Green Streets

Design Criteria

County of San Diego

Department of Public Works

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Table of Contents

SECTION 1 INTRODUCTION

Section 1.1 Introduction

These design criteria are for use by individuals who as a result of the land development process desire to have the County accept improvements using green infrastructure strategies into the County's system of maintained public roads.

Section 1.2 Purpose

The purpose of this document is to provide for the regulation of improvements using green infrastructure strategies to be dedicated to the public and accepted by the County as a result of the land development process. This document is intended to be add to the 2012 Public Road Standards upon its next update. The design criteria are intended to keep the operating cost of maintaining green infrastructure at a reasonable level at the same time provide for the service and protection of the public.

When these design criteria are applied to a project that meets the criteria specified in section 1.4.3 of the County of San Diego Best Management Practice (BMP) Design Manual, that project shall be deemed to be designed and constructed in accordance with the USEPA Green Streets Guidance (Managing Wet Weather with Green Infrastructure, USEPA, 2008) as long as these design criteria are as protective of water quality as the USEPA Green Streets Guidance. Green Streets projects are subject to County review and approval. Green Streets Design Criteria in this document build upon the Public Road Standards and Flexibility in County Road Design (FCRD) to provide the minimum requirements and procedures necessary to implement Green Streets design. The Green Streets Design Criteria are to be used in addition to the Public Road Standards for the County of San Diego. The Design Standard Drawings, minimum requirements, and procedures stated herein may be revised or amended from time to time, but only to the extent specified under the supplemental specifications or special provision included in a specific contract.

References by date and title shall be made to these Design Criteria with construction plans or other contract documents as notification of their application to those documents.

Section 1.3 Background

The Public Road Standards were created to provide for the regulation of right of way improvements to be dedicated to the public and accepted by the County as a result of the land development process. The Public Road Standards are intended to keep the operating cost of maintaining public facilities at a reasonable level and at the same time provide for the service and protection of the public.

Section 3.2 of the Public Road Standards states that: "Where the requirements for any subdivision major use permit, rezone, or other improvements are not covered by these Standards, such requirements shall be specified by the Planning Commission, or Board of Supervisors, or, if not so specified, by the Director."

Section 9.2 of the Public Road Standards references the FCRD document which is a companion to the Public Road Standards: "Flexibility is available in the implementation of the County Public Road Standards so that specific road designs may be developed that are more suitable for the context in which they are used."

FCRD is not intended to supersede existing County of San Diego Public Road Standards, procedures or practices, but it is a compilation of possible options that under appropriate conditions may be used to enhance established traffic engineering and design practices, policies and standards. The purpose of the FCRD is to provide additional information and guidance regarding designing County public roads that incorporate community values, provide adequate emergency access and are safe, efficient, effective mechanisms for the movement of people and goods. Additionally, FCRD encourages a comprehensive design process, involving the public and incorporating a multi-disciplinary design approach early and throughout the design process.

Furthermore, the FCRD states that: *"Implementation or construction of County road improvement projects often result in significant environmental impacts. These include impacts to sensitive environmental features such as biological habitat, structures or features of community interest, residential buildings or areas. These impacts may be avoided or reduced through the selection of alternative designs. Alternative design features may also be selected to enhance or preserve environmental or cultural resources. Design features may also be provided to reduce or filter storm water runoff to assist in achieving low impact development goals."*

SECTION 2 GENERAL DEFINITIONS

In addition to the general definitions included in the Public Road Standards, the following definitions shall be applicable to these Green Streets Design Criteria.

1. "BIOFILTRATION" facility is a shallow landscape depression designed to capture and treat stormwater runoff. The plants and soil in a biofiltration facility allow infiltration and pollutant removal. Biofiltration facilities are designed to hold water for a short period of time following a storm event. Water collected in a biofiltration facility will infiltrate, evapotranspire, or overflow as surface runoff.

2. "BIOFILTRATION SOIL MEDIA" is soil or growing media that has been formulated with specific components to allow for infiltration while supporting plant growth and minimizing the leaching of potential pollutants in the runoff. Biofiltration soil media is primarily composed of sand with smaller proportions of topsoil and compost.

