architect, you may be able to prepare the entire C.3 submittal yourself. If not, you will probably need to hire a qualified civil engineer, architect, or landscape architect to prepare the submittal – or at least some of the more technical aspects of the submittal. Note that the guidance in this section is intended for smaller sites that are Regulated Projects. **Appendix L** provides guidance for small projects that will create or replace less than 5,000 square feet of impervious area and detached single-family homes (that are not part of a common plan of development that create or replace less than 10,000 square feet of impervious area.

Some tips for smaller projects are provided below.

- Review submittal checklists with municipal staff. If your project does not require a planning permit, you will need to include in your building permit application submittal some of the items that are listed in **Table 3-1.** (Planning Permit Submittal Checklist) and some from **Table 0-1.** (Building Permit Checklist). But remember, not every item in the checklists is required for every project. Make an appointment with the local agency to go through the checklists with you and identify the items you need to submit for your small site. And make sure to get the list in writing, so you can refer to it, if necessary, in future conversations with municipal staff. If your project requires a planning permit, use this same strategy to get a list of required items from the local agency.
- Maximize the use of site design measures. The less impervious surface area on the site, the smaller your stormwater treatment measures will need to be. **Chapter 5** lists strategies for reducing impervious surfaces, and it offers guidance for using self-treating areas (for example, landscaping, areas paved with turf block, or green roofs) to further reduce the size of treatment measures. Projects that create and/or replace at least 2,500 but less than 5,000 square feet of impervious surface are required to incorporate site design measures, using specifications that are included in **Appendix L**.
- Use LID treatment measures. Even on small sites, LID treatment measures are required, except for projects that may receive LID treatment reduction credits as a Special Project (described in **Appendix J**). **Chapter 8** includes technical guidance for some treatment measures, such as bioretention areas and flow-through planters, which are well suited for small sites in densely developed areas. Where on-site conditions, such as proximity to buildings, high groundwater or contaminated soils prohibit infiltration, flow-through planters may be a good option.
- Use simplified sizing methods. The technical guidance in **Chapter 7** includes simplified sizing methods for flow-through planters and bioretention areas. The technical guidance for these treatment measures highlights the easy-to-follow calculations for sizing the treatment measures. In locations where infiltration is precluded by steep slopes, high groundwater, or proximity to building foundations, and the project is an infill or redevelopment project, the combination flow and volume sizing method may be used to

potentially reduce the amount of land needed for stormwater treatment (see **Chapter 5**).

- Use the planting guidance. **Chapter 7** and **Appendix B** provides guidance for selecting appropriate plantings for landscape-based stormwater treatment measures. Municipal staff will check to confirm that the plants included in your design meet the criteria set forth in this guidance.

Figure 3-6. Flow-through planters are incorporated into the landscaping in a dense, urban setting in Emeryville.

4 PUBLIC AGENCY PROJECTS

This Chapter outlines the requirements and process for regulated public agency projects.

The MRP mandates stormwater control measures for specified development projects, including development projects usually undertaken by public agencies such as development of new roads, the reconstruction of existing roads, and maintenance of pavement. This Chapter outlines the C.3 requirements and process for incorporating LID into public agency projects regulated by the MRP.

4.1 APPLICABILITY OF REQUIREMENTS FOR PUBLIC PROJECTS

4.1.1 Regulated Projects

The MRP defines types of Regulated Projects and establishes thresholds in square feet (SF) of created and/or replaced impervious area for determining whether projects must implement numeric sizing of stormwater treatment systems. These projects are summarized below and described further in **Table 4-1**.

The same stormwater control requirements apply to both public and private Regulated Projects. Refer to the following Chapters for design guidance:

Chapter 5	Site Design Measures
Chapter 6	Source Control Measures
Chapter 7	General Guidance for Treatment Measures
Chapter 8	Technical Guidance for Treatment Measures
Chapter 9	Hydromodification Measures
Chapter 9	Operations and Maintenance

4.1.1.1 New Roads, Sidewalks, and Trails

Projects that create ≥5,000 contiguous SF of impervious area by developing new roads, sidewalks, trails, or by adding travel lanes onto existing roads are Regulated Projects.

4.1.1.2 Road Reconstruction

Road reconstruction projects described in **Table 4-1** that create and/or replace ≥1 contiguous acre of impervious surface area are Regulated Projects. Utility trenches with an average width ≥8 feet are considered road reconstruction projects.

Certain pavement maintenance activities, such as crack sealing and pothole filling, are excluded from Regulated Project requirements. These exclusions, along with more details on Regulated Projects and activities, are listed in **Table 4-1**.

Table 4-1. Public Road and Trail Regulated Project Impervious Area Thresholds

Regulated Projects	Impervious Area Threshold	MRP Provision
New Roads, Sidewalks, and Trails include:		
New roads, including sidewalks and bike lanes	5,000 SF contiguous[1]	C.3.b.ii.(4)
Adding traffic lanes to an existing road	5,000 SF contiguous[1]	C.3.b.ii.(4)
New stand-alone impervious surface trail projects that are ≥10 feet wide or are creekside (within 50 feet of the top of bank)	5,000 SF contiguous[1]	C.3.b.ii.(4)
Sidewalk gap closures, sidewalk replacement, ADA curb ramps not associated with a parcel-based project	5,000 SF contiguous[1]	C.3.b.ii.(3)
Road Reconstruction includes:		
Reconstructing existing roads, including sidewalks and bicycle lanes	1-acre contiguous[1]	C.3.b.ii.(5)
Utility trenching projects greater than 8 feet in width on average	1-acre contiguous[1]	C.3.b.ii.(5)
Regulated Activities		**MRP Provision**
Specific activities considered Regulated Projects when the impervious surface area threshold is met include:		C.3.b.ii.(1)(b)(iii)
Upgrade from dirt to gravel (exempt if built to specification for pervious pavement system)		
Upgrade from dirt/gravel to pavement (exempt if built to specification for pervious pavement system)		
Removing/replacing asphalt or concrete to top of base course or lower		
Repair of pavement base (i.e., base failure repair)		
Extending roadway edge (e.g., lane widening or safety improvement)		
Paving gravel or dirt roadway shoulder		
Exempt Activities		**MRP Provision**
Specific exemptions from LID requirements include:		C.3.b.ii.(1)(b)(ii)
Pothole and square cut patching		
Overlay gravel on existing gravel (no increase in area)		
Overlay bituminous surface treatment, asphalt, or concrete on existing asphalt or concrete (no increase in area)		
Upgrade from chip seal or cape seal to asphalt or concrete (no increase in area)		
Shoulder grading		
Reshaping/regrading drainage		
Crack sealing		
Pavement preservation that does not expand the road prism		
Sidewalks built as part of new streets or roads and built to direct stormwater runoff to adjacent vegetated areas		C.3.b.ii.(4)(d)(i)

Regulated Projects	Impervious Area Threshold	MRP Provision
Bicycle lanes built as part of new streets or roads, but that are not hydraulically connected to the new streets or roads and that direct stormwater runoff to adjacent vegetated areas		C.3.b.ii.(4)(d)(ii)
Impervious trails that direct stormwater runoff to adjacent vegetated areas, or other non-erodible permeable areas, preferably away from creeks or towards the outboard side of levees, where those areas are at least half as large as the contributing impervious surface area		C.3.b.ii.(4)(d)(iii)
Sidewalks, bicycle lanes, or trails constructed as pervious pavement systems		C.3.b.ii.(4)(d)(iv)
Caltrans highway projects and associated facilities		C.3.b.ii.(4)(d)(v)

[1] Project areas interrupted by cross streets or intersections are considered contiguous.
[2] The threshold is for 5,000 SF of parking lot(s) or other pavement, cumulative, throughout the project site.

4.1.2 Green Infrastructure Opportunities

MRP Provision C.3.j.iii requires public agencies to implement a "no missed opportunities" approach and evaluate each capital improvement project (CIP) for green infrastructure opportunities. The evaluation can be conducted per the guidance previously developed by the Clean Water Program (see **Appendix M-2** *Worksheet for Identifying Green Infrastructure Potential in Municipal Capital Improvement Program Projects*). Integrating LID requirements in projects that do not meet the Regulated Project thresholds, such as a road reconstruction project of less than 1 acre, provides a public agency with an opportunity for meeting another MRP requirement, the minimum retrofit requirements in MRP Provision C.3.j.ii(2) and **Table H-1**, excerpted in **Table 4-2**.

Table 4-2. MRP 3 Numeric Retrofit Target Assignments by Municipality

Permittee	Retrofit Requirement (acres)	Permittee	Retrofit Requirement (acres)
Alameda	4.66	Livermore	5.41
Alameda County	5.00	Newark	2.95
Albany	1.18	Oakland	5.00
Berkeley	5.00	Piedmont	0.67
Dublin	3.89	Pleasanton	4.91
Emeryville	0.73	San Leandro	5.00
Fremont	5.00	Union City	4.45
Hayward	5.00		

4.1.2.1 Alternative sizing requirements for road projects

The MRP provides an alternative compliance option that allows LID treatment at an offsite location. This option is available to both private and public agency projects. For this option, a project is designed to treat as much runoff onsite as feasible, with the remaining portion to be treated at an offsite project in the same watershed. Alternative compliance projects must be completed within three years after the end of construction of the Regulated Project. The timeframe may be extended up to five years with prior Regional Water Board approval.

Figure 4-1. Bioretention Curb Extension in Union City

Additionally, severely constrained road reconstruction projects may qualify for alternative sizing criteria if they meet the conditions identified in the Guidance for Sizing Green Infrastructure Facilities in Streets Projects, with companion analysis Green Infrastructure Facility Sizing for Non-Regulated Street Projects (see **Appendix M-3**). To aid in this process, **Appendix M-1** of this Manual includes a series of standard specifications/typical details developed by the Clean Water Program for designing green infrastructure facilities in the street right of way, including bioretention in curb bulb-outs, bioretention in street medians, etc.

4.2 HOW TO INTEGRATE C.3 INTO A PUBLIC PROJECT

The successful integration of post construction stormwater control into a public infrastructure project relies on communication between municipal departments and contactors to design, build, and maintain the project to protect stormwater quality. At each phase, various departments must engage with each other to ensure successful design, construction, and operation and maintenance (O&M) of LID features.

Project Life Cycle Phases

1) Planning and Design
2) Construction
3) Operations and Maintenance

4.2.1 Planning and Design Phase

During the planning and design phase municipal departments must engage to determine if the proposed project is considered a Regulated Project or a non-regulated green stormwater infrastructure opportunity.

- 10% Design: Conceptual Design or Planning Stage – Determine if the proposed project is regulated, complete a no missed opportunity analysis, and incorporate stormwater design guidelines.
- 30% Design: Defined Project Scope, Budget, and Schedule Stage – Ensure site plans show the site design, source control, and stormwater treatment measures and locations and evaluate maintenance considerations for the proposed controls.

- 60% Design: Detailed Design, Constructability, and Detailed Budgets Stage – Ensure site design, source control, and stormwater treatment measures are integrated into the site plans and the drainage system and that detailed specifications are developed.
    - Field assessments and evaluations are completed, (e.g., percolation tests to support sizing and design of post construction stormwater controls).
    - Preliminary stormwater control plan (C.3 Checklist and supporting information) and Maintenance Plan are developed and reviewed for constructability and maintainability.
- 90% Design: Final Project Design and Schedule Stage – Confirm that final stormwater requirements have been integrated into the design, stormwater control plan (C.3 Checklist and supporting information), and Maintenance Plan.

4.2.2 Construction Phase

During the construction phase, municipal departments must oversee the construction project to ensure the plans are followed and engage with each other if the bidding process or field conditions necessitate changes to the plans to ensure that the stormwater requirements are met.

- Bidding Stage – Engage with procurement as requested, for pre-bid meetings and jobsite visits; and to respond to potential bidder questions and review qualifications.
- Submittal Stage – Review contractor submittals to ensure plans follow the design and construction plans account for protection of the areas where LID stormwater controls will be constructed.
- Construction Stage – Engage to review any deviations from the stormwater control plans; oversee the construction of the stormwater controls and conduct milestone inspections of key features of the LID controls.
- Close-out Inspection – Involve all relevant staff (e.g., maintenance, environmental, engineering) in the final inspection to identify punch-list items to be corrected before the permits are closed out or the Certificate of Occupancy (CO) is issued.
- Final Acceptance/Certificate of Occupancy – Review and sign-off on punch-list and on review and acceptance of as-builts and final Maintenance Plan.

Key Milestone Inspections

- Drainage system installation
- Verification of bioretention soil media
- Landscape plants installation

4.2.3 Operation and Maintenance Phase

During the O&M phase the newly constructed post construction stormwater controls are handed off for on-going maintenance and tracking.

> *An inter-departmental **Maintenance Notification** is recommended to document and transfer maintenance responsibility to an agency's maintenance department.*
>
> ***Appendix M-4** provides an example Maintenance Notification.*

- Transfer from the Construction Phase to Maintenance and Asset Management
- Send the final Maintenance Plan and as-builts to the department responsible for the on-going maintenance of the stormwater treatment measures.
- Enter the stormwater treatment measures into Countywide ArcGIS (AGOL) System and into the asset management system.
- Report the new system to the Alameda County Mosquito Abatement District or Alameda County Vector Control Services District.
- Add the system to the C.3 maintenance verification cycle, e.g., once every five years, as required by the MRP.
- Enter the stormwater treatment measures into the maintenance tracking system.
- Schedule routine and periodic maintenance requirements based upon the Maintenance Plan.
- Initiate Maintenance and Inspections
  - Conduct and document routine and periodic maintenance inspections.
  - Conduct inspections (e.g., monthly, or before/after rain events) based on the maintenance plan checklists.
- Conduct the required periodic maintenance verification inspections per MRP requirements.

> **Caution**
>
> Do not issue the Final CO until the as-builts and final Maintenance Plan are submitted and accepted.

5 SITE DESIGN MEASURES

This Chapter explains how site design measures can reduce the size of your project's stormwater treatment measures.

Site design measures for water quality protection are LID techniques employed in the design of a project site to reduce the project's impact on water quality and beneficial uses. Including site design measures in a project does not meet the C.3 requirements for stormwater treatment, but it can help reduce the size of treatment measures (see **Section 0**). Site design measures can be grouped into two categories:

- Site design measures that preserve sensitive areas and high-quality open space, and
- Site design measures that **reduce impervious surfaces** in a project.

This chapter emphasizes site design measures that reduce impervious surfaces, which can reduce the amount of stormwater runoff that will require treatment. This allows smaller facilities to meet stormwater treatment requirements and minimize the size of any required hydromodification management measures.

Where landscaped areas are designed to have a stormwater drainage function, they need to be carefully integrated with other landscaping features on the site early in project design. This may require coordinating separate designs prepared by different professionals.

Remember that any site design measures (including self-treating areas) used to reduce the size of stormwater treatment measures must not be removed from the project without a corresponding resizing of the stormwater treatment measures. For this reason, your municipality may require you to include site design measures in the maintenance agreement or maintenance plan for stormwater treatment measures, or otherwise record them with the deed. Depending on the municipality, site design measures may be subject to periodic operation and maintenance inspections. Check with the municipal staff regarding the local requirements.

Some portions of your site may provide "self-treatment" if properly designed and drained. Such areas may include conserved natural spaces, landscaped areas (such as parks and lawns), and green roofs. Areas of pervious pavement – such as porous concrete, porous asphalt, or unit block pavers – may function as self-treating areas if they are designed to store and infiltrate the rainfall runoff volume described in MRP Provision C.3.d. These areas are considered self-treating because infiltration and natural processes that occur in these areas remove pollutants from stormwater. Technical guidance for green roofs, pervious pavement, turf block, and permeable joint pavers is provided in **Chapter 8**.

If the self-treating areas do not receive runoff from other impervious areas on the site, your drainage design may route the runoff from self-treating areas directly to the storm drain system or receiving water. Thus, the stormwater from the self-treating areas is kept separate from the runoff from paved and roofed areas of the site, which requires treatment.

Even vegetated areas will generate some runoff. If runoff from a self-treating area co-mingles with the C.3.d amount of runoff from impervious surfaces, then your stormwater treatment measure must be hydraulically sized to treat runoff from both the self-treating area and the impervious areas. This does not apply to the high flows of stormwater that exceed the C.3.d amount of runoff, because stormwater treatment measures are not designed to treat these high flows. If your project requires hydromodification management, then the runoff from self-treating areas will need to be included in the sizing calculations for hydromodification management (HM) treatment measures.

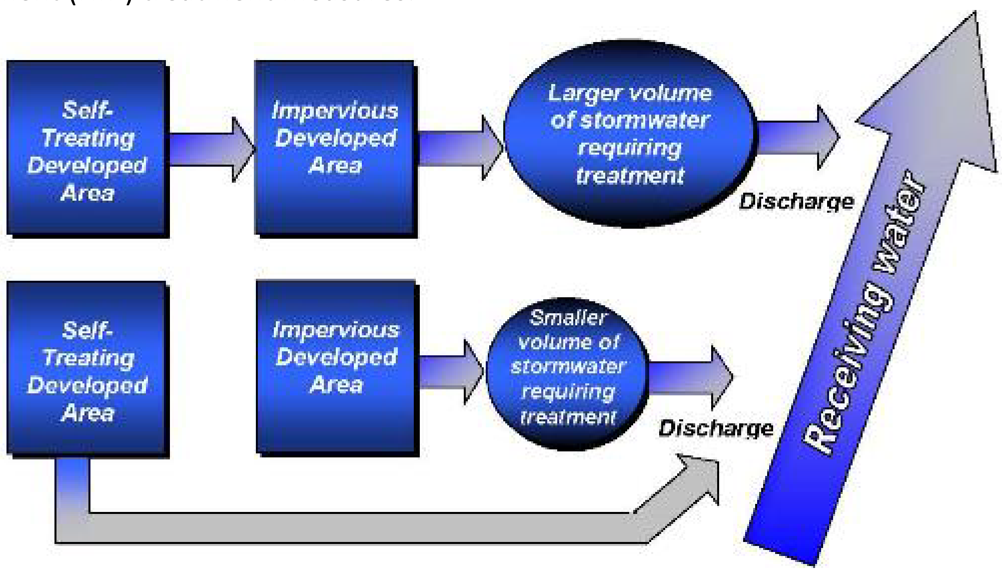
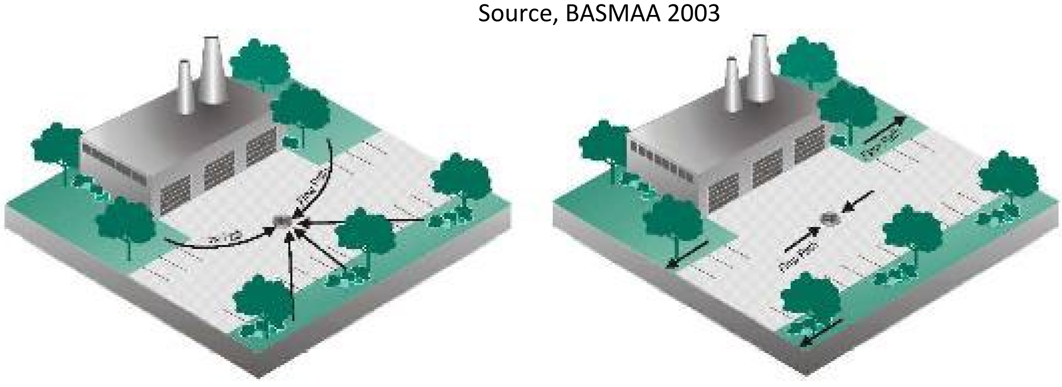


Figure 5-1. Commercial/Industrial Site Compared to Same Site with Self-Treating Areas

Source, BASMAA 2003



Conventional Drainage Approach **Self-Treating Area Approach**

Figure 5-2. Self-Treating Area Usage. Source, BASMAA, 2003

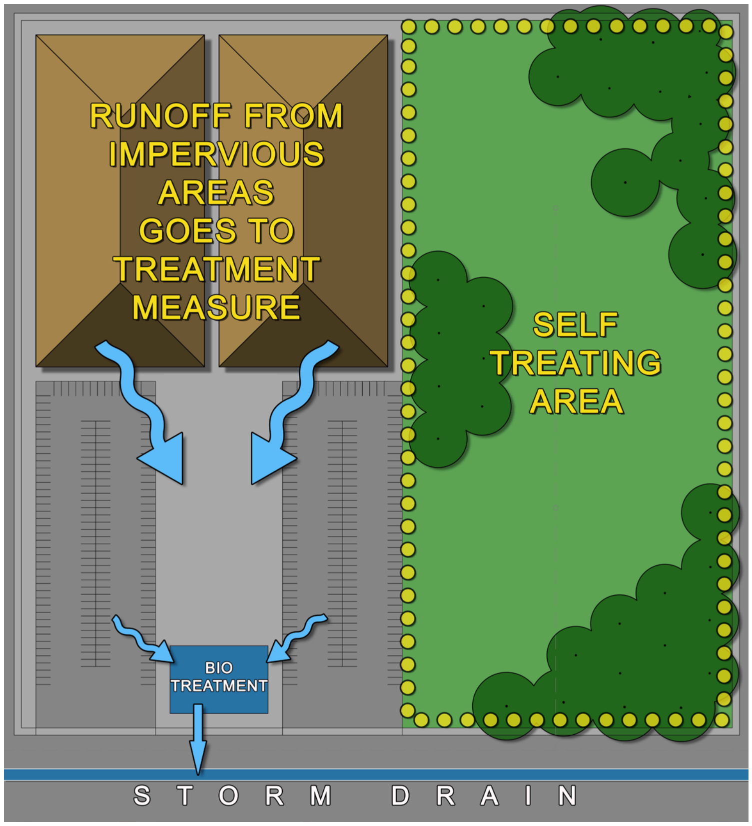


Figure 5-3. Schematic Drainage Plan for Site with a Self-Treating Area

Source: Santa Clara Valley Urban Runoff Pollution Prevention Program

5.1 SELF-RETAINING AREAS

In "self-retaining areas" or "zero discharge areas" a portion of the amount of stormwater runoff that is required to be treated is infiltrated or retained in depressed landscaped areas, or in properly designed areas of pervious paving. If it is possible to create a self-retaining area on your site, you can design smaller stormwater treatment measures.

Drainage from roofs and paving is directed to the self-retaining area, where it can be temporarily stored before infiltrating into the soil. Self-retaining areas may be created by designing concave landscaped areas at a lower elevation than surrounding paved areas, such as walkways, driveways, sidewalks, and plazas; or by designing areas of pervious paving to accept runoff from impervious surfaces. Landscaped self-retaining areas are designed as concave areas that are bermed or ditched to retain the first one inch of rainfall without producing any runoff. To meet the design objectives for self-retaining areas, projects should implement the following design guidance:

- Landscaped self-retaining areas should be designed as concave areas that are bermed or ditched to create a 3-inch ponding depth. Modeling conducted for the Harvest and Use, Infiltration and Evapotranspiration Feasibility/Infeasibility Criteria Report (Feasibility Report), prepared by Bay Area Stormwater Management Agencies Association (BASMAA), demonstrated that a ponding depth of 3 inches is sufficient to meet the C.3 stormwater treatment objective.

- Pervious paving designed as a self-retaining area must provide adequate storage in the void space of the gravel base layer to accommodate the volume of runoff specified in MRP Provision C.3.d for both the area of pervious paving and the impervious surfaces that contribute runoff.
- Runoff may enter the self-retaining area as sheet flow, or it may be piped from a roof or area of impervious pavement. The elevation difference between a landscaped self-retaining area and adjacent areas should be sufficient to allow build-up of turf or mulch within the self-retaining area.
- A maximum 2:1 ratio of impervious area to the receiving pervious area (landscaped areas or pervious paving) is acceptable. Modeling conducted for the BASMAA Feasibility Report confirmed that a 2:1 ratio is sufficient to achieve the C.3.d stormwater treatment objective, even for soils with very low permeability. The 2:1 ratio applies to both landscaped areas and pervious paving areas that are designed as self-retaining areas.
- Drainage from self-retaining areas (for amounts of runoff greater than the first one inch) must flow to off-site streets or storm drains without flowing onto paved areas within the site.
- If overflow drains or inlets to the storm drain system are installed within a landscaped self-retaining area, set them at an elevation of at least 3 inches above the low point to allow ponding. The overflow drain or storm drain inlet elevation needs to be high enough to allow ponding throughout the entire surface of the self-retaining area.
- Any impervious pavement within a predominantly pervious self-retaining area (e.g., a walkway through a landscaped area) cannot exceed five percent of the self-retaining area.
- Slopes may not exceed four percent.
- The municipality may require amended soils, vegetation, and irrigation to maintain soil stability and permeability.
- Self-retaining areas must be protected from construction traffic and compaction.

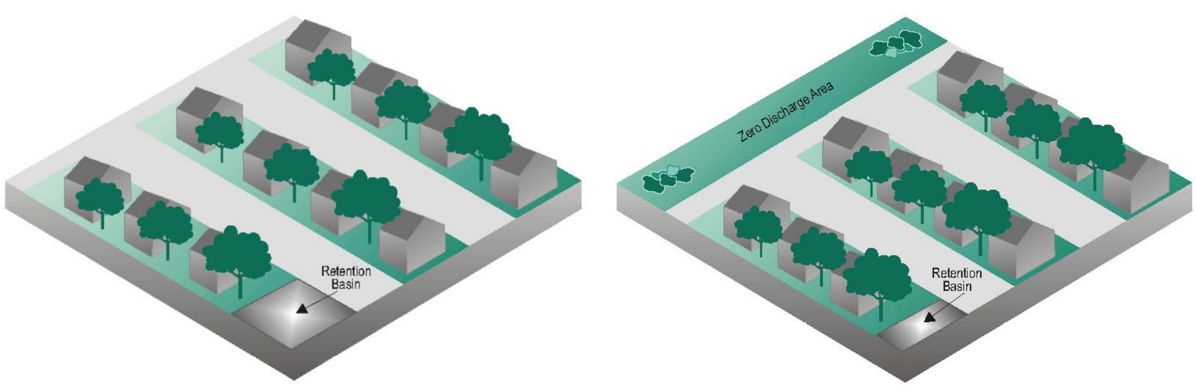


Figure 5-3. Comparison of Conventional Design (left) and Self-Retaining Area Design (right)

(Note: Allowing some runoff from impervious surfaces to be retained and infiltrate in a “self-retaining” or “zero discharge” area can reduce the size of the required stormwater treatment measure.) Source: BASMAA 2003

If you are considering using a self-retaining area in a project that must meet HM requirements, use the Bay Area Hydrology Model (BAHM) to identify the appropriate sizing of the self-retaining area, and a maximum recommended depth of 12 inches, to meet the HM objective of matching post-project stormwater flows and durations to pre-project patterns for smaller, frequent storms (ranging from 2- to 10-year storm events). See **Chapter 9**.

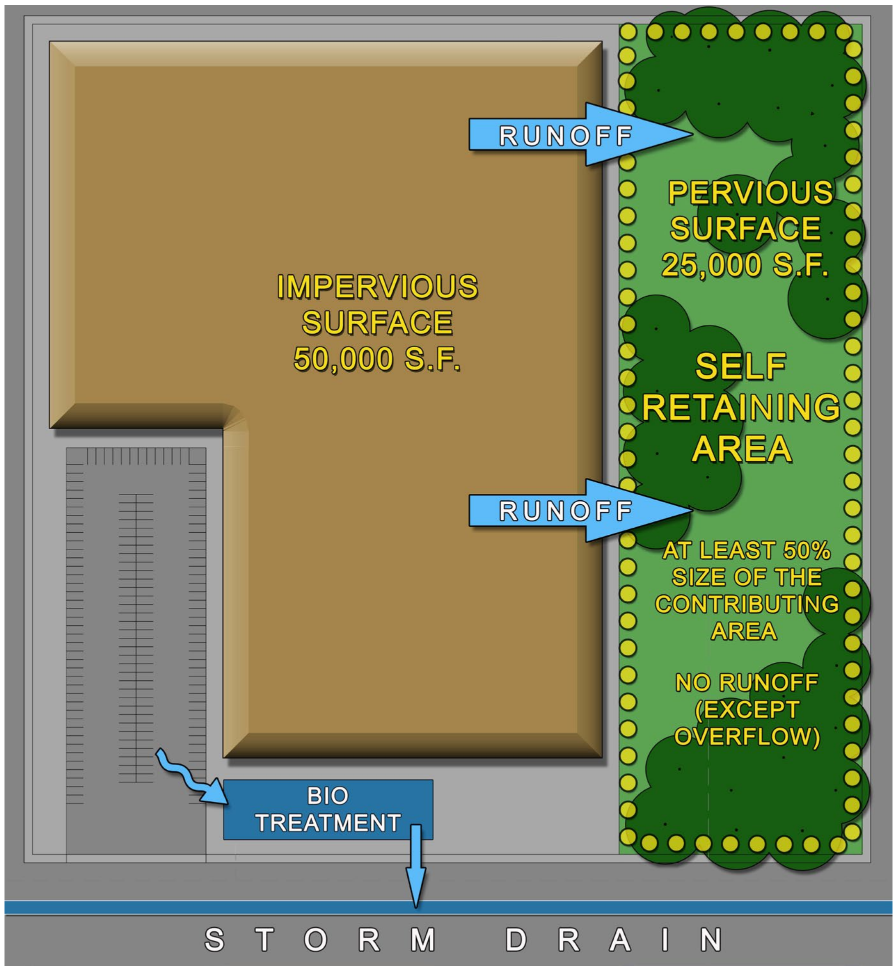


Figure 5-4. Schematic Drainage Plan for Site with a Self-Retaining Area

Source: Santa Clara Valley Urban Runoff Pollution Prevention Program

5.2 REDUCING THE SIZE OF IMPERVIOUS AREAS

A variety of project features can be designed so that they result in a smaller footprint of impervious surface. These features generally need to be incorporated very early in the project design.

Check with your local jurisdiction regarding its policies on the following site design measures:

- Use **pervious pavement** – such as porous concrete, porous asphalt, or unit block pavers – which are not considered impervious if designed to store and infiltrate the rainfall runoff volume described in MRP Provision C.3.d. See **Section 8.6** for pervious paving technical guidance.
- Reduce building footprints by using compact, **multi-story structures**, as allowed by local zoning regulations.
- **Cluster buildings** to reduce the length of streets and driveways, minimize land disturbance, and protect natural areas.
- Design **narrow streets** and driveways, as allowed by the local jurisdiction.
- Use **sidewalks on only one side** of the street may be appropriate in areas with little pedestrian and vehicular traffic, as allowed by the local jurisdiction.

A variety of techniques can be used to minimize surface parking areas, in terms of the number and size of parking spaces, as allowed by the local jurisdiction. These solutions focus on either reducing the demand for parking, maximizing the efficiency of parking utilization, or implementing design solutions to reduce the amount of impervious surface per parking space.

- Reduce parking demand by **separating the cost of parking** from the cost of housing or leasable space. This allows the buyer or tenant to choose how much parking they need and are willing to pay for.
- Maximize efficiency of parking utilization with **shared parking** that serves different land uses that have different times of peak demand. For example, an office use with demand peaks during the day can share parking with restaurants, where demand is greatest during the evening, and to some extent residential uses, where demand peaks are in the evenings and on weekends.
- **Structured parking** can be an efficient way to reduce the amount of impervious surface needed for parking. Structured parking can be integrated with usable space in buildings that also house office or residential space or include ground-floor retail lining the street. Shared parking strategies can work very well with structured parking.
- **Parking lifts** are another way to reduce the amount of impervious surface needed for parking. A parking lift stacks two to three cars using a mechanical lift for each surface space. They can be operated manually by residents, employees, or by a valet or parking attendant. With proper training for residents, employers, or parking attendants, this strategy can be a

Figure 5-5. Parking Lifts in Parking Garage, Berkeley

practical way to double or triple the parking capacity given a set amount of land.

- Another way to maximize the efficient use of parking area is valet parking, where attendants park cars much closer and tighter in than individual drivers would in the same amount of parking space.

5.3 RAINWATER HARVESTING AND USE

Technical guidance for rainwater harvesting and use is provided in **Section 8.9**. A rainwater harvesting system is considered a stormwater treatment measure if it is designed to capture and use the full amount of rainwater runoff that is required to be treated by MRP Provision C.3.d. A rainwater harvesting system is considered a site design measure if it is designed to capture and use less than the C.3.d amount of runoff. If your project will include a rainwater harvesting system as a site design measure, follow the guidance in **Section 8.9**, except for meeting the C.3.d stormwater treatment sizing criteria.

6 SOURCE CONTROL MEASURES

This Chapter explains how to evaluate and select source control measures for your project to protect stormwater quality.

Pollutants are generated by many common activities that will occur after construction is completed. Each local jurisdiction has specific pollutant source control requirements for projects that include landscaping, swimming pools, vehicle washing areas, trash/recycling areas, and other sources of pollutants. These requirements are identified in the local jurisdiction's ***Local Source Control Measures List***. Be sure to obtain the current list from your local jurisdiction. The lists are typically divided into: Part I – Structural Source Controls and Part II – Operational Source Controls, both of which prevent pollutant discharge and runoff at the source and keep pollutants from contacting stormwater.

6.1 STRUCTURAL SOURCE CONTROLS

Structural source controls are permanent features that are designed and constructed as part of a project, such as sanitary sewer connections for restaurant wash areas that are large enough to wash the largest piece of equipment. **Table 6-1.** contains examples of structural source controls.

Table 6-1. Structural Source Controls

Potential Source of Pollutants	Structural Source Controls
On-site storm drains	Mark on-site storm drains with the words "No Dumping! Flows to Bay" (or applicable water body) applied with thermoplastic.
Interior floor drains	Plumb interior floor drains to the sanitary sewer system with approval of the sanitary agency. Interior floor drains shall not be connected to storm drains.
Parking garages	Connect interior level parking garage floor drains to the sanitary sewer system with approval of the sanitary agency. Interior garage floor drains shall not be connected to storm drains.
Landscapes (Pesticide, fertilizer application and irrigation)	Design landscapes to meet Water Efficient Landscape Ordinances. An efficient irrigation system shall be installed in areas requiring irrigation. An example of an efficient irrigation system is one that includes a weather-based (automatic, self-adjusting) irrigation controller with a moisture and/or rain sensor shutoff, and in which sprinkler and spray heads are not permitted in areas less than 8-feet wide. Incorporate sustainable landscaping practices such as Bay-Friendly Landscaping.

Potential Source of Pollutants	Structural Source Controls
Pools, spas, and fountains	Provide a nearby connection to the sanitary sewer for new or rebuilt swimming pools, hot tubs, spas, and fountains to facilitate draining with approval of the sanitary agency.
Food service facilities	Provide a sink or other contained area in food service facilities (including restaurants and grocery stores) for cleaning floor mats, equipment, and hood filters that is connected to a grease interceptor prior to discharging to the sanitary sewer system, with approval of the sanitary agency.
Refuse areas	Include roofed and enclosed refuse areas for dumpsters, recycling and food waste containers, and compactors. The area shall be designed to prevent water run-on to the area and runoff from the area and to contain litter and trash, so that it is not dispersed by the wind or runoff during waste removal. Runoff from refuse areas shall not discharge to the storm drain system. Drains installed refuse areas shall be connected grease interceptor prior to discharging to the sanitary sewer system with approval of the sanitary agency
Outdoor process areas	Design outdoor process areas to prevent run-on to and runoff from the area with process activities. Process equipment areas shall drain to the sanitary sewer system with approval of the sanitary agency and shall not be connected to storm drains.
Outdoor equipment /material storage areas	Cover and berm outdoor equipment and materials storage areas.
Vehicle/equipment and commercial/ industrial cleaning	Wash water from washing operations shall not be discharged to the storm drain system. Washing areas shall be paved, designed to prevent run-on to or runoff from the area, and plumbed to drain to the sanitary sewer with approval of the sanitary agency.
Fueling areas	Fueling areas shall have impermeable surfaces (i.e., Portland cement concrete or equivalent 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 or the fueling area must be roofed with a minimum roof dimension equal to the area within the grade break or fuel dispensing area. The canopy or roof shall not drain onto the fueling area.
Loading docks	Loading docks shall be graded to minimize run-on to and runoff from the loading area and/or be covered. Roof downspouts shall be positioned to direct stormwater away from the loading area. Stormwater runoff from loading dock areas shall be connected to a post-construction stormwater treatment measure(s) prior to discharge to the storm drain system or be directed to the sanitary sewer with approval of the sanitary agency. Storm drains in loading

Potential Source of Pollutants	Structural Source Controls
	dock areas shall be equipped with locking valves that can be shut during loading and emergencies to contain spills.
Fire sprinkler test water	The project shall be designed to allow discharge of fire sprinkler test water to an onsite vegetated area where it will infiltrate or to post-construction stormwater treatment measure(s) prior to discharge to the storm drain system. Vegetated areas shall be large enough to accommodate the flow. If this is not feasible, the project shall be designed to discharge fire sprinkler test water to the sanitary sewer with approval of the sanitary agency.

NOTE: This table is included as an example only and is not intended for use in an actual submittal.

6.2 OPERATIONAL SOURCE CONTROLS

Operational source controls are "good housekeeping" activities that must be conducted routinely during the operations phase of the project – such as street sweeping and cleaning storm drain inlets. **Table 6-2.** contains examples of operational source controls.

Table 6-2. Operational Source Controls

Potential Source of Pollutants	Operational Source Controls
On-site storm drains	All on-site storm drain inlets shall be cleaned at least once a year immediately prior to the rainy season.
Landscapes (Pesticide, fertilizer application and irrigation)	Follow all federal and state guidelines for use of pesticides and fertilizers. Implement Integrated Pest Management. Compost or dispose of clippings in green waste bins.
Pools, spas, and fountains	Post signs or maintain procedures that prohibit discharge to the storm drainage system.
Food service facilities	Post signs indicating that all food service equipment washing activities are to be conducted in the contained area.
Refuse areas	Inspect refuse areas and pick up litter regularly and following trash collection days.
Vehicle/equipment and commercial/industrial cleaning	Post signs indicating the location and allowed uses in the designated wash area.
Vehicle/equipment repair and maintenance	No person shall dispose of, nor permit the disposal, directly or indirectly, of vehicle fluids, hazardous materials, or rinse water from parts cleaning operations 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 dripping parts or other open containers containing

Potential Source of Pollutants	Operational Source Controls
	vehicle fluids, unless such containers are in use or in an area that cannot discharge to the storm drain, such as an area with secondary containment.
Fueling areas	The fueling area shall be dry swept and leaks and drips shall be spot cleaned leaks routinely. Fueling areas shall not be washed down with water unless the wash water is collected and disposed of properly. Spill kits shall be readily accessible in fueling areas.
Loading docks	Loading docks shall be swept regularly, and litter shall be removed immediately. Spill kits shall be maintained.
Paved sidewalks and parking lots	Sidewalks and parking lots shall be swept regularly to minimize the accumulation of litter and debris. Debris resulting from pressure washing shall be collected to prevent entry into the storm drain system. Wash water containing soaps, cleaning agents, or degreasers shall not be discharged to the storm drain and shall be collected and discharged to the sanitary sewer with approval of the sanitary agency.
Private streets, utilities, and common areas	Owners of private streets and storm drains shall prepare and implement a plan for street sweeping of paved private roads and cleaning of all storm drain inlets.
On-site storm drains	All on-site storm drains must be inspected annually prior to the rainy season (August-September) and cleaned if necessary. Additional inspections and cleaning may be required.

NOTE: This table is included as an example only and is not intended for use in an actual submittal.

6.3 SOURCE CONTROL RESOURCES

In addition to the **Local Source Control Measures List**, the California Stormwater BMP Handbook, Development (California Stormwater Quality Association (CASQA), June 2021) provides fact sheets that detail the design considerations for source control BMPs. Additionally, fact sheets in the California Stormwater BMP Handbook, Industrial and Commercial, detail the ongoing operation of the source control measures.

Projects must incorporate the applicable structural and operational source controls for any project activity that is included in the local source control lists. The following methods may be used to accomplish this.

- ***Review*** structural source controls in Part I of the local list and compare this list to your site plan. Identify any areas on the site that require structural source controls. Remember that some activities may not have been sited yet. For example, Local Source Control Measures Lists include a requirement for enclosing and roofing refuse storage areas. If a designer was unaware of this requirement, it may not be shown on the project plans.
- ***Incorporate*** all the required structural source controls on your project drawings.

- ***If required by the municipality,*** prepare and submit a table listing in three columns the potential sources of pollutants, the permanent source control measures (Part I of the local list), and any operational source control measures (Part II of the local list) that apply to the project.

7 GENERAL TECHNICAL GUIDANCE FOR TREATMENT MEASURES

The technical guidance in this Chapter applies to all types of stormwater treatment measures.

7.1 HYDRAULIC SIZING CRITERIA

The stormwater treatment measures must be sized to treat stormwater runoff from small sized storms that are the most common. The intent is to treat most of the stormwater runoff while recognizing that it would be infeasible to size stormwater treatment measures to treat runoff from very large storms that occur every few years. See **Section 7.7** for more technical guidance on how to design stormwater treatment measures for low flow systems.

The MRP requires that all Regulated Projects, as defined in **Table 2-1.**, must provide stormwater treatment. Municipalities may require stormwater treatment for projects that are smaller than the Regulated Project threshold, and in these cases, stormwater treatment is required to the maximum extent practicable (MEP). Exceptions to the stormwater treatment requirement for Regulated Projects are pervious areas that are "self-treating" as described in **Section 5.1**., and "self-retaining areas" designed to store and infiltrate runoff from rooftops or paved areas as described in **Section 5.2**. Other than "self-treating areas" and "self-retaining areas**"** all areas at a project site must receive stormwater treatment.

Treating runoff from areas that are downgradient from stormwater treatment measures, such as driveway entrances, can be challenging. Consider using pervious pavement in these areas to reduce the amount of impervious surface created and/or replaced by driveway entrances. Opportunities to provide offsite treatment of the applicable amount of impervious surface may also be considered, as described in **Chapter 11**, Alternative Compliance.

7.1.1 Volume-Based Sizing Criteria

The MRP specifies two alternative methods for hydraulically sizing volume-based stormwater treatment measure. The *Urban Runoff Quality Management Approach* is based on simplified procedures that are not recommended for use when information is available from continuous hydrologic simulation of runoff using local rainfall records (see *Urban Runoff Quality Management, WEF Manual of Practice No. 23/ASCE Manual and Report on Engineering Practice No. 87*). Because the results of continuous simulation modeling based on local rainfall are available, the Clean Water Program recommends the use of the *California Stormwater BMP Handbook Approach*, or ***80 percent capture method***.

Please note that the Clean Water Program's member agencies may also allow project applicants to use an even simpler sizing method for sizing flow/volume-based treatment measures such as flow-through planters and bioretention areas, which is described below, under the heading, Simplified Sizing Methods.

The ***80 percent capture method*** should be used when sizing infiltration trenches, rainwater harvesting systems, or extended detention basins. The 80 percent runoff value is determined by the Storage, Treatment, Overflow, Runoff Model (STORM), which uses continuous simulation to convert rainfall to runoff based on local rainfall data. STORM was developed by the Hydrologic Engineering Center of the U.S. Army Corps of Engineers.

Volume-based BMP sizing criteria and 80 percent capture method is described in Section 5.5.1 of the California Stormwater Quality Association's 2021 Stormwater Best Management Practice Handbook New Development and Redevelopment available at www.casqa.org.

To size volume-based treatment measures, use the following steps**,** which may be performed using the volume-based sizing criteria Excel worksheet provided in **Appendix C**.

1. Mean Annual Precipitation

Determine the ***mean annual precipitation (MAP)*** for the project site using the Mean Annual Precipitation Map of Alameda County (**Appendix D**). Use the Oakland Airport unit basin storage volume values from **Table 7-1.** if the project location's mean annual precipitation is 16.4 inches or greater and the San Jose values if it is less than 16.4 inches.

To account for the difference between MAP of the project site and the two rainfall locations shown, calculate the ***MAP adjustment factor*** by dividing the project MAP by the MAP for the applicable rain gauge, as shown below:

$$\text{MAP adjustment factor} = \frac{\text{(project location mean annual precipitation)}}{\text{(18.35 or 14.4, as appropriate)}}$$

2. Effective impervious Area for the Drainage Management Area

- Based on the topography of the site and configuration of buildings, divide the site into drainage management areas (DMAs), each of which will drain to a treatment measure. Implement the steps below for each DMA with a volume-based treatment measure.
- Minimize the amount of landscaping or pervious pavement that will contribute runoff to the treatment measures. Refer to **Sections** Error! Reference source not found. and **0** to design areas of landscaping or pervious pavement as self-treating areas or self-retaining areas, so that they do not contribute runoff to the LID treatment measure and may be excluded from the DMAs for the treatment measures.
- For each DMA in which the area that will contribute runoff to the treatment measure includes pervious surfaces (landscaping or properly designed pervious paving), multiply the area of pervious surface by a factor of 0.1.
- For applicable DMAs, add the product obtained in the previous step to the area of impervious surface, to obtain the effective impervious area. (For DMAs that are 100% impervious, use the entire DMA area.)

3. Unit Basin Storage Volume

The effective impervious area of a DMA has a runoff coefficient of 1.0. Refer to **Table 7-1.** to obtain the unit basin storage volume that corresponds to your rain gauge area. For example, using the Oakland Airport gauge, the unit basin storage volume would be 0.67 inches. Adjust the unit basin storage volume for the site by multiplying the unit basin storage volume value by the MAP adjustment factor calculated in Step 1.

Calculate the required capture volume by multiplying the effective impervious area of the DMA calculated in Step 2 by the adjusted unit basin storage volume. Due to the mixed units that result, such as acre-inches, it is recommended that the resulting volume be converted to cubic feet for use during design. For example, you determined the adjusted unit basin storage volume to be 0.5 inches, and the effective impervious area draining to the bioretention facility is 7,000 square feet. Then the required capture volume would be 0.5 inches × (1 foot/12 inches) × 7,000 square feet = 292 cubic feet.

Table 7-1. Unit Basin Storage Volume (Inches) for 80 Percent Capture with 48-Hour Drawdown Time

Location	Mean Annual Precipitation (inches)	Coefficient of 1.00[1]
Oakland Airport	18.35	0.67
San Jose	14.4	0.56

Source: California Stormwater Quality Association (CASQA 2021).

[1] Unit Basin Storage Volume for Effective Impervious Area of Drainage Management Area

4. Depth of Infiltration Trench or Pervious Paving Base Layer

If you are designing an infiltration trench, or area of pervious paving that will receive runoff from adjacent impervious surfaces, determine the surface area that is available for the trench, or the area of pervious paving. Given that surface area, the depth required for the trench, or for the rock base below the pervious paving, may be calculated by dividing the required capture volume by 0.35 (which represents the assumed void space available within the rock-filled trench or base), and then dividing the rock volume by the surface area of the proposed trench or area of pervious paving.

7.1.2 Flow-Based Sizing Criteria

The MRP specifies three alternative methods for hydraulically sizing flow-based stormwater treatment control measures, such as flow through planter boxes, and media filters. These three methods are described **in Table 7-2.**

The percentile rainfall intensity method is based on ranking the hourly depth of rainfall from storms over a long period and determining the 85th percentile hourly rainfall depth and multiplying this value by two. In the Bay Area, this value is generally around 0.2 inches/hour at low elevation rain gauges. The permit also allows the use of 0.2 inches/hour as one of the three alternative methods regardless of the results from calculating values from local rainfall depths.

Table 7-2. Flow-based Sizing Criteria Included in MRP Provision C.3.d

Flow-based Sizing Criteria	Description	Practice Tips
Percentile Rainfall Intensity Method	Ranks the hourly depth of rainfall from storms over a long period, determines the 85th percentile hourly rainfall depth, and multiplies this value by two.	This approach requires hydrologic studies that have not been conducted in Alameda County. Results of studies in other Bay Area locations showed a rainfall intensity of about 0.2 inch/hour.
0.2 Inch-per-Hour Intensity Method (Recommended Method)	Simplification of the percentile Rainfall Intensity Method.	The 4 percent method, which is recommended for use throughout Alameda County, is derived from this approach.
10% of the 50-year peak flow rate (factored Flood Flow Approach)	Rainfall intensity is determined using Intensity-Duration-Frequency curves published by the local flood control agency or climactic data center.	This approach may be used if the 50-year peak flow has been determined. This approach has not been used locally.

For sizing bioretention areas and flow-through planters, there is a simplified method known as the 4 percent method, which is based on a runoff inflow of 0.2 inches per hour, with an infiltration rate through the biotreatment soil of 5 inches per hour (in/hr):

0.2 in/hr divided by 5 in/hr = 0.04

Because two of the MRP allowed methods yield similar results and the third method requires data that may not be readily available, the Clean Water Program recommends using the 4 percent method to design bioretention areas, flow-through planters, and tree well filters that use biotreatment soil.

The 4 percent method requires the surface area of the treatment measure to be 4 percent of the impervious area that drains to it (1,750 square feet of bioretention area per impervious acre). If areas of landscaping or pervious paving contribute runoff to the treatment measure, the area of these pervious surfaces is multiplied by a factor of 0.1 to obtain the amount of effective impervious area (as described in the volume-based sizing approach earlier in this chapter).

To apply the 4 percent method, use the following steps:

1. Based on the topography of the site and configuration of buildings, divide the site into drainage management areas (DMAs), each of which will drain to an LID treatment measure. Implement Steps 2 through 5 for each DMA.
2. Minimize the amount of landscaping or pervious pavement that will contribute runoff to the LID treatment measures. Refer to **Sections 5.1** and **5.2** to design areas of landscaping or pervious pavement as self-treating areas or self-retaining areas, so that

they do not contribute runoff to the LID treatment measure and may be excluded from the DMAs for the treatment measures.

3. For each DMA in which the area that will contribute runoff to the treatment measure includes pervious surfaces (landscaping or pervious paving), multiply the area of pervious surface by a factor of 0.1.
4. For applicable DMAs, add the product obtained in Step 3 to the area of impervious surface, to obtain the "effective impervious area."
5. Multiply the impervious surface (or effective impervious area in applicable DMAs) by a factor of 0.04. This is the required surface area of the LID treatment measure.
6. For sizing other flow-based stormwater treatment measures, such as media filters (where allowed on a project), the Rational Method can be used, which computes the runoff resulting from the design rainfall intensity. The Rational Method formula is:

$$Q=CiA$$

Where:

Q= flow in cubic feet/second

i = rainfall intensity in inches/hour

C= composite runoff coefficient (unitless – see **Table 7-3.**)

A= drainage area in acres

To compute the water quality design flow, use the following steps:

1. Determine the drainage area, "A," in acres for the stormwater treatment measure.
2. Determine the runoff coefficient, "C," from **Table 7-3.**. Note that it is more accurate to compute an area-weighted "C-factor" based on the surfaces in the drainage area, if possible, than to assume a composite C-factor.
3. Use a design intensity of 0.2 inches/hour for "i" in the Q=CiA equation.

Determine the design flow (Q) using Q = CiA:

Q = [Step 2] × 0.2 in/hr × [Step 1] = _____ cubic ft/sec[5]

[5] Note that the Rational Method formula produces a result with units of acre-in/hour; however, the conversion factor from acre-in/hour to cubic feet/second is approximately 1.0.

Table 7-3. Estimated Runoff Coefficients for Various Surfaces During Small Storms

Type of Surface	Runoff Coefficients "C" factor
Impervious Surfaces	
Roofs	0.90
Concrete	0.90
Asphalt	0.90
Grouted pavers	0.90
Gravel, crushed aggregate	0.85
Pervious Surfaces	
Pervious concrete	0.10
Pervious asphalt	0.10
Permeable interlocking concrete pavement	0.10
Grid pavements with grass or aggregate surface	0.10
Gravel pavement constructed as pervious pavement system	0.10
Grass and landscaping	0.10

Note: These C-factors are only appropriate for small storm treatment design and should not be used for flood control sizing. When available, locally developed small storm C-factors for various surfaces may be used.

7.1.3 Combination Flow and Volume Design Basis

For projects on sites where infiltration should be avoided, or for which the local jurisdiction determines that plans to maximize density will result in substantial environmental benefits, staff may allow the use of the combination flow and volume design basis for bioretention areas and flow-through planters that include a surface ponding area. In these treatment measures, volume-based treatment is provided when stormwater is stored in the surface ponding area. The surface ponding area may be sized so that the ponding area functions to retain water before it enters the soil at the minimum 5 inches per hour required by MRP Provision C.3.c.i (2)(c)(ii). This may allow for a reduced footprint of the bioretention area or flow-through planter. However, it is recommended that agencies not approve any bioretention areas or flow-through planters sized using this method that propose a surface area that is less than 3 percent of the effective impervious area that drains to the treatment measure.

See **Appendix C** for an example of sizing bioretention areas using the combination flow and volume method.

The 4 percent method for sizing bioretention areas and flow-through planters, in which the surface area of the treatment measure is designed to be 4 percent of the effective impervious area that drains to the treatment measure, is a flow-based sizing approach. This approach tends to result in the design of a conservatively large treatment measure because it does not account for any storage provided by the surface ponding area.

Figure *7-1*. Bioretention area, Emeryville (example of a combination flow- and volume-based treatment measure).

MRP Provision C.3.d specifies that treatment measures 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 sizing approach is best applied when using a continuous simulation hydrologic model to demonstrate that a treatment system complies C.3.d. However, when doing sizing calculations by hand, compliance with C.3.d. can be demonstrated by showing how the treatment system design meets both the flow-based and volume-based criteria.

To apply the combination flow and volume approach, use the following steps, which may be performed using the combination flow and volume sizing criteria Excel worksheet provided in **Appendix C**.

Follow steps 1-3 first, the same procedure as to size volume-based treatment measures (**Section 7.1.1**).

4. Duration of Rain Event

- Assume that the rain event that generates the required capture volume of runoff determined in Step 3 occurs at a constant rainfall intensity of 0.2 inches/hour from the start of the storm (i.e., assume a rectangular hydrograph). Calculate the duration of the rain event by dividing the unit basin storage volume by the intensity. In other words, determine the amount of time required for the unit basin storage volume to be achieved at a rate of 0.2 inches/hour. For example, if the unit basin storage volume is 0.5 inches, the rain event duration is 0.5 inches ÷ 0.2 inches/hour = 2.5 hours.

5. Preliminary Estimate of the Surface Area of the Facility

- Make a preliminary estimate of the surface area of the bioretention facility by multiplying the DMA’s impervious area (or effective impervious surface if applicable) by the 4 percent method sizing factor of 0.04. For example, a drainage area of 7,000 square feet of impervious surface × 0.04 = 280 square feet of bioretention treatment area.

6. Assume a bioretention area that is about 25% smaller than the bioretention area calculated with the 4 percent method. Using the example above, 280 – (0.25 × 280) = 210 square feet.

- Calculate the volume of runoff that filters through the biotreatment soil at a rate of 5 inches per hour (the design surface loading rate for bioretention facilities), for the duration of the rain event calculated in Step 4. For example, for a bioretention treatment area of 210 square feet, with an infiltration rate of 5 inches per hour for a duration of 2.5 hours, the volume of treated runoff = 210 square feet × 5 inches/hour × (1 foot/12 inches) × 2.5 hours = 219 cubic feet. (Note: when calculating ponding depth, the mulch layer is not included in the calculation.)

7. Initial Adjustment of Depth of Surface Ponding Area

- Calculate the portion of the required capture volume remaining after treatment is accomplished by filtering through the treatment soil. The result is the amount that must be stored in the ponding area above the reduced bioretention area assumed in Step 6. For example, the amount remaining to be stored comparing Step 3 and Step 5 is 292 cubic feet – 219 cubic feet = 73 cubic feet. If this volume is stored over a surface area of 210 square feet, the average ponding depth would be 73 cubic feet ÷210 square feet = 0.35 feet or 4.2 inches.

- Check to see if the average ponding depth is between 6 and 12 inches, which is the recommended allowance for ponding in a bioretention facility or flow-through planter.

8. Optimize the Size of the Treatment Measure

- If the ponding depth is greater than 12 inches, a larger surface area will be required. (In the above example, the optimal size of the bioretention area is 190 square feet with a ponding depth of 6 inches.) In order to build conservatism into this sizing method, the Clean Water Program recommends that municipalities not approve the design of any bioretention areas or rain gardens that have a surface area that is less than 3 percent of the effective impervious area within the DMA.

In addition to the Excel worksheet for performing the above calculations, **Appendix C** includes an example of sizing bioretention areas using the combination flow- and volume-based method.

7.2 APPLICABILITY OF NON-LOW IMPACT DEVELOPMENT (LID) TREATMENT

Only Special Projects are allowed some limited use of non-LID treatment measures for stand-alone treatment of stormwater. Special Projects, as defined in **Appendix J**, are allowed to treat specified percentages of the C.3.d amount of stormwater runoff with vault-based media filters or tree well biofilters that have a high flow rate. See **Appendix J** for additional guidance on Special Projects.

Underground vault-based, non-LID treatment measures typically require frequent maintenance to function properly, and experience has shown that because these systems tend to be "out of sight, out of mind," they often do not receive adequate maintenance. Where underground vaults are allowed, they must be sealed to prevent mosquito access and include suitable access doors and hatches to allow for frequent inspections and maintenance. But even when maintained properly, some types of underground vault systems lack the detention time required to remove pollutants associated with fine particles*.* See **Appendix E** for more information regarding inlet filters, oil/water separators, hydrodynamic separators, and media filters.

7.3 TRASH CONTROL GUIDANCE

The MRP and the Statewide Trash Amendments[6] prohibit the discharge of trash to the storm drain system or surface waters. To meet the trash control requirements, local agencies may require development and redevelopment projects located in moderate, high, and very high trash generation areas to install trash controls, known as full trash capture systems, as part of the post-construction stormwater controls.

The trash controls must meet the design criteria identified below and be selected from the list of full capture systems or multi-benefit trash treatment systems certified by the State Water Board.[7] Similar to other stormwater treatment controls, once constructed and implemented, the trash controls must be operated and maintained consistent with the manufacturer's specifications, requirements as specified by the local jurisdiction, and requirements specified by the State Water Board in the certification.[8] Full trash capture systems should be incorporated into the projects Operations and Maintenance Program.

7.3.1 Full Trash Capture Devices

A full trash capture device is a treatment control, or series of treatment controls, that include a multi-benefit trash treatment system or a LID control that meets the design criteria and operations and maintenance requirements. Full trash capture device must be designed to trap all particles that are 5 mm or greater, and have a design treatment capacity that is either:

a. Of not less than the peak flow rate, Q, resulting from a region-specific 1-year, 1-hour, storm in the subdrainage area, or
b. Appropriately sized to, and designed to carry at least the same flows as, the corresponding storm drain.

The rational method equation is used to compute the peak flow rate: Q = CiA

Q = design flow rate (cubic feet per second, cfs)

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[6] Amendment to the Water Quality Control Plan for Ocean Waters of California to Control Trash and Part 1 Trash Provision of the Water Quality Control Plan for Inland Surface Waters, Enclosed Bays, and Estuaries (ISWEBE Plan). Together, they are collectively referred to as the "Statewide Trash Amendments https://www.waterboards.ca.gov/water_issues/programs/stormwater/trash_implementation.html.

[7] See the current lists https://www.casqa.org/resources/trash/certified-full-capture-system-trash-treatment-control-devices.

[8] The current design and operations and maintenance criteria are provided by the State Water Board and can be found here https://www.waterboards.ca.gov/water_issues/programs/stormwater/trash_implementation.html.

C = runoff coefficient (unitless – see **Table 7-3.**)

I = design rainfall intensity (inches per hour)

A = subdrainage area (acres)

In addition, the installation shall be designed according to the following criteria:

a. Does not bypass trash below the design storm under maximum operational loading conditions; and
b. Does not have a diversion structure present upstream such that a portion of the peak flow is not treated to trap all particles 5 mm or greater.

7.3.2 Multi-Benefit Trash Treatment Systems

A stormwater treatment facility implemented in accordance with Provision C.3 is also deemed a full capture system if the facility, including its maintenance, prevents the discharge of trash to the downstream storm drainage system and receiving waters and discharge points from the facility, including overflows, are appropriately screened or otherwise configured to meet the full trash capture screening specification for storm flows up to the full trash capture one-year, one-hour storm hydraulic specification. These systems are referred to as multi-benefit trash treatment system (MBTTS). MBTTS may be considered a full trash capture device so long as it meets the design criteria as well as criteria for operations and maintenance. Certified MBTTS must be designed, installed, and maintained to perform in accordance with the following:

1. A MBTTS shall be designed and maintained to trap trash particles that are 5 mm or greater for the following:
    a. The peak flow rate generated by the region specific 1-year, 1-hour storm event from the applicable sub-drainage area; or
    b. The peak flow rate of the corresponding storm drain (if corresponding storm drain is designed for less than the peak flow rate generated from a 1-year, 1-hour storm event).

- MBTTS may include either or both of the following to trap trash particles for either flow described above in section 1.a or 1.b:
    c. A screen at the system's inlet, overflow, or bypass outlet; or
    d. An upgradient structure designed to bypass flows exceeding the flows described above in section 1.a or 1.b.
- The peak flow rates referenced in section 1.a, above, shall be calculated using one of the following methods:
    e. For small drainage areas (generally less than 50 acres) – the Rational Equation Method (Q = CIA)
    f. For large drainage areas (~50 acres or more) other accepted hydrologic mathematical methods are allowed that more accurately calculate peak flow rates from large drainage areas.

- A MBTTS design shall be stamped and signed by a registered California licensed professional engineer as required by California Business & Profession Code sections 6700, et seq.

As of the writing of this update the State Water Board has certified the following types of MBTTS:

- Bioretention;
- Capture and Use Systems;
- Detention Basin;
- Infiltration Trench or Basin; and
- Media Filter.

Detailed information on these MBTTS and those certified at later dates may be found at https://www.waterboards.ca.gov/water_issues/programs/stormwater/trash_implementation.html, see the Certified Multi Benefit Trash Capture Systems link.

7.4 USING TREATMENT TRAINS

What Is A Treatment Train?

A treatment train is a multiple treatment system that uses two or more stormwater treatment measures in series, for example, a settling basin/infiltration trench combination.

Stormwater can be directed to flow through a series of different types of stormwater treatment measures that are each designed to treat different broad categories of stormwater pollutants. These groupings of stormwater treatment measures have been called "stormwater treatment trains" or a "multiple treatment system." The use of a series of treatment measures is most effective where each treatment measure optimizes the removal of a particular type of pollutant, such as coarse solids and debris, pollutants associated with fine solids, and dissolved pollutants. Targeting specific treatment processes by constituent is referred to as "unit process" design. Each stormwater treatment measure in a treatment train should be sized using the MRP Provision C.3.d numeric sizing criteria.

The simplest version and most common use of a treatment train consists of pretreatment prior to the stormwater reaching the main treatment system. For example, bioretention areas may use vegetated buffer strips to settle out sediment before the stormwater enters the bioretention area. This type of pretreatment helps prevent sediment from clogging the bioretention area, which maximizes its life. Another example is when a hydrodynamic separator is used to remove trash and coarse sediment upstream of a media filter or subsurface infiltration system. Note that non-LID treatment measures may be used in the treatment train provided that the last measure in the train is an LID treatment measure.

Another option for a treatment train is to provide upstream storage for a treatment measure, which may allow the treatment measure to be reduced in size. For example, a rainwater cistern may be used to store and slowly release water to a bioretention facility. Conversely, the bioretention facility can be used to treat the overflow from the cistern if there is insufficient irrigation or toilet flushing demand to empty the cistern prior to the next rain event.

7.5 INFILTRATION GUIDELINES

Infiltration is prioritized by the MRP, and it can be a very cost-effective method to manage stormwater if the conditions on your site allow infiltration. A wide-range of site design measures and stormwater treatment measures can be used to increase stormwater infiltration and can be categorized as follows:

- ***Site design measures*** such as clustering development or otherwise laying out the site to reduce impervious area, routing drainage from building roofs to landscaped areas, and using pervious pavement.
- ***Indirect infiltration methods*** that allow stormwater runoff to percolate into surface soils. Runoff may reach groundwater indirectly, or it may be under-drained into subsurface pipes. Bioretention is an example of indirect infiltration. Unless geotechnical considerations preclude it, all projects should maximize infiltration of stormwater runoff through methods such as raising the underdrain in unlined bioretention areas (see **Section 8.1**).
- ***Direct infiltration methods*** are designed to bypass surface soils and transmit runoff directly to subsurface soils, may allow infiltration to groundwater. These types of devices must be located and designed to limit the potential for stormwater pollutants to reach groundwater. Deep infiltration trenches are an example of a direct infiltration method.

The local jurisdiction may require a geotechnical review for your project, or, at a minimum, information regarding the site's hydrologic soil type. When selecting site design and stormwater treatment measures that promote on-site infiltration, be sure to follow the geotechnical engineer's recommendations based on soil boring data, drainage pattern, and the current requirements for stormwater treatment. The geotechnical engineer's input will be critical to prevent infiltrating water from damaging surrounding properties, structures and/or public improvements.

Appendix F provides additional information to help you determine whether your project site is suitable for using site design and/or stormwater treatment measures that increase stormwater infiltration. **Appendix F** also describes regulatory requirements that apply to direct infiltration methods, as well as practical tips for design and construction.

7.6 UNDERDRAINS IN BIOTREATMENT MEASURES

Where the existing soils have a lower infiltration rate than soils specified for a landscaped-based stormwater treatment measure, or biotreatment measure, it may be necessary to install an underdrain to allow the treatment measure to function as designed and prevent the accumulation of standing water.

Underdrains are perforated to allow water to enter the pipe and flow to the storm drain system. To help prevent clogging, two rows of perforation may be used, and should be installed facing downward. Cleanouts should be installed to allow access to underdrains to remove clogs.

Do not wrap underdrains in filter fabric. Underdrains are typically installed in a layer of washed drain rock or Class 2 perm aggregate, beneath high-percolation stormwater biotreatment soils.

Where conditions allow, place the underdrain near the top of the underlying rock layer, to promote infiltration, as shown in technical guidance for specific stormwater treatment measures in **Chapter 8**.

7.7 TECHNICAL GUIDANCE FOR LOW-FLOW SYSTEMS

Although stormwater treatment measures are sized to remove pollutants from flows resulting from frequent, small storms, projects must be designed to handle flows for stormwater treatment and drainage from large infrequent flows to prevent flooding. The integration of flood control and stormwater treatment may be accomplished in one of two ways, which are described below.

One option is to have the flows that are larger than those required by the hydraulic sizing criteria (given in **Section 0**) handled within the stormwater treatment measure. However, the design should ensure that treatment measures do not re-suspend and flush out pollutants that have been accumulating during small storms, and that stormwater treatment measures do not erode during flows that will be experienced during larger storms. Some treatment measures may be designed to handle flood flows, although they would not be providing much treatment during these flows. The guidance in **Chapter 8** for treatment measures that operate in this manner includes design standards to accommodate flood flows associated with larger storms.

Bioretention areas, flow-through planter boxes, and other treatment systems that rely on filtering or infiltrating stormwater through soils must have overflow systems that allow flood flows larger than the increment of flow that can be treated to bypass the stormwater treatment measure. The guidance in **Chapter 8** for treatment measures that operate in this manner includes design standards for overflow drains or high-flow bypasses.

Another option is to restrict stormwater flows to the treatment measure or bypass high flows around the treatment measure. Since stormwater treatment measures are generally designed to treat only the water from small storm events, bypassing larger flows helps prevent hydraulic overload and resuspension of sediment, and it can also protect stormwater treatment measures from erosion.

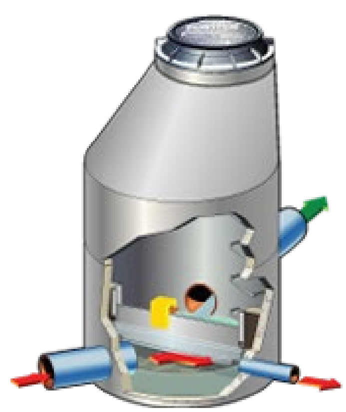

Figure 7-2. StormGate™ Flow Splitter Structure.

Note: Use of this illustration is for general information only and is not an endorsement of this or any other proprietary device.

Source: Contech Construction Products Inc.

Flow splitter devices may be used to direct the design runoff flow into a stormwater treatment measure, and bypass excess flows from larger storm events around the facility into a bypass pipe or channel. The bypass may connect directly to the storm drain system, or to another stormwater treatment measure that is designed to handle high flows. This can be accomplished using a stepped utility access hole or a proprietary flow splitter. Runoff enters the device by way of the inlet at the left side; low flows are conveyed to the stormwater treatment measure by way of the outlet pipe at the lower right. Once the treatment measure reaches its design capacity, water backs up in the low-flow outlet pipe and into the flow splitter. When the water level in the flow splitter reaches the bypass elevation, stormwater begins to flow out the overflow pipe, shown at the upper right bypassing the stormwater treatment measure. The bypass generally functions by means of a weir inside the flow splitter device.

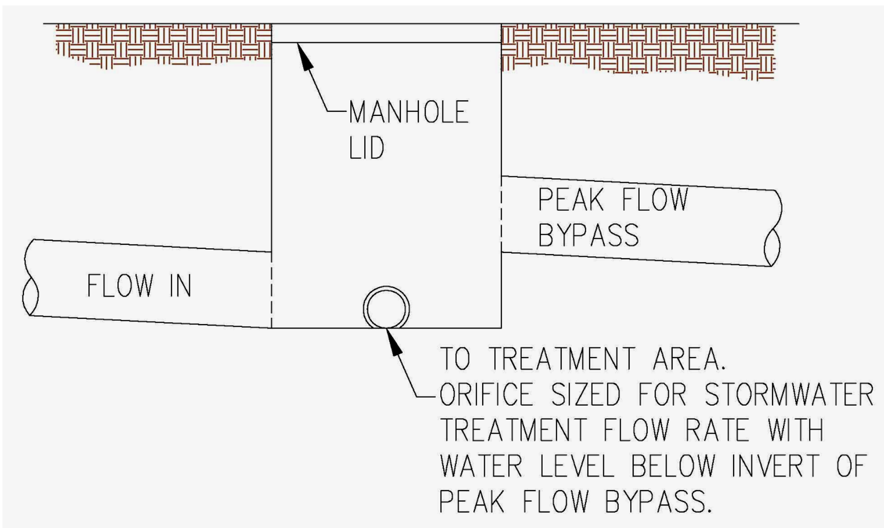

Figure 7-3. Stepped Manhole Design.

Note: A stepped manhole design directs low-flows to treatment measure and diverts high flows to storm drain system. Source: BKF Engineers

7.8 PLANT SELECTION AND MAINTENANCE

Selecting the appropriate plants and using sustainable, horticulturally sound landscape design and maintenance practices are essential components of a successful landscape-based stormwater treatment measure.

7.8.1 Plant Selection and Spacing Guidance

Plant selection must consider the type of development and location, uses on the site and an appropriate design aesthetic. Ideally, a Landscape Architect familiar with the unique nature of biotreatment soil and function of biotreatment facilities as well as the local microclimate of the project, will be involved as an active member of the design team early in the site design phase to review proposed stormwater measures and coordinate development of an integrated solution that responds to all the various site goals and constraints. In some cases, one professional will design a stormwater control, while another designs the rest of the landscaping. In these situations, it is critical for the professionals to work together very early in the process to integrate their designs.

Biotreatment facilities have sloped edges and are designed for varying slopes and ponding levels. Plants in the bottom area (Zone A) will be inundated during storms, while those planted on the side slopes (Zone B) are above the level of ponding but will experience seasonally wet conditions, see **Figure 7-4**Error! Reference source not found. (Central Coast LIDI, 2016).

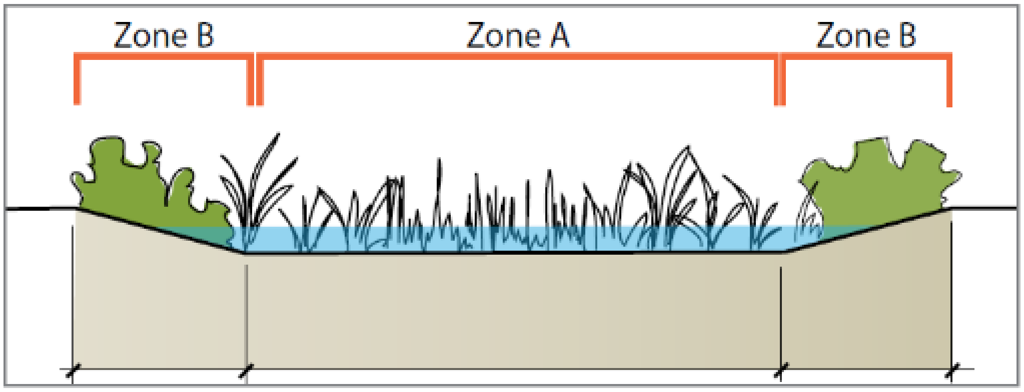

Figure 7-4. Biotreatment Planting Area
Source: Central Coast LID Initiative

Relatively few plant species can tolerate prolonged saturation in winter and prolonged drought during summer months (Fox, 2019) necessitating the careful selection of plants for biotreatment facilities. Plants native to seasonally wet grasslands in the Central Valley and dry washes of the desert southwest. While this approach reduces the overall biodiversity of biotreatment facilities, it could significantly reduce irrigation requirements while also improving aesthetics with greener, healthier plants. (Geosyntec, 2021) Plants used in biotreatment facilities should have the following criteria:

- Heat tolerant
- Low to very low water needs
- Not trees, large shrubs, or vines (unless in a system specifically adapted for trees)
- Not invasive weeds or species with aggressive or invasive root systems
- Not frost-tender
- Not annual nor deciduous species

To benefit plant health as well as prevent overgrowth of the biotreatment system[9] wider plant spacing than typically used for landscape plantings should be considered. Wider plant spacing can improve nutrient uptake and allow for more plant available water (PAW) per plant. One drawback of wider spacing is the potential for more weed growth, however, in irrigated biotreatment facilities this can be mitigated using drip irrigation that only supplies irrigation to intentional plants and by using appropriate mulch cover. (Geosyntec, 2021).

[9] Overgrowth can impede the function of the system by impeding runoff flow into and through the system and use up ponding availability as well as increase maintenance costs.

Appendix B provides guidance in selecting planting appropriate to the landscape-based stormwater treatment measures included in **Chapter 8**, while **Appendix K** provides biotreatment soil mix installation guidance.

7.8.2 Bay Friendly Landscaping

Bay-friendly landscaping is a whole systems approach to the design, construction, and maintenance of the landscape to support the integrity of the San Francisco Bay watershed. Project sponsors are encouraged to use landscape professionals who are familiar with and committed to implementing Bay-Friendly landscaping practices from the initial plant selection through the long-term maintenance of the site. **Appendix B** summarizes Bay Friendly Landscaping Practices that may be implemented to benefit water quality of the Bay and its tributaries, based on the Bay-Friendly Landscaping Guidelines (available at https://www.stopwaste.org/resource/brochures/bay-friendly-landscape-guidelines-sustainable-practices-landscape-professional).

7.8.3 Integrated Pest Management

Integrated pest management (IPM) is a holistic approach to mitigating insects, plant diseases, weeds, and other pests. Projects that require a landscaping plan as part of a development project application are encouraged to use IPM, as indicated in each local jurisdiction's source control measures list. Avoiding pesticides, including herbicides, and quick release synthetic fertilizers is particularly important when maintaining stormwater treatment measures to protect water quality.

IPM encourages the use of many strategies for first preventing, and then controlling, but not eliminating, pests. It places a priority on fostering a healthy environment in which plants have the strength to resist diseases and insect infestations, and out-compete weeds. Using IPM requires an understanding of the life cycles of pests and beneficial organisms, as well as regular monitoring of their populations. When pest problems are identified, IPM considers all viable solutions and uses a combination of strategies to control pests, rather than relying on pesticides alone. The least toxic pesticides are used only as a last resort. More information on IPM is included in **Appendix B**.

7.8.4 Wetland Regulations and Treatment Measures

The Water Board's "Policy on the Use of Constructed Wetlands for Urban Runoff Pollution Control" (Resolution No. 94-102) recognizes that stormwater treatment wetlands that are constructed and operated pursuant to Resolution 94-102 and are constructed outside a creek or other receiving water are stormwater treatment systems, and, as such, properly maintained stormwater treatment measures are not waters of the United States subject to Sections 401 and 404 of the federal Clean Water Act.

7.8.5 Water Efficient Landscaping Requirements

The California Water Conservation in Landscaping Act of 2010, and the 2015 amendments of Title 23, California Code of Regulations, Chapter 2.7 Model Water Efficient Landscape

Ordinance, Sections 490 through 495, required municipalities to adopt, by December 1, 2015, landscape water conservation ordinances that are at least as effective in conserving water as the 2015 update of the Model Water Efficient Landscape Ordinance prepared by the Department of Water Resources. The Model Ordinance automatically went into effect, on December 1, 2015, for individual municipalities that had not adopted a comparable local ordinance. For local land use agencies working together to develop a regional water efficient landscape ordinance, the reporting requirements of Model Ordinance became effective December 1, 2015, and the remainder of this ordinance went into effect February 1, 2016.

The updated Model Ordinance applies to (1) new construction projects with an aggregate landscape area equal to or greater than 500 square feet requiring a building or landscape permit, plan check or design review; (2) rehabilitated landscape projects with an aggregate landscape area equal to or greater than 2,500 square feet requiring a building or landscape permit, plan check, or design review; (3) existing landscapes that were installed before December 1, 2015, and are over 1 acre in size. The Green Building Code also requires water budgeting for non-residential projects consistent with the Ordinance. Contact the local jurisdiction to determine whether your project is subject to the updated Model Ordinance or other water efficient landscaping ordinance.

7.8.6 Irrigation of Biotreatment Facilities

The special irrigation needs of bioretention facilities, flow-through planters, and other stormwater treatment facilities that use biotreatment soil, must be considered in the system design. Biotreatment soil holds limited amounts of water due to the sand content of the media. Bioretention facilities need to receive more frequent but shorter duration irrigation than other landscaped areas to avoid water waste. Provide separate irrigation control for bioretention areas, flow-through planters, and other stormwater treatment measures that use biotreatment soil. Specify weather-based irrigation controllers, sometimes called “smart” irrigation controllers, which use soil moisture sensors to signal the irrigation controller. Drip emitters should be used instead of spray irrigation.

Inspections should be conducted on an ongoing basis, including cleaning, and adjusting all drip emitters, valves, and sprinkler and bubbler heads, for proper coverage. Inspections should include monitoring the irrigation system while operating to identify and correct problems with excess irrigation overflow or standing water. More information regarding irrigation is provided in **Appendix B**.

7.9 MOSQUITO CONTROL

Some types of stormwater treatment measures are designed to hold water, and even treatment measures that are designed to eliminate standing water between storms may have the potential to retain standing water if they are not properly designed, constructed, and maintained.

> Treatment measure designs and maintenance plans must include mosquito control design and maintenance strategies included in **Appendix G**.

To reduce the potential for stormwater treatment measures to lead to mosquito problems, the Clean

Water Program developed a Vector Control Plan, which describes the need to include physical access for mosquito control staff to monitor and treat mosquitoes and includes guidance for designing and maintaining stormwater treatment measures to control mosquitoes. The Alameda County Mosquito Abatement District has identified a 72-hour maximum allowable water retention time for stormwater treatment facilities. Except for certain stormwater treatment measures designed to hold permanent water (e.g., CDS units and wet ponds), all treatment measures need to drain completely within 72 hours to effectively suppress vector production. Please note that the design of stormwater treatment measures does not require that water be standing for 72 hours. During 72-hour period following a rain event, standing water is allowable but not required for the stormwater treatment measure to function effectively. Treatment measure designs and maintenance plans must include mosquito control design and maintenance strategies from the Vector Control Plan, included in **Appendix G**.

7.10 INCORPORATING HYDROMODIFICATION MANAGEMENT

In addition to requiring stormwater treatment, the MRP requires that stormwater runoff be detained and released in a way that prevents increased creek channel erosion and siltation in susceptible areas. The amount of stormwater flow and the duration of flows that cause erosion must be limited to match the flow and duration prior to the proposed development or re-development. These hydromodification management (HM) requirements apply to projects that create one acre or more of impervious surface in most areas of Alameda County. See Chapter 9 for more information.

The HM requirements have been in effect since 2007 and may be required in addition to stormwater treatment, LID, and flood control requirements (if any). To prevent hydromodification, HM facilities are designed to match pre-project flow durations for a range of flows from 10 percent of the two-year storm peak flow up to the ten-year storm peak flow. This is different from the sizing criteria that are used for stormwater treatment and LID measures, and from the design criteria used for flood control facilities.

Figure 7-5. Detention pond in Pleasanton provides hydromodification management.

To help applicants meet the HM requirements, the Clean Water Program developed the Bay Area Hydrology Model (BAHM) with assistance from the municipal stormwater programs in Santa Clara and San Mateo Counties. You can use the BAHM to automatically size stormwater detention measures such as detention vaults, tanks, basins, and ponds for Flow Duration Control of post-project runoff. **Chapter 9** provides more detail on HM requirements, and provides links to the BAHM.

7.11 GETTING WATER INTO TREATMENT MEASURES

Stormwater may be routed into stormwater treatment measures using sheet flow or curb cuts. The following pages from the San Mateo County Sustainable Green Streets and Parking Lots Design Guidebook show common curb cut types. An 18-inch width at bottom of curb is recommended for curb cuts, to avoid clogging. To avoid erosion, cobbles or other energy dissipaters are recommended. A minimum two-inch drop in grade between the impervious surface and the finish grade of the stormwater treatment facility is recommended. This drop in grade needs to take into consideration the height of any vegetation.

7.11.1 Standard Curb Cut: Design Guidance

- Opening should be at least 18 inches wide; for smaller facilities a 12-inch width may be allowed subject to municipal approval.
- Curb cut can have vertical sides or chamfered sides at 45 degrees (as shown).
- Works well with relatively shallow stormwater facilities that do not have steep side slope conditions.
- Need to slope the bottom of the concrete curb toward the stormwater facility.

- Allow a change in elevation of 4 to 6 inches between the paved surface and biotreatment soil elevation, so that vegetation or mulch build-up does not obstruct flow.
- Provide cobbles or other energy dissipater to prevent erosion.

Figure 7-6 Cobbles are placed at the inlet to the stormwater treatment measure to help prevent erosion.

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Figure 7-7. Standard Curb Cut.

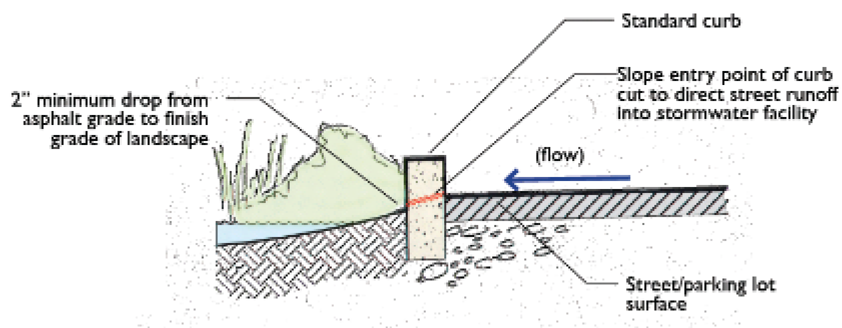

Figure 7-8. Standard Curb Cut: section view.

Source: San Mateo Countywide Water Pollution Prevention Program [SMCWPPP] 2009

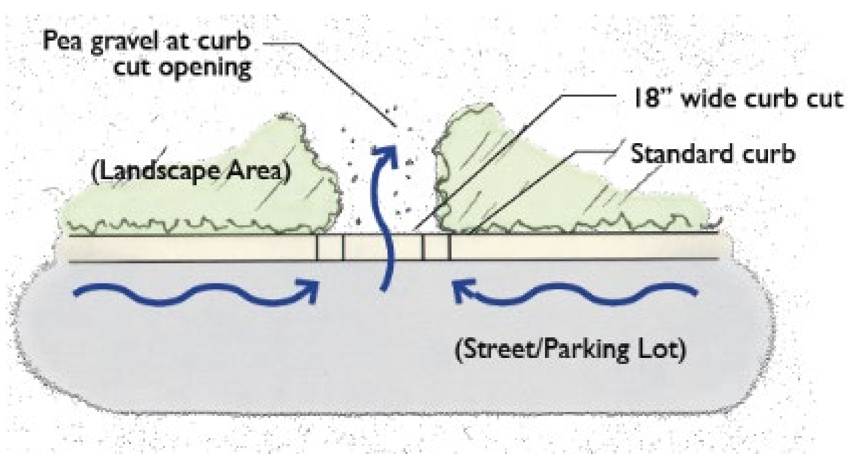

Figure 7-9. Standard Curb Cut: plan view.

Source: SMCWPPP 2009

7.11.2 Standard Curb Cut with Side Wings: Design Guidance

- Opening should be at least 18 inches wide; for smaller facilities a 12-inch width may be allowed subject to municipal approval.
- Works well with stormwater facilities that have steeper side slope conditions.
- Need to slope the bottom of the concrete curb toward the stormwater facility.
- Allow a change in elevation of 4 to 6 inches between the paved surface and biotreatment soil elevation, so that vegetation or mulch build-up does not obstruct flow.
- Provide cobbles or other energy dissipater to prevent erosion.

Figure 7-10. The side wings of this standard curb cut help retain the side slope grade on each side of the curb cut opening.

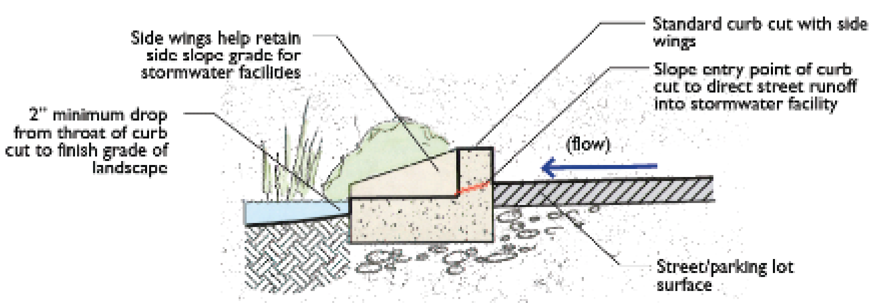

Figure 7-11. Standard Curb Cut with Side Wings: cut section view.

Source: SMCWPPP 2009

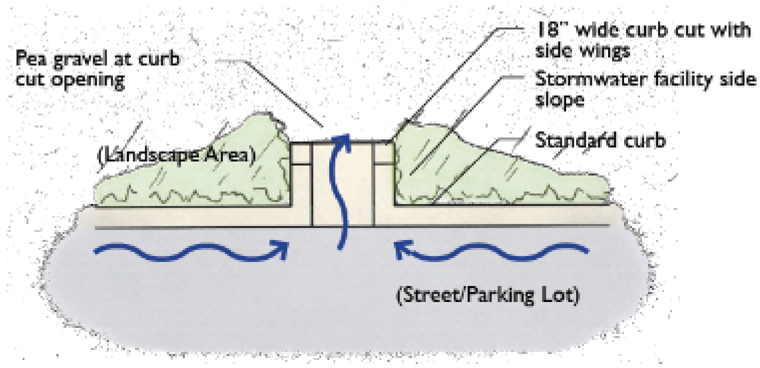

Figure 7-12. Standard Curb Cut with Side Wings: plan view.
Source: SMCWPPP 2009

7.11.3 Wheelstop Curbs: Design Guidance

- Wheelstops allow water to flow through frequently spaced openings.
- Wheelstops are most common in parking lot applications, but they may also be applied to certain street conditions.
- Need to provide a minimum of 6 inches of space between the wheelstop edge and edge of paving. This is to provide structural support for the wheelstop.
- Allow a change in elevation of 4 to 6 inches between the paved surface and biotreatment soil elevation, so that vegetation or mulch build-up does not obstruct flow.
- Provide cobbles or other energy dissipater at the wheel stop opening to prevent erosion.

