GREEN PARKING LOTS

Design Criteria

COUNTY OF SAN DIEGO
DEPARTMENT OF PUBLIC WORKS

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Executive Summary

The purpose of this document is to provide design guidance for parking lot developers who are interested in the strategies involved in Green Parking Lots. Green parking lots are required to treat stormwater runoff in accordance with the BMP Design Manual and the Regional Water Quality Control Board (RWQCB) Order No. R9-2013-0001. The types of facilities in a Green Parking Lot are described focused on elements that are conducive to the installation of Green Parking Lot strategies. Tree well design criteria are provided as one of the most effective strategies available for Green Parking Lots to reduce or meet permanent stormwater pollution controls. .

Section 1 Parking Lot Guidance and Criteria

Section 1.1 General

If your parking lot project consists of resurfacing existing parking lots, including slurry, overlay and restriping, then permanent storm water requirements do not apply. Refer to section 1.3 "Defining a Project" of the BMP Design Manual for more information.

Green parking lot facilities may include tree wells, dispersion areas, biofiltration, or permeable pavement.

Section 1.2 Performance Standard

Green parking lots drainage design shall comply with the most current versions of the County of San Diego Hydrology Manual and the Hydraulic Design Manual. Permanent stormwater requirements are defined by whether the parking lot project is determined to be a priority development project (PDP) or standard project. Refer to section 1.4 "Is the Project a PDP?" of the BMP Design Manual for more information.

Section 1.3 Design Guidance

Choice of green parking lots stormwater facilities should be based on the context of the surrounding development. In addition to the benefits to stormwater quality and quantity, multi-purpose design of stormwater facilities can add aesthetic value by providing varied landscaping and visually appealing pavement design. The process for selecting and designing LID facilities in a parking lot project begins with site analysis:

- Address the parking lot layout – The dimensions of the travel lanes, location of, islands, and buffer strips, and all elements related to the functionality of the parking lot will be established in the design plan.
- Identify sight distance corridors – Tree and shrub plantings should never compromise public safety.
- Choose stormwater locations and types – implement stormwater facilities that can capture and treat the runoff from impervious surfaces prior to entering the storm drain system. Consider space between curb and sidewalk, behind sidewalk, in channelized islands for vegetative practices. Consider parking stalls and walkways/sidewalks for permeable pavement. Maximize tree well locations. LID facilities should be placed to maximize volume capture. Adjacent LID and BMP facilities should be closely reviewed to ensure they will receive stormwater flow from the design storm.

Section 1.4 Green Parking Lot Facilities

Green Parking Lot Facilities shall be placed within vegetated areas of the parking lot and landscaped with a selection of plants consistent with the Water Efficient Landscape Design Manual and LID

Handbook. Possible areas for Green Parking Lots Facilities include tree well, parking stalls, islands, open areas, swales, and areas adjacent to the sidewalk.

Section 1.4.1 Types of Green Parking Lot Facilities

Tree well: Tree wells create an opportunity to direct impervious surface runoff for retention, infiltration, treatment and uptake by a tree. Parking lots have minimum spacing and location requirements based on the parking configuration, so there is an opportunity for the parking lot grading concept to take advantage of tree locations for stormwater treatment and retention.

Islands: Islands create an opportunity for dispersion areas or biofiltration, which may or may not incorporate a portion of the tree well. In most cases, islands will be designed as online facilities (designed to accommodate flows in excess of the design water quality treatment flow, such as the 10-year flow).

Planter: This type is typically a small-scale Green Parking Lot Facility, often located between the curb and sidewalk. These facilities may include tree, shrub and groundcover plantings. In most cases, planters will be designed as off-line facilities. Off-line facilities are designed to limit inflow so that overflow structures are not required (typically designed to accommodate only the design water quality treatment volume/flow). The facility may need to incorporate fencing or a barrier around the perimeter for pedestrian safety.

Swale: This facility type includes drainage channels or linear facilities adjacent to either the parking stall or the sidewalk, typically vegetated with trees, shrubs, or groundcovers. Swales may be designed to convey or retain stormwater as dispersion areas or biofiltration. Swales without curbs are on-line facilities. Vegetation within the swale should be sufficient to visually depict the slope and depression within the swale.