3. "CHECK DAM" is a small dam constructed across a biofiltration area, dispersion area, channel, swale, etc. of storm water facilities that controls (slows) the runoff velocity, reduces erosion, promotes sediment deposition, and increases infiltration.

4. "CURB CUT" is a part of curb that has been removed to allow an unobstructed pathway from the street level and is often used to redirect water from traditional drainage ways to a Stormwater BMP.

5. "CURB EXTENSION" is a traffic calming strategy that provides a widening of the sidewalk and a narrowing of the roadway, which allows space for a biofiltration or dispersion area within the extension.

6. "DETENTION" and "RETENTION"

   6a. "DETENTION" is a technique that stormwater runoff is directed, held (detained) for a period of time into a depressed area or structure (detention basin or pond) and slowly released to a surface water body. The structure is not designed to permanently contain water. It can help improve water quality by allowing suspended solids to settle over a period of time. The temporary storage of storm runoff water also decreases downstream peak flow rates which can reduced potential flooding.

6b. “RETENTION” is a technique that holds or retains runoff water, allowing it to infiltrate, evaporate, or/and emergency overflow to be used on-site in order to reduce off-site transportation of runoff and improve water quality.

7. “DISPERSION AREA” is a vegetated area with amended soils used to reduce stormwater runoff velocity, filter out pollutants, and enhance infiltration. They are often used around the perimeter of a biofiltration basins, at the edge of a roadway, or along a stream channel. Dispersion areas may also be referred to as buffer strips or vegetated filter strips.

8. “FILTER FABRIC” is textile of relatively small mesh or pore size that is used to allow water to pass through while keeping sediment out (permeable), or prevent both runoff and sediment from passing through (impermeable).

9. “FILTRATION” and “INFILTRATION”

   9a. “FILTRATION” is the process that treats stormwater runoff by capturing and passing the water volume through a bed of sand, other soil material, or other acceptable treatment media to remove pollutants from the water. Filtering practices differ from infiltration practices in that the stormwater filters through an engineered filter media, rather than native soil. However, filtering practices can be constructed in combination with infiltration practices, where the filtered water is discharged into the ground beneath the BMP. Alternatively, filters can be designed with an underdrain to collect the treated water and convey it to discharge. Underdrained filters can be lined to isolate the filters from the adjacent soil material or underlying groundwater.

   9b. “INFILTRATION” is the process of water moving into the native soil from the soil surface to the groundwater storage.

10. “GREEN INFRASTRUCTURE is an approach to stormwater and flood management that protects, restores, and mimics the natural water cycle. Environmental benefits of green infrastructure include improved water quality, enriched habitats, reduced heat-island effect, and recharged water tables.

11. “GREEN STREET” is a street right-of-way that uses a variety of low impact development facilities to manage stormwater runoff close to its source. Green infrastructure includes the facilities that compose a green street.

12. “HIGH VOLUME PEDESTRIAN AREA” is an area with relatively high pedestrian-oriented land uses, which may include the following: Civic (government and public facility buildings), Schools, Commercial, Higher Density Residential (apartment complexes, condominiums, town homes, or detached single-family homes on small lots), Parks and Open Space (with connectivity to one of the above land use elements).

13. “IMPERVIOUS SURFACE” is any material that prevents or substantially reduces infiltration of water into the soil.

14. “LOW IMPACT DEVELOPMENT” is a stormwater management and land development strategy that emphasizes conservation and the use of on-site natural features integrated with engineered, small-scale hydrologic controls to more closely reflect pre-development hydrologic functions.

15. “LOW VOLUME PEDESTRIAN AREA” is an area with relatively low pedestrian oriented land uses such as low density housing.

16. “OFFLINE FACILITIES” are systems that provide stormwater treatment away from the flowpath of the runoff, then return the treated flow to the conveyance system.

17. “ONLINE FACILITIES” are systems that provide stormwater control within the flowpath of the runoff.

18. “PERVIOUS” refers to a soil or material that allows the passage of water or other liquid.