Figure 7-13. Stormwater runoff enters the stormwater facility through the 3-foot space between these wheelstops. The design could be improved by providing more of a drop in grade between the asphalt and landscape area.

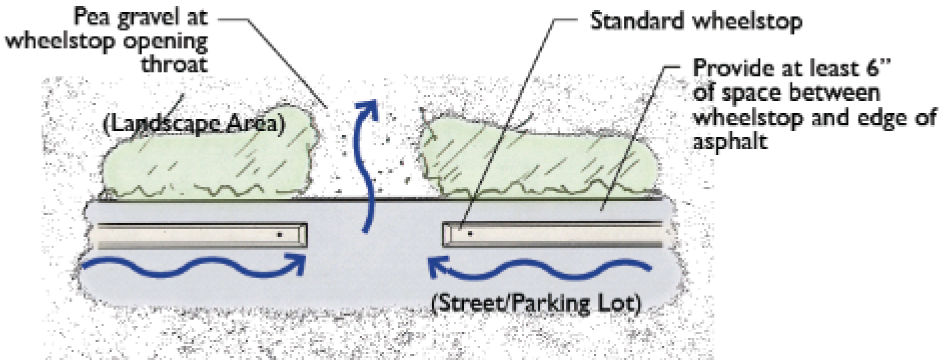

Figure 7-14. Opening between Wheelstop Curbs: plan view.

Source: SMCWPPP 2009

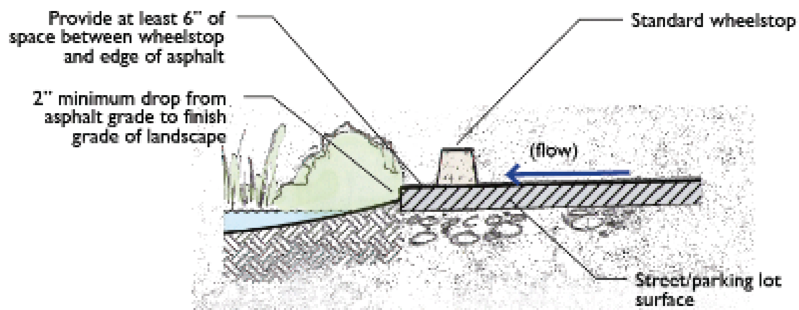

Figure 7-15. Opening between Wheelstop Curbs: section view

Source: SMCWPPP 2009

7.11.4 Grated Curb Cut: Design Guidance

- Grated curb cuts allow stormwater to be conveyed under a pedestrian walkway. The curb cut opening should be at least 18 inches wide; a 12-inch width may be allowed for smaller facilities subject to municipal approval.
- Grates need to be Americans with Disabilities Act (ADA) compliant and have sufficient slip resistance.
- A 1-to-2-inch-high asphalt or concrete berm should be placed on the downstream side of the curb cut to help direct runoff into the curb cut.
- Allow a change in elevation of 4 to 6 inches between the paved surface and biotreatment soil elevation, so that vegetation or mulch build-up does not obstruct flow.

Figure 7-16. A grated curb cut allows stormwater to pass under a pedestrian egress zone to the stormwater facility.

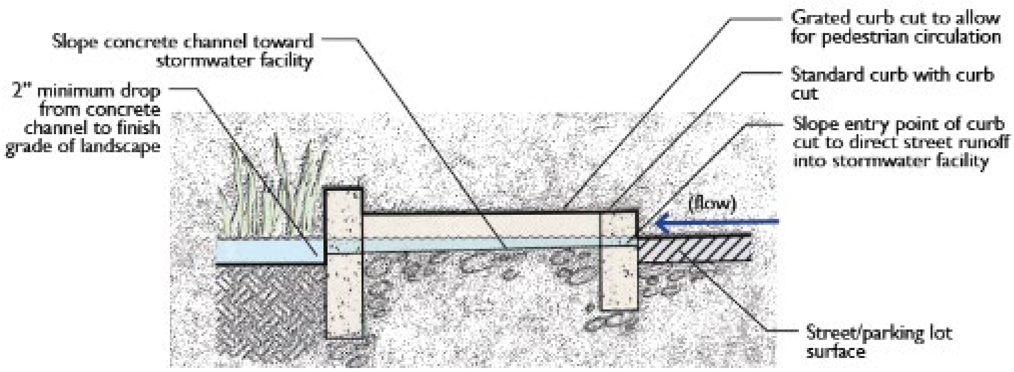

Figure 7-17. Grated Curb Cut: section view.

Source: SMCWPPP 2009

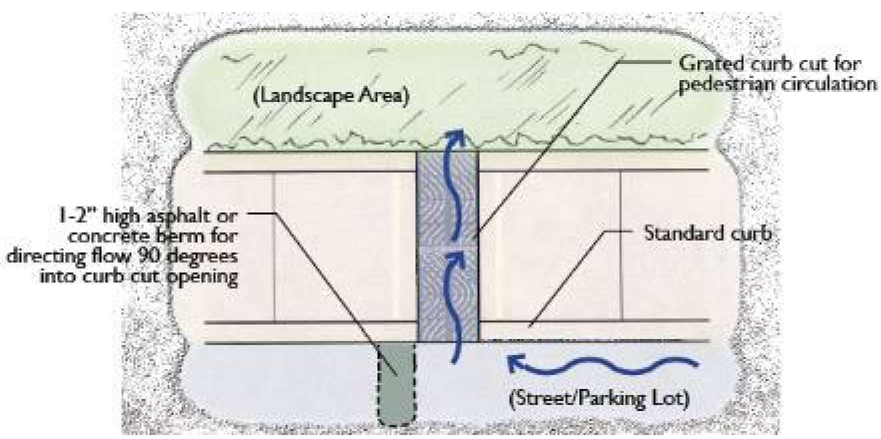

Figure 7-18. Grated Curb Cut: plan view.

Source: SMCWPPP 2009

8 TECHNICAL GUIDANCE FOR SPECIFIC TREATMENT MEASURES

Technical guidance is provided for stormwater treatment measures commonly used in Alameda County.

Guidance in this chapter is intended to assist you in preparing project permit application submittals. Municipalities will require permit applications to include specific drawings that address project site conditions, materials, plumbing connections, etc. This technical guidance was prepared using best engineering judgment and based on a review of various regional documents.

Table 8-1. Stormwater Measures

Treatment Measures	Section
Bioretention Area	8.1
Flow-Through Planter	8.2
Tree Well Filter	8.3
Infiltration Trench	8.4
Extended Detention Basin	8.5
Pervious Pavement	8.6
Grid Pavements	8.7
Green Roofs	8.8
Rainwater Harvesting And Use	8.9
Media Filter	8.10
Extended Detention (Subsurface)	8.11
Suspended Pavement Systems	8.12

The construction of biotreatment and infiltration systems requires care to protect the integrity of the system and the infiltration capacity of the underlying soil. The following precautions need to be implemented for all biotreatment systems.

- When excavating, avoid spreading soil fines on the bottom and side slopes. Remove any smeared soiled surfaces and provide a natural soil interface into which water may percolate. All debris should be removed from the excavation (e.g., concrete, or other construction debris) prior to soil scarification.

- Minimize compaction of existing soils. Protect from construction traffic and always keep heavy equipment off facility footprint.
- Protect the area from construction site runoff. High sediment loads from unstabilized areas will quickly clog biotreatment systems. Runoff from unstabilized areas must be diverted away from the facilities. Protect integrity of biotreatment soil media (BSM), drainage rock, and other materials prior to installation.

All stormwater treatment systems must be maintained to ensure the ongoing operation and function of the systems. The requirements for development and submittal of a maintenance plan and Maintenance Agreement are provided in **Chapter 10**. Maintenance considerations for stormwater treatment measures are provided in each factsheet.

8.1 BIORETENTION/BIOINFILTRATION AREA

Figure 8-1. Bioretention Area, Fremont

Best Uses

- Any type of development
- Drainage area up to 2 acres
- Landscape design element

Advantages

- Detains low flows
- Landscape feature
- Low maintenance
- Reliable once established

Limitations

- Not appropriate where soil is unstable
- Requires irrigation
- Susceptible to clogging – especially if installed prior to construction

Bioretention and bioinfiltration areas function as soil and plant-based filtration devices that remove pollutants through a variety of physical, biological, and chemical treatment processes. These facilities normally consist of a ponding area, organic layer or mulch layer, planting soil, and plants. These systems are designed to distribute stormwater runoff evenly along a ponding area. Percolation of stored water in the system's engineered soil media with a high rate of infiltration will enter an underlying rock layer, from which water will either percolate into the underlying soil or enter the underdrain, so that the bioretention area empties over two days. Unless the geotechnical engineer identifies conditions, such as steep slope or a high groundwater table, that would make infiltration unsafe, the system should be designed as a bioinfiltration area to maximize infiltration by raising the underdrain toward the top of the rock layer. Bioretention areas can be any shape, including a linear treatment measure. The guidelines listed below apply to bioretention areas. Additionally, the Example Green Infrastructure (GI) Typical Details, included in **Appendix M-1**, may be used in designing bioretention areas located in the street right of way, subject to approval by the local jurisdiction.

8.1.1 Design and Sizing Guidelines

Drainage area and setback requirements

- Set back from structures 10 feet or as required by structural or geotechnical engineer, or local jurisdiction.
- If the treatment measure is designed to infiltrate stormwater to underlying soils, a minimum 50-foot setback is needed from septic system leach fields. (Check with the local water district or health department for additional setback requirements.)

- The drainage management area (DMA) that drains to the bioretention or bioinfiltration area typically should not exceed 2 acres. If used for a DMA larger than 2 acres, divert high flows away from the facility (see **Section 7.6**), use pretreatment (vegetated filter) to reduce input of sediment, and evaluate the need for a flow spreader to distribute flows throughout the facility.
- There should be one bioretention or bioinfiltration area per DMA.
- The DMA should not contain a significant source of soil erosion, such as high velocity flows over unstabilized soil.
- Areas immediately adjacent to bioretention/bioinfiltration areas should have slopes more than 0.5% for pavement or more than 1% for vegetated areas.
- Bioretention/bioinfiltration facilities work best as one level, shallow basin—or a series of basins (See **Figure 8-2**). Runoff enters each basin and should flood and fill the entire proposed treatment facility before runoff overflows into the outlet or to the next downstream basin. This will help prevent movement of surface mulch and soil mix.[10]

Figure 8-2. Planter on Slope Provides More Storage.

- If the bioretention/bioinfiltration cells cannot be level they can be designed as shown in **Figure 8-3**. Slopes within cells over 4% are not recommended. Consultation with a geotechnical engineer is recommended when the slope of the total facility is over 6%. Key check dams into the slopes as shown in **Figure 8-4**.

Figure 8-3. Bioretention Cells with Check Dams

Note: provides limited storage

- In a linear bioretention area, check dams should be placed for 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. A similar principle applies to bioretention facilities built as terraced roadway shoulders.

[10] **Figures 8.2** through **8-4** and related guidance are from the Contra Costa Clean Water Program. February 2012. C.3 Stormwater Guidebook, 6th Edition and the Stormwater Management Handbook: Implementing Green Infrastructure in Northern Kentucky Communities, 2009. www.epa.gov/smartgrowth/publications.htm)

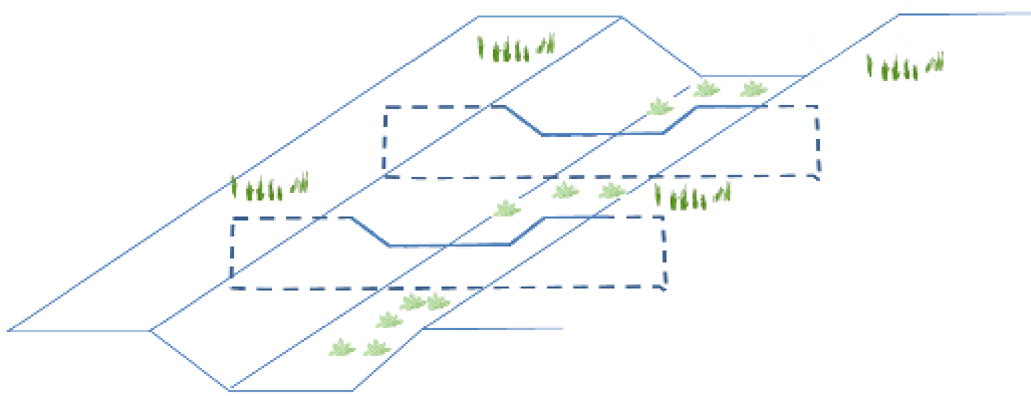

Figure 8-4. Key Check Dams into Bottom and Side Slopes.

Treatment dimensions and sizing

The surface area of bioretention areas should be equal to 4% of the effective impervious area of the drainage management area (DMA). The effective impervious area multiplied by 0.04 sizing factor will equal the footprint of the bioretention area. For sizing purposes, the footprint of the bioretention area is defined as the area that achieves the required ponding depth and that is underlain with 18 inches of the biotreatment soil media (BSM). Instructions for calculating the effective impervious area are provided in **Section 7.1**. Where allowed by the municipality for redevelopment or infill sites, bioretention facilities may be sized using the combination flow- and volume-based method described in **Section 7.1**.

- The elevation of the surface area should be level to distribute stormwater flows throughout the surface area.
- Side slopes of the bioretention area should not exceed 3:1.
- The surface ponding depth may range from 6 to 12 inches, where the surface of the BSM is assumed to be the bottom of the ponding area; there is no adjustment for depth of mulch. The landscape architect should select a planting palette for the desired depth. Check with your local jurisdiction for the maximum ponding depth allowed.
- Install the overflow to the catch basin at the top of the ponding depth.
- If the native soil has a KSAT > 1.6 in/hr, a bioinfiltration area may be sized as described above without an underdrain. Otherwise, use of an underdrain is recommended.

Inlets to treatment measure

- Flow may enter the treatment measure (see example drawings in **Section 7.11**):
    - As overland flow from landscaping (no special requirements)
    - As overland flow from pavement (cutoff wall required)
    - Through a curb opening (minimum 18 inches)
    - Through a curb drain

- With drop structure through a stepped utility access hole
- Through a bubble-up utility access hole or storm drain emitter
- Through roof leader or other conveyance from building roof

- Where flows enter the biotreatment measure, allow a change in elevation of 4 to 6 inches between the paved surface and biotreatment soil elevation, so that vegetation or mulch build-up does not obstruct flow.
- A concrete pad, cobbles or rocks should be installed to dissipate flow energy where runoff enters the treatment measure. The use of a concrete pad may facilitate maintenance as removal of accumulated sediment from cobbles can be difficult.
- Install overflow drains as far as possible from inlets to treatment measure.

Vegetation

- Plant species should be suitable to well-drained soil, and tolerant of prolonged saturation in winter and prolonged drought during summer months. See **Section 7.8** and planting guidance in **Appendix B**.
- Shrubs and small trees should be placed to anchor the bioretention or bioinfiltration area cover.
- Tree planting should be as required by the municipality. If larger trees are selected, plant them at the periphery of bioretention area. A pedestal of native soil below the tree is recommended.
- Underdrain trench should be offset at edge of tree planting zone, as needed, to maximize distance between tree roots and underdrain. Consider installing solid pipe for underdrains in the vicinity of trees, to avoid root intrusion into perforations of the underdrain pipe.
- Use integrated pest management (IPM) and/or Bay-Friendly Landscaping principles in the landscape design to avoid or minimize any use of synthetic pesticides and quick-release fertilizer. Check with the local jurisdiction for any local policies regarding the use of pesticides and fertilizers.
- Drought tolerant plants are preferred. Provide sufficient irrigation to maintain plant life. Provide separate irrigation control for bioretention or bioinfiltration areas. Specify weather-based irrigation controllers, sometimes called “smart” irrigation controllers, which use soil moisture sensors to signal the irrigation controller. Drip emitters should be used instead of spray irrigation (see irrigation guidance in **Appendix B**).
- Make sure that trees and vegetation do not block inflow, create traffic or safety issues, or obstruct utilities.
- Trees should not be planted within lined bioretention areas.

Soil and drainage considerations for bioretention/bioinfiltration systems

- Soils in the bioretention/bioinfiltration area must meet BSM specifications approved by the Regional Water Board (**Appendix K**). A long-term minimum infiltration rate of 5 inches per hour is required (initial infiltration rate may exceed this to allow for tendency of infiltration rate to reduce over time). The BSM layer should be at least 18 inches deep.

- Consider testing the BSM delivered to the project site to verify conformance with the approved BSM specifications. The local jurisdiction may require this verification. BSM test specifications are detailed in **Appendix K**.
- Following installation of the system test the infiltration rate of the system. The local jurisdiction may require this verification. Infiltration testing can be accomplished using the double ring infiltrometer test (ASTM D3385-09) or the soil-tube method.[11]
- An underdrain system is generally required. Depending on infiltration rate of in situ soils, the local jurisdiction may allow installation without an underdrain on a case-by-case basis.
- Consideration of groundwater level and placement of the underdrain:
  - If there is less than a 5-foot separation between the bottom of the facility and the seasonal high groundwater level, or infiltration is not allowed due to other site constraints, an impermeable liner should be placed between the drain rock and the bottom of the facility, and the underdrain placed on top of that liner.
  - If there is at least a 5-foot separation between the bottom of the facility and the seasonal high groundwater level, and geotechnical conditions allow infiltration, the facility should be unlined, and the underdrain should be raised at least 6 inches above the bottom of the drain rock to allow storage and infiltration of treated water.
  - Check with your local water district to determine if a greater separation from the seasonal high groundwater level is required.
- Do not install filter fabric in or around underdrain trench.
- The underdrain should include a minimum 4-inch diameter, schedule 40 perforated pipe (pipe is installed with the perforations facing downward) with cleanouts and connection to a storm drain or discharge point. To help prevent clogging, two rows of perforation may be used. Clean-out should consist of a vertical, rigid, non-perforated polyvinylchloride (PVC) pipe, with a minimum diameter of 4 inches and a watertight cap fit flush with the ground, or as required by municipality.
- There should be adequate fall from the underdrain to the storm drain or discharge point.
- The underdrain trench should include a 12-inch thick layer of Caltrans Standard Section 68-1.025 permeable material Class 2. Virgin rock shall be used in bioretention/bioinfiltration systems.
- Install and maintain a 3-inch layer of undyed “arbor”, “aged” or “composted” mulch on any exposed soil areas between plantings. Mulch Washed and clean pea gravel, decomposed granite, rock, cobble, or other mulches that resist floating may also be used. Gorilla hair bark, ground up tires, and playground fiber mulches should not be used. Only non-dyed

[11] Add details on the soil tube method.

mulch should be used (see Appendix C of the Model Water Efficient Landscape Ordinance[12] (MWELO).

- When using the combination flow and volume method, the surface of the biotreatment soil is assumed to be the bottom of the ponding area; there is no adjustment for depth of mulch.

8.1.2 Common Maintenance Concerns for Bioretention/Bioinfiltration Systems

The primary maintenance requirement for bioretention and bioinfiltration areas is the regular inspection and repair or replacement of the treatment measure's components, to avoid obstructions and clogging. Generally, the level of effort is similar to the routine, periodic maintenance of any landscaped area.

- Maintain vegetation and the irrigation system. Prune and weed, as needed, to keep the bioretention area neat and orderly in appearance.
- On a monthly basis, remove obstructions, debris, accumulated sediment, and trash.
- On a biannual basis (pre- and post-wet season) evaluate the health of plants, remove and replace any dead or diseased vegetation, and till or replace BSM as needed to maintain the design elevation of soil.
- Before and after the wet season, and monthly during the wet season, conduct inspections to assure proper functioning of bioretention area. Items to inspect include:
- Inspect and, if needed, replace mulch before the wet season begins and when erosion is evident or when the area begins to look unattractive. The entire area may need mulch replacement every two to three years, although spot mulching may be sufficient when there are random void areas.
- Inspect area for ponded water. If ponded water does not drain within 72 hours, remove surface soils and replace with BSM. If mosquito larvae are observed, contact the Alameda County Mosquito Abatement District at 510-783-7744. (In Albany, contact the Alameda County Vector Control District, at 510-567-6800.) Inspect inlets for channels, exposure of soils, or other evidence of erosion. Clear any obstructions and remove any accumulation of sediment.
- On an ongoing basis, treat diseased vegetation, as needed, using preventative and low-toxic measures to the extent possible, and replace any dead plants.
- Minimize the use of pesticides and quick-release synthetic fertilizers and follow integrated pest management (IPM)principles. Check with the local jurisdiction for any local policies regarding the use of pesticides and fertilizers.

[12] https://water.ca.gov/Programs/Water-Use-And-Efficiency/Urban-Water-Use-Efficiency/Model-Water-Efficient-Landscape-Ordinance.

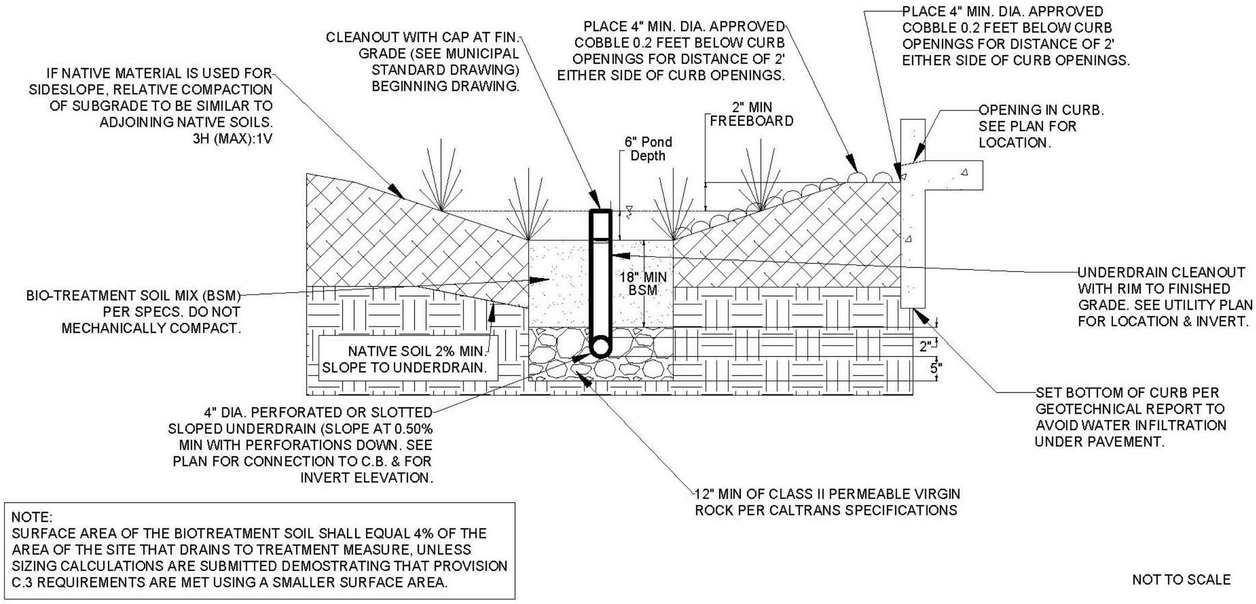

Figure 8-5. Cross Section, Bioretention Area: Showing Inlet from Pavement.
Note: Not to Scale

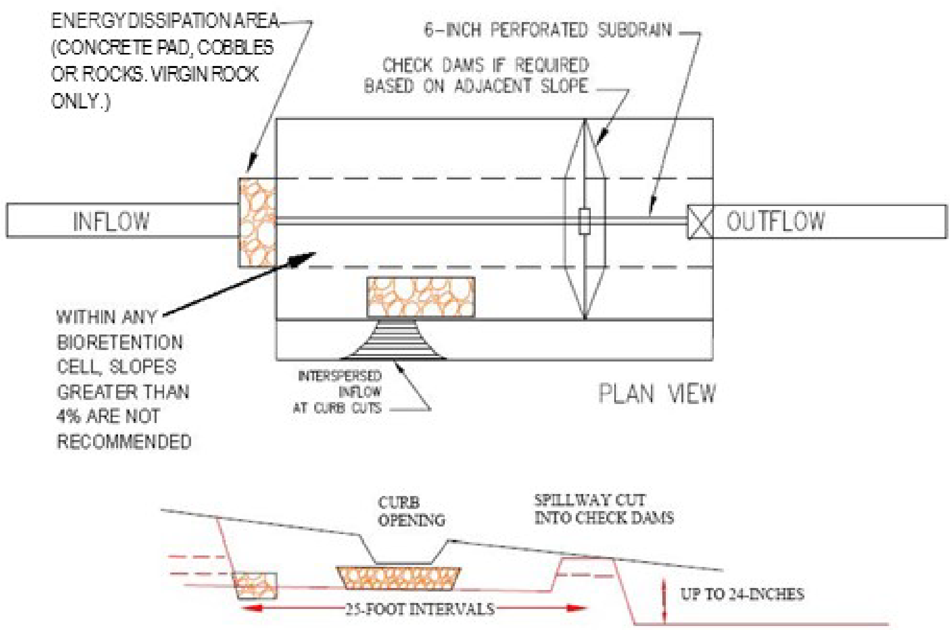

Figure 8-6. Check Dam for Installing a Series of Linear Bioretention Cells in Sloped Area: Plan View and Profile.
Note: Not to Scale

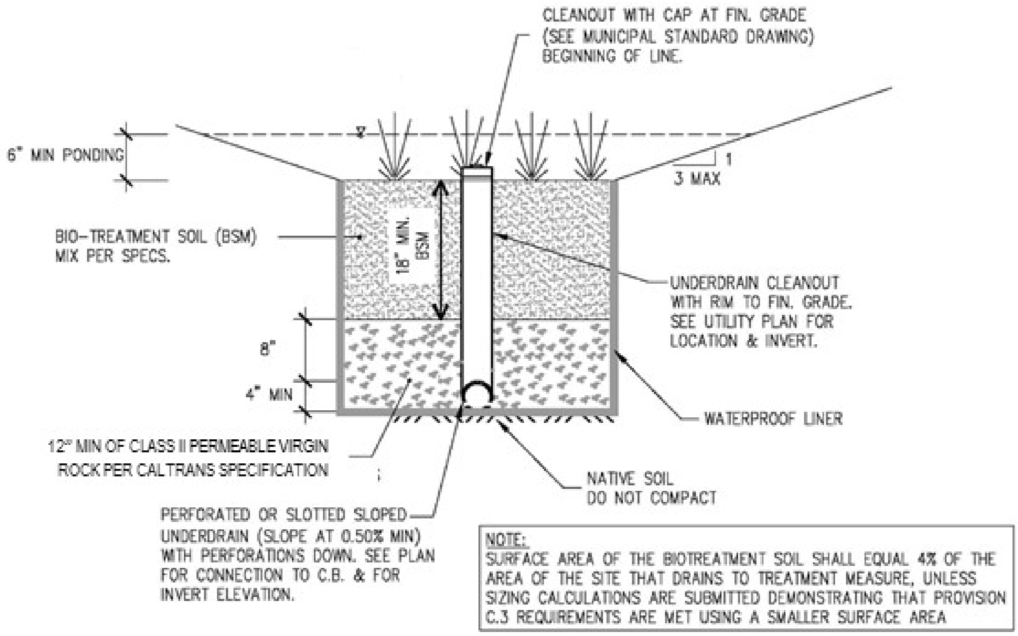

Figure 8-7. Cross Section, Lined Bioretention Area.

Note: Not to Scale

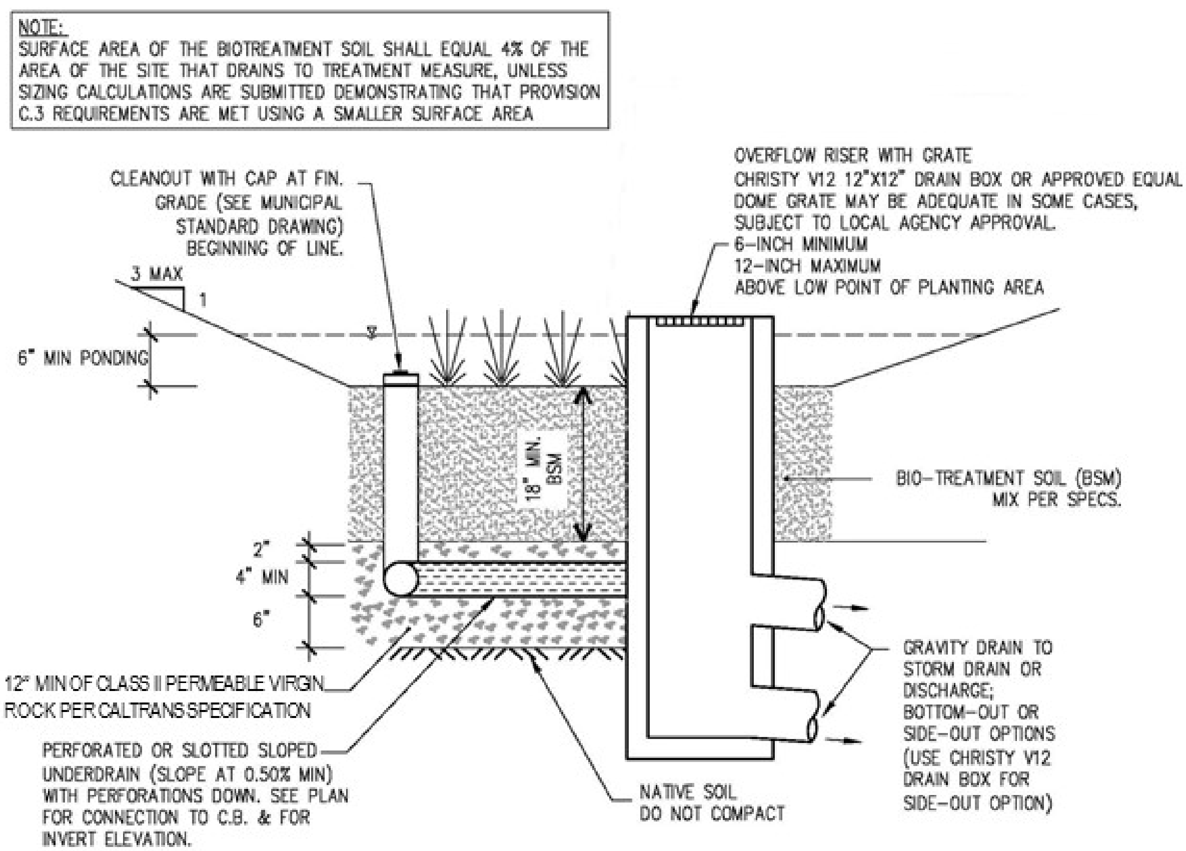

Figure 8-8. Cross Section, Lined Bioretention Area: side view.

Note: Not to Scale

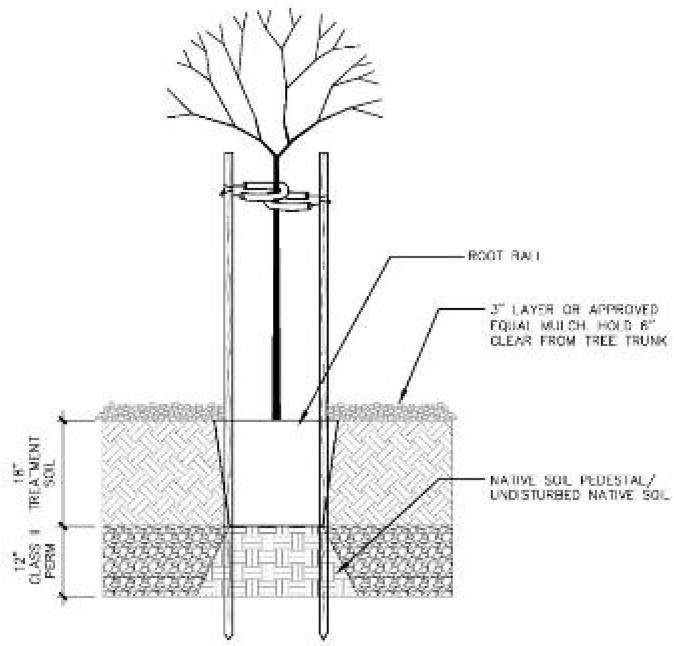

Figure 8-9 Tree Planting on Soil Pedestal
Note: Not to Scale

8.2 FLOW-THROUGH PLANTER

Figure 8-10. At-Grade Flow-Through Planters
Source: City of Emeryville

Best Uses

- Treating roof runoff
- Next to buildings
- Dense urban areas
- Locations where infiltration is not desired
- Drainage area up to 2 acres

Advantages

- Can be adjacent to structures
- Multi-use
- Versatile
- May be any shape

Limitations

- Requires sufficient head
- Careful selection of plants
- Requires level installation
- Susceptible to clogging

Flow-through planters are designed to treat and detain runoff without allowing infiltration into the underlying soil. They can be used next to buildings and other locations where soil moisture is a potential concern. Flow-through planters typically receive runoff via downspouts leading from the roofs of adjacent buildings. However, flow-through planters can also be set level with the ground and receive sheet flow. Pollutants are removed as the runoff passes through the biotreatment soil media (BSM) layer and is collected in an underlying layer of gravel or drain rock. A perforated pipe underdrain is required and must be directed to a storm drain or other discharge point. An overflow inlet conveys flows that exceed the capacity of the planter.

8.2.1 Design and Sizing Guidelines

Treatment dimensions and sizing

- Flow-through planters may be sized using either the 4% method or the combination flow- and volume-based method described in **Section 7.1**, where allowed by the municipality.
- The drainage management area (DMA) that drains to the flow-through planters typically should not exceed 2 acres. If used for a DMA larger than 2 acres, divert high flows away from the facility (see **Section 7.6**), use pretreatment (vegetated filter) to reduce input of sediment, and evaluate the need for a flow spreader to distribute flows throughout the facility.

- Flow-through planters can be used adjacent to buildings and within setback areas.
- Flow-through planters can be used above or below grade. Below grade planters are also required to have a minimum of 6 inches of ponding depth.
- Install an overflow structure adequate to meet municipal drainage requirements Size overflow structure for building code design storm and set top of overflow riser below top of planter box walls.
- The elevation of the BSM surface should be level to distribute stormwater flows throughout the surface area.
- Allow a minimum of 6 inches and a maximum of 12 inches of water surface storage between the planting surface and the top of the overflow riser. The surface of the BSM is assumed to be the bottom of the ponding area; there is no adjustment for depth of mulch.

Vegetation

- Select plants for viability in a well-drained soil, and tolerant of saturation in winter and prolonged drought during summer months. See Section 7.8 and planting guidance in Appendix B.
- Use integrated pest management (IPM) principles in the landscape design to minimize any use of synthetic pesticides and quick-release fertilizer. Check with the local jurisdiction for any local policies regarding the use of pesticides and fertilizers.
- Provide irrigation, as needed, to maintain plant life. Provide separate irrigation control for flow-through planters. Specify weather-based irrigation controllers, sometimes called “smart” irrigation controllers, which use soil moisture sensors to signal the irrigation controller. Use drip emitters instead of spray irrigation (see irrigation guidance in Appendix B).
- Make sure that trees and vegetation do not block inflow, create traffic or safety issues, or obstruct utilities.

Inlets to treatment measure

- Flow may enter the treatment measure (see example drawings in **Section 7.11**):
  - As overland flow from landscaping (no special requirements)
  - As overland flow from pavement (cutoff wall required)
  - Through a curb opening (minimum 18 inches)
  - Through a curb drain
  - With drop structure through a stepped utility access hole
  - Through a bubble-up utility access hole or storm drain emitter
  - Through roof leader or other conveyance from building roof
- Where flows enter the flow through planter, allow a change in elevation of 4 to 6 inches between the paved surface and BSM elevation, so that vegetation or mulch build-up does not obstruct flow.

- A concrete pad, splash blocks, cobbles or rocks should be installed to dissipate flow energy where runoff enters the treatment measure. The use of a concrete pad may facilitate maintenance as removal of accumulated sediment from cobbles can be difficult.
- For long linear planters, space inlets to planter at 10-foot intervals or install flow spreader.

Soil and drainage considerations for flow through planters

- Waterproofing should be installed as required to protect adjacent building foundations.
- To avoid excess hydraulic pressure on subsurface treatment system structures:
  - The depth to seasonal high groundwater level should be at least 5 feet from the bottom of the structure.
  - A geotechnical engineer should be consulted for situations where the bottom of the structure is less than 5 feet from the seasonal high groundwater level.
- An underdrain system is required for flow through planters.
- Soils in the planters must meet BSM specifications approved by the Regional Water Board (**Appendix K**). A long-term minimum infiltration rate of 5 inches per hour is required (initial infiltration rate may exceed this to allow for tendency of infiltration rate to reduce over time). The BSM soil layer should be at least 18 inches deep.
- Consider testing the BSM delivered to the project site to verify conformance with the approved specifications. The local jurisdiction may require this verification. Soil test specifications are detailed in **Appendix K**.
- Following installation of the system test the infiltration rate of the system. The local jurisdiction may require this verification. Infiltration testing can be accomplished using the double ring infiltrometer test (ASTM D3385-09) or the soil-tube method.[13]
- Filter fabric should not be used in or around underdrain trench.
- The underdrain should include a minimum 4-inch diameter, schedule 40 perforated pipe (pipe is installed with the perforations facing downward) with cleanouts and connection to a storm drain or discharge point. To help prevent clogging, two rows of perforation may be used. Clean-out should consist of a vertical, rigid, non-perforated polyvinylchloride (PVC) pipe, with a minimum diameter of 4 inches and a watertight cap fit flush with the ground, or as required by municipality.
- There should be adequate fall from the underdrain to the storm drain or discharge point.
- The underdrain trench should include a 12-inch thick layer of Caltrans Standard Section 68-1.025 permeable material Class 2. Virgin rock shall be used in bioretention/bioinfiltration systems.
- Install and maintain a 3-inch layer of undyed “arbor”, “aged” or “composted” mulch on any exposed soil areas between plantings. Mulch Washed and clean pea gravel, decomposed granite, rock, cobble, or other mulches that resist floating may also be used. Gorilla hair

[13] Add details on the soil tube method.

bark, ground up tires, and playground fiber mulches should not be used. Only non-dyed mulch should be used.

- When using the combination flow and volume method, the surface of the BSM is assumed to be the bottom of the ponding area; there is no adjustment for depth of mulch.

8.2.2 Common Maintenance Concerns for Flow-Through Planters

Maintenance objectives include maintaining healthy vegetation at an appropriate size; avoiding clogging; and ensuring the structural integrity of the planter and the proper functioning of inlets, outlets, and the high-flow bypass.

- Maintain vegetation and the irrigation system. Prune and weed as needed to keep the flow-through planter neat and orderly in appearance. Prune or remove any overgrown plants or shrubs that may interfere with planter operation. Clean up fallen leaves or debris.
- On a biannual basis (pre- and post-wet season) evaluate the health of plants, remove and replace any dead or diseased vegetation, and till or replace BSM specified in **Appendix K**) as needed to maintain the design elevation of soil.
- Before and after the wet season, and monthly during the wet season, conduct inspections to assure proper functioning of flow-through planter. Items to inspect include:
- Inspect planter box to ensure structural integrity of the box.
- Check that the soil is at the appropriate depth to allow water to temporarily pond above the soil surface and is sufficient to effectively filter stormwater. Remove any accumulations of sediment, litter, and debris. Confirm that soil is not clogging and that the planter will drain within 72 hours after a storm event. Inspect and, if needed, replenish mulch.
- Inspect downspouts from rooftops or sheet flow from paving to ensure that flow to the planter is unimpeded. Inspect the overflow pipe to make sure that it can safely convey excess flows to a storm drain. Remove any debris and repair any damaged or disconnected pipes. Check splash blocks or rocks and repair, replace or replenish, as necessary.
- Treat diseased vegetation, as needed, using preventative and low-toxic measures to the extent possible.
- The use of pesticides and quick-release synthetic fertilizers shall be minimized, and the principles of integrated pest management (IPM) followed. Check with the local jurisdiction for any local policies regarding the use of pesticides and fertilizers.

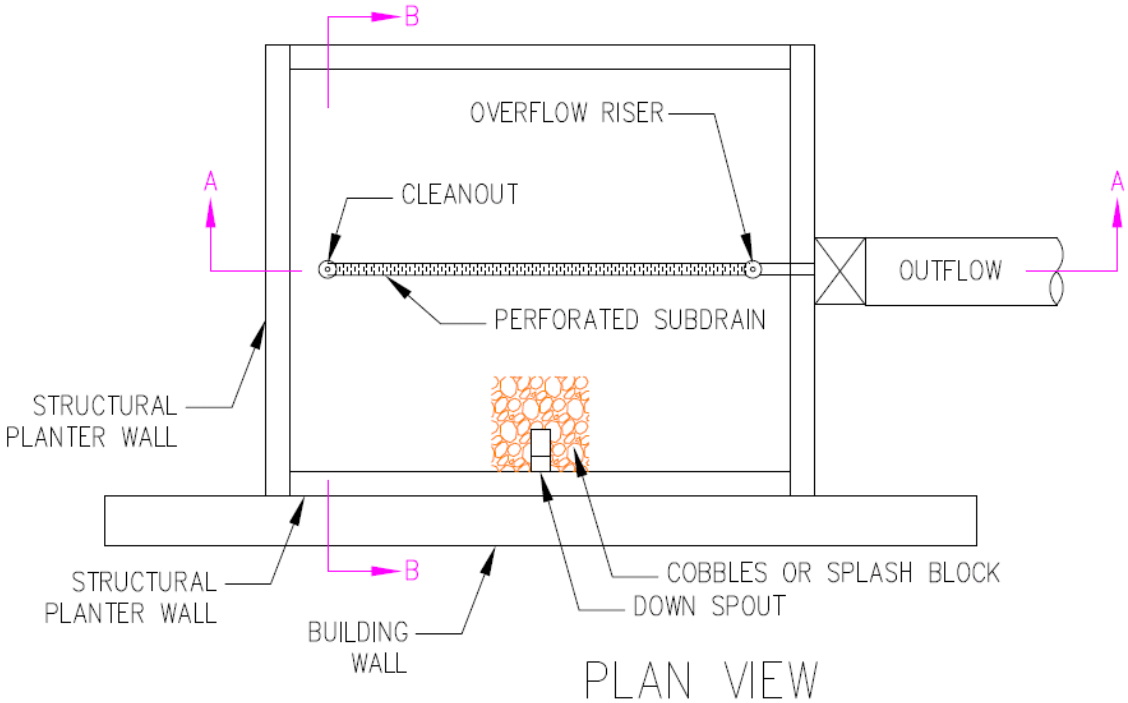

Figure 8-11. Plan View of Planter with One Inlet.
(Note: Plan view of planter designed to disperse flows adequately with only one inlet to planter)

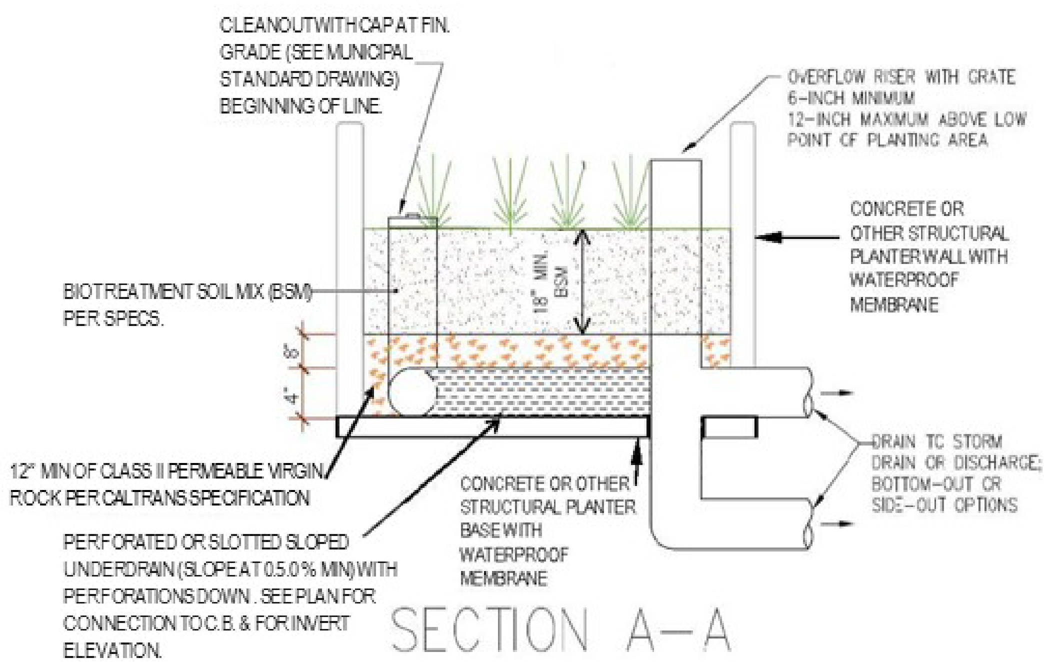

Figure 8-12. Cross-section A-A of Flow-Through Planter.
Note: Cross section A-A of flow-through planter, shows side view of underdrain

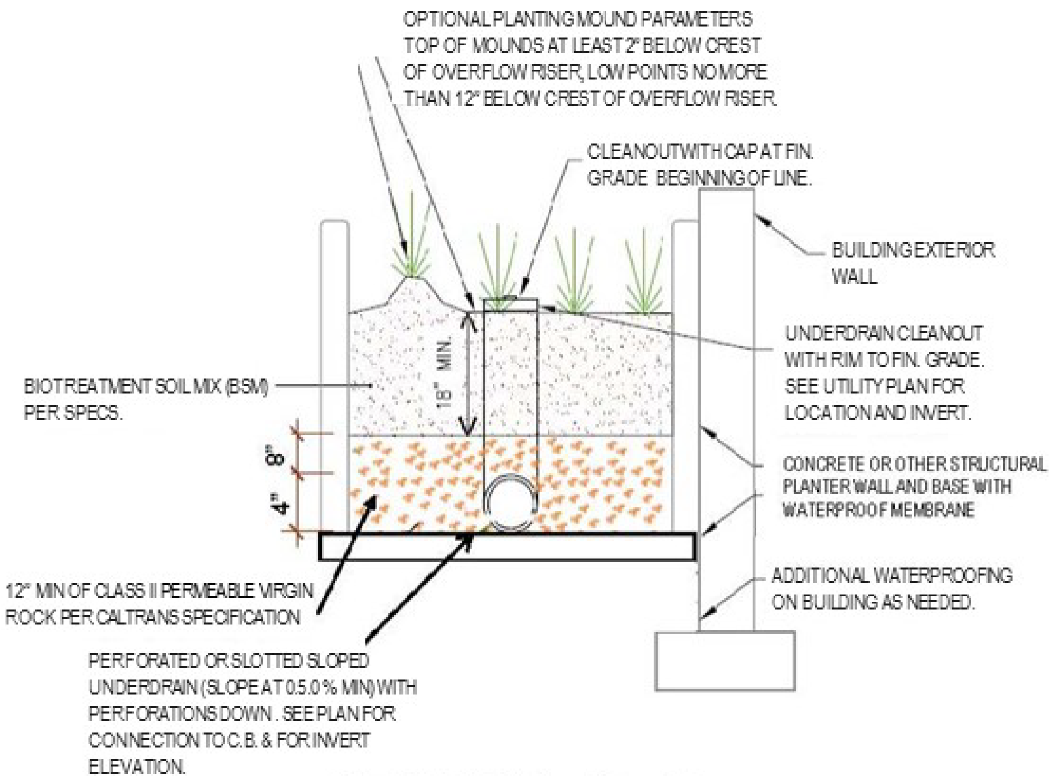

Figure 8-13. Cross-Section B-B of Flow-Through Planter.

(Note: Cross section B-B of flow-through planter, shows cross section of underdrain)

Figure 8-14. Half-buried, perforated flexible pipe serves as a flow spreader to distribute stormwater evenly throughout long, linear flow-through planter in Emeryville.

Source: GreenGrid / Weston Solutions

Figure 8-15. The same planter as shown in Figure 8-14, after vegetation has matured and partially conceals the half-buried pipe from view.

Source: San Francisco Estuary Partnership

8.3 TREE WELL FILTER

Figure 8-16. Non-proprietary tree well filters in Fremont

Best Uses

- Developments with limited space
- Parallel to roads
- Special Projects
- Drainage area up to 2 acres
- Landscape design element

Advantages

- Aesthetic
- Small surface area
- Blends with landscaping

Limitations

- Susceptible to clogging
- High installation cost
- High infiltration rate systems are limited to Special Projects

Tree well filters are especially useful in settings where available space is at a premium. They can be installed in open- or closed-bottom chambers where infiltration is undesirable or not possible, such as tight clay soils, sites with high groundwater, or areas with highly contaminated runoff. Tree well filters may be installed along urban sidewalks, but they are highly adaptable and can be used in most development scenarios. In urban areas, tree filters can be used in the design of an integrated street landscape – a choice that transforms isolated street trees into stormwater filtration devices. In general, tree well filters are sized and spaced much like catch basin inlets, and design variations are abundant. The tree well filter's basic design is a vault filled with bioretention soil mix, planted with vegetation, and underlain with a subdrain. Modular suspended pavement system products (**Section 8.12**) may be used for tree well filter construction and filled with biotreatment soil media (BSM).

8.3.1 Design and Sizing Guidelines

- Flows in excess of the treatment flow rate should bypass the tree filter to a downstream inlet structure or other appropriate outfall.
- Tree filters cannot be placed in sump condition; therefore, tree filters should have flow directed along a flow line of curb and gutter or other lateral structure. Do not direct flows directly to a tree filter.

- Tree well filters designed as biotreatment measures may be sized using the 4% method described in **Section 0**, or, where allowed by the municipality, the combination flow- and volume-based method described in **Section 0**.
- Follow manufacturer's guidelines for designing and sizing proprietary tree filters.
- High flow-rate tree well filters used for Special Projects should be sized to meet both Provision C.3.d criteria for flow-based treatment measures and the Western Washington TAPE GULD "Basic Treatment" criteria, as described in **Appendix J**.
- If a proprietary tree filter is used, the design should be reviewed by the manufacturer before installation.

Inlets to treatment measure

- Flow may enter the treatment measure (see example drawings in **Section 7.11**):
  - As overland flow from landscaping (no special requirements)
  - As overland flow from pavement (cutoff wall required)
  - Through a curb opening (minimum 18 inches)
  - Through a curb drain
  - With drop structure through a stepped utility access hole
  - Through a bubble-up utility access hole or storm drain emitter
  - Through roof leader or other conveyance from building roof
- Where flows enter the biotreatment measure, allow a change in elevation of 4 to 6 inches between the paved surface and BSM elevation, so that vegetation or mulch build-up does not obstruct flow.
- Install a concrete pad, cobbles, or rocks to dissipate energy where runoff enters the treatment measure. The use of a concrete pad may facilitate removal of accumulated sediment, which can become trapped between cobbles.

Vegetation

- Suitable plant species are identified in **Appendix B** planting guidance.
- Use integrated pest management (IPM) principles in the landscape design to help avoid or minimize any use of synthetic pesticides and quick-release fertilizer. Check with the local jurisdiction for any local policies regarding the use of pesticides and fertilizers.
- Irrigation should be provided, as needed, to maintain plant life. Provide separate irrigation control for tree well filters that use BSM. Specify weather-based irrigation controllers, sometimes called "smart" irrigation controllers, which use soil moisture sensors to signal the irrigation controller. Drip emitters should be used instead of spray irrigation (see irrigation guidance in **Appendix B**).
- Trees and vegetation do not block inflow, create traffic or safety issues, or obstruct utilities.

Soil and drainage requirements specific to high flow rate tree well filters

- Use of a high flow rate tree well filter, for which the long-term infiltration rate of the media exceeds 10 inches per hour, is only allowed for Special Projects (see **Appendix J**).
- Filter media in high-flow rate tree well filters should follow manufacturer specifications.
- An underdrain system is required for high flow-rate tree well filters.

Soil and drainage considerations for all biotreatment systems (not applicable to high flow rate tree well filters)

- Soils in the facility should meet BSM specifications approved by the Regional Water Board (**Appendix K**). A long-term minimum percolation rate of 5 inches per hour is required (initial infiltration rate may exceed this to allow for tendency of infiltration rate to reduce over time). The BSM layer should be of adequate depth for tree roots, as indicated by the project's landscape architect, at least 18 inches deep.
    - Inspect and consider testing the biotreatment soil delivered to the project site to verify conformance with the approved biotreatment soil specifications and infiltration rate. The local jurisdiction may require this verification. Soil test specifications are detailed in **Appendix K**. Infiltration testing can be accomplished using the biotreatment soil-tube test method.
    - Following installation of the system consider testing the infiltration rate of the system. The local jurisdiction may require this verification. Infiltration testing can be accomplished using the double ring infiltrometer test (ASTM D3385-09).
- An underdrain system is generally required. Depending on infiltration rate of in situ soils, the local jurisdiction may allow installation without an underdrain on a case-by-case basis. Consideration of groundwater level and placement of the underdrain:
    - If there is less than a 5-foot separation between the bottom of the facility and the seasonal high groundwater level, or infiltration is not allowed due to other site constraints, an impermeable liner should be placed between the drain rock and the bottom of the facility, and the underdrain placed on top of that liner.
    - If there is at least a 5-foot separation between the bottom of the facility and the seasonal high groundwater level, and geotechnical conditions allow infiltration, the facility should be unlined, and the underdrain should be raised at least 6 inches above the bottom of the drain rock to allow storage and infiltration of treated water.
    - Check with your local water district to determine if a greater separation from the seasonal high groundwater level is required.
- Filter fabric should not be used in or around underdrain pipe or trench.
- The underdrain should include a minimum 4-inch diameter, schedule 40 perforated pipe (perforations facing downward) with cleanouts and connection to a storm drain or discharge point. To help prevent clogging, two rows of perforation may be used. Clean-out should consist of a vertical, rigid, non-perforated polyvinyl chloride (PVC) pipe, with a

minimum diameter of 4 inches and a watertight cap fit flush with the ground, or as required by the municipality.

- There should be adequate fall from the underdrain to the storm drain or discharge point.
- Underdrain trench should include a 12-inch thick layer Caltrans Standard Section 68-1.025 permeable material Class 2. Virgin rock shall be used in biotreatment systems.
- Install and maintain a 3-inch layer of “arbor”, “aged” or “composted” mulch on any exposed soil areas between plantings. Washed and clean pea gravel, decomposed granite, rock, cobble, or other mulches that resist floating may also be used. Gorilla hair bark, virgin materials, ground up tires, and playground fiber mulches are not recommended. Only non-dyed mulch should be used (MWELO]).
- When using the combination flow and volume method, the surface of the biotreatment soil is assumed to be the bottom of the ponding area; there is no adjustment for depth of mulch.

8.3.2 Common Maintenance Concerns for Tree Well Filters

For proprietary tree well filters, consult product documents; some manufacturers require a maintenance agreement, under which the manufacturer conducts the maintenance. The following maintenance requirements are typical for non-proprietary tree well filters.

- On a biannual basis (pre- and post-wet season) evaluate the health of plants, remove and replace any dead or diseased vegetation, and till or replace BSM as needed to maintain the design elevation of soil.
- Before and after the wet season, and monthly during the wet season, conduct inspections to assure proper functioning of tree well filter. Items to inspect include:
    - Maintain vegetation and the irrigation system. Prune and weed as needed to keep the tree well filter neat and orderly in appearance. Clean up fallen leaves or debris.
    - Check that the BSM is at the appropriate depth. Remove any accumulations of sediment, litter, and debris. Confirm that the tree well filter is not clogging and will drain within 72 hours after rainfall. Till or replace the biotreatment soil as necessary.
    - Inspect the overflow pipe to make sure that it can safely convey excess flows to a storm drain. Repair or replace any damaged or disconnected piping.
    - Treat diseased vegetation, as needed, using preventative and low-toxic measures to the extent possible.
- The use of pesticides and quick-release synthetic fertilizers shall be minimized, and the principles of integrated pest management (IPM) followed. Check with the local jurisdiction for any local policies regarding the use of pesticides and fertilizers.

Figure 8-18 Non-proprietary Tree Well Filter with Overflow Bypass
Source: University of New Hampshire Environmental Research Group, 2006

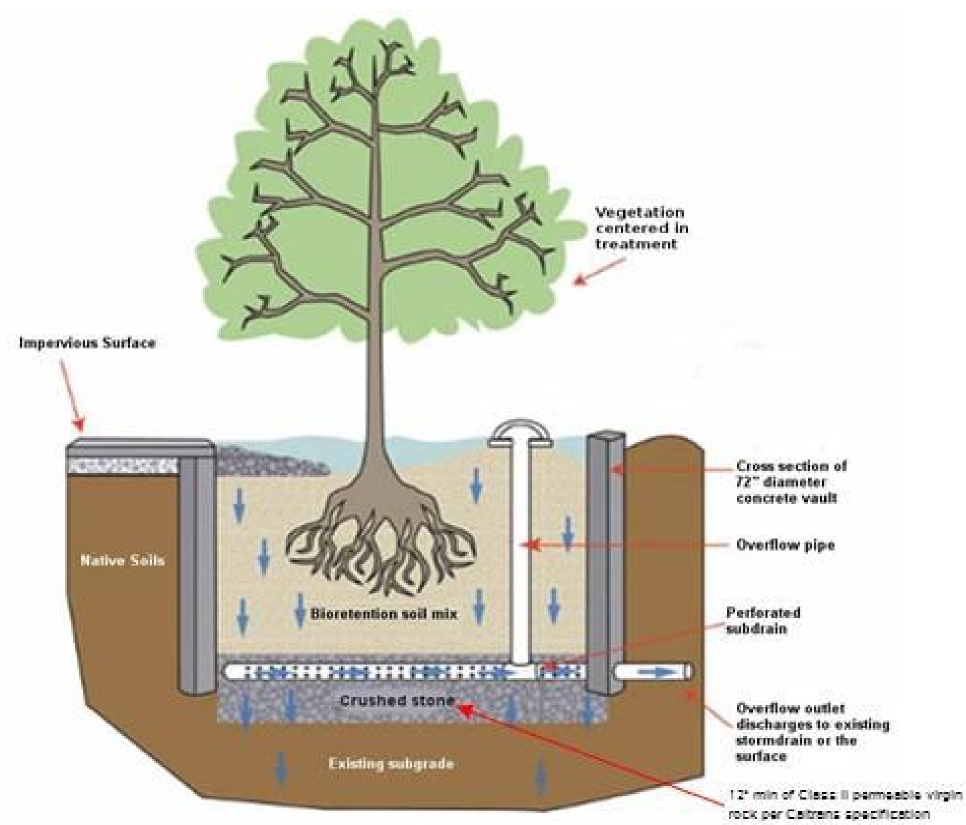

Figure 8-17. Schematic of a Non-proprietary Tree Well Filter.
Note: Design details should be consistent with those for a bioretention facility or flow-through planter.
Source: University of New Hampshire Environmental Research Group, 2006

8.4 INFILTRATION TRENCH

Figure 8-19. Infiltration trench
Source: CASQA, 2003

Best Uses

- Adjacent to paved surfaces
- Limited space
- Landscape buffers
  Advantages
- Increases groundwater recharge
- Removes suspended solids
- No surface outfalls

Limitations

- Susceptible to clogging; fails with no maintenance
- No high water tables
- Infiltration rate of existing soils must exceed 0.5 in/hr
- No steep slopes
- Drainage area less than 5 acres

An infiltration trench is a long, narrow, excavated trench backfilled with a stone aggregate, and lined with a filter fabric. Runoff is stored in the void space between the stones and infiltrates through the bottom and into the soil matrix. Pretreatment using buffer strips, swales, or detention basins is important for limiting amounts of coarse sediment, which can clog and render the trench ineffective. Infiltration practices, such as infiltration trenches, remove suspended solids, particulate pollutants, coliform bacteria, organics, and some soluble forms of metals and nutrients from stormwater runoff. The infiltration trench treats the design volume of runoff either underground or at grade. Pollutants are filtered out of the runoff as it infiltrates the surrounding soils. Infiltration trenches have a high rate of failure where soil conditions are not suitable. If an infiltration trench is designed to be deeper than its widest surface dimension, it may meet the USEPA definition of a Class V injection well and information about the device may need to be submitted to the USEPA. See **Appendix F** for more information regarding Class V injection wells.

8.4.1 Design and Sizing Guidelines

Drainage area and setback considerations

- When the drainage area exceeds 5 acres, other treatment measures should be considered.

- Infiltration trenches work best when the upgradient drainage area slope is less than 5 percent. The downgradient slope should be no greater than 20 percent to minimize slope failure and seepage.
- In-situ/undisturbed soils should have a low silt and clay content and have percolation rates greater than 0.5 inches per hour. In-situ testing is required to confirm percolation rate of trench site. CASQA's BMP Handbook recommends against using infiltration trenches in Type C or D soils. To test the infiltration rate of underlying soils, use the ASTM D3385-09 Standard Test Method for Infiltration Rate of Soils in Field Using Double-Ring Infiltrometer, or other test method approved by the local jurisdiction. Due to site variability and the potential for uncertainty in conducting tests, it is recommended that multiple tests be conducted, and a representative corrected infiltration rate be selected.
- There should be at least a 10-foot separation between the bottom of the trench and the seasonal high groundwater level to prevent potential groundwater contamination.
- Trenches should also be located at least 100 feet upgradient from water supply wells.
- A setback of 100 feet from building foundations is recommended, unless a smaller setback is approved by geotechnical engineer and allowed by local standard.

Treatment dimensions and sizing

- The infiltration trench should be sized to store and infiltrate the water quality design volume.
- A site-specific trench depth can be calculated based on the soil infiltration rate, aggregate void space, and the trench storage time. The stone aggregate used in the trench is normally 1.5 to 2.5 inches in diameter, which provides a void space of approximately 35 percent. A minimum drainage time of 6 hours should be provided to ensure satisfactory pollutant removal in the infiltration trench. Trenches may be designed to provide temporary storage of storm water. Trench depths are usually between 3 and 8 feet, with a depth of 8 feet most commonly used.
- The trench surface may consist of stone or vegetation (contact local municipality to determine if vegetation is allowed) with inlets to evenly distribute the runoff entering the trench. Runoff can be captured by depressing the trench surface or by placing a berm at the down gradient side of the trench. The basic infiltration trench design utilizes stone aggregate in the top of the trench to promote filtration; however, this design can be modified by substituting pea gravel for stone aggregate in the top 1-foot of the trench.
- Use trench rock that is 1.5 to 2.5 inches in diameter or pea gravel to improve sediment filtering and maximize the pollutant removal in the top 1 foot of the trench.
- Place permeable filter fabric around the walls and bottom of the trench and 1 foot below the trench surface. The filter fabric should overlap each side of the trench in order to cover the top of the stone aggregate layer. The filter fabric prevents sediment in the runoff and soil particles from the sides of the trench from clogging the aggregate. Filter fabric that is placed 1 foot below the trench surface will maximize pollutant removal within the top

layer of the trench and decrease the pollutant loading to the trench bottom, reducing frequency of maintenance.

- The infiltration trench should drain within 72 hours to avoid vector generation.
- An observation well is recommended to monitor water levels in the trench. The well can be a 4 to 6-inch diameter PVC pipe, which is anchored vertically to a foot plate at the bottom of the trench.

Inlet to the treatment measure

- A vegetated buffer strip at least 5-feet wide, swale or detention basin should be established adjacent to the infiltration trench to capture large sediment particles in the runoff before runoff enters the trench. If a buffer strip or swale is used, installation should occur immediately after trench construction using sod instead of hydroseeding. The buffer strip should be graded with a slope between 0.5 and 15 percent so that runoff enters the trench as sheet flow.
- If runoff is piped or channeled to the trench, a level spreader should be installed to create sheet flow.
- If surface landscaping of the trench is desired, contact the local municipality to determine if this is allowed.
- Trees and other large vegetation should be planted away from trenches such that drip lines do not overhang infiltration beds.

8.4.2 Common Maintenance Concerns for Infiltration Trenches

The primary maintenance objective is to prevent clogging, which may lead to trench failure. Typical inspection and maintenance tasks include the following.

- Inspect infiltration trenches after large storm events and remove any accumulated debris or material.
- Check the observation well 2 to 3 days after storms to confirm drainage.
- Repair any erosion at inflow or overflow structures.
- Conduct thorough inspection annually, including monitoring of the observation well to confirm that the trench is draining within the specified time.
- Trenches with filter fabric should be inspected annually for sediment deposits by removing a small section of the top layer.
- If inspection indicates that the trench is partially or completely clogged, it shall be restored to its design condition.
- Mow and trim vegetation around the trench as needed to maintain a neat and orderly appearance.
- The use of pesticides and quick-release synthetic fertilizers shall be minimized, and the principles of integrated pest management (IPM) followed. Check with the local jurisdiction for any local policies regarding the use of pesticides and fertilizers.

- Routinely remove trash, grass clippings and other debris from the trench perimeter and dispose of these materials properly. Trees or other large vegetation should be prevented from growing adjacent to the trench to prevent damage to the trench.

Figure 8-20. Infiltration trench next to parking structure, Palo Alto.
Source EOA, Inc.

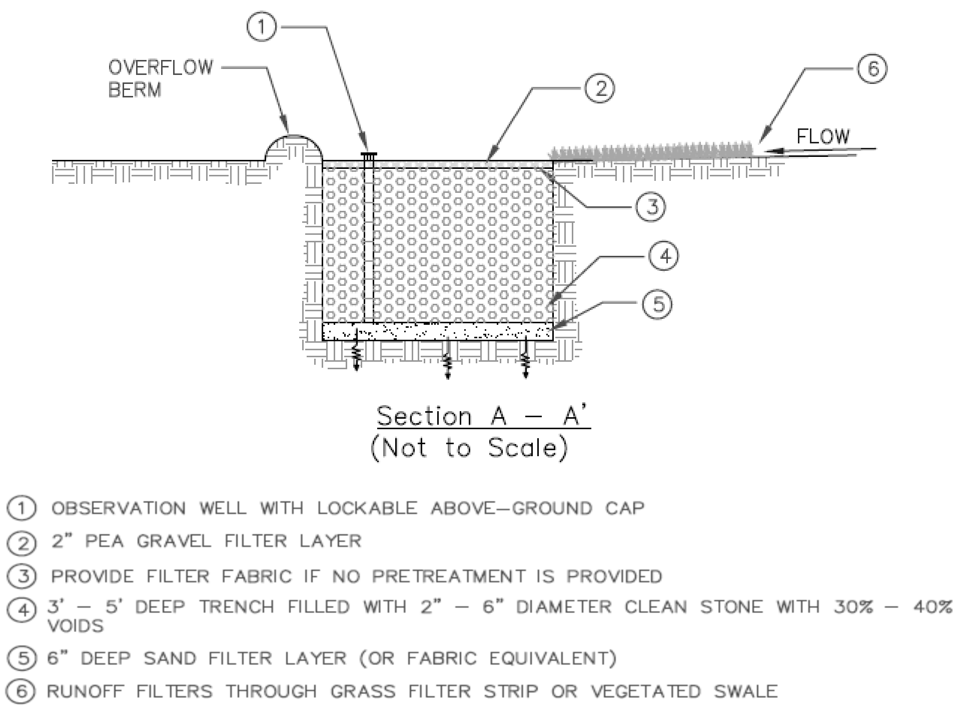

Figure 8-21. Infiltration Trench Section.
Source: County of Los Angeles, 2010.

8.5 EXTENDED DETENTION BASIN

Figure 8-22. Extended detention basin
Source: CASQA, 2003

Best Uses

- Hydromodification management
- Detain low flows and peak flows
- Settling of suspended solids
- Sites larger than 5 acres

Advantages

- Easy to operate
- Inexpensive to construct
- Low maintenance

Limitations

- Land requirements
- Not approved as a stand-alone treatment measure

Extended detention basins[14] are basins whose outlets have been designed to detain the stormwater runoff from a water quality design storm for a minimum of 48 hours to allow particles and associated pollutants to settle. Unlike wet ponds, these facilities do not have a permanent pool.

Since December 1, 2011, projects have not been allowed to meet stormwater treatment requirements with stand-alone extended detention basins that are designed to treat stormwater through the settling of pollutants and gradual release of detained stormwater through an orifice. However, this type of extended detention basin could be used as part of a treatment train, in which the basin stores a large volume of water, which is gradually released to a bioretention area that meets the MRP requirements for biotreatment soil media (BSM) and surface loading area. They can also be used to provide hydromodification management and/or flood control depending on the size of the basin and the design of the outlet structure.

8.5.1 Design and Sizing Guidelines

Treatment dimensions and sizing

- Extended detention basins should be sized to capture the required water quality volume over at least a 48-hour period. At least 10 percent additional storage should be provided to account for storage lost to deposited sediment.
- Extended detention basin should have no greater than 3:1 side slopes.

[14] Extended detention basins are also know as dry ponds, dry extended detention basins, detention ponds, and extended detention ponds.

- The optimal basin depth is between 2 and 5 feet.
- A safety bench should be added to the perimeter of the basin wall for maintenance when the basin is full.
- Ponded water in the extended detention basin should empty within a maximum of 72 hours to avoid vector generation.
- A 12-foot wide maintenance ramp leading to the bottom of the basin and a 12-foot wide perimeter access road should be provided. If not paved, the ramp should have a maximum slope of 5 percent. If paved, the ramp may slope 12 percent.
- The extended detention basin should have a length to width ratio of at least 1.5:1.
- A fixed vertical sediment depth marker should be installed in the sedimentation forebay. The depth marker should have a marking showing the depth where sediment removal is required. The marking should be at a depth where the remaining storage equals the design water quality volume.

Inlets to treatment measure

- The inlet pipe should have at least 1 foot of clearance to the basin bottom.
- Piping into the extended detention basin should have erosion protection. As a minimum, a forebay with a 6-inch thick layer of Caltrans Section 72, Class 2 rock slope protection should be placed at and below the inlet to the extent necessary for erosion protection.
- Check with municipality regarding trash screen requirements. Trash screen installation may be required upstream of the pipe conveying water into the pond, in order to capture litter and trash in a central location where it can be kept out of the pond until it is removed.

Outlets and orifices

- If the detention basin is to be used as part of a treatment train, the outlet should be sized with a drawdown time of 48 hours for the design water quality volume.
- If the detention basin is to be used for hydromodification management, see **Chapter 9** for guidance.
- Orifices should each be a minimum diameter of 1 inch. Extended detention basins are not practical for small drainage areas because the minimum orifice diameter cannot be met.
- Each orifice should be protected from clogging using a welded stainless steel wire mesh screen. The screen should protect the orifice openings from runoff on all exposed sides. For example, see Caltrans standard detail for Water Quality Outlet Riser Type 1.

Vegetation

- Plant species should be adapted to periods of inundation. See planting guidance in **Appendix B**.
- Use integrated pest management (IPM) principles in the landscape design to help avoid or minimize any use of synthetic pesticides and quick-release fertilizer. Check with the local jurisdiction for any local policies regarding the use of pesticides and fertilizers.
- Irrigation should be provided as needed to maintain plant life.

- If vegetation is not established by October 1st, place sod over loose soils. Above the area of inundation, a 1-year biodegradable loose weave geofabric may be used in place of sod.

Soil and drainage considerations

- Extended detention basins are not designed to infiltrate the entire volume of water captured, but they may infiltrate some water if conditions allow.
- Consideration of groundwater level:
  - If there is less than a 5-foot separation between the bottom of the facility and the seasonal high groundwater level, or infiltration is not allowed due to other site constraints, an impermeable liner should be placed at the bottom of the facility.
  - If there is at least a 5-foot separation between the bottom of the facility and the seasonal high groundwater level, and geotechnical conditions allow infiltration, the facility may be unlined.

8.5.2 Common Maintenance Concerns for Extended Detention Basins

Primary maintenance activities include vegetation management and sediment removal, although mosquito control is a concern in extended detention basins that are designed to include pools of standing water. The typical maintenance requirements include the following.

- Do not perform maintenance activities at the bottom of the basin with heavy equipment that would compact the soil and limit infiltration.
- Harvest vegetation annually, during the summer.
- Trim vegetation at the beginning and end of the wet season and inspect monthly to prevent establishment of woody vegetation and for aesthetic and mosquito control reasons.
- Minimize the use of pesticides and quick-release synthetic fertilizers, and follow the principles of integrated pest management (IPM). Check with the local jurisdiction for any local policies regarding the use of pesticides and fertilizers.
- Semi-annually, evaluate the health of the vegetation and remove and replace any dead or dying plants.
- Conduct semiannual inspection as follows:
  - Inspect the outlet, embankments, dikes, berms, and side slopes for structural integrity and signs of erosion.
  - Examine outlets and overflow structures and remove any debris plugging the outlets. Identify and minimize any sources of sediment and debris. Check rocks or other erosion control and replace, if necessary.
  - Check inlets to make sure piping is intact and not plugged. Remove accumulated sediment and debris near the inlet.
  - Inspect for standing water and correct any problems that prevent the extended detention basin from draining as designed.

- If you observe mosquito larvae, contact Alameda County Mosquito Abatement District, 510-783-7744. (In Albany, Alameda County Vector Control District, 510-567-6800.)
- Check for slope stability and the presence of rodent burrows. Fill in any holes detected in the side slopes.
- Inspect and remove any trash and debris.
- Confirm that any fences around the facility are secure.
- Check for sediment accumulation.

- Remove sediment from the forebay when the sediment level reaches the level shown on the fixed vertical sediment marker.
- Remove accumulated sediment and regrade about every 10 years or when the accumulated sediment volume exceeds 10 percent of the basin volume.
- Remove accumulated trash and debris from the basin at the middle and end of wet season (January and April), or as needed.

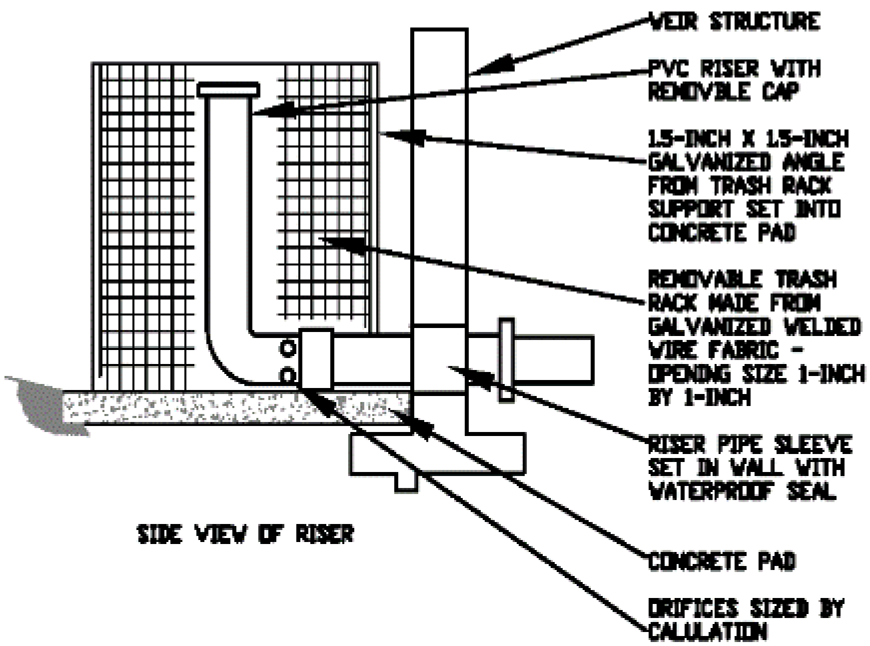

Figure 8-23. Side View of Riser, Extended Detention Basin.

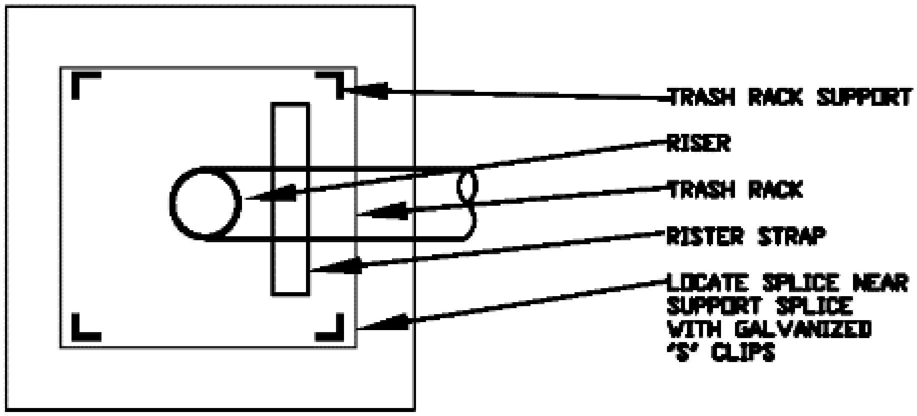

Figure 8-24. Top View of Riser, Extended Detention Basin (square design).

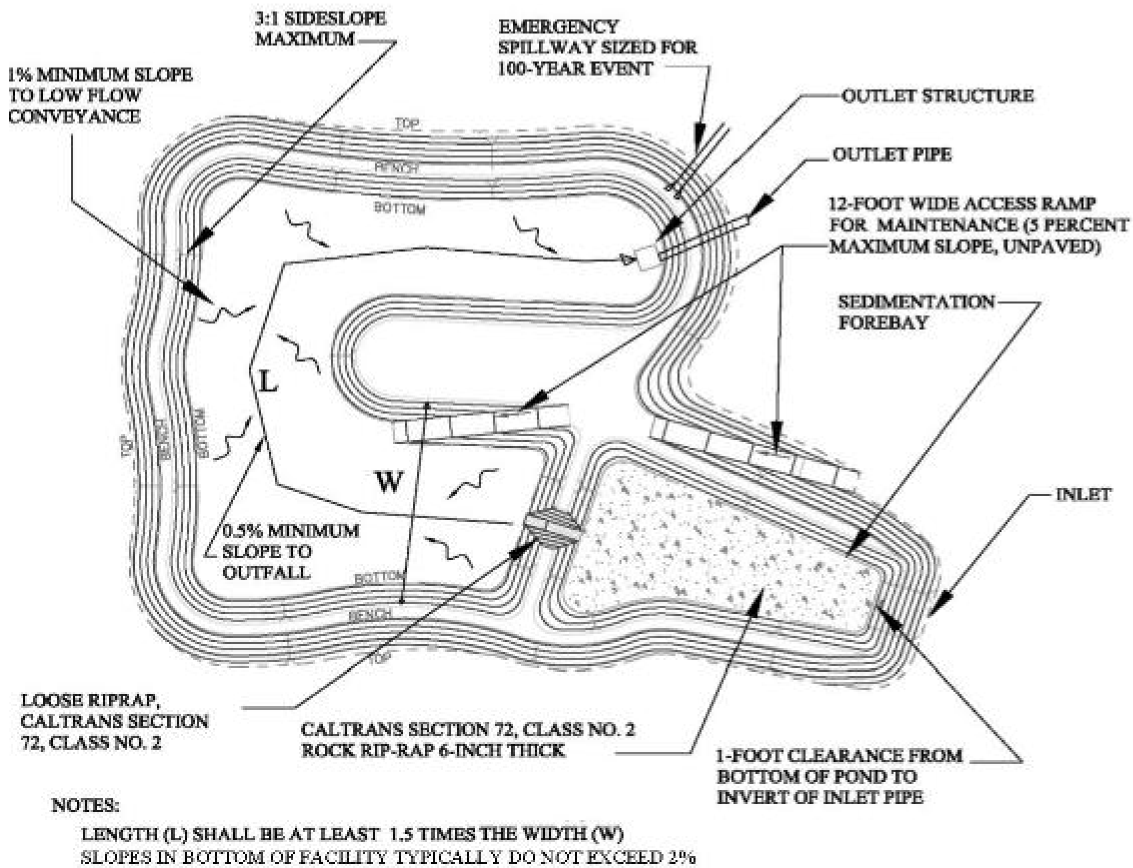

Figure 8-25. Plan View, Typical Extended Detention Basin.

8.6 PERVIOUS PAVEMENT

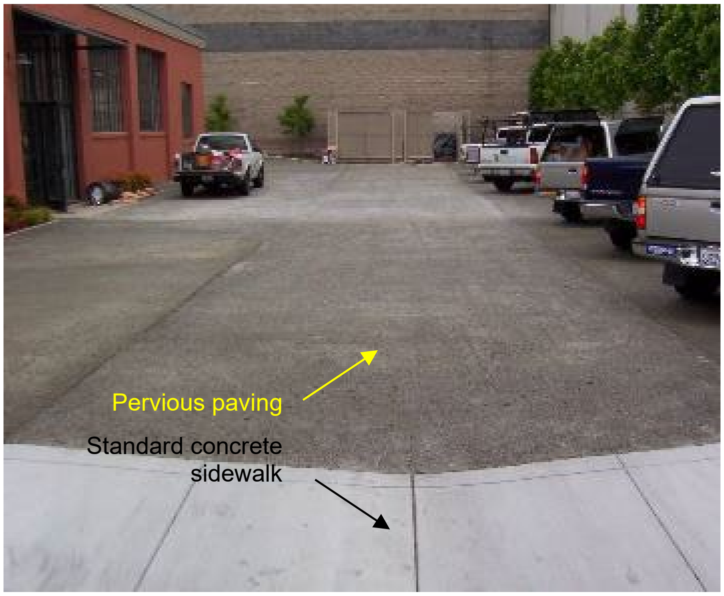

Figure 8-26. Parking Lot with Pervious Concrete Pavement, Emeryville

Best Uses

- Parking lots
- Low-speed residential roads
- Alleys and driveways
- Sidewalks, pathways, and plazas

Advantages

- Flow attenuation
- Volume reduction
- Removes fine particulates
- Reduces need for treatment

Limitations

- May clog without periodic vacuum cleaning
- Low speed areas only
- Higher installation costs than conventional paving

Pervious pavement types include pervious concrete, porous asphalt, pervious or permeable concrete pavers, permeable interlocking concrete pavement (PICP), and grid pavements such as turf block and grasscrete. (Grid pavements are described in **Section 8.7**.) Pervious paving is used for areas with light vehicle loading and lightly trafficked areas, such as automobile parking areas. The term pervious paving describes a system comprised of a load-bearing, durable surface constructed over a subbase/base structure typically consisting of compacted, open-graded aggregate. This layer or layers temporarily stores water prior to infiltration or drainage to a controlled outlet. The surface is porous allowing water to infiltrate across the entire surface of the material.

Where pervious paving is underlain with pervious soil or pervious storage material sufficient to hold the MRP Provision C.3.d volume of rainfall runoff, it is not considered impervious and can function as a self-treating area.

Gravel surface treatments are considered impervious unless they are designed as a pervious pavement system with sufficient capacity to hold the MRP Provision C.3.d volume of runoff.

8.6.1 Design and Sizing Guidelines

The design of each layer of the pavement must be determined by the likely traffic loadings and the layers' required operational life. The thickness of the base layer is also affected by hydrologic sizing considerations. The following criteria should be considered.[15]

Subgrade and site requirements

- The soil sub-grade should be able to sustain anticipated traffic loading without excessive deformation.
- The subgrade should be ungraded in-situ material with a minimum infiltration rate of 0.5-inches per hour, or based on hydrologic analysis, an underdrain should be installed to remove detained flows within the pervious paving and base (see **Figure 8-28**), or Caltrans guidance for base layer sizing may be followed (see, "Base Layer"). To test the infiltration rate of underlying soils, use the ASTM D3385-09 Standard Test Method for Infiltration Rate of Soils in Field Using Double-Ring Infiltrometer, or other test method approved by the local jurisdiction. Due to site variability and the potential for uncertainty in conducting tests, it is recommended that multiple tests be conducted for each area to be paved and a representative corrected infiltration rate be selected for design.
- In soils with less than 0.5-inch per hour infiltration rate, subject to approval by the local jurisdiction, one alternative approach to providing an underdrain, is to direct overflows from the surface of the pavement into bioretention areas and overflow drains. A second alternative approach, subject to approval by the local jurisdiction, is to increase the depth of subbase/base layer. The design should allow the stored water to infiltrate into the subgrade within 48 hours.
- Depth to seasonal high groundwater level should be at least 5 feet from the bottom of the base of the pervious paving system unless a different separation is recommended by the geotechnical engineer.
- Pervious paving systems should not be used where site conditions do not allow infiltration.
- Grading of the soil subgrade below the pervious pavement should be relatively flat (not to exceed 2% slope) to promote infiltration across the entire area.
- A slope of 1% is recommended for pavement surface. Slopes of pervious pavement should not exceed 5%, or up to 16% with underdrains. Slopes exceeding 3% typically require berms or check dams placed laterally over the soil subbase to slow the flow of water and provide some infiltration. Alternatively, pervious pavement systems can be terraced to step down a steep slope, maintaining level bed bottoms separated by earthen berms.

Base layer

- When subject to vehicular traffic, all open-graded aggregates should conform to the following or to similar specifications as directed by the municipality: crushed material,

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[15] The Clean Water Program gratefully acknowledges the contributions of Mr. David Smith, Technical Director of the Interlocking Concrete Pavement Institute, to this section of the C.3 Technical Guidance, including pavement sections, design details, and specifications.

minimum 90% with at least 2 fractured faces conforming to Caltrans test method CT 205; have Los Angeles Rattler no greater than 40% loss at 500 revolutions per Caltrans test method CT 211; and a minimum Cleanness value of 75 per Caltrans test method CT 211. Sieve analysis should conform to Caltrans test method CT 202.

- Aggregate materials shall be clean virgin rock and shall avoid introducing to the pervious paving system debris, sediment, grease, oil, and other pollutants. The use of recycled concrete aggregate (RCA) is prohibited.
- If the subbase/base layer is sized to store and infiltrate at least the Municipal Stormwater Regional Permit Provision C.3.d volume of rainfall runoff, the area of pervious paving is not considered an impervious surface and can function as a self-treating area, as described in Section 5. 1.
- If the subbase/base layer has sufficient capacity in the void space to store and infiltrate the C.3.d amount of runoff for both the area of pervious paving and the area that drains to it, the pervious paving area can function as a self-retaining area, described in Section 5.2.
- Pervious paving designed to function as a self-retaining may accept runoff from an area of impervious surface that has a surface area of up to two times the surface area of the pervious paving area.
- If an underdrain is used, position the perforated pipe a minimum of 2 inches above bottom elevation of base course. To be considered a self-treating area or self-retaining area, the underdrain should be positioned above the portion of the base layer that is sized to meet the C.3.d sizing criteria.
- Design calculations for the base should quantify the following:
- Soil type/classification and soil permeability rate; if subject to vehicular traffic, k-values (psi/cubic inch) or R-values characterizing soil strength when saturated;
- Fill type if used, installation, and compaction methods plus target densities;
- Lifetime expected vehicular traffic loading (in 18,000 lb. equivalent single axle loads or Caltrans Traffic Index); the maximum recommended Traffic Index = 9.

Pavement materials

- The pavement materials should not crack or suffer excessive rutting under anticipated traffic loads. This is controlled by designing pervious concrete and porous asphalt surfacing materials and layer thicknesses that minimize the horizontal tensile stress at their base. All pervious pavements benefit from using open-graded aggregate base materials with sufficient thicknesses and compaction that spread and minimize applied vertical stresses from vehicles.
- Pervious concrete and porous asphalt materials require narrow aggregate grading to create open voids in their surfaces. Materials choice is therefore a balance between stiffness in the surface layer and permeability. PICP requires similar types of aggregate (without cement or asphalt) placed in the joints, typically ASTM No. 8, 89, or 9 stone depending on the paver joint widths. Refer to industry association literature for grading recommendations for all surfaces.

