Chapter

4

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 low impact development (LID) techniques employed in the design of a project site in order to reduce the project's impact on water quality and beneficial uses. Site design measures are not treatment measures. 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 4.1). 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 translates into smaller facilities to meet stormwater treatment requirements than would have been needed without the site design measures. Site design measures are also important in minimizing the size of any required hydromodification management measures for the site. A wide variety of site design measures can be incorporated in your project. This Chapter presents the following site design topics:

- Self-Treating Areas;
- Self-Retaining Areas;
- Reducing the Size of Impervious Areas;
- Rainwater Harvesting and Use;
- Tree Preservation/Planting and Interceptor Tree Credits;
- Site Design Requirements for Small Projects

Site design measures used to reduce the size of stormwater treatment measures ***must not be removed*** from the project without resizing the stormwater treatment 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.

4.1 Self-Treating Areas

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), green roofs, and areas paved with turf block. 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 Provision C.3.d of the MRP. 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 6.

If self-treating areas do not receive runoff from impervious areas, runoff from self-treating areas may discharge ***directly*** to the storm drain.

As long as the self-treating areas are not used to 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 other 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 are in excess of 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 HM treatment measures.

Figure 4-1 compares the size of the stormwater treatment measure that would be required to treat the runoff from a site, depending on whether or not the runoff from a self-treating area discharges directly to the storm drain system or other receiving water. In the first (upper) sequence, runoff from the self-treating area is directed to the stormwater treatment measure. In the second (lower) sequence, runoff from the self-treating area bypasses the treatment measure and flows directly to the storm drain system or other receiving water, resulting in a smaller volume of stormwater that will require treatment. This results in a ***smaller stormwater treatment measure***.

Figure 4-2 compares the conventional drainage approach to the self-treating area approach. The conventional approach combines stormwater runoff from landscaped areas with the runoff from impervious surfaces. Assuming the parking lot storm drain leads to a treatment measure, in the conventional approach, the treatment measure will need to be sized to treat runoff from the entire site. The ***self-treating area approach*** routes runoff from the landscaped areas directly to the storm drain system. In this approach, the treatment measure is sized to treat only the runoff from impervious areas.

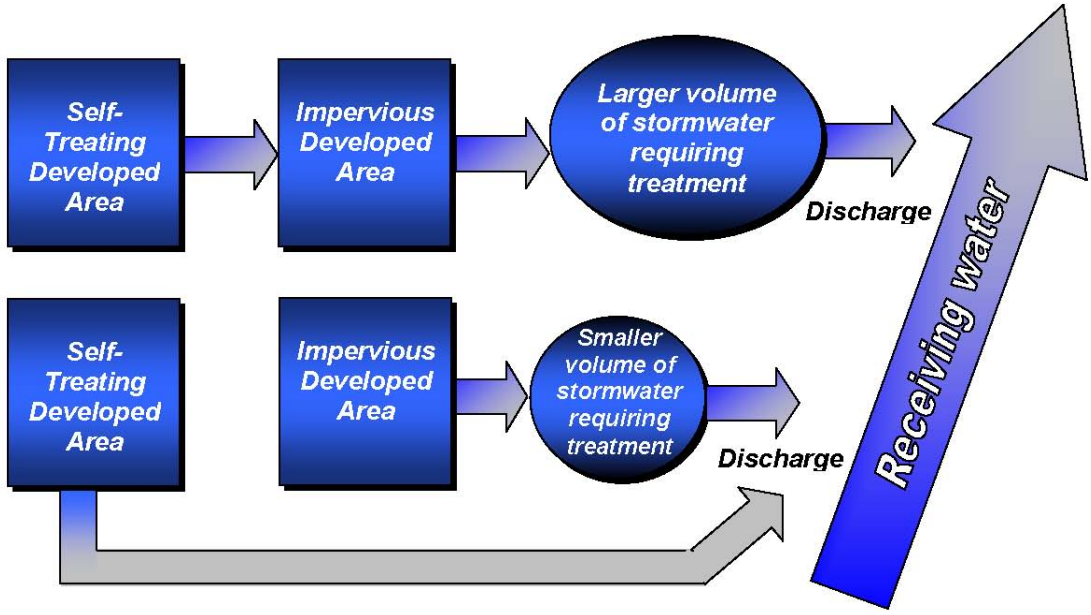
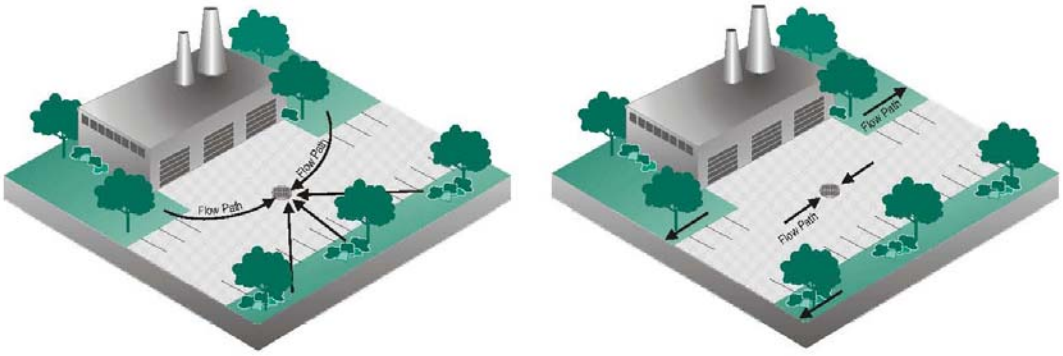