19. “PERMEABLE PAVEMENT” is a paving material that has sufficient interconnected voids to provide a high rate of permeability. Permeable pavement is inclusive of permeable interlocking concrete pavers, pervious concrete, porous asphalt, and porous rubber. These terms are reflective of the industry standard nomenclature.

20. “SPLASH PAD” is a stormwater flow control device designed to diffuse and decrease the velocity of the inflow water into a stormwater facility to provide erosion protection and to trap sediments and debris; splash pad is also required at outfall points of the stormwater facility.

21. “STRUCTURAL SOIL” is a designed medium which can meet or exceed pavement design and installation requirements while remaining root penetrable and supportive of tree growth, such as CU-Structural Soil^{TM}, Silva Cells, or suspended pavement

22. “TREE WELL” is the combination of a tree and soil media reservoir. Tree Wells have high pollutant removal efficiency for many pollutants of concern. Properly installed tree wells increase the survivability of trees and prevent the degradation of the functioning roots and surrounding infrastructure.

SECTION 3 GENERAL POLICY

Under the Municipal Separate Storm Sewer System (MS4) permit for San Diego Region (Permit [Order No. R9-2013-0001]), the County is allowed to make Priority Development Project (PDP) Exemptions for roadway type projects by redeveloping or retrofitting existing paved roads, streets, and alleys as "EPA Green Streets" under an adopted program by the County and based in part on the EPA publication *"Green Streets: Municipal Handbook, Managing Wet Weather with Green Infrastructure."*

The Green Streets program incorporates a wide variety of Low Impact Development (LID) design elements including, but not limited to, tree wells, dispersion areas, biofiltration, pervious pavements, and removal of unnecessary pavement. Features implemented as part of the Green Streets program are designed to meet the pollutant control requirements of Section 2.2 and Appendix 'B' of the County's BMP Design Manual, but are not necessarily designed to meet the flow control requirements of the County's Hydromodification Management Plan (HMP) and are not categorized as structural BMPs.

Section 3.1 Plans to be Approved by Director, Department of Public Works

In addition to the requirements set forth in the Public Road Standards, the Developer shall cause to be prepared by a California Registered Civil Engineer, in accordance with these Green Street design criteria, plans, profiles, specifications, and calculations for the proposed green infrastructure improvements as follows:

3.1.1 Storm Water Quality Management Plan (SWQMP)

A Storm Water Quality Management Plan shall be prepared to meet Storm Water Pollutant Control Requirements as described in Chapter 2.2 and Chapter 5 of the County BMP Design Manual.

3.1.2 Landscape and Irrigation Plans

Landscape and Irrigation plans shall comply with the most current version of the County of San Diego Water Efficient Landscape Design Manual. Plants should be selected based upon LID feature drawdown times. Only plants tolerant of saturated soil conditions should be planted in zones subject to frequent inundation. Details for planting, structural soils, biofiltration soil media shall be specified in the SWQMP and shall correlate exactly with the plan. Clear recovery zones and horizontal sight distances associated with travel lanes shall be plotted on the Landscape and Irrigation plans. Additional information for tree well design shall include:

- The type, locations and dimensions of all tree wells.

- Clearly depict the locations, dimensions, open and covered soil area, and soil volume method for each tree.

- Details shall be provided which illustrate the overall size, depth, soil composition, and drainage of the planting space.

- Calculations of soil rooting volume and maximum tree canopy supported.

3.1.3 Project Improvement Plans

Separate from the conventional plans Storm Water Management Plan set shall be included in the project improvement plans. Storm water management plans will include

- Drainage management areas

- Land uses and cover types

- Peak flow rates for Q100 design storm

Plans with the type, locations and dimensions of all stormwater management facilities with key elevations depicted as follows:

- Inflow elevation

- Outflow elevation (for online facilities)

- Invert elevation of BMP surface

- Top of ponding elevation

- Bottom of reservoir/stone layer (bottom of storage)

- If applicable, underdrain connection point with tie-in invert elevation, and

- Sections and profiles to show any steps, underdrains, and utility lines through the facility.