- Paving units for PICP should conform to the dimensional tolerances, compressive strengths, and absorption requirements in ASTM C936. Paving units subject to vehicular traffic should be at least 3 1/8 in. thick.

Design and installation

- All designs should be reviewed and approved by a licensed civil or geotechnical engineer or as directed by the municipality.
- Design for pervious concrete should be reviewed by the concrete manufacturer or National Ready Mixed Concrete Association (NRMCA) (www.nrmca.org), or as directed, the municipality. Consult Portland Cement Association publication, Hydrologic Design of Pervious Concrete (2007) available from www.cement.org.
- Design for porous asphalt should be reviewed by the asphalt manufacturer, the National Asphalt Pavement Association (NAPA) (www.porousasphalt.net), or as directed by the municipality. Consult NAPA publication, Porous Asphalt for Stormwater Management (2008) for additional information on design, construction, and maintenance.
- Design for PICP should be reviewed by the concrete paver manufacturer, the Interlocking Concrete Pavement Institute (ICPI) (www.icpi.org), or as directed by the municipality. Consult ICPI publication, Permeable Interlocking Concrete Pavements 4th Edition (2011) for additional information on design, construction, and maintenance.
- Installation of pervious concrete, porous asphalt and PICP should be done by contractors who have constructed pervious pavement projects similar in size to that under consideration.
- For pervious concrete, only contractors with certification from NRMCA should be considered, and such contractors should have at least one supervisor with this certification on the job site at all times. More information can be found at www.concreteparking.org.
- For PICP, it is recommended that only contractors holding a certificate of completion in the Interlocking Concrete Pavement Institute’s PICP Installer Technician Course should be considered and such contractors should have at least one supervisor with this certificate on the job site at all times. More information can be found at www.icpi.org.
- After installation, conduct an infiltration test using ASTM C1701 (for pervious concrete or porous asphalt) or ASTM C1781 (for PICP); record the test results to compare with results of future tests. All new pavements should have a minimum surface infiltration rate of 100 in./hr when tested in accordance with ASTM C1701 or C1781.
- Protect excavated area from excessive compaction due to construction traffic and protect the finished pavement from construction traffic.
- Post a sign at pervious pavement sites to alert maintenance personnel to:
- Keep silt and debris from entering onto the pervious pavements.
- Not seal the pavement, and
- Clean surface with high performance vacuum equipment, not mechanical broom type.

8.6.2 Common Maintenance Concerns for Pervious Concrete and Asphalt

The primary maintenance objective is to prevent clogging of the pervious matrix through routine maintenance. Periodically more intensive maintenance may be needed to restore infiltration capacity.

Standard routine maintenance

- On a monthly basis, remove any accumulated trash or debris from pervious paving surface. Also remove any trash or debris from downspouts to pervious paving facility or in outlets to storm drains.
- On a biannual basis (pre- and post-wet season) vacuum sweep and clean surface of pervious pavement. If power washing is used, avoid forcing fine sediments into the pervious pavement.
- Before and after the wet season, and monthly during the wet season, conduct inspections to assure proper functioning of pervious paving. Items to inspect include:
- Check for standing water on the pavement surface.
- Inspect pervious paving for any signs of hydraulic failure.
- Inspect outlets and remove accumulated trash/debris.
- Keep landscaped areas well maintained.

As needed maintenance

- If any signs of clogging are noted, use high performance vacuum equipment. If pavement is determined to be clogged after vacuuming with high performance equipment, test sections test the infiltration rate using ASTM C1701 and compare against original test results after construction, if available. A minimum tested infiltration rate of 10 inches per hour indicates the system is approaching near-clogged condition.
- If routine cleaning does not restore infiltration rates, then reconstruction of the pervious surface area that is not infiltrating is required.
- The surface area affected by hydraulic failure should be lifted after vacuuming, if possible, for inspection of the internal materials to identify the location and extent of the blockage.
- Surface materials should be lifted and replaced if damaged by abrasive or brush cleaning. Geotextiles may need complete replacement.
- Sub-surface layers may need cleaning and replacing.
- Removed silts may need to be disposed of as controlled waste.

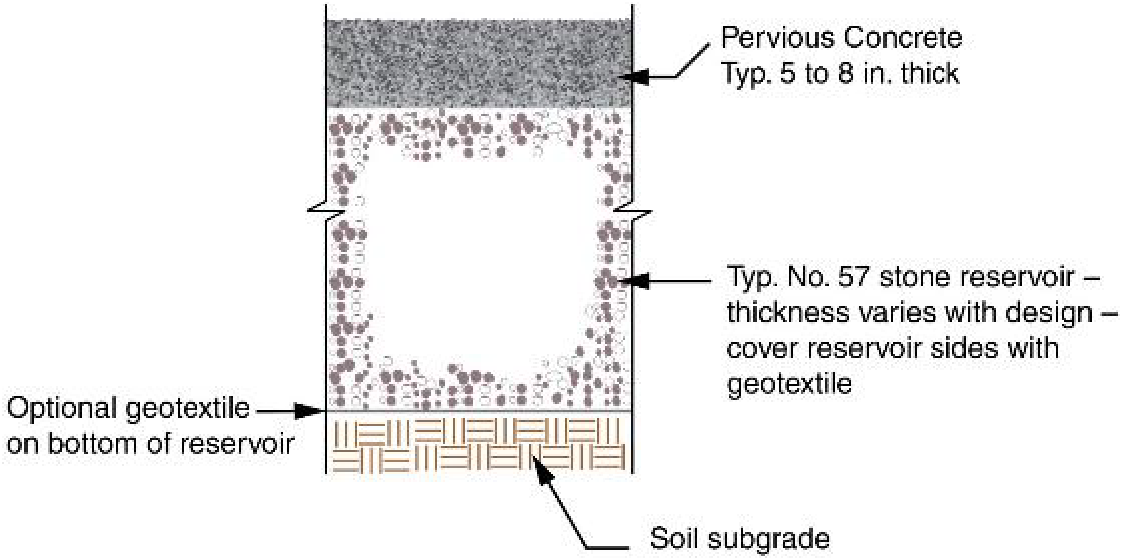

Figure 8-27. Typical Pervious Concrete Pavement.

Note: Aggregate materials shall be clean virgin rock; recycled concrete aggregate (RCA) is prohibited.

Source: Interlocking Concrete Pavement Institute

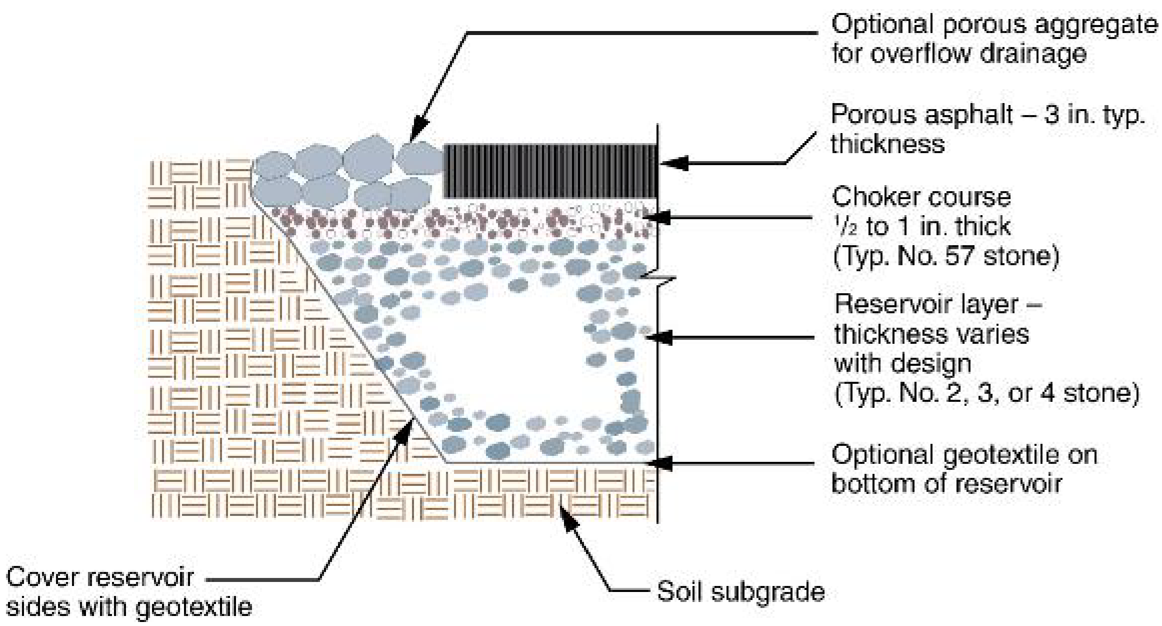

Figure 8-28. Typical Porous Asphalt Pavement.

Note: ASTM No. 3 or 4 stone may be substituted for No. 2 stone. Aggregate materials shall be clean virgin rock; recycled concrete aggregate (RCA) is prohibited.

Source: Interlocking Concrete Pavement Institute

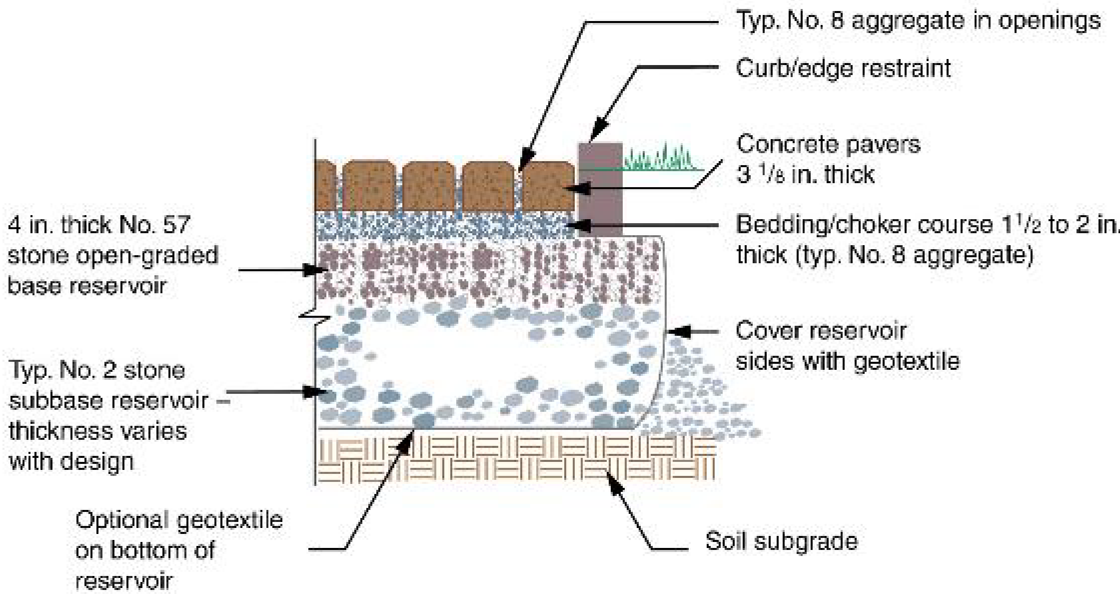

Figure 8-29. Typical Permeable Interlocking Concrete Pavement.

Note: ASTM No. 3 or 4 stone may be substituted for No. 2 stone.
ASTM No. 89 or 9 stone may be used in the paver openings.
Aggregate materials shall be clean virgin rock; recycled concrete aggregate (RCA) is prohibited.
Source: Interlocking Concrete Pavement Institute

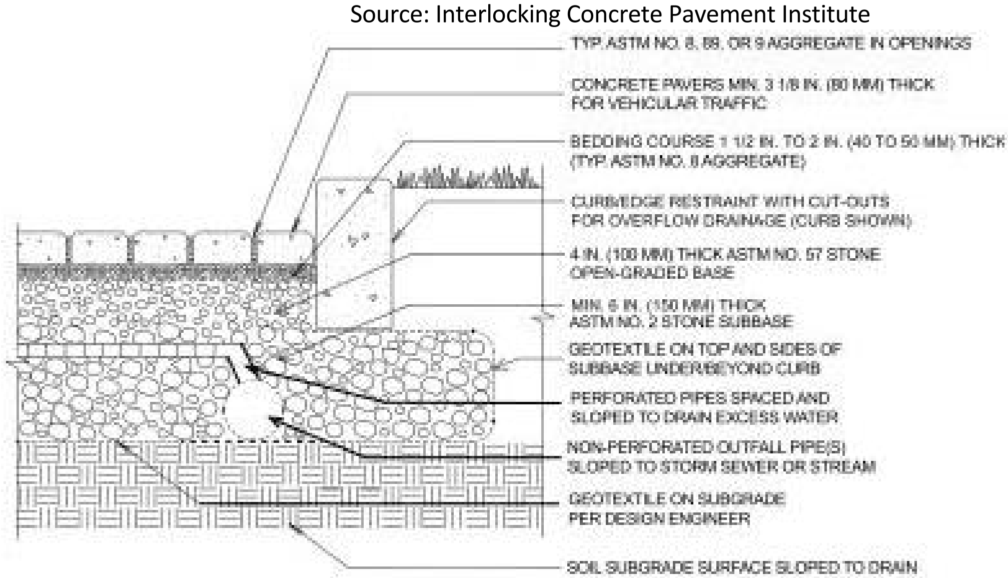

Figure 8-30. Underdrain Installation in Pervious Pavement.

Note: Perforated pipes can be raised above the soil subgrade to drain water from storm events that generate high flows. Aggregate materials shall be clean virgin rock; recycled concrete aggregate (RCA) is prohibited.
Source: Interlocking Concrete Pavement Institute

8.7 GRID PAVEMENTS

Figure 8-31. Turf Block Fire Access
Source: City of Pleasanton

Best Uses

- Overflow parking areas
- Emergency access lanes
- Common areas
- Lawn/landscape buffers
- Pathways

Advantages

- Flow attenuation
- Removes fine particulates
- Reduces need for treatment

Limitations

- May clog without periodic vacuum cleaning
- Lightly-trafficked areas only
- Higher installation costs than conventional paving

Grid pavements consist of concrete or plastic grids used in areas that receive occasional light traffic (i.e., < 7,500 lifetime 18,000-lb equivalent single axle loads or a Caltrans Traffic Index < 5), typically overflow parking or fire access lanes. The surfaces of these systems can be planted with topsoil and grass in their openings and installed over a sand bedding layer that rests over a compacted, dense-graded aggregate base (see **Figures 8-30** and **8-31**). When planted with turf grass, they also assist in providing a cooler surface than conventional pavement. These systems are also known as turf block or grasscrete. Grid pavements can also be designed with aggregates in the openings.

Figure 8-32. Plastic Grid Pavement for Occasional Vehicular Use or for Emergency Access Lanes.
Note: Sand and turf grass can be replaced with ASTM No. 8 aggregate in cell openings.
Source: Interlocking Concrete Pavement Institute. The Clean Water Program gratefully acknowledges the contributions of Mr. David Smith, Technical Director of the Interlocking Concrete Pavement Institute, to this section of the C.3 Technical Guidance, including pavement sections, design details, and specifications.

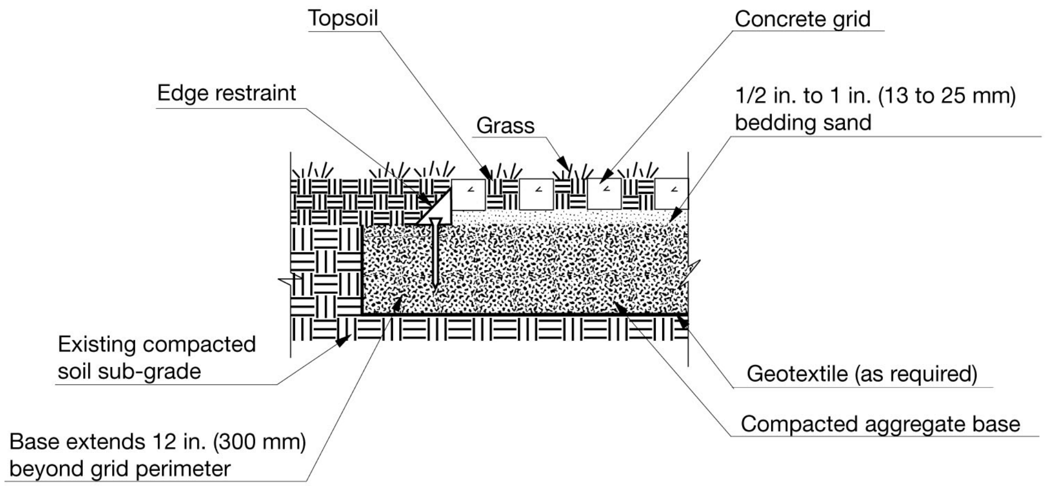

Figure 8-33. Concrete Grid Pavement for Occasional Vehicular Use or for Emergency Access Lanes.
Note: Aggregate materials shall be clean virgin rock; recycled concrete aggregate (RCA) is prohibited.

Source: Interlocking Concrete Pavement Institute

Grid pavements can be installed over open-graded aggregate bases for additional water storage, infiltration, and outflow via an underdrain in low permeability soils if needed. Grid pavements are not considered an impervious area and can function as "self-treating areas" when supported by an aggregate base sufficient to hold the volume of rainfall runoff specified in the MRP Provision C.3.d. If a grid pavement is designed with a dense-graded base, instead of an open-graded base, this design is not suitable to accept runoff from adjacent areas.

8.7.1 Design and Sizing Guidelines

To provide satisfactory performance, the following criteria should be considered:

Subgrade and Site Requirements

- The soil subgrade should be able to sustain anticipated traffic loads without excessive deformation while temporarily saturated.
- The soil subgrade should have sufficient infiltration rate to meet the requirements in this manual or include an underdrain(s) to remove detained flows within the aggregate base. The surfacing and bedding materials are not used to store water. To test the infiltration rate of underlying soils, use the ASTM D3385-09 Standard Test Method for Infiltration Rate of Soils in Field Using Double-Ring Infiltrometer, or other test method approved by the local jurisdiction. Due to site variability and the potential for uncertainty in conducting tests, it is recommended that multiple tests be conducted for each area to be paved and a representative corrected infiltration rate be selected for design.
- In soils with less than 0.5-inch per hour infiltration rate, subject to approval by the local jurisdiction, one alternative approach to providing an underdrain, is to direct overflows from the surface of the pavement into bioretention areas and overflow drains. A second alternative approach, subject to approval by the local jurisdiction, is to increase the depth

of subbase/base layer. The design should allow the stored water to infiltrate into the subgrade within 48 hours.

- Depth to seasonal high groundwater level should be at least 5 feet from the bottom of the base of the grid pavement system unless a different separation is recommended by the geotechnical engineer.
- Grid pavement systems should not be used where site conditions do not allow infiltration.
- Grading of the soil subgrade below the pervious pavement should be relatively flat (not to exceed 2% slope) to promote infiltration across the entire area.
- A slope of 1% is recommended for pavement surface. Slopes of grid pavements should not exceed 5%. Slopes exceeding 3% typically require berms or check dams placed laterally over the soil subgrade to slow the flow of water and provide some infiltration.

Aggregates

- When subject to vehicular traffic, all dense-graded aggregate bases should conform to Caltrans Class 2 or similar specifications as directed by the municipality. All open-graded aggregates should be crushed material, minimum 50% with one or more fractured faces conforming to Caltrans test method CT 205; have Los Angeles Rattler no greater than 45% loss at 500 revolutions per Caltrans test method CT 211; and a minimum Cleanness value of 75 per Caltrans test method CT 211. Sieve analysis should conform to Caltrans test method CT 202.
- Aggregate materials shall be clean virgin rock and shall avoid introducing to the pervious paving system debris, sediment, grease, oil, and other pollutants. The use of recycled concrete aggregate (RCA) is prohibited.
- If the subbase/base layer is sized to hold at least the C.3.d volume of runoff, the area of pervious paving is not considered an impervious surface and can function as a self-treating area as described in Section 5.1.
- If an underdrain is used, position perforated pipe a minimum of 2 inches above the surface of the soil subgrade and provide non-perforated, upturned pipe for outflows. To be considered a self-treating area or self-retaining area, the outflow should be positioned above the portion of the base layer sized to meet the C.3.d sizing criteria.
- Design calculations for the base should describe and quantify the following:
    - Soil type/classification and soil permeability rate; for vehicular areas, k-values (psi/cubic inch) or R-values characterizing soil strength when saturated.
    - Fill type if used, installation, and compaction methods plus target densities.
    - Lifetime expected traffic loading in 18,000 lb. equiv. single axle loads or Caltrans Traffic Index; the maximum Traffic Index <5.

Grid pavement materials

- Concrete grids should conform to the dimensional tolerances, compressive strength, and absorption requirements in ASTM C1319 and should be a minimum of 3 1/8 in. thick.

- Aggregates used for bedding and filling the grid openings should be No. 8 stone or similar sized crushed materials.
- If topsoil and grass are used in the grids, they should be placed over a 1 in. thick layer of bedding sand and over Caltrans Class 2 base compacted to a minimum 95% standard Proctor density. Do not use topsoil, grass, sand bedding and geotextile over an open-graded aggregate base as the surface has a low infiltration rate.
- Grid pavements should have edge restraints to render them stationary when subject to pedestrian or vehicular traffic.

Design and installation recommendations

- All designs should be reviewed and approved by a licensed civil or geotechnical engineer or as directed by the municipality.
- Design for plastic grid pavements should be done per the manufacturer's recommendation. Such designs should be reviewed by the manufacturer or as directed by the municipality.
- Design for concrete grid pavements should be reviewed by the concrete paver manufacturer, the Interlocking Concrete Pavement Institute (ICPI) (www.icpi.org), or as directed by the municipality.
- Consult ICPI Tech Spec 8 Concrete Grid Pavements available at www.icpi.org for additional design information and guide specifications.
- Installation of grid pavements should be done by contractors who have constructed grid pavement projects similar in size to that under consideration. Only contractors holding a certificate of completion in the Interlocking Concrete Pavement Institute's Commercial Paver Technician Course should be considered for concrete grid pavement construction, and such contractors should have at least one supervisor with this certificate on the job site at all times. More information can be found at www.icpi.org.
- Protect excavated areas from excessive compaction due to construction traffic and protect the finished pavement from construction traffic.
- Post a sign at grid pavement sites to alert maintenance personnel to keep silt and debris from entering onto the grid pavements.

8.7.2 Common Maintenance Concerns for Grid Pavements

The primary maintenance objective is to prevent clogging of the pervious matrix through routine maintenance. Periodically more intensive maintenance may be needed to restore infiltration capacity.

Standard routine maintenance

- Irrigate and mow turf block grass as required for selected turf species; no-mow and low-water species are advised.

- On a monthly basis, remove any accumulated trash or debris from pervious paving surface and/or between joints. Also remove any trash or debris from downspouts to pervious paving facility or in outlets to storm drains.
- On a biannual basis (pre- and post-wet season) Vacuum sweep the surface of the unplanted turf block and permeable joint pavers (for pervious joint pavers with sand in joints use minimum suction required to remove surface debris and minimize aggregate loss) and clean surface of pervious pavement, taking care not to move fine sediments into any permeable joints. If power washing is used, aim the spray at a minimum 45-degree angle in relation to the pavement surface, to avoid dislodging aggregate. Avoid forcing fine sediments into the pervious pavement.
- Before and after the wet season, and monthly during the wet season, conduct inspections to assure proper functioning of pervious paving. Items to inspect include:
    - Check for standing water on the pavement surface.
    - Inspect permeable joint pavers for any signs of hydraulic failure.
    - Inspect outlets and remove accumulated trash and debris.
    - Keep landscaped areas well maintained.

As needed maintenance:

- If any signs of clogging are noted, use high performance vacuum equipment. If pavement is determined to be clogged after vacuuming with high performance equipment, test sections test the infiltration rate using ASTM C1781 and compare against original post-infiltration test results, if available. A minimum tested infiltration rate of 10 inches per hour indicates the system is approaching near-clogged condition.
- If routine cleaning does not restore infiltration rates, then reconstruction of the pervious surface area that is not infiltrating is required.
- The surface area affected by hydraulic failure should be lifted, if possible, for inspection of the internal materials to identify the location and extent of the blockage.
- Surface materials should be lifted and replaced if damaged by brush (or abrasive) cleaning.
- Sub-surface layers may need periodic cleaning and replacing.
- Deposits may need to be disposed of as controlled waste.
- Replace permeable joint materials, as necessary.

8.8 GREEN ROOFS

Figure 8-34. Extensive Green Roof in Emeryville

Best Uses

- Infill developments with limited space
- For innovative architecture
- Urban centers

Advantages

- Minimizes roof runoff
- Reduces “heat island” effect
- Absorbs sound
- Provides bird habitat
- Longer “lifespan” than conventional roofs
- Aesthetics

Limitations

- Sloped roofs require steps
- Non-traditional design
- High installation costs

A green roof can be either ***extensive***, with a 3 to 7 inches of lightweight substrate and a few types of low-profile, low-maintenance plants, or ***intensive*** with a thicker (8 to 48 inches) substrate, more varied plantings, and a more garden-like appearance. The extensive installation at the Gap Headquarters in San Bruno **(Figure 8-31**), has experienced relatively few problems after nearly a decade in use. Native vegetation may be selected to provide habitat for endangered species of butterflies, as at the extensive green roof of the Academy of Sciences in San Francisco. See www.greenroofs.com for information about and more examples of green roofs.

8.8.1 Design and Sizing Guidelines

- Green roofs are considered “self-treating areas” or “self-retaining areas” and may drain directly to the storm drain, if they meet the following MRP requirements:
  - The green roof system planting media should be sufficiently deep to provide capacity within the pore space of the media to capture 80 percent of the average annual runoff.
  - The planting media should be sufficiently deep to support the long-term health of the vegetation selected for the green roof, as specified by the landscape architect or other knowledgeable professional.

- Extensive green roof systems contain layers of protective materials to convey water away from the roof deck. Starting from the bottom up, a waterproof membrane is installed, followed by a root barrier, a layer of insulation (optional), a drainage layer, a filter fabric for fine soils, the engineered growing medium or soil substrate, and the plant material.
- The components of intensive green roofs are generally the same as those used in extensive green roofs, with differences in depth and project-specific design application.
- Design and installation is typically completed by an established vendor.
- Follow manufacturer recommendations for slope, treatment width, and maintenance.
- Either grass or a diverse selection of other low growing, drought tolerant, native vegetation should be specified. Vegetation whose growing season corresponds to the wet season is preferred. See **Appendix B** for planting guidance.
- Frequent watering may be needed during hot winder periods.
- Green roofs need to be free of gullies or rills.
- Irrigation is typically required.

8.8.2 Common Maintenance Concerns for Green Roofs

- Inspection required at least semiannually. Confirm adequate irrigation for plant health; inspect liner for leaks; inspect downspouts and gutters for clogging.
- Fertilize and replenish growing media as specified by landscape designer and as needed for plant health. See **Appendix B** for alternatives to quick release fertilizers.
- Replace wind-scoured and eroded media and plants.

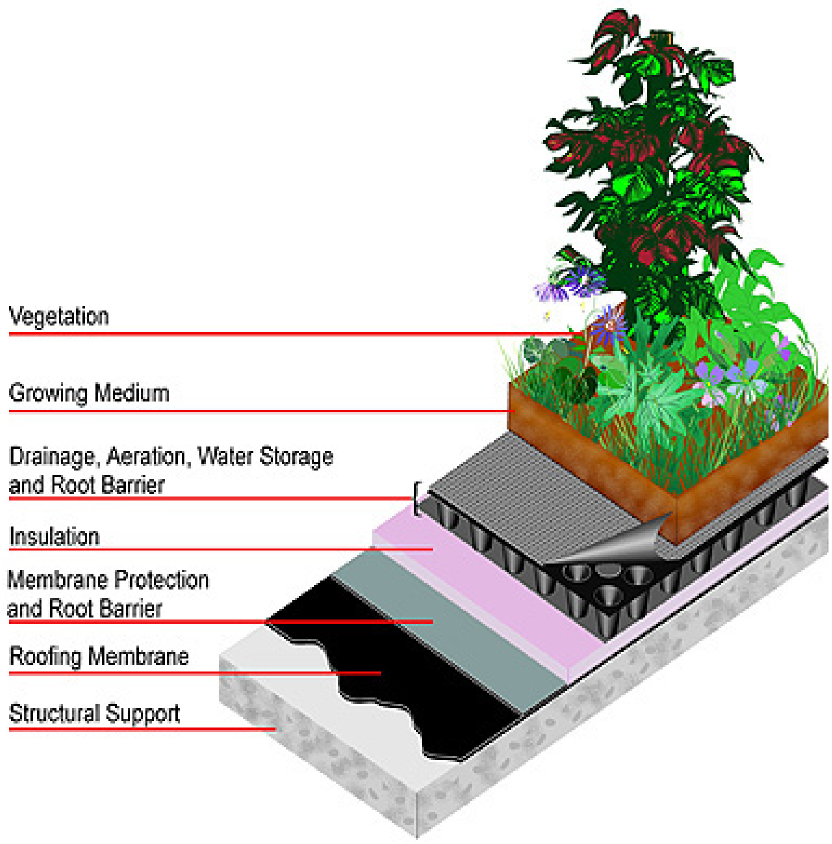

Figure 8-35. Green Roof Cross-section
Source: American Wick Drain Corp

Figure 8-36. Extensive Green Roof at Gap Corporate Headquarters, San Bruno
Source: William McDonough & Partners

Figure 8-37. Plants selected to support endangered butterflies.
Source: California Academy of Sciences

Figure 8-38. Intensive Green Roof at Kaiser Center, Oakland.

8.9 RAINWATER HARVESTING AND USE

Figure 8-39. Rainwater is collected and used for flushing toilets at Mills College, Oakland.

Best Uses

- High density residential or office towers with high toilet flushing demand.
- Park or low density development with high irrigation demand.
- Industrial use with high non-potable water demand.

Advantages

- Helps obtain LEED or other credits for green building.
- Replaces potable water use.

Limitations

- High installation and maintenance costs.
- Low return on investment.
- Municipal permitting requirements not standardized.

Rainwater harvesting systems area engineered to store a specified volume of water with no discharge until this volume is exceeded. Storage facilities that can be used to harvest rainwater include above-ground or below-ground cisterns, open storage reservoirs (e.g., ponds and lakes), and various underground storage devices (tanks, vaults, pipes, arch spans, and proprietary storage systems). Rooftop runoff is most often collected in harvesting/use systems because it often contains lower pollutant loads than surface runoff, and it provides accessible locations for collection. Rainwater can also be stored under hardscape elements, such as paths and walkways, by using structural proprietary storage products. Water stored in this way can be used to supplement onsite irrigation needs, typically requiring pumps to connect to the irrigation system. Rain barrels are often used in residential installations, but typically collect only 55 to 120 gallons per barrel; whereas systems that are sized to meet Provision C.3 stormwater treatment requirements typically require thousands of gallons of storage.

Uses of harvested water

Uses of captured water potentially includes irrigation, indoor non-potable use such as toilet flushing, industrial processing, or other uses. The Harvest and Use, Infiltration and Evapotranspiration Feasibility/Infeasibility Criteria Report prepared by the Bay Area Stormwater Management Agency's Association (BASMAA 2011) identified toilet flushing as the use that is most likely to generate sufficient demand to use the amount of runoff specified in Provision C.3.d. The demand for indoor toilet flushing is most likely to equal to the C.3.d amount of stormwater in high rise residential or office projects, and in schools. Irrigation demand may equal the C.3.d amount of runoff in projects with a very high percentage of landscaping.

System components

Rainwater harvesting systems typically include: (1) methods to divert stormwater runoff to the storage device, (2) an overflow for when the storage device is full, 3) a distribution system to get the water to where it is intended to be used, and (4) filtration and treatment systems (see Treatment Requirements below).

Leaf screens, first-flush diverters, and roof washers

These features may be installed to remove debris and dust from the captured rainwater before it goes to the tank. The initial rainfall of any storm often picks up the most pollutants from dust, bird droppings and other particles that accumulate on the roof surface between rain events. Leaf screens remove larger debris, such as leaves, twigs, and blooms that fall on the roof. A first-flush diverter routes the first flow of water from the catchment surface away from the storage tank to remove accumulated smaller contaminants, such as dust, pollen, and bird and rodent droppings. A roof washer may be placed just ahead of the storage tank and filters small debris for systems using drip irrigation. Roof washers consist of a tank, usually between 30- and 50-gallon capacity, with leaf strainers and a filter.

Codes and standards

The California Plumbing code includes rainwater harvesting and graywater regulations. The California Plumbing Code Chapter 16 allows rainwater to be harvested from roof tops for use in outdoor irrigation and some non-potable indoor uses. Rainwater collected from parking lots or other impervious surfaces at or below grade is considered graywater and subject to the water quality requirements for graywater in California Plumbing Code Chapter 16. Some small catchment systems (5,000 gallons or less) being used for non-spray irrigation do not require permits – see California Plumbing Code for more details.

The California Plumbing Code defines rainwater as "precipitation on any public or private parcel that has not entered an offsite storm drain system or channel, a flood control channel, or any other stream channel, and has not previously been put to beneficial use." The Rainwater Capture Act of 2013, which took effect January 1, 2013, specifically states that the use of rainwater collected from rooftops does not require a water rights permit from the State Water Board.

The ARCSA/ASPE Rainwater Catchment Design and Installation Standard may also be used as a resource.

Regulations governing rainwater capture and use are evolving. Pursuant to California Water Code section 13558 the State Water Board is in the process of adopting regulations for risk-based water quality standards for the onsite treatment and reuse of non-potable water for non-potable end uses in multifamily residential, commercial, and mixed-use buildings.[16] Designers

[16] See https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/onsite_nonpotable_reuse_regulations.html for updates regarding these regulations.

planning to implement a rainwater capture system need to consult with state and local authorities to confirm design standards and treatment requirements.

Treatment requirements

Rainwater catchment system treatment requirements in the California Plumbing Code vary depending on the use. Small systems described above are not required to treat rainwater. Other systems may be required to remove turbidity, bacteria, particulates and/or debris. Uses of rainwater for car washing, drip irrigation and small volume spray irrigation require filtration, while uses for large volume spray irrigation, toilet flushing, ornamental water features and cooling tower makeup water require filtration and disinfection. More details are provided in California Plumbing Code Chapter 16, Table 1603.5.[17]

8.9.1 Design and Sizing Guidelines

Hydraulic sizing

- If a project applicant voluntarily chooses to design a rainwater harvesting system that will fully meet Provision C.3 stormwater requirements, there must be sufficient demand to use 80 percent of the average annual rainfall runoff, as specified in Provision C.3.d. Project designers may refer to the sizing curves included in Appendix F of the 2011 report, "Harvest and Use, Infiltration and Evapotranspiration Feasibility/Infeasibility Criteria Report" (BASMAA 2011) to size the cistern (or other storage device) to achieve the appropriate combination of drawdown time and cistern volume to harvest and use the C.3.d amount of runoff. These curves are included in **Appendix N,** Rainwater Harvesting.

Design guidelines for all systems

- Equip water storage facility covers with tight seals, to reduce mosquito-breeding risk. Follow mosquito control guidance in Appendix G.
- Water storage systems in proximity to the building may be subject to approval by the building official. The use of waterproofing as defined in the building code may be required for some systems, and the municipality may require periodic inspection. Check with municipal staff for the local jurisdiction's requirements.
- Do not install rainwater storage devices in locations where geotechnical/stability concerns may prohibit the storage of large quantities of water. Above-ground cisterns should be located in a stable, flat area, and anchored for earthquake safety.
- To avoid excess hydraulic pressure on subsurface cisterns:
  - The depth to seasonal high groundwater level should be at least 5 feet from the bottom of the cistern.
  - A geotechnical engineer should be consulted for situations where the bottom of the cistern is less than 5 feet from the seasonal high groundwater level.
- Provide separate piping without direct connection to potable water piping. Dedicated piping should be color coded and labeled as harvested rainwater, not for consumption.

[17] https://epubs.iapmo.org/2022/CPC/, see page 323.

Faucets supplied with non-potable rainwater should include signage identifying the water source as non-potable and not for consumption.

- The harvesting system must not be directly connected to the potable water system at any time.
- When make-up water is provided to the harvest/use system from the municipal system, prevent cross contamination by providing a backflow prevention assembly on the potable water supply line, an air gap, or both, to prevent harvested water from entering the potable supply. Contact local water system authorities to determine specific requirements.
- The rainwater storage facility should be constructed using opaque, UV resistant materials, such as heavily tinted plastic, lined metal, concrete, or wood, or protected from sunlight by a structure or roof to prevent algae growth. Check with municipal staff for local building code requirements.
- Storage facilities should be provided with access for maintenance, and with a means of draining and cleaning.

Design guidelines for indoor use

- Avoid harvesting water for indoor use from roofs with architectural copper, which may discolor porcelain.
- Provide filtration of rainwater harvested for indoor non-potable use, as required by the plumbing code and any municipality-specific requirements.

Design guidelines for irrigation use

- Water diverted by a first flush diverter may be routed to a landscaped area large enough to accommodate the volume, or a hydraulically-sized treatment measure.
- First flush diverters should be installed in such a way that they will be easily accessible for regular maintenance.
- Do not direct to food-producing gardens rainwater harvested from roofs with wood shingles or shakes (due to the leaching of compounds), asphalt shingles, tar, lead, or other materials that may adversely affect food for human consumption.

8.9.2 Common Maintenance Concerns for Rainwater Harvesting Systems

Routine maintenance

- Conduct annual inspections of backflow prevention systems.
- If rainwater is provided for indoor use, conduct annual water quality testing.
- Clean gutters and first-flush devices at least annually, and as needed, to prevent clogging.
- Conduct regular inspection and replacement of treatment system components, such as filters and UV lights.
- If the system includes a roof washer, regularly inspect, and clean the roof washer to avoid clogging.
- Regularly inspect for and repair leaks.

Maintenance requirements specific to cisterns

- Flush cisterns annually to remove sediment.
- For buried structures, vacuum removal of sediment is required.
- Brush the inside surfaces and thoroughly disinfect twice per year.

Maintenance requirements specific to rain barrels

- Inspect rain barrels four times per year and after major storms
- Remove debris from screens as needed.
- Replace screens, spigots, downspouts, and rain leaders as needed.

8.10 MEDIA FILTER

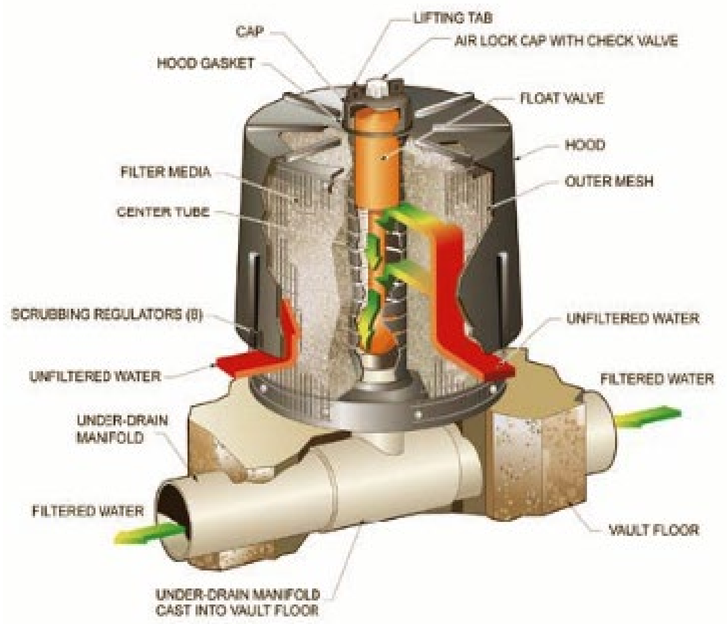

Figure 8-40. System C Filter Cartridge, Typically Used as Part of Array

Note: Proprietary products shown are for general information only and are not endorsed by the Clean Water Program. An equivalent filter may be used. Source: Contech Stormwater Solutions, 2006.

Best Uses

- Special Projects
- As part of a treatment train (pre-treatment)

Advantages

- Less area required
- Customized media
- Customized sizing

Limitations

- Not considered LID
- No removal of trash without pre-treatment
- High installation and maintenance costs.
- Confined space entry may be required
- Media filtration is allowed only for qualifying Special Projects

Media filters are flow-through treatment systems that remove pollutants from runoff through screening and adsorptive media such as sand, peat, or manufactured media. Types of allowable non-vegetated media filters include: 1) bed filters, such as Austin or Delaware sand filters; 2) proprietary modular cartridge filters; and 3) powered filtration systems.

Under MRP requirements, the use of media filters as a stand-alone treatment measure is only allowed at Special Projects that qualify for LID treatment reduction credits (see **Appendix J**). Media filters may be used as part of a treatment train, for example, as pre-treatment for a subsurface infiltration system. Because Special Projects are typically dense urban infill projects where LID treatment is infeasible due to space constraints, this section focuses on proprietary cartridge filters, which are suitable for limited space and/or underground applications.

Cartridge filters use cartridges of a standard size that can be filled with various types of manufactured media, individually or in combination, including perlite, zeolite, granular activated carbon, and granular organic media. The media are designed to remove certain types of pollutants. The media cartridges are placed in vaults, utility access holes, or catch basins. In the unit shown in **Figure 8-41**, the water flows laterally (horizontally) into the cartridge to a center tube, then downward to an underdrain system. The number of cartridges required is a function of the water quality design flow rate and cartridge design operating rate (that is, the surface loading rate).

8.10.1 Design and Sizing Guidelines

- Select a media filter product certified by the Washington State Technical Assistance Protocol – Ecology (TAPE) program under the General Use Level Designation (GULD) for Basic Treatment.[18] A list of proprietary media filters currently holding this certification can be obtained from the Department of Ecology's website.[19]
- The treatment measure should be sized based on the water quality design flow specified in MRP Provision C.3.d and the cartridge design operating rate for which the product received TAPE GULD certification.
- Consult the manufacturer to determine the proper type of media for the project site and pollutants of concern. Some use combinations of media to address a wide range of pollutants.
- Pretreatment to remove debris and coarse sediment upstream of the media filter, extending the life of the cartridges, is highly recommended. Pretreatment can be provided in a separate upstream unit and/or within the vault containing the cartridges.
- Consider filter head loss when selecting a media filter product. Your options may be limited if the site has limited available head or if you are trying to match up with existing storm drain invert elevations.
- Include features to bypass high flows, either an internal bypass within the treatment measure or an external bypass using a piping configuration with a flow splitter (see **Figure 8-41** for an example).
- Inform the contractor that if there is a product substitution prior to or during construction, the contractor must obtain approval from the local jurisdiction for any changes in the selected treatment product or design. The substituted product must have TAPE GULD certification for Basic Treatment, and the design calculations must be revised if the design operating rate of the substituted product is different than the originally specified product.

Installation requirements

- Consult the manufacturer to determine the installation requirements for a specific product.
- For vault-based media filters, base preparation will be required. Typically, the soil subbase will need to be compacted and a minimum 6-inch layer of crushed rock base material provided. See manufacturer's specifications.
- To avoid excess hydraulic pressure on subsurface treatment system structures:
  - The depth to seasonal high groundwater level should be at least 5 feet from the bottom of the structure.

[18] "General Use" is distinguished from pilot or conditional use designation, and "Basic Treatment" is distinguished from treatment effectiveness for phosphorus removal. Basic treatment is intended to achieve 80% removal of total suspended solids (TSS) for influent concentrations from 100 mg/l to 200 mg/l and achieve 20 mg/l TSS for less heavily loaded influents.

[19] See: http://www.ecy.wa.gov/programs/wq/stormwater/newtech/technologies.html

- A geotechnical engineer should be consulted for situations where the bottom of the structure is less than 5 feet from the seasonal high groundwater level.

8.10.2 Common Maintenance Concerns for Media Filters

Follow manufacturer requirements for maintenance. Clogging is the primary maintenance concern for media filters, although mosquito control is also an issue. Typical maintenance requirements are as follows:

- During the wet season, inspect periodically for standing water, sediment, trash, and debris, and to identify potential problems.
- Remove accumulated trash and debris in the sedimentation basin, from the riser pipe, and the filter bed during routine inspections.
- Inspect the media filter once during the wet season after a large rain event to determine whether the facility is draining completely within 72 hours.
- If the facility drain time exceeds 72 hours, remove the top 2 inches of media, and dispose of the material. Restore media depth to 18 inches when overall media depth drops to 12 inches.

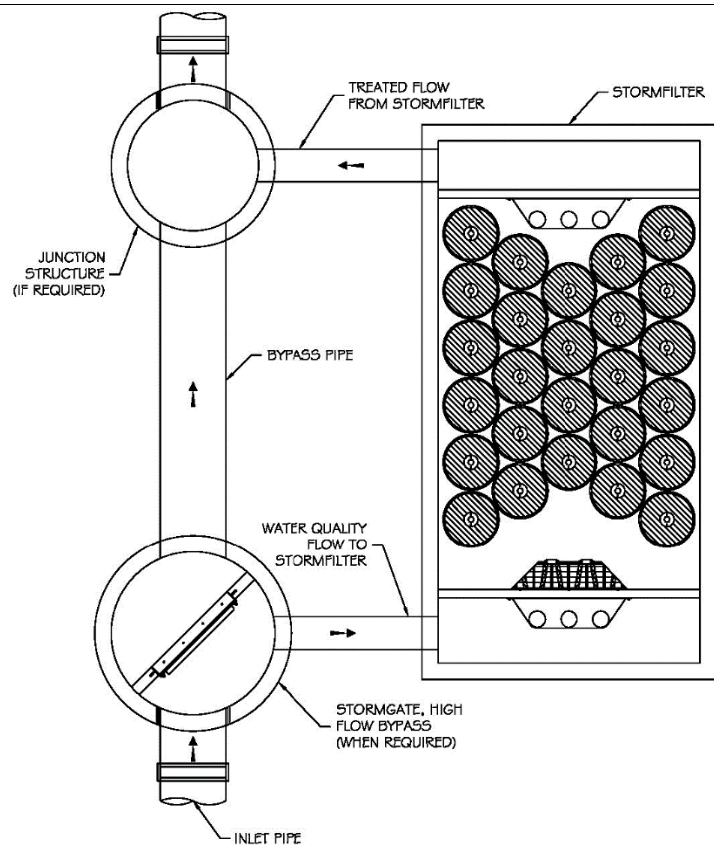

Figure 8-41. Plan View Schematic Detail, Typical System C Filter Array.

Note: The proprietary media filters shown are for general information only and are not endorsed by the Clean Water Program.

Source: Contech Stormwater Solutions, 2006.

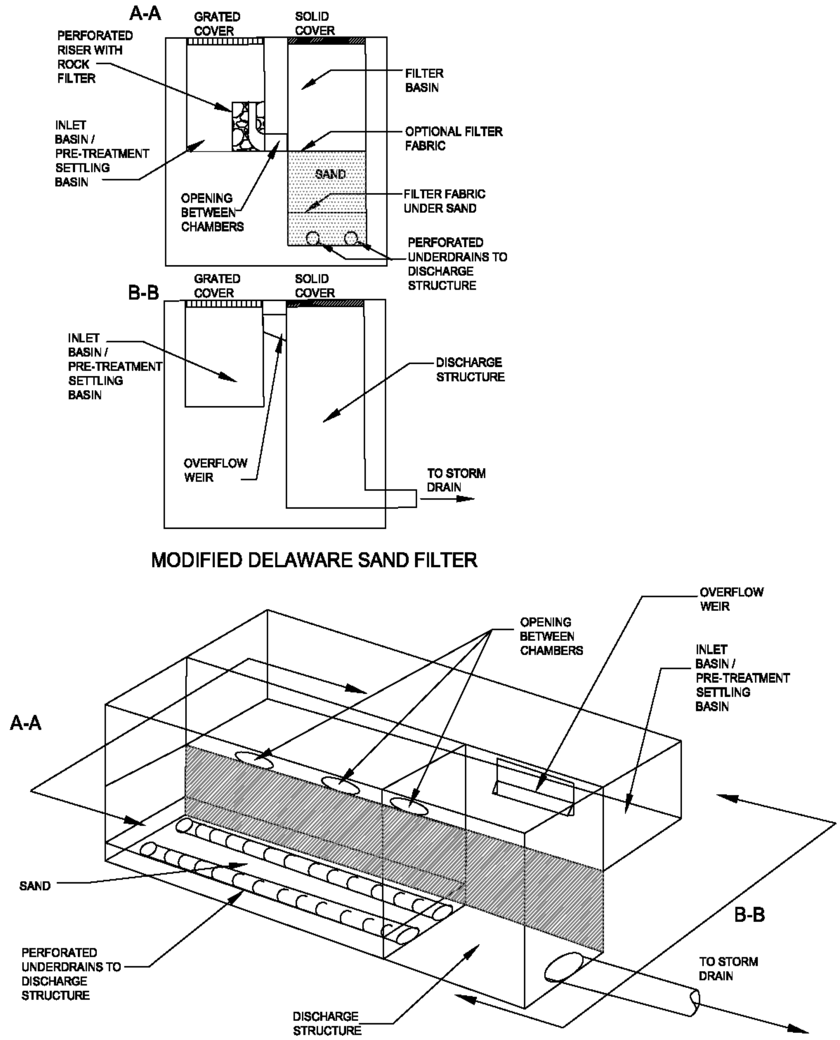

Figure 8-42. Cut Away Profile Views, System A Filter (Modified Delaware Sand Filter).

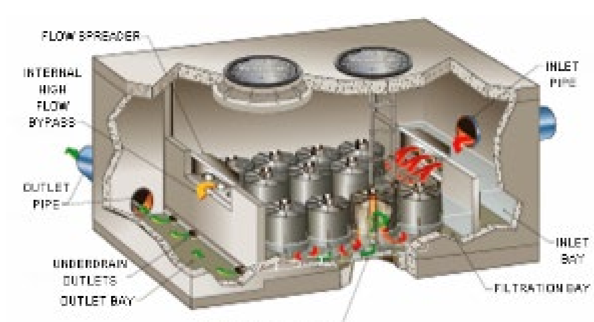

Figure 8-43. Cut Away View, Typical System C Filter Array.

Note: Proprietary media filters shown are for general information only and are not endorsed by the Clean Water Program.

Source: Contech, 2006.

8.11 EXTENDED SUBSURFACE DETENTION/INFILTRATION

Figure 8-44. Subsurface Retention/Infiltration System Installation Under a Parking Lot

Note: Proprietary systems shown are for general information only and are not endorsed by the Clean Water Program.
Source: Contech

Best Uses

- Residential or commercial projects with large parking lots or common areas
- Large drainage areas

Advantages

- Can be located beneath at-grade features
- Systems are modular, allowing flexible design
- Can be sized to meet hydromodification requirements

Limitations

- Not recommended for poorly infiltrating soils or areas with polluted runoff
- Requires pretreatment
- Potential for standing water and mosquito production

Subsurface infiltration systems, also known as infiltration galleries, are underground vaults or pipes that store and infiltrate stormwater. See **Appendix F** for infiltration guidelines. Storage can take the form of large-diameter perforated metal or plastic pipe, or concrete arches, concrete vaults, plastic chambers, or crates with open bottoms. These systems allow infiltration into surrounding soil while preserving the land surface above for parking lots, parks and playing fields. Several vendors offer prefabricated, modular infiltration galleries in a variety of material types, shapes, and sizes. Most of these options are strong enough for heavy vehicle loads and can be reinforced if needed.

Another type of subsurface infiltration system is an exfiltration basin or trench, which consists of a perforated or slotted pipe laid in a bed of gravel. It is similar to an infiltration basin or trench with the exception that it can be placed below paved surfaces such as parking lots and streets. Stormwater runoff is temporarily stored in perforated pipe or coarse aggregate and allowed to infiltrate into the trench walls bottom for disposal and treatment.

Subsurface infiltration systems are appropriate for residential and commercial sites where soil conditions and groundwater depths allow for safe infiltration of stormwater into the ground and no risk of groundwater contamination exists. These systems are not appropriate for industrial sites, locations where chemical spills may occur, fill sites, or steep slopes. Pretreatment of runoff to remove sediment and other pollutants is typically required to maintain the infiltration capacity of the facility, reduce the cost and frequency of maintenance, and protect groundwater quality.

A subsurface fluid distribution system is considered a Class V injection well that is regulated by EPA's Underground Injection Control Program. These systems are authorized by rule and do not require a permit if they do not endanger underground sources of drinking water and comply with federal UIC requirements (see **Appendix F**).

8.11.1 Design and Sizing Guidelines

Drainage area and setback requirements

- In-situ/undisturbed soils should have a low silt and clay content and have infiltration rates greater than 0.5 inches per hour. Hydrologic soil groups C and D are generally not suitable. Soil testing should be performed to confirm infiltration rates, and an appropriate safety factor (minimum of 2) applied as directed by the municipality.
- A 10-foot separation between the bottom of the drain rock and seasonal high groundwater levels is required to avoid the risk of groundwater contamination.
- A setback of 18 feet from building foundations is recommended, or a 1:1 slope from the bottom of the foundation, unless a different setback is allowed by a geotechnical engineer or local standard, or a cutoff wall is provided.

Treatment measure dimensions and sizing (infiltration galleries)

- The subsurface infiltration system should be sized to store and infiltrate the water quality design volume per MRP Provision C.3.d. The system may also be sized to store a larger volume for hydromodification management, if site conditions allow.
- Design the system to drain down (infiltrate) within 72 hours, to provide storage for runoff from back-to-back storms and to avoid mosquito production.
- The maximum allowable effective depth of water (inches) stored in the system can be calculated by multiplying the drawdown time (hours) by the design infiltration rate of the native soils adjusted by the safety factor (in/hr). The required footprint of the system can then be calculated by dividing the storage volume by the effective depth. Consult with the manufacturer for sizing of various components to achieve storage and infiltration of the water quality design volume.
- Install one or more observation wells to monitor water levels (drain time) in the facility. The well should be a minimum 6-inch diameter perforated PVC pipe, which is anchored vertically to a foot plate at the bottom of the facility.
- Maintenance access to the underground galleries must be provided, as periodic cleaning is necessary to maintain performance. Open systems such as large diameter pipe or concrete structures can more easily be inspected and entered for maintenance if necessary than low profile or crate-type systems. The access should be large enough to allow equipment to be lowered into each gallery.
- Provide a layer of aggregate between the subsurface storage component or galleries and native soils to prevent migration of native soils into the storage component.

Treatment measure dimensions and sizing (exfiltration trenches)

- The exfiltration trench should be sized to store and infiltrate the water quality design volume per MRP Provision C.3.d. It is designed similar to an infiltration trench.
- A site-specific trench depth can be calculated based on the soil infiltration rate, aggregate void space, and the trench storage time. The stone aggregate used in the trench is typically 1.5 to 2.5 inches in diameter, which provides a void space of approximately 35 percent. Trenches may be designed to provide temporary storage of storm water, but should drain within 72 hours, to provide storage for runoff from back-to-back storms. To avoid mosquito production, the system should drain within 5 days.
- The trench depth should maintain the required separation from seasonal high groundwater, and the depth should be less than the widest surface dimension, to avoid regulation as a Class V injection well.
- The invert of the trench should be flat (no slope).
- Place permeable filter fabric around the walls and bottom of the trench and top of the aggregate layer. The filter fabric should overlap each side of the trench in order to cover the top of the aggregate. The filter fabric prevents sediment in the runoff and soil particles from the sides of the trench from clogging the aggregate.
- A layer of filter fabric or sand should be placed at the bottom of the trench to keep the rock matrix from settling into the subgrade over time.
- Install an observation well to monitor water levels (drain time) in the trench. The well should be a minimum 6-inch diameter perforated PVC pipe, which is anchored vertically to a foot plate at the bottom of the trench.

Inlets to treatment measure

Flow may enter the treatment measure in the following ways:

- Through a pipe
- Through a drop inlet or catch basin
- Through roof leader or other conveyance from building roof

Pretreatment measures

- The pretreatment measure(s) should be selected based on the expected pollutants on site and the infiltration system's susceptibility to clogging. Sediment removal is important for maintaining the long-term infiltration capability of the system.
- Hydrodynamic separators or media filters are most commonly used for subsurface systems and are allowed as part of a treatment train with the infiltration system. Landscaped-based treatment, such buffer strips, or bioretention may also be used upstream of subsurface systems if appropriate and if space allows.

8.11.2 Common Maintenance Concerns for Subsurface Extended Detention

Primary maintenance activities sediment removal, although mosquito control is a concern. The typical maintenance requirements include the following.

- Remove excess sediment, trash, and debris.
- Check inlets to make sure piping is intact and not plugged. Remove accumulated sediment and debris near the inlet.
- Identify and minimize any sources of sediment and debris. Check rocks or other erosion controls and replace, if necessary.
- Inspect for standing water and correct any problems that prevent the extended detention basin from draining as designed.
- If you observe mosquito larvae, contact Alameda County Mosquito Abatement District, 510-783-7744. (In Albany, Alameda County Vector Control District, 510-567-6800.)
- Remove sediment from the forebay when the sediment level reaches the level identified in the maintenance plan.
- Inspect integrity of the pre-treatment features and repair as needed.
- Remove accumulated trash and debris from the basin at the middle and end of wet season (January and April), or as needed.

8.12 MODULAR SUSPENDED PAVEMENT SYSTEMS

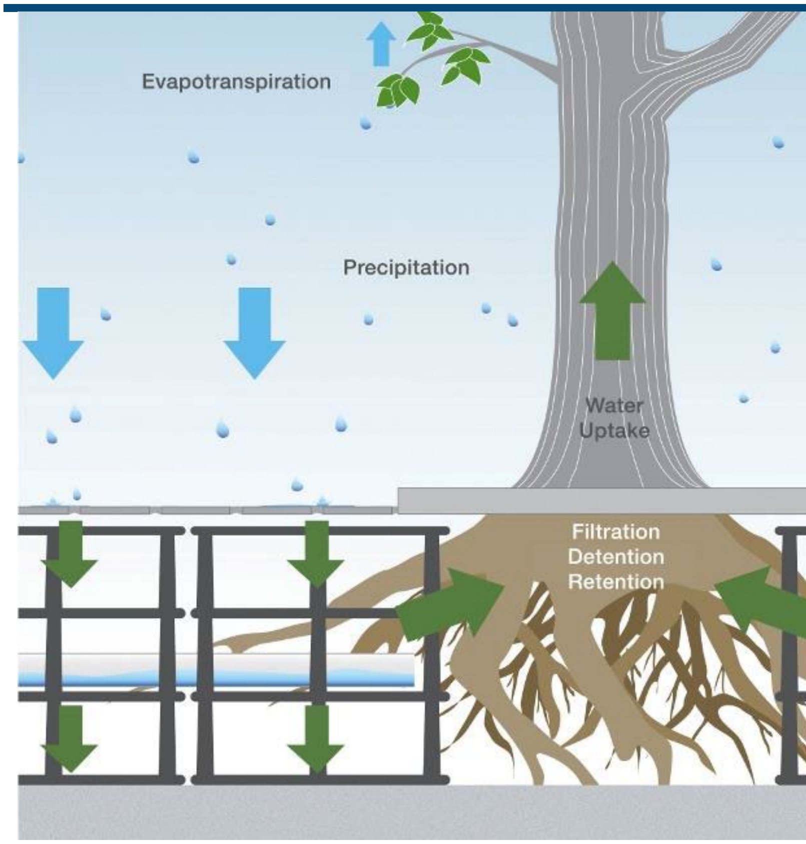

Figure 8-45. Schematic Illustration Load-Bearing Modular Suspended Pavement System

Note: Proprietary systems shown are for general information only and are not endorsed by the Clean Water Program.
Source: Deep Root Technologies

Best Uses

- Parking lots
- Sidewalks, pathways, and plazas
- Limited space
- Landscape design element

Advantages

- Improved tree health
- Customized sizing
- Landscape feature
- Small surface area

Limitations

- Can clog without maintenance
- High Installation cost
- Lightly-trafficked areas only
- High infiltration rate systems are limited to Special Projects

A modular suspended pavement system is a sub-surface treatment facility and typically planted with a tree. In areas that do not have enough open space to grow large trees, these systems provide uncompacted soil volume for tree root growth under load bearing surfaces and create favorable conditions to grow large trees in urban areas.[20] When used as a stormwater treatment system, this rooting area is filled with BSM. The pavement is suspended using modular units so that the soil is protected from the weight of the pavement and the compaction generated from its traffic. These systems were developed for ultra-urban environments with highly impervious contributing drainage areas and limited above ground area for stormwater control and treatment. The treatment process is similar to bioretention and tree well filters.

Suspended pavement systems are appropriate for residential and commercial sites where soil conditions and groundwater depths allow for safe infiltration of stormwater into the ground and no risk of groundwater contamination exists. These systems are not appropriate for

[20] Trees must be included in order to be considered LID treatment. Specific canopy coverage requirements vary by jurisdiction.

industrial sites, locations where chemical spills may occur, fill sites, or steep slopes[21]. Pretreatment of runoff to remove sediment and other pollutants should be installed per the local requirements for bioretention facilities, to maintain the infiltration capacity of the facility, reduce the cost and frequency of maintenance, and protect groundwater quality.

8.12.1 Design and Sizing Guidelines

- Modular Suspended Pavement Systems designed as biotreatment measures may be sized using the 4% method described in **Section 0**, or where allowed by the municipality, the combination flow- and volume-based method described in **Section 0**.
- Follow manufacturer's guidelines for designing and sizing proprietary Modular Suspended Pavement Systems.[22]
- Consult with the local jurisdiction regarding the tree canopy requirements, in general the tree canopy should cover the entire treatment area.
- Select systems that have been tested and shown to support the loading requirements in excess of the AASHTO H/HS-20 standard. Load bearing capacity can be increased or decreased with adjustments to the pavement profile.
- Design to distribute the influent stormwater evenly throughout the system.
- Flows in excess of the treatment flow rate should bypass the tree filter to a downstream inlet structure or other appropriate outfall.
- Compact native soil to 95% to provide sufficient strength to achieve loading requirements. A geotechnical engineer should be consulted to identify whether infiltration is feasible/allowable given the in-situ soil types. If infiltration is feasible, a geotechnical engineer may be consulted to waive the requirement to compact the subgrade to 95% to allow for infiltration, provided that the loading requirements are still met. Infiltration rates should be assessed after compaction has been completed.
- The system should be located at least 5-feet above the seasonal high groundwater table except in special conditions where such siting is unavoidable. For designs that will utilize infiltration, the design should adhere to local requirements for separation of the system base from groundwater, bedrock, or low permeability soil layers.
- Systems can be installed on slopes up to 5% when full load-bearing capacity is needed. Slopes of up to 10% are allowable for locations requiring less load-bearing capacity.
- If slope stability is a concern in or adjacent to the location of the system, consult a geotechnical engineer to ensure that introduction of water to the subgrade would not lead to slope failure. If it is determined that a facility can be sited, an impermeable liner is recommended to minimize introduction of water to the subgrade.

[21] Check applicability with local agencies. Not all agencies allow modular suspended pavement systems as a treatment measure.

[22] Deep Root issued supplemental guidance for designing Silva Cell systems to meet the MRP requirements: https://www.deeproot.com/silvapdfs/resources/SC2/supporting/Silva-Cell-Stormwater-Manual.pdf.

Drainage and setback requirements

- If water flows directly into the system energy dissipation should be provided. This could involve installation of aggregate or concrete pads to reduce inflow velocities and prevent erosion.
- Install a gravel drainage layer at the bottom of the modules. This drainage layer is equivalent to the typical drainage layer that would be provided in a standard bioretention facility.
- Install BSM above the gravel drainage layer to the depth required by local criteria (typically 18 inches).
- Within the modules, above the media layer, a ponding layer can be provided to the depth required by local criteria to provide flow distribution throughout the system.
- A distribution pipe connected to an inlet should consist of 4-inch slotted polyvinyl chloride (PVC) pipe spaced at an average of 10 to 15 feet on-center. The distribution pipe should be sloped at a minimum of 0.5% to allow positive flow through the facility.
- Use of a high flow rate system for which the long-term infiltration rate of the media exceeds 10 inches per hour, is only allowed for Special Projects (see **Appendix J**).
  - If using rock based structural soils which drain quickly, designers should select tree species tolerant of extremely well drained soils.
- Install a root barrier around the top edge of the tree opening to direct roots into the BSM in the Silva Cell system and to prevent root intrusion into pavement.
- Refer to local requirements for infiltrating facilities when planning for setbacks from structures, such as buildings and curbs, water-based infrastructure, like drinking water supply wells, or potential sources of contamination, such as septic fields.
- Standard or pervious concrete, asphalt, or pavers can be installed above the top layer of the system.
  - Removable pavers of pavement panels can facilitate system maintenance.

Inlets to treatment measure

Flow may enter the treatment measure in the following ways:

- Pipe from catch basin or diversion pipe through a drop inlet or catch basin
- Permeable paving
- Roof leader
- Trench drain
- Pretreatment device

8.12.2 Common Maintenance Concerns for Modular Suspended Pavement Systems

Consult manufacturers recommendations for maintenance of Modular Suspended Pavement System. The following maintenance requirements are typical for Modular Suspended Pavement Systems.

- Before and after the wet season, and monthly during the wet season, inspect for evidence of clogging, standing water, and accumulation of sediment or trash. Clear blockages, clear pipes, and remove sediment and trash as needed.
- Check trees monthly for evidence of water stress, adjust irrigation as needed and confirm that water is penetrating the soil column.
- On a biannual basis evaluate the health of trees. Prune trees as needed to promote healthy growth and avoid conflicts with adjacent features (e.g., power lines, buildings).
- Annually, confirm water distribution through underdrains, remove pipe blockages (jet clean, rotary cut roots and debris.)
- Inspect the overflow pipe to make sure that it can safely convey excess flows to a storm drain. Repair or replace any damaged or disconnected piping.
- Minimize the use of pesticides and quick-release synthetic fertilizers and follow the principles of integrated pest management (IPM). Check with the local jurisdiction for any local policies regarding the use of pesticides and fertilizers.
- Periodically (every 4-5 years) inspect for and remove any girdling roots.

9 HYDROMODIFICATION MANAGEMENT MEASURES

This Chapter summarizes the requirements for controlling erosive flows from development projects.

9.1 WHY REQUIRE HYDROMODIFICATION MANAGEMENT?

Changes in the timing and volume of runoff from a site are known as “hydrograph modification” or “hydromodification.” When a site is developed, most rainwater can no longer infiltrate into the soil and flows offsite at faster rates and greater volumes. As a result, erosive levels of flow occur more frequently and for longer periods of time in creeks and channels downstream of the development. Hydrograph modification is illustrated in **Figure 9-1**, which shows the peak stormwater discharges after rainstorms in an urban watershed (red, darker line) compared to a less developed (yellow, lighter line). The figure compares the volume of water discharged over time.

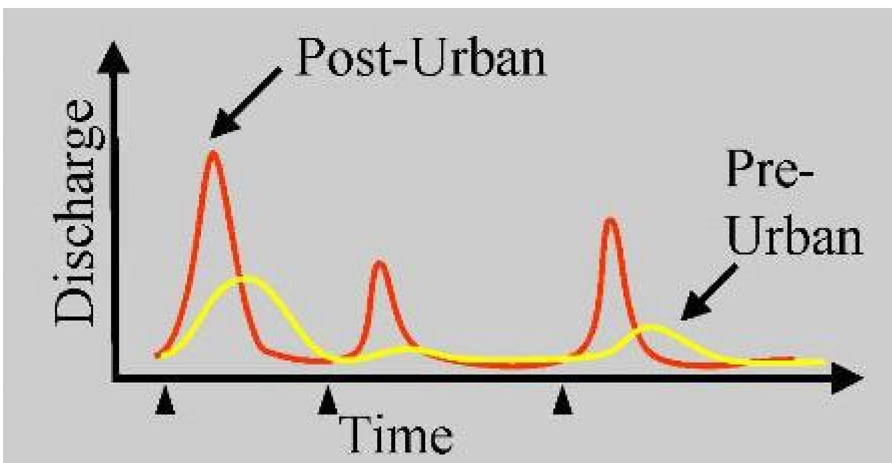

Figure 9-1. Stormwater Peak Discharges in Urban (Red) and Less Developed (Yellow) Watersheds.

Source: NEMO-California Partnership, No Date

In watersheds with large amounts of impervious surface, the larger runoff volumes, and rapid rate of flow for extended durations results in erosion. Natural creeks and earthen channels erode as the channel enlarges in response to the increased flows. Negative effects of erosion include property damage, degradation of stream habitat, and loss of water quality. **Figures 9-2** and **9-3** illustrate the effect of increasing urbanization on stormwater runoff volumes.

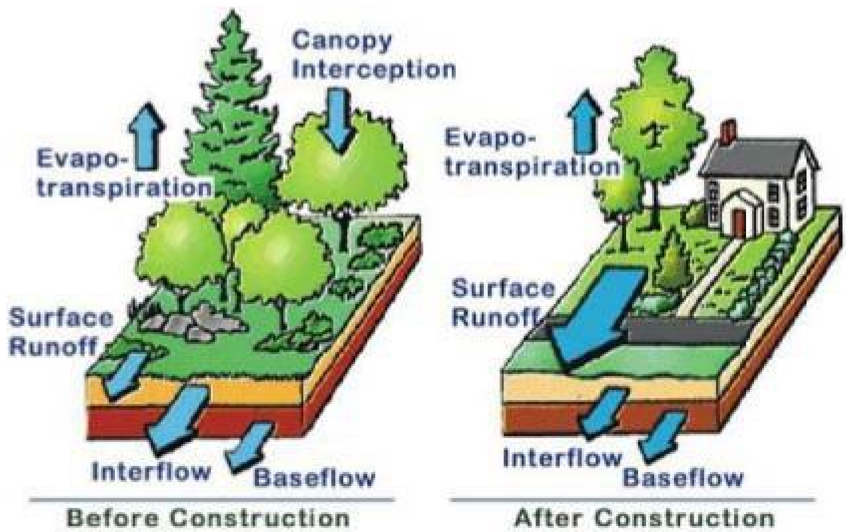

Figure 9-2. Effects of Urbanization on the Local Hydrologic Cycle.

Source: 2000 Maryland Stormwater Design Manual

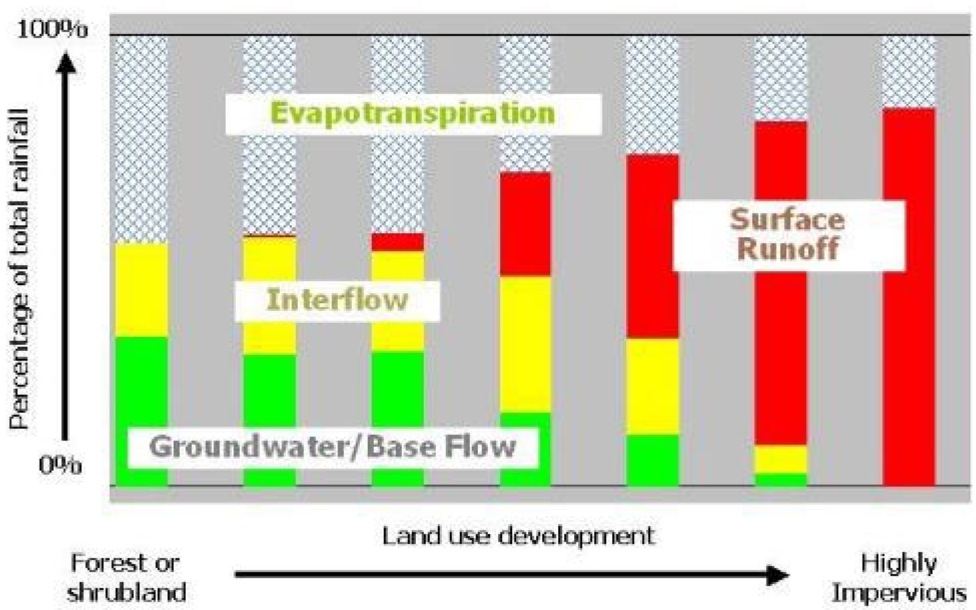

Figure 9-3. Variation in rainfall contribution to different components of the hydrological cycle for areas with different intensity of urban development.

Chart used by permission of Clear Creek Solutions.

Since 2007, hydromodification management (HM) techniques have been required in areas across the San Francisco Bay Area that are susceptible to hydromodification. These techniques focus on retaining, detaining, or infiltrating runoff and matching post-development flows rates to pre-development patterns for a specified range of smaller, more frequent rain events, to prevent increases in channel erosion downstream. Within Alameda County, a simple map-based approach is used to determine which parts of the drainage network are susceptible to hydromodification impacts. Projects that meet certain criteria, and from which runoff passes through the susceptible areas, are required to incorporate one or more HM measures in the design to reduce erosive flows from a range of runoff conditions.

> Hydromodification management (HM) techniques focus on retaining, detaining or infiltrating runoff.

9.2 WHICH PROJECTS NEED TO IMPLEMENT HYDROMODIFICATION MANAGEMENT?

Projects will be required to comply with the HM requirements if they meet the following applicability criteria:

- The project creates and/or replaces one acre or more of impervious surface,
- The project will increase impervious surface over pre-project conditions,
- The project is located in a catchment or sub watershed that is highly developed (i.e., that is 70 percent or more impervious),[23] AND
- The project is located in a susceptible area, as shown on the default susceptibility map.

Appendix I shows a schematic view of a portion of the hydromodification susceptibility map. The full map may be downloaded from the Clean Water Program website https://accwp.maps.arcgis.com/apps/webappviewer/index.html?id=11d7a1bfb90d46ce80f94defc03d012c in an interactive format that enables zooming to a closer view of the project vicinity with local streets. The requirements do not apply to projects that drain directly to the bay or tidal channels nor to projects that drain into channel segments that have been hardened on three sides and/or are contained in culverts continuously downstream to their outfall in a tidal area. Note that project sites draining to earthen flood control channels are not automatically exempt from HM requirements.

For guidance on whether it is necessary to implement controls, see the following description of the color coding used in the countywide map:

- *Solid pink areas* – Pink designates hilly areas with high slopes (greater than 25 percent). The HM Standard and all associated requirements apply in areas shown in solid pink on the map. In this area, the HM Standard does not apply if a project proponent demonstrates that all project runoff will flow through enclosed storm drains, existing concrete culverts,

[23] 3 The Permittees' maps accepted for Order No. R2-2009-0074 were prepared using this standard, adjusted to 65 percent imperviousness to account for the presence of vegetation on the photographic references used to determine imperviousness. Thus, the maps for are accepted as meeting the 70 percent requirement.

or fully hardened (with bed and banks continuously concrete-lined) channels to the tidal area shown in light gray.

- *Purple/red hatched areas* – These are upstream of areas where hydromodification impacts are of concern because of factors such as bank instability, sensitive habitat, or restoration projects. The HM Standard and all associated requirements apply in areas shown in purple/red (printer-dependent) hatch marking on the map. Projects in these areas may be subject to additional agency reviews related to hydrologic, habitat or other watershed-specific concerns.
- *Solid white areas* – Solid white designates the land area between the hills and the tidal zone. The HM Standard and all associated requirements apply to projects in solid white areas unless a project proponent demonstrates that all project runoff will flow through fully hardened channels. Short segments of engineered earthen channels (length less than 10 times the maximum width of trapezoidal cross-section) can be considered resistant to erosion if located downstream of a concrete channel of similar or greater length and comparable cross-sectional dimensions. Plans to restore a hardened channel may affect the HM Standard applicability in this area.
- *Solid gray areas* – Solid gray designates areas where streams or channels are tidally influenced or primarily depositional near their outfall in San Francisco Bay. The HM Standard does not apply to projects in this area. Plans to restore a hardened channel may affect the HM Standard applicability in this area.
- *Dark gray, Eastern County area* – Dark gray designates the portion of eastern Alameda County that lies outside the discharge area of this NPDES permit. This area is in the Central Valley Regional Board's jurisdiction.

Please note that projects located in susceptible areas are encouraged to include hydrologic source control measures for HM if they are likely to cause hydrograph changes, even if they create and/or replace less than one acre of impervious surface.

9.3 HYDROMODIFICATION MANAGEMENT MEASURES

Provision C.3.g.iv identifies three types of hydromodification management (HM) measures: on-site controls, regional controls, and in-stream measures, as described below.

- **Onsite HM controls** consist of hydrologic source controls (site design measures), low impact development (LID) features and facilities, and flow duration control structures, which collectively prevent increases in runoff flow and volume, to meet the HM Standard described in **Section 9.4** at the point(s) where stormwater runoff discharges from the project site.

- **On-site hydrologic source control measures**, which are generally distributed throughout a project site as site design measures, minimize hydrological changes caused by development beginning with the point where rainfall initially meets the ground. Examples include minimizing impervious area, disconnecting roof leaders, and providing localized detention – which also helps reduce stormwater pollution.
- **On-site LID features and facilities**, which are generally included to meet stormwater treatment requirements described in Provisions C.3.c and C.3.d, also contribute to hydromodification management by infiltrating and detaining runoff.

Figure 9-4. Draining roof runoff to a landscaped area is an example of hydrologic source control.

- **On-site structural HM measures** manage excess runoff from the site after hydrologic source control measures are applied. These "end-of-pipe" measures mitigate the effects of hydrograph changes. Stormwater is temporarily detained, and then the runoff is gradually discharged to a natural channel at a rate calculated to avoid adverse effects. Examples include extended detention basins, wet ponds, and constructed wetlands. Please note that there is a difference between the design approach for sizing measures to remove pollutants from stormwater and the approach for designing HM measures to prevent a potential increase in creek bank erosion. The treatment of stormwater pollutants targets capture of 80% of average runoff volume, which means that treatment measures will be bypassed every one to two years. Structural HM measures must be sized for flow duration control for frequent, small runoff events (with average occurrence ranging from less than two-years to approximately ten-years). The structural HM measures are sized to control the statistical duration of a wide range of flow levels under simulated runoff conditions. Depending on pre-project and post-project conditions, the required detention volume is likely to be greater than the capture volume required for treatment.

- **Regional HM controls** are flow duration control structures that collect discharge of stormwater runoff from multiple projects (each of which shall incorporate hydrologic source control measures as well) and are designed such that the HM Standard described in **Section 9.4** is met for all the projects at the point where the regional HM control discharges.
- **In-stream measures** are an option only where the stream, which receives runoff from the project, is already impacted by erosive flows and shows evidence of excessive sediment, erosion, deposition, or is a hardened channel. In-stream measures involve modifying the receiving stream

Structural HM measures must be sized to control the flow and duration of stormwater runoff according to a ***Flow Duration Control*** standard, which is often greater than size requirements for volume-based treatment.

channel slope and geometry so that the stream can convey the new flow regime without increasing the potential for erosion and aggradation. In-stream measures are intended to improve long-term channel stability and prevent erosion by reducing the erosive forces imposed on the channel boundary.

- In-stream measures, or a combination of in-stream and onsite controls, are designed to achieve the HM Standard described in **Section 9.4** from the point where the project(s) discharge to the stream and to achieve an equivalent degree of flow control mitigation (based on amount of impervious surface mitigated) as part of an in-stream project located in the same watershed. Designing in-stream controls requires a hydrologic and geomorphic evaluation (including a longitudinal profile) of the stream system downstream and upstream of the project. Examples of in-stream measures include bio stabilization techniques using roots of live vegetation to stabilize banks and localized structural measures such as rock weirs, boulder clusters or deflectors. These measures will not automatically provide HM protection for channel reaches farther downstream and may require longer planning timelines and cooperation among multiple jurisdictions compared to on-site measures. As with all in-stream activities, other regulatory permits must be obtained by the project proponent.

9.4 REQUIREMENTS FOR HYDROMODIFICATION MANAGEMENT

9.4.1 Meeting the Hydromodification Management Standard

The HM Standard specified in Provision C.3.g.ii requires that storm water discharges from HM projects shall not cause an increase in the erosion potential of the receiving stream over the pre-project (existing) condition. HM controls shall be designed such that post-project stormwater discharge rates and durations match pre-project discharge rates and durations from 10 percent of the pre-project two-year peak flow up to the pre-project 10-year peak flow. HM controls designed using the Bay Area Hydrology Model (BAHM) and site-specific input data are considered meeting the HM Standard.

The Flow Duration Control approach manages runoff rather than specifying static holding times for one or a few discrete events. For projects subject to HM requirements, consider HM at every stage of project development and incorporate the step-by-step instructions for C.3 submittals, provided in **Chapter 3**. The most effective use of land and resources may require combining measures from all three categories described above. In general, the strategy for designing HM measures should:

- Start with site design to minimize the amount of runoff to be managed (see Planning Steps 2 & 3 in **Chapter 3**).
- Where possible, maximize infiltration to further reduce detention requirements, using hydrologic source controls (site design measures) and LID features and facilities. Note that infiltration is limited by site constraints such as slope stability concerns, low-permeability soils, or groundwater protection constraints.
- Use structural HM measures (e.g., extended detention basins, wet ponds, constructed wetlands) to detain the remaining calculated runoff from the site enough to control its

release in a way that meets the remaining runoff design requirements. For some project locations, off-site options may be available to reduce or eliminate the need for onsite detention.

9.4.2 Flow Duration Control

Flow Duration Control differs from traditional "design storm" approaches used to design detention facilities for flood control or water quality treatment. Instead of specifying static holding times for one or a few discrete events, the Flow Duration standard manages runoff discharge over the full range of runoff flow levels predicted through continuous hydrologic simulation modeling, based on a long-term precipitation record. Flow Duration Control requires that the increase in surface runoff resulting from new impervious surfaces be retained on-site with gradual discharge either to groundwater through infiltration, losses by evapotranspiration, and/or discharge to the downstream watercourse at a level below the critical flow that will not cause creek channel erosion. Critical flow, or Qc, is the lower threshold of in-stream flows that contribute to sediment erosion and sediment transport or effective work. The duration of channel flows below Qc may be increased indefinitely without significant contribution to hydromodification impacts.

9.4.3 Application of Flow Duration Control to Project Areas

> The duration of channel flows below the "critical flow" may be increased indefinitely without significant contribution to hydromodification impacts.

The Flow Duration approach involves a continuous model that applies a time series of at least 20 years of rainfall records to a watershed area or project site to generate a simulated stormwater runoff record based on two sets of inputs, one representing future development and the other representing pre-project conditions. The 20-year precipitation record is the minimum length necessary to capture the range of runoff conditions that are cumulatively responsible for most of the erosion and sediment transport in the watershed, primarily flow levels that would recur at average intervals of 10 years or less in the pre-project condition. The design objective is to preserve the pre-project cumulative frequency distribution of flow durations and sizes under post-project flows. This is done with a combination of site design, infiltration, and detention. Typically, the post-project increase in surface runoff volume is routed through a flow duration control pond or other structure that detains a certain portion of the increased runoff and discharges it through a specialized outlet structure (see **Figure 9-4**).

The flow duration basin, tank or vault is designed conceptually to incorporate multiple pools that are filled with different frequencies and discharge at different rates. The low-flow pool is the bottom level designed to capture and retain small to moderate size storms, the initial portions of larger storms, and dry weather flows. These flows are discharged through the lowest orifice which allows continuous discharge below the critical flow rate for a project (Qcp). Successively higher-flow pools store and release higher but less frequent flows through other orifices or graded weir notches to approximate the pre-project runoff durations. In practice the multiple pools are usually integrated into a single detention basin, tank or vault that works as a unit with the specialized outlet structure. Matching the pre-project flow durations is achieved through fine-tuning of the number, heights and dimensions of orifices or weir notches, as well as depth and volume of the basin, tank, or vault.

Flow Duration control facilities are subject to Operations and Maintenance reporting and verification requirements similar to those for numerically sized treatment measures.

As shown in the example chart of **Figure 9-5**, the post-project flow duration curve (red, or dark line) is reduced by the facility to remain at or below the pre-project curve (yellow, or light line), except for flows less than Qcp. Minor exceedances are permissible at a limited number of higher flows since at other flow levels the post-project duration is less than the pre-project condition.

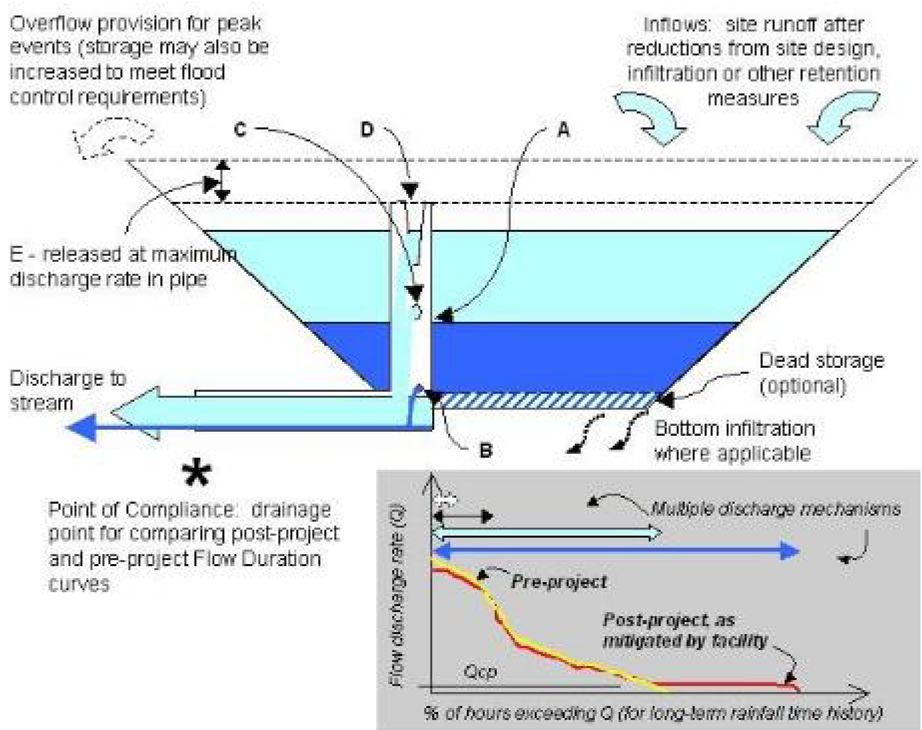

Figure 9-5. Schematic flow duration pond and flow duration curves matched by varying discharge rates according to detained volume.

If feasible, combining flow duration and water quality treatment into a single facility reduces the overall land requirements for stormwater management. Adequate maintenance of the low-flow orifice or notch is critical to proper performance. The outlet may be in a protective enclosure to reduce the risk of clogging. Please note that Flow Duration Control facilities are subject to Operations and Maintenance verification requirements similar to those for numerically sized treatment measures.

9.4.4 Bay Area Hydrology Model (BAHM)

To facilitate the simulation modeling aspect of Flow Duration Control for project proponents and their engineers, the Clean Water Program collaborated with the Santa Clara and San Mateo Counties' stormwater programs to develop a Bay Area Hydrology Model software package that is adapted from Version 3 of the Western Washington Hydrology Model (WWHM) developed by Clear Creek Solutions for the State of Washington Department of Ecology (WDOE). The WWHM was specifically developed to help engineers design facilities to meet a Flow Duration Control standard for development projects.

The current version of the BAHM (BAHM 2013) is available for downloading at https://www.clearcreeksolutions.info/downloads, and it includes:

- Databases to automatically assign default rainfall conditions for a project location selected within the County boundary.
- A user interface for developing a schematic drainage model of the project site, with forms for entering areas of land use or impervious surface for multiple sub-basins.
- Continuous simulation modeling of pre-project and post-project runoff from the site using actual long-term rainfall records appropriately scaled for the project location.
- A design module for sizing a Flow Duration Control detention facility and designing the discharge structure to meet the Flow Duration standard for matching post-project and pre-project duration-frequency curves. Pre-project and post-project runoff are compared at a "point of compliance" selected by the designer, usually near the point where runoff leaves the project area.
- Standardized output report files that can be saved in Word format, and include all information about data inputs, model runs, facility design, and summary of the hydrological statistics showing the compliance of post-project flow duration curves with the Flow Duration standard. Project input and output data can also be saved in Excel and other formats for other uses.