Figure 4-1: Self-Treating Area Usage (Source, BASMAA, 2003)



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

Figure 4-2: Commercial/Industrial Site Compared to Same Site with Self-Treating Areas (Source, BASMAA 2003)

Figure 4-3 shows an example site in which the runoff from impervious areas must flow to the stormwater treatment measure before discharging to the storm drain, while runoff from the self-treating area may discharge directly to the storm drain. This is allowable because the self-treating area does not accept runoff from the impervious portions of the site.

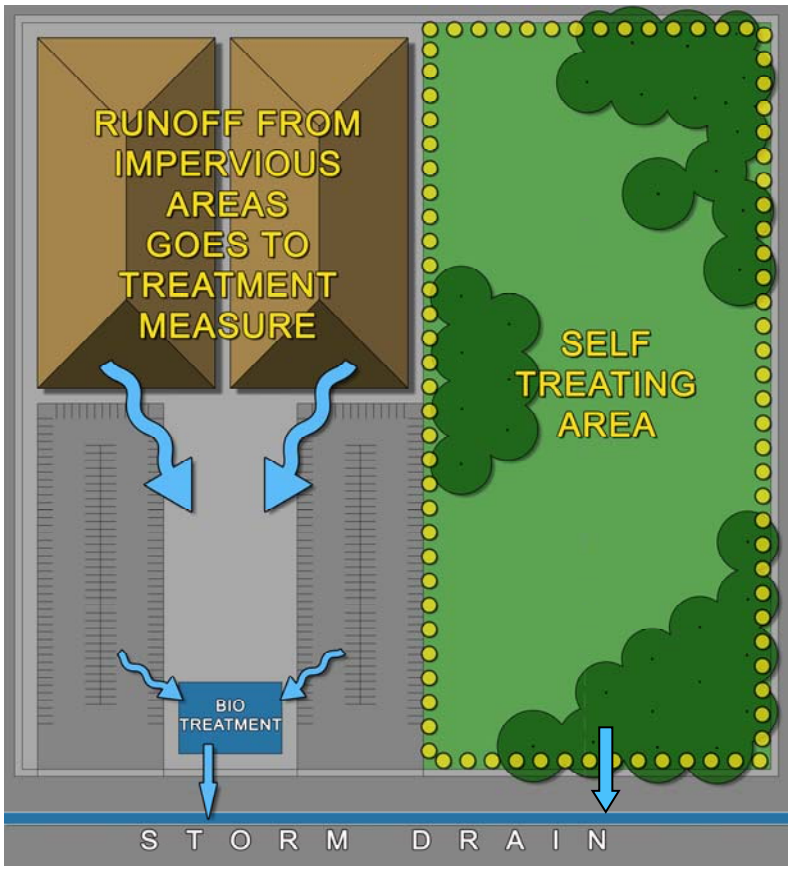
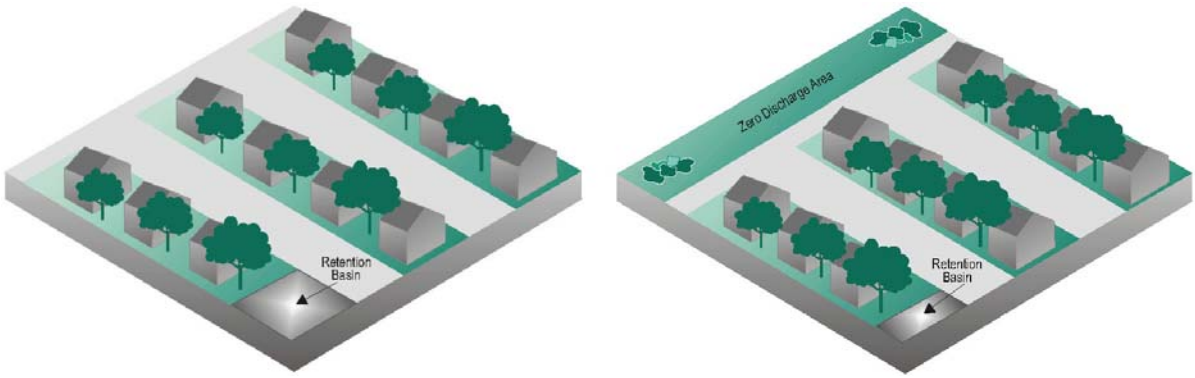