SECTION 4 REQUIRED PUBLIC ROAD RIGHTS-OF-WAY IMPROVEMENTS

Section 4.2 Road Cross Sections

The data specified in Tables 2A and 2B of the Public Road Standards are minimums and are subject to modification for Green Street implementation with the approval of the Director.

Section 4.3 GENERAL NOTES

A. Additional right-of-way width, beyond that specified in Tables 2A and 2B of the Public Road Standards may be required to accommodate Green Street features or improvements.

SECTION 5 REQUIRED ROAD IMPROVEMENTS

Section 5.1 Curbs and Dikes

Per approval of the Director, flush curb may also be considered for a Green Street to accommodate drainage into dispersion areas and biofiltration.

Section 5.2 SIDEWALKS

Sidewalks constructed with permeable pavement conforming to the Green Street Standard Drawings may also be considered for construction.

Section 5.4 DRIVEWAYS

Per the approval of the Director, residential and commercial driveway aprons in the public right may be constructed of permeable pavements but will remain the responsibility of the owner of the property being served.

Section 5.6 Traffic Signals, Regulatory, and Warning Signs

Signage for education and public awareness of Green Street LID facilities shall be included in the design at locations specified by the Director as part of the Green Street improvement.

Section 5.10 MEDIANS

Per approval of the Director, tree wells, permeable pavement, dispersion areas, or biofiltration may be used rather than conventional concrete median curb and gutter drainage provided the requirements of the Hydraulic Design Manual are met. Tree wells, permeable pavement, dispersion areas, and biofiltration shall conform to the Green Street Standard Drawings.

Section 5.11 Drainage Improvements

5.11.1. Green Streets Facilities

5.11.1.1 General

Green Streets facilities to be used in the public ROW may include tree wells, dispersion areas, biofiltration, or permeable pavement. Other Green Streets facilities may be used with approval by the Director.

5.11.1.2 Design Storm

Green Streets roadway drainage design shall comply with the most current versions of the County of San Diego BMP Design Manual, Hydrology Manual, and the Hydraulic Design Manual. Green Streets LID BMP facilities shall be sized to convey the 100 year storm within the public right of way.

5.11.1.3 Design Guidance

Choice of green streets stormwater facilities should be based on the context of the surrounding streetscape. In addition to the benefits to stormwater quality and quantity, multi-purpose design of stormwater facilities can add aesthetic value to the County by providing varied landscaping, visually appealing pavement design and enhanced community spaces on streets. They can also be combined with traffic calming features.

The process for selecting and designing LID facilities in a roadway project begins with site analysis:

- Address the street layout – The dimensions of the travel lanes, location of medians, islands and buffer strips, and all elements related to the functionality of the roadway will be established in the design plan.

- Identify clear recovery zones and sight distance corridors – Tree and shrub plantings should never compromise public safety. Trees with an expected mature diameter of 4" or larger at chest height shall not be planted within clear recovery zones. Sight distance through horizontal curves, at intersections, and driveways shall not contain vegetation that will obstruct sight

- Include other transportation modes – The requirements for pedestrian traffic, cyclists, mass transit, and other possible modes are incorporated into the right of way as well.

- 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 and medians for vegetative practices. Consider parking lanes, alleys, sidewalks, and other roadways 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.

5.11.1.4 Green Street Facilities

- Green Street Facilities shall be placed within vegetated areas of the public ROW and landscaped with a selection of plants consistent with the Water Efficient Landscape Design Manual and LID Handbook. Possible areas for Green Street Facilities include tree well, parking lanes, curb extensions, intersection triangles, open areas, swales, and areas adjacent to the sidewalk. Green Street Facility design shall comply with the Green Streets Guidelines and Standard Drawings.

5.11.1.4.1 Types of Green Street Facilities

- Tree well: This type of facility is a tree planted to intercept rainfall and runoff to be used as a stormwater management measure. It is designed to provide water quality benefits beyond those typically associated with trees, such as energy conservation, air quality improvement, and aesthetic enhancement.