Please make sure to use the current version of the BAHM (BAHM 2013). Training courses on using the BAHM are offered periodically. For more information, please visit https://www.clearcreeksolutions.info/downloads.

9.5 HYDROMODIFICATION MANAGEMENT CONTROL SUBMITTALS FOR REVIEW

The potential applicability of the HM requirements the proposed project can be determined using the guidelines in **Section 9.2**, the applicability map shown in **Appendix I** (which can also be accessed at the following link: https://accwp.maps.arcgis.com/apps/webappviewer/index.html?id=11d7a1bfb90d46ce80f94defc03d012c, and the City-specific Stormwater Requirements Form (available from municipal staff). The next step is to prepare an HM Control Plan as part of the project's Provision C.3. submittal.

Table 9-1 provides a model checklist of submittal requirements for the HM Control Plan. Information on site design and LID treatment measures should also be included, if they are part of the HM Control Plan, and any modeling analyses. Check with the local jurisdiction to determine the specific requirements for your project.

Table 9-1. HM Control Plan Checklist

Required?*		Information on Plan Sheets
Yes	No	
❑	❑	Soil types and depth to groundwater
❑	❑	Existing and proposed site drainage plan and grades
❑	❑	Drainage Management Area (DMA) boundaries
❑	❑	Amount of existing pervious and impervious areas (for total site and each DMA)
❑	❑	Amount of proposed impervious area (for total site and each DMA)
❑	❑	Amount of proposed pervious area (for total site and each DMA)
❑	❑	Proposed site design measures to minimize impervious surface and promote infiltration**
❑	❑	Proposed locations and sizes of stormwater treatment measures and HM measures
❑	❑	Stormwater treatment measure and HM measure details
Information on Modeling Analysis and HM Facility Sizing		
❑	❑	BAHM Report with input and output data and additional files as required by municipality
❑	❑	If different model is used, description of model input and output
❑	❑	Description of how site is represented in the model, what is proposed and why
❑	❑	Description of any changes to standard parameters (e.g., scaling factor, duration criteria)
❑	❑	Comparison of HM facility sizing per model results vs. details on plan
❑	❑	Description of any unique hydraulic conditions due to HM facility location
❑	❑	Description of orifice/weir sizing, outlet protection measures, and drawdown time
❑	❑	Preliminary maintenance plan for HM facility

Note 1: Municipal staff may check the boxes in the "Required" column to indicate which items are required for your project.
Note 2: Site design, treatment and HM measures that promote infiltration should be designed consistent with the recommendations of the project geotechnical engineer.

9.6 AREA-SPECIFIC HYDROMODIFICATION MANAGEMENT PROVISIONS

Individual municipalities may have special policies or ordinances for creek protection applicable in all, or part, of their jurisdictions. Contact the municipal staff from your jurisdiction to identify any special local provisions that may encourage or affect specific forms of HM implementation. Examples of area-specific HM provisions can include:

> Individual municipalities may have special policies or ordinances for ***creek protection*** applicable in all or part of their jurisdictions.

- Watershed-based land-use planning measures, such as creek buffers, which may be incorporated in local General Plans, zoning codes or watercourse ordinances.
- Special permitting provisions for project design and review of projects on streamside properties.
- Specific plans for regional HM measures or in-stream restoration projects.

10 OPERATION AND MAINTENANCE

This Chapter summarizes the operation and maintenance requirements for stormwater treatment and structural hydromodification management measures.

10.1 SUMMARY OF O&M REQUIREMENTS

Maintenance is essential for assuring that stormwater treatment and structural hydromodification management (HM) measures continue to function effectively and do not cause flooding, provide habitat for mosquitoes, or otherwise become a nuisance. The maintenance requirements described in this chapter apply to stormwater treatment measures and structural HM measures included in your project. The operation and maintenance (O&M) process can be organized into five phases:

- Determining ownership and maintenance responsibility,
- Identifying maintenance requirements when selecting treatment measures,
- Preparing the maintenance plan and other documentation,
- Executing a maintenance agreement or other maintenance assurance, and
- Conducting ongoing inspections and maintenance.

10.1.1 Responsibility for Maintenance

The responsibility for the maintenance of stormwater treatment and structural HM measures belongs to the project applicant and/or property owner unless other specific arrangements have been made. Ownership and maintenance responsibility for stormwater treatment measures and structural HM measures should be considered at the earliest stages of project planning, typically at the pre-application meeting with municipal staff. The municipal stormwater permit also requires that the project applicant provide a signed statement accepting responsibility for maintenance until this responsibility is legally transferred, as well as ensuring access to municipal, Regional Water Board, and Alameda County Mosquito Abatement District or Vector Control District staff.

10.1.2 Considerations When Selecting Treatment Measures

Consider Operation and Maintenance

When determining which types of treatment measures to incorporate into project plans, be mindful of how maintenance intensive they are. Study the operation manual for any manufactured, proprietary system. Treatment measures must be maintained so that they continue to treat stormwater runoff effectively throughout the life of the project and do not provide habitat for mosquito breeding. Adequate funds must be allocated to support long-term site maintenance. Manufactured, proprietary systems tend to clog easily and therefore require frequent maintenance to ensure that they operate as intended and do not hold standing water.

A properly designed and established bioretention area, by contrast, may require little maintenance beyond the typical requirements for areas of landscaping.

The party responsible for maintenance will also be required to dispose of accumulated residuals properly. Residuals are defined as trash, oil and grease, filter media and fine sediments that are collected from treatment measures that may or may not be contaminated. At present, research generally indicates that residuals are not hazardous wastes and as such, after dewatering, property owners can generally dispose of residuals in the same way they would dispose of any uncontaminated soil.

The USEPA Fact Sheet *Storm Water O&M Fact Sheet: Handling and Disposal of Residuals*[24] provides useful information to help property owners dispose of residuals properly. The fact sheet describes the properties of stormwater residuals, O&M requirements for specific types of treatment measures, key elements for a residual handling and disposal program, and specific information on residual disposal from case studies. Two landfills in Alameda County accept sediment ("soil"), contaminated or otherwise:

- Altamont Landfill and Resource Recovery, 1040 Altamont Pass Road, Livermore, 510-430-8509
- Vasco Road Sanitary Landfill, 4001 N. Vasco Road, Livermore, 661-257-3655.

Alternatively, property owners may choose to contract with the treatment device manufacturer to maintain their treatment measures. Services typically provided include inspection, maintenance, handling, and disposal of all residuals.

Control Mosquitoes

When selecting and installing stormwater treatment devices, you will need to consider the various environmental, construction, and local factors that may influence mosquito breeding. Treatment measures should drain completely within 72 hours to effectively suppress mosquito production, except for certain treatment measures designed to hold permanent pools of standing water. The Clean Water Program has prepared a Vector Control Plan that includes mosquito control design guidance and maintenance guidance for treatment measures, which focus on mosquito control. This guidance is included in **Appendix G**.

Consider Access

The maintenance agreement for your project will need to guarantee access permission for local municipality staff, the Alameda County Mosquito Abatement District, and Water Board staff to enter the property to verify that maintenance is being conducted in accordance with the maintenance plan, throughout the life of the project. Make sure stormwater treatment and structural HM measures are readily accessible to the inspectors and contact municipal staff to determine whether easements will be needed. Stormwater treatment and structural HM measures must also be accessible to equipment needed to maintain them. Maintenance needs vary by the type of treatment measure that is used. Review the maintenance requirements described in **Section 10.2** to identify the accessibility needs for maintenance equipment. By

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[24] EPA Stormwater O&M Factsheet

nature, it is more difficult to provide adequate access for below-ground treatment measures than above-ground treatment measures.

10.1.3 Documentation Required with Permit Application

As part of the building permit application, project applicants typically need to prepare and submit the documents listed below. Check with the local jurisdiction for exact requirements.

A legible conceptual plan of the site, clearly showing the locations of stormwater treatment measures, including areas of pervious pavement, and the locations of HM controls, if any. The plan should specifically identify all pervious pavements systems that total ≥ 3000 sq. ft (excluding private-use patios for single-family homes, townhomes, or condominiums). Letter-sized plans are preferred; legal-sized plans may be accepted.

- A detailed maintenance plan for stormwater treatment and structural HM measures, including inspection checklists, as appropriate.
- A standard treatment measure O&M report form, to be attached to a maintenance agreement, or other maintenance assurance.

Please note that requirements may vary from one jurisdiction to another. Ask the staff from the local municipality if there are any additional requirements. **Appendix H** includes templates to assist project applicants in preparing their standard treatment measure O&M report form and maintenance plan. Guidance on preparing these documents is provided in **Section 10.2**.

10.1.4 Maintenance Agreement or Other Maintenance Assurance

Where a property owner is responsible for maintenance, they are required to enter into a maintenance agreement with the municipality to ensure long-term maintenance of treatment and structural HM measures. The agreement will be recorded against the property to run with the title of the land. Contact your local jurisdiction to obtain a copy of its standard maintenance agreement. The maintenance agreements require property owners to conduct maintenance inspections of all stormwater treatment measures, and – depending on the municipality – may require the annual submittal of a Standard Treatment Operation and Maintenance Inspection Report form.

For residential properties where the stormwater treatment measures are located within a common area that will be maintained by a homeowner's association, language regarding the responsibility for maintenance must be included in the project's conditions, covenants, and restrictions (CC&Rs). Printed educational materials regarding on-site stormwater controls are typically required to be included with the first, and any subsequent, deed transfer. The educational materials typically include the following information:

- Explanation of post-construction stormwater controls requirements,
- Information on what stormwater controls are present,
- Description of the need for maintenance,
- Explanation of how the necessary maintenance can be performed; and

- For the initial deed transfer, description of the assistance that the project applicant can provide.

If stormwater treatment measures are proposed in a public area for transfer to the municipality, these treatment measures must meet the design guidelines specified in **Chapter 7** and shall remain the property owner's responsibility for maintenance until the treatment measures are accepted for transfer.

10.1.5 Ongoing Inspections and Maintenance

After the maintenance agreement is executed, or the municipality approves other maintenance assurance such as CC&Rs, the party responsible for maintenance begins to implement the maintenance plan. Inspection reports are submitted to the municipality as required by the maintenance agreement, or other maintenance assurance.

The municipality, Regional Water Board and Alameda County Mosquito Abatement District may conduct operation and maintenance verification inspections to make sure that stormwater treatment measures are being maintained. In the event adequate maintenance is not conducted, the municipality will take necessary steps to restore the treatment measures to good working order. The property owner will be responsible for reimbursing the municipality for expenditures associated with restoring the treatment measures to good working order.

10.1.6 Maintenance Assurance for Public Agency Projects

Maintenance Plans are required for public development and redevelopment projects to assure the ongoing maintenance of the stormwater treatment systems. However, the mechanisms are different and usually rely on interdepartmental procedures. An interdepartmental notification is recommended for publicly-maintained projects to document and transfer maintenance responsibility to an agency's maintenance department. This notification needs to include the following information:

- Site Plan
- Design Details
- Maintenance Plan
- Inspection Report Form

Maintenance staff should be involved in the early stages of design to review the plans and provide input on the maintenance considerations for the stormwater treatment measures.

10.2 PREPARING MAINTENANCE-RELATED DOCUMENTS

This section provides instructions for preparing the following documents that will typically be required as parts of the building permit application, if your project includes stormwater treatment measures and/or structural HM measures:

- A standard treatment measure O&M report form
- A maintenance plan, including a schedule of maintenance activities.

10.2.1 Standard Treatment Measure O&M Report Form

The municipality may require the property owner, or other responsible party, to submit an annual report summarizing the maintenance and inspections of treatment measures included in the project. To standardize and simplify the reporting process, the property owner submits a *Standard Treatment Measure O&M Report Form* with the building permit application, and the municipality includes the report form as an Exhibit to the maintenance agreement. After the agreement is executed, the property owner, or other responsible party, uses this form to prepare the annual report, which is typically submitted by December 31 of each calendar year. When submitting the completed report form each year, the responsible party will typically be required to attach the inspection forms that were completed during that calendar year.

To help you prepare your Standard Treatment Measure O&M Report Form, a template is included in **Appendix H**. Check with the local jurisdiction for an electronic version of the template.

When using the template to prepare your report form, please insert project-specific information where you find highlighted prompts such as the following:

[[== insert name of property owner/responsible party ==]]

10.2.2 Maintenance Plan

The maintenance plan must be sufficiently detailed to demonstrate to the municipality that stormwater treatment measures, including pervious paving, and/or structural HM measures will receive adequate inspections and maintenance to continue functioning as designed over the life of the project. A maintenance plan typically includes the following elements:

- Contact information for the property owner or other responsible party.
- Project address and, if required, the Assessor's Parcel Number and directions to the site.
- Identification of the number, type, and location of all stormwater treatment/structural HM measures on the site
- A site plan that shows the location of each stormwater treatment measure, including areas of pervious paving, and structural HM measures. The site plan should specifically identify all pervious pavements systems that total 3,000 square feet or more (excluding private use patios for single-family homes, townhomes, or condominiums). Letter-sized plans are preferred; legal-sized plans may be accepted.
- A list of specific, routine maintenance tasks that will be conducted, and the intervals at which they are conducted. (For example, "Inspect treatment measure once a month, using the attached checklist.")
- An inspection checklist, specific to the treatment/HM measure(s) included in your project, which indicates the items that will be reviewed during regular maintenance inspections. You will typically be required to submit completed inspection forms as part of the annual Stormwater Treatment Measure O&M Report, as described in **Section 10.2.1**.

The following materials are available to help you prepare your maintenance plan:

- Maintenance plan templates included in **Appendix H**. Electronic versions of the templates are available at www.cleanwaterprogram.org (Click on "Businesses," then "Development" and go to Appendix H of the C.3 Technical Guidance).
- A list of common maintenance concerns for the frequently used stormwater treatment measures.
- When using a template to prepare your maintenance plan, please insert project-specific information where you find prompts such as the following: [[== insert name of property owner/responsible party ==]]. Each template includes sample inspection checklists. If your project includes different treatment/HM measures, you may also refer to the treatment measure-specific maintenance information presented in **Chapter 8**.

11 ALTERNATIVE COMPLIANCE

This chapter provides information on using Alternative Compliance options where LID treatment is required.

11.1 WHAT IS ALTERNATIVE COMPLIANCE

MRP Provision C.3.e allows municipalities to grant alternative compliance to new development or redevelopment projects in lieu of requiring that the Provision C.3.d amount of stormwater be treated with LID onsite or at a Joint Treatment Facility.[25]

Projects that receive alternative compliance must still provide LID treatment for the full amount of stormwater runoff, but the treatment may occur at an Offsite Project or in a Regional Project. There are no special eligibility criteria for using alternative compliance. If your project is required to provide LID treatment, it may use alternative compliance to meet these requirements. There is no requirement to make LID impracticability or infeasibility findings to use alternative compliance, however the MRP encourages treating as much runoff onsite as possible. The MRP offers two options for using alternative compliance, described in **Section 11.2;** sets deadlines for constructing offsite alternative compliance projects (**Section 11.3**); and sets a timeline for the alternative compliance provision to take effect.

11.2 CATEGORIES OF ALTERNATIVE COMPLIANCE

A project may use either of the alternative compliance options with the concurrence of the local municipality.

11.2.1 Option 1: LID Treatment at an Off-Site Location

Projects may treat a portion of the required amount of stormwater runoff using LID on-site or at a Joint Treatment Facility **and** then treat the remaining portion of runoff at an Offsite Project within the same watershed.

Offsite Projects must provide an equivalent quantity of hydraulically sized treatment of both stormwater runoff and pollutant loads and achieve a net environmental benefit.

An Offsite Project provides LID treatment for a surface area or volume and pollutant loading of stormwater runoff equivalent to that of the proposed new development or redevelopment project for which alternative compliance is sought. An Offsite Project is on a different parcel or property than the Regulated Project but must be in the same watershed as the Regulated Project. Examples of acceptable Offsite Projects include the installation of hydraulically sized

[25] A Joint Treatment Facility treats stormwater from more than one Regulated Project, typically adjacent projects, at a nearby location. A Joint Treatment Facility must be completed by the end of construction of the first Regulated Project that will be discharging runoff to the facility.

LID treatment measures in a nearby parking lot, or other development where hydraulically sized LID treatment measures were not previously installed.

11.2.2 Option 2: Payment of In-Lieu Fees

Projects may treat a portion of the required amount of stormwater runoff using LID on-site or at a Joint Treatment Facility **and** pay equivalent in-lieu fees to treat the remaining amount of stormwater runoff with LID treatment measures at an Offsite Project or Regional Project.

A Regional Project is a regional or municipal stormwater treatment facility that captures runoff from a drainage area larger than the parcel on which it is located and discharges into the same watershed as the Regulated Project. A Regional Project must achieve a net environmental benefit, through a net increase in impervious surface treated, and/or a net reduction in flow and/or pollutant load.

In-lieu fees provide the monetary amount necessary to provide both LID treatment for a surface area or volume and pollutant loading of stormwater runoff equivalent to that of the proposed new development or redevelopment project for which alternative compliance is sought and a proportional share of the operation and maintenance costs.

11.3 OFFSITE OR REGIONAL PROJECT COMPLETION DEADLINES

11.3.1 Timeline for Construction of Offsite or Regional Projects

Construction of the Offsite and Regional Projects must be completed within three years after the end of construction of the Regulated Project. With prior approval of the Regional Water Board Executive Officer and demonstration of a good faith effort, e.g., encumbered funds and application for regulatory permits, this timeline can be extended by two years for a total of five years.

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APPENDIX A. LOCAL CONTACTS

Please contact the local agency with any questions regarding requirements specific to the local jurisdiction, using contact information provided below.

Alameda (City)	Public Works Department, 510.747.7930
Alameda County Flood Control and Water Conservation District:	510.670.5543, 339 Elmhurst Street, 1st Floor, Permit Center, Hayward, CA 94544 ; Fernando Gonzales, 510-670-5267, fernando@acpwa.org , www.acpwa.org
Albany	Community Development Department, 1000 San Pablo Avenue, Albany, CA 94706. 510.528.5760, www.albanyca.org
Berkeley	510.981.6421, 510.981.6409
Dublin	Environmental & Sustainability Division, Public Works Department, 100 Civic Plaza, Dublin, CA 94568. 925-833-6630, es@dublin.ca.gov, www.dublin.ca.gov
Emeryville	Environmental Programs, Public Works, 510.596.3728
Fremont	Environmental Services Division, 39550 Liberty Street, Fremont, CA 94538, 510.494.4570 https://www.fremont.gov/government/departments/environmental-services
Hayward	Engineering and Transportation Division, Department of Public Works, City Hall, 2nd Floor, 777 B Street, Hayward CA 94541, 510.583.4730
Livermore	Athena Watson, 925.872.2736 (100 N. Canyons Pkwy. Livermore, CA 94551, athena@zone7water.com
Newark	James Scanlin, City Hall – Public Works, 37101 Newark Boulevard, 1st Floor, Newark CA 94560, 510.578.4320, james.scanlin@newark.org
Oakland	Permit Center, 250 Frank H. Ogawa Plaza, 2nd Floor, Oakland, CA 94612, 510.238.3911, www.oaklandca.gov
Piedmont	Public Works Counter, City Hall, 120 Vista Avenue, Piedmont, CA 94611, 510.420.3050, www.ci.piedmont.ca.us
Pleasanton	Engineering Land Development, 200 Old Bernal Avenue, Pleasanton, CA 94566, 925.931.5650, www.cityofpleasantonca.gov, Michael Stella, 510.577.3433, MStella@cityofpleasantonca.gov
San Leandro	Erwin Ching, 510.577.3439, EChing@sanleandro.org Engineering and Transportation Department, Civic Center, San Leandro
Union City	Farooq Azim, fazim@unioncity.org, 510.675.5368, 34009 Alvarado-Niles Road, Union City, CA 94587
Unincorporated Alameda County	339 Elmhurst Street, 1st Floor, Permit Center, Hayward, CA 94544, Fernando Gonzales, 510-670-5267, fernando@acpwa.org, www.apcwa.org
Zone 7 Water Agency	925.454.5036

APPENDIX B. PLANT LIST AND PLANTING GUIDANCE FOR LANDSCAPE-BASED STORMWATER MEASURES

B.1 INTRODUCTION

The purpose of this appendix is to provide guidance on the planting techniques and selection of appropriate plant materials for the stormwater measures described in this handbook.

The plant lists described in this appendix are not prescriptive, but should serve as a guide. In selecting plant materials, it is important to consider factors that influence plant establishment and success, such as microclimate, type of soil, water availability, proximity to saltwater and exposure to sun. Numerous resources are available to assist in selecting appropriate plant species in Alameda County, including Sunset's *Western Garden Book* and the East Bay Municipal Utility District’s *Plants and Landscapes for Summer-Dry Climates of the San Francisco Bay Region.*

The plant lists described in this appendix are not prescriptive but should ***serve as a guide.*** In selecting plant materials, it is important to consider factors that influence plant establishment and success, such as microclimate, type of soil, water availability, proximity to saltwater and exposure to sun as well as the unique nature of biotreatment soil.

In addition, the function of the individual stormwater measure should be carefully considered when selecting plant materials. Factors to be considered include inundation period, expected flow of water, fast draining soil media used in biotreatment system, and access and maintenance requirements.

B.2 GENERAL RECOMMENDATIONS

Avoid the use of invasive species. In selecting plants for stormwater measures, the use of invasive species should be avoided. A complete list of invasive plants can be found at www.cal-ipc.org, the California Invasive Plant Council’s Invasive Plant Inventory.

Minimize or eliminate the use of irrigated turf. Effort should be made to minimize the use of irrigated turf, which has higher maintenance requirements and greater potential for polluted runoff.

Select California natives and/or drought tolerant plants. Planting appropriate, drought tolerant California natives or Mediterranean plants reduces water consumption for irrigations, and reduces mowing, fertilizing, and spraying. For the purposes of the plant list on the following pages, "drought tolerant" refers to plants that meet the following criteria:

- Are identified as drought tolerant as follows: California Native Plants for the Garden (Borstein, et al.).
- Are identified as requiring occasional or infrequent irrigation in Borstein, et al., or Plants and Landscapes for Summer Dry Climates (East Bay Municipal Utilities District [EBMUD]).
- Are identified as requiring no summer water in EBMUD.

- Are identified as requiring little or no water in the Sunset Western Garden Book.
- Are identified as requiring low or very low irrigation in the Guide to Estimating Irrigation Water Needs of Landscape Plantings in California (University of California Cooperative Extension).

Plants not listed in any of the above references will require that the design professional base selection upon successful experience with species on previous projects under similar horticultural conditions.

Site-specific Factors. Given Alameda County spans several Sunset climate zones, with variable humidity, heat, frost, and wind factors, as well as varying soil characteristics, plants need to be selected with an understanding of specific climate and microclimate conditions, and grouped in appropriate hydrozones.

Supplemental watering needs. Many plants listed as drought tolerant per the above references may require more supplemental watering in fast-draining, engineered soils.

B.3 PLANTS FOR STORMWATER MEASURES

Plants play an important role in the function of landscape-based stormwater treatment measures:

- Infiltration and evapotranspiration. Plants aid in the reduction of stormwater runoff by both increasing infiltration, and by returning water to the atmosphere through evapotranspiration.
- Sedimentation. Some stormwater treatment measures, such as vegetated swales and vegetated buffer strips, are designed to remove coarse solids through sedimentation that is aided by dense, low-growing vegetation.
- Pollutant trapping. Vegetation helps to prevent the resuspension of pollutants associated with sediment particles. It is essential that pollutants removed during small storms are not remobilized during large storms.
- Phytoremediation. Plants for stormwater treatment measures are important for their role in phytoremediation, the uptake of nutrients and the ability to neutralize pollutants.
- Soil stabilization. As in any landscaped area, established plantings help control soil erosion. This is important both to keep sediment out of stormwater and to retain the surface soils, which help to remove pollutants from infiltrated runoff.
- Aesthetic benefits. Plants within or adjacent to stormwater facilities provide an aesthetic benefit.

Plants suitable for use in stormwater treatment measures are organized according to the following categories:

- **Emergent** refers to those species which occur on saturated soils or on soils covered with water for most of the growing season. The foliage of emergent aquatics is partly or entirely borne above the water surface.

- **Grasses** refer to those species that are monocotyledonous plants with slender-leaved herbage found in the in the Family Poaceae.
- **Herbaceous** refers to those species with soft upper growth rather than woody growth. Some species will die back to the roots at the end of the growing season and grow again at the start of the next season. Annuals, biennials, and perennials may be herbaceous.
- **Shrub** is a horticultural distinction that refers to those species of woody plants which are distinguished from trees by their multiple stems and lower height. A large number of plants can be either shrubs or trees, depending on the growing conditions they experience.
- **Tree** refers to those species of woody plants with one main trunk and a rather distinct and elevated head.

Plants suitable for use in stormwater treatment measures are listed in two ways. First, a comprehensive list of all recommended plant species is provided in **Table B-1**, which lists the plants in alphabetical order by Latin name, in the categories described above. The columns in **Table B-1** indicate stormwater treatment measures for which each plant species may be suitable. Following **Table B-1** are brief descriptions of the stormwater measures for which technical guidance is included in this handbook, including the suitable plantings from **Table B-1.**

Invasive species. Under no circumstances shall any plants listed as invasive under www.cal-ipc.org/paf be specified.

A brief paragraph describing each stormwater measure is provided below, including the key factors that should influence planting techniques and plant selection. For suitable plantings, please refer to **Table B-1**.

B.3.1 Bioretention Area (Including Linear Treatment Measures)

Bioretention areas are intended to act as filters with plants. Plants in bioretention areas help with phytoremediation and infiltration. Therefore, nutrient uptake and the ability to neutralize pollutants are priorities for species selection. Plants for these areas should be able to withstand periods of inundation as well as extended periods of drought. Emergent, grass and herbaceous species can be planted in the bioretention area, while shrub and tree species should be concentrated on the outer edges. Grasses can also be planted along the exterior to slow the velocity of flow and allow the sedimentation of coarse solids, which helps minimize clogging of the bioretention area. Biotreatment soil holds limited amounts of water due to the sand content of the media. Bioretention facilities need to receive more frequent but shorter duration irrigation than traditionally landscaped areas to avoid water waste.

B.3.2 Flow-Through Planter

Plant species for flow-through planters will depend on the size of the planter. Shrubs and trees should be planted in planters only when there is sufficient space. Recommended minimum soil depth for shrubs is 18”, and for small trees is 36”. Plant species should be adapted to well-drained soils. Irrigation is typically required, but selecting plants adapted to extended dry periods can reduce irrigation requirements. Biotreatment soil used in the planters holds limited amounts. During dry periods, the planters need to receive more frequent but shorter duration irrigation than traditionally landscaped areas to avoid water waste.

B.3.3 Tree Well Filter

Trees and shrubs planted in tree well filters should be an appropriate size for the space provided. Because plant roots are confined to the container, it is recommended that small trees and shrubs with shallow, fibrous roots be planted in the tree well filter. Provided that site conditions allow, it may be possible to work with the manufacturer to design a container that would allow for the planting of larger trees or shrubs. Larger trees and shrubs can be planted in suspended pavement systems because of the expanded area available for tree roots. Plants for tree well filters should be tolerant of frequent, but temporary periods of inundation as well as adapted to extremely well-drained soils. Species with the ability to neutralize contaminants are preferred. Tree well filter systems that use biotreatment soil need to receive more frequent but shorter duration irrigation than traditionally landscaped areas to avoid water waste. Follow manufacturers guidelines and local lists on selecting plants for proprietary tree well filter systems.

B.3.4 Vegetated Buffer Strips

Vegetated buffer strips should be designed to function and appear as natural vegetated areas adjacent to development. They treat surface runoff from adjacent impervious areas so a variety of trees, shrubs, and grass and herbaceous species should be included in order to maximize water and nutrient uptake, as well as to retain sediment.

B.3.5 Infiltration Trench

An infiltration trench is an aggregate filled trench that receives and stores stormwater runoff in the void spaces between the aggregate and allows it to infiltrate into the surrounding soil. Vegetated filter strips of grass species on either side of the trench can slow and pre-treat the runoff while the trench can physically remove fine sediment and other suspended solids.

B.3.6 Extended Detention Basin

Extended detention basins are intended to capture and detain water for much longer periods (up to 5 days) than bioretention areas. They are designed to drain completely between storms. Plants in extended detention basins increase pollutant removal and assist with soil stabilization; therefore, nutrient uptake and the ability to neutralize pollutants are priorities for species selection. Because extended detention basins are intended to capture and move large quantities of water, trees should not be planted in the basins, and shrubs are typically not specified for extended detention basins. Subject to approval by the municipality, trees and shrubs may be included on the outer perimeter (top of bank), provided that they do not interfere with detention. Species should be adapted to periodic inundation and saturation and extended periods of dry conditions. Emergent, grass and herbaceous species for extended detention basins should consist of species that are able withstand extended periods of inundation. Supplemental irrigation will be necessary to maintain emergent species during extremely dry conditions. Extended detention basins typically have not been constructed with special soil, and beginning December 1, 2011, basins designed without biotreatment soil (having a long-term infiltration rate of 5 to 10 inches per hour) may not be used as stand-alone treatment measures, although they could be used as part of a treatment train, along with biotreatment measures (more information in **Section 8.5**).

B.3.7 Pervious Paving – Turf Block Pavers

Some pervious paving systems can be planted with grass or herbaceous species in order to assist with erosion prevention as well as promote infiltration and pollutant uptake. Plant species should be tolerant of compaction, have the ability to neutralize contaminants, and should not interfere with maintenance and use of the paved surface. Most plant species cannot tolerate frequent vehicular compaction. Therefore, turf block pavers are best suited for areas requiring infrequent access, such as emergency vehicle access routes. Paver manufacturer should be consulted regarding recommended and acceptable plant species.

B.3.8 Green Roof

A green roof is intended to capture precipitation and roof runoff. Green roofs utilize a lightweight, porous planting substrate as a medium for plant growth. The depth and composition of this substrate is extremely important in determining types of plants that will be successful as part of a green roof system. Intensive green roofs, which can have up to 48” of substrate, can support a wider variety of plant types. The list in Table B-1 is only a sample of plants that could be suitable for an intensive green roof. Please note that shrub species may be used only if the substrate has a minimum depth of 12 inches; a minimum dept of 36 inches is required for planting trees.

Extensive green roofs, which have a depth of 3” to 7” of planting medium, are suitable for a limited number of grass and herbaceous species. These roofs generally require little maintenance and should be designed to succeed with minimal irrigation. In addition to the species listed in **Table B-1**, pre-vegetated mats can be utilized on extensive green roofs. Information can be found at: www.thehenryford.org/rouge/leedlivingroof.aspx.

B.4 PLANTING SPECIFICATIONS

Planting plans and specifications must be prepared by a qualified professional and coordinated with other site development details and specifications including earthwork, soil preparation and irrigation (if used). Plans indicating a planting layout, with species composition and density, should be prepared on a site-specific basis. Reference Alameda County’s Bay Friendly Landscaping Guidelines prepared by Rescape California, also known as the Bay-Friendly Landscaping Coalition (available at www.rescapeca.org), which outline principles and practices to minimize waste, protect air and water quality, conserve energy and water, and protect natural ecosystems, including:

- Evaluate site and assess the soil;
- Consider potential for fire;
- Select plants for appropriate size upon maturity, do not over-plant;

- Irrigation, if required, should be designed as a high efficiency, water conserving system; and
- Utilize compost (see the specification in the Bay-Friendly Landscaping Guidelines) and non-dyed mulch to build healthy soils and increase the water holding capacity of the soil. Mulch should be organic, non-dyed, and should resist floating, as described in Section B5, under the heading, "Erosion Control."

B.4.1 Propagation and Planting Methods

The propagation methods for different species will vary, depending upon type of plant and stormwater adaptation. In general, container stock will be utilized most commonly for green roofs, flow-through planters, tree well filters, vegetated swales and buffer strips and infiltration trenches. Bioretention areas and extended detention basins will generally utilize native plants available as transplants (plugs), pole cuttings and seed mixes.

Container Stock. Planting holes for container stock should be twice as wide and only as deep as the container size. Plant spacing should be determined on a site-specific basis. When planting, the root collar and base of the stem should be 1" above the adjacent soil surface. Soils should be backfilled and tamped down to assure contact with the roots. The planting should be watered-in promptly to promote the settling of soil. If appropriate, container plantings may receive a balanced time-released fertilizer tablet, quantity, and placement per manufacturer's recommendation, placed in the planting hole prior to installation of the plant. Planting berms for water retention and mulch shall be used to enhance plant establishment. Trees shall be staked or guyed to provide interim support until established.

Transplants (Plugs). Transplanted plant divisions, referred to here as plugs, should be planted during the fall dormant period, preferably between October 1 and November 15 after first soaking rain. Plugs should be collected from a suitable collection site in the vicinity of the constructed basins. Plugs are clumps of plant roots, rhizomes or tubers combined with associated soil that can be manually removed, or salvaged with an excavator or backhoe. The maximum recommended size is 1 foot x 1 foot. Whole plants or plant divisions can be utilized. The plugs should be from healthy specimens free of insects, weeds, and disease. The plugs should be spaced from 1 foot to 6 feet apart, depending on the size of the plug. Smaller plugs can be planted at the minimum distance to promote faster spreading and cover. Larger plugs from cattail and bulrush species should be planted at 3-foot to 6-foot intervals.

To plant a plug, a hole slightly wider than the diameter of the plug should be prepared and the roots system of the plug placed in the hole. Do not over-excavate the hole depth or the plant will settle below grade. A shovel could be used to create the planting hole. Manual planting with a spade is recommended for wet soils. Power augers can be used for creating holes in dry soils. Alternatively, a trench could be created along the narrow axis of the extended detention basin, and planting material manually placed at specified elevations in relation to the proximity of permanently saturated soils. To plant a plug with an established root system, the base of the stem and top of the root collar should be level with the ground surface. Tubers should be secured to prevent floating. Rhizomes should be placed in the soil with a slight upward angle.

The hole or trench containing the plug(s) should be backfilled with soil and the soil tamped down to assure good soil contact and secure the plug. The vegetative portion of the plant should be cut back to prevent water loss and wilting and encourage the growth of roots and new shoots. Plugs of wetland plants should be grown in saturated soil. The soil should not be allowed to dry out after planting. Plugs should be planted immediately, when possible. When necessary, plugs can be stored in a cool, moist, shaded location for a maximum of one day. Plants must be thoroughly watered.

Pole Cuttings. Pole cuttings should be collected from the 1-year old wood of dormant trees and have a minimum of 5 viable nodes. The parent material should be healthy and free of diseases. The basal area of the pole cutting should be a minimum of one to two inches in diameter; however, the diameter at the base should not exceed 2 inches. The optimum diameter width of the base is 1 inch. The length of the cutting should be a minimum of 2 feet and should not exceed a maximum of 4 feet in length. Generally, 75 percent of the length of the cutting should be planted beneath the soil surface.

Pole cuttings should be collected no more than 2 days prior to planting. Cuttings should be placed in cool water to promote swelling of the nodes. Water should be kept fresh by aeration and/or by daily replacement. The pole cuttings should be placed in a hole approximately 3 feet deep (as determined by the length of the cutting) and backfilled with native soil, or a rich organic medium mixed with native soil. Soil should be tamped down to remove air pockets and assure soil contact with the cutting.

Seeding. Seeding should be conducted after plugs, container stock and pole cuttings are installed. Hydroseeding or broadcast method shall be utilized as appropriate for the size and accessibility of the area. The soil surface should be scarified prior to seeding. Do not damage previously planted vegetation. The seeds should be planted in fall, ideally in October.

Seeds should be broadcast or hydroseeded over the specified planting area. With broadcast seeding, the seed should be applied with hand-held spreaders to scarified soil. The soil surface should then be raked to cover the seeds with about one-eighth to one-quarter inch of soil to discourage predation, and tamped or rolled to firm soil surface.

Seeds should be planted at the ratios and rates specified by the supplier. The seed should be free of weeds and diseases. The supplier should provide the certified germination percentage.

B.4.2 Water Level Management and Irrigation for Plant Establishment

All newly planted material needs careful attention to watering requirements to ensure proper establishment. As mentioned in the introduction, it is important to select plants based on specific site conditions, which will affect the availability of water for plant use. Also, grouping plants with similar water needs can help reduce irrigation demand. The specific approach will vary for irrigated and non-irrigated conditions, and for each stormwater application. In most cases, stormwater applications require a permanent irrigation system which shall be designed to maximize water conservation. Irrigation specifications and design plans shall be provided.

Plants such as shrubs and trees grown in naturalized areas that are not saturated to the surface or inundated shall be irrigated with drip irrigation. The irrigation system shall remain in place for a minimum of three years, and should continue until it is demonstrated that the plantings can survive on annual rainfall and/or groundwater. Seeded areas do not need irrigation in years of normal rainfall. If a period of drought occurs after seeding, supplemental watering may be needed for germination in the first year.

The plants on the bottom and edge of the constructed basins should be allowed to become established for one growing season prior to the onset of significant flooding that will inundate the plantings for extended periods. The types of plants recommended for these locations are rushes, sedges, grasses, and herbaceous species. Initially, saturated soils are required for the bioretention areas and extended detention basins during the establishment period of the plantings. After the plants have become established, inundation with a surface depth of 1 cm to 2 cm alternating with short dry periods is recommended for the basins during the first year. Periodic shallow flooding of these basins can slow the growth of non-native weedy terrestrial species in the wetland system; however, the water depth should not be greater than the height of the plants. This initial irrigation regime will prevent plant mortality from dry periods or excessive flooding in the first year, and reduce the growth of non-native weedy species.

Emergent species should be planted in saturated soil so the plants will become established. For emergent species, the water level in the first year should be maintained to allow for soil saturation or shallow inundation around the base of the plants. Significant flooding and inundation of stems and leaves of the plants should be avoided the first year. Tall plugs and plantings can tolerate greater depths of inundation if a significant portion of the stems and leaves of the plantings remain above the water surface.

B.5 MONITORING AND MAINTENANCE

B.5.1 General Requirements

All planted areas shall be monitored and maintained as required to ensure proper establishment by a Contractor with a valid California C-27 contractor’s license. Frequency of site visits and required maintenance practices will vary depending upon the stormwater measure and plant selection. Maintenance shall include watering, cultivation, weeding and pruning as necessary to maintain optimum growth conditions and, as appropriate to the specific stormwater measure, to keep the planted areas neat and attractive in appearance. In all instances, controlling weeds and unwanted growth with chemical applications is prohibited.

The contractor shall be familiar with the design and function of the specific stormwater measure(s) to ensure that the plantings are maintained appropriately and do not interfere with the efficient runoff drainage and filtration.

Ongoing management of invasive weed species is required in all applications. Monthly hand weeding will allow the naturalized vegetation to take hold, and will ultimately be less costly than less frequent, and more intensive clearing. Regular application of compost mulch, or other organic, non-dyed mulch material that will resist floating with surface runoff (such as pea gravel, rock, cobble, or large float-resistant wood mulches), will also help control weed growth. “Micro-bark” or “gorilla hair” mulches are not recommended.

B.5.2 Erosion Control

Particularly with landscapes that are not fully established, contractors will need to monitor and evaluate potential for erosion and sediment accumulation in the runoff, which will influence irrigation scheduling and as well as determine the need for additional erosion control measures. Soil can be protected from erosion by a number of methods including:

- Keep the soil covered with vegetation to the extent possible;
- Slow water runoff by using compost berms, blanket, socks, or tubes along slopes;
- Cover bare soil and maintain a 3-inch layer of “arbor”, “aged” or “composted” mulch on any exposed soil areas between plantings. Washed and clean pea gravel, rock, cobble, or other mulches that resist floating may also be used. Bark and “gorilla hair” mulches are not recommended. Only non-dyed mulch should be used in stormwater treatment facilities.
- Minimize the use of blowers in planting beds and on turf;
- Store leaf litter as additional much in planting beds as appropriate.

B.5.3 Irrigation Systems

Bioretention facilities, flow-through planters, and other stormwater treatment facilities that use biotreatment soil may need to receive more frequent but shorter duration irrigation than other landscaped areas, due to the sand content of biotreatment soil. Provide separate irrigation control for bioretention areas, flow-through planters, and other stormwater treatment measures that use biotreatment soil. Specify weather-based irrigation controllers, sometimes called “smart” irrigation controllers, which use soil moisture sensors to signal the irrigation controller. Drip emitters should be used instead of spray irrigation. Where irrigation systems have been installed for temporary or permanent irrigation, the contractor shall maintain the irrigation system for optimum performance, as per manufacturer’s specifications. Contractor shall inspect the entire system on an ongoing basis, including cleaning and adjusting all drip emitters and valves, and any sprinkler and bubbler heads, for proper coverage. Contractor shall monitor the irrigation system while operating to identify and correct problems with water runoff or standing water.

In the event that a weather-based irrigation controller is not used, monitor soil moisture within plant root zones using a soil probe or shovel and adjust irrigation schedules accordingly , and schedule irrigation using a water budget approach, basing irrigation frequency on evapotranspiration data (ET) to avoid over-irrigation of plant material. Adjust irrigation frequency within each hydrozone area a minimum of every four weeks to respond to expected adjustments in ET data.

If a standard turf mix is used in lieu of a no-mow variety, implement grasscycling, where appropriate to the stormwater treatment measure. Grass clippings shall not be carried into the drainage structures. Refer to A Landscaper’s Guide to Grasscycling available from Rescape California (also known as the Bay-Friendly Landscaping Coalition) at www.rescapeca.org.

B.5.4 Bioretention and Extended Detention Basins

In bioretention and extended detention basins, in particular, non-native invasive plant species should be carefully monitored and controlled to reduce competition with the native plantings and to assure the success of the revegetation activities. The establishment of weeds and invasive species in the bottom of the basins can be partially controlled during the establishment period by implementing the watering schedule of initial saturation followed by alternating periods of shallow inundation and dry soil. Manual methods of weed removal should be conducted on the bottom, edge, and side of the basins when these areas are not inundated. Areas with hydroseeding on the banks of the basins should be weeded carefully to avoid removal of the native species.

Weeding should be conducted regularly during the first two years to prevent the growth, flowering, and seed set of non-native weeds and invasive species. After the first two years, weeding frequency will be determined on a site-specific basis as determined by the type of weeds and seasonal growth cycle of the weed species. In general, weeding once a month will be necessary to avoid more extensive and costly eradication in the future.

Long-term maintenance tasks on the banks of the basins will include continued control of nonnative weeds and invasive plants, and control of erosion. Erosion could include gullies, rills, and sheet erosion. Actions to control erosion should include redirecting or dissipating the water source. Recontouring and subsequent mulching and/or reseeding with erosion control species may be required in bare areas. Maintain an adequate layer of organic, non-dyed, floating-resistant mulch, as described above, under the heading, "Erosion Control." In the event of extensive die-off of the native plant species, the bare areas should be replanted. Where the event that caused plant mortality was not a natural catastrophic occurrence, the site condition that resulted in the die-off should be investigated and remedial action to correct the problem should be undertaken prior to replanting.

B.6 BAY-FRIENDLY LANDSCAPING AND IPM

This section provides a summary of Bay-Friendly landscaping and integrated pest management (IPM) techniques, based on Alameda County's Bay Friendly Landscaping Guidelines prepared by Rescape California, also known as the Bay-Friendly Landscaping Coalition (available at www.rescapeca.org).

B.6.1 Bay Friendly Landscaping

Bay-Friendly landscaping is a whole systems approach to the design, construction and maintenance of the landscape in order to support the integrity of the San Francisco Bay watershed. Project sponsors are encouraged to use landscape professionals who are familiar with and committed to implementing Bay-Friendly landscaping practices from the initial plant selection through the long-term maintenance of the site. This section summarizes Bay-Friendly Landscaping practices that may be implemented information that project sponsors need about how these practices canto benefit water quality of the Bay and its tributaries.

Bay-Friendly landscaping is based on 7 principles of sustainable landscaping and features the following practices:

1. **Landscape Locally.** Landscapes designed to be part of the larger ecosystem of the Bay Area can both protect the health, diversity and sustainability of this valuable resource while making the most of the natural processes of a well-functioning ecosystem. By selecting plants appropriate to the climate, exposure, soils, drainage and topography, plantings can be established more successfully with less consumption of resources and intensive maintenance. Landscape designers are also encouraged to use local, well-adapted plant communities as models and to consider the potential for fire when developing the plant palette for a project.

2. **Less to the Landfill.** Reducing waste –and thus conserving landfill space and fossil fuel for hauling this material to the landfill - starts with not generating it in the first place. Plant trimmings pruning can be reduced by selecting plants that can grow to their natural size is the space allotted them, by avoiding the use of sheared hedges as design elements and not specifying invasive species (see the list provided by the California Invasive Plant Council at www.cal-ipc.org). Prune selectively, and avoid excessive plant growth by applying water and fertilizer judiciously.

   The second step is to recognize the value of plant debris, and to keep this organic matter on the site, using it as a gardening resource for mulching and composting.

3. **Nurture the Soil.** Returning organic matter to the soil, in the form of plant debris, is the link between protecting our watershed and conserving landfill space. Healthy soil that is rich in organic matter is full of life and can store water and actively cycle nutrients, regulate and partition water flow, neutralize pollutants, and resist pests. The following practices will encourage a complex soil community of microorganisms, worms, and other beneficial creatures. Base the landscape design on a soil analysis and understanding of soil texture, structure and drainage. The following practices are recommended during construction:

- Remove and store the topsoil for re-spreading after grading;
- Limit construction traffic to areas that will not be landscaped;
- Control soil erosion;
- Amend the soils with compost before planting; and
- Specify and maintain an adequate layer of organic, non-dyed, floating-resistant mulch, as described in **Section B.5** -- taking into account water flow and designing to avoid the loss of mulch with runoff.

Maintenance practices to benefit soils and the watershed include allowing grass clippings to remain on the lawn; feeding soils with naturally based products including compost and a water extract of mature compost, instead of synthetic, fast release fertilizers and avoiding pesticides.

4. Conserve Water. Amending the soil with compost and keeping it covered with composted mulch (or other organic, non-dyed mulch that resists floating) can increase soil permeability and water-holding capacity, reduce water loss through evaporation and decrease the need for irrigation. Planting appropriate, drought tolerant California natives or Mediterranean plants also reduces water consumption for irrigation, as well as consumption of other resources for mowing, fertilizing, and spraying. Minimize the use of turf grasses that require regular watering and fertilizing to remain green, particularly on slopes or in narrow, irregular hard to water shapes. Arrange plants in "hydrozones" of low, medium or highwater demand. Onsite collection systems can allow the use of rainwater, or the reuse of "graywater" – uncontaminated wastewater from sinks, bathtubs, and washing machines. Specify, install and maintain high-efficiency irrigation systems, and train landscaping staff to manage irrigation according to need.

5. **Conserve Energy.** Conventional landscapes are very fossil fuel consumptive. Selecting plantings that do not require regular mowing or pruning, fertilizing and watering can help reduce this demand and restore our landscapes to those that are more productive than consumptive. Tree plantings can be used to moderate building temperatures, and to shade paved areas and air conditioners. Trees can also intercept significant amounts of rainfall each year and thus help control stormwater runoff. Specify as large a tree as possible but be sure that it will be allowed to grow to its natural shape and size in the allotted space. Outdoor lighting should be designed to use less energy and minimize "light pollution." Choose and maintain energy-efficient landscaping equipment to conserve fuel. Specifying local products and suppliers reduces the energy needed to transport products and supports local economies.

6. **Protect Water and Air Quality.** Bay-Friendly landscaping can help protect water quality by increasing on-site infiltration and reducing runoff, reducing pollutants in runoff, and increasing the soil's ability to remove pollutants from runoff. It can help protect air quality by reducing fossil fuel consumption, recycling plant debris onsite, and planting trees to remove carbon dioxide and absorb air pollutants. Many of the practices described previously, such as minimizing high input decorative lawns, keeping soil covered with organic, non-dyed, floating-resistant mulch and planting trees play a critical role in protecting water and air quality. An additional very important component of Bay-Friendly landscaping is reducing the use of pesticides through integrated pest management, which is described in a separate section, below.

7. **Create and Protect Wildlife Habitat.** Although we tend to rely on parks and open space to preserve wildlife habitat, developed landscapes can also provide food, water, shelter and nesting sites for birds, butterflies, beneficial insects, and other creatures. This can be accomplished by providing a diverse landscape that includes annuals, biennials and perennials of many different sizes, shapes, colors and textures; by choosing California natives first; providing appropriate water and shelter for wildlife; eliminating the use of pesticides; and planning sites to conserve or restore natural areas and wildlife corridors.

B.6.2 Integrated Pest Management

All creeks in the San Francisco Bay Area exceed water quality toxicity limits, primarily due to the pesticide Diazinon entering urban runoff. Although the residential use of Diazinon is currently being phased out, the use of a group of highly toxic chemicals, called pyrethroids, is increasing. Because all pesticides are toxins, integrated pest management (IPM) places a priority on avoiding their use. IPM is a holistic approach to mitigating insects, plant diseases, weeds, and other pests. Projects that require a landscaping plan as part of a development project application are required encouraged to use IPM, as indicated in each agency's source control measures list, which is based on the Clean Water Program's Source Control Model List. Avoiding pesticides and quick release synthetic fertilizers are particularly important when maintaining stormwater treatment measures, to protect water quality.

IPM encourages the use of many strategies to first prevent, and then control, but not eliminate, pests. It places a priority on fostering a healthy environment in which plants have the strength to resist diseases and insect infestations, and out-compete weeds. Using IPM requires an understanding of the life cycles of pests and beneficial organisms, as well as regular monitoring of their populations. When pest problems are identified, IPM considers all viable solutions and uses a combination of strategies to control pests, rather than relying on pesticides alone. The least toxic pesticides are used only as a last resort. IPM features the following practices:

- **Prevent Pest Problems.** Fostering a healthy soil and selecting appropriate plant communities for the site helps reduce the susceptibility to disease and other pests. Landscape designs should include a diversity of species that are well-suited to the site; specify resistant varieties and native species, including plants that attract beneficial insects; place plants a proper distance from buildings; avoid over-planting; and include compost in the soil specifications. Cultural methods of avoiding pests during construction and maintenance include the following:
    - Selecting plant material that is free from disease and insects;
    - Planting at the right depth;
    - Watering thoroughly but not over-watering;
    - Keeping an adequate layer of organic, non-dyed, floating-resistant mulch on the soil surface at all times, and keeping it away from root crowns, as described above, under the heading, "Erosion Control.";
    - Using slow release fertilizer, if necessary, and not over-fertilizing;
    - Pruning judiciously;
    - Eliminating noxious weeds before they go to seed or spread;
    - Cleaning equipment after use on infected plants;
    - Inspecting and removing invasive plant parts or seeds from clothing, tools, and vehicle before leaving an infected site; and
    - Cleaning up fruit and plant material that is infected with insects or diseases.
- **Watch for and Monitor Problems.** Landscaping firms should provide their staff with the time and resources to learn to identify both pest and beneficial organisms, and train residential clients to monitor and record pest problems. Plants should be checked often for vigor and signs of pests. Clarify which problems are the result of pests and not other environmental problems. Evaluate the results of any treatments, and check regularly with the Bio-Integral Resource Center (www.birc.org) or UC Davis (www.ipm.ucdavis.edu) for up-to-date resources and information.
- **Education is Key.** Many property owners have unrealistic standards of absolute pest control and need to learn how landscapes can tolerate a certain level of pests without

resulting in significant, or even noticeable, damage. Landscape professionals should educate their clients and refer them to www.ourwaterourworld.org for fact sheets and information on alternative pest control strategies.

- **Use Physical and Mechanical Controls.** If pests are identified as causing unacceptable levels of damage, physical barriers or mechanical techniques are the first line of control. This can include the carefully timed and conducted pruning of infested plant material or removal of whole plants, spraying aphids with a strong jet of water, using pheromone or sticky traps to keep ants and other insects away or hand-picking large adult insect pests and larvae as they appear.
- **Use Biological Controls.** Living organisms can also be used to keep pest populations under control. The most important biological controls appear naturally and will be abundant in a landscape that is not heavily treated with pesticides. Encourage beneficial insects by planting a wide range of plants that flower throughout the year (a list is provided in the Bay-Friendly Landscaping Guidelines), and introduce natural predators. Buy all biological controls from a reputable source, and do not use pesticides except as a last resort.
- **Least Toxic Pesticides are a Last Resort.** The least toxic and least persistent pesticide is used only when monitoring indicates that preventative and non-chemical methods are not keeping pests below acceptable levels. Pesticides are not used on a calendar basis. When used, their efficiency is maximized by understanding the pest and beneficial life cycles, by careful timing and targeted application.

B.7 NURSERY SOURCES FOR NATIVE PLANTS

It is recommended that the native plants used in treatment controls be grown by a qualified nursery. Seed collection should be conducted by a qualified botanist and/or nursery staff. Seed should be collected locally from selected sites to maintain the genetic integrity of the native plant species. The seeds shall be propagated by the nursery for planting during the fall dormant season. The appropriate container size for each species shall be used by the nursery.

Berkeley Horticultural Nursery*
1310 McGee Ave., Berkeley, CA
510-526-4704
http://www.berkeleyhort.com/

East Bay Nursery*
2332 San Pablo Ave., Berkeley, CA
510- 845-6490
http://www.eastbaynursery.com/

Larner Seeds
PO Box 407
Bolinas, California
415-868-9407, info@larnerseeds.com
www.larnerseeds.com/

Mostly Natives Nursery
54 B Street, Unit D
Point Reyes Station, CA 94956
415- 663-8835
www.mostlynatives.com

Native Here Nursery
101 Golf Course Road, Berkeley, CA
510-549-0211
www.ebcnps.org (click on "Native Here Nursery")

Oaktown Native Plant Nursery
702 Channing Way
Berkeley, CA 94710
510-387-9744
https://oaktownnursery.com/

Pacific Coast Seed
1925 N. MacArthur Drive Suite 100
Tracy, CA 95376
925- 373-4417
www.pcseed.com

Watershed Nursery
Berkeley, CA
510-548-4714
www.thewatershednursery.com

* Nurseries with a dedicated native plant section

B.7 REFERENCES

1. Rescape California (also known as the Bay-Friendly Landscaping Coalition) www.rescapeca.org

- Bay-Friendly Landscape Guidelines
- A Landscaper's Guide to Grasscycling
- A Landscaper's Guide to Mulch

2. A Guide to Estimating Irrigation of Water Needs of Landscape Plantings, California Dept of Water Resources, www.cdec.water.ca.gov
3. Irrigation water audits, Irrigation Association, www.irrigation.org, and the Irrigation Technology Research Center, www.itrc.org
4. California Irrigation Management Information System, www.cimis.water.ca.gov, Waste management and recycling, www.ciwmb.ca.gov

5. The Weed Worker's Handbook, A Guide to Techniques for Removing Bay Area Invasive Plants, The Watershed Council (510) 231-5655 and the California Invasive Plant Council (510) 843-3902
6. Pests of Landscape Trees and Shrubs: An Integrated Pest Management Guide, 2nd ed., UC Publication 3359, www.ipm.ucdavis.edu
7. City of Santa Rosa. 2005. Appendix A. Landscaping and Vegetation for Storm Water Best Management Practices in New Development and Redevelopment in the Santa Rosa Area.
8. Hogan, E.L., Ed. 1994. Sunset Western Garden Book, Sunset Publishing Corporation, Menlo Park, CA.
9. California Stormwater Quality Association (CASQA). Stormwater BMP Handbook: New Development and Redevelopment. 2021.
10. Bornstein, Carol, David Fross and Bart O'Brien, California Native Plants for the Garden
11. East Bay Municipal Utility District (EBMUD), Plants and Landscapes for Summer Dry Climates
12. University of California Cooperative Extension, Guide to Estimating Irrigation Water Needs of Landscape Plantings in CA

Table B-1 Plant List for Stormwater Measures

		Bioretention Area - Including linear treatment measure	Flow-Through Planters	Tree Well Filters	Vegetated Buffer Strip	Infiltration Trench	Extended Detention Basin - biotreatment soil	Extended Detention Basin - non-biotreatment soil	Turf Block Pavers	Green Roof - extensive	Green Roof - Intensive	California Native	Drought Tolerant
Emergent Species													
Carex barbarae	Santa Barbara sedge				✓		✓	✓		✓	✓	✓	✓
Carex pansa	California meadow sedge			✓	✓		✓	✓	✓	✓	✓	✓	✓
Juncus patens [2]	California gray rush	✓	✓		✓	✓	✓	✓			✓	✓	
Juncus patens 'Elk Blue' [2]	Elk Blue California Gray Rush	✓	✓										
Limonium californicum	Marsh rosemary						✓	✓				✓	
Grasses, grass-like plants, ground cover													
Aristida purpurea	Purple three-awn	✓	✓		✓						✓	✓	✓
Calamagrostis foliosa [2]	Mendocino reed grass	✓	✓										
Chondropetalum tectorum [2]	cape rush	✓	✓		✓	✓	✓	✓			✓		
Deschampsia cespitosa [1]	tufted hairgrass	✓			✓	✓	✓	✓			✓	✓	✓
Deschampsia cespitosa ssp. holciformis	Pacific hairgrass	✓			✓	✓	✓	✓			✓	✓	
Festuca rubra [1]	red fescue		✓	✓	✓				✓		✓	✓	✓
Festuca rubra 'molate'	Molate fescue		✓	✓	✓				✓		✓	✓	✓
Hordeum brachyantherum [1]	meadow barley	✓			✓		✓	✓				✓	✓
Phyla nodiflora [2]	Kurapia, a.k.a. Pink lippia	✓	✓										
Leymus triticoides	creeping wild rye	✓			✓	✓		✓			✓	✓	✓
Leymus condensatus 'Canyon Prince' [2]	Canyon Prince wild rye	✓	✓										
Melica californica	California melic				✓							✓	✓
Melica imperfecta	coast range melic	✓	✓		✓							✓	✓
Muhlenbergia rigens	deergrass	✓	✓		✓	✓	✓	✓			✓	✓	✓
Nasella pulchra	purple needlegrass	✓		✓	✓	✓					✓	✓	✓
Nassella lepida	Foothill needlegrass			✓	✓	✓					✓	✓	✓
Sesleria autumnalis [2]	Autumn moor grass	✓	✓										

Table B-1 Plant List for Stormwater Measures

Herbaceous Species

Species	Common name	Bioretention Area - Including linear treatment measure	Flow-Through Planters	Tree Well Filters	Vegetated Buffer Strip	Infiltration Trench	Extended Detention Basin - biotreatment soil	Extended Detention Basin - non-biotreatment soil	Turf Block Pavers	Green Roof - extensive	Green Roof - Intensive	California Native	Drought Tolerant
Achillea filipendulina [2]	Cloth of gold yarrow	✓	✓										
Achillea millefolium	common yarrow		✓	✓	✓					✓	✓	✓	✓
Anigozanthos manglesii [2]	Kangaroo paws tail red	✓	✓										
Anthemis nobilis (Chamaemelum nobile)	chamomile			✓					✓				✓
Armeria maritima	sea pink		✓	✓	✓					✓	✓	✓	✓
Clarkia spp.	Clarkia	✓			✓					✓	✓	✓	✓
Dietes	fortnight lily	✓			✓					✓	✓		✓
Epilobium densiflorum	dense spike-primrose	✓	✓		✓	✓						✓	✓
Eriogonum latifolium	coast buckwheat			✓	✓							✓	✓
Eriogonum fasciculatum	flattop buckwheat			✓	✓							✓	✓
Eschscholzia californica	California poppy	✓	✓		✓				✓	✓	✓	✓	✓
Hesperaloe parviflora [2]	Red yucca	✓	✓										
Kniphofia	Red hot poker	✓											✓
Layia platyglossa	tidy tips				✓					✓	✓	✓	✓
Linum usitatissimum [1]	flax	✓	✓										✓
Limonium californicum	marsh rosemary	✓	✓		✓	✓	✓	✓				✓	
Limonium perezii	sea lavender	✓	✓		✓	✓	✓	✓					✓
Linanthus spp.	Linanthus	✓			✓					✓	✓	✓	✓
Lotus scoparius (Acmispon glaber)	deerweed	✓			✓					✓	✓	✓	✓
Mimulus aurantiacus	common monkeyflower	✓	✓		✓						✓	✓	✓
Mimulus cardinalis	scarlet monkeyflower	✓	✓	✓	✓		✓	✓			✓	✓	
Monardella spp.	coyote mint	✓			✓							✓	✓
Myoporum parvifolium'Pink'	prostrate myoporum	✓	✓	✓	✓						✓		✓
Narcissus	daffodil	✓	✓		✓								✓

Table B-1 Plant List for Stormwater Measures

		Bioretention Area - Including linear treatment measure	Flow-Through Planters	Tree Well Filters	Vegetated Buffer Strip	Infiltration Trench	Extended Detention Basin - biotreatment soil	Extended Detention Basin - non-biotreatment soil	Turf Block Pavers	Green Roof - extensive	Green Roof - Intensive	California Native	Drought Tolerant
Herbaceous Species continued													
Nepeta spp.	catmint	✓		✓	✓						✓		✓
Penstemon spp.	bearded tongue	✓		✓	✓						✓	✓	✓
Sedum spp.	stonecrop				✓					✓	✓		✓
Sempervivum spp.	hen and chicks				✓					✓	✓		✓
Sisyrinchium bellum	blue-eyed grass	✓			✓			✓		✓	✓	✓	✓
Teucrium fruticans 'Azureum'[2]	Azure bush germander	✓	✓										
Yucca filamentosa 'Golden Sword'[2]	Golden sword yucca	✓	✓										
Succulents and Succulent-like Plants													
Aeoniums[2]	Aeoniums	✓	✓										
Aeonium haworthii[2]	Kiwi Aeonium	✓	✓										
Aeonium arboreum[2]	Large Purple Aeonium	✓	✓										
Bulbine futescens 'Orange'[2]	Orange Bulbine	✓	✓										
Agave desmettiana[2]	Smooth Agave	✓	✓										
Shrub Species													
Adenostoma fasciculatum	chamise				✓						✓	✓	✓
Arctostaphylos densiflora 'McMinn'	manzanita 'McMinn'	✓	✓		✓						✓	✓	✓
Arctostaphylos 'John Dourley'[2]	John Dourley Manzanita	✓	✓										
Arctostaphylos manzanita	common manzanita		✓		✓						✓	✓	✓
Arctostaphylos uva-ursi 'Emerald Carpet'	manzanita 'Emerald Carpet'	✓	✓	✓	✓						✓	✓	✓
Asparagus densiflorus	Myers asparagus	✓	✓										
Baccharis pilularis 'Twin Peaks'	Baccharis pilularis 'Twin Peaks'	✓	✓	✓	✓						✓	✓	✓
Buddleia spp. (<u>excluding</u> Buddleja davidii, which is invasive)	butterfly bush	✓			✓								✓
Calycanthus occidentalis	Spicebush	✓	✓		✓	✓						✓	✓
Carpenteria californica	bush anemone	✓	✓		✓							✓	✓

Table B-1 Plant List for Stormwater Measures

Shrub Species continued

		Bioretention Area - Including linear treatment measure	Flow-Through Planters	Tree Well Filters	Vegetated Buffer Strip	Infiltration Trench	Extended Detention Basin - biotreatment soil	Extended Detention Basin - non-biotreatment soil	Turf Block Pavers	Green Roof - extensive	Green Roof - Intensive	California Native	Drought Tolerant
Ceanothus hearstiorum	ceanothus	✓			✓						✓	✓	✓
Ceanothus spp.	ceanothus	✓			✓						✓	✓	✓
Cercocarpus betuloides	mountain mahogany				✓							✓	✓
Cistus spp.	rockrose				✓								✓
Corylus cornuta v. californica	California hazelnut	✓			✓							✓	✓
Euphorbia characias [2]	Chartreuse euphorbia	✓	✓										
Garrya elliptica	coast silk tassle		✓		✓						✓	✓	✓
Heteromeles arbutifolia	toyon	✓	✓		✓						✓	✓	✓
Lavandula spp.	lavender		✓	✓	✓						✓		✓
Lepechina calycina	pitcher sage				✓							✓	✓
Lupinus albifrons	bush lupine				✓							✓	✓
Mahonia aquifolium (Berberis aquifolium)	Oregon grape	✓	✓		✓						✓	✓	✓
Mahonia repens (Berberis aquifolium var repens)	creeping Oregon grape	✓	✓	✓	✓						✓	✓	✓
Myrica californica	Pacific wax myrtle				✓						✓	✓	✓
Nandina	Heavenly bamboo	✓	✓	✓	✓								✓
Phlomis fruticosa [2]	Jerusalem sage	✓	✓										
Physocarpus capitatus	Pacific ninebark	✓		✓	✓		✓	✓			✓	✓	
Pinus mugo [2]	Dwarf mugo pine	✓	✓										
Pittosporum tobira	mock orange		✓		✓								✓
Prunus ilicifolia	holleyleaf cherry				✓	✓						✓	✓
Rhamnus californica (Frangula californica)	coffeeberry	✓	✓		✓						✓	✓	✓
Rhus integrifolia	lemonade berry				✓							✓	✓
Ribes aureum	golden currant	✓	✓		✓	✓						✓	✓
Ribes malvaceum	chaparral currant				✓							✓	✓

Table B-1 Plant List for Stormwater Measures

Shrub Species continued

		Bioretention Area - Including linear treatment measure	Flow-Through Planters	Tree Well Filters	Vegetated Buffer Strip	Infiltration Trench	Extended Detention Basin - biotreatment soil	Extended Detention Basin - non-biotreatment soil	Turf Block Pavers	Green Roof - extensive	Green Roof - Intensive	California Native	Drought Tolerant
Ribes sanguineum	red-flowering currant				✓							✓	✓
Rosa californica	California wild rose	✓	✓		✓	✓						✓	✓
Rubus parviflorus	thimbleberry	✓	✓		✓	✓						✓	
Rubus spectabilis	salmonberry	✓	✓		✓	✓						✓	
Rubus ursinus	California blackberry	✓			✓							✓	✓
Salvia brandegeei	black sage				✓							✓	✓
Salvia clevelandii	Cleveland sage				✓							✓	✓
Salvia leucophylla	purple sage				✓							✓	✓
Salvia melifera	black sage				✓							✓	✓
Salvia sonomensis	creeping sage				✓							✓	✓
Sambucus mexicana	elderberry	✓	✓		✓							✓	✓
Santolina spp.	santolina	✓	✓		✓								✓
Symphoricarpos albus	snowberry		✓		✓							✓	✓
Stachys spp.	lambs ear	✓		✓	✓					✓	✓		✓
Styrax officinalis redivivus	California snowdrop	✓			✓							✓	✓
Trichostema spp.	wooly blue curls	✓			✓						✓	✓	✓
Vaccinium ovatum	evergreen huckleberry	✓	✓		✓							✓	
Westringia fruticosa	Morning light westringia	✓	✓										
Zauschneria californica (Epilobium c.)	California fuchsia	✓	✓	✓	✓						✓	✓	✓

Table B-1 Plant List for Stormwater Measures

Tree Species

		Bioretention Area - Including linear treatment measure	Flow-Through Planters	Tree Well Filters	Vegetated Buffer Strip	Infiltration Trench	Extended Detention Basin - biotreatment soil	Extended Detention Basin - non-biotreatment soil	Turf Block Pavers	Green Roof - extensive	Green Roof - Intensive	California Native	Drought Tolerant
Aesculus californica	buckeye	✓			✓							✓	✓
Arbutus unedo	strawberry tree	✓			✓								✓
Carpinus betulus	European hornbeam	✓	✓	✓									✓
Celtis occidentalis	Common hackberry	✓	✓	✓									✓
Cercis occidentalis	redbud	✓			✓							✓	✓
Crataegus (<u>excluding</u> Crataegus monoyna, which is invasive)	Hawthorn	✓		✓	✓								✓
Lagerstroemia spp.	crape myrtle	✓		✓	✓								✓
Laurus 'Saratoga'	Saratoga laurel	✓		✓	✓								✓
Koelreuteria paniculata	goldenrain tree	✓		✓	✓								✓
Nyssa sylvatica	sour gum	✓		✓	✓								✓
Platanus acerifolia 'Columbia'	London plane tree	✓	✓	✓									
Platanus racemosa	California sycamore	✓	✓	✓								✓	✓
Pistacia chinensis 'Keith Davey	Chinese pistache	✓		✓	✓								✓
Quercus agrifolia	California live oak	✓			✓							✓	✓
Tilia tomentosa	Silver linden	✓	✓	✓									✓
Ulmus propinqua 'JFS-Bieberich'	Emerald sunshine elm	✓	✓	✓									✓
Zelkova serrata	Zelkova	✓	✓	✓									✓

[1] Denotes species with phytoremediation capabilities

[2] Denotes species recommended for biotreatment planting areas

APPENDIX C. EXAMPLE SCENARIOS

C.1. PARKING LOT EXAMPLE

This example shows a proposed parking lot in Alameda County with bioretention areas. LID feasibility/infeasibility criteria (**Appendix E**) shall be used to determine whether bioretention areas may be used and methods to design bioretention areas to maximize infiltration and evapotranspiration. This example demonstrates the use of the 4 percent standard for sizing bioretention areas.

Summary of Stormwater Controls

Site Design Measures

- Landscaped areas within one drainage management area are designed to function as a self-treating area, so that it bypasses the bioretention area, as described in **Section 7.1** of this manual. A second landscaped area drains to the bioretention area.

Source Controls

- Stenciling storm drain inlets
- Landscape designer will be asked to follow Integrated Pest Management principles.

Treatment Measures

- Bioretention areas

The example parking lot site description:

- The project site is 1.2 acres with 1% slope from edge of lot to street.
- The site has one ingress/egress point.
- Sidewalks shall be graded toward landscaped areas.
- The parking lot will have standard asphalt paving.
- The parking lot will have landscaping as an amenity.
- All areas will be graded to drain to bioretention areas along the perimeter of the site.
- Parking lot slopes are approximately 1%.

Bioretention areas are sized following the four percent standard described in **Section 8.1**. The following shows sizing and calculations of the site and the treatment measures used.

C.1.1. Procedure for Sizing Treatment Measures using the 4 Percent Standard

1. Based on the topography of the site and configuration of buildings, divide the site into drainage management areas (DMAs), each of which will drain to an LID treatment measure. Implement Steps 2 through 5 for each DMA.
2. To minimize the amount of landscaping or pervious pavement that will contribute runoff to the LID treatment measures, it was possible to design landscaping in Drainage Management Area B as a "self-treating area" (as described in Section 7.1), so that runoff from that landscaped area bypasses the treatment measure.
3. List the area of impervious surfaces that drain to each treatment measure; include the area of pervious surface (landscaping) in Area A and multiply the pervious area by a factor of 0.1.
4. For Area A, add the product obtained in Step 3 to the area of impervious surface, to obtain the area of effective impervious area (EIA).
5. Multiply the impervious surface (or effective impervious surface in applicable DMAs) by a factor of 0.04. This is the required surface area of the LID treatment measure.

Steps 2 through 5 are shown in **Table C-1**.

Table C-1. Bioretention Sizing for Parking Lot Example (4% standard sizing approach)

DMA	Impervious Area (SF)	Pervious Area (SF)[1]	Pervious Area * 0.1	Effective Impervious Area (EIA) (SF)	EIA * 0.04 (SF)
A	6,788	7,868	786.8	7,575	303
B	24,491	0	0	24,491	980
Totals	31,279	7,868	786.8	32,066	1,283

[1] Include only the pervious area that drains to the treatment measure, not self-treating areas.

C.2. PODIUM TYPE BUILDING EXAMPLE

C.2.1. Introduction

This example shows a proposed podium type building in Alameda County, with flow- through planters. LID feasibility/infeasibility criteria (**Appendix E**) need to be used to determine whether the use of flow-through planters will be allowed. Flow-through planters in this example are sized using the combination flow and volume sizing approach.

Summary of Stormwater Controls

Site Design Measures

- Multistory building above covered parking

Source Controls

- Covered trash storage areas
- Landscape designer will be asked to follow Integrated Pest Management principles

Treatment Measures

- Flow-through planters

The example podium style building site description:

- The project site is approximately 25,000 SF.
- The site is Type D soil with expected compaction of 95%.
- Lot line is assumed to be to the edge of city right-of-way (sidewalks).
- The proposed podium building is a zero-lot line design with flow through planters in the center of the building around a concrete patio and down at ground level.
- The podium building is a mixed-use building with residential units on the top floors, retail space on the second floor and parking on the bottom floor. The building mechanical facilities and trash facilities are also on the bottom floor.
- The roof area of the podium building consists of approximately 9,000 SF patio, 1,000 SF of landscaping and 15,000 SF of conventional roof.
- Offsite sidewalks and driveways will be graded toward the street.
- The ground floor is a concrete slab with buildings and a covered parking structure. There is no potential for infiltration. The soils within the planter will be at least 18 inches of treatment soil with a surface loading rate of 5 inch/hour. A 12-inch layer of drain rock will

be placed around the perforated underdrain to allow for dewatering of the flow through the planter.

- The flow through planter areas will connect directly to the storm drain system through a system of perforated underdrains and overflow pipes.
- The flow through planters shall have splash blocks at rainwater leader discharge points to protect against erosion.
- Design flow criterion: rainfall intensity – 0.2 in/hr
- Design volume criterion: capture 80% of the average annual runoff.
- The mean annual precipitation (MAP) at the site is 16 inches. Because this value is less than 16.4 inches, the applicable rain gauge is the San Jose Airport gauge (MAP = 14.4 inches)

The following steps show the sizes and calculations for the Podium building treatment measures.

C.2.2. Source Control

Parking and trash shall be under the building and covered.

C.2.3. Procedure for Sizing Using Combined Flow and Volume Method

1. List areas to each treatment measure. ("A" in Q = CIA)

Impervious Patio Surfaces	9,000 SF
Patio Landscaping	500 SF
Roof Surfaces	15,000 SF
Landscape	500 SF

2. The approach assumes that all the design rainfall becomes runoff, and thus it is appropriate for use where the drainage area to the bioretention area is mostly impervious. Convert landscape area to effective impervious area by multiplying by 0.1. (Note: In this example, the landscaped area is designed to flow through the planter. For an example where self-treating areas bypass the bioretention area, see the preceding parking lot example.)

Impervious Patio Surfaces	9,000 SF
Roof Impervious Surfaces	15,000 SF
Landscape	1,000*0.1 = 100 SF
Effective Impervious Area	**24,100 SF**

3. Determine the Unit Basin Storage Volumes for 80 Percent Capture using 48-hour drawdown. using **Table 7-1** based on 100 percent impervious area (runoff coefficient of 1.0). The unit basin storage volume at the San Jose Airport gauge for a coefficient of 1.0

is **0.56 inches**. Adjust this volume based on the mean annual precipitation at the site (16 inches).

Adjusted unit basin storage volume = 0.56 in * (16/14.4 in) = 0.62 in.

4. Calculate the Water Quality Design Volume. The water quality design volume is the area from Step 2 times the adjusted unit basin storage volume. (24,100 SF *0.62 in * 1/12 ft/in = **1,245 cubic feet**.)
5. Use a constant surface loading rate of 5 in/hr through the soil as required by the Permit for use with treatment soils.
6. Assume that the rain event that generates the required capture volume of runoff determined in Step 4 occurs at a constant intensity of 0.2 in/hr from the start of the storm (i.e., assume a rectangular hydrograph). Calculate the duration of the rain event by dividing the unit basin storage volume by the intensity. In other words, determine the amount of time required for the unit basin storage volume to be achieved at a rate of 0.2 in/hr. For this example, the unit basin storage volume is 0.62 in, the rain event duration is 0.62 in / 0.2 inches/hour = **3.1 hours**.
7. Compute Required Depth of Storage for a given treatment area. (Maximum Allowable Depth = 12 in).

   Start by calculating the bioretention area using the 4% standard sizing factor. For the effective impervious area calculated in Step 2 (24,100 square feet), the required bioretention surface area would be (0.04*24,100) = **964 square feet**.

   Then assume a bioretention area size that is 25% smaller than that calculated using the 4% standard. Using the example, 964 - (0.25 * 964) = **723 square feet**.

   Calculate the volume of runoff that filters through the treatment soil at a surface loading rate of 5 inches per hour (the design surface loading rate for bioretention facilities), for the duration of the rain event calculated in Step 6. For this example, for a bioretention treatment area of 723 SF, with a surface loading rate of 5 in/hr per hour for a duration of 3.1 hours, the volume of treated runoff = 723 SF * 5 in/hr * (1 ft/12 in) * 3.1 hours = **934 cubic feet**.
8. The difference between the volume of runoff from Step 4 and the volume that flows through the planter for the storm duration from Step 7 is (1,245 cubic feet - 934 cubic feet) = 311 cubic feet. If this volume is stored over a surface area of 723 SF, the average ponding depth would be 311 cubic feet / 723 SF = 0.43 ft or 5.2 in.
9. Check to see if the average ponding depth is between 6 and 12 in, which is the recommended allowance for ponding in a bioretention facility or flow-through planter. If the ponding depth is less than 6 inches, the bioretention design can be optimized with a smaller surface area (i.e., repeat Steps 7 and 8 with a smaller treatment area). If the ponding depth is greater than 12 in, a larger surface treatment area will be required. In this example, the ponding depth of 5.2 in is less than the recommended range of 6 to 12 in. A repetition of Steps 7 and 8 with a

bioretention area that is 30 percent smaller than the bioretention area calculated in Step 2 is provided below.

10. Repeat Step 7 with a bioretention area 30% smaller than the bioretention area in Step 2: 964 SF - (0.30 x 964) = 674 SF. Calculate the volume treated during the rain event duration: 674 SF * 5 in/hr * 1 ft/12 in * 3.1 hours = **871 cubic feet**.
11. Repeat Step 9 for the smaller bioretention area to calculate the volume remaining in the ponded area: 1245 cubic feet - 871 cubic feet = 374 cubic feet. Calculate the average ponding depth: 374 cubic feet / 674 SF. = **0.55 ft or 6.6 in**.

Note: See worksheets on the following pages:

3.1 Worksheet for Calculating the Water Quality Design Volume (80 percent capture method)

3.2 Worksheet for Calculating the Combination Flow and Volume Method

The worksheets are also available for download at www.cleanwaterprogram.org.

Worksheet for Calculating the Water Quality Design Volume (80 percent capture method)

Instructions: After completing Section 1, make a copy of this Excel file for each Drainage Management Area within the project. Enter information specific to the project and DMA in the cells shaded in yellow. Cells shaded in light blue contain formulas and values that will be automatically calculated.

1.0 Project Information

The calculations presented here are based on the 80% capture method of sizing **volume-based treatment measures** provided in the Clean Water Program Alameda County C.3 Technical Guidance, v. 4.0. The steps presented below are explained in Chapter 5, Section 5.1 of the guidance manual, applicable portions of which are included in this file, in the tab called "Guidance from Chapter 5".

1-1 Project Name:

1-2 City application ID:

1-3 Site Address or APN:

1-4 Tract or Parcel Map No:

1-5 Site Mean Annual Precip. (MAP)[1] Inches

Refer to the Mean Annual Precipitation Map in Appendix D of the C.3 Technical Guidance to determine the MAP, in inches, for the site. Click here for map

1-6 Applicable Rain Gauge[2]

Enter "Oakland Airport" if the site MAP is 16.4 inches or greater. Enter "San Jose" if the site MAP is less than 16.4 inches.

MAP adjustment factor is automatically calculated as:

(The "Site Mean Annual Precipitation (MAP)" is divided by the MAP for the applicable rain gauge, showin in Table 5.2, below.)

2.0 Calculate Percentage of Impervious Surface for Drainage Management Area (DMA)

2-1 Name of DMA:

For items 2-2 and 2-3, enter the areas in square feet for each type of surface within the DMA.

	Type of Surface	Area of surface type within DMA (Sq. Ft)	Adjust Pervious Surface	Effective Impervious Area
2-2	Impervious surface		**1.0**	
2-3	Pervious service		**0.1**	
	Total DMA Area (square feet) =			

2-4 ***Total Effective Impervious Area (EIA)*** Square feet

3.0 Calculate Unit Basin Storage Volume in Inches

Table 5-2: Unit Basin Storage Volumes (in inches) for 80 Percent Capture Using 48-Hour Drawdowns		
		Unit Basin Storage Volume (in) for Applicable Runoff Coefficients
Applicable Rain Gauge	**Mean Annual Precipitation (in)**	**Coefficient of 1.00**
Oakland Airport	18.35	0.67
San Jose	14.4	0.56

3-1 ***Unit basin storage volume from Table 5.2:*** Inches

(The coefficient for this method is 1.00, due to the conversion of any landscaping to effective impervious area)

3-2 ***Adjusted unit basin storage volume:*** Inches

(The unit basin storage volume is adjusted by applying the MAP adjustment factor.)

3-3 ***Required Capture Volume (in cubic feet):*** Cubic feet

(The adjusted unit basin sizing volume [inches] is multiplied by the size of the DMA and converted to feet)

3-4 ***To size an infiltration trench, enter the surface area available:*** Square feet

3-5 ***Required depth of infiltration trench, given the surface area available (in 3-4):*** Feet

(Assumes 35% void space in rectangular trench with vertical sides.)
(Note: Infiltration trench depths are typically between 3 and 8 feet.)

Worksheet for Calculating the Combination Flow and Volume Method

Instructions: After completing Section 1, make a copy of this Excel file for each Drainage Management Area within the project. Enter information specific to the project and DMA in the cells shaded in yellow. Cells shaded in light blue contain formulas and values that will be automatically calculated.

1.0 Project Information

The calculations presented here are based on the **combination flow and volume hydraulic sizing method** provided in the Clean Water Program Alameda County C.3 Technical Guidance, Version 4.0. The steps presented below are explained in Chapter 5, Section 5.1 of the guidance manual, applicable portions of which are included in this file, in the tab called "Guidance from Chapter 5".

1-1 Project Name:

1-2 City application ID:

1-3 Site Address or APN:

1-4 Tract or Parcel Map No:

1-5 Site Mean Annual Precip. (MAP)[1] **Inches**

Refer to the Mean Annual Precipitation Map in Appendix D of the C.3 Technical Guidance to determine the MAP, in inches, for the site. Click here for map

1-6 Applicable Rain Gauge[2]

Enter "Oakland Airport" if the site MAP is 16.4 inches or greater. Enter "San Jose" if the site MAP is less than 16.4 inches.

MAP adjustment factor is automatically calculated as:

(The "Site Mean Annual Precipitation (MAP)" is divided by the MAP for the applicable rain gauge, showin in Table 5.2, below.)

2.0 Calculate Percentage of Impervious Surface for Drainage Management Area (DMA)

2-1 Name of DMA:

For items 2-2 and 2-3, enter the areas in square feet for each type of surface within the DMA.

	Type of Surface	Area of surface type within DMA (Sq. Ft)	Adjust Pervious Surface	Effective Impervious Area
2-2	Impervious surface		**1.0**	
2-3	Pervious service		**0.1**	
	Total DMA Area (square feet) =			

2-4 ***Total Effective Impervious Area (EIA)*** **Square feet**

3.0 Calculate Unit Basin Storage Volume in Inches

Table 5-2: Unit Basin Storage Volumes (in inches) for 80 Percent Capture Using 48-Hour Drawdowns		
		Unit Basin Storage Volume (in) for Applicable Runoff Coefficients
Applicable Rain Gauge	**Mean Annual Precipitation (in)**	**Coefficient of 1.00**
Oakland Airport	18.35	0.67
San Jose	14.4	0.56

3-1 ***Unit basin storage volume from Table 5.2:*** **Inches**

(The coefficient for this method is 1.00, due to the conversion of any landscaping to effective impervious area)

3-2 ***Adjusted unit basin storage volume:*** **Inches**

(The unit basin storage volume is adjusted by applying the MAP adjustment factor.)

3-3 ***Required Capture Volume (in cubic feet):*** **Cubic feet**

(The adjusted unit basin sizing volume [inches] is multiplied by the size of the DMA and converted to feet)

4.0 Calculate the Duration of the Rain Event

4-1 Rainfall intensity **0.2 Inches per hour**

4-2 Divide Item 3-2 by Item 4-1 **Hours of Rain Event Duration**

5.0 Preliminary Estimate of Surface Area of Treatment Measure

5-1 4% of DMA impervious surface **Square feet**

5-2 Area 25% smaller than item 5-1 **Square feet**

5-3 Volume of treated runoff for area in Item 5-2 **Cubic feet** (Item 5-2 * 5 inches per hour * 1/12 * Item 4-2)

6.0 Initial Adjustment of Depth of Surface Ponding Area

6-1 Subtract Item 5-3 from Item 3-3 **Cubic feet** (Amount of runoff to be stored in ponding area)

6-2 Divide Item 6-1 by Item 5-2 **Feet** (Depth of stored runoff in surface ponding area)

6-3 Convert Item 6-2 from ft to inches **Inches** (Depth of stored runoff in surface ponding area)

6-4 If ponding depth in Item 6-3 meets your target depth, skip to Item 8-1. If not, continue to Step 7-1.

7.0 Optimize Size of Treatment Measure

7-1 Enter an area larger or smaller than Item 5-2 **Sq.ft.** (enter larger area if you need less ponding depth; smaller for more depth.)