Section 1.4.2 Green Parking Lot Facilities Cross Section

Materials used in the various Green Parking Lot Facilities shall be in accordance with the Green Streets Specifications (Appendix K.2.6). Green Parking Lot Facilities shall be designed per the Green Street Standard Drawings (Appendix K.2.4).

Impermeable PVC liners are required in Green Parking Lot Facilities as follows:

- Facilities within 10 feet of a structure (e.g. an existing building) shall be lined on the side adjacent to the structure.
- Facilities within 5 feet of the parking lot face of curb shall be lined on the side adjacent to the parking lot.
- In areas where infiltration is not permitted facilities shall be lined on all sides and subsurface drainage is required.

Section 1.4.3 Allowable Ponding Depths

Allowable ponding depth in Green Parking Lot Facilities shall be selected based on the adjacent land use, and the associated need for barriers around the facilities.

- The maximum allowed ponding depth in Green Parking Lot Facilities is 18 inches.
- Green Parking Lot Facilities in high-volume pedestrian and residential areas will typically have a 6 inch maximum ponding depth. The ponding depth may vary based on slope conditions.

Section 1.4.4 Subsurface Drainage

- A minimum of one clean-out is required for basins and islands, and shall be shown on design plans. For other Green Parking Lot facilities, a clean-out shall be provided within 10 feet of the underdrain connection to the catch basin or manhole.
- Connect underdrains to catch basins, manholes, or direct connect to storm sewer pipe. Connection to catch basin is generally the most cost effective option. When directly connected to the storm drain, place a backflow preventer valve on the underdrain connection.
- For Green Parking Lot Facilities without underdrains, observation wells are required and shall be shown on the design plans. The maximum spacing of observation wells shall be 100 feet.
- Use curb openings with depressed gutters to convey runoff to Green Parking Lot Facilities adjacent to curbed areas. Space the openings to deliver the design capture volume to the facility:

  - Convert the flow associated with the design capture volume for which the BMP is being designed into peak discharge.

  - Space the curb opening to achieve 100-percent interception of the DCV. Multiple curb openings can be used for each facility to deliver the required volume.

- Curb cuts across sidewalks require trench covers.
- Check dams in Green Parking Lot Facilities may be necessary to allow ponding volume, achieve the storage volume, to slow velocities, or both. Check dams will be placed in sloped facilities at intervals to maintain ponding depth and facility depth within allowable limits.
- Pre-treatment devices are required to trap coarse sediment and dissipate energy. Applicable choices include:

  - Green Parking Lot Facilities in Open Area: or Vegetated filter strip.

  - Islands: Splash pad as depicted in standard drawings.

  - Planters: /Splash pad adjacent to curb cut. Overflow devices are required for online facilities and for off-line facilities where the lowest adjacent top of curb or sidewalk is equal to or lower than the inflow point elevation. Typical overflow devices include outflow curb openings to gutter, and overflow structures. Size overflow devices for online Green Parking Lot Facilities to convey the 10 year storm. For online facilities, provide a minimum of 3-inches of freeboard from overflow structure to overtopping elevation.

- Side slopes of swales shall be designed to prevent erosion based on anticipated stormwater flow rates. Temporary soil stabilization and erosion control measures shall be used to stabilize soils until plant materials have been established.

Section 1.4.5 Safety and Access

- Edge conditions around green parking lot facilities adjacent to pedestrian areas may be sloped or with a vertical drop.

  - Railings are required around Green Parking Lot Facilities with a vertical drop adjacent to sidewalks in high-volume pedestrian areas.

    - Top of railing shall be 18" above sidewalk, with vertical and/or horizontal member spacing which meets ADA detection requirements for visually impaired pedestrians.

  - Green Parking Lot Facilities with a vertical drop adjacent to sidewalks in low-volume pedestrian areas must be surrounded by a minimum 4 inch high curb.

  - Green Parking Lot Facilities with a vertical drop must have a minimum 4-inch curb or railing between the parking step out zone and the drop.

  - Green Parking Lot Facilities with a sloped side must provide a flat (5% maximum slope) 6-inch minimum width buffer of different material to meet flush with adjacent sidewalk. Green Parking Lot Facilities with a depth greater than 3-feet must provide a flat (5% maximum slope) 24-inch minimum width buffer. When sides are sloped, the finished grade must be stabilized with plants, sod, seed, mulch, or stone.