Figure 4-3: Schematic Drainage Plan for Site with a Self-Treating Area
(Source: Santa Clara Valley Urban Runoff Pollution Prevention Program)

4.2 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 (as illustrated in Figures 4-4 and 4-5). ***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. The following design considerations apply to self-retaining areas:

- 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. Modeling conducted for the Harvest and Use, Infiltration and Evapotranspiration Feasibility/Infeasibility Criteria Report (Feasibility Report), prepared by 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 Provision C.3.d of the MRP 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 LID Feasibility Criteria 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 should 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 5 percent of the self-retaining area.
- Slopes may not exceed 4 percent.
- The municipality may require amended soils, vegetation and irrigation to maintain soil stability and permeability.
- Self-retaining areas shall be protected from construction traffic and compaction.



Conventional Design **Design with "Self-Retaining" or "Zero Discharge" Area**

Figure 4-4: 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)

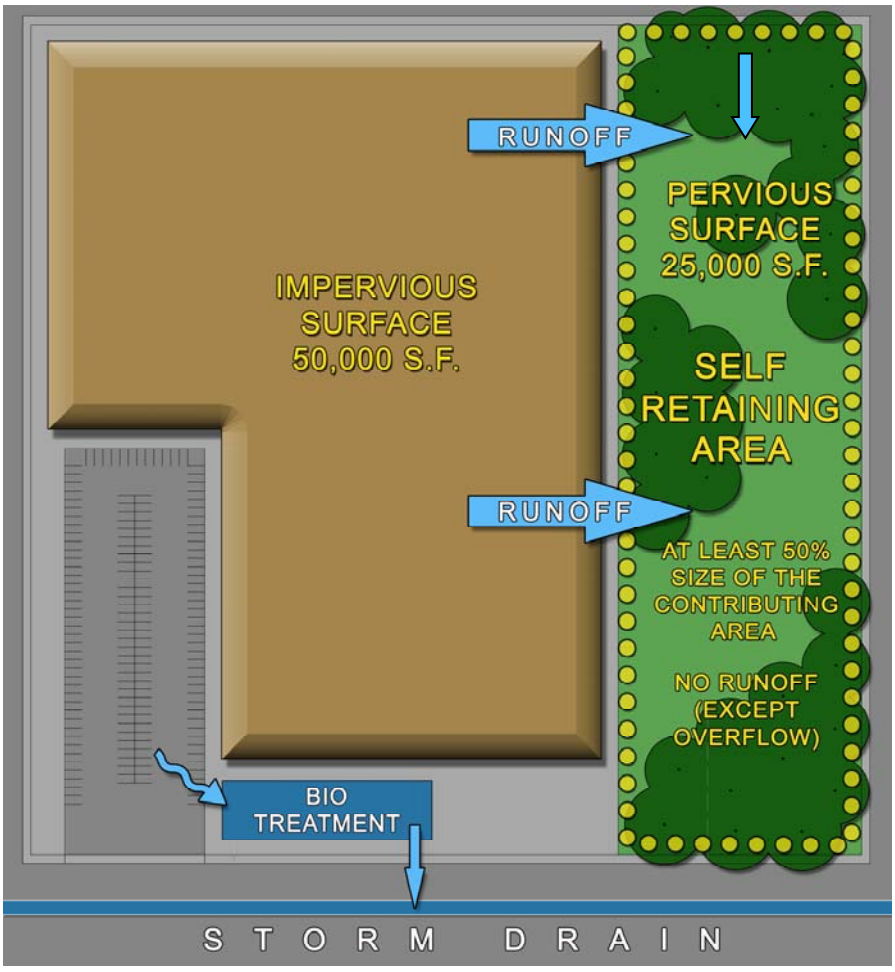


Figure 4-5: Schematic Drainage Plan for Site with a Self-Retaining Area (Source: Santa Clara Valley Urban Runoff Pollution Prevention Program)

If you are considering using a self-retaining area in a project that must meet hydromodification management (HM) requirements, use the Bay Area Hydrology Model to identify the appropriate sizing of the self-retaining area 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 7.