7-2 Volume of treated runoff for area in Item 7-1 **Cubic feet** (Item 7-1 * 5 inches per hour * 1/12 * Item 4-2)

7-3 Subtract Item 7-2 from Item 3-3 **Cubic feet** (Amount of runoff to be stored in ponding area)

7-4 Divide Item 7-3 by Item 7-1 **Feet** (Depth of stored runoff in surface ponding area)

7-5 Convert Item 7-4 from feet to inches **Inches** (Depth of stored runoff in surface ponding area)

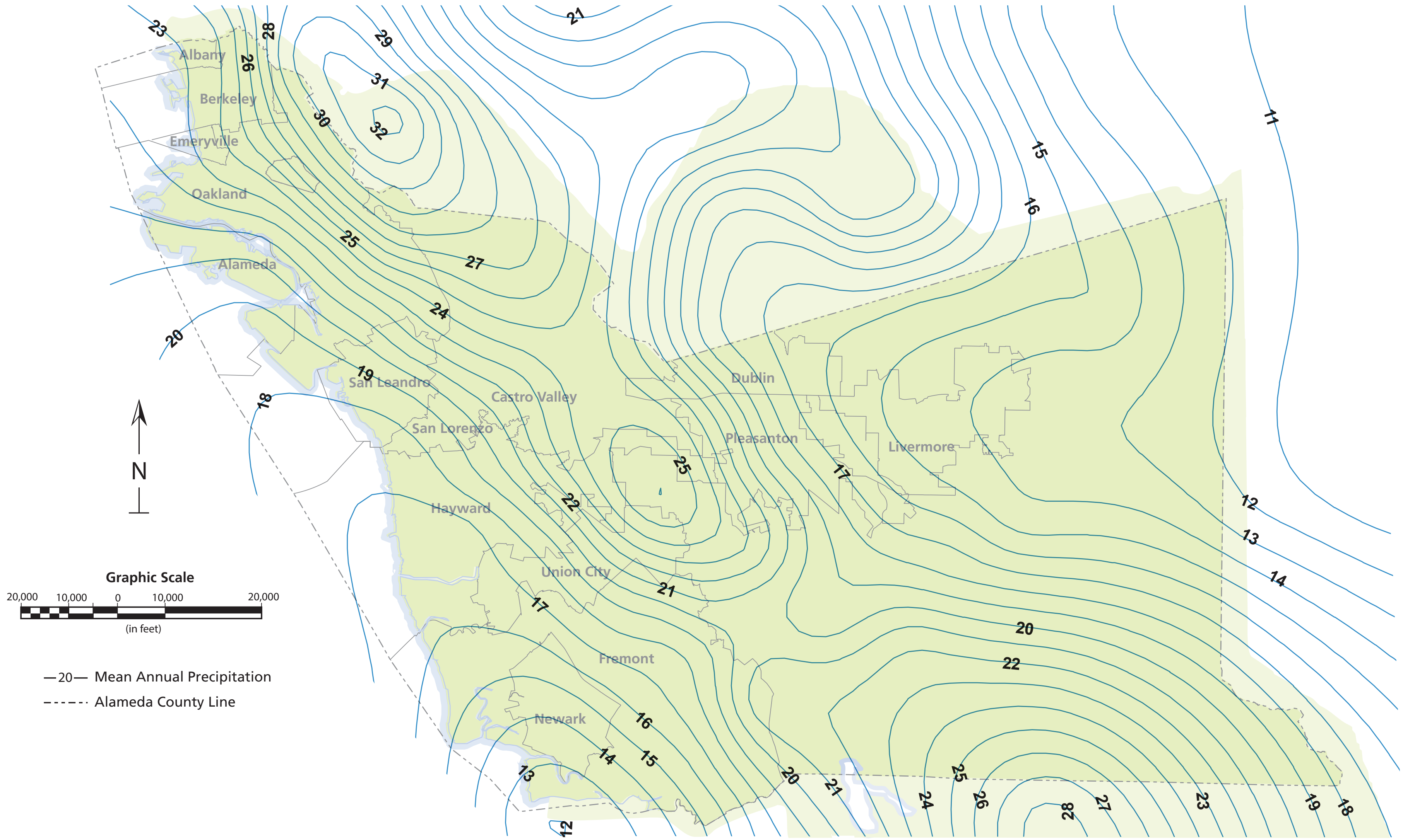
7-6 If the ponding depth in Item 7-5 meets target, stop here. If not, repeat Steps 7-1 through 7-5 until you obtain target depth

8.0 Surface Area of Treatment Measure for DMA

8-1 Final surface area of treatment* **Square feet** (Either Item 5-2 or final amount in Item 7-1)

**Note: Check with the local jurisdiction as to its policy regarding the minimum biotreatment surface area allowed.*

APPENDIX D. MEAN ANNUAL PRECIPITATION MAPS



This map is Attachment 6 of the Alameda County Hydrology & Hydraulics Manual and may be downloaded as a GIS file from the Alameda County Flood Control District website.

(District 2011)

Alameda County Flood Control & Water Conservation District

Mean Annual Precipitation

APPENDIX E. APPLICABILITY OF NON-LID TREATMENT MEASURES

As described in **Section 7.2**, since December 1, 2011, no underground vault systems have been allowed to be used as stand-alone stormwater treatment measures to meet the requirements of MRP Provisions C.3.c and C.3.d, except in certain types of Special Projects, for which media filters may be allowed. Special Projects criteria are included in **Appendix J**. Three types of underground systems have been shown to have particular difficulty meeting the MRP standard of removing pollutants to the maximum extent practicable (MEP) These three systems – inlet filters (also called manufactured drain inserts), oil/water separators (also called water quality inlets), and hydrodynamic separators – are described below. The Water Board staff's August 2004 letter that describes issues associated with these treatment measures is included at the end of this Appendix. A discussion of media filters precedes the attached letter.

As described below, some of these devices can be extremely effective in removing trash and other gross solid pollutants, as well as sediment and oil. While not adequate to meet the MEP standard alone, their use may be worth considering if used as part of a treatment train.

E.1 Inlet Filters

The California Stormwater Quality Association's (CASQA) New Development BMP Handbook describes storm drain inlet filters (which are also called manufactured drain inserts) as manufactured filters or fabric that are placed in a storm drain inlet to remove sediment and debris. In a letter dated August 5, 2004, the Regional Water Board's Executive Officer described its assessment of studies and literature reviews for this type of treatment measure. The letter reported that these filters are subject to clogging, have very limited ability to remove dissolved pollutants, need very frequent maintenance, and are likely to receive inadequate maintenance. The following conclusion was made regarding inlet filters:

> "Based on our review of these references and experience in the Bay Area, it would be very unlikely for a proposal using inlet filters as the sole treatment measures to meet the MEP standard." [26]

Based on the Regional Water Board staff's statements, the Clean Water Program's member agencies do not approve proposals for the use of inlet filters as permanent post-construction treatment measures, unless they are part of a stormwater treatment train approach that includes other, more effective types of stormwater treatment measures. The use of treatment trains is discussed in **Section 7.4**. Long-term use of inlet filters can be problematic due to their need for frequent maintenance; however, they may be used effectively as construction BMPs.

[26] Letter from Bruce H. Wolfe, Executive Officer of the San Francisco Bay Regional Water Quality Control Board to the Bay Area Stormwater Management Agencies Association (BASMAA), dated August 5, 2004 (included in this appendix).

E.2 Oil/Water Separators

Oil/water separators, also called water quality inlets, are described in CASQA's New Development BMP Handbook as consisting of one or more chambers that promote sedimentation of coarse materials and separation of free oil (as opposed to emulsified or dissolved oil). The Regional Water Board's August 5, 2004, letter described oil/water separators as originally developed for industrial uses and recognized as generally ineffective in removing the types of pollutants normally found in urban stormwater. The letter included the following summary statement regarding oil/water separators:

> *"With the exception of projects where oil and grease concentrations are expected to be very high, and other measures are included in a 'treatment train' approach, Board staff is unlikely to consider oil/water separators as a means of meeting the MEP standard."*

As with inlet filters, based on the Regional Water Board staff's statements, Clean Water Program member agencies do not approve proposals for the use of oil/water separators to treat stormwater, unless they are used to treat high concentrations of oil and grease and the stormwater receives further treatment for fine particulates associated with pollutants.

E.3 Hydrodynamic Separators

The US Environmental Protection Agency (USEPA) has described hydrodynamic separators as "flow-through structures with a settling or separation unit to remove sediments".[27] The energy from the flowing water allows sediments to settle, so no outside power source is needed.

In 2005 the Contra Costa Clean Water Program conducted a literature review that found that hydrodynamic separators were substantially less effective than various landscape-based treatment measures for removing pollutants that are associated with very fine particles and are identified as pollutants of concern in the Contra Costa Countywide NPDES municipal stormwater permit.[28] The technical memorandum also described local experience successfully applying a variety of landscape-based treatment measures to development projects in Contra Costa County, as well as operation and maintenance concerns and mosquito generation potential associated with hydrodynamic separators. Effective December 1, 2011, the stand-alone use of hydrodynamic separators is no longer allowed to meet stormwater treatment requirements.

Hydrodynamic separators can be very effective at removing trash and gross solids from runoff and may be included as part of a treatment train in order to remove large solids before the stormwater is routed to a treatment measure that is more effective at removing fine particulates.

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[27] USEPA, Hydrodynamic Separators Fact Sheet, 1999. https://nepis.epa.gov/Exe/ZyPDF.cgi/P1000ZRK.PDF?Dockey=P1000ZRK.PDF

[28] Contra Costa Clean Water Program, November 16, 2005. Policy on the Use of Hydrodynamic Separators to Achieve Compliance with NPDES Provision C.3.

E.4 Media Filters

A technical description of media filters is provided in **Section 8.10**. Effective December 1, 2011, the stand-alone use of media filters to meet stormwater treatment requirements is no longer allowed, except for use in Special Projects, as described in **Appendix J**. While media filters have been demonstrated to remove suspended solids more effectively than the manufactured treatment systems described above, concerns remain about the maintenance of these systems. Media filters have more intensive maintenance requirements than low impact development treatment measures, and, since they are located underground, tend to be "out of sight, out of mind," and often do not receive the maintenance required to function properly. When used in Special Projects, it will be important for municipal staff to conduct regular maintenance verification inspections to verify that these systems are maintained properly and operating as designed.

E.5 Regional Water Board Letter

A copy of the Regional Water Board August 2004 letter is included in the following pages.

APPENDIX F. INFILTRATION GUIDANCE

As a stormwater management method, infiltration means retaining or detaining water within soils to reduce runoff. Infiltration can be a cost-effective method to manage stormwater – if the conditions on your site allow. These infiltration guidelines identify categories of stormwater infiltration methods, and describe factors that affect the feasibility of their use.

F.1. STORMWATER CONTROLS THAT PROMOTE INFILTRATION

A wide-range of site-design measures and stormwater treatment measures allow stormwater infiltration and can be categorized as described below and illustrated in **Figure F-1**.

A. ***Site design measures –*** such as clustering development or otherwise laying out the site to reduce impervious area, routing drainage from building roofs to landscaped areas, and using pervious pavement.

B. ***Indirect infiltration methods***, which allow stormwater runoff to percolate into surface soils. The infiltrated water may either percolate down into subsurface soils and eventually reach groundwater, or it may be underdrained into subsurface pipes. Examples of indirect infiltration methods include bioretention areas and vegetated buffer strips.

C. ***Direct infiltration methods***, which are designed to bypass surface soils and transmit runoff directly to subsurface soils and eventually groundwater. These types of devices must be located and designed to limit the potential for groundwater contamination. Examples of direct infiltration methods include infiltration trenches, infiltration basins, and dry wells.

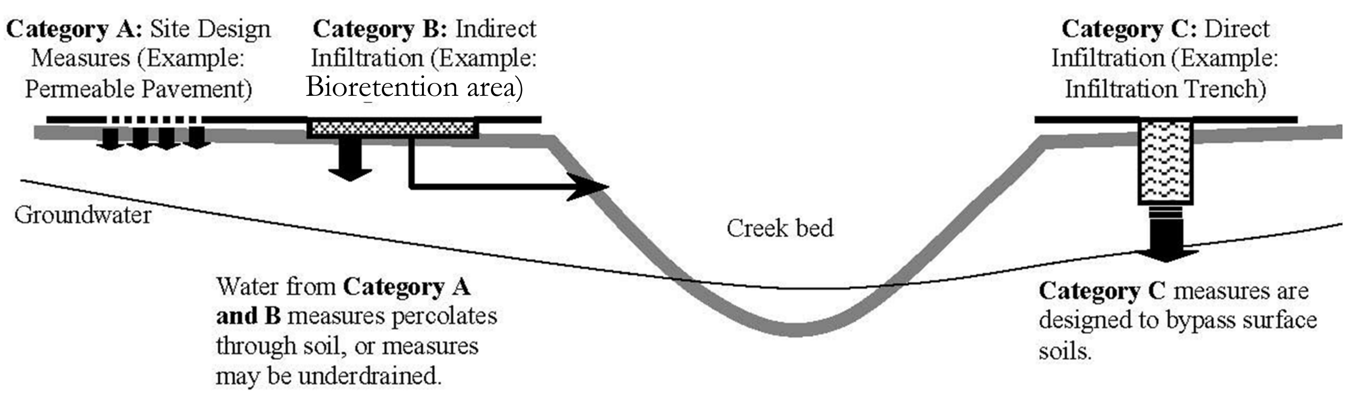


Figure F-1. Stormwater Infiltration Methods

Source: Contra Costa County Clean Water Program, 2005)

Table F-1 describes common stormwater controls and groups them according to whether they meet the above definitions of categories A, B and C. References to the applicable section of Chapter 5 or 6 are given for stormwater controls that have specific technical guidance included in this handbook.

Table F-1. Infiltration Methods in Commonly-Used Stormwater Controls

Stormwater Control	Description	Guidance in Section
Category A: Site Design Measures		
Disconnected Downspouts	Instead of connecting directly to storm drains, roof runoff is directed away from the building to nearby landscaped areas.	N/A
Site Grading	Using gentler slopes and concave areas to reduce runoff and encourage infiltration.	N/A
Site Layout Practices	Examples: Use compact, multi-story buildings to reduce building footprint, cluster buildings to reduce street length and protect sensitive areas, design narrow streets, use sidewalks on one side of street.	N/A
Category B: Indirect Infiltration		
Bioretention Area	Briefly ponds stormwater on the surface of a shallow depression and allows it to percolate through permeable soil. May require underdrain if native soils drain poorly.	6.1
Pervious Pavements	Special mixes of concrete and asphalt. Require a base course of crushed aggregate and installation by experienced crews.	6.6
Turf Block	A load-bearing, durable surface of impermeable blocks separated by spaces and joints in which soil is planted with turf.	6.7
Unit Pavers	Traditional bricks or other pavers on sand or fine crushed	6.7
Cisterns	Above- or below-ground storage vessels, sometimes with a manually operated valve, provide infiltration if runoff is stored for post-storm discharge to landscaping.	6.9
Category C: Direct Infiltration		
Infiltration Trench	A trench with no outlet, filled with rock or open graded aggregate.	6.4
Infiltration Basin	An excavation that exposes relatively permeable soils and impounds water for rapid infiltration.	N/A
Dry Well	Small, deep hole filled with open graded aggregate. Sides may be lined with filter fabric or may be structural (i.e., an open bottom box sunk below grade). Typically receives roof runoff.	N/A

Sources: Contra Costa Clean Water Program, 2005; CASQA, 2003.

F.2. FACTORS AFFECTING FEASIBILITY OF INFILTRATION

The Harvest and Use, Infiltration and Evapotranspiration Feasibility/Infeasibility Criteria Report (Feasibility Report) submitted to the Regional Water Board by BASMAA on April 29, 2011 identified the following factors affecting the feasibility of infiltration. These factors are grouped according to whether they apply to infiltration measures, which provide indirect infiltration, or "infiltration devices," which provide direct infiltration. The MRP defines "infiltration device" as any structure that is deeper than wide and designed to infiltrate stormwater into the subsurface and, as designed, bypass the natural groundwater protection afforded by surface soil. The MRP lists the following as examples of infiltration devices: dry wells, injection wells, infiltration trenches, and French drains.

F.2.1. Factors Affecting Feasibility of Both Indirect and Direct Infiltration

The permeability of the underlying soil is a key factor in determining the feasibility of either direct or indirect infiltration. Additionally, there are various factors that may preclude the use of both infiltration measures (indirect infiltration) and infiltration devices (direct infiltration). These include the following:

- Development sites where pollutant mobilization in the soil or groundwater is a documented concern;
- Locations with potential geotechnical hazards;
- Conflicts with the location of existing or proposed underground utilities or easements.

F.2.2. Factors Affecting Feasibility of Direct Infiltration

Factors that specifically preclude the use of infiltration devices (direct infiltration) include the following:

- Locations where policies of local water districts or other applicable agencies preclude infiltration.
- Locations within 100 feet of a groundwater well used for drinking water;
- Appropriate pollution prevention and source control measures, including a minimum of two feet of suitable soil to achieve a maximum of 5 inches/hour infiltration rate;
- Adequate maintenance is provided to maximize pollutant removal capabilities;
- Vertical distance from the base of any infiltration device to the seasonal high groundwater mark is at least 10 feet (or greater if the site has highly porous soils or there are other concerns for groundwater protection);
- Unless stormwater is first treated by a method other than infiltration, infiltration devices are not approved as a treatment measure for stormwater runoff from areas of industrial areas, areas of high vehicular traffic or land uses that pose a high threat to water quality;
- Infiltration devices are not placed in the vicinity of known contaminated sites; and
- Infiltration devices are located a minimum of 100 feet horizontally away from any known water supply wells, septic systems, and underground storage tanks (or greater if the site has highly porous soils or there are other concerns for groundwater protection).

F.3. DEALING WITH COMMON SITE CONSTRAINTS

The following tips are intended to help manage constraints to infiltration that are common in Alameda County.

- Where conditions (such as steep slopes or high groundwater table) do not preclude infiltration, the design of bioretention areas should ***maximize infiltration to the underlying soil***, as shown in **Section 8.1**.

- Infiltration is generally infeasible on ***steep or unstable slopes***. Site design measures that limit impervious area may be appropriate if approved by a geotechnical engineer. Consider detaining runoff in green roofs and cisterns, or using stormwater treatment measures that do not infiltrate water into the natural ground, such as flow- through planters.
- Green roofs, cisterns, flow-through planters, and other stormwater controls that are isolated from underlying soils are also appropriate for areas with ***steep slopes, high ground water*** and/or ***groundwater contamination***.
- A variety of ***site design measures*** can often be used even on sites with the constraints described above, including (but not limited to) structural soils, grading landscaping to a concave form, designing taller buildings with smaller footprints, and concentrating development on less sensitive portions of the site.

F.4. INFILTRATION DEVICES AND CLASS V INJECTION WELL REQUIREMENTS

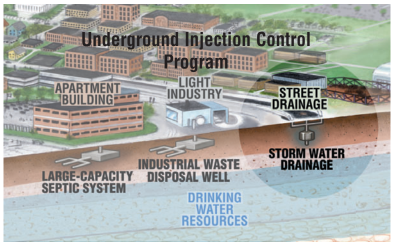
In order to protect underground sources of drinking water, the USEPA regulates some infiltration devices as Class V wells under its Underground Injection Control (UIC) Program. A Class V injection well is defined as "… any bored, drilled, or driven shaft, or dug hole that is deeper than its widest surface dimension, or an improved sinkhole, or a subsurface fluid distribution system."[1] The USEPA's regulations state that stormwater drainage wells are "authorized by rule" (40 CFR 144), which means they do not require a permit if they do not endanger underground sources of drinking water, and they comply with federal UIC requirements. The USEPA's fact sheet, "When Are Storm Water Discharges Regulated as Class V Wells?" is included at the end of this appendix.

If your project includes one or more infiltration devices that are regulated as Class V injection wells, you will need to submit basic inventory information about the device(s) to the regional office of the USEPA. Instructions for submitting this information are available on the USEPA Region 9 website at http://www.epa.gov/uic/forms/underground-injection-wells-registration. Project sponsors are responsible for constructing, operating and closing the drainage well in a manner that does not risk contaminating underground sources of drinking water. The USEPA may place additional requirements on the infiltration device. Project sponsors should contact the appropriate USEPA staff, identified on the Internet link provided above, to learn what inventory information should be submitted, and when the submittal should be made.

1 USEPA Office of Ground Water and Drinking Water, "When Are Storm Water Discharges Regulated as Class V Wells?," June 2003.

United States Environmental Protection Agency

WHEN ARE STORM WATER DISCHARGES REGULATED AS CLASS V WELLS?



Audience: This fact sheet is for storm water managers that implement the National Pollutant Discharge Elimination System (NPDES) program.

Purpose: To increase awareness that storm water drainage wells are regulated as Class V injection wells and to ensure that NPDES regulators understand the minimum federal requirements under the Safe Drinking Water Act (SDWA) for the Underground Injection Control (UIC) program.

ARE STORM WATER DRAINAGE WELLS REGULATED BY THE UIC PROGRAM?

Yes. These wells are regulated by EPA and primacy states through the UIC program as Class V injection wells with requirements to protect underground sources of drinking water (USDWs). A USDW is defined as an aquifer that contains less than 10,000 mg/L total dissolved solids and is capable of supplying water to a public drinking water system.

Class V storm water drainage wells are typically shallow disposal wells designed to place rain water or melted snow below the land surface. By definition, a Class V injection well is any bored, drilled, or driven shaft, or dug hole that is deeper than its widest surface dimension, or an improved sinkhole, or a subsurface fluid distribution system.

Storm water management strategies that include subsurface drainage must comply with UIC program regulations.

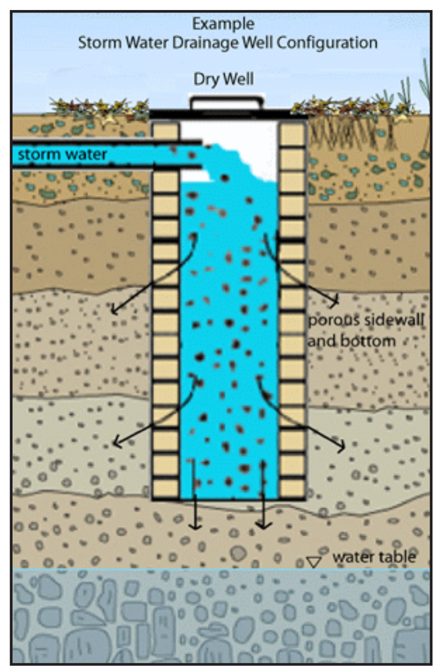
WHY ARE STORM WATER DRAINAGE WELLS A CONCERN?

State and federal UIC program representatives are concerned that there may be a dramatic increase in the use of Class V wells as an NPDES Best Management Practice (BMP) to dispose of storm water. Infiltration through storm water drainage wells has the potential to adversely impact USDWs. The runoff that enters storm water drainage wells may be contaminated with sediments, nutrients, metals, salts, fertilizers, pesticides, and microorganisms.

WHAT ARE SOME EXAMPLES OF STORM WATER DRAINAGE WELLS?

The broad definition of Class V wells covers a variety of storm water injection well configurations, including:

- Dry wells
- Bored wells
- Infiltration galleries



The underground injection well definition applies to any subsurface drainfields that release fluids underground. These can include French drains, tile drains, infiltration sumps, and percolation areas with vertical drainage. Improved sinkholes designed for storm water management are also considered Class V storm water drainage wells. These wells are natural karst depressions or open fractures that have been intentionally altered to accept and drain storm water runoff. The pictures on the back page illustrate an example of a Class V injection well that is subject to UIC requirements.

WHAT INFILTRATION SYSTEMS ARE NOT STORM WATER DRAINAGE WELLS?

Two types of infiltration systems are not considered storm water drainage wells:

- **Infiltration trenches** are excavated trenches filled with stone (no piping or drain tile) to create an underground reservoir. They are usually wider than they are deep.

- **Surface impoundments or ditches** are excavated ponds, lagoons, and ditches (lined or unlined, without piping or drain tile) with an opened surface. They are used to hold storm water. These devices **would be** considered Class V injection wells, however, if they include subsurface fluid distribution systems.

Picture and schematic drawing of parking lot infiltration (Source: Louisiana Department of Transportation)

Storm water drainage well designs can be as varied as the engineers who design them. A fluid distribution system that discharges underground through piping is typically the defining characteristic. If you are unsure about the classification of your infiltration system, contact your UIC program representative for clarification.

HOW ARE STORM WATER DRAINAGE WELLS REGULATED?

Under the minimum federal requirements, storm water drainage wells are “authorized by rule” (40 CFR 144). This means that storm water drainage wells do not require a permit if **they do not** endanger USDWs **and they comply with** federal UIC program requirements. The prohibition on endangerment means the introduction of any storm water contaminant must not result in a violation of drinking water standards or otherwise endanger human health. Primacy states may have more stringent requirements.

Federal program requirements include:

- Submitting basic inventory information about the storm water drainage wells to the state or EPA. (Contact your UIC program to learn what inventory information must be submitted and when.) In some cases, the information may be required prior to constructing the well.

- Constructing, operating, and closing the drainage well in a manner that does not endanger USDWs.

- Meeting any additional prohibitions or requirements (including permitting or closure requirements) specified by a primacy state or EPA region.

HOW CAN I HELP PREVENT NEGATIVE IMPACTS FROM STORM WATER DRAINAGE WELLS?

As an NPDES storm water manager, you can help to ensure that current and future storm water systems using Class V wells meet regulatory requirements under the UIC program. You can also help identify storm water drainage systems that may affect USDWs, and recommend BMPs to protect USDWs. BMPs for storm water drainage wells may address well siting, design, and operation, as well as education and outreach to prevent misuse.

For More Information...

EPA’s Office of Ground Water and Drinking Water Web Site:
http://www.epa.gov/safewater

UIC Program Contacts:
http://www.epa.gov/safewater/uic/primacy.html

EPA’s NPDES Web Site:
http://www.epa.gov/NPDES/Stormwater

Safe Drinking Water Hotline:
1-800-426-4791

Office of Ground Water and Drinking Water (4606M)

EPA 816-F-03-001

June 2003

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APPENDIX G. MOSQUITO CONTROL GUIDELINES

This Appendix presents the guidance for designing and maintaining stormwater treatment measures to control mosquitoes from the Clean Water Program's Vector Control Plan. Project sponsors are responsible for incorporating in their treatment measure designs and maintenance plans the Vector Control Plan's design and maintenance guidance, which is presented below.

G.1 DESIGN GUIDANCE FOR MOSQUITO CONTROL

The following design considerations were adapted from guidance prepared by the California Department of Public Health[1,2], and are provided for project sponsors to use when selecting, designing, and constructing stormwater treatment measures.

G.1.1 General Design Principles

- Preserve natural drainage. Better site design measures reduce the amount of stormwater runoff and provide natural on-site runoff control. This will reduce the number of stormwater treatment measures required.
- In flat areas, where standing water may occur for more than 72 hours under existing conditions, grade to make minor increases in slope to improve surface drainage and prevent standing water.
- Select stormwater treatment measures based on site-specific conditions. Designs that take into account site conditions tend to improve drainage and limit the occurrence of stagnant water.
- Careful consideration should be made before intermittently flooded stormwater treatment measures are selected for handling stormwater. Facilities that pond water temporarily (e.g., extended detention basins) should be designed to drain water completely within 72 hours of a storm event. Avoid placement of extended detention basins and underground structures in areas where they are likely to remain wet (i.e., high water tables). The principal outlet should have positive drainage.
- When a new stormwater treatment measure is being installed, select a type that does not require a wet pond or other permanent pool of water.
- Properly design storm drains. The sheltered environment inside storm drains can promote mosquito breeding. Design and construct pipes for a rate of flow that flushes the system of sediment and prevents water backing up in the pipe. Construct storm drains so that the invert out is at the same elevation as the interior bottom to prevent standing water.
- Use grouted rock energy dissipaters instead of loose rock.

[1] Metzger, Marco, Vector-Borne Disease Section, California Department of Health Services. "Managing Mosquitoes in Stormwater Treatment Devices," 2004.

[2] California Department of Public Health. "Checklist for Minimizing Vector Production in Stormwater Management Structures," 2010.

- In practice, many stormwater treatment measures, not only wet ponds, hold water for over 72 hours, sometimes due to their outdated designs, and possibly due to improper construction and maintenance. To ensure that public health and safety are protected, implement one of the following suggestions for any structure that holds water for over 72 hours:
    - Select or design an alternative (or modified) device that provides adequate pollutant removal and complete drainage in 72 hours. This is the most reliable and cost-effective choice.
    - Contact Alameda County Mosquito Abatement District (ACMAD); in the City of Albany, contact the Alameda County Vector Control Services District (ACVCSD) to determine whether local mosquito species and local factors may preclude rapid mosquito emergence, thus safely allowing water residence times to exceed 72 hours. In some areas this may require a detailed study that should be funded by the soliciting party.

G.1.2. General Access Requirements for Mosquito Control

The following requirements are necessary to provide mosquito abatement personnel access to treatment measures for inspection and abatement activities.

- Design stormwater treatment measures to be easily and safely accessible without the need for special requirements (e.g., OSHA requirements for “confined space”).
- Provide signage with details on design, ownership, and contact information.
- If utilizing covers, include in the design spring-loaded or light-weight access hatches that can be opened easily for inspection.
- Provide all-weather road access (with provisions for turning into a full-size work vehicle) along at least one side of large above-ground structures that are less than 25 feet wide. For structures that have shoreline-to-shoreline distances in excess of 25 feet, a perimeter road is required for access to all sides.
- Provide ACMAD with all keys or gate codes needed for access (in the City of Albany, provide the necessary keys and gate codes to the ACVCSD).

G.1.3. Dry System Design Principles for Mosquito Control

- Structures should be designed so they do not hold standing water for more than 72 hours.
- Avoid locating the base of the system below the local groundwater level.
- Incorporate features that prevent or reduce the possibility of clogged discharge orifices (e.g., debris screens). The use of weep holes is not recommended due to rapid clogging.
- Use the hydraulic grade line of the site to select a stormwater treatment measure that allows water to flow by gravity through the structure. Pumps are not recommended because they are subject to failure and often require sumps that hold water.
- Design distribution piping and containment basins with adequate slopes to drain fully and prevent standing water. The design slope should take into consideration buildup of

sediment between maintenance periods. Compaction during grading may also be needed to avoid slumping and settling.

- Avoid the use of loose riprap or concrete depressions that may hold standing water.
- Avoid barriers, diversions, or flow spreaders that may retain standing water.
- Use mosquito net to cover sand media filter sump pumps.
- Use aluminum "smoke proof" covers for any vault sedimentation basins.
- Properly design storm drain measures. The sheltered environment inside storm drains can promote mosquito breeding. Design and construct pipes for a rate of flow that flushes the system of sediment and prevents water backing up in the pipe.
- Properly design inlets and other structures to prevent scour depressions.

G.1.4. Sumps, Wet Vaults, and Catch Basin Design Principles for Mosquito Control

- Completely seal structures that retain water permanently or longer than 72 hours to prevent entry of adult mosquitoes. Adult female mosquitoes may penetrate openings as small as 1/16 inch (2 mm) to gain access to water for egg laying. Screening (24 mesh screens) can exclude mosquitoes, but it is subject to damage and is not a method of choice.
- If covers are used, they should be tight fitting with maximum allowable gaps or holes of 1/16 inch (2 mm) to exclude entry of adult mosquitoes. Gaskets are a more effective barrier when used properly.
- Any covers or openings to enclosed areas where stagnant water may pool must be large enough (2 feet by 3 feet) to permit access by mosquito control personnel for surveillance and, if necessary, abatement activities.
- If the sump, vault, or basin is sealed against mosquitoes, with the exception of the inlet and outlet, use a design that will submerge the inlet and outlet completely to reduce the available surface area of water for mosquito egg-laying (female mosquitoes can fly through pipes).
- Creative use of flapper or pinch valves, collapsible tubes and "brush curtains" may be effective for mosquito exclusion in certain designs.
- Design structures with the appropriate pumping, piping, valves, or other necessary equipment to allow for easy dewatering of the unit, if necessary.

G.1.5. Wet Ponds and Wetlands Design Principles for Mosquito Control

- If a wet pond or constructed, modified, or restored wetland must be built, contact ACMAD for consultation (in Albany, contact the ACVCSD). Appropriate and adequate funds must be allocated to support long-term site maintenance as well as routine monitoring and management of mosquitoes by a qualified agency.

- Long-term management of mosquitoes in wet ponds and wetlands should integrate biological control, vegetation management and other physical practices, and chemical control as appropriate.
- Provide for regular inspection of sites for detection of developing mosquito populations. Local factors may influence the overall effectiveness of certain approaches for mosquito reduction.
- Wet ponds and wetlands should maintain water quality sufficient to support surface feeding fish, which feed on immature mosquitoes and can aid significantly in mosquito control.
- If large predatory fish are present (e.g., perch and bass), careful vegetation management remains the only nonchemical mosquito control system.
- Where mosquito fish are not allowed, careful vegetation management remains the only nonchemical mosquito control system. Other predators such as dragonflies, diving beetles, birds, and bats feed on mosquitoes when available, but their effects are generally insufficient to preclude chemical treatment.
- Perform routine maintenance to reduce emergent plant densities. Emergent vegetation provides mosquito larvae with refuge from predators, protection from surface disturbances, and increased nutrient availability while interfering with monitoring and control efforts.
- Whenever possible, maintain wet ponds and wetlands at depths in excess of 4 feet to limit the spread of invasive emergent vegetation such as cattails (*Typha* spp.). Deep, open areas of exposed water are typically unsuitable for mosquito immatures due to surface disturbances and predation. Deep zones also provide refuge areas for fish and beneficial macroinvertebrates should the densely vegetated emergent zones be drained.
- Build shoreline perimeters as steep and uniform as practicable to discourage dense plant growth.
- Use concrete or liners in shallow areas to discourage unwanted plant growth where vegetation is unnecessary.
- Eliminate floating vegetation conducive to mosquito production, such as water hyacinth (*Eichhornia* spp.), duckweed (*Lemna* and *Spirodela* spp.), and filamentous algal mats.
- Make shorelines accessible to maintenance and mosquito abatement crews for periodic maintenance, control, and removal of emergent vegetation, as well as for routine mosquito monitoring and abatement procedures, if necessary.
- Improve designs of permanent pools. Minimize shallow depths and increase circulation in ponds. Permanently flooded measures may be stocked with native surface feeding fish known to feed on mosquito larvae.
- Do not use stormwater structures to meet endangered species mitigation requirements. Aquatic habitat for endangered species should not be created near areas populated by humans.

G.2 MAINTENANCE GUIDANCE FOR MOSQUITO CONTROL

Routine and timely maintenance is critical for suppressing mosquito breeding as well as for meeting local water quality goals. If maintenance is neglected or inappropriate for a given site, even structures designed to be the least “mosquito friendly” may become significant breeding sites. Although general principles of mosquito control are described here, maintenance guidelines for individual treatment measures are often site-specific. Therefore, consult with ACMAD regarding the site-specific design of stormwater treatment measures (in Albany, consult with ACVCSD).

The maintenance principles given below are intended to reduce the mosquito population. These principles should be incorporated, as appropriate, in maintenance plans developed for stormwater treatment control measures and in the ongoing maintenance and inspection of treatment measures.

G.2.1. General Maintenance Principles

- With the exception of certain treatment control measures designed to hold permanent water, treatment measures should drain completely within 72 hours to effectively suppress mosquito production.
- Any circumstances that restrict the flow of water from a system as designed should be corrected. Debris or silt build-up obstructing an outfall structure should be removed. Underdrains and filtration media should be inspected periodically and cleaned out or replaced as needed.
- Conduct inspection and maintenance activities regularly, in accordance with a municipality-approved maintenance plan.

G.2.2.1 Vegetation Management Maintenance Principles

- Conduct annual vegetative management, such as removing weeds and restricting growth of aquatic vegetation to the periphery of wet ponds.
- Remove grass cuttings, trash and other debris, especially at outlet structures.
- Avoid producing ruts when mowing (water may pool in ruts).

G.2.2.2. Dry System Maintenance Principles for Mosquito Control

- Extended detention basins are usually designed to detain water for 40 or 48 hours. If they detain water for longer than 72 hours, they are poorly maintained.
- If a detention basin has been installed at an inappropriate location (e.g., on a site where the water table is too close to the surface), and if elimination or modification of the system isn’t possible then mosquitoes must be controlled with larvicides. The larvicide operation, in order to be effective, must be supported by a quality inspection program. Larvacides should only be applied by licensed pesticide applicators. Contact ACMAD for inspection (in Albany, contact ACVCSD).

G.2.2.3. Underground Structure Maintenance Principles for Mosquito Control

- Prevent mosquito access to underground treatment control measures that may have standing water (i.e., seal openings that are 1/16-inch in diameter or greater).
- Provide ACMAD access to underground measures that may have standing water (in Albany, provide access to ACVCSD).

G.2.2.4. Infiltration and Filtration Device Maintenance Principles for Mosquito Control

- Infiltration trenches and sand filter structures should not hold water for longer than 24 hours. If they retain water for longer than 48 hours, they are poorly maintained.

APPENDIX H. O&M DOCUMENTS

Example templates are provided to assist project applicants in preparing the following documents, which municipalities may require as exhibits to a stormwater treatment measure maintenance agreement:

- Standard Treatment Measure O&M Report Form
- How to Use the Maintenance Plan Templates
- Maintenance Plan for Bioretention Area
- Maintenance Plan for Flow-through Planter
- Maintenance Plan for Tree Well Filter
- Maintenance Plan for Infiltration Trench
- Maintenance Plan for Extended Detention Basin
- Maintenance Plan for Pervious Paving
- Maintenance Plan for Media Filter
- Maintenance Plan for Modular Suspended Pavement Systems

Requirements vary from one municipality to the next. Contact the local jurisdiction to obtain electronic files for use in preparing these documents, and to obtain information on municipality-specific requirements.

Stormwater Treatment Measures Operation and Maintenance Inspection Report
[[==Insert Name of Municipality==]], California

This report and attached Inspection and Maintenance Checklists document the inspection and maintenance conducted for the identified stormwater treatment measure(s) and flow duration controls (FDCs) subject to the Maintenance Agreement between the City and the property owner during the annual reporting period indicated below.

I. Property Information:

Property Address or APN:____

____

Property Owner:____

____

II. Contact Information:

Name of person to contact regarding this report:____________________________

____

Phone number of contact person: ___________________ Email:_____________________

Address to which correspondence regarding this report should be directed:

____

____

III. Reporting Period:

This report, with the attached completed inspection checklists, documents the inspections and maintenance of the identified treatment measures during the time period from _________ to __________ annually.

IV. Stormwater Treatment Measure and Flow Duration Control Information:

The following Stormwater Treatment Measures and Flow Duration Controls are located on the property identified above and are subject to the Maintenance Agreement:

Identifying Number of Facility	Type of Stormwater Treatment Measure or Flow Duration Control	Location of Facility on the Property

V: Summary of Inspections and Maintenance

Summarize the following information using the attached Inspection and Maintenance Checklists:

Identifying Number of Treatment Measure	Date of Inspection	Operation and Maintenance Activities Performed and Date(s) Conducted	Additional Comments

VI: Sediment Removal

Total amount of accumulated sediment removed from the stormwater treatment measure(s) during the reporting period: __________ cubic yards.

The sediment was removed and disposed as follows: ________________________________

____

____

VII. Inspector Information:

The inspections documented in the attached inspection checklists were conducted by the following inspector(s):

Inspector Name and Title	Inspector's Employer and Address

VIII. Statement of STM and FDC Condition

Based on the inspections documented in the attached checklists, are the facilities identified in this report present, functional and being maintained as required by the Maintenance Plan? (Check yes or no.)

_____YES _____NO

If "NO", describe problem, proposed solution and schedule of correction:

VIII.Certification:

I hereby certify, under penalty of perjury, that the information presented in this report and attachments is true and complete:

____ __________

Signature of Property Owner or Other Responsible Party Date

____

Type or Print Name

____

Company Name

____

Address

Phone number:__________ Email:____

Attachments to the
Stormwater Treatment Measure
Operation and Maintenance
Inspection Report:
Inspection Checklists

Using the Maintenance Plan Templates for Stormwater Treatment Measures

The New Development Subcommittee (NDS) of the Clean Water Program has prepared templates that project applicants may use to prepare maintenance plans for the following stormwater treatment measures:

- Bioretention[1] areas,
- Flow-through planters,
- Tree well filters,
- Infiltration trenches,
- Extended detention basins,
- Pervious paving, and
- Media filters.

These are treatment measures for which technical guidance has been provided in Chapter 6 of the Clean Water Program's C.3 Stormwater Technical Guidance, which may be downloaded from www.cleanwaterprogram.org (click on "Businesses," then "Development" and go to Appendix H of the C.3 Technical Guidance to download the maintenance plan templates). In some cases, a treatment measure may be sized to function as both a treatment and hydromodification management (HM) measure, as described in Chapter 7 of the Clean Water Program's C.3 Technical Guidance. If your project includes treatment and/or HM measures that are not listed above, but have been approved by the municipality, you may customize one of the maintenance plan templates with information specific to your treatment/HM measure(s).

Microsoft Word documents of the maintenance plan templates may be downloaded from the above link to the Clean Water Program's New Development webpage. When using a template to prepare your maintenance plan, please insert project-specific information where you find prompts such as the following: [[== insert name of property owner/responsible party ==]]. You will need to attach to your maintenance plan a legible, letter-size (8.5-by-11-inch) site plan showing the location(s) of the treatment/HM measure(s). Also, be sure to contact the municipality to learn about any requirements specific to the local jurisdiction. Agency contact information is provided inside the front cover of the C.3 Technical Guidance.

---

1 A bioretention area that is unlined and has a raised underdrain in the underlying rock layer to promote infiltration, as shown in Section 6.1 of the C.3 Technical Guidance, may also be called a "bioinfiltration area"

Bioretention Area[32] Maintenance Plan for
[[== Insert Project Name ==]]

[[== Insert Date ==]]

Project Address and Cross Streets ______________________________

Assessor's Parcel No.:______________________________

Property Owner:____________________ Phone No.: ____________________

Designated Contact: ____________________ Phone No.: ____________________

Mailing Address: ______________________________

The property contains [[== insert number ==]] bioretention area(s), located as described below and as shown in the attached site plan[33].

- **Bioretention Area No. 1** is located at [[== describe location ==]].
- [[== Add descriptions of other bioretention areas, if applicable. ==]]

I. Routine Maintenance Activities

The principal maintenance objective is to prevent sediment buildup and clogging, which reduces pollutant removal efficiency and may lead to bioretention area failure. Routine maintenance activities, and the frequency at which they will be conducted, are shown in Table 1.

Table 1
Routine Maintenance Activities for Bioretention Areas

No.	Maintenance Task	Frequency of Task
1	▪ Remove obstructions, debris, accumulated sediment and trash from bioretention area and dispose of properly. ▪ Maintain vegetation and the irrigation system. Prune and weed to keep bioretention area neat and orderly in appearance.	Monthly
2	▪ Remove and replace all dead and diseased vegetation (replace plants in kind, or per Alameda Countywide Clean Water Program C.3 Technical Guidance Appendix B plant list). ▪ Till or replace soil (using biotreatment soil mix specified in C.3 Technical Guidance Appendix K) as necessary to maintain the design elevation of soil.	Before wet season (August or September), and After wet season (May)
3	▪ Inspect bioretention area using the attached inspection checklist.	Before wet season (inspect in August make all corrections by September 30), and After wet season (May), and Monthly during wet season (October through April)

[32] Bioretention areas include linear treatment measures designed for water to filter through biotreatment soils. A bioretention area that is unlined and has a raised underdrain in the underlying rock layer to promote infiltration, as shown in Section 6.1, may also be called a "bioinfiltration area".

[33] Attached site plan must match the site plan exhibit to Maintenance Agreement.

II. Prohibitions

The use of pesticides and quick release fertilizers is strongly discouraged. For the purposes of stormwater treatment measure maintenance and function, it is anticipated that non-chemical controls (i.e., biological, physical, and cultural controls) will be adequate to address any pest problems. Proper and timely maintenance, as described in this plan, should serve to reduce the potential for pest establishment.

To avoid the need for pesticides or quick release fertilizers, follow the principles of integrated pest management (IPM):

1. Employ non-chemical controls (biological, physical and cultural controls) before using chemicals to treat a pest problem.
2. Prune plants properly and at the appropriate time of year.
3. Provide adequate irrigation for landscape plants. Do not over water.
4. Limit fertilizer use unless soil testing indicates a deficiency. Slow-release or organic fertilizer is strongly preferred. Check with municipality for specific requirements and prohibitions.
5. Pest control should avoid harming non-target organisms, or negatively affecting air and water quality and public health. Apply chemical controls only when monitoring indicates that preventative and non-chemical methods are not keeping pests below acceptable levels. When pesticides are required, apply the least toxic and the least persistent pesticide that will provide adequate pest control. Do not apply pesticides on a prescheduled basis.
6. Sweep up spilled fertilizer and pesticides. Do not wash away or bury such spills.
7. Do not over apply pesticide. Spray only where the infestation exists. Follow the manufacturer's instructions for mixing and applying materials.
8. Only licensed, trained pesticide applicators shall apply pesticides.
9. Apply pesticides at the appropriate time to maximize their effectiveness and minimize the likelihood of discharging pesticides into runoff. With the exception of pre-emergent pesticides, avoid application if rain is expected.
10. Unwanted/unused pesticides shall be disposed as hazardous waste.

Standing water shall not remain in the treatment measures for more than 72 hours, to prevent mosquito generation. Should any mosquito issues arise, contact the Alameda County Mosquito Abatement District (ACMAD), as needed for assistance. In Albany, contact the Alameda County Vector Control Services District (ACVCSD). Mosquito larvicides shall be applied only when absolutely necessary, as indicated by the ACMAD or ACVCSD, and then only by a licensed professional or contractor. Contact information for ACMAD and ACVCSD is provided below.

III. Vector Control Contacts

Alameda County Mosquito Abatement District
23187 Connecticut St.
Hayward, CA 94545
Phone: (510) 783-7747

Alameda County Vector Control Services District
1131 Harbor Bay Parkway, Ste. 166
Alameda, CA 94502
Phone: (510) 567-6800

IV. Inspections

The attached Bioretention Area Inspection and Maintenance Checklist shall be used to conduct inspections, identify needed maintenance, and record maintenance that is conducted. The, schedule of inspections is as follows:

- Before the wet season (in August so that corrections can be made by September 30);
- Monthly during the wet season (October through April);
- After the wet season (May).

Bioretention Area
Inspection and Maintenance Checklist

Property Address:____

Property Owner:________________________ Treatment Measure No.:__________________

Date of Inspection:______________________ Inspector:______________________________

Type of Inspection: ☐ Monthly ☐ Pre-Wet Season ☐ After heavy runoff ☐ End of Wet Season ☐ Other:________________________

Defect	Conditions When Maintenance Is Needed	Maintenance Needed? (Y/N)	**Comments** (Describe maintenance completed and if needed maintenance was not conducted, note when it will be done)	Corrective Action/Results Expected When Maintenance Is Performed
1. Standing Water	When water stands in the bioretention area between storms and does not drain within 72 hours after rainfall; water may not flow evenly through facility.			▪ Remove top 2 to 4 inches of sediment at inlets to the facility. Add biotreatment soil (C.3 Technical Guidance Appendix K) to design elevation of soil (top of mulch is typically 6 inches below the overflow outlet). Rake, till, or amend with soil mix until infiltration rate is restored. Use ASTM D3385-09 to test infiltration rate. ▪ Install a flow spreader or regrade to distribute flow evenly.
2. Trash/Debris Accumulation	Trash and debris accumulated in the bioretention area.			▪ Trash and debris removed from bioretention area and disposed of properly.
3. Sediment	Evidence of sedimentation in bioretention area.			▪ Material removed so that there is no clogging or blockage. Material is disposed of properly.
4. Erosion	Channels or ruts have formed around inlets, there are areas of bare soil, and/or other evidence of erosion.			▪ Obstructions and sediment removed so that water flows freely and disperses over a wide area. Obstructions and sediment are disposed of properly.
5. Vegetation	Vegetation is dead, diseased and/or overgrown.			▪ Replant in-kind or substitute from C.3 Technical Guidance Appendix B plant list. ▪ Manually weed and prune to ensure inlets and outlets convey water into/out of the facility. Remove plant debris.
6. Mulch	Mulch is missing or patchy in appearance. Areas of bare earth are exposed, or mulch layer is less than 3 inches in depth.			▪ Replenish mulch; use aged or composted mulch. ▪ All bare earth is covered, except mulch is kept 6 inches away from trunks of trees and shrubs. ▪ Mulch is even in appearance, at a depth of 3 inches.
7. Irrigation	Irrigation system is not working properly.			▪ Repair as needed and confirm irrigation system works properly.
8. Soil shrinkage	The soil surface is more than 6” below overflow drain).			▪ Add biotreatment soil mix (specified in C.3 Technical Guidance Appendix K), so that soil is at proper depth (top of mulch is typically 6 inches below the overflow

Defect	**Conditions When Maintenance Is Needed**	**Maintenance Needed? (Y/N)**	**Comments** (Describe maintenance completed and if needed maintenance was not conducted, note when it will be done)	**Corrective Action/Results Expected When Maintenance Is Performed**
				outlet).
9. Downspouts and Inlets to Planters	Flow to the facility is impeded, or downspouts are clogged or pipes are damaged. Splash blocks and rocks in need of repair/replenishment.			▪ Repair or replace broken downspouts and curb cuts as needed, so that flow is conveyed efficiently to the planter. ▪ Repair, replace or replenish splash blocks/cobbles, to protect soil from erosive flows at downspouts and inlets.
10. Overflow Pipe or Outlet to Storm Drain	Excess flows are not conveyed safely to storm drain. Piping is damaged or disconnected. Mulch/debris clogs outlet to storm drain (check inside the drain).			▪ Repair the overflow pipe or remove material clogging the overflow outlet, so that excess flow is conveyed efficiently to storm drain. ▪ Remove any mulch, debris or obstruction that is blocking the drain, including any material inside the drain.

Flow-Through Planter Maintenance Plan for
[[== Insert Project Name ==]]

[[== Insert Date =]]

Project Address and Cross Streets ______________________________

Assessor's Parcel No.:______________________________

Property Owner:____________________ Phone No.: ____________________

Designated Contact: ____________________ Phone No.: ____________________

Mailing Address: ______________________________

The property contains [[== insert number ==]] Flow-Through Planter(s), located as described below and as shown in the attached site plan[34].

- **Flow-Through Planter No. 1** is located at [[== describe location ==]].
- [[== Add descriptions of other Flow-Through Planters, if applicable. ==]]

I. Routine Maintenance Activities

The principal maintenance objectives are to ensure that water flows unimpeded into the flow-through planter and landscaping remains attractive in appearance. Table 1 shows the routine maintenance activities, and the frequency at which they will be conducted.

Table 1
Routine Maintenance Activities for Flow-Through Planters

No.	Maintenance Task	Frequency of Task
1	▪ Prune and weed excess vegetation to maintain conveyance/infiltration capacity. ▪ Remove litter, debris, and accumulated sediment; dispose of it properly.	Monthly
2	▪ Till or replace soil (using biotreatment soil mix specified in Appendix K) as necessary to maintain the design elevation of soil. ▪ Remove and replace all dead and diseased vegetation (replace plants in kind, or per Appendix B plant list).	Before wet season (August or September); After wet season (May)
3	▪ Inspect flow-through planter using the attached inspection checklist.	Before wet season (inspect in August make all corrections by September 30), and After wet season (May), and Monthly during wet season (October through April)

II. Prohibitions

The use of pesticides and quick release fertilizers is strongly discouraged. For the purposes of stormwater treatment measure maintenance and function, it is anticipated that non-chemical controls (i.e., biological, physical, and cultural controls) will be adequate to address any pest problems. Proper and timely maintenance, as described in this plan, should serve to reduce the potential for pest establishment.

[34] Attached site plan must match the site plan exhibit to Maintenance Agreement.

To avoid the need for pesticides or quick release fertilizers, follow the principles of integrated pest management (IPM):

1. Employ non-chemical controls (biological, physical and cultural controls) before using chemicals to treat a pest problem.
2. Prune plants properly and at the appropriate time of year.
3. Provide adequate irrigation for landscape plants. Do not over water.
4. Limit fertilizer use unless soil testing indicates a deficiency. Slow-release or organic fertilizer is strongly preferred. Check with municipality for specific requirements and prohibitions.
5. Pest control should avoid harming non-target organisms, or negatively affecting air and water quality and public health. Apply chemical controls only when monitoring indicates that preventative and non-chemical methods are not keeping pests below acceptable levels. When pesticides are required, apply the least toxic and the least persistent pesticide that will provide adequate pest control. Do not apply pesticides on a prescheduled basis.
6. Sweep up spilled fertilizer and pesticides. Do not wash away or bury such spills.
7. Do not over apply pesticide. Spray only where the infestation exists. Follow the manufacturer's instructions for mixing and applying materials.
8. Only licensed, trained pesticide applicators shall apply pesticides.
9. Apply pesticides at the appropriate time to maximize their effectiveness and minimize the likelihood of discharging pesticides into runoff. With the exception of pre-emergent pesticides, avoid application if rain is expected.
10. Unwanted/unused pesticides shall be disposed as hazardous waste.

Standing water shall not remain in the treatment measures for more than 72 hours, to prevent mosquito generation. Should any mosquito issues arise, contact the Alameda County Mosquito Abatement District (ACMAD), as needed for assistance. In Albany, contact the Alameda County Vector Control Services District (ACVCSD). Mosquito larvicides shall be applied only when absolutely necessary, as indicated by the ACMAD or ACVCSD, and then only by a licensed professional or contractor. Contact information for ACMAD and ACVCSD is provided below.

III. Vector Control Contacts

Alameda County Mosquito Abatement District
23187 Connecticut St.
Hayward, CA 94545
Phone: (510) 783-7747

Alameda County Vector Control Services District
1131 Harbor Bay Parkway, Ste. 166
Alameda, CA 94502
Phone: (510) 567-6800

IV. Inspections

The attached Flow-Through Planter Inspection and Maintenance Checklist shall be used to conduct inspections, identify needed maintenance, and record maintenance that is conducted. The schedule of inspections is as follows:

- Before the wet season (in August so that corrections can be made by September 30);
- Monthly during the wet season (October through April);
- After the wet season (May).

Flow-Through Planter
Inspection and Maintenance Checklist

Property Address:____

Property Owner:_________________________ Treatment Measure No.:__________________

Date of Inspection:_______________________ Inspector:______________________________

Type of Inspection: ☐ Pre-wet season ☐ Monthly during wet season ☐ Post-wet season ☐ Other:_________________

Items to Review	Conditions When Maintenance Is Needed	Maintenance Needed? (Y/N)	Comments (Describe maintenance completed and if needed maintenance was not conducted, note when it will be done)	Corrective Action/Results Expected When Maintenance Is Performed
1. Vegetation	▪ Vegetation is dead, diseased and/or overgrown.			▪ Replant in-kind or substitute from Appendix B plant list. ▪ Manually weed and prune to ensure inlets and outlets convey water into/out of the facility. Remove plant debris.
2. Irrigation	▪ Irrigation system is not working properly.			▪ Repair as needed and confirm irrigation system works properly.
3. Soil	▪ Soil too deep (i.e., the soil surface is more than 6 inches below the overflow drain). ▪ Channels or ruts have formed around inlets, and/or other evidence of erosion.			▪ Add biotreatment soil mix (specified in Appendix K), so that soil is at proper depth (top of mulch is typically 6 inches below the overflow outlet). ▪ Obstructions and sediment removed so that water flows freely and disperses over a wide area. Obstructions and sediment are disposed of properly.
4. Mulch	▪ Mulch is missing or patchy in appearance. ▪ Areas of bare earth are exposed, or mulch is less than 3 in deep.			▪ Replenish mulch; use aged or composted mulch. ▪ All bare earth is covered, except mulch is kept 6 inches away from trunks of trees and shrubs. ▪ Mulch is even in appearance, at a depth of 3 inches.
5. Sediment, Trash & Debris	▪ Sediment, trash and debris accumulated in the planter.			▪ Sediment, trash and debris removed from flow-through planter and disposed of properly.
6. Confirm Proper Drainage	▪ The planter does not drain within 72 hours after rainfall.			▪ Remove top 2 to 4 inches of sediment at all inlets to the planter. Add biotreatment soil mix (Appendix K) to restore the design elevation of soil (top of mulch is typically 6 inches below the overflow outlet). Rake, till, or amend with soil mix until infiltration rate is restored.
7. Downspouts and Inlets	▪ Flow to planter is impeded. ▪ Downspouts are clogged or pipes are damaged. ▪ Splash blocks and rocks in need of repair/replacement.			▪ Repair or replace broken downspouts and curb cuts as needed, so that flow is conveyed efficiently to the planter. ▪ Repair, replace or replenish splash blocks and rocks, to protect soil from erosive flows at all downspouts and inlets.
8. Overflow Pipe or Outlet to Storm Drain	▪ Does not safely convey excess flows to storm drain. ▪ Piping damaged or disconnected. ▪ Mulch/debris clogs outlet to storm drain (check inside drain).			▪ Repair the overflow pipe or remove material clogging the overflow outlet, so that excess flow is conveyed efficiently to the storm drain. ▪ Remove any mulch, debris or obstruction that is blocking the drain, including any material inside the drain.

Items to Review	Conditions When Maintenance Is Needed	Maintenance Needed? (Y/N)	Comments (Describe maintenance completed and if needed maintenance was not conducted, note when it will be done)	Corrective Action/Results Expected When Maintenance Is Performed
9. Structural Soundness	▪ Planter is cracked, leaking or falling apart.			▪ Extend and secure liner to planter walls above the high water mark. If abutting a building, the planter must be water tight to protect building foundation from moisture damage. ▪ Repair cracks and leaks, so that planter is structurally sound.
10. No Dumping Signage	▪ Drain inlet "No dumping, flows to Bay" sign is damaged or missing			▪ Install new sign (standard metal plaque).

Tree Well Filter Maintenance Plan for
[[== Insert Project Name ==]]

[[== Insert Date =]]

Project Address and Cross Streets ______________________________

Assessor's Parcel No.:______________________________

Property Owner:______________________ Phone No.: ______________

Designated Contact: ___________________ Phone No.: ______________

Mailing Address: ______________________________

The property contains [[== insert number ==]] tree well filter(s), located as described below and as shown in the attached site plan[35].

- **Tree Well Filter No. 1** is located at [[== describe location ==]].
- [[== Add descriptions of other tree well filters, if applicable. ==]]

I. Routine Maintenance Activities

The principal maintenance objective is to prevent sediment buildup and clogging, which reduces pollutant removal efficiency and may lead to tree well filter failure. Routine maintenance activities, and the frequency at which they will be conducted, are shown in Table 1.

Table 1
Routine Maintenance Activities for Tree Well Filters

No.	Maintenance Task	Frequency of Task
1	▪ Prune and weed excess vegetation to maintain conveyance/infiltration capacity. ▪ Remove litter, debris, and accumulated sediment; dispose of it properly.	Monthly
2	▪ Till or replace soil (using biotreatment soil mix specified in Appendix K) as necessary to maintain the design elevation of soil. ▪ Remove and replace all dead and diseased vegetation (replace plants in kind, or per Appendix B plant list).	Before wet season (August or September); After wet season (May)
3	▪ Inspect tree well filter using the attached inspection checklist.	Before wet season (inspect in August, make all corrections by September 30), and After wet season (May), and Monthly during wet season (October through April)

II. Prohibitions

The use of pesticides and quick release fertilizers is strongly discouraged. For the purposes of stormwater treatment measure maintenance and function, it is anticipated that non-chemical controls (i.e., biological, physical, and cultural controls) will be adequate to address any pest problems. Proper and timely maintenance, as described in this plan, should serve to reduce the potential for pest establishment.

[35] Attached site plan must match the site plan exhibit to Maintenance Agreement.

To avoid the need for pesticides and quick release fertilizers, follow the principles of integrated pest management (IPM):

1. Employ non-chemical controls (biological, physical and cultural controls) before using chemicals to treat a pest problem.
2. Prune plants properly and at the appropriate time of year.
3. Provide adequate irrigation for landscape plants. Do not over water.
4. Limit fertilizer use unless soil testing indicates a deficiency. Slow-release or organic fertilizer is strongly preferred. Check with municipality for specific requirements and prohibitions.
5. Pest control should avoid harming non-target organisms, or negatively affecting air and water quality and public health. Apply chemical controls only when monitoring indicates that preventative and non-chemical methods are not keeping pests below acceptable levels. When pesticides are required, apply the least toxic and the least persistent pesticide that will provide adequate pest control. Do not apply pesticides on a prescheduled basis.
6. Sweep up spilled fertilizer and pesticides. Do not wash away or bury such spills.
7. Do not over apply pesticide. Spray only where the infestation exists. Follow the manufacturer's instructions for mixing and applying materials.
8. Only licensed, trained pesticide applicators shall apply pesticides.
9. Apply pesticides at the appropriate time to maximize their effectiveness and minimize the likelihood of discharging pesticides into runoff. With the exception of pre-emergent pesticides, avoid application if rain is expected.
10. Unwanted/unused pesticides shall be disposed as hazardous waste.

Standing water shall not remain in the treatment measures for more than 72 hours, to prevent mosquito generation. Should any mosquito issues arise, contact the Alameda County Mosquito Abatement District (ACMAD), as needed for assistance. In Albany, contact the Alameda County Vector Control Services District (ACVCSD). Mosquito larvicides shall be applied only when absolutely necessary, as indicated by the ACMAD or ACVCSD, and then only by a licensed professional or contractor. Contact information for ACMAD and ACVCSD is provided below.

III. Vector Control Contacts

Alameda County Mosquito Abatement District
23187 Connecticut St.
Hayward, CA 94545
Phone: (510) 783-7747

Alameda County Vector Control Services District
1131 Harbor Bay Parkway, Ste. 166
Alameda, CA 94502
Phone: (510) 567-6800

IV. Inspections

The attached Tree Well Filter Inspection and Maintenance Checklist shall be used to conduct inspections, identify needed maintenance, and record maintenance that is conducted. The schedule of inspections is as follows:

- Before the wet season (in August so that corrections can be made by September 30);
- Monthly during the wet season (October through April);
- After the wet season (May).

Tree Well Filter
Inspection and Maintenance Checklist

Property Address:____

Property Owner:_______________________ Treatment Measure No.:_______________

Date of Inspection:_____________________ Inspector:___________________________

Type of Inspection: ☐ Pre-wet season ☐ Monthly during wet season ☐ Post-wet season ☐ Other:_______________

Items to Review	**Conditions When Maintenance Is Needed**	**Maintenance Needed? (Y/N)**	**Comments** (Describe maintenance completed and if needed maintenance was not conducted, note when it will be done)	**Corrective Action / Results Expected When Maintenance Is Performed**
1. Vegetation	▪ Vegetation is dead, diseased and/or overgrown.			▪ Replant in-kind or substitute from Appendix B plant list. ▪ Manually remove weeds and prune to ensure inlets freely convey stormwater into the tree well filter. Remove all plant debris.
2. Irrigation	▪ Irrigation system is not working properly.			▪ Repair as needed and confirm irrigation system works properly.
3. Soil/Planting Mix	▪ Soil/planting mix too deep (i.e., the soil surface is more than 6 inches below overflow drain). ▪ Channels or ruts have formed around inlets, and/or other evidence of erosion.			▪ Add biotreatment soil mix (specified in Appendix K) so that soil is at proper depth (top of mulch is typically 6 inches below the overflow outlet). ▪ Obstructions and sediment removed so that water flows freely into the tree well filter. Obstructions and sediment are disposed of properly.
4. Mulch	▪ Mulch is missing or patchy in appearance. ▪ Areas of bare earth are exposed, or mulch layer is less than 3 inches in depth.			▪ Replenish mulch; use aged or composted mulch. ▪ All bare earth is covered, except mulch is kept 6 inches away from trunks of trees and shrubs. ▪ Mulch is even in appearance, at a depth of 3 inches.
5. Sediment, Trash and Debris	▪ Sediment, trash and debris accumulated in the tree well filter.			▪ Sediment, trash and debris removed from tree well filter and disposed of properly.
6. Confirm Proper Drainage	▪ The tree well filter does not drain within 72 hours after rainfall.			▪ Remove top 2 to 4 inches of sediment at all inlets to the tree well filter. Add biotreatment soil mix (Appendix K) to restore the design elevation of soil (top of mulch is typically 6 inches below the overflow outlet). Rake, till, or amend with soil mix until infiltration rate is restored.

Items to Review	**Conditions When Maintenance Is Needed**	**Maintenance Needed? (Y/N)**	**Comments** (Describe maintenance completed and if needed maintenance was not conducted, note when it will be done)	**Corrective Action / Results Expected When Maintenance Is Performed**
7. Overflow Pipe	▪ Does not safely convey excess flows to storm drain. ▪ Piping damaged or disconnected. ▪ Mulch/debris clogs outlet to storm drain (check inside drain).			▪ Repair the overflow pipe or remove material clogging the overflow outlet, so that excess flow is conveyed efficiently to storm drain.

Infiltration Trench Maintenance Plan for
[[== Insert Project Name ==]]

[[== Insert Date ==]]

Project Address and Cross Streets ______________________________

Assessor's Parcel No.:______________________________

Property Owner:______________________ Phone No.: ______________

Designated Contact: ______________________ Phone No.: ______________

Mailing Address: ______________________________

The property contains [[== insert number ==]] infiltration trench(es), located as described below and as shown in the attached site plan.

- **Infiltration Trench No. 1** is located at [[== describe location ==]].
- [[== Add descriptions of other infiltration trenches, if applicable. ==]]

I. Routine Maintenance Activities

The principal maintenance objective is to prevent sediment buildup and clogging, which reduces pollutant removal efficiency and may lead to trench failure. Routine maintenance activities, and the frequency at which they will be conducted, are shown in Table 1.

Table 1
Routine Maintenance Activities for Infiltration Trenches

No.	Maintenance Task	Frequency of Task
1	Remove obstructions, debris and trash from infiltration trench and dispose of properly.	Monthly, or as needed after storm events
2	Inspect trench to ensure that it drains between storms, and within 72 hours after rainfall. Check observation well 2-3 days after storm to confirm drainage.	Monthly during wet season, or as needed after storm events
3	Inspect filter fabric for sediment deposits by removing a small section of the top layer.	Annually
4	Monitor observation well to confirm that trench has drained during dry season.	Annually, during dry season
5	Mow and trim vegetation around the trench to maintain a neat and orderly appearance.	As needed
6	Remove any trash, grass clippings and other debris from the trench perimeter and dispose of properly.	As needed
7	Check for erosion at inflow or overflow structures.	As needed
8	Confirm that cap of observation well is sealed.	At every inspection
9	Inspect infiltration trench using the attached inspection checklist.	Monthly, or after large storm events, and after removal of accumulated debris or material

II. Prohibitions

Trees and other large vegetation shall be prevented from growing adjacent to the trench to prevent damage.

Standing water shall not remain in the treatment measures for more than 72 hours, to prevent mosquito generation. Should any mosquito issues arise, contact the Alameda County Mosquito Abatement District (ACMAD), as needed for assistance. In Albany, contact the Alameda County Vector Control Services District (ACVCSD). Mosquito larvicides shall be applied only when absolutely necessary, as indicated by the ACMAD or ACVCSD, and then only by a licensed professional or contractor. Contact information for ACMAD and ACVCSD is provided below.

III. Vector Control Contacts

Alameda County Mosquito Abatement District

23187 Connecticut St.

Hayward, CA 94545

Phone: (510) 783-7747

Alameda County Vector Control Services District

1131 Harbor Bay Parkway, Ste. 166

Alameda, CA 94502

Phone: (510) 567-6800

IV. Inspections

The attached Infiltration Trench Inspection and Maintenance Checklist shall be used to conduct inspections monthly (or as needed), identify needed maintenance, and record maintenance that is conducted.

Infiltration Trench
Inspection and Maintenance Checklist

Property Address:____

Property Owner:__________________________ Treatment Measure No.:__________________

Date of Inspection:________________________ Inspector:________________________________

Type of Inspection: ☐ Monthly ☐ Pre-Wet Season ☐ After heavy runoff ☐ End of Wet Season ☐ Other:________________________

Defect	**Conditions When Maintenance Is Needed**	**Maintenance Needed? (Y/N)**	**Comments** (Describe maintenance completed and if needed maintenance was not conducted, note when it will be done)	**Results Expected When Maintenance Is Performed**
1. Standing Water	When water stands in the infiltration trench between storms and does not drain within 72 hours after rainfall.			There should be no areas of standing water once inflow has ceased. Any of the following may apply: sediment or trash blockages removed, improved grade from head to foot of infiltration trench, removed clogging at check dams, or added underdrains.
2. Trash and Debris Accumulation	Trash and debris accumulated in the infiltration trench.			Trash and debris removed from infiltration trench and disposed of properly.
3. Sediment	Evidence of sedimentation in trench. Less than 50% storage volume remaining in sediment traps, forebays or pretreatment swales.			Material removed and disposed of properly so that there is no clogging or blockage.
4. Inlet/Outlet	Inlet/outlet areas clogged with sediment or debris, and/or eroded.			Material removed and disposed of properly so that there is no clogging or blockage in the inlet and outlet areas.
5. Overflow Spillway	Clogged with sediment or debris, and/or eroded.			Material removed and disposed of properly so that there is no clogging or blockage, and trench is restored to design condition.
6. Filter Fabric	Annual inspection, by removing a small section of the top layer, shows sediment accumulation that may lead to trench failure.			Replace filter fabric, as needed, to restore infiltration trench to design condition.
7. Observation Well	Routine monitoring of observation well indicates that trench is not draining within specified time or observation well cap is missing.			Restore trench to design conditions. Observation well cap is sealed.
8. Miscellaneous	Any condition not covered above that needs attention in order for the infiltration trench to function as designed.			Meet the design specifications.

Extended Detention Basin Maintenance Plan for
[[== Insert Project Name ==]]

[[== Insert Date ==]]

Project Address and Cross Streets ____

Assessor's Parcel No.:____

Property Owner:______________________________ Phone No.: ____________________

Designated Contact: __________________________ Phone No.: ____________________

Mailing Address: ____

The property contains [[== insert number ==]] extended detention basins, located as described below and as shown in the attached site plan.

- **Extended Detention Basin No. 1** is located at [[== describe location ==]].
- [[== Add descriptions of other extended detention basins, if applicable. ==]]
- [[== Identify Extended Detention Basin(s) designed for Hydromodification Management (HM).]]

I. Routine Maintenance Activities

Primary maintenance activities include vegetation management and sediment removal, although mosquito abatement is a concern if the extended detention basin is designed to include permanent pools of standing water. Routine maintenance activities, and the frequency at which they will be conducted, are shown in Table 1.

Table 1.
Routine Maintenance Activities for Extended Detention Basins

No.	Maintenance Task	Frequency of Task
1	Conduct annual vegetation management during the summer, removing weeds and harvesting vegetation. Remove all grass cuttings and other green waste.	Once a year
2	Trim vegetation at beginning and end of wet season to prevent establishment of woody vegetation, and for aesthetics and mosquito control.	Twice a year (spring and fall)
3	Evaluate health of vegetation and remove and replace any dead or dying plants. Remove all green waste and dispose of properly.	Twice a year
4	If turf grass is included in basin design, conduct regular mowing and remove all grass cuttings. Avoid producing ruts when mowing.	[[== insert frequency, if applicable ==]]
5	Remove sediment from forebay when the sediment level reaches the level shown on the fixed vertical sediment marker and dispose of sediment properly.	As needed
6	Remove accumulated sediment and regrade when the accumulated sediment volume exceeds 10% of basin volume and dispose of sediment properly.	Every 10 years, or as needed [[to maintain 2 in. clearance below low-flow orifice for HM design]]
7	Remove accumulated trash and debris from the extended detention basin at the middle and end of the wet season and dispose of trash and debris properly.	Twice a year (January and April)
8	Irrigate during dry weather.	[[== insert frequency ==]]
9	Inspect extended detention basin using the attached inspection checklist.	Quarterly, or as needed

II. Prohibitions

The use of pesticides and quick release fertilizers is strongly discouraged. For the purposes of stormwater treatment measure maintenance and function, it is anticipated that non-chemical controls (i.e., biological, physical, and cultural controls) will be adequate to address any pest problems. Proper and timely maintenance, as described in this plan, should serve to reduce the potential for pest establishment.

To avoid the need for pesticides or quick release fertilizers, follow the principles of integrated pest management (IPM):

1. Employ non-chemical controls (biological, physical and cultural controls) before using chemicals to treat a pest problem.
2. Prune plants properly and at the appropriate time of year.
3. Provide adequate irrigation for landscape plants. Do not over water.
4. Limit fertilizer use unless soil testing indicates a deficiency. Slow-release or organic fertilizer is strongly preferred. Check with the municipality for specific requirements and prohibitions.
5. Pest control should avoid harming non-target organisms, or negatively affecting air and water quality and public health. Apply chemical controls only when monitoring indicates that preventative and non-chemical methods are not keeping pests below acceptable levels. When pesticides are required, apply the least toxic and the least persistent pesticide that will provide adequate pest control. Do not apply pesticides on a prescheduled basis.
6. Sweep up spilled fertilizer and pesticides. Do not wash away or bury such spills.
7. Do not over apply pesticide. Spray only where the infestation exists. Follow the manufacturer’s instructions for mixing and applying materials.
8. Only licensed, trained pesticide applicators shall apply pesticides.
9. Apply pesticides at the appropriate time to maximize their effectiveness and minimize the likelihood of discharging pesticides into runoff. With the exception of pre-emergent pesticides, avoid application if rain is expected.
10. Unwanted/unused pesticides shall be disposed as hazardous waste.

Standing water shall not remain in the treatment and/or hydromodification management measures for more than 72 hours, to prevent mosquito generation. Should any mosquito issues arise, contact the Alameda County Mosquito Abatement District (ACMAD), as needed for assistance. In Albany, contact the Alameda County Vector Control Services District (ACVCSD). Mosquito larvicides shall be applied only when absolutely necessary, as indicated by the ACMAD or ACVCSD, and then only by a licensed professional or contractor. Contact information for ACMAD and ACVCSD is provided below.

III. Vector Control Contacts

Alameda County Mosquito Abatement District
23187 Connecticut St.
Hayward, CA 94545
Phone: (510) 783-7747

Alameda County Vector Control Services District
1131 Harbor Bay Parkway, Ste. 166
Alameda, CA 94502

IV. Inspections

The attached Extended Detention Basin Inspection and Maintenance Checklist shall be used to conduct inspections monthly (or as needed), identify needed maintenance, and record maintenance that is conducted.

Extended Detention Basin
Inspection and Maintenance Checklist

Property Address:____

Property Owner:_________________________ Treatment Measure No.:__________________

Date of Inspection:_______________________ Inspector:________________________________

Type of Inspection: ☐ Monthly ☐ Pre-Wet Season ☐ After heavy runoff ☐ End of Wet Season ☐ Other:________________________

Defect	Conditions When Maintenance Is Needed	Maintenance Needed? (Y/N)	Comments (Describe maintenance completed and if any needed maintenance was not conducted, note when it will be done.)	Results Expected When Maintenance Is Performed
General				
Trash & Debris	• Trash and debris accumulated in basin. • Visual evidence of dumping.			Trash and debris cleared from site and disposed of properly.
Poisonous Vegetation and noxious weeds	Poisonous or nuisance vegetation or noxious weeds, e.g., morning glory, English ivy, reed canary grass, Japanese knotweed, purple loosestrife, blackberry, Scotch broom, poison oak, stinging nettles, or devil's club.			Use Integrated Pest Management techniques to control noxious weeds or invasive species.
Contaminants and Pollution	Any evidence of oil, gasoline, contaminants or other pollutants.			No contaminants or pollutants present.
Rodent Holes	If facility acts as a dam or berm, any evidence of rodent holes, or any evidence of water piping through dam or berm via rodent holes.			The design specifications are not compromised by holes. Any rodent control activities are in accordance with applicable laws and do not affect any protected species.
Insects	Insects such as wasps and hornets interfere with maintenance activities.			Insects do not interfere with maintenance activities.
Tree/Brush Growth and Hazard Trees	• Growth does not allow maintenance access or interferes with maintenance activity. • Dead, diseased, or dying trees.			• Trees do not hinder maintenance activities. • Remove hazard trees as approved by the City. • (Use a certified Arborist to determine health of tree or removal requirements).

Extended Detention Basin Maintenance Plan Date of Inspection: ________________________

Property Address: _____________ Treatment Measure No.: ___________________________

Defect	**Conditions When Maintenance Is Needed**	**Maintenance Needed? (Y/N)**	**Comments** (Describe maintenance completed and if any needed maintenance was not conducted, note when it will be done.)	**Results Expected When Maintenance Is Performed**
Drainage time	Standing water remains in basin more than 72 hours.			Correct any circumstances that restrict the flow of water from the system. Restore drainage to design condition. If the problem cannot be corrected and problems with standing water recur, then mosquitoes should be controlled with larvicides, applied by a licensed pesticide applicator.
Outfall structure	Debris or silt build-up obstructs an outfall structure.			Remove debris and/or silt build-up and dispose of properly.
Side Slopes				
Erosion	• Eroded over 2 in. deep where cause of damage is still present or where there is potential for continued erosion. • Any erosion on a compacted berm embankment.			Cause of erosion is managed appropriately. Side slopes or berm are restored to design specifications, as needed.
Storage Area				
Sediment	Accumulated sediment >10% of designed basin depth or affects inletting or outletting condition of the facility.			Sediment cleaned out to designed basin shape and depth; basin reseeded if necessary to control erosion. Sediment disposed of properly.
Liner (If Applicable)	Liner is visible and has more than three 1/4-inch holes in it.			Liner repaired or replaced. Liner is fully covered.
Emergency Overflow/ Spillway and Berms				
Settlement	Berm settlement 4 inches lower than the design elevation.			Dike is built back to the design elevation.
Tree Growth	Tree growth on berms or emergency spillway >4 ft in height or covering more than 10% of spillway.			• Trees should be removed. If root system is small (base less than 4 inches) the root system may be left in place. Otherwise the roots should be removed and the berm restored. • A civil engineer should be consulted for proper berm/spillway restoration.
Emergency Overflow/ Spillway	Rock is missing and soil is exposed at top of spillway or outside slope.			Rocks and pad depth are restored to design standards.

Extended Detention Basin Maintenance Plan Date of Inspection: ________________________

Property Address: _____________ Treatment Measure No.: __________________________

Defect	Conditions When Maintenance Is Needed	Maintenance Needed? (Y/N)	**Comments** (Describe maintenance completed and if any needed maintenance was not conducted, note when it will be done.)	Results Expected When Maintenance Is Performed
Debris Barriers (e.g., Trash Racks)				
Trash and Debris	Trash or debris is plugging openings in the barrier.			Trash or debris is removed and disposed of properly.
Damaged/ Missing Bars	Bars are missing, loose, bent out of shape, or deteriorating due to excessive rust.			Bars are repaired or replaced to allow proper functioning of trash rack.
Inlet/Outlet Pipe	Debris barrier is missing or not attached to pipe.			Debris barrier is repaired or replaced to allow proper functioning of trash rack.
Fencing and Gates				
Missing or broken parts	Any defect in or damage to the fence or gate that permits easy entry to a facility.			Fencing and gate are restored to design specifications.
Deteriorating Paint or Protective Coating	Part or parts that have a rusting or scaling condition that has affected structural adequacy.			Paint or protective coating is sufficient to protect structural adequacy of fence or gate.
Flow Duration Control Outlet (if included in design to meet Hydromodification Management Standard) [[==refer to any attachments with additional provisions==]]				
Risers, orifices and screens	Any debris or clogging			Restore unobstructed flow through discharge structure; to meet original design; dispose of debris properly.
Miscellaneous				
Miscellaneous	Any condition not covered above that needs attention to restore extended detention basin to design conditions.			Meets the design specifications.

Pervious Paving Maintenance Plan for
[[== Insert Project Name ==]]

[[== Insert Date =]]

Project Address and Cross Streets____

Assessor's Parcel No.: ____________________

Property Owner: ____________________________ Phone No.:________________

Designated Contact: _______________ Phone No.:___________

Mailing Address:_________________________________

The term "pervious paving" encompasses a range of paved stormwater treatment practices, including pervious concrete or porous asphalt, as well as paving stones with permeable joints ("permeable joint pavers"), paving stones or pavers that are permeable themselves, and turf blocks. These different types of pervious paving facilities all accomplish a similar function by allowing infiltration of stormwater.

The property contains [[== insert number ==]] areas of pervious paving, located as described below and as shown in the attached site plan[36].

- **Pervious Paving Facility No. 1** is located at [[== describe location ==]].
- [[== Add descriptions of other pervious paving facilities, if applicable. ==]]

I. Routine Maintenance Activities

Routine maintenance activities for pervious paving facilities, and the frequency at which they will be conducted, are shown in Table 1. Note that there is some variation in maintenance requirements depending on the type of pavement. For example, vacuum sweeping is generally required for pervious pavement, but is prohibited for permeable joint pavers that use sand in the joints between pavers.

In addition to, or in support of, any routine maintenance activities identified here, pervious paving products should be maintained in accordance with any manufacturer's instructions. Where applicable, manufacturer's instructions/maintenance guidelines for pervious paving products should be included as an attachment to this plan.

.

Table 1
Routine Maintenance Activities for Pervious Paving

No.	Maintenance Task	Frequency of Task
1	• Remove any accumulated trash or debris from pervious paving surface and/or between joints. Also remove any trash or debris from downspouts to pervious paving facility or in outlets to storm drains.	Monthly
2	• Irrigate and mow turf block grass as required for selected turf species; no-mow and low-water species are advised.	Irrigate turf block as specified by landscape architect. Mow turf block as needed to maintain grass at the upper end of the range of height specified by manufacturer or landscape architect.

[36] Attached site plan must match the site plan exhibit to Maintenance Agreement.

Table 1 Routine Maintenance Activities for Pervious Paving		
No.	**Maintenance Task**	**Frequency of Task**
3	• Vacuum sweep (for permeable joint pavers with sand in joints use minimum suction required to remove surface debris and minimize aggregate loss). • Clean surface of pervious paving, taking care not to move fine sediments into any permeable joints. If power washing is used, aim the spray at a minimum 45 degree angle in relation to the pavement surface, to avoid dislodging aggregate.	Twice annually (in September before wet season, and in May, after wet season)
4	• Inspect pervious paving using the attached inspection checklist.	Before wet season (inspect in August, make all corrections by September 30); After wet season (May); Monthly during wet season (October through April)

II. Prohibitions of Pesticides and Quick-release Fertilizer

The use of pesticides and quick release fertilizers is strongly discouraged. For the purposes of stormwater treatment measure maintenance and function, it is anticipated that non-chemical controls (i.e., biological, physical, and cultural controls) will be adequate to address any pest problems. Proper and timely maintenance, as described in this plan, should serve to reduce the potential for pest establishment.

To avoid the need for pesticides or quick release fertilizers, follow the principles of integrated pest management (IPM):

1. Employ non-chemical controls (biological, physical and cultural controls) before using chemicals to treat a pest problem.
2. Prune plants properly and at the appropriate time of year.
3. Provide adequate irrigation for landscape plants. Do not over water.
4. Limit fertilizer use unless soil testing indicates a deficiency. Slow-release or organic fertilizer is strongly preferred. Check with municipality for specific requirements and prohibitions.
5. Pest control should avoid harming non-target organisms, or negatively affecting air and water quality and public health. Apply chemical controls only when monitoring indicates that preventative and non-chemical methods are not keeping pests below acceptable levels. When pesticides are required, apply the least toxic and the least persistent pesticide that will provide adequate pest control. Do not apply pesticides on a prescheduled basis.
6. Sweep up spilled fertilizer and pesticides. Do not wash away or bury such spills.
7. Do not over apply pesticide. Spray only where the infestation exists. Follow the manufacturer's instructions for mixing and applying materials.
8. Only licensed, trained pesticide applicators shall apply pesticides.
9. Apply pesticides at the appropriate time to maximize their effectiveness and minimize the likelihood of discharging pesticides into runoff. With the exception of pre-emergent pesticides, avoid application if rain is expected.
10. Unwanted/unused pesticides shall be disposed as hazardous waste.

III. Pollution Prevention

Do not apply, transfer, or store chemicals or fine-grained material on pervious pavement. Contact the local stormwater agency [[== insert phone number ==]] for immediate assistance responding to spills of hazardous materials. Record the time/date, weather, and site conditions if site activities contaminate stormwater. Record the date/time and description of corrective action taken.

IV. Mosquito Abatement

Mosquitoes can potentially pose a threat to public health by serving as vectors for disease. To prevent mosquito generation, standing water shall not remain in any treatment measure for more than four days. Should any mosquito issues arise, contact the Alameda County Mosquito Abatement District (ACMAD), as needed for assistance. In Albany, contact the Alameda County Vector Control Services District (ACVCSD). Mosquito larvicides shall be applied only when absolutely necessary, as indicated by the ACMAD or ACVCSD, and then only by a licensed professional or contractor. Contact information for ACMAD and ACVCSD is provided below.

Alameda County Mosquito Abatement District
23187 Connecticut St.
Hayward, CA 94545
Phone: (510) 783-7747

Alameda County Vector Control Services District
1131 Harbor Bay Parkway, Ste. 166
Alameda, CA 94502
Phone: (510) 567-6800

V. Inspections

The attached Pervious Paving Inspection and Maintenance Checklist shall be used to conduct inspections at the frequency indicated in Table 1 (or as needed), identify needed maintenance, and record maintenance that is conducted.

Pervious Paving: Inspection and Maintenance Checklist

Property Address: ______________________________ Property Owner: ___________________

Treatment Measure No.: _____ Date of Inspection: __________ Type of Inspection: ☐ Monthly during wet season ☐ Pre-Wet Season ☐ After heavy runoff ☐ End of Wet Season Inspector(s): ____________________ ☐ Other:__________

Defect	Conditions When Maintenance Is Needed	Maintenance Needed? (Y/N)	Comments (Describe maintenance completed and if needed maintenance was not conducted, note when it will be done)	Recommended Action / Results Expected When Maintenance Is Performed
1. Drainage	• Ponds covering more than 10 percent of the paved area remain present for more than one hour after a rainstorm.			• Vacuum/clean permeable surface/joints of any debris that may be obstructing flow. • Use industrial pressure washer to restore permeability. • For permeable joint pavers, replace permeable joint materials. • If above methods do not restore infiltration rates, reconstruction or replacement of the surface and/or subsurface layers may be required.
2. Downspouts (if any)	• Flow to the facility is impeded • Downspouts are clogged or pipes are damaged			• Remove any sediment or debris blocking flows. • Repair or replace broken downspouts as needed, so that flow is conveyed efficiently to the pervious paving surface area.
3. Outlet to Storm Drain (if any)	• Does not safely convey excess flows to storm drain • Piping damaged or disconnected • Sediment/debris clogs outlet to storm drain (check inside drain)			• Repair the overflow pipe or remove material clogging the overflow outlet, so that excess flow is conveyed efficiently to storm drain. • Remove any debris or obstruction that is blocking the drain, including any material inside the drain.
4. Structural Integrity	• Pervious paving structure is cracked, broken, concrete spalling or raveling; missing paver blocks or grid • Aggregate loss in permeable joint pavers			• ***Porous concrete or asphalt*** - Fill with patching mixes; large cracks and settlement may require cutting and replacing the pavement section. ***Pavers/turf block:*** Repair or replace broken structural components as needed, per manufacturer's instructions. • Replenish permeable joint material as specified by manufacturer or in design plans
4. Pavement Settling	• Portions of the paved area are one inch (1"), or more, lower than the general surface of the pavement			• Remove pavers and bedding stone[1] in the affected area. Level the exposed base course[2] and compact. Replace bedding stone and reinstate pavers and jointing aggregate.
5. Vegetation	• Root systems of adjacent trees encroach on subsurface structural components or cause pavement lift • Weeds in joints of permeable joint pavement			• Consult with arborist to assess safety of pruning off problem roots; consider installing a mechanical barrier. • Manually remove weeds. Do not use herbicides. Mow, torch, or, if vegetation is specified in joints, inoculate with preferred vegetation.

[1] The bedding stone is the shallow layer of stone (or, in some cases, sand) on which the pavers are placed. The bedding stone is located above the base course.

[2] The base course is the layer of stone below the bedding stone. The stone size used for the base course is typically larger than the bedding stone.

Media Filter Maintenance Plan for
[[== Insert Project Name ==]]

[[== Insert Date =]]

Project Address and Cross Streets ______________________________

Assessor's Parcel No.:______________________________

Property Owner:______________________ Phone No.: ______________________

Designated Contact: ______________________ Phone No.: ______________________

Mailing Address: ______________________________

The property contains [[== insert number ==]] media filter(s), located as described below and as shown in the attached site plan[39].

- **Media Filter No. 1** is located at [[== describe location ==]].
- [[== Add descriptions of other media filters, if applicable. ==]]

I. Routine Maintenance Activities

The principal maintenance objective is to prevent sediment buildup and clogging, which reduces pollutant removal efficiency and may lead to Media Filter failure. Routine maintenance activities, and the frequency at which they will be conducted, are shown in Table 1.

Table 1
Routine Maintenance Activities for Media Filters

No.	Maintenance Task	Frequency of Task
1	Inspect for standing water, sediment, trash and debris.	Monthly during rainy season
2	Remove sediment, trash and debris from sedimentation basin, riser pipe and filter bed. Dispose of sediment, trash and debris properly.	As needed
3	Ensure that media filter drains completely within 72 hours.	After major storm events and as needed.
4	For media filters with a filter bed, inspect media depth to ensure proper drainage.	Monthly during rainy season, or as needed after storm events
5	For manufactured media filter, follow manufacturer's guidelines for maintenance and cartridge replacement.	As per manufacturer's specifications.
6	Inspect Media Filter using the attached inspection checklist.	Monthly, or after large storm events, and after removal of accumulated debris or material

II. Prohibitions

Trees and other large vegetation shall be prevented from growing adjacent to the media filter to prevent damage.