- Dispersion Area with Amended Soil: This type of facility is generally routing runoff from impervious surfaces within the right-of-way to vegetated areas with amended soil to increase the amount of retention and infiltration. The intent is to slow runoff discharges, and reduce volumes. Dispersion with partial or full infiltration results in significant volume reduction by means of infiltration and evapotranspiration.

- Biofiltration: This type of facility is a vegetated shallow basin filled with treatment media and drainage rock that treat storm water runoff by capturing and detaining inflows prior to controlled release through minimal incidental infiltration, evapotranspiration, or discharge via underdrain or surface outlet structure. Treatment is achieved through filtration, sedimentation, sorption, biochemical processes and/or vegetative uptake. The facility may need to incorporate fencing or a barrier around the perimeter for pedestrian safety. Refer to Section 5.11.1.5.6 for more information on safety and access.

- Permeable Pavement: This facility type is pavement that allows for percolation through void spaces in the pavement surface into subsurface layers. Permeable pavements reduce runoff volumes and rates and can provide pollutant control via infiltration, filtration, sorption, sedimentation, and biodegradation processes.

5.11.1.5.2 Green Street Facilities Cross Section

Materials used in the various Green Street Facilities shall be in accordance with the Green Streets Specifications. Green Street Facilities shall be designed per the Green Street Standard Drawings.

Impermeable PVC liners are required in Green Street 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 roadway face of curb shall be lined on the side adjacent to the roadway.

- In areas where infiltration is not permitted facilities shall be lined on all sides and subsurface drainage is required.

5.11.1.5.3 Allowable Ponding Depths

Allowable ponding depth in Green Street Facilities shall be selected based on the adjacent land use, and the associated need for barriers around the facilities as described in Section 5.11.1.5.6 on Safety & Access.

- The maximum allowed ponding depth in Green Street Facilities is 18 inches.

- Green Street 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.

5.11.1.5.4 Subsurface Drainage

- A minimum of one clean-out is required for basins and curb extensions, and shall be shown on design plans. For other Green Street 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 Street 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 Street Facilities adjacent curbed roadways. 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 Street 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 Street Facilities in Open Area: Splash pad or vegetated filter strip.

    - Curb Extensions: Splash pad as depicted in standard drawings.

    - Streetscape 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 Street Facilities to convey the 10 year storm. Where in the roadway, the overflow device shall be sized to meet the roadway drainage requirements listed din Section 2.2.1 of the Hydraulic Design Manual. For online facilities, provide a minimum of 3-inches of freeboard from overflow structure to overtopping elevation.

- Side slopes of the LID facilities 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.

5.11.1.5.5 Safety and Access

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

    - Railings are required around Green Street 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 Street Facilities with a vertical drop adjacent to sidewalks in low-volume pedestrian areas must be surrounded by a minimum 4 inch high curb.

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

    - Green Street 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 Street 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 Street 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.

- Pedestrian crossings of continuous Green Street Facilities adjacent to curb are required as below.

    - One 4' wide paved crossing between each tree well and 35 foot maximum spacing in high-volume pedestrian areas

    - One 4' wide crossing every other tree and 70 foot maximum spacing in other areas consistent with surrounding area (paved, vegetated, or mulched).

- Parking step out zone of a width between 18” and 36”, (measured from face of curb) is required for Green Street Facilities adjacent to parking lanes. When placing and designing Green Street Facilities adjacent to travel ways, check for clear zone and traffic barrier needs. Adjust design to avoid use of traffic barriers whenever possible. The curb serves as a barrier for vehicle safety on most County streets. On streets without curb, provide a concrete header between the road and Green Street Facilities, with maximum 10:1 side slope beyond the header to a maximum drop of 18 inches.

- Green Street 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 Street Facilities with a greater than 18” vertical drop require a 42” railing meeting International Building Code 1013 (Guards).

- Access is required to all Green Street Facility areas for maintenance. For facilities off the road, an access road may be needed. For facilities on high speed roads, ensure safe access via a shoulder or designated area. Within the facility area, the overflow structure must be accessible to maintenance crews.

5.11.1.5.6 Limitations

- A vertical separation of 10 feet is required between the bottom of Green Street Facilities proposing infiltration and the top of the seasonally high groundwater table.