4.3 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 techniques generally need to be incorporated very early in the project design. A number of techniques for reducing impervious surfaces are described below.

Alternative Site Layout Techniques

Check with your local jurisdiction regarding its policies regarding 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 Provision C.3.d of the MRP. See section 6.9 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.

Minimize Surface Parking Areas

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 actually 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, nights 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

Figure 4-6: Parking Lifts in Parking Garage, Berkeley

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 or employees, or by a valet or parking attendant. With proper training for residents, employers, or parking attendants, this strategy can be a 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.

4.4 Rainwater Harvesting and Use

Technical guidance for rainwater harvesting and use is provided in Section 6.10 of Chapter 6. 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 per Provision C.3.d of the MRP. 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 6.10, with the exception of meeting the C.3.d stormwater treatment sizing criteria.

4.5 Tree Preservation/Planting and Interceptor Tree Credits

Trees perform a variety of functions that reduce runoff volumes and improve water quality. Leaf canopies intercept and hold rainwater on the leaf surface, preventing it from reaching the ground and becoming runoff. Root systems create voids in the soil that facilitate infiltration. Trees also absorb and transpire large quantities of groundwater, making the soil less saturated, which allows more stormwater to infiltrate. Through the absorption process, trees remove pollutants from stormwater and stabilize them. Finally, tree canopies shade and cool paved areas.

Consistent with the Feasibility Report submitted to the Water Board by BASMAA on April 29, 2011, a project may earn stormwater treatment credits by planting new trees and preserving existing trees at the project site. In other words, the stormwater treatment credit can be subtracted from the amount of impervious surface area requiring treatment. To be eligible for these credits, the trees need to meet the minimum requirements listed in Section 4.5.1. The system of interceptor tree credits is described in Table 4-1, and guidance for planting and protection during construction is provided in Section 4.5.2. Additional information about planting trees in dense, urban settings is provided in Section 4.5.3.

Table 4-1
Stormwater Treatment Credits for Interceptor Trees

	New Evergreen Trees	New Deciduous Trees	Existing Trees
Credits for new and existing trees that meet interceptor tree minimum requirements	200 square feet	100 square feet	Square footage under the tree canopy trees with an average DBH of 12 inches or more.

*DBH: Diameter at breast height (4.5 feet above grade)
Source: BASMAA LID Feasibility Criteria Report, 2011 (based on the tree credit system in the State Construction General Permit standards for post-construction stormwater control)

4.5.1 Minimum Requirements for Interceptor Trees

The following requirements are based on guidance in the Stormwater Quality Design Manual for the Sacramento and South Placer Regions.

PLANTING NEW INTERCEPTOR TREES
To be eligible for stormwater interceptor tree credits, trees planted as part of the project must meet the following minimum requirements:

- Plant tree within 25 feet of ground-level impervious surface;
- Maintain appropriate distance from infrastructure and other structures that could be damaged by roots; avoid overhead power lines, underground utilities, septic systems, sidewalks, curbs, patios, etc.
- Space trees so crowns do not overlap at 15 yrs of growth;
- Specified trees must be 15 gallon container minimum size at planting;
- Dwarf species are not acceptable; native species and trees with a large canopy at maturity are preferred.
- Clearly label on project plans the trees designated for stormwater interceptor tree credits.

PRESERVING EXISTING INTERCEPTOR TREES
To be eligible for stormwater interceptor tree credits, existing trees preserved at the project site must meet the following minimum requirements:

- The tree trunk must be located within 25 feet of ground-level impervious surface that is included in the project's calculation of the amount of stormwater runoff that will require treatment.
- Dwarf species are ineligible.

- Clearly label on project plans the trees designated for stormwater interceptor tree credits.

4.5.2 Interceptor Tree Planting and Construction Guidelines

The following guidelines are based on guidance in the Stormwater Quality Design Manual for the Sacramento and South Placer Regions.