  - Green Parking Lot Facilities adjacent to a designed shared use path (bicycle facilities) must provide a 5% maximum slope, 24-inch width buffer of different material to meet flush with adjacent path. A sloped side with maximum 3:1 slope and maximum 5-foot depth or 12-inch maximum drop is allowed. If either of those conditions is exceeded, a 42-inch height guard is required.

- Green Parking Lot Facilities with sloped sides with a total depth of more than 18 inches shall require a fence of 36-inch height enclosing the entire facility.
- Green Parking Lot Facilities with a greater than 18" vertical drop require a 42" railing meeting International Building Code 1013 (Guards).
- Access is required to all Green Parking Lot Facility areas for maintenance. Within the facility area, the overflow structure must be accessible to maintenance crews.

Section 1.4.6 Limitations

- A vertical separation of 10 feet is required between the bottom of Green Parking Lot Facilities proposing infiltration and the top of the seasonally high groundwater table.
- Green Parking Lot Facilities with infiltration are not allowed in areas with contaminated soil or groundwater.

Section 1.4.7 Permeable Pavement Facilities

The types of permeable pavement facilities and appropriate uses are tabulated below. Types subjected to vehicular traffic loads include permeable asphalt, pervious concrete, and permeable interlocking

concrete pavers. Other types not subjected to traffic loads, may be allowed on a project by project basis. Designs which differ from the table below may be allowed with approval by the Director.

Permeable Pavement Type	**Appropriate Uses**
Permeable Interlocking Concrete Pavers	Parking Spaces Sidewalks
Pervious Concrete	
Porous Asphalt	
Decomposed Granite	Walkways and trails
Porous Rubber	Tree covers

Section 1.4.7.1 Contributing Drainage Area

Stormwater runoff from pervious areas often contribute sediment and lead to clogging and increased maintenance requirements for pervious pavement, and should be avoided to the extent possible. Ideally, at least 90-percent of the area draining to pervious pavement shall be impervious, not including the permeable pavement area itself. Pretreatment, drainage area stabilization, and specific maintenance program are options that the County will consider for implementation where contributing drainage area is less than 90-percent impervious.

Section 1.4.7.2 Permeable Pavement Base Design

<u>All Permeable Pavement Systems:</u>

- The wearing surface is the pavement material plus any required bedding layers under the surface and inside of the joints, in accordance with all applicable standard details, specifications and manufacturer recommendations as applicable. The wearing surface shall meet the latest ADA requirements.

Section 1.4.7.3 Stormwater Conveyance and Retention

Stormwater conveyance from all impervious areas including standard pavement shall, to the extent feasible, drain to permeable pavement as sheet flow. Otherwise pre-treatment for energy dissipation and sediment control may be required where any concentrated flow is directed onto pervious pavement. Level spreaders may be designed to convert concentrated flow to sheet flow into the pervious pavement facility.

<u>Reservoir and Underdrain - Sizing for Retention Volume</u>

The volume of storage for permeable pavements systems shall be designed to meet the regulatory requirements promulgated by County. Storage design shall meet the following:

- Subsurface drainage will consist of a minimum 6-inch diameter perforated underdrain in the reservoir layer or a separate layer of open graded stone below the reservoir layer. Subsurface drainage is recommended beneath all vehicular use permeable pavement installations unless elimination of the underdrain is expressly approved by the Director. Permeable pavement may be installed in areas with no traffic volume without underdrains if infiltration results are good and underdrain connections are not feasible.
- For sites where native soil design infiltration rate sufficient to drain the volume below the underdrain within 72 hours, the subsurface pipes may be elevated to provide infiltration sumps of reservoir stone. Use of a raised underdrain is encouraged and provides enhanced retention. An alternative approach to a raised underdrain is an underdrain with an up-turned elbow outlet.
- For designs with a waterproof membrane on the bottom as required in the Geotextiles and Liners section, the minimum slope of the subsurface drainage pipes is 2-percent and shall match the bottom (invert) slope of the facility.
- For designs without a waterproof membrane, the minimum slope of subsurface drainage pipes shall be 0.5-percent.
- Clean-outs are required for all underdrained permeable pavement facilities. Clean-outs shall be spaced at 100 foot maximum intervals. Where a storm drain structure such as catch basin, manhole, or overflow structure is within 100 feet of a clean-out, it will serve the same function as a clean-out.
- Observation wells are required for facilities without underdrain and shall be shown on design plans. Observation wells shall be spaced at 100 foot maximum intervals.
- Drawdown time for shall be 24 hours minimum and 96 hours maximum. Drawdown time is calculated based on infiltration rate of native soils at the invert of the facility, and the flow through underdrains.
- The reservoir will be sized so that the runoff associated with the 2 year, 24 hour frequency storm does not surcharge the wearing surface at the low end of the facility.
- Overflow conveyance for higher storms shall be designed to surface convey into existing or new storm sewer systems adjacent to the permeable pavement.