Standing water shall not remain in the treatment measures for more than 72 hours, to prevent mosquito generation. Should any mosquito issues arise, contact the Alameda County Mosquito Abatement District (ACMAD), as needed for assistance. In Albany, contact the Alameda County

[39] Attached site plan must match the site plan exhibit to Maintenance Agreement.

Vector Control Services District (ACVCSD). Mosquito larvicides shall be applied only when absolutely necessary, as indicated by the ACMAD or ACVCSD, and then only by a licensed professional or contractor. Contact information for ACMAD and ACVCSD is provided below.

III. Vector Control Contacts

Alameda County Mosquito Abatement District
23187 Connecticut St.
Hayward, CA 94545
Phone: (510) 783-7747

Alameda County Vector Control Services District
1131 Harbor Bay Parkway, Ste. 166
Alameda, CA 94502
Phone: (510) 567-6800

III. Inspections

The attached Media Filter Inspection and Maintenance Checklist shall be used to conduct inspections monthly (or as needed), identify needed maintenance, and record maintenance that is conducted.

Media Filter
Inspection and Maintenance Checklist

Property Address:____

Property Owner:_________________________ Treatment Measure No.:__________________

Date of Inspection:_______________________ Inspector:_______________________________

Type of Inspection: ☐ Monthly ☐ Pre-Wet Season ☐ After heavy runoff ☐ End of Wet Season ☐ Other:________________________

Defect	**Conditions When Maintenance Is Needed**	**Maintenance Needed? (Y/N)**	**Comments** (Describe maintenance completed and if needed maintenance was not conducted, note when it will be done)	**Results Expected When Maintenance Is Performed**
1. Sediment, trash and debris accumulation	Sediment, trash and debris accumulated in the sedimentation basin, riser pipe and filter bed. Filter does not drain as specified.			Sediment, trash and debris removed from sedimentation basin, riser pipe and filter bed and disposed of properly. Filter drains per design specifications.
2. Standing water	Media filter does not drain within 72 hours after rainfall.			Clogs removed from sedimentation basin, riser pipe and filter bed. Filter drains per design specifications.
3. Mosquitoes	Evidence of mosquito larvae in media filter.			Clogs removed from sedimentation basin, riser pipe and filter bed. Filter drains per design specifications.
4. Filter bed	Overall media depth 300 millimeters (12 inches) or less.			Media depth restored to 450 millimeters (18 inches).
5. Miscellaneous	Any condition not covered above that needs attention in order for the media filter to function as designed.			Meet the design specifications.

Modular Suspended Pavement System Maintenance Plan for
[[== Insert Project Name ==]]

[[== Insert Date =]]

Project Address and Cross Streets:____

Assessor's Parcel No.:____

Property Owner:___________________________ Phone No.: ________________________

Designated Contact: _______________________ Phone No.: ________________________

Mailing Address: ____

The property contains [[== insert number ==]] modular suspended pavement system(s), located as described below and as shown in the attached site plan[40].

Modular Suspended Pavement System No. 1 is located at [[== describe location ==]].

[[== Add descriptions of other modular suspended pavement systems, if applicable. ==]]

I. Routine Maintenance Activities

The principal maintenance objective is to prevent sediment buildup and clogging, which reduces pollutant removal efficiency and may lead to modular suspended pavement system failure. Routine maintenance activities, and the frequency at which they will be conducted, are shown in Table 1.

Table 1
Routine Maintenance Activities for Modular Suspended Pavement Systems

No.	Maintenance Task	Frequency of Task
1	Check trees for evidence of water stress and adjust irrigation as needed and confirm that water is penetrating the soil column. Remove litter, debris, and accumulated sediment; dispose of it properly.	Monthly
2	Evaluate the health of trees, prune as needed to promote healthy growth and avoid conflicts with adjacent feature (e.g., power lines, buildings) Inspect the overflow pipe to make sure that it can safely convey excess flows to a storm drain. Repair or replace any damaged or disconnected piping.	Before wet season (August or September); After wet season (May)
3	Confirm water distribution through underdrains, remove pipe blockages (jet clean, rotary cut roots and debris.)	Annually
4	Inspect for and remove any girdling roots.	Periodically (every 4-5 years)
5	Inspect Modular Suspended Pavement Systems using the attached inspection checklist.	Before wet season (inspect in August, make all corrections by September 30), and After wet season (May), and Monthly during wet season (October through April)

[40] Attached site plan must match the site plan exhibit to Maintenance Agreement.

II. Prohibitions

The use of pesticides and quick release fertilizers is strongly discouraged. For the purposes of stormwater treatment measure maintenance and function, it is anticipated that non-chemical controls (i.e., biological, physical, and cultural controls) will be adequate to address any pest problems. Proper and timely maintenance, as described in this plan, should serve to reduce the potential for pest establishment.

To avoid the need for pesticides and quick release fertilizers, follow the principles of integrated pest management (IPM):

- Employ non-chemical controls (biological, physical, and cultural controls) before using chemicals to treat a pest problem.
- Prune plants properly and at the appropriate time of year.
- Provide adequate irrigation for landscape plants. Do not overwater.
- Limit fertilizer use unless soil testing indicates a deficiency. Slow-release or organic fertilizer is strongly preferred. Check with the municipality for specific requirements and prohibitions.
- Pest control should avoid harming non-target organisms, or negatively affecting air and water quality and public health. Apply chemical controls only when monitoring indicates that preventative and non-chemical methods are not keeping pests below acceptable levels. When pesticides are required, apply the least toxic and the least persistent pesticide that will provide adequate pest control. Do not apply pesticides on a prescheduled basis.
- Sweep up spilled fertilizer and pesticides. Do not wash away or bury such spills.
- Do not over apply pesticide. Spray only where the infestation exists. Follow the manufacturer's instructions for mixing and applying materials.
- Only licensed, trained pesticide applicators shall apply pesticides.
- Apply pesticides at the appropriate time to maximize their effectiveness and minimize the likelihood of discharging pesticides into runoff. Except for pre-emergent pesticides, avoid application if rain is expected.
- Unwanted/unused pesticides shall be disposed of as hazardous waste.

Standing water shall not remain in the treatment measures for more than 72 hours, to prevent mosquito generation. Should any mosquito issues arise, contact the Alameda County Mosquito Abatement District (ACMAD), as needed for assistance. In Albany, contact the Alameda County Vector Control Services District (ACVCSD). Mosquito larvicides shall be applied only when absolutely necessary, as indicated by the ACMAD or ACVCSD, and then only by a licensed professional or contractor. Contact information for ACMAD and ACVCSD is provided below.

III. Vector Control Contacts

Alameda County Mosquito Abatement District
23187 Connecticut St.
Hayward, CA 94545
Phone: (510) 783-7747

Alameda County Vector Control Services District
1131 Harbor Bay Parkway, Ste. 166
Alameda, CA 94502
Phone: (510) 567-6800

IV. Inspections

The attached Modular Suspended Pavement System Inspection and Maintenance Checklist shall be used to conduct inspections, identify needed maintenance, and record maintenance that is conducted. The schedule of inspections is as follows:

- Before the wet season (in August so that corrections can be made by September 30);
- Monthly during the wet season (October through April);
- After the wet season (May)

Modular Suspended Pavement System
Inspection and Maintenance Checklist

Property Address:____

Property Owner:__________________________ Treatment Measure No.:___________________

Date of Inspection:________________________ Inspector:________________________________

Type of Inspection: ☐ Pre-wet season ☐ Monthly during wet season ☐ Post-wet season ☐ Other:__________________

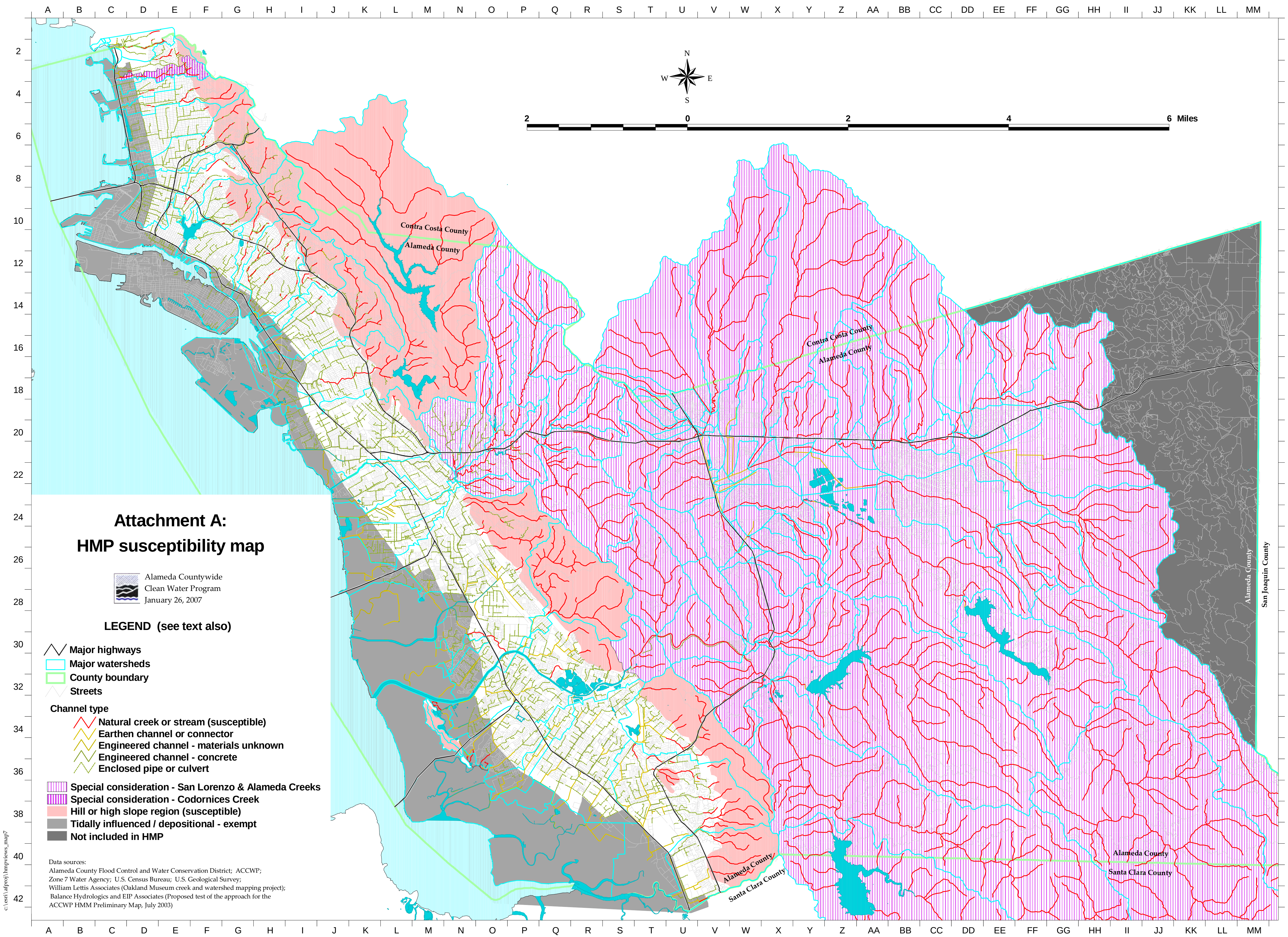
Items to Review	**Conditions When Maintenance Is Needed**	**Maintenance Needed? (Y/N)**	**Comments** (Describe maintenance completed and if needed maintenance was not conducted, note when it will be done)	**Corrective Action / Results Expected When Maintenance Is Performed**
1. Vegetation	▪ Dying, dead, or unhealthy plants ▪ Weeds present in the facility			▪ Remove and replace dying, dead or unhealthy plants. ▪ Manually remove weeds and prune to ensure inlets freely convey stormwater into the Modular Suspended Pavement System. Remove all plant debris.
2. Irrigation	▪ Irrigation system is not working properly.			▪ Repair as needed and confirm irrigation system works properly.
3. Tree	▪ Tree requires pruning for safety reasons, to promote healthy growth or to prevent the tree from growing in an undesirable manner. ▪ Broken, dead, or hanging branches, cracks, fungi, cavities, weak trunk, or branch unions. ▪ Mower and weed whip damage, vandal damage, and animal damage. Signs of insect or disease problems.			▪ Prune tree as needed. Pruning should be performed by a landscape professional that has experience pruning trees and per the guidance of an arborist certified by the International Society of Arboriculture. ▪ Remove components of the facility above the frames and decks to minimize damage to the facility. Install new tree and Modular Suspended Pavement System components as needed to restore the facility to its designed configuration. ▪ Diagnose cause of damage and remedy.
4. Mulch	▪ Mulch is missing or patchy in appearance. ▪ Areas of bare earth are exposed, or mulch layer is less than 3 inches in depth.			▪ Replenish mulch; use aged or composted mulch. ▪ All bare earth is covered, except mulch is kept 6 inches away from trunks of trees and shrubs. ▪ Mulch is even in appearance, at a depth of 3 inches.

Items to Review	Conditions When Maintenance Is Needed	Maintenance Needed? (Y/N)	Comments (Describe maintenance completed and if needed maintenance was not conducted, note when it will be done)	Corrective Action / Results Expected When Maintenance Is Performed
5. Sediment, Trash and Debris	▪ Sediment, trash, and debris accumulated in the Modular Suspended Pavement System opening.			▪ Remove sediment, trash and debris from Modular Suspended Pavement System opening and dispose of properly.
6. Confirm Proper Drainage	▪ The Modular Suspended Pavement System does not drain within 72 hours after rainfall.			▪ Remove the top 2 to 4 inches of sediment at all inlets to the Modular Suspended Pavement System. Add biotreatment soil mix (**Appendix K**) to restore the design elevation of soil. ▪ Rake, till, or amend with soil mix until infiltration rate is restored.
7. Overflow of inlets/outlets or pipes	▪ Water is not being directed properly to or out of the Silva Cell facility. ▪ Water is not passing through the flow restrictor per the design flow rate. ▪ Water is not being distributed within the facility per design. ▪ Water is not being drained through the underdrain pipes per design			▪ Remove any blockages and clean pipes as needed. Remove material causing the blockage and repair component as needed. ▪ Remove blockages from pipes (e.g., jet clean, rotary cut roots/debris).

APPENDIX I. HM SUSCEPTIBILITY MAPS

This map in this appendix shows a portion of the Hydromodification Management Susceptibility Map included in the MRP. This map is available for download in a format that enables zooming to a closer view of the project vicinity with local streets on the Clean Water Program's website:

https://accwp.maps.arcgis.com/apps/webappviewer/index.html?id=11d7a1bfb90d46ce80f94defc03d012c


Attachment A:
HMP susceptibility map
Alameda Countywide
Clean Water Program
January 26, 2007
LEGEND (see text also)
Major highways
Major watersheds
County boundary
Streets
Channel type
Natural creek or stream (susceptible)
Earthen channel or connector
Engineered channel - materials unknown
Engineered channel - concrete
Enclosed pipe or culvert
Special consideration - San Lorenzo & Alameda Creeks
Special consideration - Codornices Creek
Hill or high slope region (susceptible)
Tidally influenced / depositional - exempt
Not included in HMP
Data sources:
Alameda County Flood Control and Water Conservation District; ACCWP;
Zone 7 Water Agency; U.S. Census Bureau; U.S. Geological Survey;
William Lettis Associates (Oakland Museum creek and watershed mapping project);
Balance Hydrologics and EIP Associates (Proposed test of the approach for the
ACCWP HMM Preliminary Map, July 2003)
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Alameda County
San Joaquin County
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Santa Clara County
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Santa Clara County

APPENDIX J. SPECIAL PROJECTS

J.1 INTRODUCTION

On May 11, 2022, the San Francisco Bay Regional Water Quality Control Board (Water Board) re-issued the MRP, revising search and aspects of Provision C.3.e.ii, which allows LID treatment reduction credits for three categories of smart growth and high density and transit-oriented development projects, described below. Projects that receive LID treatment reduction credits are allowed to use specific types of non-LID treatment, if the use of LID treatment is first evaluated and determined to be infeasible. As described in **Section J.6**, documentation must be provided to discuss the feasibility and infeasibility of using 100 percent LID treatment onsite and offsite.

The types of non-LID treatment that may be used are:

- High flow-rate media filters, and
- High flow-rate tree well filters (also called high flow-rate tree box filters).

The three categories of Special Projects are:

- Category A: Small Infill Projects (< ½ acre of impervious surface)
- Category B: Larger Infill Projects (< 2 acres of impervious surface)
- Category C: Affordable Housing

Any Regulated Project that meets all the criteria for more than one Special Project Category (such as a Regulated Project that may be characterized as a Category B or C Special Project) may only use the LID Treatment Reduction Credit allowed under one of the categories. For example, a Regulated Project that may be characterized as a Category B or C Special Project may use the LID Treatment Reduction Credit allowed under Category B or Category C, but not the sum of both. A Special Projects Worksheet is included in **Section J.8**.

J.2 CATEGORY A: SMALL INFILL PROJECTS

The defining criteria and LID treatment reduction credits for Category A projects are described below.

J.2.1 Criteria For Category A (Small Infill) Special Projects

To be considered a Category A Special Project, a Provision C.3 Regulated Project must meet all of the following criteria:

1. Be built as part of the municipality's stated objective to preserve or enhance a pedestrian-oriented type of urban design.
2. Be located in the 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. Create and/or replace ½ acre or less of impervious surface area.
4. Include no surface parking, except for incidental surface parking. Incidental surface parking is allowed only for emergency vehicle access, Americans with Disabilities Act (ADA) accessibility, and passenger and freight loading zones.
5. Have at least 85% coverage for the entire project site by permanent structures. The remaining 15% portion of the site is to be used for safety access, parking structure entrances, trash and recycling service, utility access, pedestrian connections, public uses, landscaping, and stormwater treatment.

J.2.2 LID Treatment Reduction for Category A (Small Infill) Special Projects

Any Category A Special Project may qualify for 100% LID Treatment Reduction Credit, which would allow the Category A Special Project to treat up to 100% of the amount of stormwater runoff specified by Provision C.3.d with either one or a combination of the two types of non-LID treatment systems identified in **Section J.1**. Prior to receiving the LID treatment reduction credits, the applicant must demonstrate, to the satisfaction of municipal staff, that LID treatment is infeasible, as described in **Section J.6**.

J.3 CATEGORY B: LARGER INFILL PROJECTS

The defining criteria and LID treatment reduction credits for Category B projects are described below.

J.3.1 Criteria For Category B (Larger Infill) Special Projects

To be considered a Category B Special Project, a Provision C.3 Regulated Project must meet <u>all</u> of the following criteria:

1. Be built as part of the municipality's stated objective to preserve or enhance a pedestrian-oriented type of urban design.
2. Be located in a permittee'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. Create and/or replace greater than 1/2 acre but no more than 2 acres of impervious surface area.
4. Include no surface parking, except for incidental surface parking. Incidental surface parking is allowed only for emergency vehicle access, ADA accessibility, and passenger and freight loading zones.
5. Have at least 85% coverage for the entire project site by permanent structures. The remaining 15% portion of the site is to be used for safety access, parking structure

entrances, trash and recycling service, utility access, pedestrian connections, public uses, landscaping, and stormwater treatment.

6. Minimum density of either 50 dwelling units per acre (DU/ac) (for residential projects) or a Floor Area Ratio (FAR) of 2:1 (for commercial or mixed-use projects)

J.3.2 LID Treatment Reduction for Category B (Larger Infill) Special Projects

For Category B Special Projects, the maximum LID treatment reduction credit allowed varies depending upon the density achieved by the project in accordance with the criteria shown in **Table J-1**. Density is expressed in Floor Area Ratios (FARs) for commercial projects, and in Dwelling Units per Acre (DU/Ac) for residential development projects. Density of mixed-use projects can be expressed in either FARs or DU/Ac. The credits are expressed in percentages of the amount of stormwater runoff specified by Provision C.3.d for the Project's drainage area. The Special Project may treat the percentage of the C.3.d amount of runoff that corresponds to the project's density using either one or a combination of the two types of non-LID treatment systems listed in **Section J.1**. To be eligible to receive the LID treatment reduction credits, the applicant must demonstrate, to the satisfaction of municipal staff, that LID treatment is infeasible, as described in **Section J.6**. Any remaining amount of stormwater runoff must be treated with LID treatment measures.

Table J-1 Category B LID Treatment Reduction Credits, Based on the Density of Development

% of the C.3.d Amount of Runoff that May Receive Non-LID Treatment	Land Use Type	Density Required to Obtain the LID Treatment Reduction Credit
50%	Commercial	Floor Area Ratio 2:1
50%	Residential	50 dwelling units/acre
50%	Mixed Use	Floor Area Ratio 2:1 or 50 dwelling units/acre
75%	Commercial	Floor Area Ratio 3:1
75%	Residential	75 dwelling units/acre
75%	Mixed Use	Floor Area Ratio 3:1 or 75 dwelling units/acre
100%	Commercial	Floor Area Ratio 4:1
100%	Residential	100 dwelling units/acre
100%	Mixed Use	Floor Area Ratio 4:1 or 100 dwelling units/acre

J.4 CATEGORY C: AFFORDABLE HOUSING

The defining criteria and LID treatment reduction credits for Category C projects are described below.

J.4.1 Criteria for Category C (Affordable Housing) Special Projects

To be considered a Category C Special Project, a Provision C.3 Regulated Project must meet all the following criteria:

1. Must have affordable housing deed restrictions running a minimum of 55 years that limit the rent/mortgage rates (including utilities) to be no greater than 30 percent of the total household income and meet the income levels specified by the Federal Department of Housing and Urban Development's (HUD's) affordable housing in metropolitan areas: Extremely Low: 0-30 percent of area median household income (AMI); Very Low: 31-50 percent of AMI; Low: 51-80 percent of AMI; and Moderate 81-120 percent of AMI.
2. Is primarily a residential development.
3. Minimum gross density of 40 DU/ac.

J.4.2 LID Treatment Reduction For Category C (Affordable Housing)

For Category C Special Projects, the total maximum LID treatment reduction credit allowed is the sum of four different types of credits for which the Category C Special Project qualifies. These credits are categorized as follows:

- Affordable Housing Credits,
- Location Credits,
- Density Credits, and
- Minimized Surface Parking Credits.

The Special Project may use either one or a combination of the two types of non-LID treatment systems listed in **Section J.1** to treat the total percentage of the C.3.d amount of stormwater runoff that results from adding together the affordable housing, Location, Density and Minimized Surface Parking credits that the project is eligible for. In addition, to be eligible to receive the LID treatment reduction credits, the applicant must demonstrate, to the satisfaction of municipal staff, that LID treatment is infeasible, as described in **Section J.6**. Any remaining amount of stormwater runoff must be treated with LID treatment measures.

J.4.2.1 Affordable Housing Credits

A project may qualify for Affordable Housing credits according to the following criteria. The income limits that shall be used for these criteria are the most current Official State Income Limits (adjusted for household size), which are defined on the California Department of Housing and Community Development's website[41]. All qualifying affordable housing DUs must be

[41] https://www.hcd.ca.gov/grants-and-funding/income-limits

preserved housing with deed restrictions running at least 55 years, at rent/mortgage rates (including utilities) no greater than 30 percent of the total household income. The Affordable Housing Credits are presented in **Table J-2**, expressed in percentages of the amount of stormwater runoff specified by Provision C.3.d for the project's drainage area. The income levels specified in the HUD's definition of affordable housing in metropolitan areas are as follows: For metropolitan areas, HUD defines Extremely Low household incomes as 0-30 percent of area median household income (AMI), Very Low household incomes as 31-50 percent of AMI, Low household incomes as 51-80 percent of AMI, and Moderate household incomes as 81-120 percent of AMI.

Table J-2 Category B LID Treatment Reduction Credits, Based on the Density of Development

AMI	Minimum Percentage of DUs		
	70% Credit	50% Credit	25% Credit
Moderate (≤120% of AMI)	100	75	50
Low (≤80% of AMI)	75	50	25
Very Low (≤50% of AMI)	50	25	15
Extremely Low (≤30% of AMI)	25	15	5

J.4.2.2 Location Credits (Affordable Housing)

To qualify for any Location Credits, a Category C Special Project must first qualify for one of the Affordable Housing Credits. Location credits are based on the project site's proximity to a transit hub[42], or its location within a planned Priority Development Area (PDA)[43]. Only one Location Credit may be used by an individual Category C Special Project, even if the project qualifies for multiple Location Credits. To qualify for 5% Location Credit, 100 percent of a Category C Special Project's site must be located within the ¼ mile radius of an existing or planned transit hub. To qualify for 10% Location Credit, 100 percent of the site must be located within a PDA.

J.4.2.3 Density Credits (Affordable Housing)

To qualify for any Density Credits, a Category C Special Project must first qualify for one of the Affordable Housing Credits. The Density Credits are based on the density achieved by the project in accordance with the criteria shown in Table J-3. Density is expressed in Dwelling Units per Acre (DU/Ac) for residential development projects. The credits are expressed in percentages of the amount of stormwater runoff specified in Provision C.3.d. Only one Density

[42] Transit hub is defined as a rail, light rail, or commuter rail station, ferry terminal, or bus transfer station served by three or more bus routes (i.e., a bus stop with no supporting services does not qualify). A planned transit hub is a station on the MTC's Regional Transit Expansion Program list, per MTC's Resolution 3434 (revised April 2006), which is a regional priority funding plan for future transit stations in the San Francisco Bay Area.

[43] A planned Priority Development Area (PDA) is an infill development area formally designated by the Association of Bay Area Government's / Metropolitan Transportation Commission's FOCUS regional planning program. FOCUS is a regional incentive-based development and conservation strategy for the Bay Area.

Credit may be used by an individual Category C Special Project, even if the project qualifies for multiple Density Credits.

Table J-3 Category C Density Credits

% of the C.3.d Amount of Runoff that May Receive Non-LID	Density Requirement
5%	Achieve a gross density of at least 40 DU/Ac.
10%	Achieve a gross density of at least 60 DU/Ac.
15%	Achieve a gross density of at least 100 DU/Ac.

J.4.2.4 Minimized Surface Parking Credits (Affordable Housing)

To qualify for any Minimized Surface Parking Credits, a Category C Special Project must first qualify for one of the Affordable Housing Credits. The LID treatment reduction credit is based on the amount of post-project impervious surface area that is dedicated to at-grade surface parking. To qualify for 5 percent Minimized Surface Parking Credits, a Category C Special Project must have no surface parking except for incidental surface parking. Incidental surface parking is allowed only for emergency vehicle access, ADA accessibility, and passenger and freight loading zones. Only one Minimized Surface Parking Credit may be used by an individual Category C Special Project, even if the project qualifies for multiple Minimized Surface Parking Credits.

J.5 CALCULATING THE LID TREATMENT REDUCTION CREDIT (SPECIAL PROJECTS WORKSHEET)

The Countywide Program has prepared a Special Projects Worksheet (**Section J.8**), which municipal staff may ask you to complete to document that your project meets the criteria for Special Project Categories A, B, and/or C and to calculate the total allowable LID treatment reduction credit for which the project is eligible. Some municipalities may have developed their own forms; contact municipal staff for the appropriate Special Projects Worksheet. To download an electronic version of the worksheet, visit the Program's website https://cleanwaterprogram.org and click on "Resources," then "Development."

If the project meets all the criteria for more than one Special Project Category, it may use only the LID treatment reduction credit allowed under one of the categories. However, the worksheet may be used to compute the credit allowed under each category in order to determine which category would allow the most credit.

J.6 LID INFEASIBILITY REQUIREMENT FOR SPECIAL PROJECTS

To be considered a Special Project, in addition to documenting that all applicable criteria for one of the above-described Special Project categories have been met, the applicant must provide a narrative discussion of the feasibility or infeasibility of using 100 % LID treatment onsite, offsite, or at a Regional Project. The narrative discussion is required to address the following:

1. The infeasibility of treating 100% of the amount of runoff identified in Provision C.3.d for the Regulated Project's drainage area with LID treatment measures onsite;
2. The infeasibility of treating 100% of the amount of runoff identified in Provision C.3.d for the Regulated Project's drainage area with LID treatment measures offsite or paying in-lieu fees to treat 100% of the Provision C.3.d runoff with LID treatment measures at an offsite or Regional Project; and
3. The infeasibility of treating 100% of the amount of runoff identified in Provision C.3.d for the Regulated Project's drainage area with some combination of LID treatment measures onsite, offsite, and/or paying in-lieu fees towards at an offsite or Regional Project.

The discussion is required to contain enough technical and/or economic detail to document the basis of any infeasibility that is determined. The Template for Narrative Discussion of LID Feasibility or Infeasibility, (**Section J.9**), can be used to document the basis of infeasibility.

J.6.1 On-Site LID Treatment

The narrative discussion needs to describe how the routing of stormwater runoff has been optimized to route as much runoff as possible to LID treatment measures. Additionally, provide a discussion for each area of the site for which runoff must be treated with non-LID treatment measures, and should include the following:

1. Uses of impervious surfaces that preclude the use of LID treatment; and
2. Technical constraints that preclude the use of any landscaped areas for LID treatment, such as:
    a. Inadequate size to accommodate biotreatment facilities that meet the sizing requirements for the drainage area;
    b. Slopes too steep to terrace;
    c. Proximity to an unstable bank or slope;
    d. Environmental constraints (e.g., landscaped area is within riparian corridor);
    e. High groundwater or shallow bedrock;
    f. Conflict with subsurface utilities;
    g. Cap over polluted soil or groundwater;
    h. Lack of head or routing path to move collected runoff to the landscaped area or from the landscaped area to the disposal point;
    i. Other conflicts or required uses that preclude use for stormwater treatment).

J.6.2 Off-Site LID Treatment

The applicant must demonstrate to the municipality performing the project review that it is infeasible to provide LID treatment of an equivalent amount of runoff offsite either by paying in-lieu fees to a regional project or on other property owned by the project proponent in the same watershed (in other words, that alternative compliance, as described in **Chapter 11**, is infeasible).

Check with the local municipality to determine if there are any regional projects available for alternative compliance purposes (at the time of completion of this Appendix, there were none in Alameda County). Document these considerations in the narrative discussion of the feasibility and infeasibility of providing 100% LID treatment.

J.6.3 Combination of On-Site and Off-Site LID Treatment

The applicant must also demonstrate to the municipality performing the project review that it is infeasible to provide LID treatment of 100% of the amount of runoff specified in Provision C.3.d with some combination of LID measures on-site, offsite, and or paying in-lieu fees to a regional project.

After determining the extent to which stormwater runoff can be optimized to route as much runoff as possible to LID treatment measures, if that amount is less than 100%, and if there are no opportunity to provide LID treatment off-site on a property owned by the project proponent in the same watershed, check with the municipality to determine if there are any regional projects available for alternative compliance purposes for the remainder of the C.3.d amount of runoff. These considerations should be documented in the narrative discussion of the feasibility and infeasibility of providing 100% L ID treatment.

J.7 SELECT NON-LID TREATMENT MEASURES CERTIFIED BY A GOVERNMENT AGENCY

For each non-LID treatment measure approved, MRP Provision C.3.e.vi.(3)(i) requires municipalities to report to the Regional Water Board, "whether the treatment system either meets minimum design criteria published by a government agency or received certification issued by a government agency, and reference the applicable criteria or certification."

For Special Projects that are allowed to use non-LID treatment measures, applicants are advised to use treatment measures that have been certified by the Washington State Department of Ecology's Technical Assessment Protocol – Ecology (TAPE), under General Use Level Designation (GULD) for Basic Treatment.[44] You can identify proprietary media filters and high flow rate tree well filters currently holding this certification at the following link: http://www.ecy.wa.gov/programs/wq/stormwater/newtech/technologies.html.

The municipality may require that any non-LID treatment measures used in a Special Project be TAPE-certified, or the municipality may allow the use of non-LID treatment measures certified by another governmental program.

If the TAPE system is used, treatment measures must be sized based on the hydraulic sizing criteria specified in MRP Provision C.3.d and the design operating rate for which the product

[44] "General Use" is distinguished from a pilot or conditional use designation. "Basic Treatment" is distinguished from treatment effectiveness for phosphorus removal. Basic treatment is intended to achieve 80 percent removal of total suspended solids (TSS) for influent concentrations from 100 mg/L to 200 mg/L TSS and achieve 20 mg/L TSS for less heavily loaded influents.

received TAPE GULD certification for Basic Treatment. If a different certification program is used, specify the design operating rate for which the product received the relevant certification.

Special Projects Worksheet

Complete this worksheet for projects that appear to meet the definition of "Special Project", per Provision C.3.e.ii of the Municipal Regional Stormwater Permit (MRP). The form assists in determining whether a project meets Special Project criteria, and the percentage of low impact development (LID) treatment reduction credit. Special Projects that implement less than 100% LID treatment must provide a narrative discussion of the feasibility or infeasibility of 100% LID treatment. See Appendix J of the C.3 Technical Guidance (download at https://www.cleanwaterprogram.org/ *) for more information.*

Project Name:____

Project Address:____

Applicant/Developer Name:____

1. "Special Project" Determination *(Check the boxes to determine if the project meets any of the following categories.)*

Special Project Category "A"

Does the project have ALL of the following characteristics?

- ☐ 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[1];
- ☐ Creates and/or replaces 0.5 acre or less of impervious surface;
- ☐ Includes no surface parking, except for incidental parking for emergency vehicle access, ADA access, and passenger or freight loading zones;
- ☐ Has at least 85% coverage of the entire site by permanent structures. The remaining 15% portion of the site may be used for safety access, parking structure entrances, trash and recycling service, utility access, pedestrian connections, public uses, landscaping and stormwater treatment.

☐ **No (continue)** ☐ **Yes – complete Section 2A of the Special Project Worksheet**

Special Project Category "B"

Does the project have ALL of the following characteristics?

- ☐ 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[1];
- ☐ Creates and/or replaces an area of impervious surface that is greater than 0.5 acre, and no more than 2.0 acres of impervious surface;
- ☐ Includes no surface parking, except for incidental parking for emergency access, ADA access, and passenger or freight loading zones;
- ☐ Has at least 85% coverage of the entire site by permanent structures. The remaining 15% portion of the site may be used for safety access, parking structure entrances, trash and recycling service, utility access, pedestrian connections, public uses, landscaping, and stormwater treatment;
- ☐ Minimum density of either 50 dwelling units per acre (DU/ac) (for residential projects) or a Floor Area Ratio (FAR) of 2:1 (for commercial or mixed use projects)

☐ **No (continue)** ☐ **Yes – complete Section 2B of the Special Project Worksheet**

Special Project Category "C"

Does the project have ALL of the following characteristics?

- ☐ Must have affordable housing deed restrictions running a minimum of 55 years that limit the rent/mortgage rates (including utilities) to be no greater than 30 percent of the total household income and meet the income levels specified by the Federal Department of Housing and Urban Development's affordable housing in metropolitan areas: Extremely Low: 0-30 percent of area median household income (AMI); Very Low: 31-50 percent of AMI; Low: 51-80 percent of AMI; and Moderate 81-120 percent of AMI.
- ☐ Is primarily a residential development.
- ☐ Minimum gross density of 40 DU/ac.

☐ **No** ☐ **Yes – complete Section 2C of the Special Project Worksheet**

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

Special Projects Worksheet (continued)

2. **LID Treatment Reduction Credit Calculation** *(If more than one category applies, choose only one of the applicable categories and fill out the table for that category.)*

Category	Impervious Area Created/Replaced (sq. ft.)	Site Coverage (%)	Project Density or FAR	Density/Criteria	Allowable Credit (%)	Applied Credit (%)
A			NA	NA	100%	
B				Res ≥ 50 DU/ac or FAR ≥ 2:1	50%	
				Res ≥ 75 DU/ac or FAR ≥ 3:1	75%	
				Res ≥ 100 DU/ac or FAR ≥ 4:1	100%	
C[2]				**Affordable Housing credit (select one):**		
				The minimum percentage of the DUs meet the 70% credit requirements listed in **Table 1**.	70%	
				The minimum percentage of the DUs meet the 50% credit requirements listed in **Table 1**.	50%	
				The minimum percentage of the DUs meet the 25% credit requirements listed in **Table 1**.	25%	
				Location credit (select one)[3]:		
				Within ¼ mile of transit hub	5%	
				Within a planned Priority Development Area (PDA)[4]	10%	
				Density credit (select one):		
				Gross density ≥ 40 DU/Ac	5%	
				Gross density ≥ 60 DU/Ac	10%	
				Gross density ≥ 100 DU/Ac	15%	
				Parking credit (select one):		
				Includes no surface parking, except for incidental parking for emergency vehicle access, ADA access, and passenger or freight loading zones	5%	
				TOTAL CATEGORY C CREDIT =		

[2] For any Category C Special Project, the total maximum LID Treatment Reduction Credit allowed is the sum of four different types of credits that the Category C Special Project may qualify for, namely: Affordable Housing + Location, Density + Minimized Surface Parking Credits. A Category C Special Project must at least qualify for an Affordable Housing credit before it can earn any credits in the other categories.

[3] To qualify for a Location Credit, 100% of the Category C Special Project's site must be located within the ¼-mile radius of an existing or planned transit hub.

[4] A "planned Priority Development Area" is an infill development area formally designated by the Association of Bay Area Government's Metropolitan Transportation Commission's FOCUS regional planning program.

Special Projects Worksheet (continued)

3. Narrative Discussion of the Feasibility/Infeasibility of 100% LID Treatment:

If project will implement less than 100% LID, prepare a discussion of the feasibility or infeasibility of 100% LID treatment, as described in Appendix J of the C.3 Technical Guidance.

4. Select Certified Non-LID Treatment Measures:

If the project will include non-LID treatment measures, select a treatment measure certified for "Basic" General Use Level Designation (GULD) by the Washington State Department of Ecology's Technical Assessment Protocol – Ecology (TAPE). Guidance is provided in Appendix J of the C.3 Technical Guidance.[5]

Special Projects Worksheet Completed by:

______________________________ ______________

Signature Date

____

Print or Type Name

Table 1 Affordable Housing Credit Table

AMI	Minimum Percentage of DUs		
	70% credit	50% credit	25% credit
Moderate (≤120% of AMI)	100	75	50
Low (≤80% of AMI)	75	50	25
Very Low (≤50% of AMI)	50	25	15
Extremely Low (≤30% of AMI)	25	15	5

[5] TAPE certification is used in order to satisfy Special Project's reporting requirements in the MRP.

APPENDIX K. BSM SPECIFICATION

The revised regional Specification of Soils for Biotreatment or Bioretention Facilities, approved by the Regional Water Board on April 18, 2016, are provided on the following pages. Provision C.3.c.i.(2)(c)(ii) of the reissued MRP (Regional Water Board Order No. R2-2015-0049), dated November 19, 2015, allowed for the previous version of these specifications to be revised, subject to approval of the Regional Water Board's Executive Officer. Biotreatment facilities designed to meet Provision C.3 requirements must use biotreatment soil media that meet the minimum specifications set forth in the following pages. Alternative biotreatment mixes that achieve a long-term infiltration rate of 5 to 10 inches per hour, and are suitable for plant health, may be used in accordance with the requirements described in the specifications, under the heading "Verification of Alternative Bioretention Soil Mixes"

This appendix includes the following documents:

- Specification of Soils for Biotreatment or Bioretention Facilities
- Approval letter from the Regional Water Board Executive Office
- Biotreatment Soil Mix Specification Verification Checklist
- Biotreatment Soil Supplier List
- Biotreatment Soil Mix Supplier Certification Statement
- Bioretention Soil Installation Guidance

The documents included in this appendix may be downloaded from the Clean Water Program's website at: www.cleanwaterprogram.org (click on "Resources," then "Development") or https://cleanwaterprogram.org/c3-popular-files/.

Specification of soils for Biotreatment or Bioretention Facilities

Soils for biotreatment or bioretention areas shall meet two objectives:

- Be sufficiently permeable to infiltrate runoff at a minimum rate of 5" per hour during the life of the facility, and
- Have sufficient moisture retention to support healthy vegetation.

Achieving both objectives with an engineered soil mix requires careful specification of soil gradations and a substantial component of organic material (typically compost).

Local soil products suppliers have expressed interest in developing ‘brand-name’ mixes that meet these specifications. At their sole discretion, municipal construction inspectors may choose to accept test results and certification for a ‘brand-name’ mix from a soil supplier.

Tests must be conducted within 120 days prior to the delivery date of the bioretention soil to the project site.

Batch-specific test results and certification shall be required for projects installing more than 100 cubic yards of bioretention soil.

SOIL SPECIFICATIONS

Bioretention soils shall meet the following criteria. “Applicant” refers to the entity proposing the soil mixture for approval by a Permittee.

1. General Requirements – Bioretention soil shall:
   a. Achieve a long-term, in-place infiltration rate of at least 5 inches per hour.
   b. Support vigorous plant growth.
   c. Consist of the following mixture of fine sand and compost, measured on a volume basis:
      60%-70% Sand
      30%-40% Compost
2. Submittal Requirements – The applicant shall submit to the Permittee for approval:
   a. A minimum one-gallon size sample of mixed bioretention soil.
   b. Certification from the soil supplier or an accredited laboratory that the Bioretention Soil meets the requirements of this guideline specification.
   c. Grain size analysis results of the fine sand component performed in accordance with ASTM D 422, Standard Test Method for Particle Size Analysis of Soils or Caltrans Test Method (CTM) C202.
   d. Quality analysis results for compost performed in accordance with Seal of Testing Assurance (STA) standards, as specified in 4.
   e. Organic content test results of mixed Bioretention Soil. Organic content test shall be performed in accordance with by Testing Methods for the Examination of Compost and Composting (TMECC) 05.07A, “Loss-On-Ignition Organic Matter Method”.
   f. Grain size analysis results of compost component performed in accordance with ASTM D 422, Standard Test Method for Particle Size Analysis of Soils.
   g. A description of the equipment and methods used to mix the sand and compost to produce Bioretention Soil.

h. Provide the name of the testing laboratory(s) and the following information:

(1) Contact person(s)

(2) Address(s)

(3) Phone contact(s)

(4) E-mail address(s)

(5) Qualifications of laboratory(s), and personnel including date of current certification by USCC, ASTM, Caltrans, or approved equal

3. Sand for Bioretention Soil
   a. Sand shall be free of wood, waste, coating such as clay, stone dust, carbonate, etc., or any other deleterious material. All aggregate passing the No. 200 sieve size shall be nonplastic.
   b. Sand for Bioretention Soils shall be analyzed by an accredited lab using #200, #100, #40 or #50, #30, #16. #8, #4, and 3/8 inch sieves (ASTM D 422, CTM 202 or as approved by municipality), and meet the following gradation:

Sieve Size	**Percent Passing (by weight)**	
	Min	***Max***
3/8 inch	100	100
No. 4	90	100
No. 8	70	100
No. 16	40	95
No. 30	15	70
No. 40 or No.50	5	55
No. 100	0	15
No. 200	0	5

Note: all sands complying with ASTM C33 for fine aggregate comply with the above gradation requirements.

4. Composted Material

   Compost shall be a well decomposed, stable, weed free organic matter source derived from waste materials including yard debris, wood wastes or other organic materials not including manure or biosolids meeting the standards developed by the US Composting Council (USCC). The product shall be certified through the USCC Seal of Testing Assurance (STA) Program (a compost testing and information disclosure program).

a. Compost Quality Analysis by Laboratory – Before delivery of the soil, the supplier shall submit a copy of lab analysis performed by a laboratory that is enrolled in the US Composting Council's Compost Analysis Proficiency (CAP) program and using approved Test Methods for the Examination of Composting and Compost (TMECC). The lab report shall verify:
   (1) Organic Matter Content: 35% - 75% by dry wt.
   (2) Carbon and Nitrogen Ratio: C:N < 25:1 and C:N >15:1
   (3) Maturity/Stability: Any one of the following is required to indicate stability:
      (i) Oxygen Test < 1.3 O2 /unit TS /hr
      (ii) Specific oxy. Test < 1.5 O2 / unit BVS /hr
      (iii) Respiration test < 8 mg CO_2-C /g OM / day
      (iv) Dewar test < 20 Temp. rise (°C) e.
      (v) Solvita® > 5 Index value
   (4) Toxicity: Any one of the following measures is sufficient to indicate non-toxicity.
      (i) $NH_4^+ : NO_3^-$-N < 3
      (ii) Ammonium < 500 ppm, dry basis
      (iii) Seed Germination > 80 % of control
      (iv) Plant Trials > 80% of control
      (v) Solvita® = 5 Index value
   (5) Nutrient Content: provide analysis detailing nutrient content including N-P-K, Ca, Na, Mg, S, and B.
      (i) Total Nitrogen content 0.9% or above preferred.
      (ii) Boron: Total shall be <80 ppm;
   (6) Salinity: Must be reported; < 6.0 mmhos/cm
   (7) pH shall be between 6.2 and 8.2 May vary with plant species.

b. Compost Quality Analysis by Compost Supplier – Before delivery of the compost to the soil supplier the Compost Supplier shall verify the following:
   (1) Feedstock materials shall be specified and include one or more of the following: landscaping/yard trimmings, grass clippings, food scraps, and agricultural crop residues.
   (2) Maturity/Stability: shall have a dark brown color and a soil-like odor. Compost exhibiting a sour or putrid smell or containing recognizable grass or leaves, or is hot (120F) upon delivery or rewetting is not acceptable.
   (3) Weed seed/pathogen destruction: provide proof of process to further reduce pathogens (PFRP). For example, turned windrows must reach min. 55C for 15 days with at least 5 turnings during that period.

c. Compost for Bioretention Soil Texture – Compost for bioretention soils shall be analyzed by an accredited lab using #200, 1/4 inch, 1/2 inch, and 1 inch sieves (ASTM D 422 or as approved by municipality), and meet the following gradation:

Sieve Size	**Percent Passing (by weight)**	
	Min	***Max***

1 inch	99	100
1/2 inch	90	100
1/4 inch	40	90
No. 200	1	10

d. Bulk density shall be between 500 and 1100 dry lbs/cubic yard
e. Moisture content shall be between 30% - 55% of dry solids.
f. Inerts – compost shall be relatively free of inert ingredients, including glass, plastic and paper, < 1 % by weight or volume.

g. Select Pathogens – Salmonella <3 MPN/4grams of TS, or Coliform Bacteria <10000 MPN/gram.
h. Trace Contaminants Metals (Lead, Mercury, Etc.) – Product must meet US EPA, 40 CFR 503 regulations.
i. Compost Testing – The compost supplier will test all compost products within 120 calendar days prior to application. Samples will be taken using the STA sample collection protocol. (The sample collection protocol can be obtained from the U.S. Composting Council, 4250 Veterans Memorial Highway, Suite 275, Holbrook, NY 11741 Phone: 631-737-4931, www.compostingcouncil.org). The sample shall be sent to an independent STA Program approved lab. The compost supplier will pay for the test.

VERIFICATION OF ALTERNATIVE BIORETENTION SOIL MIXES

Bioretention soils not meeting the above criteria shall be evaluated on a case by case basis. Alternative bioretention soil shall meet the following specification: “Soils for bioretention facilities shall be sufficiently permeable to infiltrate runoff at a minimum rate of 5 inches per hour during the life of the facility, and provide sufficient retention of moisture and nutrients to support healthy vegetation.”

The following steps shall be followed by municipalities to verify that alternative soil mixes meet the specification:

1. General Requirements – Bioretention soil shall achieve a long-term, in-place infiltration rate of at least 5 inches per hour. Bioretention soil shall also support vigorous plant growth. The applicant refers to the entity proposing the soil mixture for approval.
   a. Submittals – The applicant must submit to the municipality for approval:
      (1) A minimum one-gallon size sample of mixed bioretention soil.
      (2) Certification from the soil supplier or an accredited laboratory that the Bioretention Soil meets the requirements of this guideline specification.

(3) Certification from an accredited geotechnical testing laboratory that the Bioretention Soil has an infiltration rate between 5 and 12 inches per hour as tested according to Section 1.b.(2)(ii).
(4) Organic content test results of mixed Bioretention Soil. Organic content test shall be performed in accordance with by Testing Methods for the Examination of Compost and Composting (TMECC) 05.07A, “Loss-On-Ignition Organic Matter Method”.
(5) Grain size analysis results of mixed bioretention soil performed in accordance with ASTM D 422, Standard Test Method for Particle Size Analysis of Soils.
(6) A description of the equipment and methods used to mix the sand and compost to produce Bioretention Soil.
(7) The name of the testing laboratory(s) and the following information:
  (i) Contact person(s)
  (ii) Address(s)
  (iii) Phone contact(s)
  (iv) E-mail address(s)
  (v) Qualifications of laboratory(s), and personnel including date of current certification by STA, ASTM, or approved equal.

b. Bioretention Soil
(1) Bioretention Soil Texture: Bioretention Soils shall be analyzed by an accredited lab using #200, and 1/2” inch sieves (ASTM D 422 or as approved by municipality), and meet the following gradation:

Sieve Size	**Percent Passing (by weight)** *Min*	*Max*
1/2 inch	97	100
No. 200	2	5

(2) Bioretention Soil Permeability testing: Bioretention Soils shall be analyzed by an accredited geotechnical lab for the following tests:
  (i) Moisture – density relationships (compaction tests) shall be conducted on bioretention soil. Bioretention soil for the permeability test shall be compacted to 85 to 90 percent of the maximum dry density (ASTM D1557).
  (ii) Constant head permeability testing in accordance with ASTM D2434 shall be conducted on a minimum of two samples with a 6-inch mold and vacuum saturation.

MULCH FOR BIORETENTION FACILITIES

Three inches of mulch is recommended for the purpose of retaining moisture, preventing erosion and minimizing weed growth. Projects subject to the State’s Model Water Efficiency Landscaping Ordinance (or comparable local ordinance) will be required to provide at least three inches of mulch. 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. It is recommended to apply 1" to 2" of composted mulch, once a year, preferably in June following weeding.

April 18, 2016
CIWQS Place No. 756972 (SKM)

To: Municipal Regional Stormwater NPDES Permit (Order No. R2-2015-0049) Permittees

Sent via email to:

Mr. James Scanlin, Alameda Countywide Clean Water Program: jimd@acpwa.org
Mr. Tom Dalziel, Contra Costa Clean Water Program: tdalz@pw.cccounty.us
Mr. Kevin Cullen, Fairfield-Suisun Urban Runoff Management Program: kcullen@fssd.com
Matt Fabry, San Mateo countywide Water Pollution Prevention Program: mfabry@smcgov.org
Adam Olivieri, Santa Clara Valley Urban Runoff Pollution Prevention Program: awo@eoainc.com
Doug Scott, Vallejo Sanitation and Flood Control District: dscott@vsfcd.com
Geoff Brosseau, Bay Area Stormwater Management Agencies Association: Geoff@brosseau.us

Subject: Approval of Revisions to Biotreatment Soil Media Specifications in Water Board Order No. R2-2015-0049, Municipal Regional Stormwater NPDES Permit

On February 5, 2016, the Bay Area Stormwater Management Agencies Association (BASMAA) submitted proposed revisions to the biotreatment soil media specifications referenced in Provision C.3.c.i.(2)(c)((ii) of Board Order No. R2-2015-0049, the Municipal Regional Stormwater NPDES Permit (MRP). The proposed revisions were submitted on behalf of the 76 Permittees regulated by the MRP and were submitted as allowed under and in accordance with the requirements of Provision C.3.c.i.(2)(c)((ii).

The proposed revisions address issues with the current soil media specifications that Permittees have identified, based on implementation of these soil media specifications for the last 5 years under the previous MRP. These identified issues are as follows:

- Compost suppliers are having difficulties meeting the gradation specifications, soluble boron criteria, and occasionally the pH limits listed in the specifications.
- The specifications contain typographical errors and missing or incorrectly identified units of measurement.

This letter approves the Permittees' proposed changes to the biotreatment soil media specifications referenced in Provision C.3.c.i.(2)(c)(ii) of the MRP. We understand that BASMAA intends to convene a soil specification roundtable in Spring 2016 to investigate the need for alternative specifications that might enhance the performance of bioretention facilities under varying microclimates and drought conditions and with diverse planting palettes, including trees.

If you have questions, please contact Sue Ma of my staff at (510) 622-2386 or via email to sma@waterboards.ca.gov.

Sincerely,

for Bruce H. Wolfe
Executive Officer

Biotreatment Soil Mix
Specification Verification Checklist

This checklist is intended to supply municipal staff, contractors, designers and others with an easy-to-read summary of the detailed information needed to verify that the biotreatment soil mix being provided by the Soil Mix Supplier meets the BASMAA Regional Biotreatment Soil Specification[1] approved by the Regional Water Board Executive Officer on April 18, 2016[2].

The checklist should be provided to the Soil Mix Supplier by the municipality or contractor before the soil mix has been ordered to allow for sufficient time to compile the information and time to review the completed checklist before delivery of the soil mix to the job site.

Use of this checklist is not required by the MRP and is intended only for assistance in reviewing submittals. Additionally or alternatively, the one page Supplier Certification Statement, developed by the stormwater programs listed below, can be requested from the Supplier to guarantee that the product meets the specification.

The Certification Statement, a list of Soil Mix Suppliers, the BASMAA Regional Biotreatment Soil Specification (2016) and other materials are available at the following websites:

- Santa Clara Valley Urban Runoff Pollution Prevention Program:
  www.scvurppp-w2k.com/nd_wp.shtml
- San Mateo Countywide Water Pollution Prevention Program:
  www.flowstobay.org/newdevelopment
- Alameda Countywide Clean Water Program:
  www.cleanwaterprogram.org (click on "Resources," then "Development")

If a municipality chooses to use the checklist, the following five items are required to be submitted by the Soil Mix Supplier to the requesting municipality or contractor:

- **Sample of the Biotreatment Soil Mix**
  A minimum 1-gallon bag of soil mix.
- **Attachment A – Supplier Analysis of the Biotreatment Soil Mix**
  To be completed by the Soil Mix Supplier providing the soil mix.
- **Attachment B – Lab Analysis of Sand Component of the Biotreatment Soil Mix**
  To be completed by the laboratory conducting the analysis of the sand.
- **Attachment C – Lab Analysis of Compost Component of the Biotreatment Soil Mix**
  To be completed by the laboratory conducting the analysis of the compost. Compost analysis of a sample collected (in accordance with the STA sample collection protocol) shall be completed within the last 120 days. Analysis must be completed by a laboratory enrolled in the US Composting Council's Compost Analysis Proficiency program, and shall use the Test Methods for the Evaluation of Composting and Compost (TMECC).
- **Attachment D – Supplier Analysis of Compost Component of the Biotreatment Soil Mix**
  To be completed by the Compost Supplier providing the compost component of the soil mix.

1. www.basmaa.org
2. www.swrcb.ca.gov/rwqcb2/water_issues/programs/stormwater/mrp.shtml

Attachment A

Supplier Analysis of Biotreatment Soil Mix

The table below shall be completed by the Biotreatment Soil Mix Supplier.

Date: **(All lab tests must be done within the last 120 days)**	**Name of Person Filling Out This Form:**
Title:	**Signature:**
Phone:	**Email:**
Company Name:	**City:**
Street Address:	**Zip:**

I certify that the provided Biotreatment Soil Mix meets the requirements of the BASMAA Regional Biotreatment Soil Specification (2016).	☐ Yes (Pass) ☐ No (Fail)

Describe the equipment and methods used to mix the compost and sand components of the Biotreatment Soil Mix.	

Material	**Standard Percent (by volume)**	**Actual Mix %**	**Pass**	**Fail**
Sand	60% - 70%		☐	☐
Compost	30% - 40%		☐	☐

Does the soil mix have a permeability of at least 5 inches per hour?[1]	☐ Yes (Pass) ☐ No (Fail)
Will the soil mix support vigorous plant growth?	☐ Yes (Pass) ☐ No (Fail)

[1]Soil mix permeability testing is only required for alternative biotreatment soil mixes. Soil permeability tests must be conducted on a minimum of two samples using constant head permeability in accordance with ASTM D2434 with a 6-inch mold and vacuum saturation.

Attachment B

Lab Analysis of Sand Component of Biotreatment Soil Mix

The table below shall be completed by the laboratory conducting the sand analysis.

Name of Person Filling Out This Form:	**Signature:**
Title:	**Date:**
Phone:	**Email:**
Company:	**City:**
Street Address:	**Zip:**
Qualifications & relevant certifications (ASTM, CTM or approved equivalent certifications):	

Is sand free of wood, waste, coating (such as clay, stone dust, carbonate, etc.), or any other deleterious material?	☐ Yes (Pass) ☐ No (Fail)
Is all aggregate passing the No. 200 sieve non-plastic?	☐ Yes (Pass) ☐ No (Fail)

Particle size analysis shall be conducted in accordance with ASTM D 422 (Standard Test Method for Particle Size Analysis of Soils) or CTM 202. Other equivalent methods acceptable only if approved.

Sieve Size	Standard Percent Passing (% by weight)	Testing Results (%)	Pass	Fail
3/8 inch	100%		☐	☐
No. 4	90% - 100%		☐	☐
No. 8	70% - 100%		☐	☐
No. 16	40% - 95%		☐	☐
No. 30	15% - 70%		☐	☐
No. 40 or 50	5% - 55%		☐	☐
No. 100	0% - 15%		☐	☐
No. 200	0% - 5%		☐	☐

Attachment C

Lab Analysis of Compost Component of Biotreatment Soil Mix

The table below shall be completed by the laboratory conducting the compost analysis.

Name of Person Filling Out This Form:	**Signature:**
Title:	**Date:**
Phone:	**Email:**
Company:	**City:**
Street Address:	**Zip:**
Qualifications & relevant certifications: **(STA, ASTM or approved equivalent certification)**	

Specification	Standard	Testing Results		Pass	Fail
Organic Matter Content	35% - 75% (by dry weight)		%	☐	☐
Carbon-to-Nitrogen Ratio	15:1 to 25:1 (C:N)		C:N	☐	☐
Salinity	< 6.0 mm hos/cm		mm hos/cm	☐	☐
pH	6.2 - 8.2		pH	☐	☐
Bulk Density	500 – 1100 dry lbs / yd^3		dry lbs / yd^3	☐	☐
Moisture Content	30%-55% (of dry solids)		%	☐	☐
Percent inert ingredients (incl. plastic, glass, paper)	< 1% (by weight or volume)		%	☐	☐

Provide the results of <u>at least one</u> of the following analyses to indicate compost stability:

Specification	Standard	Testing Results		Pass	Fail
Oxygen Test	< 1.3 0_2 /unit TS/hr		0_2 /unit TS/hr	☐	☐
Specific Oxygen Test	< 1.5 0_2/unit BVS/hr		0_2/unit BVS/hr	☐	☐
Respiration Test	< 8mg CO_2-C/g OM/day		mgCO_2-C/g OM/day	☐	☐
Dewar test	< 20 ˚C Temp. rise e.		˚C Temp. rise e.	☐	☐
Solvita® Index value	> 5 Index value		Index value	☐	☐

Provide the results of at least one of the following analyses to indicate compost toxicity:					
Specification	**Standard**	**Testing Results**		**Pass**	**Fail**
Ratio $NH_4^+N: NO_3^-$-N	< 3		NH_4^+-N : NO_3^--N	☐	☐
Ammonium	< 500 ppm, dry basis		ppm, dry basis	☐	☐
Seed Germination	> 80% of control		% of control	☐	☐
Plant Trials	> 80% of control		% of control	☐	☐
Solvita® Index value	= 5 Index value		Index value	☐	☐

Provide the analysis of the nutrient content of the compost, including the following:					
Specification	**Standard**	**Testing Results**		**Pass**	**Fail**
Boron (total, in ppm)	< 80 ppm		ppm	☐	☐
Nitrogen (N)(total %)	> 0.9% preferred.		%		
Phosphorus (as P_2O_5)	*[not specified]*		%		
Potassium (as K_2O)	*[not specified]*		%		
Calcium (Ca)	*[not specified]*		%		
Sodium (Na)	*[not specified]*		%		
Magnesium (Mg)	*[not specified]*		%		
Sulfur (S)	*[not specified]*		ppm		

Provide the results of at least one of the following select pathogens:					
Specification	**Standard**	**Testing Results**		**Pass**	**Fail**
Salmonella	< 3 MPN/4 grams TS		MPN/4 grams TS	☐	☐
Coliform Bacteria	< 10,000 MPN/gram		MPN/gram	☐	☐

Does the product meet US EPA, 40CFR 503 regulations regarding trace contaminants metals (Lead, Mercury, etc.)?	☐ Yes (Pass) ☐ No (Fail)

Particle size analysis shall be conducted in accordance with ASTM D 422 (Standard Test Method for Particle Size Analysis of Soils)-washing not required. Equivalent methods acceptable if approved.				
Sieve Size	**Standard Percent Passing (by weight)**	**Testing Results (%)**	**Pass**	**Fail**
1 inch	**99% - 100%**		☐	☐
½ inch	**90% - 100%**		☐	☐
¼ inch	**40% - 90%**		☐	☐
No. 200	**1% - 10%**		☐	☐

Attachment D

Supplier Analysis of Compost Component of Biotreatment Soil Mix

The table below shall be completed by the Compost Supplier providing the compost for the mix.

Name of Company:	**Date of Delivery:**
Qualifications & relevant certifications: **(STA, ASTM or approved equivalent certifications)**	**Date of the Compost Lab Analysis Report:** **(Must be dated within 120 days prior to delivery)**
Name of Person Filling Out This Form:	**Date:**
Signature:	**Street Address:**
Email address:	**City:**
Phone:	**Zip:**

Feedstock materials have been specified and include only the following: Landscape/yard trimmings, grass clippings, food scraps, or agricultural crop residues?	☐ Yes (Pass) ☐ No (Fail)
Compost has a dark brown color and a soil-like odor, does not exhibit a sour or putrid smell, does not contain recognizable grass or leaves, and is not hot (120˚F) upon delivery or rewetting?	☐ Yes (Pass) ☐ No (Fail)
The compost has gone through the process to further reduce pathogens (PFRP)? For example, turned windrows must reach a minimum temperature of 55˚C for 15 days with at least 5 turnings during that period.	☐ Yes (Pass) ☐ No (Fail)

BIOTREATMENT SOIL MIX SUPPLIER LIST

Company	Contact Name	Phone	Address	City	Zip	E-mail	Website
American Soil & Stone Products Inc.	Ryan Hoffman	510-292-3000	Richmond Annex 2121 San Joaquin Street, Building A	Richmond	94804	ryan@americansoil.com	www.americansoil.com
California Landscape Supply	Ryan Thornberry	209-538-8493	4107 Morgan Road	Ceres	95307	ryan@californialandscapesupply.com	www.californialandscapesupply.com
L.H. Voss Materials, Inc.	Nyoka Corley	925-676-7910	5965 Dougherty Road	Dublin	94568	nyoka.corley@gmail.com	www.lhvoss.com
Lyngso Garden Materials, Inc.	Erik Aichelen	650-364-1730 ext. 131	345 Shoreway Road	San Carlos	94070	eaichelen@lyngsogarden.com	www.lyngsogarden.com
Marshall Brothers Enterprises, Inc.	Phillip Marshall	925-449-4020	P.O. Box 2188	Livermore	94551	Phillip@marshallbrothers.com	www.mbenterprises.com
Pleasanton Trucking Inc.	Tom Bonnell	925-449-5400	P.O. Box 11462 (mail only) 30 B Greenville Road (Yard)	Pleasanton Livermore	94588 94551	tom@ptisoils.com	www.ptisoils.com
Soiland Company	Willie Leuzinger	707-889-7800	7171 Stony Point Road	Cotati	94931	WLeuzinger@SoilandRocks.com	www.SoilandRocks.com
South County Rockery	Todd Quilici	408-842-0022	281 Yamane Drive	Gilroy	95020	todd@southcountyrockery.net	www.southcountyrockery.net/floriteblend-bioswale
TMT Enterprises, Inc.	Matt Moore	408-432-9040	1996 Oakland Road	San Jose	95131	matt@tmtenterprises.net	www.tmtenterprises.net

As of: 8/20/2021

Disclaimer: ACCWP provides this list of biotreatment soil mix suppliers for the use of its member agencies, contractors, designers, and others in finding suppliers for their projects. Suppliers are listed based on a general review of their soil mix product including test results, adherence to the biotreatment soil specification approved by the Regional Water Board Executive Officer on April 18, 2016, and knowledge of the specification. Users of this list must make the final determination as to the products and adherence to the approved biotreatment soil specification Users of the list assume all liability directly or indirectly arising from use of this list. The listing of any soil supplier should not be construed as an actual or implied endorsement, recommendation, or warranty of such soil provider or their products, nor is criticism implied of similar soil suppliers that are not listed. This disclaimer is applicable whether the information is obtained in hard copy or downloaded from the Internet. Check the ACCWP website for the “Biotreatment Soil Mix Verification Checklist” and “Biotreatment Soil Mix Supplier Verification Statement" for assistance in reviewing and approving soil mix submittals, https://cleanwaterprogram.org (click on "Resources," then "Development.")

<COMPANY NAME>
<ADDRESS>

To: <city rep, contractor or other appropriate party>

Job Ref: <XYZ STREET, PROJECT# 1234>

Certificate of Compliance for Biotreatment Soil Mix

I hereby certify that the Biotreatment Soil Mix, to be delivered to the project cited above from our company, meets the "Soil Specifications" criteria approved by the Executive Officer of the San Francisco Bay Regional Water Quality Control Board on April 18, 2016, in accordance with Provision C.3.c.i.(2)(c)(ii) of the Municipal Regional Stormwater NPDES Permit (MRP) adopted on November 19, 2015.

A copy of this Certificate of Compliance will be provided with the delivery of the soil mix. Our test results have been conducted within 120 days prior to the delivery date of the biotreatment soil mix to the project site.

Thank You,

Signed: ____

Name: ____

Title: ____

Contact email address_____________________________

Contact phone number_____________________________

APPENDIX L. SITE DESIGN REQUIREMENTS FOR SMALL PROJECTS

L.1 PERMIT REQUIREMENTS FOR SMALL PROJECTS

Since December 1, 2012, specific sizes of Small Projects have had to meet site design requirements under the MRP. With the reissuance of the MRP in 2022, the thresholds for small projects were modified based on the modification of the thresholds for Regulated Projects.

Provision C.3.i establishes requirements for Small Projects and Small Detached Single-Family Homes. Effective July 1, 2023[45] the following thresholds apply:

- Small Projects create or replace between 2,500 to less than 5,000 square feet (SF) of impervious area.
- Small Detached Single-Family Homes create or replace between 2,500 to less than 10,000 SF of impervious area.

Projects approved prior to July 1, 2023 are subject to the thresholds in the previous MRP.

Small Projects and Small Detached Single-Family Homes must implement at least one of the following site design measures.

- Direct roof runoff into cisterns or rain barrels for use.
- Direct roof runoff onto vegetated areas.
- Direct runoff from sidewalks, walkways, and/or patios onto vegetated areas.
- Direct runoff from driveways and/or uncovered parking lots onto vegetated areas.
- Construct sidewalks, walkways, and/or patios with permeable surfaces.
- Construct bike lanes, driveways, and/or uncovered parking lots with permeable surfaces.

L.1.1 Do the Requirements Apply to My Project?

The requirements apply to your project if it meets the size thresholds described above, and it received final discretionary approval on or after July 1, 2023. If your project does not require discretionary approval, such as tract map approval, conditional use permit, or design review, then the requirements apply if the building permit is issued on or after July 1, 2023.

Provision C.3.b of the MRP excludes specific types of development and redevelopment projects from Provision C.3.c requirements for stormwater treatment, source controls, and site design measures, even if the thresholds described above are met or exceeded. The list of excluded project types is shown in **Table 2-2**. However, project proponents need to confirm the exclusion with the local agency.

[45] Projects approved prior to July 1, 2023 are subject to the thresholds in the previous MRP: all development projects, which create and/or replace > 2,500 SF to < 10,000 SF of impervious surface, and detached single-family home projects, which create and/or replace 2,500 square feet or more of impervious surface.

L.2 REGIONAL GUIDANCE FOR SITE DESIGN MEASURES

To help you select and design site design measures appropriate for the project site, the Clean Water Program collaborated regionally through the Bay Area Stormwater Management Agencies Association (BASMAA) to develop four fact sheets that provide guidance regarding the six site design measures listed above. The fact sheets are included at the end of this appendix, and copies are available for download from the Clean Water Program's website www.cleanwaterprogram.org (Click on "Resources," then "Development"). **Table L-1** shows how the fact sheets correspond with the six site design measures.

Table L-1. Regional Fact Sheets and Corresponding Site Design Measures

Fact Sheet	Corresponding Site Design Measures listed in Provision C.3.i
Managing Stormwater in Landscapes	• Direct roof runoff onto vegetated areas. • Direct runoff from sidewalks, walkways, and/or patios onto vegetated areas. • Direct runoff from driveways/uncovered parking lots onto vegetated areas.
Rain Gardens	• Corresponds to the same site design measures as Managing Stormwater in Landscapes, above. Differences between rain gardens and other landscaped area include: • Applicants may choose to select a rain garden if they want to capture and infiltrate more stormwater in a smaller area than is possible with most native soils. • Rain gardens should have well-drained soil; soil amendments may be needed. • An underdrain may be required if native soils are slow-draining.
Pervious Paving	• Construct sidewalks, walkways, and/or patios with permeable surfaces. • Construct bike lanes, driveways, and/or uncovered parking lots with permeable surfaces.
Rain Barrels and Cisterns	• Direct roof runoff into cisterns or rain barrels for use.

L.3 SELECTING SITE DESIGN MEASURES

To supplement guidance provided in the regional fact sheets, refer to **Table L-2** to identify key opportunities and constraints for the site design measures listed in Provision C.3.i. Choose one or more site design measures that are a good match for your project site. Only one site design measure is required, but you may choose to implement additional measures to increase the water quality benefits of your project.

Table L-2. Opportunities and Constraints for Site Design Measures

Site Design Measure	Opportunities	Constraints	Guidance to Address Constraints
• Managing Stormwater in Landscapes	• Low areas. • Flat areas or minimal slope.	• Steep slopes • Insufficient space for landscaping	• Avoid on steep slopes where increased infiltration may undermine slope. • Landscaped area should be at least half the size of the impervious area draining to it. • Direct runoff away from building foundations.
• Rain Gardens	• Low areas. • Flat areas or minimal slope. • Well-drained soil • Existing storm drain to tie in underdrain (if underdrain is needed)	• Steep slopes • Insufficient space for landscaping • Poorly drained soil	• Avoid on steep slopes. • Rain garden should be at least 4% of the size of the impervious area draining to it. • If soils do not drain well, consider soil amendments. • An underdrain may be needed if native soils are clayey. • Recommended setbacks: 10 ft. from building foundation and 5 ft. from property line
• Pervious Paving	• Flat areas or minimal slope. • Well-drained soil. • Existing storm drain to tie in underdrain (if underdrain is needed).	• Steep slopes • Poorly drained soils • Buildings close to pavement	• Avoid use in 5% slopes and greater unless municipality approves use of underdrain. • Underdrain may be needed if native soils are clayey. • Install away from buildings, or provide impermeable barrier.

Site Design Measure	Opportunities	Constraints	Guidance to Address Constraints
• Rain Barrels and Cisterns	• Roof area that drains to downspouts. • Flat, firm area near the building for rain barrelor cistern. • Landscaping that is downslope from rainbarrel or cistern,allowing gravity flow of water for irrigation and discharge of overflow.	• Lack of landscape that requires irrigation. • Irrigation system thatrequires high waterpressure. • Absence of flat, firm area near the building. • Lack of suitable areas to receive overflow	• Interior non-potable use may be considered, ifallowed by municipality. • Use with low-pressure irrigation systems. • Ensure adequate space to safely install rainbarrel or cistern and accommodate overflow.

L.4 SELECTING SITE DESIGN MEASURES FOR CONSTRAINED SITES

Provision C.3.i does not allow for findings of infeasibility or impracticability, nor does it provide alternative compliance or in-lieu options. Therefore, one of the six site design measures must be implemented in applicable projects, even on sites with constraints such as those identified in **Table L-2**.

If your site has constraints such as poorly draining soils, steep slopes, or limited space for landscaping, consult with municipal staff regarding approaches to incorporating the site design measures within the constrained site.

Design Checklist

- ❑ Maximize the use of landscaping and natural areas that already exist. Try to design new landscapes immediately adjacent to impervious surfaces.
- ❑ Water should flow evenly (without concentrating runoff into small streams) from the impervious surface to the landscape; this will maximize the filtration and settling of sediment and pollutants and prevent erosion. The design should avoid allowing straight channels and streams to form.
- ❑ Amend soils to improve drainage, when necessary.
- ❑ If the project is located next to standard asphalt or concrete pavement, and there is concern about water undermining the pavement, include a water barrier in the design.
- ❑ Use curb cuts to create places where water can flow through to the landscape.
- ❑ Disconnect roof downspouts and redirect flow to adjacent landscapes. Disconnected downspout systems should incorporate a splash block to slow the runoff flow rate; a landscape flow path length of 10 to 15 feet is recommended.
- ❑ Use drought-tolerant native or climate-adapted plant species whenever possible. Avoid invasive or pest species. A list of invasive species may be found at the California Invasive Plant Council website (www.cal-ipc.org). Contact municipal staff for a list of plants suitable for stormwater management areas.
- ❑ Design the landscape area so that overflow from large storms discharges to another landscaped area or the storm drain system to prevent flooding.

Maintain Your Landscape

The following practices will help maintain your landscape to keep it attractive and managing stormwater runoff effectively.

- ❑ During dry months, irrigate during the first year to encourage root growth and establish the plants. In subsequent years, irrigate as needed by the plant species to maintain plant health.
- ❑ Repair signs of erosion immediately and prevent further erosion by reinforcing the surrounding area with ground cover or using rocks for energy dissipation.
- ❑ If standing water remains in the landscaped area for more than 4 days, use soil amendments to improve infiltration.
- ❑ Inspect the locations where water flows into a landscaped area from adjacent pavement to ensure that there is positive flow into the landscape, and vegetation or debris does not block the entrance point.

The City of Los Angeles and Geosyntec Consultants are acknowledged for providing text, formatting and various images used in this fact sheet. The Sonoma Valley Groundwater Management Program, San Mateo Countywide Water Pollution Prevention Program, City of San Jose, Sacramento Stormwater Quality Partnership, and the Purissima Hills Water District are acknowledged for images used in the fact sheet.

LANDSCAPE DESIGNS FOR STORMWATER MANAGEMENT

Stormwater Control for Small Projects

Bay Area Stormwater Management Agencies Association

Dry creek infiltrates and conveys runoff.

Designing landscaped areas to soak up rainfall runoff from building roofs and paved areas helps protect water quality in local creeks and waterways. These landscape designs reduce polluted runoff and help prevent creek erosion.

As the runoff flows over vegetation and soil in the landscaped area, the water percolates into the ground and pollutants are filtered out or broken down by the soil and plants.

This fact sheet shows how you can design your landscape to absorb runoff from impervious surfaces, such as roofs, patios, driveways, and sidewalks, with landscape designs that can be very attractive.

If you are interested in capturing and storing water for irrigation use, see the Rain Barrel fact sheet in this series.

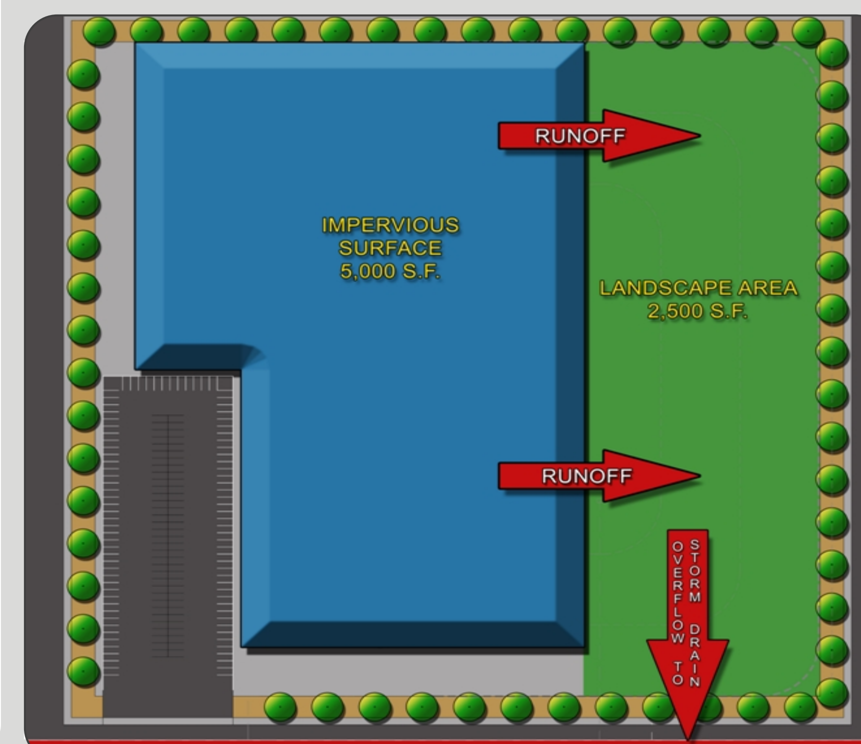
Can My Project Manage Stormwater in the Landscape?

Directing stormwater runoff to the landscape is suitable for sites with the following conditions:

- Roofs, driveways, parking areas, patios, and walkways that can drain to an existing landscape, or an area that may be converted to landscape.
- Areas of landscape with a slope of 5% or less are preferred; check with the municipality regarding requirements for steeper sites.
- Works best in well-drained soil; soil amendments may be used in areas with poor drainage.
- Landscaped areas that total at least 1/2 the size of the impervious area draining to it.
- Direct runoff away from building foundations.
- Runoff should not create ponding around trees and plants that won't tolerate wet conditions.

How Do I Size My Landscape?

The landscaped area should be 50% of the size of the contributing impervious surface. For example (see below), to manage runoff from a 5,000 square foot roof or paved surface, you should have 2,500 square feet of landscaping.

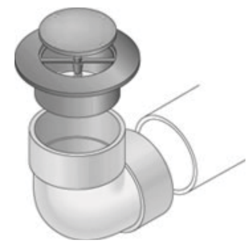


Approved August 23, 2012

Direct Roof Runoff to Landscape

- Use additional piping to connect the downspout to the landscape if needed.
- Direct runoff away from building foundation.
- Prevent erosion by installing:
    - Splash blocks,
    - Rain chains,
    - Gravel area under a gutterless roof,
    - Pop-up drainage emitter connected to a pipe that carries runoff away from the foundation, or
    - Other energy dissipation technique.

Splash block

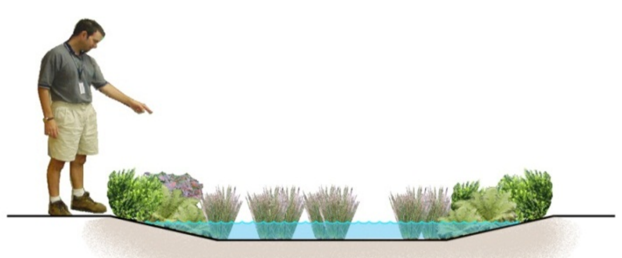


Pop-up emitter

Gravel area under a gutterless roof

Rain chain

Swales or Dry Creeks



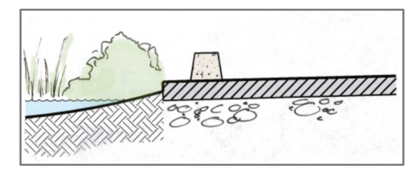
Cross section

Swales and dry creeks are narrow, linear depressions designed to capture and convey water. Swales imitate a natural creek's ability to slow, infiltrate, and filter stormwater. To install a swale follow these steps:

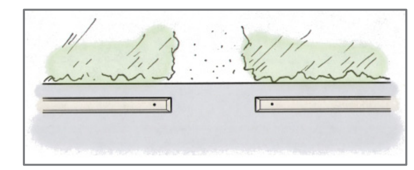
- Excavate a narrow linear depression that slopes down to provide a flow path for runoff. The path length (10 to 15 feet or more) should meander to slow water and prevent erosion.
- Use plants from creek and river ecosystems to help reduce erosion and increase evaporation of runoff.
- The end of the swale requires an outlet for high flows (another landscaped area or a yard drain). Talk to municipal staff to identify an appropriate discharge location.
- Contact municipal staff for a local list of plants suitable for swales.

Techniques to Manage Stormwater in Landscaping

Direct Parking Lot Runoff to Landscape



Cross section



View from above

During storms, parking lots generate large amounts of runoff, which picks up oils, grease, and metals from vehicles. Landscaped areas can be designed to absorb and filter this runoff.

- Landscaped areas must be below the paved elevation. Allow an elevation change of 4 to 6 inches between the pavement and the soil, so that vegetation or mulch build-up does not block the flow.
- Grade the paved area to direct runoff towards the landscaping.
- If possible, provide a long path for runoff to infiltrate (while meeting the landscaped area sizing on page 1).
- Provide multiple access points for runoff to enter the landscape. Install curb cuts or separate wheel stops for the water to flow through. Provide cobbles or other permanent erosion control at points of concentrated flow.

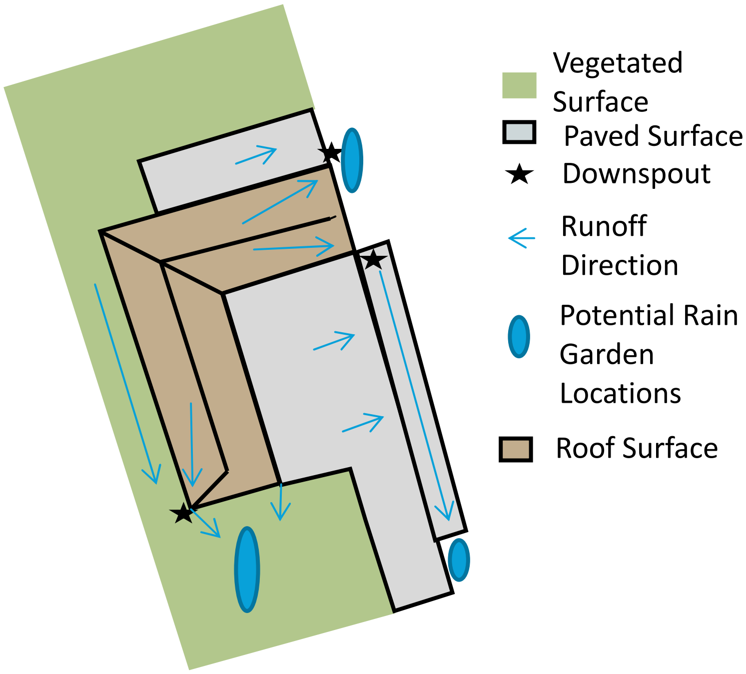
Manage Runoff from Driveways/Small Paved Areas

Driveways, sidewalks, patios, walkways, and other small paved areas can offer creative opportunities to drain runoff to landscaping.

- Install landscape adjacent to the paved surface, and grade the paved area so runoff flows toward the landscaping.
- Landscaped areas must be below the paved elevation. Allow an elevation change of 4 to 6 inches between the pavement and the soil, so that vegetation or mulch build-up does not block the flow.
- Install cobbles or rocks where runoff enters the landscape to avoid erosion.
- Use sizing ratio described on page 1.
- Use drought-tolerant native or climate-adapted plants to reduce irrigation.

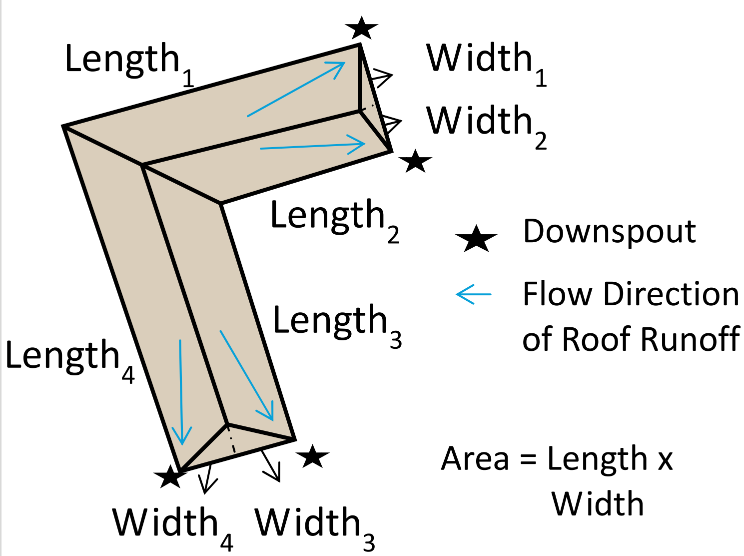
How to Plan and Install a Rain Garden

Select a Location and Plan for Overflow



- Before choosing the location of your rain garden, observe how rainwater is distributed across your home and yard. The ideal rain garden location is a flat or gently sloped area and is down slope from a runoff source.
- Site your garden at least 10 feet away from any structures (unless an impermeable barrier is used) and 5 feet from property lines.
- Avoid siting your garden over underground utilities and septic systems, near large trees, or next to a creek, stream or other water body.
- Your rain garden will overflow in large storms. Therefore, all garden designs should include an overflow system. One option is to build the perimeter of the garden so that it is perfectly level and to allow water to gently spill over the top during large storms. Another option is to build in a spillway that connects to another landscaped area, or the storm drain system.

Plan the Size of Your Rain Garden

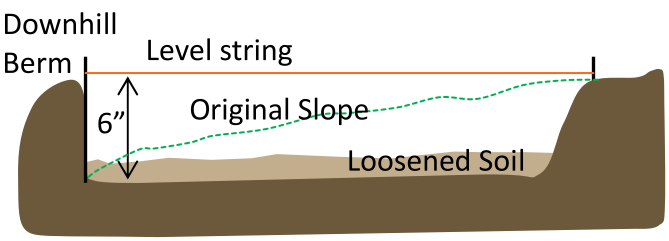


- Once you have determined where your garden will be sited, look at the surrounding area and identify which surfaces will contribute runoff to the garden. Is it all or just a part of the roof, patio, or driveway?
- Estimate the roof area by measuring the length and width of the building foundation and adding a few inches for the overhang. Multiply the length times the width to determine the contributing area. Once you have calculated the area of each contributing surface, add them up to obtain the total contributing area.
- Refer to the chart on page 1 to identify the size of the rain garden you will need to manage runoff from the contributing area.

If you do not have the space, budget, or interest in building a garden of this size, you may consider capturing some of your roof runoff in rain barrels to reduce the amount of runoff, or discharge the overflow to another landscaped area.

How to Plan and Install a Rain Garden

Install your Rain Garden



- Once you have selected a site and planned the size of your rain garden, lay out the shape using a string or tape to define the outline of where you will dig.
- If the yard is level, dig to a depth of 6-inches and slope the sides. If the site is sloped, you may need to dig out soil on the uphill side of the area and use the soil to construct a small berm (a compacted wall of soil) along the down slope side of the garden.
- Use a string level to help level the top of the garden and maintain an even 6-inch depth.
- Once the garden is excavated, loosen the soil on the bottom of the area so you have about 12 inches of soft soil for plants to root in. Mix in about 3 inches of compost to help the plants get established and improve the water-holding capacity of the soil.
- If water enters the garden quickly, include a layer of gravel or river rock at the entry points to prevent erosion.

Select Appropriate Plants


California Fuchsia


Common Rush


White Sage


Douglas Iris

You can design your rain garden to be as beautiful as any other type of garden. Select plants that are appropriate for your location and the extremes of living in a rain garden

Site Considerations:

- How much light will your garden receive?
- Is your property near the coast or located in an inland area (this affects sun and temperature)?
- Are there high winds near your home?