- Green Street Facilities with infiltration are not allowed in areas with contaminated soil or groundwater.

5.11.1.6 Permeable Pavement

Permeable pavement is being demonstrated for suitability and durability in the County ROW. Permeable pavement may be proposed for use in place of impervious surfaces, in appropriate locations. The Director must approve any use of permeable pavement at specific locations in County roadways, alleys, and trails.

5.11.1.6.1 Types of 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	Shoulders Parking Spaces Sidewalks
Pervious Concrete	
Pervious Asphalt	
Stabilized Decomposed Granite	Walkways and trails
Pervious Rubber	Tree well covers

5.11.1.6.2 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.

5.11.1.6.3 Permeable Pavement Base Design

All Permeable Pavement Systems:

- 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.

5.11.1.6.4 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.

Reservoir and Underdrain - Sizing for Retention Volume

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.

5.11.1.6.5 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.

5.11.1.6.6 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 6 DESIGN PRINCIPLES

All Green Streets facilities shall comply with the most current version of the County of San Diego Hydraulic Design Manual

Section 6.4 Pavement and Structural Section

6.4.1 Green Street Surfacing

Per approval of the Director, permeable pavement roadway may only be used in medians, shoulders and parking lanes if deemed appropriate for use immediately adjacent to a standard structural section. The permeable pavement facility can be designed to provide an adequate drainage system. Overflows and storm drain lines may still be required. The permeable pavement shall conform to the Green Street Standard Drawings.

Section 6.6 Utility Placement

Potential conflicts between Green Streets LID/BMP facilities and utilities within the street and parkway will need to be addressed during the early design phases of the project and may require flexibility in the design to accommodate utility locations and access.

6.6.1 Utility Clearances at LID Facilities

Utilities are allowed to co-locate in LID facilities subject to acceptance by the utility owner. Individual projects should be coordinated with the utility owners for specific requirements. Current guidelines for clearances of utilities are as follows:

6.6.1.1 Communications/Power

a. Offsets to communications, power and Gas facilities must be coordinated with the utility company on a project by project basis.

6.6.1.2 Gas

a. For gas lines within 6 inches of LID facilities, the contractor must install a protective shield around the pipe. The shield must be made of fiberglass reinforced plastic (FRP), or other approved insulating material, in either a 12-inch by 12-inch flat-tie plate or clip-on configuration. The shield must be placed over the gas pipe and secured in place to provide adequate protection.

b. For gas lines that are less than 6-inches from the LID facility or within the LID facility, the

contractor must install a combination of a protective shield and sleeve. The protective sleeve must consist of either a gray PVC semi-circular sleeve, which comes in 60-inch lengths, or a larger plastic pipe. This protective sleeve must be installed over the gas pipe so that the protective sleeve extends at least 9-inches on either side of the area in conflict. The shield shall meet requirements described above.

c. Maintain a minimum of 12-inches separation from underdrains to gas facility.

d. Four (4) foot minimum clearance is required between the top of gas facilities and finished road surface grade.

e. Three (3) foot minimum cover is required over gas facilities in open drainage or road ditches.

6.6.1.3 Water and Sewer

a. A minimum of 12-inches of cover is required between bottom of LID facilities and water main, sewer main, or sewer lateral.

b. When less than 5 feet vertical clearance is provided between bottom of LID facility and sanitary sewer main, an impermeable liner shall be used at the bottom of the LID facility to a horizontal distance at least 3 feet beyond the sewer main.

c. Water service laterals my run through LID facilities. Impermeable liners must be properly sealed where penetrated by water service laterals.

d. Concrete collars shall be provided around surface structures within LID facilities (cleanouts, valve boxes, etc.). Top of collar shall be above ponding depth in LID facilities.

6.6.1.4 Street Lights

a. Street light conduits and poles can run through LID facilities.

b. The designer shall ensure that installation of shrubs or plants do not block access to openings of the transformer base. Access to transformer bases can face either the roadway or towards the sidewalk.