To achieve the design volume, the profile of the pavement shall be designed in one of the following scenarios, which shall be selected based on topography of the site, location of utilities and other underground features, project budget, and any other constraints related to specific site:

- Use of a continuous bottom slope less than or equal to 2-percent.
- Use of a terraced invert, with the slope between steps less than or equal to 2-percent. Vertical drop of terraced invert shall generally be 6-inches to 12-inches, but can vary to achieve design requirements.
- Use of check dams with variable bottom slope, located so that the 2 year, 24 hour runoff volume does not surcharge the low end of the wearing course Check dam material options include waterproof membrane, PVC sheeting, acrylic sheeting, and concrete. Use of membranes and sheeting are the most cost effective and generally preferred options. A transverse underdrain

may be needed in check dam systems if the base of a step does not slope to the longitudinal underdrain or if needed due to the width of the permeable pavement system.

Section 1.4.7.4 Pavement Structural Design

For pavements subjected to vehicle traffic loading, pavement design calculations shall be required. Pavement design may result modifications to the pavement cross section in the County approved standard drawings to meet or exceed the pavement strength requirements.

Caltrans methods for rigid pavement design shall be used for permeable concrete. Caltrans methods for flexible pavement design shall be used for pervious asphalt. Caltrans methods for flexible pavement design, with appropriate layer coefficients as applicable to the interlocking, shape, and thickness of the pavers, shall be used for interlocking permeable unit pavers. Guidance for layer coefficients is provided by the Interlocking Concrete Pavers Institute.

Testing of the bearing capacity for underlying soils shall be required for all permeable pavements for vehicular use, shall be site specific, and shall be in accordance with ASTM D4429-09a, Standard Test for California Bearing Capacity of Soils in Place. Other considerations for the pavement design include:

- Edge restraints shall be used for all permeable unit pavers. Edge restraints may also be used for permeable asphalt and permeable concrete as necessary.
- In soft soils with low bearing capacity where infiltration is planned, geo-grid as the preferred option over removal of the material and placement/compaction of select backfill.

Section 1.4.7.5 Limitations

- Permeable pavements are not to be used in the traveled way.
- A 10-foot vertical separation is required between the bottom of the permeable pavement system and the top of the groundwater table.
- Permeable pavements with infiltration are not allowed in areas of soil or groundwater contamination.

Section 1.5 Green Parking Lots Landscape Criteria

Section 1.5.1 Tree Well Design

Surrounding soils shall comply with the design requirements noted below.

Section 1.5.1.1 Minimum Soil Volumes

The following are the minimum allowable soil volumes for tree rooting:

a. 2 cubic feet of soil volume shall be provided for each square foot of mature tree canopy footprint. Soil volume must be within 1.5 times the canopy radius. Soil depth shall be a minimum of 30 inches deep, preferably 36 inches deep.

b. Where soil volumes within the maximum allowable radii for adjacent trees overlap, up to 25-percent of the required soil volume per tree may be shared.

c. For trees that are designed to have a covered soil volume which connects to an open area (for example behind the sidewalk), the open area can be considered as part of the required soil volume.

d. For existing trees to remain, the root structure of existing tree shall be protected to the extent feasible and provided with additional soil volumes to meet the above requirements.

e. Soil Volume calculation shall be calculated as:

i. (Area of Open Soil x Depth of soil) plus (Area of Covered Soil x Depth of soil)

ii. All soil types are calculated at full volume.

iii. There may be multiple soil volume areas included in the calculation depending on design.

Section 1.5.1.2 Tree Planting Design in New or Reconstructed Parking Lots

- Maximized open soil area for tree planting is the most cost effective method of achieving the required soil volume.
- Open tree wells within sidewalks that have soil volume beneath pavement will be a minimum of four feet wide by six feet long. Larger areas may be required to accommodate large root balls or additional plant materials.
- Tree well planting space with continuous open areas adjacent to sidewalk may utilize mulched areas between trees, defined as “plant bed.”