Recommended plant characteristics:

- Native plants adapted to local soil and climate,
- Drought tolerant,
- Flood tolerant,
- Not invasive weedy plants,
- Non-aggressive root systems to avoid damaging water pipes,
- Attracts birds and beneficial insects.

*Contact municipal staff to obtain a full list of recommended plants, provided in the countywide stormwater guidance.

Design Checklist

When installing a rain garden, the following design considerations are recommended.

- ❑ Locate the rain garden at least 10 feet from home foundation, 3 feet from public sidewalks, and 5 feet from private property lines. If rain gardens need to be located closer to buildings and infrastructure, use an impermeable barrier.
- ❑ Locate the rain garden to intercept and collect runoff from a roof downspout or adjacent impervious area.
- ❑ Size the rain garden appropriately based on the soil type and drainage area (see Page 1).
- ❑ Do not locate the rain garden over septic systems or shallow utilities. Locate utilities before digging by calling Underground Service Alert at 811 or (800) 227-2600.
- ❑ Locate the rain garden on a relatively flat area, away from steep slopes. If you plan on moving a large quantity of soil, you may need a grading permit. Contact your local municipality for further assistance.
- ❑ Consider installing an underdrain to enhance infiltration in very clayey soils. Contact municipal staff for guidance on how to properly install an underdrain.
- ❑ An overflow should been incorporated in the rain garden to move water that does not infiltrate to another pervious area and away from the home's foundation or neighboring property.
- ❑ Drought and flood resistant native plants are highly recommended and a variety of species should be planted. Avoid invasive plants. Contact municipal staff for a list of plants appropriate for rain gardens from the applicable countywide stormwater guidance. A list of invasive species may be found at the California Invasive Plant Council website (www.cal-ipc.org).

Maintenance Considerations

Once a rain garden is installed, the following steps will help the garden function effectively.

- ❑ Rain gardens should be irrigated periodically (as needed) during dry months, especially while plants are being established. Plants should be inspected for health and weeds should be removed as often as necessary.
- ❑ Apply about 2 inches of mulch and replace as needed. Mulch with a material that will not float away such as compost or a larger sized hardwood mulch (avoid microbark, for example).
- ❑ Areas of erosion should be repaired. Further erosion can be prevented by stabilizing the eroding soil with ground cover or using energy dispersion techniques (e.g., splashblock or cobbles) below downspouts.
- ❑ Avoid using synthetic fertilizers or herbicides in your rain garden because these chemicals are water pollutants.
- ❑ Standing water should not remain in a rain garden for more than 3 days. Extended periods of flooding will not only kill vegetation, but may result in the breeding of mosquitos or other vectors.

The City of Los Angeles and Geosyntec Consultants are acknowledged for providing text, formatting and various images used in this fact sheet. Contra Costa County is acknowledged for an image used in the fact sheet.

Design Checklist

When installing pervious pavement, the following design criteria should be considered.

- ❑ An open-graded base of crushed stone, which has 35 to 45 percent pore space, is installed below the surface pavement. The recommended base thickness is 6 inches for pedestrian use and 10 inches for driveways to provide adequate structural strength.
- ❑ Slope is flat or nearly flat (not greater than 2 percent).
- ❑ Flow directed to pervious pavement is dispersed so as not to be concentrated at a small area of pavement.
- ❑ No erodible areas drain onto the pavement.
- ❑ The subgrade is uniform and compaction is the minimum required for structural stability.
- ❑ If a subdrain is provided, its outlet elevation is a minimum of 3 inches above the bottom of the base course.
- ❑ A rigid edge is provided to retain granular pavements and unit pavers.
- ❑ If paving is close to a building, a barrier or impermeable liner may be required to keep water away from the building foundation.
- ❑ Pavers have a minimum thickness of 80 mm (3 1/8 inches) and are set in sand or gravel with minimum 3/8-inch gaps between pavers.
- ❑ Proprietary products must be installed per the manufacturer's specifications.
- ❑ The project complies with applicable sections of the current municipal code, including disabled access requirements and site drainage requirements, if applicable.

Maintenance Considerations

Once pervious pavement is installed, the following maintenance criteria should be followed:

- ❑ The use of leaf blowers on permeable pavement can force dirt and debris into pavement void spaces. Avoid blowing leaves, grass trimmings and other debris across permeable pavement.
- ❑ Remove weeds from pavement and replace missing sand or gravel between pavers as needed.
- ❑ Inspect subdrain outlets (if applicable) yearly to verify they are not blocked.
- ❑ Inspect pavement after rains for ponding or other visible problems. If there are problems with standing water, vacuum sweeping with specialized equipment may be required. Concrete grid pavers do not require sweeping.

Open Joint Pavers

The City of Los Angeles and Geosyntec Consultants are acknowledged for providing text, formatting and various images used in this fact sheet. The Interlocking Concrete Pavement Institute is acknowledged for contributing pavement sections, design details and specifications. The San Mateo Countywide Water Pollution Prevention Program, Santa Clara Valley Urban Runoff Pollution Prevention Program, and City of San Jose are acknowledged for images used in the fact sheet.

PERVIOUS PAVEMENT

Stormwater Control for Small Projects

Bay Area Stormwater Management Agencies Association

Permeable Interlocking Concrete Pavers

Pervious pavement, also referred to as permeable pavement, contains pores or separation joints that allow water to flow through and seep into a base material (typically gravel or drain rock). Types of pervious pavement include porous asphalt and concrete, open joint pavers, interlocking concrete or permeable pavers, and plastic or concrete grid systems with gravel-filled voids.

Pervious pavement systems allow infiltration of stormwater into soils, thereby reducing runoff and the amount of pollutants that enter creeks, San Francisco Bay, the Pacific Ocean, and other water bodies. This improves water quality, helps reduce creek erosion, and can facilitate groundwater recharge. Pervious pavement is available in many different types that offer environmentally-friendly and aesthetically pleasing options for driveways, walkways, parking areas, and patios.

Is Pervious Pavement Feasible for My Project?

Pervious pavement is appropriate in locations with the following characteristics:

- The location is flat or nearly flat (a maximum 2% slope).
- The location is not in a seasonally wet area.
- The location is not close to a building foundation, unless measures are taken to prevent infiltration under the structure. (See Design Checklist.)

Approved August 23, 2012

RAIN BARRELS AND CISTERNS

Stormwater Control for Small Projects

Bay Area Stormwater Management Agencies Association

Daisy chained system of 205-gallon rain barrels
Courtesy of The City of Oakland

Rain barrels and cisterns can be installed to capture stormwater runoff from rooftops and store it for later use. They are low-cost systems that will allow you to supplement your water supply with a sustainable source and help preserve local watersheds by detaining rainfall.

Collected rainwater may be used for landscape irrigation. Subject to permitting requirements, harvested rainwater may be allowed for toilet flushing; contact municipal staff for more information. Capturing even a small amount of your roof runoff will have environmental benefits because it will reduce the quantity and speed of stormwater runoff flowing to local creeks.

Rain barrels typically store between 50 and 200 gallons. They require very little space and can be connected or "daisy chained" to increase total storage capacity.

Cisterns are larger storage containers that can store 200 to over 10,000 gallons. These come in many shapes, sizes, and materials, and can be installed underground to save space.

How Much Storage is Recommended?

The number of rain barrels recommended to capture runoff from a given roof (or other impervious area) is shown in the following table.

Are Rain Barrels or Cisterns Feasible for My Project?

Rain barrels and cisterns are appropriate for sites with the following characteristics:

- Roof areas that drain to downspouts.
- A level, firm surface is needed to support a rain barrel(s) or cistern to prevent shifting or falling over. A full 55-gallon rain barrel will weigh over 400 lbs.
- A landscaped area where the captured water can be used (and where it can be drained by gravity flow) should be located within a reasonable distance from the rain barrel(s).
- A landscaped area or safe path to the storm drain system that can handle overflow.

Roof or Impervious Area (sq. ft.)	Suggested Minimum Number of 55 Gallon Rain Barrels*
Up to 750	1-2
750 – 1,250	2-3
1,250 – 1,750	3-4
1,750 – 2,250**	4-5

* Or equivalent capture using larger rain barrels or a cistern.
** To harvest rainwater from an area greater than 2,250 sq. ft. install 1 additional rain barrel per each additional 500 sq. ft.

Components of a Rainwater Harvesting System

Rain Barrel and Cistern Accessories to Keep Water Clean

First flush and downspout diverter installation
Courtesy of The City of Oakland

Various accessories to rain barrels and cisterns help protect the quality of harvested water and reduce maintenance. These accessories include "first flush" diverters, filters, and screens.

Leaves, twigs, sediment, and animal waste are common in runoff, especially at the beginning of a storm ("first flush"). This debris can result in clogging and encourage bacterial growth. A first flush diverter helps remove debris and contaminants by directing the first few gallons of runoff from the roof to landscaping, away from the rain barrel or cistern.

The following tips will help you keep the water in your system clean.

- Install a first flush diverter directly under your downspout. You may have to cut the downspout to connect the first flush diverter above the rain barrel.
- Use the same diameter pipe for the first flush diverter, the downspout, and the connector to the rain barrel. Avoid changing diameters of pipes in order to keep the system from backing up.
- Design the first flush diverter to discharge the first flush to non-edible landscaping.
- Install mosquito-proof screens under the lid of the rain barrel and inside the overflow outlet.

Foundation and Overflow

Before installing a rain barrel or cistern, prepare the site so that the system will function safely.

- Find or create a level location near the downspout on which to place the rain barrel or cistern.
- A concrete or stone paver foundation may be appropriate for smaller rain barrels. A more substantial foundation will likely be required for large cisterns.
- Secure rain barrels and cisterns to your structure with metal strapping, or anchor to the foundation, to prevent tipping in an earthquake.
- Maintain clear access to the rain barrel outlets and cleaning access points.
- Design an overflow path, so that overflow from the rain barrel(s) will discharge safely to a landscaped area, or storm drain system.
- Where possible, direct overflow to a rain garden, swale, or other landscaped area to maximize retention of rainwater onsite.
- Direct the overflow away from the rain barrel, building foundation, and neighboring properties.
- Consult with the municipality to identify overflow locations.

Large unit installed at a single family residence.
Courtesy of Stephanie Morris

Design Checklist

When installing rain barrels and cisterns, consider the following criteria unless otherwise instructed by the municipality.

- ❑ Do not use flexible piping, to prevent mosquito breeding in water that may pool in flexible pipes. If irrigating edible landscapes, consider pipes that meet FDA food grade standards.
- ❑ When designing the overflow path, remember that in heavy storms rain barrels and cisterns *will* overflow. A 1,000-sq.-ft. roof will produce about 600 gallons of runoff during a storm that has produces a depth of 1 inch of rain.
- ❑ There shall be no direct connection of any rain barrel or cistern and/or rainwater collection piping to any potable water pipe system. Rainwater systems shall be completely separate from potable water piping systems.
- ❑ Place the bottom of the barrel at a higher elevation than the landscape, to use gravity flow.
- ❑ All rain barrels and cisterns should have a screen to ensure mosquitoes cannot enter.
- ❑ Allow overflow to drain to your landscape or a rain garden. Ensure that areas receiving overflow do not have standing water for more than 48-hours.
- ❑ The low water pressure from a small rain barrel will not operate in-ground sprinkler or low-volume devices. Consider using a soaker hose.
- ❑ If using a soaker hose, remove the pressure-reducing washer to increase the water flow.
- ❑ If the water is not needed for irrigation during the rainy season, consider releasing the water to a vegetated area between storms, so the barrels will be empty to catch rain from the next storm. This will help protect your watershed by reducing the quantity and speed of water entering local creeks during storms. Install a spigot and drip tape to allow the rain barrel or cistern to slowly drain between storms. You can store the water captured towards the end of the rainy season to irrigate your garden in the dry season.
- ❑ For more information, ask municipal staff to refer you to countywide stormwater guidance.

Operation and Maintenance

After installing your rain barrel or cistern, follow these tips for long-term safety and functionality.

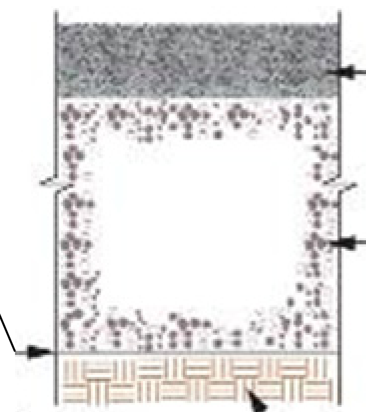
- ❑ Regularly check the gutters and gutter guards to make sure debris is not entering the rainwater harvesting system.
- ❑ Inspect the screens on the rain barrel or cistern prior to the wet season to make sure debris is not collecting on the surface and that there are not holes allowing mosquitoes to enter the rain barrel. Inspect screens more frequently if there are trees that drop debris on the roof.
- ❑ Clean the inside of the rain barrel once a year (preferably at the end of the dry season when the rain barrel has been fully drained) to prevent buildup of debris. If debris cannot be removed by rinsing, use vinegar or another non-toxic cleaner. Use a large scrub brush on a long stick, and avoid actually entering the rain barrel. Drain washwater to landscaping.
- ❑ Clean out debris from cisterns once a year, preferably at the end of the dry season.

Daisy-chained system
Courtesy of Acterra

The City of Los Angeles and Geosyntec Consultants are acknowledged for providing text and formatting used in this fact sheet. The City of Oakland, Acterra, Gutter Glove, and Stephanie Morris are acknowledged for images used in the fact sheet.

Typical Materials and Example Applications

Pervious Concrete



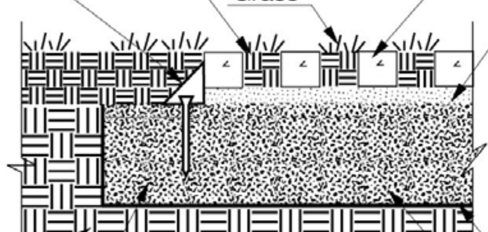
Pervious Concrete
Typ. 5 to 8 in. (125 to 200 mm) thick

No. 57 stone subbase – thickness varies with design

Optional geotextile on bottom and sides of open-graded base

Soil subgrade

Turf Block



Topsoil

Concrete grid

Edge restraint

Grass

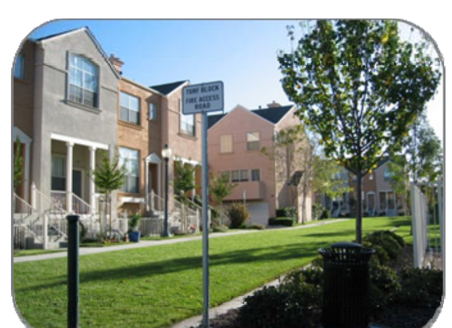
1/2 in. to 1 in. (13 to 25 mm) bedding sand

Existing compacted soil sub-grade

Base extends 12 in. (300 mm) beyond grid perimeter

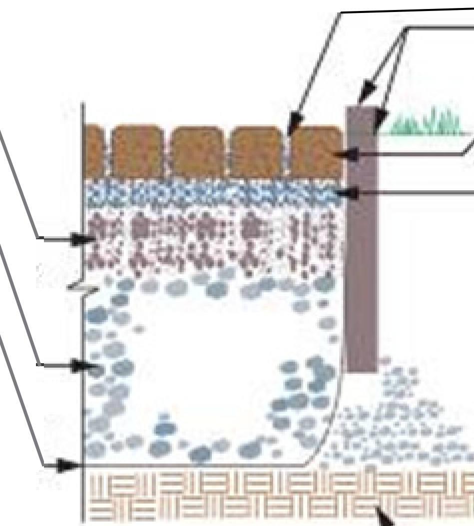
Geotextile (as required)

Compacted aggregate base



Typical Materials and Example Applications

Permeable Interlocking Concrete Pavers



4 in. (100 mm) thick No. 57 stone open-graded base

No. 2 stone subbase – thickness varies with design

Optional geotextile on bottom and sides of open graded base

Typ. No. 8 aggregate in openings

Curb/edge restraint with cut-outs for overflow drainage

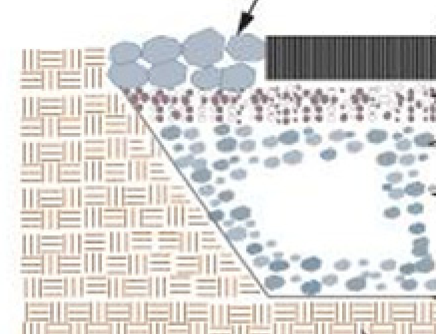
Concrete pavers min. 3 1/8 in (80 mm) thick

Bedding course 1 ½ to 2 in. (40 to 50 mm) thick (typ. No.8 aggregate)

Soil subgrade

Note: ASTM No. 3 or 4 stone may be substituted for No. 2 stone.
ASTM No. 89 or 9 stone may be used in the paver openings.

Porous Asphalt



3 to 6 in. stone for overflow drainage

Porous asphalt, Typ. 3 in. (75 mm) thick

Bedding course, Typ. 2 in. (50 mm) thick (Typ. No. 57 stone)

No. 2 stone subbase – thickness varies with design

Optional geotextile on bottom and sides of open-graded base

Soil subgrade

Note: ASTM No. 3 or 4 stone may be substituted for No. 2 stone.
ASTM No. 89 or 9 stone may be used in the paver openings.

APPENDIX M. PUBLIC AGENCY RESOURCES

M.1 GREEN STREETS

Streets can represent 80% of a municipality's public property and typically occupy 25% of all the impervious surfaces in the jurisdiction. Therefore, the planning, designing, construction and maintenance of streetscapes is an important aspect of a jurisdictional stormwater program.

Under the previous MRP (Order R2-2015-0049) the Clean Water Program developed *Example GI Typical Details* (Attachment M-1) that may be used to design green infrastructure (also known as green stormwater infrastructure) facilities for projects located in the street right of way. Green infrastructure projects located in the street right of way area commonly referred to as Green Streets. Additionally, each municipality in Alameda County developed a Green Infrastructure Plan. The Green Infrastructure Plans incorporated the typical details or customized them for local use.

Green Street designers should refer to the local jurisdictions Green Infrastructure Plan as well as the C.3.b requirements for regulated road projects described in **Chapter 4** for additional guidance, including guidance for sizing for GI facilities in street projects.

In addition to the local Green Infrastructure Plans, there are many excellent resources for Green Street planning, design, construction, and maintenance. Some are listed below:

- San Mateo County - *Sustainable Green Streets and Parking Lots Design Guidebook* https://flowstobay.org/greenstreets
- Portland - *Stormwater Manual* (see Green Streets Details section) www.portlandoregon.gov/bes/64040
- Los Angeles County - *Model Design Manual for Living Streets* www.modelstreetdesignmanual.com
- Seattle - *Right of Way Improvements Manual* http://www.seattle.gov/transportation/projects-and-programs/programs/transportation-planning/right-of-way-improvements-manual-update
- Washington D.C. - *Green Infrastructure Standards* https://ddot.dc.gov/GreenInfrastructure
- San Francisco - Better Streets Plan www.sfbetterstreets.org/
- Boston - Complete Streets Manual
- https://bostoncompletestreets.org/
- Philadelphia - *Green Streets Design Manual* https://water.phila.gov/gsi/planning-design/
- City of San Mateo - *Sustainable Streets Manual* https://www.cityofsanmateo.org/2738/Plans-and-Policies

M.1.1. Example Typical Details

The Clean Water Program's Example Typical Details for designing green infrastructure facilities for projects located in the street right of way are listed below and provided on the following pages. Please note that the use of these details is subject to local jurisdiction approval. The details were originally created by the San Francisco Public Utilities Commission and modified by Geosyntec Consultants for the Clean Water Program.

Table M-1. Clean Water Program Typical GI Details

Sheet No.	Title of Drawing/Standard Specifications
GI-2A	Bioretention Area: Plan view with street parking
GI-2B	Bioretention Area: Bulbout plan view
GI-2C	Bioretention Area: Street Median
GI-3A	Bioretention Area: Sloped Sides Cross Section
GI-3B	Bioretention Area: Vertical Side Wall Cross Section
GI-4	Bioretention Components: Outlet Detail
GI-5	Bioretention Components: Edge Treatment Detail
GI-6A	Bioretention Components: Gutter Curb Cut Inlet Detail
GI-6B	Bioretention Components: Trench Drain Curb Cut Inlet Detail
GI-6C	Bioretention Components: Curb Cut At Bulbout Inlet Detail
GI-7	Bioretention Components: Check Dam Detail
GI-8	Bioretention Area: With Bike Lane Plan View

PURPOSE:

PROVISION C.3 OF THE MUNICIPAL REGIONAL STORMWATER NPDES PERMIT (MRP) REQUIRES TREATMENT OF IMPERVIOUS SURFACES USING GREEN INFRASTRUCTURE FOR BOTH PUBLIC AND PRIVATE DEVELOPMENT PROJECTS. BIORETENTION AREAS ARE EXPECTED TO BE THE MOST COMMON GREEN INFRASTRUCTURE APPLICATION IN PUBLIC RIGHT-OF-WAY (ROW). THE PURPOSE OF THE BIORETENTION AREA IS TO IMPROVE WATER QUALITY BY FILTRATION THROUGH THE BIOTREATMENT SOIL AND TO CONTROL RUNOFF PEAK FLOW RATES AND VOLUMES THROUGH STORAGE AND INFILTRATION.

NOTES & GUIDELINES:

1. THE ENGINEER SHALL ADAPT PLAN AND SECTION DRAWINGS TO ADDRESS SITE-SPECIFIC CONDITIONS.
2. BIORETENTION AREA SHALL BE SIZED TO MEET THE REQUIREMENTS OF MRP PROVISION C.3 SIZING.
3. 48 HOUR MAXIMUM FACILITY DRAWDOWN TIME (TIME FOR MAXIMUM SURFACE PONDING TO DRAIN THROUGH THE BIOTREATMENT SOIL AFTER THE END OF A STORM). REFER TO C.3 TECHNICAL GUIDANCE MANUAL (ACCWP) FOR DRAINAGE CONSIDERATIONS.
4. A STORAGE LAYER OF CALTRANS STANDARD CLASS II PERMEABLE MATERIAL IS REQUIRED UNDER THE BIOTREATMENT SOIL. REFER TO C.3 TECHNICAL GUIDANCE MANUAL (ACCWP) FOR SPECIFICATIONS.
5. CHECK DAMS SHALL BE USED TO TERRACE FACILITIES TO PROVIDE SUFFICIENT PONDING FOR SLOPED INSTALLATIONS. ENGINEER SHALL SPECIFY CHECK DAM HEIGHT AND SPACING. REFER TO DETAIL **GI-7** FOR GUIDANCE ON CHECK DAM DESIGN.
6. DEPENDING ON THE DEPTH OF THE BIORETENTION AREA, ADDITIONAL STRUCTURAL CONSIDERATIONS MAY BE REQUIRED TO ADDRESS HORIZONTAL LOADING. REFER TO DETAIL **GI-5** FOR GUIDANCE ON EDGE TREATMENTS.
7. WHEN FACILITY CONSTRUCTION IMPACTS EXISTING SIDEWALK, ALL SAW CUTS SHALL ADHERE TO LOCAL JURISDICTION STANDARDS. SAW CUTS SHALL BE ALONG SCORE LINES OR ALONG CONSTRUCTION JOINTS, AS DETERMINED BY THE CITY ENGINEER, AND ANY DISTURBED SIDEWALK FLAGS SHALL BE REPLACED IN THEIR ENTIRETY.
8. BIORETENTION AREAS IN PUBLIC RIGHT OF WAY SHALL BE DESIGNED WITH AN EMERGENCY OVERFLOW. IN THE EVENT THE BIORETENTION AREA OVERFLOW DRAIN IS OBSTRUCTED OR CLOGGED, THE INUNDATION AREA SHALL BE CONTAINED WITHIN THE STREET AND SHALL NOT BE WITHIN ADJACENT PRIVATE PROPERTIES.
9. BIORETENTION AREA VEGETATION SHALL BE SPECIFIED BY LANDSCAPE DESIGN PROFESSIONAL. SEE C.3 TECHNICAL GUIDANCE MANUAL (ACCWP) FOR PLANT LIST AND VEGETATION GUIDANCE.
10. THE ENGINEER SHALL EVALUATE THE NEED FOR EROSION PROTECTION AT ALL INLET LOCATIONS. ALL COBBLES USED FOR ENERGY DISSIPATION SHALL BE GROUTED. ENGINEER TO CONSIDER MAINTENANCE REQUIREMENTS TO FACILITATE EASY SEDIMENT REMOVAL AND ADEQUATE VECTOR CONTROL.
11. THE PROJECT PLANS SHALL SHOW ALL EXISTING UTILITIES AND INDICATE POTENTIAL UTILITY CROSSINGS OR CONFLICTS.
12. CHECK WITH LOCAL JURISDICTION FOR UTILITY CROSSING PROVISIONS.
13. MINIMUM UTILITY SETBACKS AND PROTECTION MEASURES SHALL CONFORM TO CURRENT LOCAL JURISDICTION STANDARDS AND OTHER UTILITY PROVIDER REQUIREMENTS.
14. VERTICAL SIDEWALLS EXTENDING INTO EXISTING STORM DRAIN PIPE TRENCH BACKFILL SHALL BE DESIGNED WITH A CONCRETE BACKFILL ACCEPTABLE TO THE CITY ENGINEER.
15. OVERFLOW RISER MUST BE FORMED SUCH THAT IT IS A MINIMUM OF 6" ABOVE THE BOTTOM OF THE SYSTEM INLET, OR AS DESIGNED. PLACE STRUCTURE ADJACENT TO PEDESTRIAN EDGE TO ALLOW FOR MONITORING ACCESS.
16. DETAILS WERE ADAPTED FROM SFPUC GREEN INFRASTRUCTURE TYPICAL DETAILS AND SPECIFICATIONS.
17. DETAILS WERE DEVELOPED BY GEOSYNTEC CONSULTANTS.

ENGINEER CHECKLIST (SHALL SPECIFY, AS APPLICABLE):

- ☐ BIORETENTION AREA WIDTH AND LENGTH
- ☐ DEPTH OF PONDING
- ☐ AMOUNT OF FREEBOARD PROVIDED
- ☐ DEPTH OF BIOTREATMENT SOIL (18" MIN)
- ☐ UNDERDRAIN SPECIFICATIONS AND LOCATION (IF FACILITY IS LINED PLACE UNDERDRAIN AT BOTTOM OF FACILITY)
- ☐ BIORETENTION SURFACE ELEVATION (TOP OF BIOTREATMENT SOIL) AT UPSLOPE AND DOWNSLOPE ENDS OF FACILITY
- ☐ CONTROL POINTS AT EVERY BIORETENTION WALL CORNER AND POINT OF TANGENCY
- ☐ DIMENSIONS AND DISTANCE TO EVERY INLET, OUTLET, CHECK DAM, SIDEWALK NOTCH, ETC.
- ☐ ELEVATIONS OF EVERY INLET, OVERFLOW RISER, STRUCTURE RIM AND INVERT CHECK DAM, BIORETENTION AREA WALL CORNER, AND SIDEWALK NOTCH
- ☐ TYPE AND DESIGN OF BIORETENTION AREA COMPONENTS (E.G., EDGE TREATMENTS, INLETS/GUTTER MODIFICATIONS, UTILITY CROSSINGS, LINER, AND PLANTING DETAILS)
- ☐ DEPTH AND TYPE OF MULCH (NON-FLOATING; ORGANICALLY-DERIVED; NOT BARK OR GORILLA HAIR; 3" MIN)

RELATED TECHNICAL GUIDANCE	SOURCE
BIORETENTION: - BIOTREATMENT SOIL MIX - CALTRANS CLASS II PERM LAYER STORAGE - PERFORATED UNDERDRAIN - NON-FLOATING MULCH	C.3 TECHNICAL GUIDANCE MANUAL (ACCWP)

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clean water PROGRAM

BIORETENTION AREA: NOTES

GREEN INFRASTRUCTURE EXAMPLE DETAILS

ALAMEDA COUNTYWIDE CLEAN WATER PROGRAM

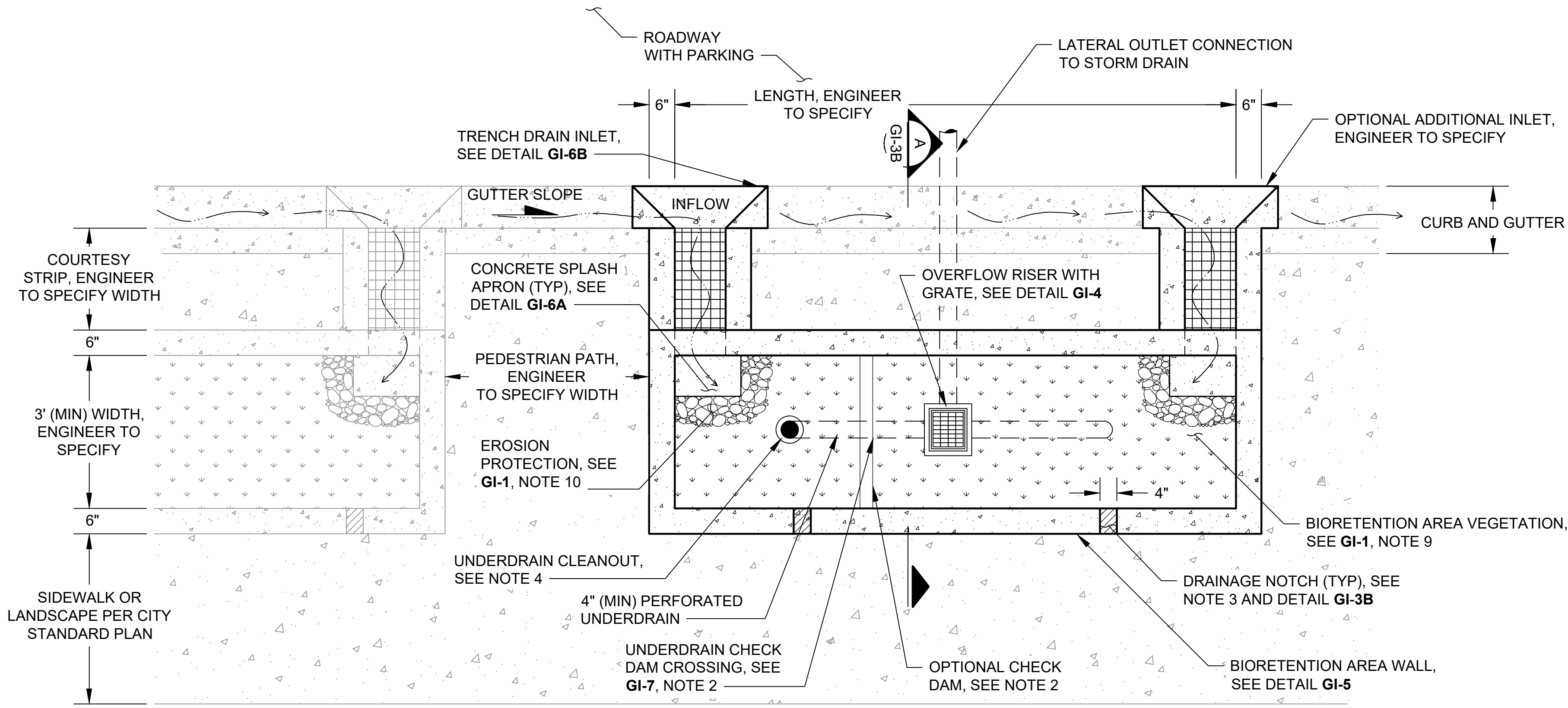
SCALE: NOT TO SCALE

DATE: MAY 11, 2018 REVISED: JUNE 11, 2019

DRAWN BY: K. K. REVISED BY: E. F.

CHECKED BY: A. R.

GI-1



NOTES:

1. REFER TO **GI-1** NOTES FOR GUIDELINES AND CHECKLIST.
2. CHECK DAMS SHALL BE SPACED TO PROVIDE PONDING PER SITE SPECIFIC DESIGN (SEE DETAIL **GI-7**).
3. LAY OUT DRAINAGE NOTCHES AS APPLICABLE TO PREVENT PONDING BEHIND BIORETENTION AREA WALL WITH 5' MAXIMUM SPACING BETWEEN NOTCHES.
4. PROVIDE ONE UNDERDRAIN CLEANOUT PER BIORETENTION AREA (MIN). CLEANOUT REQUIRED AT UPSTREAM END AND PIPE ANGLE POINTS EXCEEDING 45 DEGREES. LONGITUDINAL SLOPE OF PIPE SHALL BE 0.5% (MIN).

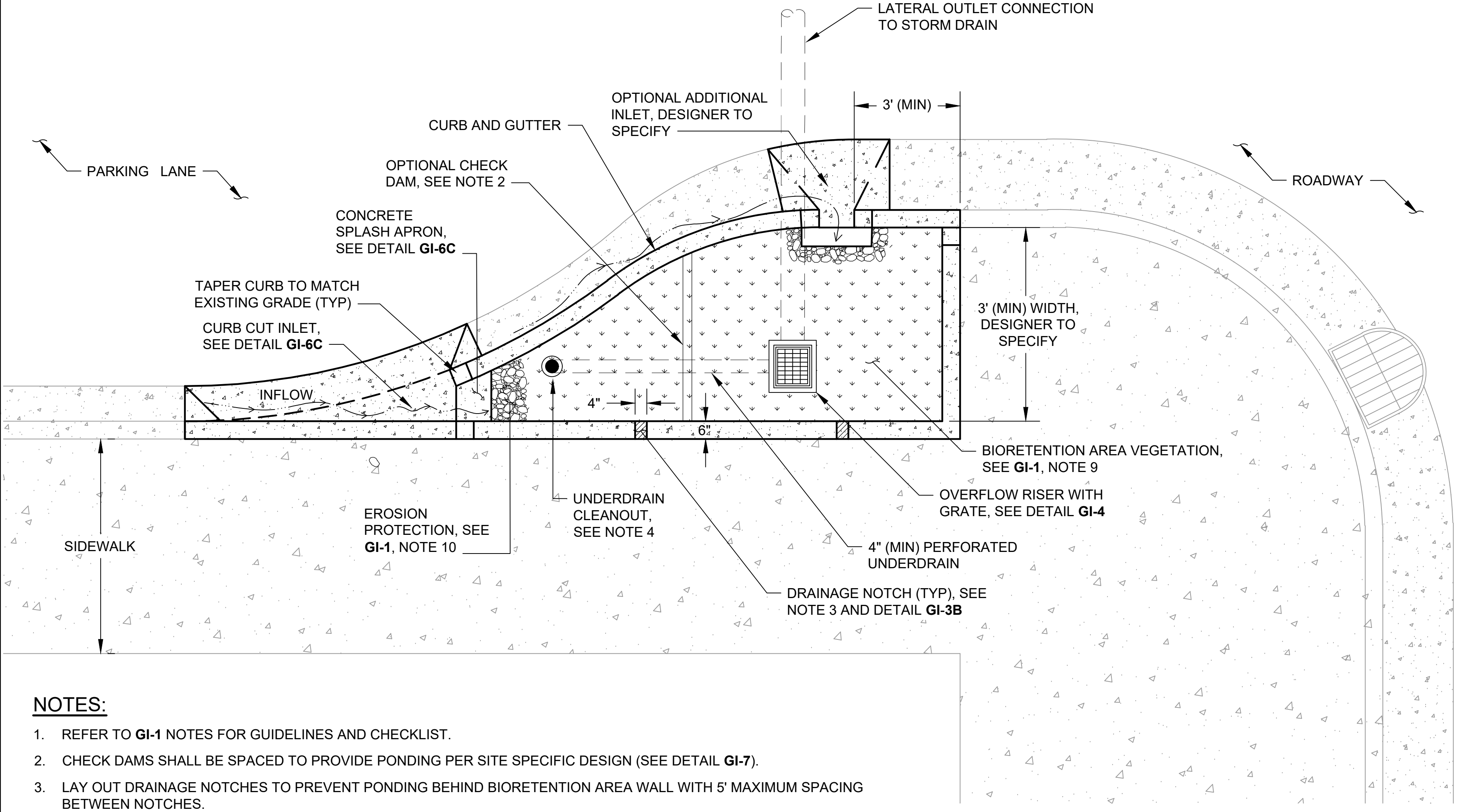
NOT FOR CONSTRUCTION

BIORETENTION AREA: PLAN VIEW WITH STREET PARKING

GREEN INFRASTRUCTURE EXAMPLE DETAILS	SCALE: NOT TO SCALE
	DATE: MAY 11, 2018 REVISED: JUNE 11, 2019
ALAMEDA COUNTYWIDE CLEAN WATER PROGRAM	DRAWN BY: K. K REVISED BY: E. F.
	CHECKED BY: A. R.

cleanwater PROGRAM

GI-2A



NOTES:

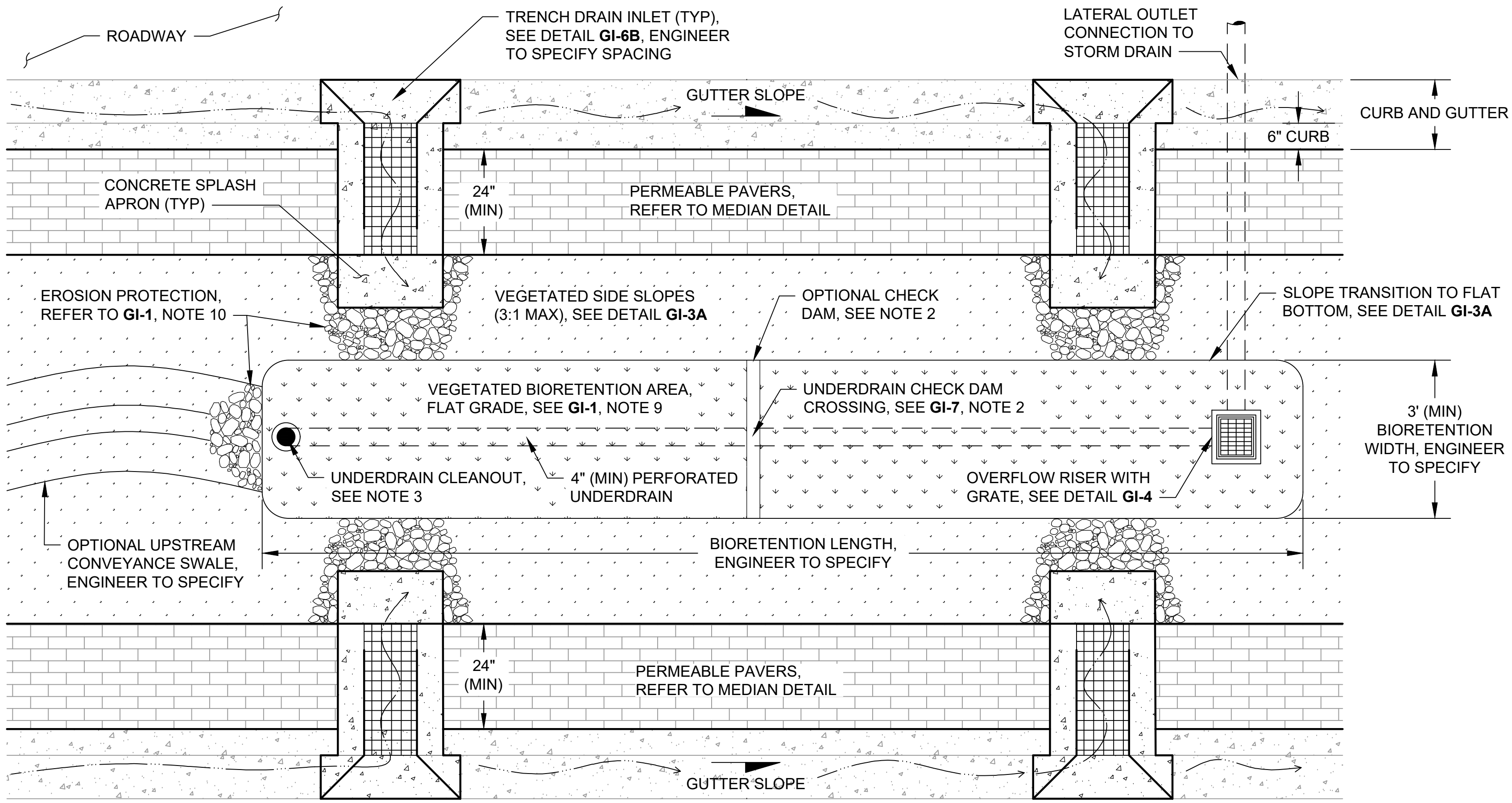
1. REFER TO **GI-1** NOTES FOR GUIDELINES AND CHECKLIST.
2. CHECK DAMS SHALL BE SPACED TO PROVIDE PONDING PER SITE SPECIFIC DESIGN (SEE DETAIL **GI-7**).
3. LAY OUT DRAINAGE NOTCHES TO PREVENT PONDING BEHIND BIORETENTION AREA WALL WITH 5' MAXIMUM SPACING BETWEEN NOTCHES.
4. PROVIDE ONE UNDERDRAIN CLEANOUT PER BIORETENTION AREA (MIN). CLEANOUT REQUIRED AT UPSTREAM END AND PIPE ANGLE POINTS EXCEEDING 45 DEGREES. LONGITUDINAL SLOPE OF PIPE SHALL BE 0.5% (MIN).

NOT FOR CONSTRUCTION

BIORETENTION AREA: BULBOUT PLAN VIEW

clean water PROGRAM	GREEN INFRASTRUCTURE EXAMPLE DETAILS ALAMEDA COUNTYWIDE CLEAN WATER PROGRAM	SCALE: NOT TO SCALE DATE: MAY 11, 2018 REVISED: JUNE 11, 2019 DRAWN BY: K. K. REVISED BY: E. F. CHECKED BY: A. R.

GI-2B



NOTES:

1. REFER TO **GI-1** NOTES FOR GUIDELINES AND CHECKLIST.
2. CHECK DAMS SHALL BE SPACED TO PROVIDE PONDING PER SITE SPECIFIC DESIGN (SEE DETAIL **GI-7**).
3. PROVIDE ONE UNDERDRAIN CLEANOUT PER BIORETENTION AREA (MIN). CLEANOUT REQUIRED AT UPSTREAM END AND PIPE ANGLE POINTS EXCEEDING 45 DEGREES. LONGITUDINAL SLOPE OF PIPE SHALL BE 0.5% (MIN).
4. DESIGNERS TO REFERENCE AASHTO ROADSIDE SAFETY DESIGN REQUIREMENTS AND CONSIDER USE OF MEDIAN BIORETENTION AREAS IN RELATION TO STREET CLASSIFICATION AND STREET SPEEDS.
5. A STORAGE VOLUME SAFETY FACTOR OF 1.5 SHALL BE INCLUDED IN THE DESIGN OF MEDIAN BIORETENTION AREAS TO PREVENT FLOODING.
6. SLOPED SIDES (**GI-3A**) DEPICTED IN PLAN VIEW ABOVE, REFER TO **GI-3B** IF VERTICAL SIDE WALLS ARE USED.

NOT FOR CONSTRUCTION

clean water PROGRAM

BIORETENTION AREA: STREET MEDIAN

GREEN INFRASTRUCTURE EXAMPLE DETAILS

ALAMEDA COUNTYWIDE CLEAN WATER PROGRAM

SCALE: NOT TO SCALE

DATE: MAY 11, 2018 REVISED: JUNE 11, 2019

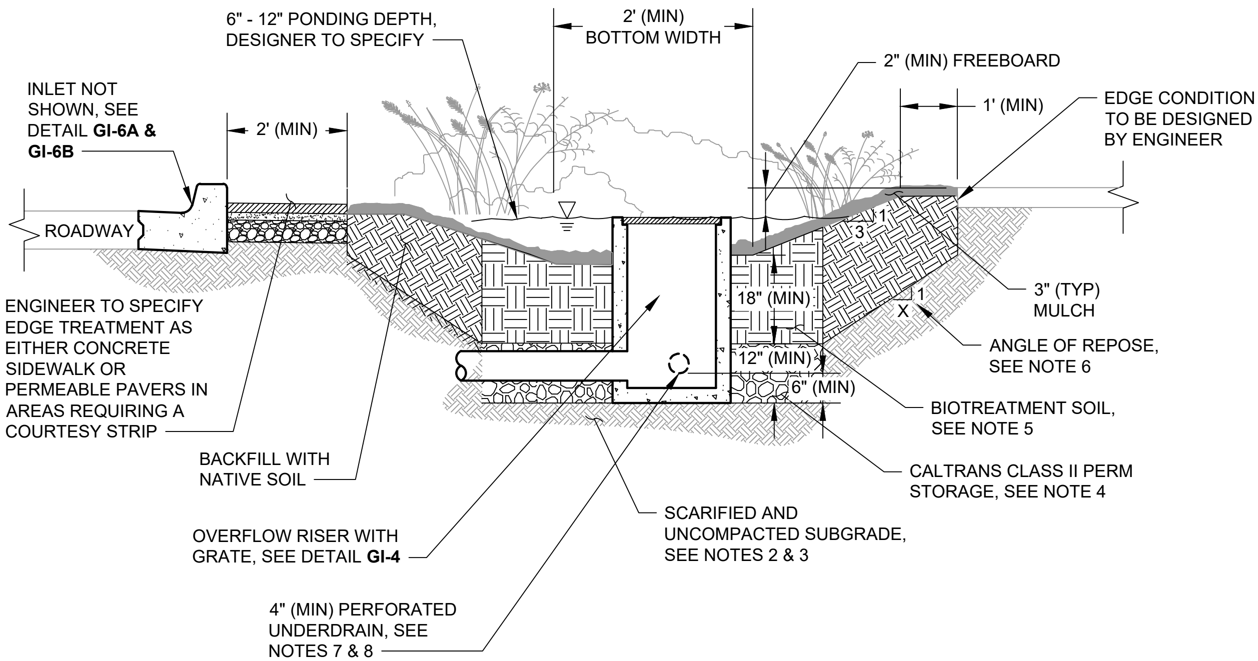
DRAWN BY: K. K. REVISED BY: E. F.

CHECKED BY: A. R.

GI-2C

NOTES:

1. REFER TO **GI-1** NOTES FOR GUIDELINES AND CHECKLIST.
2. AVOID UNNECESSARY COMPACTION OF EXISTING SUBGRADE BELOW AREA.
3. SCARIFY SUBGRADE TO A DEPTH OF 3" (MIN) IMMEDIATELY PRIOR TO PLACEMENT OF CALTRANS CLASS 2 PERMEABLE MATERIAL STORAGE LAYER AND BIOTREATMENT SOIL MATERIALS.
4. AGGREGATE STORAGE LAYER COMPRISED OF 12" MIN CALTRANS CLASS 2 PERMEABLE MATERIAL.
5. REFER TO C.3 TECHNICAL GUIDANCE MANUAL (ACCWP) FOR BIOTREATMENT SOIL MIX SPECIFICATIONS. INSTALL BIOTREATMENT SOIL AT 85% COMPACTION FOLLOWING BASMAA INSTALLATION GUIDANCE.
6. ANGLE OF REPOSE VARIES PER GEOTECHNICAL ENGINEER RECOMMENDATIONS.
7. UNDERDRAIN AND CLEAN OUT PIPE (1 MIN PER FACILITY) REQUIRED, REFER TO C.3 TECHNICAL GUIDANCE MANUAL (ACCWP) FOR DESIGN CONSIDERATIONS. UNDERDRAINS SHOULD BE ELEVATED 6" (MIN) WITHIN THE CALTRANS CLASS 2 PERMEABLE MATERIAL STORAGE LAYER TO PROMOTE INFILTRATION. IN FACILITIES WITH AN IMPERMEABLE LINER, THE UNDERDRAIN SHOULD BE PLACED AT THE BOTTOM OF THE CALTRANS CLASS 2 PERMEABLE MATERIAL STORAGE LAYER. PERFORATED/SLOT DRAINS SHOULD BE DOWNWARD FACING TO FACILITATE BETTER STORAGE IN THE GRAVEL LAYER.
8. THE UNDERDRAIN IN ALL FACILITIES LOCATED IN THE PUBLIC RIGHT-OF-WAY SHALL BE VIDEO RECORDED AND PROVIDED TO THE CITY FOR REVIEW PRIOR TO PROJECT ACCEPTANCE.
9. REFER TO LOCAL JURISDICTION STANDARDS FOR CURB AND SIDEWALK DETAILS.



NOT FOR CONSTRUCTION

BIORETENTION AREA: SLOPED SIDES CROSS SECTION

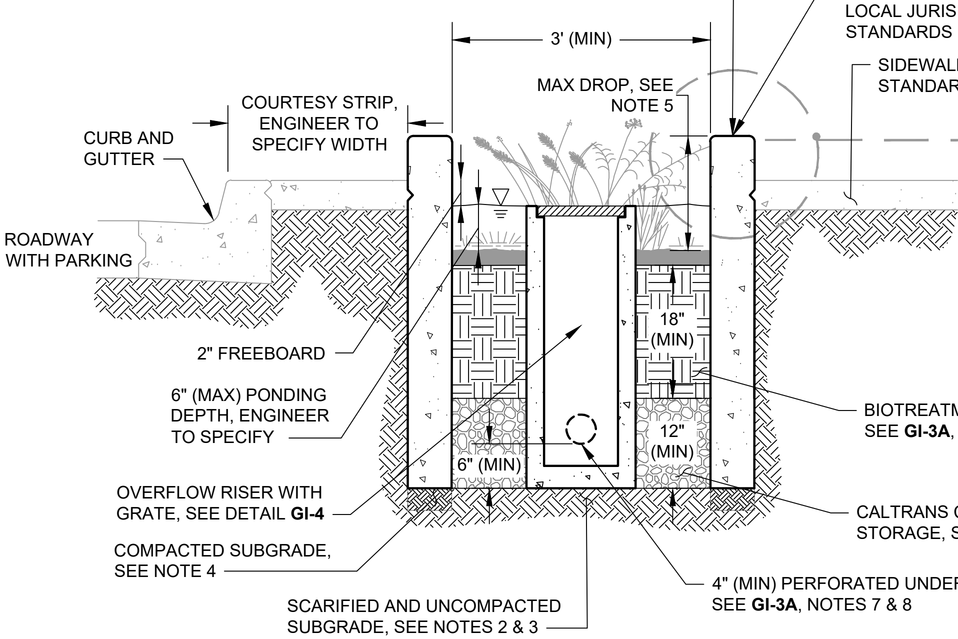
cleanwater PROGRAM

GREEN INFRASTRUCTURE EXAMPLE DETAILS

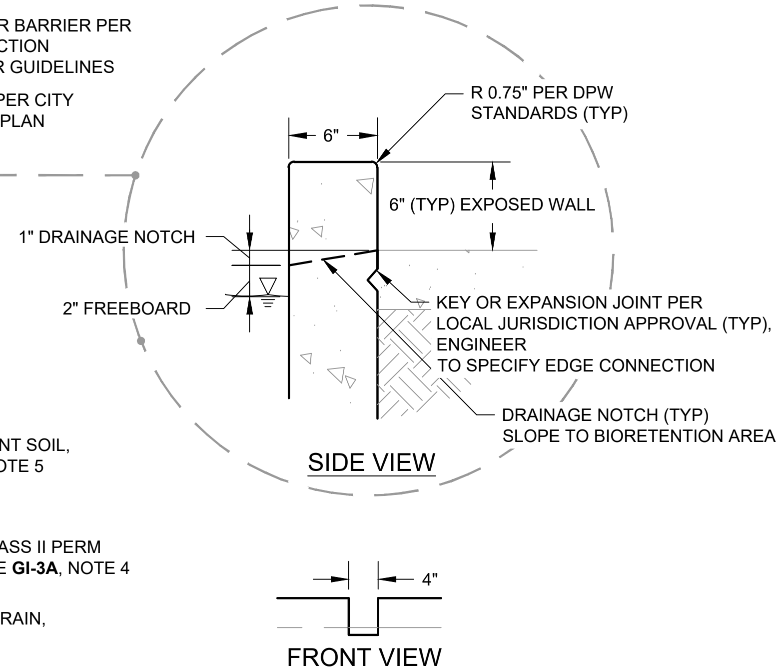
ALAMEDA COUNTYWIDE CLEAN WATER PROGRAM

SCALE: NOT TO SCALE	
DATE: MAY 11, 2018	REVISED: JUNE 11, 2019
DRAWN BY: K. K.	REVISED BY: E. F.
CHECKED BY: A. R.	

GI-3A



BIORETENTION AREA WITH VERTICAL SIDE WALLS (A)



DRAINAGE NOTCH DETAIL

NOTES:

1. REFER TO **GI-1** NOTES FOR GUIDELINES AND CHECKLIST.
2. AVOID UNNECESSARY COMPACTION OF EXISTING SUBGRADE BELOW BIORETENTION AREA.
3. SCARIFY SUBGRADE TO A DEPTH OF 3" (MIN) IMMEDIATELY PRIOR TO PLACEMENT OF AGGREGATE STORAGE AND BIOTREATMENT SOIL MATERIAL.
4. FOR STRUCTURAL SUPPORT, SUBGRADE UNDER WALLS ONLY COMPACTED PER ENGINEER SPECIFICATIONS.
5. MAXIMUM DROP, PER LOCAL BUILDING CODE, FROM TOP OF CURB TO TOP OF BIOTREATMENT SOIL SHALL INCLUDE CONSIDERATIONS FOR BIOTREATMENT SOIL SETTLEMENT. THE DROP IS THE SUM OF PONDING DEPTH (6" TYP), FREEBOARD (2" TYP), AND CURB HEIGHT (6" TYP).
6. REFER TO LOCAL JURISDICTION STANDARDS FOR CURB AND SIDEWALK DETAILS.

NOT FOR CONSTRUCTION

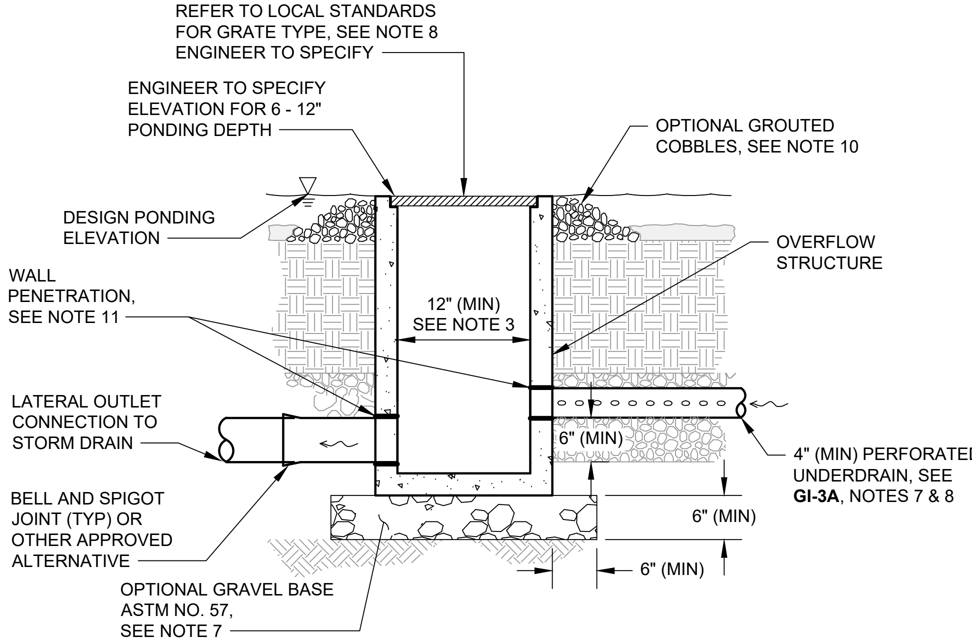
clean water PROGRAM

BIORETENTION AREA: VERTICAL SIDE WALL CROSS SECTION

GREEN INFRASTRUCTURE EXAMPLE DETAILS	SCALE: NOT TO SCALE	
ALAMEDA COUNTYWIDE CLEAN WATER PROGRAM	DATE: MAY 11, 2018 REVISED: JUNE 11, 2019	
	DRAWN BY: K. K. REVISED BY: E. F.	
	CHECKED BY: A. R.	GI-3B

NOTES:

1. REFER TO **GI-1** NOTES FOR GUIDELINES AND CHECKLIST.
2. ALL MATERIAL AND WORKMANSHIP FOR OVERFLOW STRUCTURES SHALL CONFORM TO LOCAL JURISDICTION STANDARDS.
3. DESIGN OVERFLOW WEIR AND OUTLET PIPE TO CONVEY 10-YR, 24-HR STORM FLOW OR DESIGN INLET TO DIVERT FLOWS LARGER THAN THE DESIGN STORM DIRECTLY TO THE STORM DRAIN. LOCATE ALL OVERFLOW PIPES AT AN ELEVATION HIGHER THAN THE STORM SEWER HYDRAULIC GRADE LINE TO PREVENT BACKFLOW INTO THE BIORETENTION FACILITY.
4. STORM DRAIN OUTLET PIPES SHALL BE SIZED TO MEET HYDRAULIC REQUIREMENTS WITH APPROPRIATE COVER DEPTH AND PIPE MATERIAL.
5. PERFORATED UNDERDRAINS WITH CLEANOUT PIPES ARE REQUIRED. PERFORATED/SLOT DRAINS SHOULD BE DOWNWARD FACING TO FACILITATE BETTER STORAGE IN THE GRAVEL LAYER.
6. MAINTENANCE ACCESS IS REQUIRED FOR ALL OUTLET STRUCTURES AND CLEANOUT FACILITIES. 12" (MIN) CLEARANCE WITHIN OVERFLOW STRUCTURE SHALL BE PROVIDED FOR MAINTENANCE ACCESS.
7. ENGINEER SHALL REFER TO LOCAL JURISDICTION STANDARDS AND/OR ASSESS NEED FOR GRAVEL BASE. ENGINEER SHALL EVALUATE BUOYANCY OF STRUCTURES FOR SITE SPECIFIC APPLICATION AND SPECIFY THICKENED OR EXTENDED BASE / ANTI-FLOATATION COLLAR, AS NECESSARY.
8. SIZE OF GRATE SHALL MATCH SIZE OF RISER SPECIFIED IN PLANS, SHALL BE REMOVABLE TO PROVIDE MAINTENANCE ACCESS, AND SHALL BE BOLTED IN PLACE OR OUTFITTED WITH APPROVED TAMPER-RESISTANT LOCKING MECHANISM. MAXIMUM GRATE OPENING SHALL BE 2".
9. IF INTERIOR DEPTH OF OVERFLOW STRUCTURE EXCEEDS 5', A PERMANENT BOLTED LADDER AND MINIMUM CLEAR SPACE OF 30" BY 30" SHALL BE PROVIDED FOR MAINTENANCE ACCESS.
10. MINIMUM DIAMETER OF OPTIONAL GROUTED COBBLES SHALL BE LARGER THAN MAXIMUM GRATE OPENING.
11. GROUT ALL PENETRATIONS, CRACKS, SEAMS, AND JOINTS WITH CLASS "C" MORTAR.



NOT FOR CONSTRUCTION

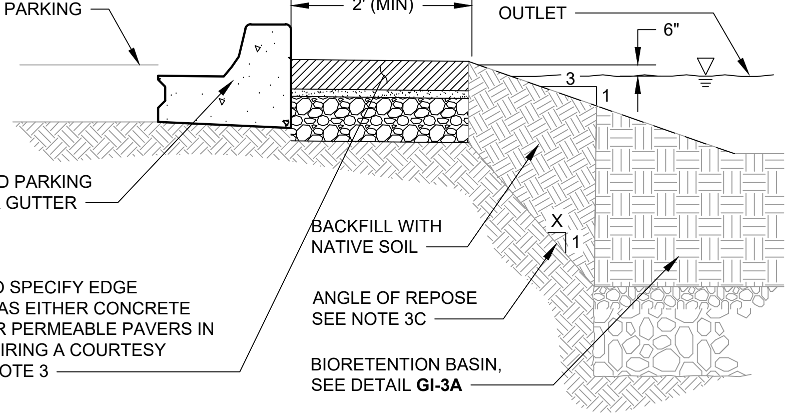
BIORETENTION COMPONENTS: OUTLET DETAIL

GREEN INFRASTRUCTURE EXAMPLE DETAILS	SCALE: NOT TO SCALE	
ALAMEDA COUNTYWIDE CLEAN WATER PROGRAM	DATE: MAY 11, 2018 REVISED: JUNE 11, 2019	
	DRAWN BY: K. K. REVISED BY: E. F.	
	CHECKED BY: A. R.	GI-4

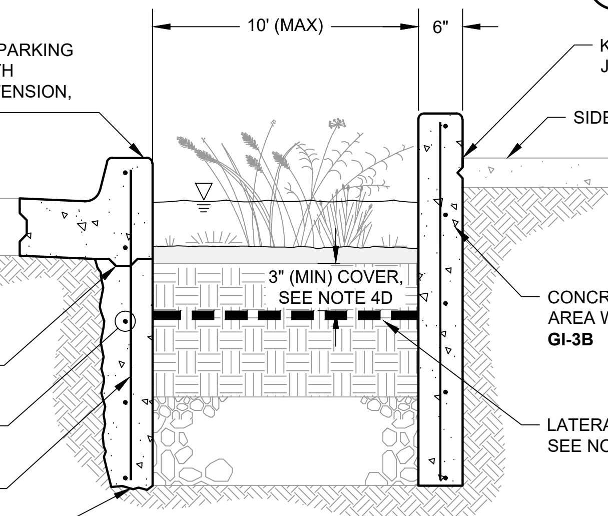
clean water PROGRAM

NOTES:

1. REFER TO **GI-1** NOTES FOR GUIDELINES AND CHECKLIST.
2. THE ENGINEER SHALL ADAPT EDGE TREATMENT DESIGN TO ADDRESS SITE SPECIFIC CONSTRAINTS TO EFFECTIVELY STABILIZE ADJACENT PAVEMENT AND MINIMIZE LATERAL MOVEMENT OF WATER.
3. STANDARD CURB EDGE (WHEN SPACE AVAILABLE):
   A. REFER TO LOCAL JURISDICTION STANDARDS FOR CURB AND SIDEWALK DETAILS.
   B. ANGLE OF REPOSE VARIES PER GEOTECHNICAL ENGINEERS RECOMMENDATIONS.
4. VERTICAL SIDE WALLS (WHEN SPACE LIMITED):
   A. ALL BIORETENTION AREA WALLS SHALL EXTEND TO BOTTOM OF AGGREGATE STORAGE LAYER OR DEEPER. MINIMUM DEPTHS SHALL BE DESIGNED TO PREVENT LATERAL SEEPAGE INTO THE ADJACENT PAVEMENT SECTION.
   B. FOOTING AND/OR LATERAL BRACING SHALL SHALL BE DESIGNED BY THE ENGINEER TO WITHSTAND ANTICIPATED LOADING ASSUMING NO REACTIVE FORCES FROM THE UNCOMPACTED BIOTREATMENT SOIL.
   C. BIORETENTION AREA WALLS EXTENDING MORE THAN 36" BELOW ADJACENT LOAD-BEARING SURFACE, OR WHEN LOCATED ADJACENT TO PAVERS, SHALL HAVE FOOTING OR LATERAL BRACING. FOOTING OR LATERAL BRACING MAY BE EXCLUDED ONLY IF THE ENGINEER DEMONSTRATES THAT THE PROPOSED WALL DESIGN MEETS LOADING REQUIREMENTS. WALL SHALL NOT ENCROACH INTO TREATMENT AREA.
   D. CONTRACTOR TO PROVIDE 3" MINIMUM COVER OVER ALL LATERAL BRACING FOR PLANT ESTABLISHMENT.
   E. ALL CONSTRUCTION COLD JOINTS SHALL INCORPORATE EPOXY, DOWEL/TIE BAR, KEYWAY, OR WATER STOP.



STANDARD CURB EDGE AT BIORETENTION BASIN (1)



EXTENDED BIORETENTION AREA WALL WITH LATERAL BRACING (2)

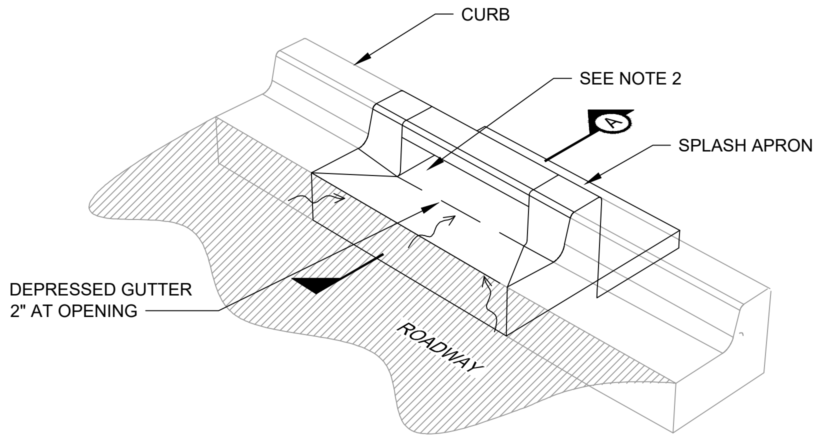
NOT FOR CONSTRUCTION

BIORETENTION COMPONENTS: EDGE TREATMENT DETAIL

GREEN INFRASTRUCTURE EXAMPLE DETAILS	SCALE: NOT TO SCALE	
ALAMEDA COUNTYWIDE CLEAN WATER PROGRAM	DATE: MAY 11, 2018	REVISED: JUNE 11, 2019
	DRAWN BY: K. K.	REVISED BY: E. F.
	CHECKED BY: A. R.	

clean water PROGRAM

GI-5



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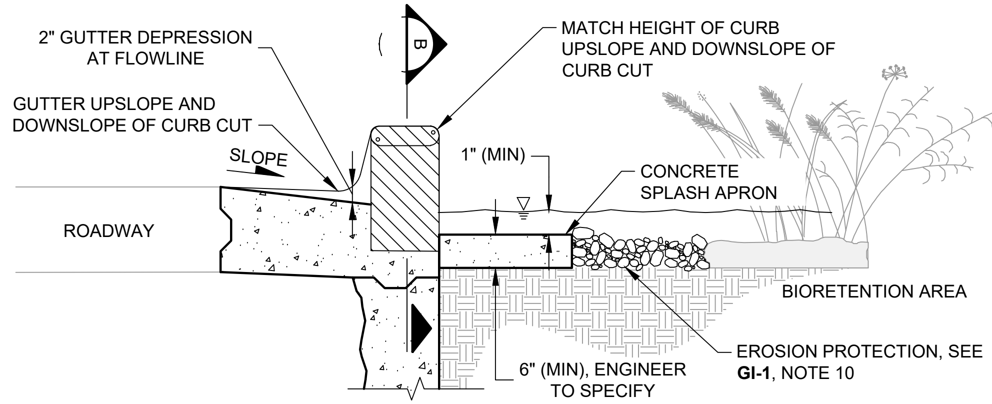
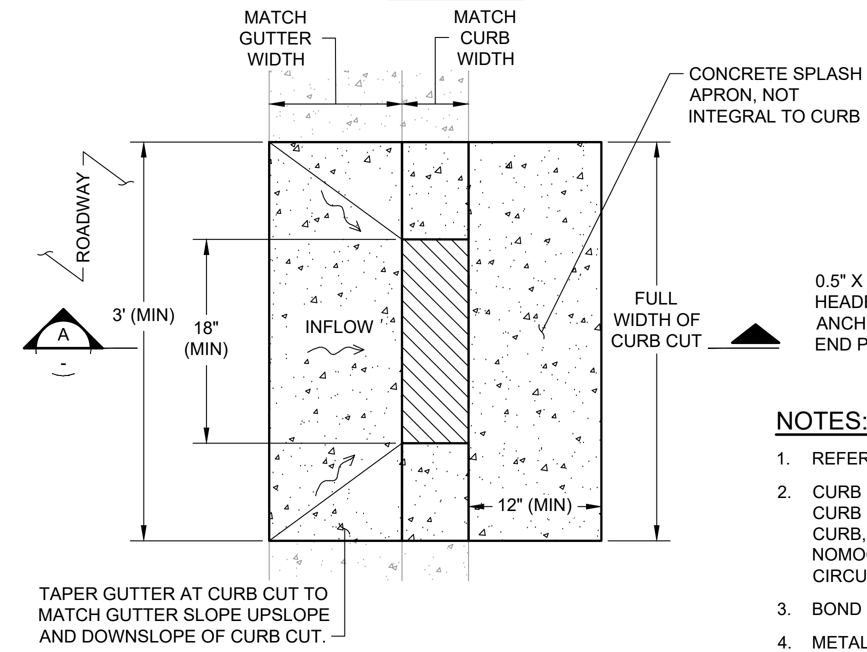
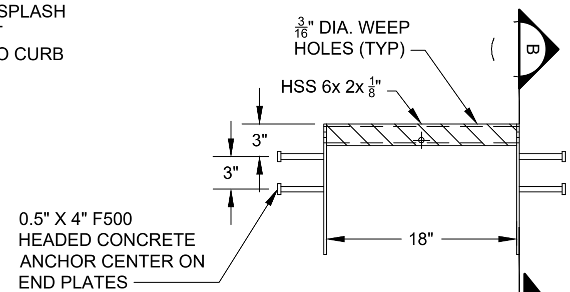


SECTION A

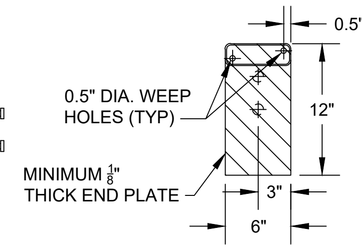


PLAN

METAL INLET ASSEMBLY



ELEVATION



SECTION B

NOTES:

1. REFER TO **GI-1** NOTES FOR GUIDELINES AND CHECKLIST.
2. CURB CUT INLETS SHALL BE ADEQUATELY SIZED, SPACED, AND SLOPED TO MEET HYDRAULIC REQUIREMENTS. THE CURB CUT OPENING WIDTH SHALL BE SIZED BASED ON THE CATCHMENT AREA, LONGITUDINAL SLOPE ALONG THE CURB, AND THE CROSS SLOPE OF THE GUTTER OR ADJACENT PAVEMENT AT THE INLET. SEE SIZING EQUATIONS AND NOMOGRAPHS FOR CURB OPENING INLETS IN THE U.S. DEPARTMENT OF TRANSPORTATION HYDRAULIC ENGINEERING CIRCULAR NO. 27.
3. BOND NEW CURB AND GUTTER TO EXISTING CURB AND GUTTER WITH EPOXY AND DOWEL CONNECTION.
4. METAL INLET ASSEMBLY SHALL BE HOT-DIP GALVANIZED IN ACCORDANCE WITH ASTM A-123.

NOT FOR CONSTRUCTION

BIORETENTION COMPONENTS: GUTTER CURB CUT INLET DETAIL

clean water PROGRAM

GREEN INFRASTRUCTURE EXAMPLE DETAILS

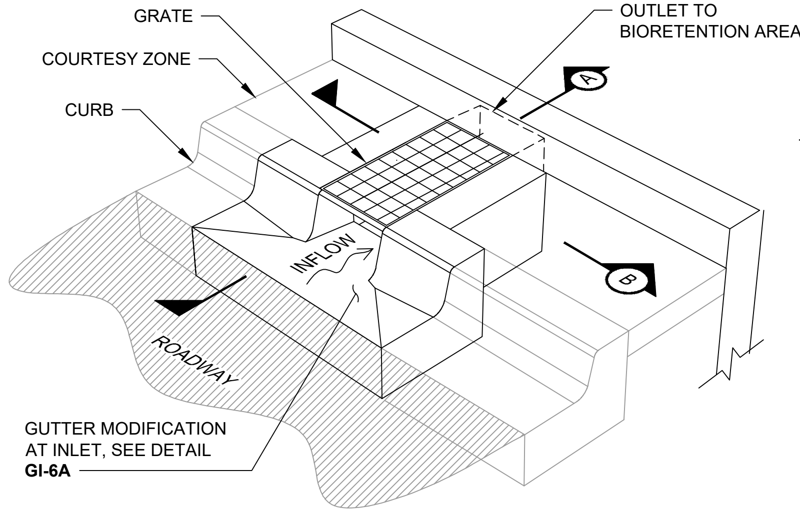
ALAMEDA COUNTYWIDE CLEAN WATER PROGRAM

SCALE: NOT TO SCALE	
DATE: MAY 11, 2018	REVISED: JUNE 11, 2019
DRAWN BY: K. K.	REVISED BY: E.F.
CHECKED BY: A. R.	

GI-6A

NOTES:

1. REFER TO **GI-1** NOTES FOR GUIDELINES AND CHECKLIST.
2. ALL MATERIAL AND WORKMANSHIP FOR TRENCH DRAIN ASSEMBLY SHALL CONFORM TO LOCAL JURISDICTION STANDARDS.
3. TRENCH DRAIN INLETS SHALL BE ADEQUATELY SIZED, SPACED, AND SLOPED TO MEET HYDRAULIC REQUIREMENTS. SEE NOTE 2 DETAIL **GI-6A** FOR REFERENCE.
4. SLOPE TO PROVIDE AT LEAST 1" DROP OVER LENGTH OF CHANNEL OR A MINIMUM OF 2%, WHICHEVER IS LARGER.
5. ALL TRENCH GRATES SHALL BE REMOVABLE, RATED PER THE ANTICIPATED LOADING, AND BOLTED IN PLACE OR OUTFITTED WITH APPROVED TAMPER-RESISTANT LOCKING MECHANISM, FLUSH OR RECESSED IN GRATE.
6. BOND NEW CURB AND GUTTER TO EXISTING CURB AND GUTTER WITH EPOXY AND DOWEL CONNECTION.
7. HORIZONTAL CONTROL JOINTS SHALL BE PROVIDED EVERY 10' (LINEAR), OR PER MANUFACTURER'S RECOMMENDATIONS.
8. APPLY EPOXY BONDING AGENT AT ALL TRENCH DRAIN CONSTRUCTION COLD JOINTS.
9. INLET CURB CUT AND CONCRETE CHANNEL WIDTH SHALL BE SIZED TO ACCOUNT FOR CATCHMENT AREA AND GUTTER SLOPE.



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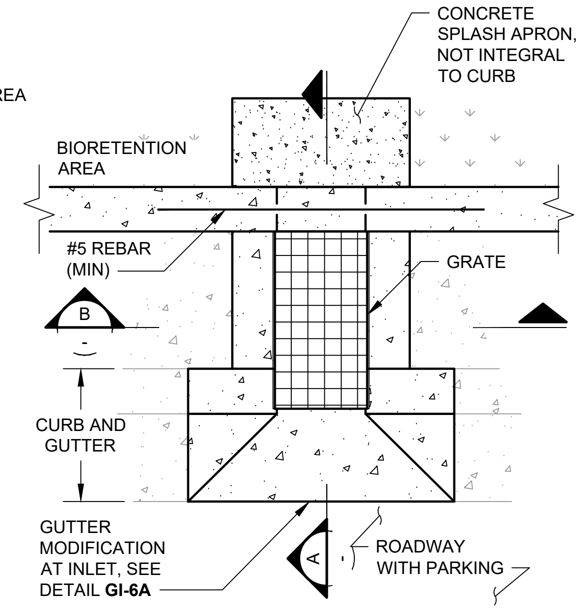
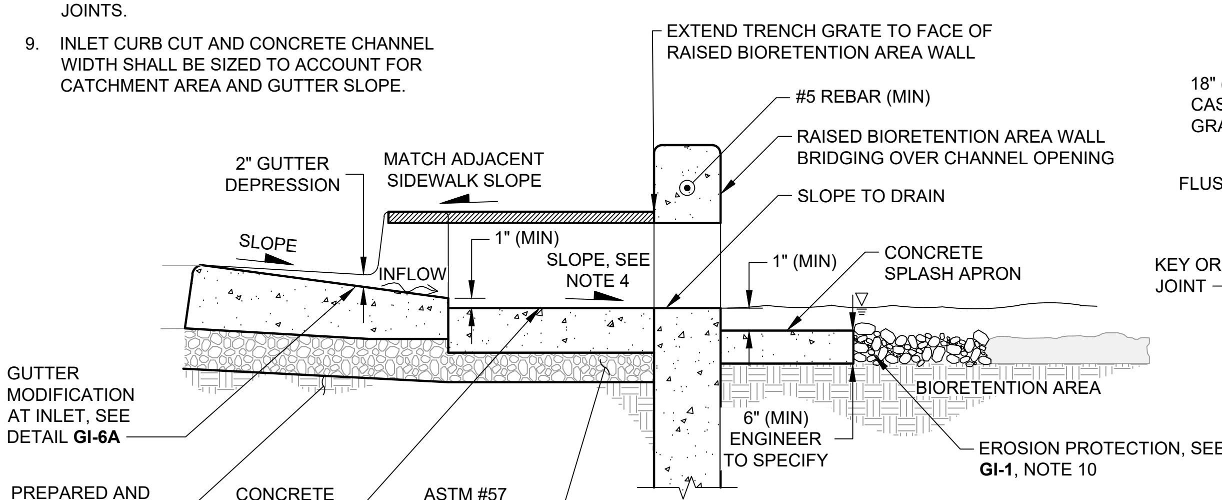
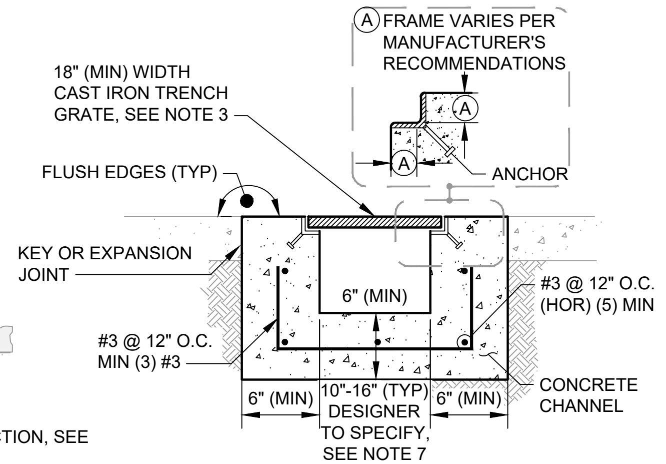




SECTION A



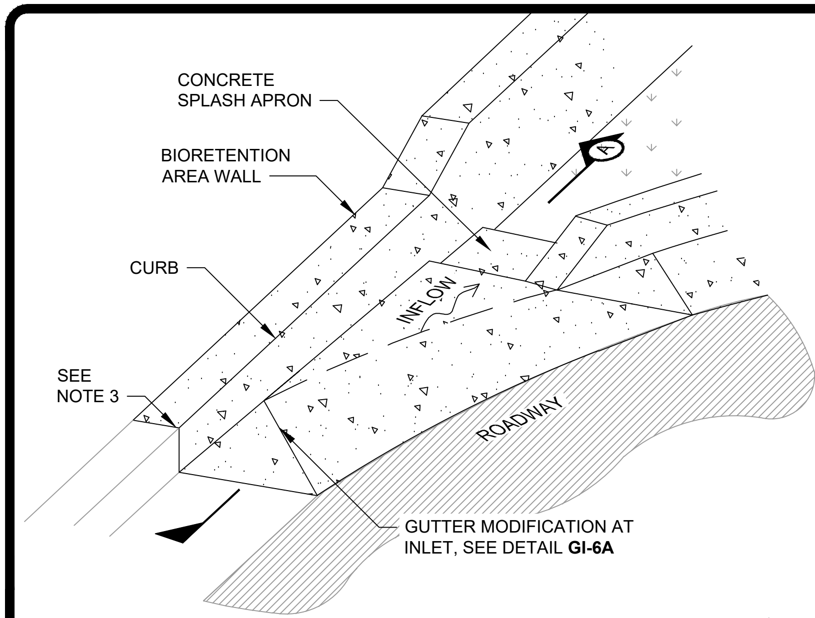
SECTION B

NOT FOR CONSTRUCTION

BIORETENTION COMPONENTS: TRENCH DRAIN CURB CUT INLET DETAIL

clean water PROGRAM

GREEN INFRASTRUCTURE EXAMPLE DETAILS	SCALE: NOT TO SCALE	
	DATE: MAY 11, 2018 REVISED: JUNE 11, 2019	
ALAMEDA COUNTYWIDE CLEAN WATER PROGRAM	DRAWN BY: K. K. REVISED BY: E.F.	
	CHECKED BY: A. R.	GI-6B



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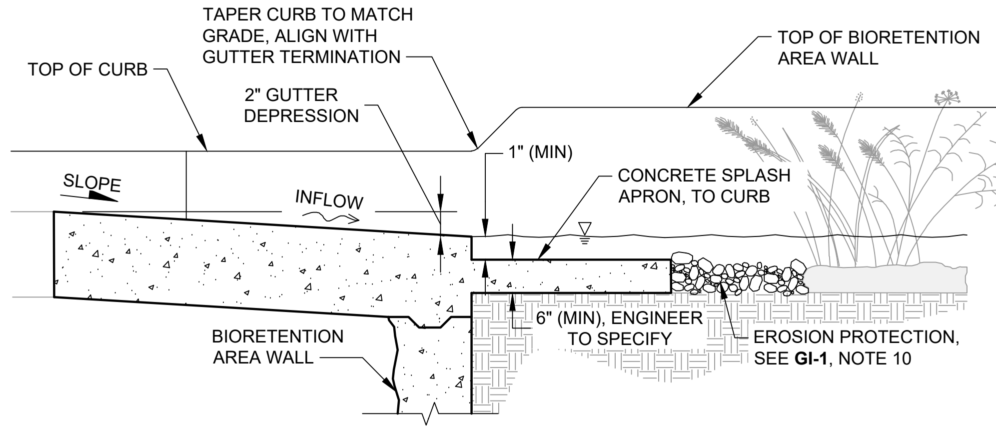
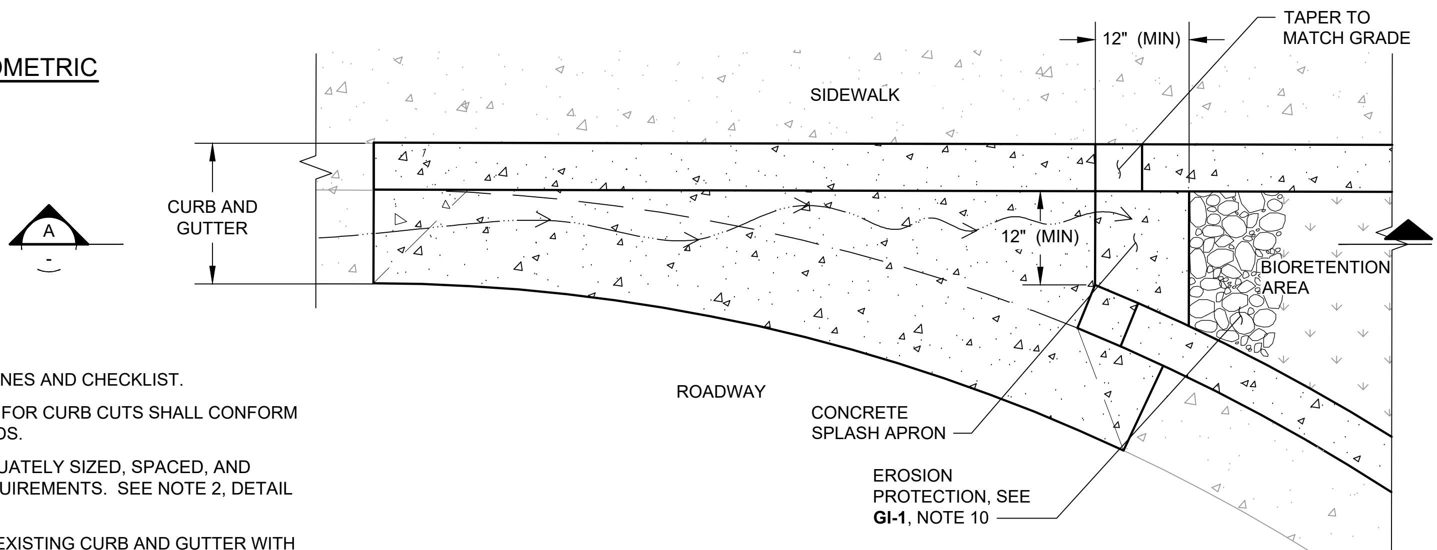


SECTION A



PLAN

NOTES:

1. REFER TO **GI-1** NOTES FOR GUIDELINES AND CHECKLIST.
2. ALL MATERIAL AND WORKMANSHIP FOR CURB CUTS SHALL CONFORM TO LOCAL JURISDICTION STANDARDS.
3. CURB CUT INLETS SHALL BE ADEQUATELY SIZED, SPACED, AND SLOPED TO MEET HYDRAULIC REQUIREMENTS. SEE NOTE 2, DETAIL **GI-6A** FOR REFERENCE.
4. BOND NEW CURB AND GUTTER TO EXISTING CURB AND GUTTER WITH EPOXY AND DOWEL CONNECTION.

NOT FOR CONSTRUCTION

BIORETENTION COMPONENTS: CURB CUT AT BULBOUT INLET DETAIL

clean water PROGRAM

GREEN INFRASTRUCTURE EXAMPLE DETAILS

ALAMEDA COUNTYWIDE CLEAN WATER PROGRAM

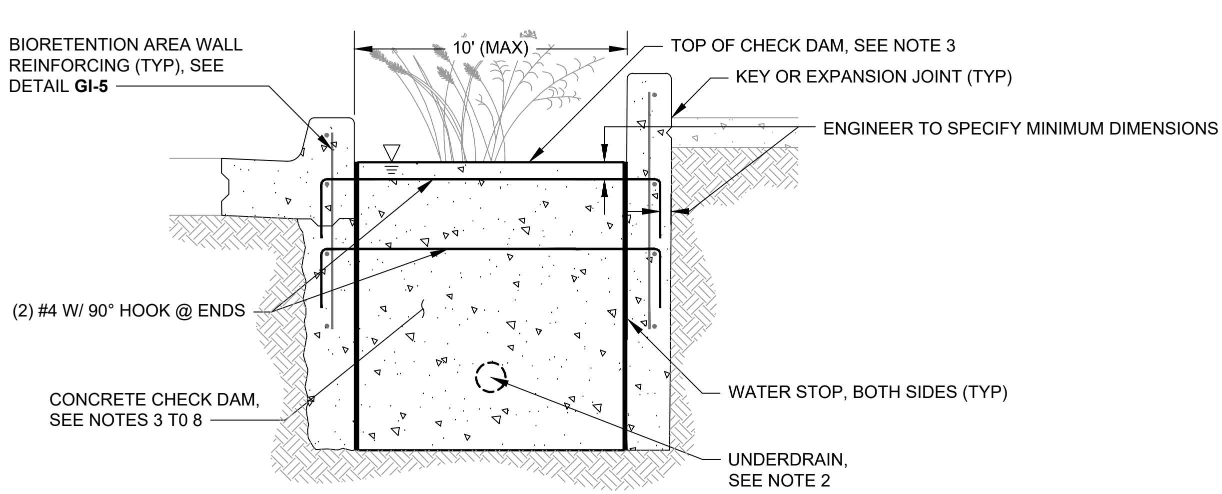
SCALE: NOT TO SCALE

DATE: MAY 11, 2018 REVISED: JUNE 11, 2019

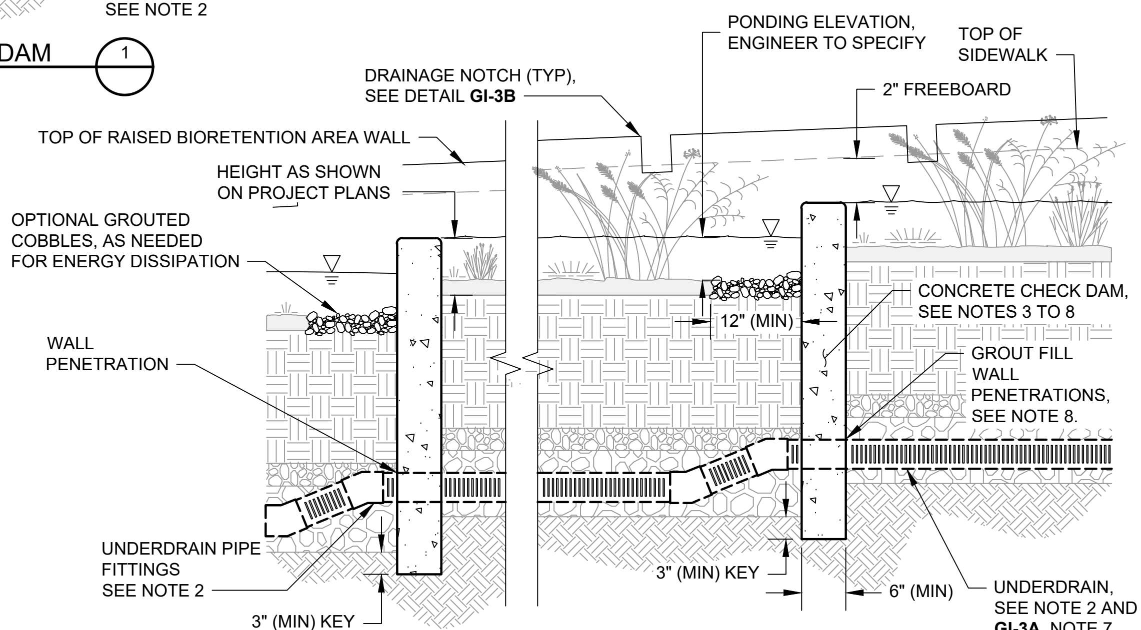
DRAWN BY: K. K. REVISED BY: E. F.