6.6.1.5 Fire Hydrants

a. On sidewalk side, 3 feet minimum clearance must be provided around hydrants.

b. On street side, clearance must be provided for 10 feet in each direction longitudinally along the street, and 4 feet into the street to create a 4 feet by 20 feet access area. This access area may be paved with permeable pavement capable of supporting fire equipment.

Section 6.7 DRIVEWAYS

Curb openings shall be allowed where drainage is conveyed to LID facilities or other Green Infrastructure.

Section 6.9 Green Streets Landscape Design Criteria

6.9.1 Tree Well Design

Tree wells shall be selected from approved lists, and placed in appropriate locations within the public ROW out of the Clear Recovery Zone and lines of sight. Surrounding soils, including nearby soils under sidewalks shall comply with the design requirements noted below.

6.9.1.1 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.

6.9.1.2 Tree Planting Design in New or Reconstructed Streetscapes

- 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."

- The size of the open tree well planting area is influenced by the site as follows:

    - For narrow public space areas, the open tree well will typically be covered by a tree well grate, with a goal of providing additional paved surface for pedestrian usage.

    - For wider public space areas, the open tree well can be continuous, with pedestrian crossings.

6.9.1.3 Tree Planting Design in Confined Spaces

Reductions in tree well planting space and soil volumes must be justified by physical constraints and approved by the Director.

- Open tree well planting space within existing sidewalk areas that do not have soil volume beneath pavement will be a minimum of four feet wide by six feet long.

- 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.

6.9.1.4 Meeting Tree Soil Volume Requirements where Structural Stability is needed

In order to provide adequate soil volume for tree wells, horticulturally appropriate soils must often be placed beneath the adjacent paved surfaces. Acceptable soil systems 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-StructuralSoil™ or Stalite Structural Soil, or equivalent, may be used however; there use may be limited in conjunction with stormwater infiltration.

- Stalite Structural Soil is a proprietary product consisting of lightweight aggregate with a horticultural application.

6.9.1.5 Tree Well Soil Volume Cross Section

Soil Types

Soil types used in the tree well, in accordance with the County's approved specification, are generally described as follows:

- Amended Soil: used for the top 12 inches of dispersion areas.

- Biofiltration soil media: used in biofiltration basins, dispersion areas, tree wells, and beneath suspended pavements.

- Structural soil systems: used to support pavements and allow healthy root growth.

6.9.1.6 Stormwater Retention and Treatment Volume

Tree wells with expanded soil volume will serve as a method of capturing and retaining the required volume of stormwater in accordance with County requirements. These facilities can be designed in the various configurations as shown in Standard Drawings series GS-1.0 through GS-1.9. The tree well can function reduce the treatment volume of runoff or fulfill the entire treatment requirement.

6.9.2 Access and Safety Barriers

- Pedestrian crossings of continuous open planting strips adjacent to curb are required as below.

- 4 foot paved area between each tree in high-volume pedestrian areas

- Alternating every other tree in other areas, with surface material appropriate to surrounding area (paved, vegetated, or mulch).

- Parking egress strip of an 18-inch minimum width (measured from face of curb) may be provided adjacent to curb in street parking zones where total public space width is at least 10 feet between face of curb and back of sidewalk, using the remaining space available after deducting the required sidewalk width and minimum open tree well dimension requirements.

- Ornamental fencing meeting County requirements may be required around open tree planting space to protect planting soil from pedestrian foot traffic.

- Bike racks may be combined with ornamental fencing around open tree planting space. Type of rack to be selected in coordination with the Department of Public Works.

6.9.3 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 soil and biofiltration soil media are not structurally stable. Acceptable soil systems include suspended pavements, structural cells, and several types of structural soils.

6.9.4 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 street 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. Trees located within the clear recovery zone shall have a mature diameter less than 4" at breast height.

The designer will select the plants for the LID 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.

SECTION 9 EXCEPTIONS

Section 9.1 Exception Processing Procedures

Green Street facilities should allow for fire vehicle access such that an exception request for roadway width or median width is not required due to Fire Authority approval.

Section 9.2 Flexibility in County Road Design

Design guidelines for considering and implementing design flexibilities that allow variations for environmental constraints are included within these Green Street Design Criteria.