Section 1.5.1.3 Tree Planting Design in Confined Spaces

- To the extent feasible, soil rooting volumes shall be expanded by creating vegetated areas adjacent to trees longitudinally, or by placing structural soils beneath pavements extending along the sidewalk or across the sidewalk.
- Other soil expansion options include reducing compaction, air spading around roots and addition of planting soil, or other methods as recommended by arborist or landscape architect.

Section 1.5.1.4 Supporting Paved Surfaces while Meeting Tree Soil Volume Requirements

In order to provide adequate soil volume for tree wells, horticulturally appropriate soils must often be placed beneath the adjacent paved surfaces. The paved surfaces require compacted soil and base materials to maintain structural integrity. Acceptable soil systems that provide structural stability, appropriate growing medium, and stormwater infiltration/retention include suspended pavements, structural cells, and several types of structural soils:

- Suspended pavements include structural slabs that span between structural supports that allow uncompacted growing soil beneath the sidewalk, and commercially available structural systems. Manufacturer details and certification must be provided for commercial systems. Structural calculations and details must be provided for Suspended Pavement installations.
- Structural cells are commercially-available structural systems placed subsurface that support the sidewalk and are filled with amended soil. Manufacturer details and certification must be provided for commercial systems. Amended soil placed within structural cells shall be a minimum of 36 inches.

- Proprietary structural soil systems, such as CU-Structural Soil™ or Stalite Structural Soil, or equivalent, may be used; however, their use may be limited in conjunction with stormwater infiltration.

Section 1.5.1.5 Tree Well Soil Types

Soil types used in the tree well, in accordance with the County's approved specifications (see Green Streets Specifications in Appendix K.2.6), are generally described as follows:

- Amended Soil: used generally in open planting beds. Soil shall be amended per fact sheet SD-F in Appendix E of the BMP Design Manual or the approved specifications.
- Biofiltration Soil Media: used in dispersion areas, biofiltration, swales, curb extensions, and beneath suspended pavements.
- Structural soil: used to support pavements and provide a growing medium for vegetation.

Section 1.5.1.6 Stormwater Retention and Treatment Volume

Tree wells with expanded soil volume can serve as a method of capturing and retaining the required volume of stormwater in accordance with County requirements. These facilities can be designed to meet the requirements of Tree Wells when surface ponding volume is provided, whether designed as an enclosed plant bed with covered soil volume, or a continuous open area (either mulched or with turf) with soil volume under the adjacent sidewalk. The tree well can function as an area for "Disconnected Impervious Surface" to capture runoff from the sidewalk.

Section 1.5.2 Structural Support

All structural elements, including pavements and curbs, must be founded over structurally stable soils. Stable buried soils should extend laterally from the point of support at a slope of 1 horizontal to 2 vertical in the downward direction. Amended soils and biofiltration soil media are not structurally stable. Acceptable soil systems include, but are not limited to, suspended pavements, structural cells, and several types of structural soils.

Section 1.5.3 Planting Guidance for Vegetated Stormwater Systems

Selection of plant species, locations, and spacing within vegetated stormwater management facilities will be based on the following parameters:

a. Light - full sun, partial shade, full shade

b. Water - Some plants will succeed in areas that are inundated with water frequently while others will only do well when they are located in the driest part of the facility

c. Salt - Plants that have a high salt tolerance are the best choice for facilities that will receive a large amount of salt-tainted runoff

d. Pollution – Generally, plants that are in areas with higher pollution will require more maintenance and care throughout their lifespan in order to remain aesthetically pleasing

e. Maintenance – Areas with low maintenance should be planted with plants that do not require intensive care. Areas that will be maintained several times a year can be planted with plants that require more attention.

f. Survivability in urban environment - All of the above factors relate to the plant's ability to survive in a green parking lot facility

g. Size – plants should be the appropriate mature size for the site. Site viewing lines, pedestrian, and vehicle safety should be considered. Plants, except tree wells, between the curb and sidewalk should be less than 18-inches high above the sidewalk level.

The designer will select the plants for the vegetated stormwater facilities that are compatible with the Water Efficient Landscape Design Manual. The list is organized in accordance with the above factors, and is grouped into three maintenance categories: low level of care, medium level of care, and high level of care.