CHECKED BY: A. R.

GI-6C



SECTION - CONCRETE CHECK DAM (1)



PROFILE - CONCRETE CHECK DAM (2)

NOTES:

1. REFER TO **GI-1** NOTES FOR GUIDELINES AND CHECKLIST.
2. UNDERDRAIN TO PASS THROUGH CHECK DAM IN NON-PERFORATED PIPE. PIPE FITTINGS SHALL BE USED TO ACCOMMODATE CHANGES IN GRADE, AS NEEDED.
3. HEIGHT AND SPACING OF CHECK DAMS SHALL BE ESTABLISHED BASED ON THE PONDING DEPTH REQUIRED TO MEET PROJECT HYDROLOGIC PERFORMANCE GOALS AND THE MAXIMUM DESIRED DROP FROM THE SURROUNDING GRADE TO THE FACILITY BOTTOM.
4. ALL MATERIAL AND WORKMANSHIP FOR CHECK DAM ASSEMBLY SHALL CONFORM TO LOCAL JURISDICTION STANDARD SPECIFICATIONS.
5. CONCRETE CHECK DAM SHALL BE CONTINUOUS (NO JOINTS) AND REINFORCED WITH #4 BAR, PLACED AT 18" ON CENTER, EACH WAY.
6. CONCRETE CHECK DAM SHALL BE DESIGNED BY THE ENGINEER AND MEET STRUCTURAL REQUIREMENTS FOR LATERAL BRACING WHEN USED AS LATERAL BRACING.
7. TOP OF CHECK DAM TO BE LEVEL WITH CREST ELEVATION MATCHING PONDING ELEVATION UNLESS NOTCH SIZED TO CONVEY DESIGN FLOWS PROVIDED.
8. GROUT ALL PENETRATIONS, CRACKS, SEAMS, AND JOINTS WITH CLASS "C" MORTAR.

NOT FOR CONSTRUCTION

BIORETENTION COMPONENTS: CHECK DAM DETAIL

GREEN INFRASTRUCTURE EXAMPLE DETAILS

ALAMEDA COUNTYWIDE CLEAN WATER PROGRAM

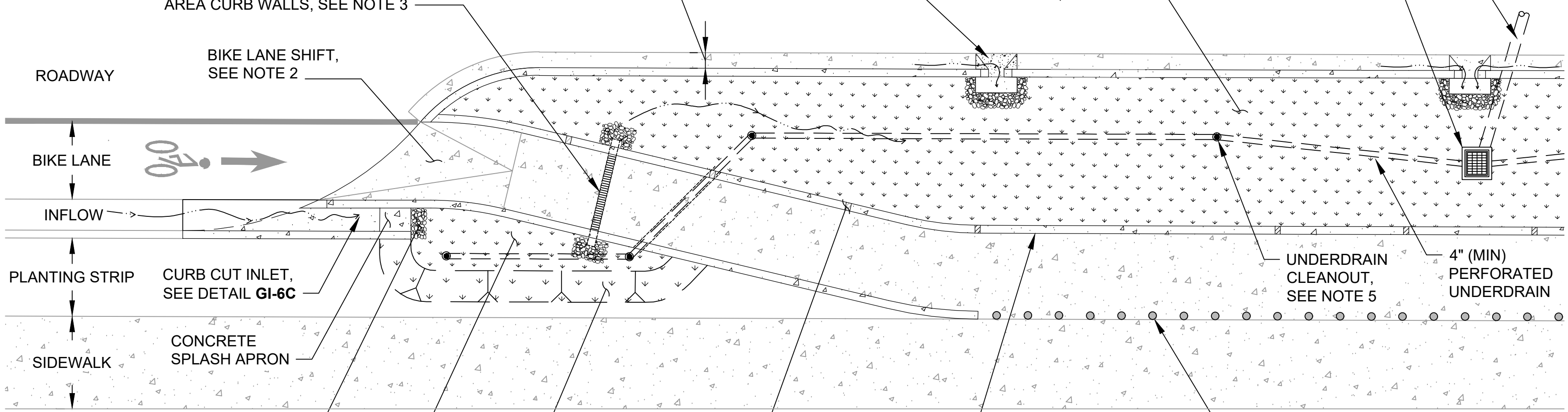
SCALE: NOT TO SCALE

DATE: MAY 11, 2018 REVISED: JUNE 11, 2019

DRAWN BY: K. K. REVISED BY: E. F.

CHECKED BY: A. R.

GI-7



NOTES:

1. REFER TO **GI-1** NOTES FOR GUIDELINES AND CHECKLIST.
2. RAMP BIKE LANE UP ONTO BULBOUT AND SHIFT LANE OVER. MAXIMUM 1:5 HORIZONTAL TRANSITION RATE. TRANSITION GEOMETRY SHALL CONFORM TO LOCAL JURISDICTION STANDARDS.
3. HYDRAULIC CONNECTION OF SEPARATED BIORETENTION AREAS PROVIDED BY TRENCH DRAINS. ENGINEER TO SPECIFY, FOLLOWING FLOW AND STRUCTURAL REQUIREMENTS.
4. LAY OUT DRAINAGE NOTCHES AS APPLICABLE TO PREVENT PONDING BEHIND BIORETENTION AREA WALL WITH 5' MAXIMUM SPACING BETWEEN NOTCHES.
5. PROVIDE ONE UNDERDRAIN CLEANOUT PER BIORETENTION AREA (MIN). CLEANOUT REQUIRED AT UPSTREAM END AND PIPE ANGLE POINTS EXCEEDING 45 DEGREES. LONGITUDINAL SLOPE OF PIPE SHALL BE 0.5% (MIN). PIPE SLEEVES REQUIRED FOR UNDERDRAINS TRANSITIONING BETWEEN BIORETENTION AREAS.
6. DRAWING GI-XX MODIFIED FROM THE BASMAA URBAN GREENING BAY AREA TYPICAL GI DETAILS FIGURE C-1.4.

NOT FOR CONSTRUCTION

clean water PROGRAM	BIORETENTION AREA: WITH BIKE LANE PLAN VIEW	
GREEN INFRASTRUCTURE EXAMPLE DETAILS ALAMEDA COUNTYWIDE CLEAN WATER PROGRAM	SCALE: NOT TO SCALE DATE: MAY 11, 2018 REVISED: JUNE 11, 2019 DRAWN BY: K. K. REVISED BY: E. F. CHECKED BY: A. R.	GI-8

M.2 WORKSHEET FOR IDENTIFYING GI OPPORTUNITIES

Worksheet for Identifying Green Infrastructure Potential in Municipal Capital Improvement Program Projects

This worksheet provides a series of checklists to walk agency staff through the process of reviewing capital improvement program (CIP) projects for green infrastructure (GI) developed by the Bay Area Municipal Stormwater Management Agencies Association (BASMAA), in its Guidance for Identifying Green Infrastructure Potential in Municipal Capital Improvement Program Projects. The BASMAA guidance is included as Appendix A. This worksheet includes three parts:

- Part 1: Initial Screening
- Part 2: Assessment of Green Infrastructure Potential of a Project
- Part 3: Documentation of Results

Part 1: Initial Screening

Part 1 of this worksheet corresponds to the BASMAA guidance document's Part 1, Initial Screening.

Step 1.1 Screen out projects by project type

1.1.a Obtain an editable electronic file that shows the agency's CIP list in tabular format.
1.1.b Add a new column to the table, with the heading "Screened out from GI Potential Review".
1.1.c For each project that meets one of the descriptions provided below, enter the words "Project Type" in the new column of the CIP list.
1.1.d After the words "Project Type", enter the number of the applicable project type. For example, if a project is screened out because it has no exterior work, enter "Project Type 1".

Types of Projects with No GI Potential (from Attachment 1 of the BASMAA guidance)

Project Type No.	*Description*
1	Projects with no exterior work, such as interior remodels
2	Projects involving exterior building upgrades or equipment, such as HVAC, solar panels, window replacement, roof repairs and maintenance
3	Projects related to development and/or continued funding of municipal programs or related organizations
4	Projects related to technical studies, mapping, aerial photography, surveying, database development/upgrades, monitoring, training, or update of standard specs and details
5	Construction of new streetlights, traffic signals or communication facilities
6	Minor bridge and culvert repairs/replacement
7	Non-stormwater utility projects, such as sewer or water main repairs/replacement, utility undergrounding, treatment plant upgrades
8	Equipment purchase or maintenance (including vehicles, street or park furniture, equipment for sports fields and golf courses, etc.)
9	Irrigation system installation, upgrades or repairs

Step 1.2 Screen out projects consisting of maintenance or minor construction work orders

1.2.a Using the electronic file of the table of CIP projects, for each project that meets the description shown below, enter "Maintenance/Minor Construction" in the new column that was added in Step 1.1.

Description
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.

Step 1.3 Screen out projects that are too early to assess

1.3.a Using the editable electronic file of the table of CIP projects, for each project that meets one of the descriptions provided below, enter the words "Too Early" in the new column that was added in Step 1.1.

1.3.b After the words "Too Early", enter the number of the applicable description. For example, if a project is screened out because there is not yet enough information to assess the project for green infrastructure potential, enter "Too Early 1".[1]

"Too Early" No.	*Description*
1	There is not yet enough information to assess the project for green infrastructure potential
2	The project is not scheduled to begin design within the permit term (January 2016 – December 2020)
3	The project is scheduled to begin within the permit term, but it has not yet moved forward to conceptual design

Step 1.4 Screen out projects that are too late to change

1.4.a Using the editable electronic file of the table of CIP projects, for each project that meets one of the descriptions provided below, enter the words "Too Late" in the new column that was added in Step 1.1.

1.4.b After the words "Too Late", enter the number of the applicable description. For example, if a project is under construction, enter "Too Late 1".

"Too Late" No.	*Description*
1	The project is under construction
2	The project has moved to a stage of design in which changes cannot be made[2]

Part 2: Assessment of Green Infrastructure Potential

Part 2 of this worksheet corresponds to the BASMAA guidance document's Part 2, Assessment of GI Potential.

Step 2.0 Identify projects that already include GI or low impact development (LID) treatment

2.0.a Review the projects that were not screened out to identify any "Regulated Projects" as defined in Provision C.3.b. of the reissued Municipal Regional Stormwater Permit (MRP 2). This information may be in the project files, or you may use the Clean Water Program's Stormwater Requirements Checklist to make the determination. C.3 Regulated Projects are required to include LID treatment measures, and are not considered further in Part 2 of this worksheet. See Part 3, paragraph 2, for reporting guidance.

2.0.b Review the remaining projects to identify any non-C.3 Regulated Projects that already include green infrastructure and are funded. This information is anticipated to be included in the project files. There is no further consideration in Part 2 of this worksheet for projects that already include green infrastructure and are funded. See Part 3, paragraph 3, for reporting guidance.

Step 2.1 Collect Information/Reconnaissance

2.1.a For each project that was not screened out in Part 1, or found to include GI or LID treatment in Step 2.0, obtain project plans that show:

- Proposed project layout
- Existing topography
- Proposed grading plan (if available)
- Existing and (if available) proposed storm drain inlets or catch basins and other drainage structures.

[1] Projects that are determined to be too early to assess will need to be reassessed during the next fiscal year's review.

[2] 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. Agency staff completing the form may need to consult with the project manager or other staff members with specific knowledge of each project to make these determinations.

2.1.b Complete a copy of the Step 2.1 Checklist for each project, to consider GI opportunities that may be associated with the following types of improvements, as applicable:

- 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)

Enter the Project Name:____

Checklist: Step 2.1 Project Information/Reconnaissance

Yes	*No*		
☐	☐	1.	Does the project include alterations to building drainage? If Yes, identify the locations of roof leaders and downspouts, and where they discharge or where they are connected to storm drains.
☐	☐	2.	Is the project a street or landscape project? If Yes, locate drainage structures, including storm drain inlets or catch basins. Identify and locate drainage pathways, including curb and gutter. Next, evaluate potential opportunities to substitute pervious pavements or grid pavements for impervious pavements. Refer to Sections 6.6 and 6.7 of the C.3 Technical Guidance to consider site suitability. Document the results of this evaluation in the space provided below. Check one: There ☐ is / ☐ is not potential to substitute pervious or grid pavements for impervious paving. Enter the basis for the above finding regarding pervious or grid pavements:
☐	☐	3.	Are there any landscaped areas and/or paved areas that are adjacent to, or down gradient from, roof leaders and downspouts identified in item 1, above, or the paved surfaces of a street/landscape project reviewed in item 2, above? ▶ If Yes, skip to Step 2.2. Note that the project area boundaries may be, but are not required to be, expanded to include potential green infrastructure facilities. ▶ If No, continue to item 4, below.
☐	☐	4.	Based on the results in item 2, above, is there is potential to substitute pervious pavements or grid pavements for impervious pavements? ▶ If Yes, skip to Step 2.3. ▶ If No, the project does not have GI potential. See Part 3, paragraph 5, for reporting guidance.

Step 2.2 Preliminary Sizing and Drainage Analysis

Complete a copy of the Step 2.2 Checklist for each project that continues to Step 2.2.

Checklist: Step 2.2 Preliminary Sizing and Drainage Analysis

1. Scan the landscaped areas and/or paved areas identified in Step 2.1, item 3, to consider their feasibility for LID facility locations. Factors that may influence feasibility include slope, size, and proximity to impervious surfaces that would contribute runoff. Document the results of this preliminary scan in the space provided below.

   In the space provided, list the landscaped areas and/or paved areas in order of apparent feasibility for LID:

Checklist: Step 2.2 Preliminary Sizing and Drainage Analysis

2. 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). Document the results of this evaluation in the space provided below.

   Runoff could be conveyed to the potential LID facility locations using (check all that apply):

   ☐ Sheet flow ☐ Valley gutters ☐ Trench drains ☐ Pipes ☐ Pump(s)

   ☐ Other (describe):

3. Delineate (roughly) the area of each potential LID facility location, and the drainage area tributary to each potential LID facility location. Typically, the delineation of a drainage area requires site reconnaissance, which may or may not include the use of a level to measure relative elevations. Use the blank columns below to enter the approximate areas. Values in the far right column will be automatically calculated.

Potential LID Facility Location Name	Potential LID Facility Location Area (sq.ft.)	Tributary Drainage Area (sq.ft.)	Facility Area Divided by Tributary Area
			0
			0
			0
			0

4. Compare the preliminary sizing factors (facility area/tributary area) for potential LID facility types, provided below, with the automatically-calculated values in the far right column of item 3, above. If the value in the table above is greater than or equal to a sizing factor listed below, there is potential to construct the applicable type of facility within the potential LID facility location. Note that these sizing factors are guidelines (not strict rules, but targets).

   - Sizing factor $\geq$ 0.5 for dispersal to landscape or pervious pavement[3], which allows for a maximum 2:1 ratio of impervious area to pervious area.
   - Sizing factor $\geq$ 0.04 for bioretention
   - Sizing factor $\geq$ 0.004 (or less) for proprietary tree-box-type biofilters

   In the space provided below, check the boxes for the LID facility types that may be feasible to construct in the potential LID facility locations, based on the above sizing factors (check all that apply):

   ☐ Dispersal to landscape or pervious pavement ☐ Bioretention ☐ Proprietary tree-box-type biofilters

   ☐ None of the above

   ▶ If the bioretention or tree-box-type biofilters boxes are checked, continue to item 5, below If not, skip to item 6.

[3] 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.

Checklist: Step 2.2 Preliminary Sizing and Drainage Analysis

5. For bioretention facilities requiring underdrains and tree-box-type biofilters, note whether 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). Indicate below whether this condition is met.

☐ There is potential to connect an underdrain beneath the facility checked in 2d to the storm drain.

▶ Skip to Step 2.3.

☐ There is NOT potential to connect an underdrain beneath the facility checked in 2d to the storm drain, but there IS potential to construct a bioretention facility without an underdrain.

▶ Skip to Step 2.3.

☐ There is NOT potential to connect an underdrain beneath the facility checked in 2d to the storm drain, and there is NOT potential to construct a facility without an underdrain.

▶ Continue to item 6, below.

6. Review the responses in items 5 and 6, above, and check all that apply:

☐ In item 5, the box for "Dispersal to landscape or pervious pavement" was checked.

▶ Continue to Step 2.3.

☐ In item 5, the box for "None of the above" was checked.

▶ The project does not have GI potential. See Part 3, paragraph 5, for reporting guidance.

☐ In item 6, the third box was checked (no potential for an underdrain, and no potential facility without an underdrain).

▶ The project does not have GI potential. See Part 3, paragraph 5, for reporting guidance.

Step 2.3 Barriers and Conflicts

Complete a copy of the Step 2.3 Checklist for each project that continues to Step 2.3. 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.

Checklist: Step 2.3 Barriers and Conflicts

Yes	*No*	
☐	☐	1. Are there confirmed or potential conflicts with subsurface utilities?
☐	☐	2. Are there known or potential issues with property ownership, or need for acquisition or easements?
☐	☐	3. Is there a lack of water supply for irrigation?
☐	☐	4. Is green infrastructure well integrated with the rest of the project? (If no, explain in the space provided)

Step 2.4 Project Budget and Schedule

Complete a copy of the Step 2.4 Checklist for each project that continues to Step 2.4.

Checklist: Step 2.4 Project Budget and Schedule

1. In the space provided below, list the sources of funding that may be available to include the design and construction of green infrastructure in the project, and note the likelihood for each potential funding source to become available.

Potential Funding Source	*Discuss Likelihood of Funding Source Becoming Available*

2. Would the inclusion of GI in the project require acquisition of right of way, in addition to that required for the project without the inclusion of GI? ☐ Yes ☐ No ☐ To be determined (TBD)

   If "Yes" or "TBD", please explain:

3. In the space provided below, list the sources of funding that may be available to include maintenance of green infrastructure in the project, and note the likelihood for each potential funding source to become available.

Potential Funding Source	*Discuss Likelihood of Funding Source Becoming Available*

4. Are there 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? ☐ Yes ☐ No ☐ TBD

   If "Yes" or "TBD", please explain:

5. In the space provided below, provide a discussion of 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 2.5 Assessment of Green Infrastructure Potential

Complete a copy of the Step 2.5 Checklist for each project that continues to Step 2.5.

Checklist: Step 2.5 Assessment of Green Infrastructure Potential

1. Using the table format provided below, describe potential opportunities for specific ancillary benefits of green infrastructure to enhance this particular project and the surrounding area.

Ancillary GI Benefit	*Potential for GI Benefits to Enhance this Project and Surrounding Area*
Improvement of quality of public spaces	
Provision of parks and play areas	
Provision of habitat	
Enhancement of urban forestry	
Mitigation of heat island effects	
Aesthetic improvements	
Other (describe):	

2. Review the project information entered in Steps 2.3 and 2.4, and the benefits identified in item 1, above. Based on this information, 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?

   ☐ Yes ☐ No ☐ To be determined (TBD)

   If "No" or "TBD", please explain:

3. In the space provided below, identify any additional conditions that would have to be met for green infrastructure elements to be constructed consequent with the project:

Part 3: Documentation of Results

The following paragraphs provide guidance for documenting and reporting on the process of reviewing CIP projects for green infrastructure potential. Paragraph 1, below, is from Part 1 of the BASMAA guidance document; Paragraphs 2 through 5 are from Part 2 of the BASMAA guidance document.

1. **Documentation of Each Project that Was Screened Out in the Part 1 Process.** 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.
2. **Reporting of Each C.3 Regulated Project.** 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.
3. **Reporting of Each Project that Already Includes Green Infrastructure and Is Funded.** 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.

4. **Reporting of Each Project that May Have Green Infrastructure Potential Pending Further Assessment of Feasibility, Incremental Cost, and Availability of Funding.** 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.
5. **Reporting of Each Project that Does Not Have Green Infrastructure Potential.** 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.

Name of staff person completing the worksheet:____

Signature: ____________________________ Date: ________________

Appendix A

BASMAA's

Guidance for Identifying Green Infrastructure Potential

in Municipal Capital Improvement Program Projects

May 6, 2016

M.3 GUIDANCE FOR SIZING GI FACILITIES IN STREET PROJECTS

Guidance available on the Clean Water Program site under Resources

https://cleanwaterprogram.org/download/basmaa-green-infrastructure-facility-sizing-for-non-regulated-street-projects-2017-12-13/

M.4 INTER-DEPARTMENTAL MAINTENANCE NOTIFICATION

Template Update Notes:

1. Insert municipality logo,
2. Customize and populate information as necessary, and
3. Add content to Exhibits A through D.
4. Review and update highlighted division names and titles.

INSERT MUNICIPALITY LOGO

Maintenance Notification

REGARDING OPERATION AND MAINTENANCE OF STORMWATER TREATMENT MEASURE(S)

This maintenance notification outlines the details of the operation and maintenance of the stormwater treatment measures and/or flow duration controls (collectively termed "stormwater controls") installed at **[Insert Property Location Address]** and identifies the roles of **[Insert Division/Departments Responsible for Compliance Oversight], [Insert Division/Departments Responsible for Maintenance]** and **[Insert Division Responsible for Location*]** Divisions regarding maintenance requirements.

OPERATION AND MAINTENANCE OF STORMWATER TREATMENT MEASURE(S)

To support proper operation of the stormwater controls listed in **Table 1** and referenced in Exhibit A – Site Plan, inspections and routine maintenance activities will be conducted by:

- ☐ **[Insert Division/Departement]** staff. Contact: **[Insert First and Last Name, Phone Number, Email Address]**
- ☐ **[Insert Division/Departement]** staff. Contact: **[Insert First and Last Name, Phone Number, Email Address]**
- ☐ Other: ____________________________
  Contact telephone number & e-mail: ____________________________

Funding for maintenance of the stormwater controls shall come from one of the following:

- ☐ **[Insert Division/Departement]**
- ☐ Allocated in the annual budget for ____________________________
- ☐ One-time maintenance fund from the developer
- ☐ Other: ____________________________

Estimated start date maintenance required: ____________________________

As required in the Municipal Regional Stormwater NPDES Permit, **[Insert Division/Departement]** or designee will conduct periodic inspections of the stormwater controls to verify proper operation and maintenance. As necessary, **[Insert Division/Departement]** will provide technical guidance concerning the functioning of the stormwater controls. Design details of the treatment measures and/or flow duration controls are provided in Exhibit B. Inspection/maintenance details follow:

INSPECTION AND REPORTING: As delineated in the Maintenance Plan, Exhibit C, the stormwater controls will be inspected by either **[Insert Division/Departement]** staff or a qualified contractor, as specified above, to determine that the stormwater controls are functioning properly and/or to note if maintenance is required. The inspection report forms provided in Exhibit D will be used for conducting inspections and are specific to the project GSI types. To meet the Municipal Regional Stormwater NPDES Permit requirements, **[Insert Division/Departement]** or designee will conduct periodic inspections of the stormwater controls to verify that they are being maintained in working order. As required, inspection results will be reported to the Regional Water Quality Control Board in the Annual NPDES Permit Report.

Exhibit A - Site Plan

Exhibit B - Design Details

Exhibit C - Maintenance Plan

Exhibit D - Inspection Report Form

Table 1: Stormwater Control Information

The following stormwater controls are located on the property identified above and are subject to the Maintenance Notification:

Number of Each Type of Stormwater Control	Type of Stormwater Control

_______________________ Date_________
[Insert Division/Departments Responsible for Compliance Oversight] Manager
____

_______________________ Date_________
[Insert Division/Departments Responsible for Design/Construction] Manager
____

_______________________ Date_________
[Insert Division/Departments Responsible for Maintenance] Manager
____

_______________________ Date_________
[Insert Division/Departments Responsible for Maintenance] Manager
____

_______________________ Date_________
Deputy Director of **[Insert Division/Departments Responsible for Maintenance]**
____

Return signed document to the **[Insert Division/Departments Responsible for Compliance Oversight]**

APPENDIX N. RAINWATER HARVESTING

For a rainwater harvesting system to fully meet Provision C.3 stormwater treatment requirements, there must be sufficient demand to use 80 percent of the average annual rainfall runoff (C.3.d amount of runoff"), as specified in MRP Provision C.3.d. In order to size the cistern (or other storage device) to achieve the appropriate combination of drawdown time and cistern volume to harvest and use the C.3.d amount of runoff, project designers may refer to the sizing curves presented in this appendix, which are from Appendix F of the 2011 report, "Harvest and Use, Infiltration and Evapotranspiration Feasibility/Infeasibility Criteria Report" (BASMAA 2011).[1]

This appendix includes the following excerpts from the 2011 report:

- Map of Alameda County Precipitation Polygons for applicable precipitation gages.
- Table 8: Required Cistern Volume and Demand per Acre of Impervious Area to Achieve 80% Capture with a 48-Hour Drawdown Time (by precipitation gage)
- Table 9: Required Cistern Volume and Demand per Acre of Impervious Area to Achieve 80% Capture with the Longer Drawdown Time Allowable (Minimum Demand) for Cistern of 50,000 Gallons or Less (by precipitation gage)
- Table 9: Required Cistern Volume and Demand per Acre of Impervious Area to Achieve 80% Capture with the Longer Drawdown Time Allowable (Minimum Demand) for Cistern of 50,000 Gallons or Less (by precipitation gage)
    - Figure F-1: Berkely
    - Figure F-3: Dublin
    - Figure F-4: Hayward
    - Figure F-8: Palo Alto
    - Figure F-11: San Jose

[1] This report is available on the Clean Water Program's website (www.cleanwaterprogram.org – click on "Resources", then "Development" and scroll to "Feasibility Infeasibility Criteria Report").

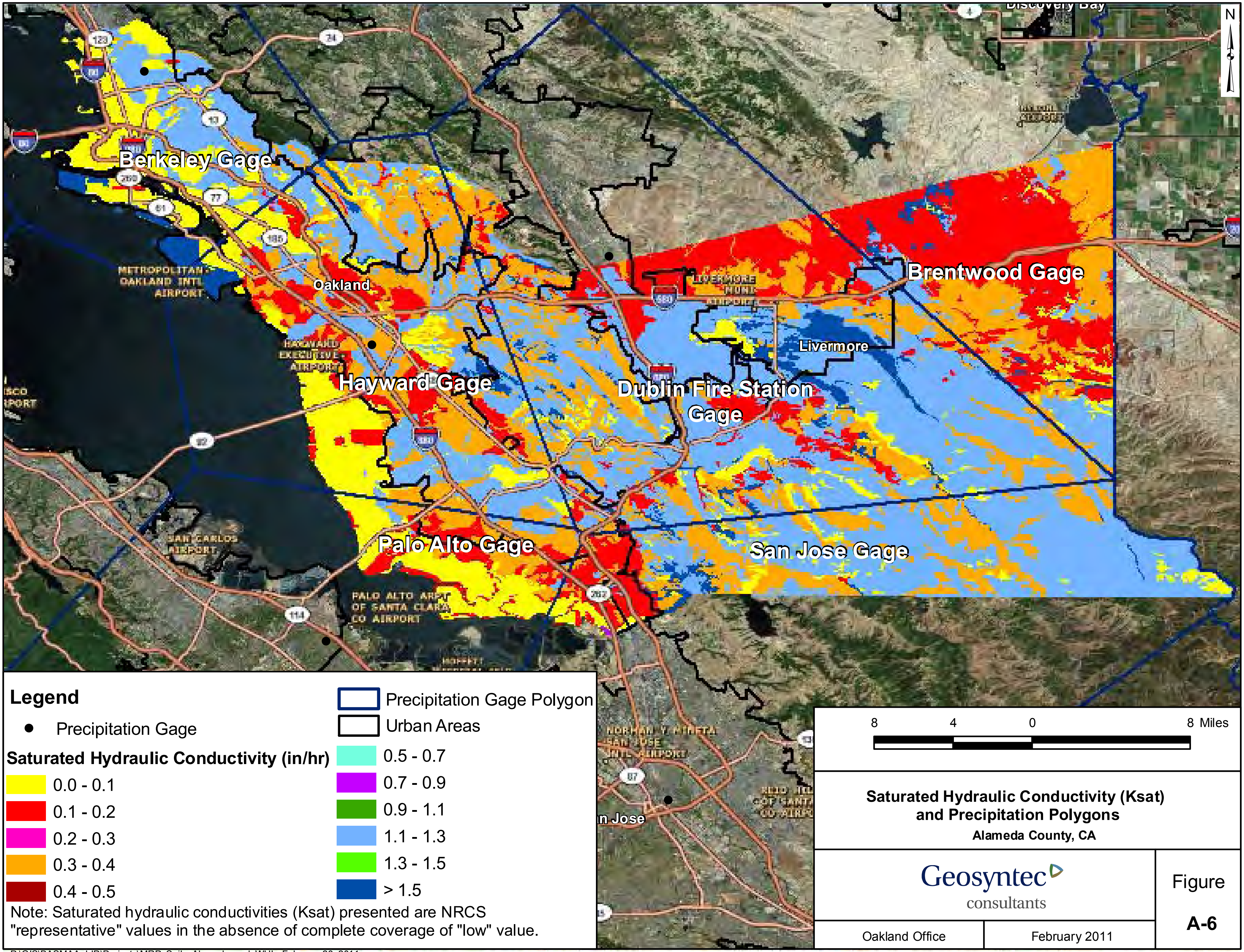


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Table 8: Required Cistern Volume and Demand per Acre of Impervious Area to Achieve 80% Capture with a 48-hour Drawdown Time

Rain Gauge	Drawdown Time (hr.)	Required Cistern Size (gallons)	Required Demand (gal/day)
Berkeley	48	23,000	11,500
Brentwood	48	19,000	9,500
Dublin	48	21,000	10,500
Hayward	48	23,500	11,750
Lake Solano	48	29,000	14,500
Martinez	48	23,000	11,500
Morgan Hill	48	25,500	12,750
Palo Alto	48	16,500	8,250
San Francisco	48	20,000	10,000
San Francisco Oceanside	48	19,000	9,500
San Jose	48	15,000	7,500

If a longer drawdown time (and lower minimum demand) is desired, Table 9 includes the maximum drawdown time allowable to achieve 80 percent capture for a cistern sized at 50,000 gallons or less per acre of impervious area, along with the required cistern sizes and daily demands.

Table 9: Required Cistern Volume and Demand per Acre of Impervious Area to Achieve 80% Capture with the Longer Drawdown Time Allowable (Minimum Demand) for Cistern of 50,000 Gallons or Less

Rain Gauge	Drawdown Time (hr.)	Required Cistern Size (gallons)	Required Demand (gal/day)
Berkeley	180	44,000	5,900
Brentwood	240	42,000	4,200
Dublin	240	41,000	4,100
Hayward	240	47,500	4,800
Lake Solano	120	45,000	9,000
Martinez	180	44,000	5,900
Morgan Hill	180	49,000	6,500
Palo Alto	360	44,000	2,900
San Francisco	240	45,500	4,600
San Francisco Oceanside	240	43,000	4,300
San Jose	480	48,000	2,400

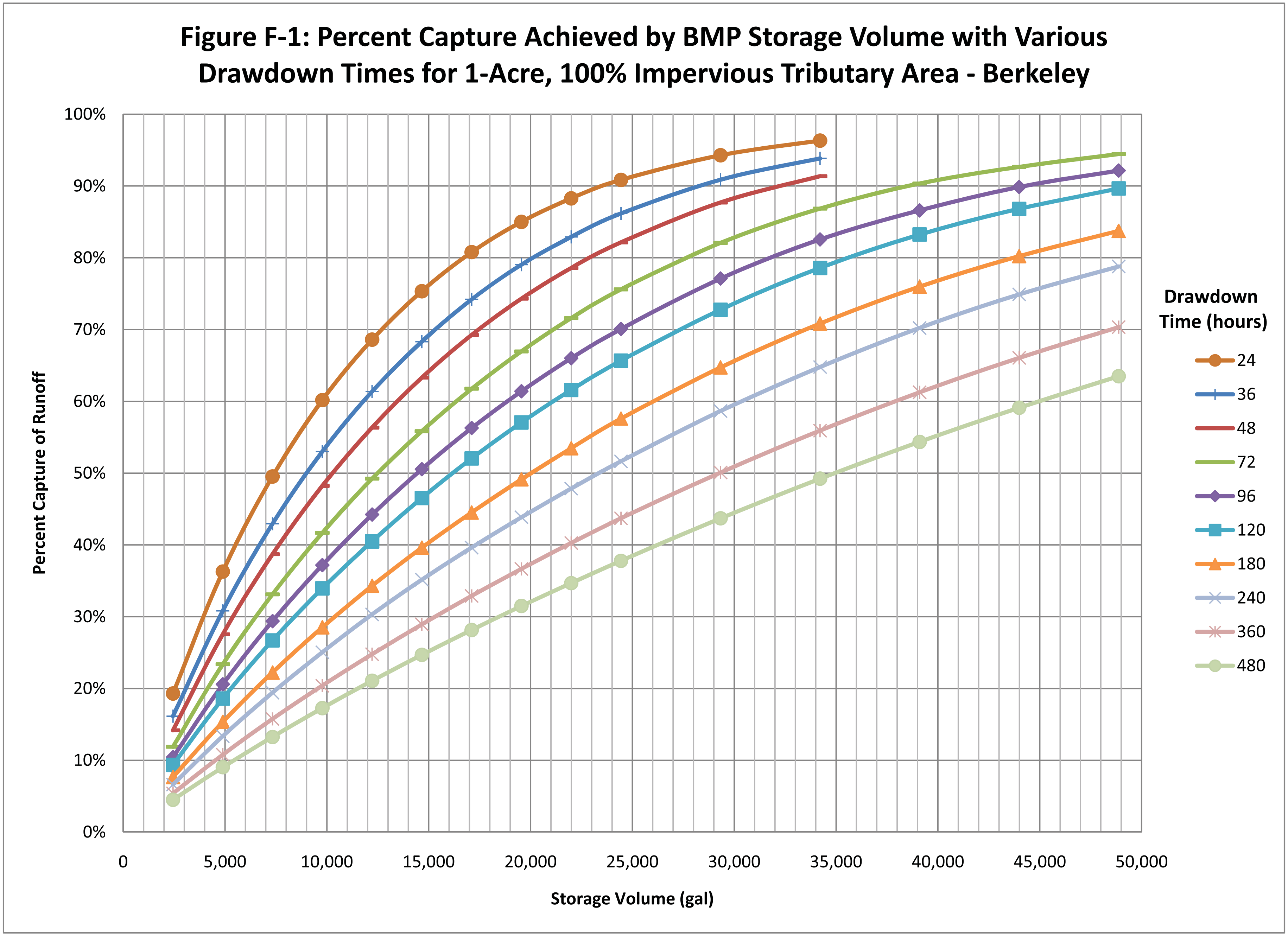


Figure F-1: Percent Capture Achieved by BMP Storage Volume with Various Drawdown Times for 1-Acre, 100% Impervious Tributary Area - Berkeley
Percent Capture of Runoff
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0
5,000
10,000
15,000
20,000
25,000
30,000
35,000
40,000
45,000
50,000
Storage Volume (gal)
Drawdown Time (hours)
24
36
48
72
96
120
180
240
360
480

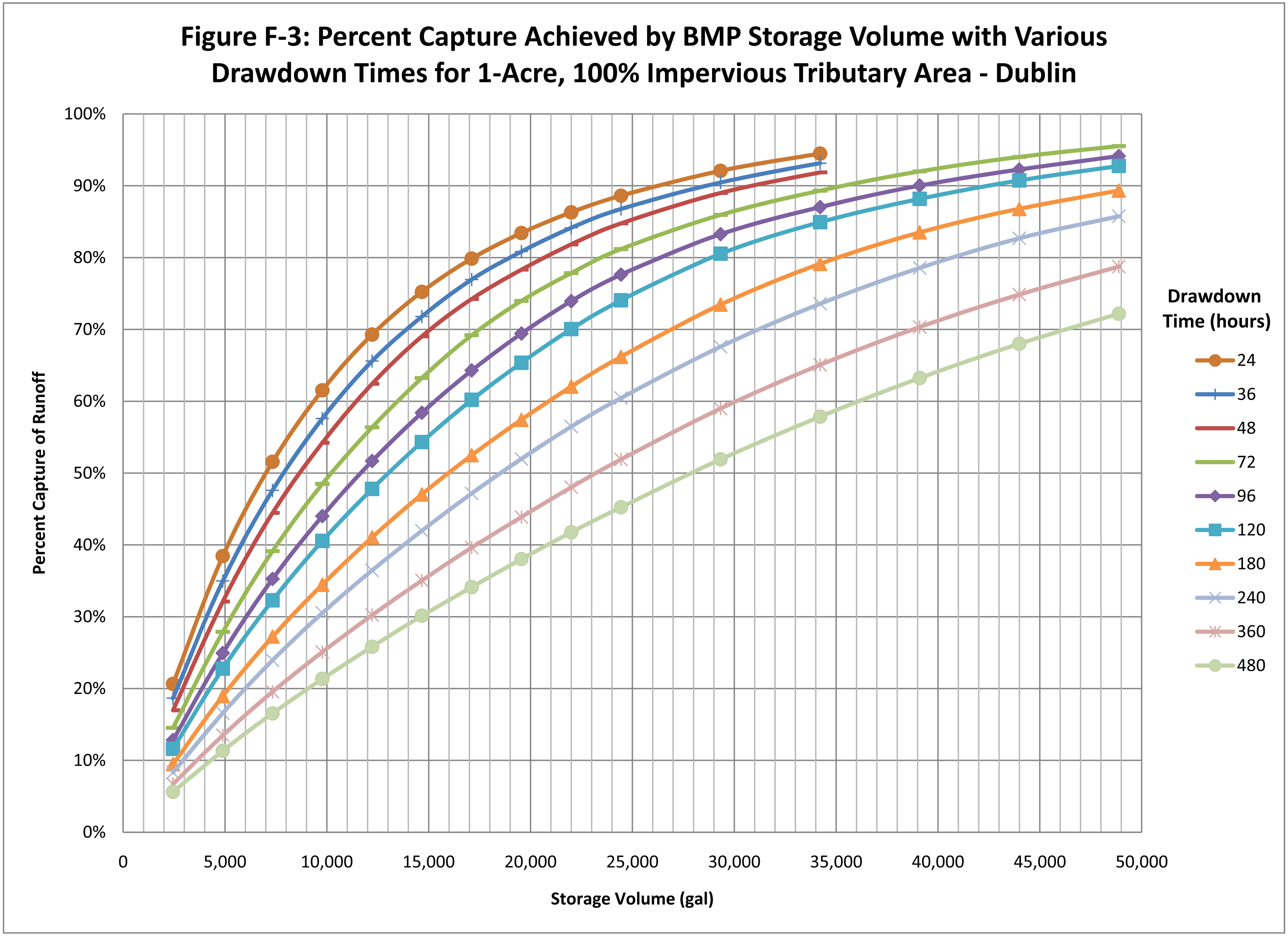


Figure F-3: Percent Capture Achieved by BMP Storage Volume with Various Drawdown Times for 1-Acre, 100% Impervious Tributary Area - Dublin
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Percent Capture of Runoff
0
5,000
10,000
15,000
20,000
25,000
30,000
35,000
40,000
45,000
50,000
Storage Volume (gal)
Drawdown Time (hours)
24
36
48
72
96
120
180
240
360
480

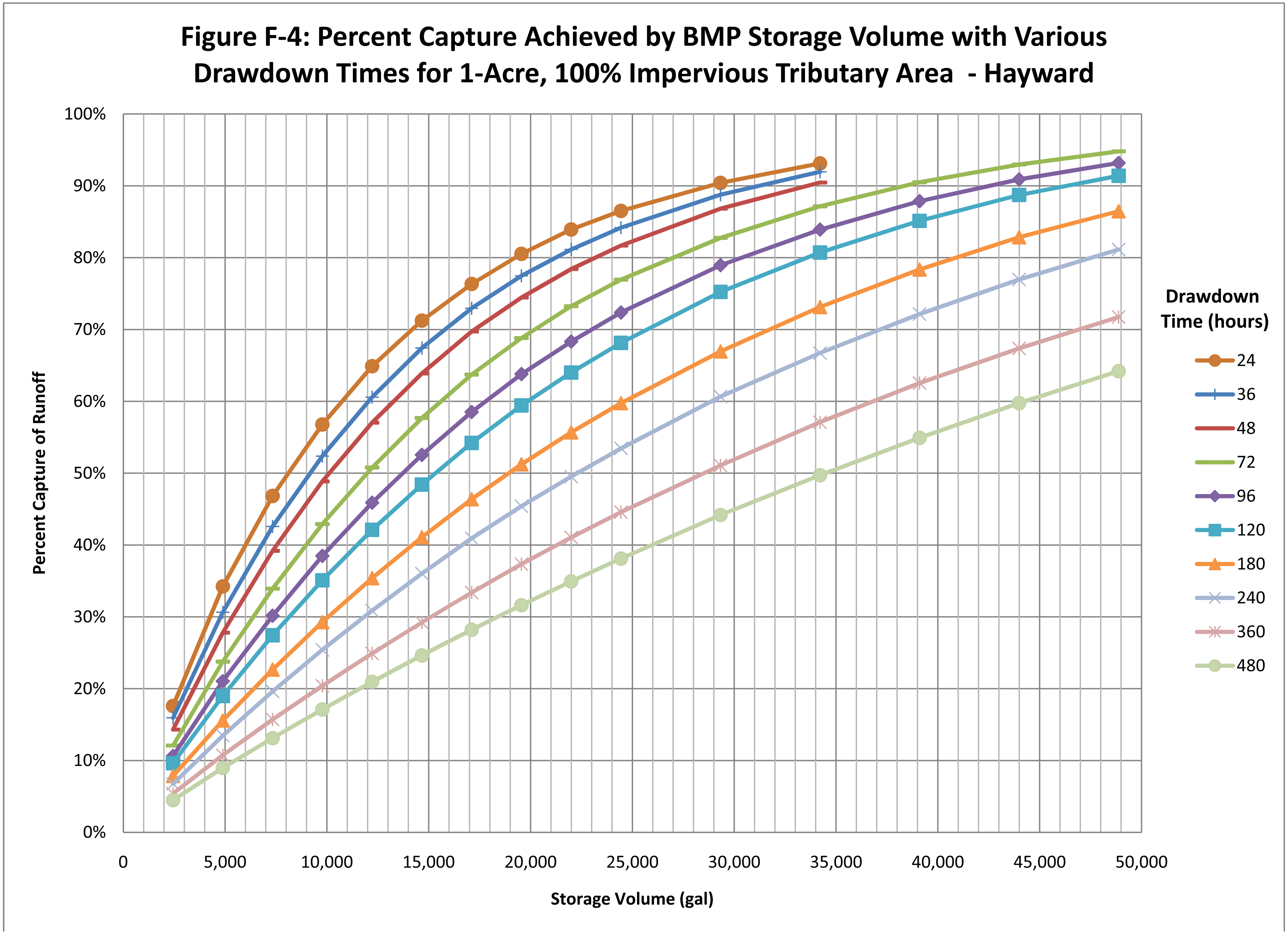


Figure F-4: Percent Capture Achieved by BMP Storage Volume with Various Drawdown Times for 1-Acre, 100% Impervious Tributary Area - Hayward
Percent Capture of Runoff
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0
5,000
10,000
15,000
20,000
25,000
30,000
35,000
40,000
45,000
50,000
Storage Volume (gal)
Drawdown Time (hours)
24
36
48
72
96
120
180
240
360
480

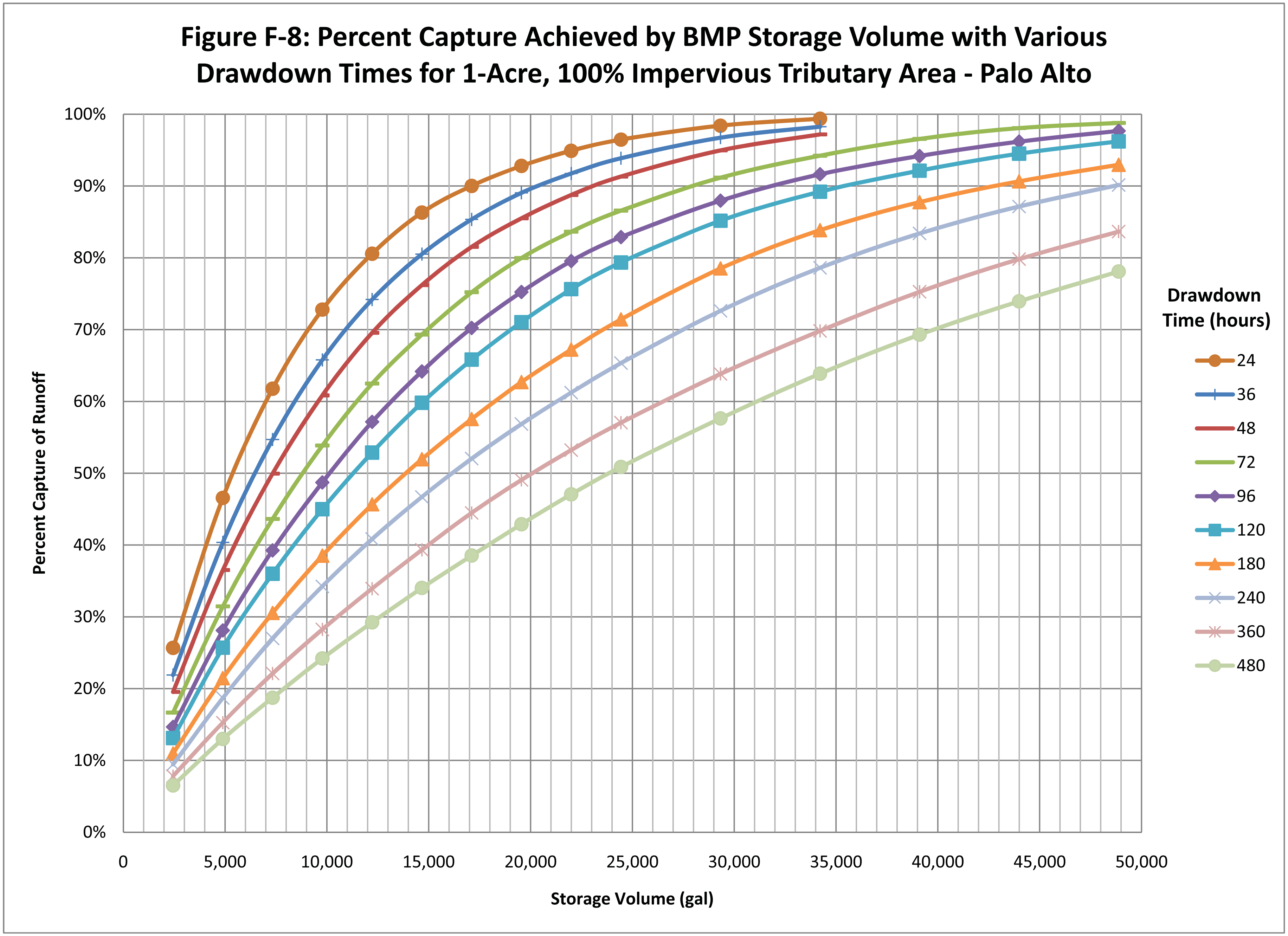
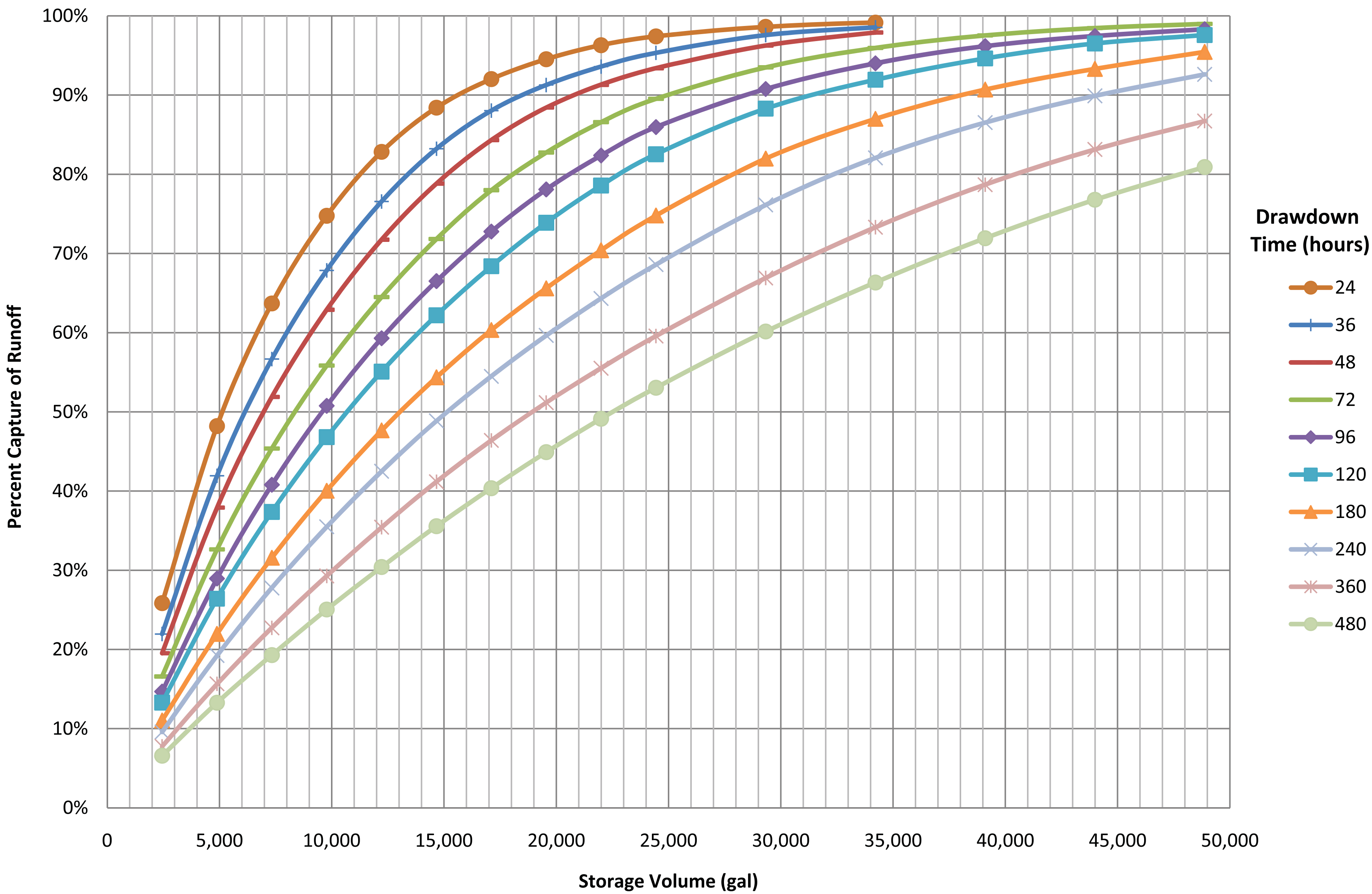


Figure F-8: Percent Capture Achieved by BMP Storage Volume with Various Drawdown Times for 1-Acre, 100% Impervious Tributary Area - Palo Alto
Percent Capture of Runoff
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Storage Volume (gal)
0
5,000
10,000
15,000
20,000
25,000
30,000
35,000
40,000
45,000
50,000
Drawdown Time (hours)
24
36
48
72
96
120
180
240
360
480

Figure F-11: Percent Capture Achieved by BMP Storage Volume with Various Drawdown Times for 1-Acre, 100% Impervious Tributary Area - San Jose



APPENDIX O. STORMWATER REQUIREMENTS CHECKLIST

I. Applicability C.3 Stormwater Requirements

All projects must complete Section I.

I.A. Enter Project Data *(Data for "C.3 Regulated Projects," will be reported in the municipality's stormwater Annual Report.)*

I.A.1 Project Name:			
I.A.2 Project Address (include cross street)			
I.A.3 Project APN(s)			
I.A.4 Project Watershed[1]			
I.A.5 Applicant Name			
I.A.6 Date Submitted			
I.A.7 Applicant Address			
I.A.8 Applicant Phone		I.A.9 Applicant E-mail Address	
I.A.10 Development Type (check all that apply)	☐ Residential ☐Commercial ☐ Industrial ☐ Mixed-Use ☐ Streets, Roads, etc. ☐ Detached Single Family Home ☐ Redevelopment[2]		
I.A.11 Project Description (Include any past or future phase of the project)			
I.A.12 Total Project Area		I.A.13 % Slope on Site	
I.A.14 Total Land Disturbance Area (Include all areas to be cleared, excavated, graded, and borrow and stockpile areas)			

I.B. Is the project a "C.3 Regulated Project" per MRP Provision C.3.b or a Small Project per MRP Provision C.3.i

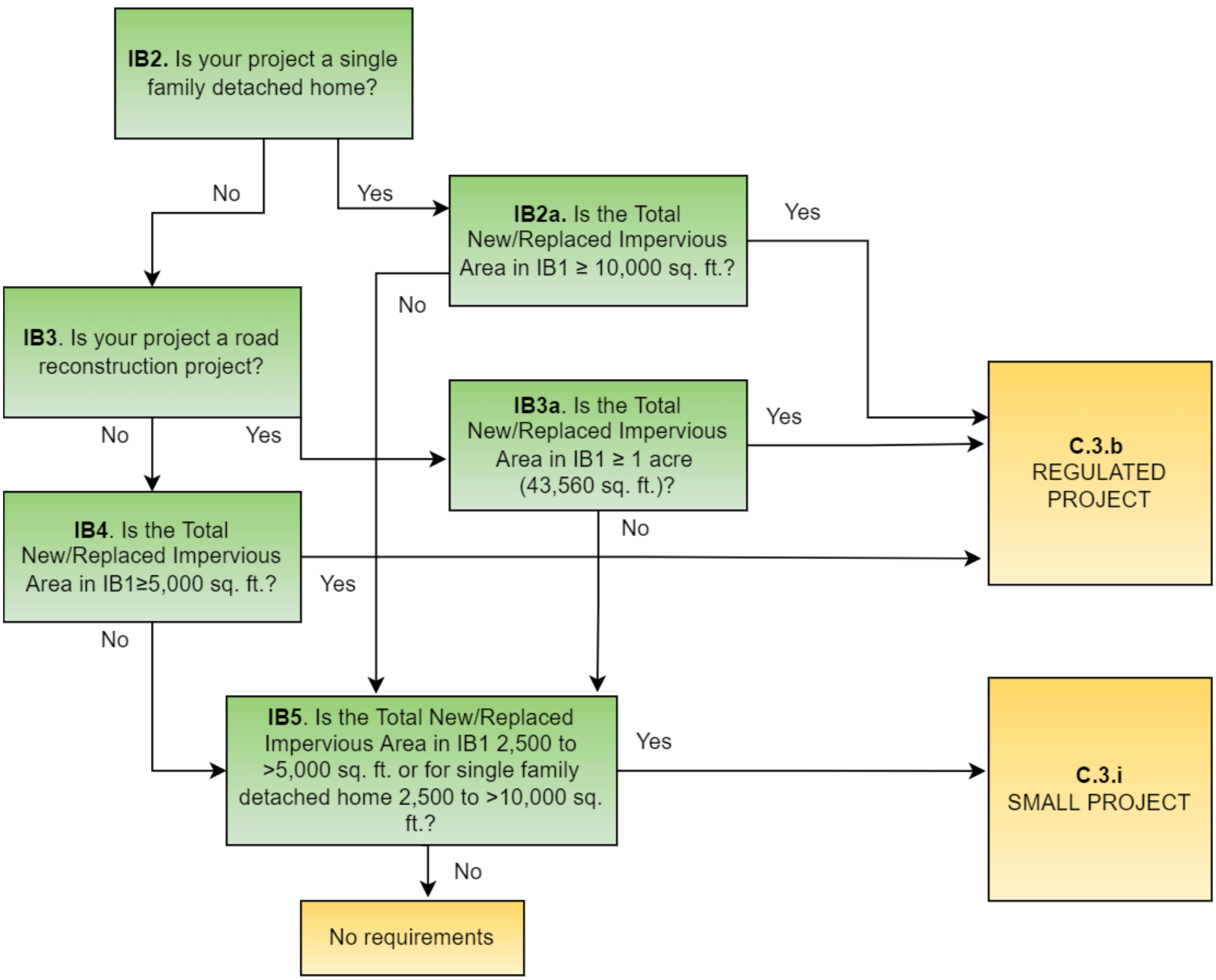
I.B.1 Complete the *Impervious and Pervious Surfaces Table*

	a	b	c	d
Type of Impervious Surface[3]	**Pre-Project Impervious Area (sq ft)**	**Existing Impervious Area to be Replaced (sq ft[4])**	**New Impervious Area to be Created (sq ft)**	**Post-Project Pervious Area (sq ft)**
a. Impervious roof area(s)[5]				**NA**
b. Impervious sidewalks, patios, paths, driveways[6]				
c. Uncovered impervious parking[7]				
d. Streets (public)				
e. Streets (private)				
Totals				

[1] Watershed is defined by the maps from the Alameda County Flood Control District at http://acfloodcontrol.org/resources/explore-watersheds
[2] As defined by MRP: creating, adding and/or replacing exterior existing impervious surface on a site where past development has occurred.
[3] A surface covering or pavement of a developed parcel of land that prevents the land's natural ability to absorb and infiltrate rainfall/stormwater.
[4] Replaced impervious area means any impervious area that is removed and replaced in kind or upgraded. See Chapter 2 of the *C.3 Technical Guidance.*
[5] Exclude green roofs.
[6] A gravel surface is an impervious surface, except when it is constructed as part of appropriately designed pervious pavement system.
[7] Uncovered parking includes top level of a parking structure unless drainage from the uncovered portion is connected to the sanitary sewer along with the covered portions of the parking structure.

Existing Impervious Area to remain in place		**NA**
Total New/Replaced Impervious Area *(sum columns b and c)*		

I.B. Is the project a "C.3 Regulated Project per MRP Provision C.3.b or a Small Project per MRP Provision C.3.i (cont'd)			
	Yes	No	NA
I.B.2 Is your project a single family detached home? If Yes go to I.B.2.a; if NO go to I.B.3	☐	☐	☐
I.B.2.a Is the Total New/Replaced Impervious Area in I.B.1 ≥10,000 sq ft? If YES, your project is a C.3.b Regulated Project. (See I.D). If NO go to I.B.5.	☐	☐	☐
I.B.3 Is your project a road reconstruction project? If YES go to I.B.3.a; if NO go to I.B.4	☐	☐	☐
I.B.3.a Is the Total New/Replaced Impervious Area in I.B.1 ≥1 acre (43,560 sq ft)? If YES, your project is a C.3.b Regulated Project. (See I.D)	☐	☐	☐
I.B.4 Is the Total New/Replaced Impervious Area in I.B.1 ≥5,000 sq ft? If YES, your project is a C.3.b Regulated Project. If NO go to I.B.5	☐	☐	☐
I.B.5 Is the Total New/Replaced Impervious Area in I.B.1 2,500 to >5,000 sq ft or for single family detached home 2,500 to >10,000 sq ft? If Yes, your project is a C.3.i Small Project.	☐	☐	☐



I.C. Pervious Pavement Systems			
I.C.1 Will your project install 3,000 sq ft or more of pervious pavement systems (not including private-use patios at residences)? If **YES, stormwater treatment system inspection requirements (C.3.h) apply.** (Municipal staff – add this site to your list of sites needing a final inspection at the end of construction and on-going O&M inspections.)	☐	☐	☐
I.D. Projects not regulated by C.3 If your project is not regulated by C.3.b or C.3.i you are not subject to stormwater treatment requirements, however you are encouraged to incorporate site design and source control measures. The municipality may determine that source controls and site design measures are required for your project, if so, you must complete Section II and if required by the municipality, complete Sections III.A and III.B.			
I.E. C.3.i Small Projects If your project is regulated by C.3.i you are considered a “Small Project” and must implement site design (See III.A) and source control requirements (See III.B). You are not required to implement stormwater treatment requirements. You must complete Sections II, III.A, and III.B.			
I.F. C.3.b Regulated Projects If your project is a C.3.b regulated project, the project must include appropriate site design measures and source controls AND hydraulically-sized stormwater treatment measures. Hydromodification management may also be required. Complete Sections II, III, and V.			

II. Applicability C.6 Stormwater Requirements

All projects must complete Section II.

	Yes	No
II.A Does the project disturb one acre or more of land? If YES you are required to obtain coverage under the State Construction Stormwater Permit, see https://www.waterboards.ca.gov/water_issues/programs/stormwater/construction.html. You must submit your WDID number and Stormwater Pollution Prevention Plan to the municipality before a building or grading permit will be issued. You do not need to complete Section IV.	☐	☐
II.B Does the project disturb less than one acre of land? If NO, you are subject to MRP C.6 requirements. Complete Section IV to identify best management practices (BMPs) that will be in the erosion control plan and implemented during construction.	☐	☐
II.C. Priority Inspection Factors	☐	☐
II.C.1 Is the project 1 acre or more?	☐	☐
II.C.2 Does the project require a grading permit?	☐	☐
II.C.3 Is the project adjacent to a creek or waterway?	☐	☐
II.C.4 Is the project in a municipally defined hillside development area or meet local hillside criteria?	☐	☐
II.C.5 Does the project site have a slope of >15% and disturb ≥ 5,000 sq ft?	☐	☐
II.C.6 Does the project involve demolition of a structure subject to the PCBs Building Demolition requirements? If yes the completion of the PCBs Building Material Demolition is required.	☐	☐
(Municipal staff – refer projects answering YES to any questions in section II.C to construction site inspection staff to be added to their list of projects that require stormwater inspections at least monthly during the wet season (October 1 through April 30) and other times of the year as appropriate.)		

III. Implementation of C.3 Stormwater Requirements

C.3.b Regulated Projects must complete all of Section III.
C.3.i Small Projects must complete Sections III.A and III.B
Projects not regulated by C.3 must complete Sections III.A and III.B if directed by the municipality.

III.A Select Appropriate Site Design Measures

C.3.b Regulated Projects must implement appropriate and feasible site design measures.
C.3.i Small Projects must implement at least one of site design measures listed in items a-f.
Projects not regulated by C.3 are encouraged to implement appropriate site design measures and those directed by the municipality.

Site Design Measure	Plan Sheet #	Yes	No
a. Direct roof runoff into cisterns or rain barrels and use rainwater for irrigation or other non-potable use.		☐	☐
b. Direct roof runoff onto vegetated areas.		☐	☐
c. Direct runoff from sidewalks, walkways, and/or patios onto vegetated areas.		☐	☐
d. Direct runoff from driveways and/or uncovered parking lots onto vegetated areas.		☐	☐
e. Construct sidewalks, walkways, and/or patios with pervious pavement systems.[8]		☐	☐
f. Construct bike lanes, driveways, and/or uncovered parking lots with pervious pavement systems.[8]		☐	☐
g. Minimize land disturbance and impervious surface (especially parking lots).		☐	☐
h. Maximize permeability by clustering development and preserving open space.		☐	☐
i. Use micro-detention, including distributed landscape-based detention.		☐	☐
j. Protect sensitive areas, including wetland and riparian areas, and minimize changes to the natural topography.		☐	☐
k. Self-treating area (see Chapter 5 of the *C.3 Technical Guidance*)		☐	☐
l. Self-retaining area (see Chapter 5 of the *C.3 Technical Guidance*)		☐	☐

III.B Select Appropriate Source Control Measures

C.3.b Regulated Projects must select and implement appropriate source control measures.
C.3.i Small Projects and projects not regulated by C.3 are encouraged to select and implement appropriate source control measures and those directed by the municipality.

Features in the project?		Features requiring source controls	Source control measures (Refer to Local Source Control List for detailed requirements)	Measure included in project plans?		
Yes	**No**			**Yes**	**NO**	**Plan Sheet #**
☐	☐	Storm Drain	Mark on-site inlets with the words “No Dumping! Flows to Bay” or equivalent.	☐	☐	
☐	☐	Floor Drains	Plumb interior floor drains to sanitary sewer[9] [or prohibit].	☐	☐	
☐	☐	Parking garage	Plumb interior parking garage floor drains to sanitary sewer.[9]	☐	☐	
☐	☐	Landscaping	▪ Retain existing vegetation as practicable. ▪ Select diverse species appropriate to the site. Include plants that are pest- and/or disease-resistant, drought-tolerant, and/or attract beneficial insects. ▪ Minimize use of pesticides and quick-release fertilizers. ▪ Use efficient irrigation system; design to minimize runoff.	☐	☐	
☐	☐	Pool/Spa/ Fountain	Provide connection to the sanitary sewer to facilitate draining.[9]	☐	☐	
☐	☐	Food Service Equipment (non-residential)	Provide sink or other area for equipment cleaning, which is: ▪ Connected to a grease interceptor prior to sanitary sewer discharge.[9] ▪ Large enough for the largest mat or piece of equipment to be cleaned. ▪ Indoors or in an outdoor roofed area designed to prevent stormwater run-on and run-off and signed to require equipment washing in this area.	☐	☐	

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[8] Use the specifications in the *C.3 Technical Guidance* or for small projects see the *BASMAA Pervious Paving Factsheet*. For these documents and others go to www.cleanwaterprogram.org and click on “Resources.”
[9] Any connection to the sanitary sewer system is subject to sanitary district approval.

Features in the project?		Features requiring source controls	Source control measures (Refer to Local Source Control List for detailed requirements)	Measure included in project plans?		
Yes	No			Yes	NO	Plan Sheet #
☐	☐	Refuse Areas	▪ Provide a roofed and enclosed area for dumpsters, recycling containers, etc., designed to prevent stormwater run-on and runoff. ▪ Connect any drains in or beneath dumpsters, compactors, and tallow bin areas serving food service facilities to the sanitary sewer.[9]	☐	☐	
☐	☐	Outdoor Process Activities [10]	Perform process activities either indoors or in roofed outdoor area, designed to prevent stormwater run-on and runoff, and to drain to the sanitary sewer.[9]	☐	☐	
☐	☐	Outdoor Equipment/ Materials Storage	▪ Cover the area or design to avoid pollutant contact with stormwater runoff. ▪ Locate area only on paved and contained areas. ▪ Roof storage areas that will contain non-hazardous liquids, drain to sanitary sewer[9], and contain by berms or similar.	☐	☐	
☐	☐	Vehicle/ Equipment Cleaning	▪ Roofed, pave and berm wash area to prevent stormwater run-on and runoff, plumb to the sanitary sewer,[9] and sign as a designated wash area. ▪ Commercial car wash facilities shall discharge to the sanitary sewer.[9]	☐	☐	
☐	☐	Vehicle/ Equipment Repair and Maintenance	▪ Designate repair/maintenance area indoors, or an outdoors area designed to prevent stormwater run-on and runoff and provide secondary containment. Do not install drains in the secondary containment areas. ▪ No floor drains unless pretreated prior to discharge to the sanitary sewer. [9] ▪ Connect containers or sinks used for parts cleaning to the sanitary sewer. [9]	☐	☐	
☐	☐	Fuel Dispensing Areas	▪ Fueling areas shall have impermeable surface that is a) minimally graded to prevent ponding and b) separated from the rest of the site by a grade break. ▪ Canopy shall extend at least 10 ft in each direction from each pump and drain away from fueling area.	☐	☐	
☐	☐	Loading Docks	▪ Cover and/or grade to minimize run-on to and runoff from the loading area. ▪ Position downspouts to direct stormwater away from the loading area. ▪ Drain water from loading dock areas to the sanitary sewer.[9] ▪ Install door skirts between the trailers and the building.	☐	☐	
☐	☐	Fire Sprinklers	Design for discharge of fire sprinkler test water to landscape or sanitary sewer.[9]	☐	☐	
☐	☐	Miscellaneous Drain or Wash Water	▪ Drain condensate of air conditioning units to landscaping. Large air conditioning units may connect to the sanitary sewer.[9] ▪ Roof drains shall drain to unpaved area where practicable. ▪ Drain boiler drain lines, roof top equipment, all wash water to sanitary sewer. [9]	☐	☐	
☐	☐	Architectural Copper	Discharge rinse water to sanitary sewer [9] or collect and dispose properly offsite. See flyer *Requirements for Architectural Copper*.	☐	☐	

[10] Businesses that may have outdoor process activities/equipment include machine shops, auto repair, industries with pretreatment facilities.

III.C Stormwater Treatment Measures *C.3.b Regulated Projects must select and implement stormwater treatment measures to manage the C.3.d numeric sizing criteria. Complete the applicable sections below.*				
Yes	No			
☐	☐	**III.C.1 Is the project a Special Project?** (See Appendix J of the *C.3 Technical Guidance* for Special Project criteria.) If YES, complete the Special Projects Worksheet and consult with municipal staff about the need to prepare a discussion of the feasibility and infeasibility of 100% LID treatment. Indicate the type of non-LID treatment to be used, the hydraulic sizing method*, and percentage of the amount of runoff specified in Provision C.3.d that is treated.		
		Non-LID Treatment	Hydraulic Sizing Method (See Note 1)	% of C.3. Amount of Runoff Treated
		☐ Media filter		
		☐ Tree well filter		
☐	☐	**III.C.2 Is the project using biotreatment to treat the C.3.d amount of runoff?** (See the *C.3 Technical Guidance* for information on infiltration and rainwater harvesting[11] and use of stormwater.) If YES, indicate the biotreatment measures to be used, and the hydraulic sizing method:		
		Biotreatment Measures	Hydraulic sizing method (See Note 1)	
		☐ Bioretention area		
		☐ Flow-through planter		
		☐ Other (specify):		

Note 1. Indicate which of the following Provision C.3.d.i hydraulic sizing methods were used:

1. Volume based approaches – Refer to Provision C.3.d.i.(1):
   1(a) Urban Runoff Quality Management approach, or
   1(b) 80% capture approach (recommended volume-based approach).
2. Flow-based approaches – Refer to Provision C.3.d.i.(2):
   2(a) 10% of 50-year peak flow approach,
   2(b) Percentile rainfall intensity approach, or
   2(c) 0.2-Inch-per-hour intensity approach (this is recommended flow-based approach AND the basis for the 4% rule of thumb described in Section 7.1 of the C.3 Technical Guidance).
3. Combination hydraulic sizing approach -- Refer to Provision C.3.d.i.(3):
   If a combination flow and volume design basis was used, indicate which flow-based and volume-based criteria were used.

III.D Hydromodification Management (HM) Requirements *C.3.b Regulated Projects must complete this section*		
	YES	**NO**
III.D.1 Does the project create and/or replace 1 acre (43,560 sq. ft.) or more of impervious area? If YES continue to item III.D.2. If NO, this project is not subject to the HM requirements.	☐	☐
III.D.2 Is the total impervious area increased from the pre-project condition? If YES continue to item III.D.3. If NO, this project is not subject to the HM requirements.	☐	☐
III.D.3 Is the site located in a tidally influenced/depositional area, or in the extreme eastern portion of the county that is not subject to HM requirements? (See HMP Susceptibility Map.) If YES continue to III.D.4. If NO the project is exempt from HM requirements. Attach map indicating project location. Skip to III.D.6 and check "NO".	☐	☐
III.D.4 Is the site located in a high slope zone or special consideration watershed, as shown on the HMP Susceptibility Map? If YES Project is subject to HM requirements. Attach map indicating project location. Skip to III.D.6 and check "YES.". If NO, continue to III.D.5.	☐	☐
III.D.5 For sites located in a white area on the HMP Susceptibility Map, has an engineer or qualified environmental professional determined that runoff from the project flows only through a hardened channel or enclosed pipe along its entire length before emptying into a waterway in the exempt area?	☐	☐

[11] The MRP no longer requires that a feasibility analysis of infiltration and rainwater harvesting be conducted. However, applicants using biotreatment are encouraged to maximize infiltration of stormwater if site conditions allow. If feasible and desired, infiltration and rainwater harvesting may be cost effective solutions depending on the project.

If YES, the project is exempt from HM requirements. Attach signed statement by qualified professional. Go to III.D.6 and check "NO." If NO, the project is subject to HM requirements. Attach map indicating project location. Go to Item G.6 and check "YES."	☐	☐

III.D.6 Is the project a Hydromodification Management Project?
☐ YES the project is subject to the *HM requirements in MRP Provision C.3.g.*
☐ NO, the project is not subject to the HM requirements.
➢ If the project is subject to the HM requirements, incorporate in the project flow duration stormwater control measures designed such that post-project stormwater discharge rates and durations match pre-project discharge rates and durations. The Bay Area Hydrology Model (BAHM) has been developed to size flow duration controls. See https://www.clearcreeksolutions.info/downloads.Guidance is provided the *C.3 Technical Guidance*.

IV. Implementation of C.6 Construction Phase Requirements

All projects must complete Section IV.

IV.A Select Appropriate Construction Phase BMPs[12]

BMP	Plan Sheet #	Yes	No
Attach the municipality's construction BMP plan sheet to project plans and require contractor to implement the applicable BMPs on the plan sheet.		☐	☐
Implement temporary erosion controls to stabilize all disturbed areas until permanent erosion controls are established.		☐	☐
Delineate with field markers clearing limits, easements, setbacks, sensitive or critical areas, buffer zones, trees, and drainage courses.		☐	☐
Provide notes, specifications, or attachments describing: ▪ Construction, operation and maintenance of erosion and sediment controls, include inspection frequency; ▪ Methods and schedule for grading, excavation, filling, clearing of vegetation, and storage and disposal of excavated or cleared material; ▪ Specifications for vegetative cover and mulch, include methods and schedules for planting and fertilization; ▪ Provisions for temporary and/or permanent irrigation.		☐	☐
Perform clearing and earth moving activities only during dry weather.		☐	☐
Use sediment controls or filtration to remove sediment when dewatering and obtain all necessary permits.		☐	☐
Protect all storm drain inlets in vicinity of site using drop inlet protection		☐	☐
Trap sediment on-site, using BMPs such as sediment basins or traps, earthen dikes or berms, silt fences, check dams, erosion control blankets, covers for soil stock piles, etc.		☐	☐
Divert on-site runoff around disturbed areas and construction materials; divert off-site runoff around the site (e.g., swales and dikes).		☐	☐
Protect adjacent properties and undisturbed areas from construction impacts using vegetative buffer strips, sediment barriers or filters, dikes, mulching, or other measures as appropriate.		☐	☐
No cleaning, fueling, or maintaining vehicles on-site, except in a designated area where wash water is contained for proper management and spill controls are in place.		☐	☐
Store, handle, and dispose of construction materials/wastes properly to prevent contact with stormwater.		☐	☐
Contractor shall train and provide instruction to all employees/subcontractors re: construction BMPs.		☐	☐
Control and prevent the discharge of all potential pollutants, including pavement cutting wastes, paints, concrete, petroleum products, chemicals, wash water or sediments, rinse water from architectural copper, and non-stormwater discharges to storm drains and watercourses.		☐	☐

[12] Additional information on Construction Phase BMPs can be found is MRP Provision C.6 and the California Stormwater Quality Association's Construction BMP Handbook.

V. Stormwater Treatment Measure and/HM Control Owner or Operator's Information

C.3.b Regulated Projects must complete Section V.

Name	
Address	
Phone	
Email	

- *Applicant must call for inspection and receive inspection within 45 days of installation of treatment measures and/or hydromodification management controls.*

Name of Applicant Completing Form	
Signature	
Date	

VI. For Completion by Municipal Staff

(This section is only applicable for C.3.b Regulated Projects)

VI.1 Alternative Certification	YES	NO
Was the treatment system sizing and design reviewed by a qualified third-party professional that is not a member of the project team or agency staff?	☐	☐
Name of Reviewer:	☐	☐
VI.2 Confirm Operations and Maintenance (O&M) Submittal Complete for C.3.b Regulated Projects and HM Projects	☐	☐
VI.2.a Was the maintenance plan submitted?	☐	☐
VI.2.b Was the maintenance plan approved?	☐	☐
VI.2.c Was the maintenance agreement approved?	☐	☐
Date maintenance agreement was executed:		

VI.3 HM Controls (if required) Are the applicable items for HM compliance included in the plan submittal?			
Documentation for HM Compliance	**YES**	**NO**	**NA**
Site plans with pre- and post-project impervious surface areas, surface flow directions of entire site, locations of flow duration controls and site design measures per HM site design requirement	☐	☐	☐
Soils report or other site-specific document showing soil types at all parts of site	☐	☐	☐
If project uses the Bay Area Hydrology Model (BAHM), a list of model inputs.	☐	☐	☐
If project uses custom modeling, a summary of the modeling calculations with corresponding graph showing curve matching (existing, post-project, and post-project with HM controls curves), goodness of fit, and (allowable) low flow rate.	☐	☐	☐
If project uses the Impracticability Provision, a listing of all applicable costs and a brief description of the alternative HM project (name, location, date of start up, entity responsible for maintenance).	☐	☐	☐
If the project uses alternatives to the default BAHM approach or settings, a written description and rationale.	☐	☐	☐

- Municipal staff: Refer to the “Flow Duration Control Review Worksheet for HM Submittals” to review the documentation submitted for HM compliance.

APPENDIX P. BAHM CHECKLIST

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Glossary for the
Flow Duration Control Review Worksheet for HM Submittals

The worksheet and glossary are intended to assist the development community and municipal staff in determining whether the HM submittal complies with the HM standard as mandated in the Municipal Regional NPDES Permit (MRP) reissued by the San Francisco Bay Regional Water Quality Control Board on October 14, 2009 as Order R2-2009-0074, NPDES Permit No. CAS612008.
For projects using the Bay Area Hydrology Model to meet the HM Standard, this worksheet may be used to assist project engineers in determining the correct BAHM settings to use; municipal staff may use the worksheet to determine if the software has been used properly to demonstrate compliance with the HM Standard. All questions must be checked "Yes" for the project to be in compliance.

Glossary of Terms

Bay Area Hydrology Model (BAHM) – A computer software application, available for downloading from www.bayareahydrologymodel.com, for analyzing the potential hydrograph modification effects of land development projects, and sizing specialized flow duration control facilities to mitigate the increased stormwater runoff from these projects and assist project applicants in meeting the requirements of the HM standard permit amendment.

DOC file – An electronic report file produced by the Bay Area Hydrology Model (BAHM), which can be read by Microsoft Word or any text-editing program, and must be included in HM submittals that include flow duration controls and are designed using the BAHM.

Flow duration controls – Specialized detention and discharge structures designed to reduce excess post-project flow duration for a designated range of flows based on continuous simulation models of runoff from both pre-project and post-project site conditions, comparing flow durations for the designated range of flows, in order to mitigate development-caused hydromodification.

Hydrologic source controls – The HM Standard uses the term hydrologic source controls to refer to site design techniques that minimize and/or slow the rate of stormwater runoff from the site. There is considerable overlap between site design measures that minimize and/or slow the rate of runoff and site design measures that reduce impacts to water quality and beneficial uses. Because municipal staff are familiar with the term "site design measures" and already require site design measures to reduce impacts to water quality/beneficial uses, the HM Applicability Worksheet does not use the term hydrologic source controls, and instead uses the term "site design measures," specifying that when site design measures are incorporated to meet the HM standard, they must serve to minimize and/or slow the rate of runoff.

Hydromodification - The modification of a stream's hydrograph, caused in general by increases in flows and durations that result when land is developed (e.g., made more impervious). The effects of hydromodification include, but are not limited to, increased bed and bank erosion, loss of habitat, increased sediment transport and deposition, and increased flooding.

Hydromodification Management (HM) Standard – Stormwater discharges from applicable new development and redevelopment projects shall not cause an increase in the erosion potential of the receiving stream over the pre-project (existing) condition. Increase in runoff flow and volume shall be managed so that post-project runoff shall not exceed estimated 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 to beneficial uses due to increased erosive force. Such management shall be through implementation of the hydromodification requirements the HM Standard permit provision and its Attachment B.

Impracticability Provision – Provision C.3.g.2 (Attachment B of the MRP) of the HM Standard, which identifies conditions under which a project may be allowed to meet the requirement for flow duration control by contributing financially to an alternative HM project.

In-stream measures - In-stream measures involve modifying the receiving stream channel slope and geometry so that the stream can convey the new flow regime without increasing the potential for erosion and aggradation. In-stream measures are intended to improve channel stability and prevent erosion by reducing the erosive forces imposed on the channel boundary.

Site Design Measures - Site planning techniques to conserve natural areas and/or limit the amount of impervious surface at new development and significant redevelopment projects. Site design measures may be employed for the purpose of reducing impacts to water quality and beneficial uses, or for the purpose of minimizing and/or slowing the rate of runoff offsite and thereby reducing potential for hydromodification of creek channels. Site design measures that minimize and/or slow the rate of runoff are also called hydrologic source controls. In practice, many site design measures accomplish both purposes described above.

WD2, WDM and WHM Files – project files that are created by the Bay Area Hydrology Model (BAHM), which must be included in HM submittals that include flow duration controls and are designed using the BAHM.

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Flow Duration Control Review Worksheet for HM Submittals

(To be completed for projects that include **flow duration controls**. Terms in **bold** text are defined in the glossary section of the HM Applicability Worksheet Guidance and Glossary.)

1. Project Location or Address:____, CA

2. Project Name (if applicable): ____

3. Design Engineer:____________________ 3a. Phone No.:______________ 3a. Email:_________________

4. Parcel/Tract No.: ________________ 4a. Lot No.:_______________ 4b. APN # ____________________

Required Project Information

5. Check the "Included" box if the submittal includes the following documents, or check "NA" if NOT applicable. All applicable documents must be included.

	Included	NA
5a. Site plans with pre- and post-project impervious areas, surface flow directions of entire site, locations of **flow duration controls** and **site design measures** per HM site design requirement[2].	☐	
5b. Soils report or other site-specific document showing soil types at all parts of site.	☐	
5c. If project uses the **Bay Area Hydrology Model** (BAHM), a list of model inputs.	○	○
5d. If project uses custom modeling, a summary of the modeling calculations with corresponding graph showing curve matching (existing, post-project, and post-project with HM controls curves), goodness of fit, and (allowable) low flow rate.	○	○
5e. If project uses the **Impracticability Provision**, a listing of all applicable costs and a brief description of the alternative HM project (name, location, date of start up, entity responsible for maintenance).	○	○
5f. If the project uses alternatives to the default BAHM approach or settings, a written description and rationale (see also Question 7 below).	○	○

Hydromodification Management (HM) Site Design Requirement[2]

6. Do plans include appropriate **site design measures** that minimize and/or slow rate of runoff from site?
   - ○ Yes. *Continue to Question 7.*
   - ○ No. Incorporate appropriate site design measures prior to approval, or explain why this is impracticable:

Bay Area Hydrology Model (BAHM)

7. Is the **Bay Area Hydrology Model** used to demonstrate compliance with the **HM standard**?
   - ○ Yes. *Continue to Question 8.*
   - ○ No. *Describe the method used to comply with the HM standard and attach an evaluation of the method and results, indicating whether the HM standard has been met. Skip to Question 29.*

   Alternative method(s): ☐ Modified design criteria in BAHM ☐ Alternate modeling software
   ☐ **In-stream measures** ☐ Full channel stability assessment ☐ Other:__________________________
8. Soil types used for BAHM are based on: ☐ Project geotechnical report by________________________
   ☐ NRCS soils map ☐ Other/unknown (describe):

Checklist for BAHM Project Review (All boxes must be checked Yes for approval.)

	Yes	No
9. Were required **project files (WDM, WHM, WD2)** received?	○	○
10. Was the BAHM report **(DOC) file** received?	○	○
11. Do the project files load to reviewer's computer properly?	○	○
12. Does the project location in submittal match location on the BAHM screen?	○	○
13. Does the Pre-Project scenario run properly?	○	○
14. Does the Post-project Mitigated scenario run properly?	○	○
15. Compare BAHM Report screen with report file:		

Checklist for BAHM Project Review (All boxes must be checked Yes for approval.)

	Yes	No
15a. Project location descriptions match.	○	○
15b. Precipitation gages and precipitation factors match.	○	○
15c. Flow frequency results match.	○	○
15d. All flow duration values PASS. (Flow values are non-zero.)	○	○
15e. Any pervious area (PERLND) changes?	○	○
15f. Any impervious area (IMPLND) changes?	○	○
15g. Any scaling factor changes?	○	○
15h. Any duration criteria changes?	○	○
15i. Pond (or vault or tank) dimensions match.	○	○
15j. Pond Discharge Structure information matches.	○	○
16. Do the BAHM pond/vault/tank dimensions match drawings?	○	○
17. Compare Discharge Structure(s) in BAHM report to drawings:		
17a. Do configuration and dimensions match, including low-flow orifice?	○	○
17b. If low-flow orifice is enlarged on plans, is the difference mitigated via design features consistent with Appendix D of the User Manual?	○	○
18. Is the pond surface area included in the Post-project Mitigated basin?	○	○
19. Are the Precipitation Applied and Evaporation Applied options used appropriately for each type of element?	○	○
20. Infiltration: a. Is this turned ON for each infiltration pond or LID element?	○	○
b. Is selection of Infiltration Reduction Factors consistent with Appendix D?	○	○
21. Does total BAHM drainage area match drainage maps/drawings?	○	○
22. Does Post-project Mitigated drainage area(s) match Pre-project?	○	○
23. Is Pre-project vegetation correct? (e.g. lawns shown as Urban, not Grass)	○	○
24. Are Post-project Unmitigated land use areas correct?	○	○
25. Do low impact development (LID) options correspond to the site design measures to minimize/reduce runoff rate, or other stormwater management measures shown on plans?	○	○
26. Are the routing and connectivity of drainage areas and LID or stormwater management measures consistent with plans?	○	○
27. Does the pond usually drain in 5 days or less, according to the Drawdown Table?	○	○
28. If claiming treatment credit on a volume basis for the pond, are documentation or calculations provided and consistent with volumes shown in Drawdown Table?	○	○

HM Submittal Approval

	Yes	No	N/A
29. Is documentation provided for any required review or approval by other agencies (e.g. ACFCWCD, Zone 7, local groundwater managers)?	○	○	○
30. Do other issues need correction before project is approved? Describe:__________ ____	○	○	
31. Is the HM submittal APPROVED? NOTE: Operation & maintenance agreement required prior to occupancy.	○	○	

APPENDIX Q. LOCAL REQUIREMENTS