PLANTING NEW INTERCEPTOR TREES

- Drainage and soil type must support selected tree species.
- Avoid compaction of soil in planting areas.
- Avoid contamination of planting areas by construction related materials such as lime or limestone gravel.
- Install turf grass no closer than 24 inches from trunk;
- Add 4-6 inches deep of hardwood mulch, 6 inches away from trunk;
- Permanent irrigation system may be required;
- Avoid excess irrigation due to mosquito issues;
- Pruning and removal and replacement of diseased/damaged tree may be required.
- If construction is ongoing, install high-visibility protective fencing at the outer limit of the critical root zone area.

PRESERVING EXISTING INTERCEPTOR TREES

- Plan new landscaping under existing trees to avoid grade changes and excess moisture in the trunk area, depending on the tree species. Preserve existing plants that are compatible with irrigation requirements and are consistent with the landscape design.
- Avoid grade changes greater than 6 inches within the critical root zone.
- Avoid soil compaction under trees.
- During construction minimize disruption of the root system.
- Plans and specifications shall clearly state protection procedures for interceptor trees to be preserved.
- Protect existing trees during construction through the use of high-visibility construction fencing at the outer limit of the critical root zone area. The fence must prevent equipment traffic and storage under trees. Excavation in this area should be done by hand and roots ½-inch and larger should be preserved. Pruning of branches or roots should be done by, or under supervision of, an arborist.
- Provide irrigation of trees during and after construction.
- Install turf grass no closer than 24 inches of trunk.

4.5.3 Tree Planting in Dense, Urban Areas

When planting trees, particularly along streets where space is limited and roots may damage hard surfaces, ***consider the use of structural soils***. Structural soil is a planting medium that consists of a stone skeleton structure for strength and clay soil for water retention, which allows urban trees to grow under pavement. The structural soil system creates a load-bearing matrix with voids filled with soil and air, essential for tree health. This allows for greater tree growth, better overall heath of trees, and reduced pavement uplifting by tree roots. The voids that benefit the tree roots also provide increased stormwater storage capacity, allowing tree pits in paved areas to serve as a series of small detention basins. See www.hort.cornell.edu/uhi/outreach/csc/ for more information on structural soils. Before including structural soils in your project, please contact the municipality for information and requirements specific to the local jurisdiction.

Structural soils may allow the installation of ***large shade trees*** in narrow medians where the tree otherwise may conflict with infrastructure.

Load-bearing modular grid products, such as the Silva Cell, have also been developed to allow the planting of trees in uncompacted native soils, fill soils, or stormwater treatment soils, extending under sidewalks and other areas of pavement. With the Silva Cell product, for example, each cell is composed of a frame (or frames) and a deck (see Figure 4-7).

The frames can be stacked one, two, or three units high before they are topped with a deck to create a maximum amount of soil volume for tree root growth and stormwater infiltration. Cells can be installed laterally as wide as necessary. Void space within the cells may accommodate the surrounding utilities.

Figure 4-7: Silva Cells, stacked three units high. (Source: Deep Root Technologies, www.deeproot.com). The use of this photograph is for general information only, and is not an endorsement of this or any other proprietary product.

4.6 Site Design Requirements for Small Projects

Provision C.3.i of the MRP requires small projects that meet the following thresholds to include site design measures:

- Projects that create and/or replace at least 2,500 but less than 10,000 square feet of impervious surface[1]; and
- Individual single family home projects that create and/or replace 2,500 square feet or more of impervious surface.

Applicable projects 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.

To help applicants with small projects select site design measures appropriate for their sites, the Clean Water Program collaborated regionally through the Bay Area Stormwater Management Agencies Association (BASMAA) to develop the following four fact sheets:

- Managing Stormwater in Landscapes
- Rain Gardens
- Pervious Paving
- Rain Barrels and Cisterns

These factsheets, and further detail on implementing site design for small projects, are presented in Appendix L.

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 the project site. Only one site design measure is required for small projects, but additional measures may be selected to increase the water quality benefits of your project.

[1] The threshold at which Special Land Use Projects (uncovered parking areas, restaurants, auto service facilities, and retail gasoline outlets) are considered C.3 Regulated Projects is 5,000 square feet of impervious surface. For these projects, the implementation of LID site design and stormwater treatment systems per Provision C.3.b of the MRP will also satisfy the requirements of Provision C.3.i.